Survival Tricks for Living under Deep-Sea Pressure

Any life capable of surviving and thriving in areas below 6,000 meters in the deep sea, the so-called hadal zone, must be marvelous and ought to be unique in some certain ways. This also speaks for a small hadal snailfish (*Pseudoliparis swirei*) that lives about 7,000 meters down in the Mariana Trench. Its survival tricks, however, seem quite plain: Be soft and make sure you have a hole in the skull.

Common fish or other vertebrates could not withstand the enormous pressure that prevails in the deep sea, because this requires special adjustments. Otherwise, their gas-filled cavities such as skull, lungs and bones would be simply crushed upon hadal pressure; while the cell membrane and proteins will be deformed and loss their proper functions at great depth. How the hadal snailfish adjust itself to survive and thrive in the extreme environments and which genes are responsible for such adjustments remained unknown to researchers until recently when a research report appeared on the 15 April issue of *Nature Ecology & Evolution*. The new finding, which not only reveals the distinctive external traits that enable the hadal fish's deep-sea adaptation, but also sheds light on its intrinsic genetic adjustments that lead to such successful adaptation, has been made by a joint team from the CAS Institute of Deep Sea Science and Engineering, the CAS Institute of Hydrobiology, and the Northwestern

A transparent snailfish (*Pseudoliparis swirei*) has soft bones and a non-closed skull that help it survive the immense pressure deep down in the Mariana Trench. (Credit: HE Shunping, CAS)

Polytechnical University.

The hadal snailfish specimens were caught at a depth of about seven kilometers down in the Mariana Trench using the deep-sea landers *Tianya* and *Haijiao*, operated from the *RV Tan Suo Yi Hao*. A morphologic comparison with its relatives at higher elevations reveals that a skeleton made of cartilage (soft bone) and an incompletely closed skull are two distinctive traits for the hadal fish. Consistently, genomic comparative analysis reveals a gene related to cartilage calcification is mutated in the hadal fish. This genetic adjustment not only causes the hadal fish's skeleton to be soft and thin, but also leaves holes in the hadal fish's skull. The non-closed skull could bypass the risk of being crushed under immense hydrostatic pressure.

The hadal fish also makes other adjustments to ensure its cell membrane and proteins function properly under the extreme pressure. For example, it expands the genes involved in the biosynthesis of fatty acids, especially the unsaturated ones, such as docosahexaenoic acid (DHA) that acts to maintain cell membrane's fluidity under immense pressure. Otherwise, cell membrane would become rigid and impenetrable, which is fatal. Besides, critical mutations were also found in genes, whose products act to prevent proteins from folding incorrectly under ultra-huge pressure. In particular, small organic solutes, working as a protein stabilizer against extreme hydrostatic pressure, were highly abundant within cells of hadal snailfish.

"These captured (snailfish) specimens died quickly after they were out of their native hadal niche. The ascending process alone could be fatal for most of the deep-sea creatures, unless they are brought up in a special pressurized tank," says WANG Kun, the first co-author of this research.

So, this hadal snailfish sets a good example of how to adjust oneself to survive and thrive in the hostile deep-sea environments. However, it remains to be explored whether the fish's adaptive strategy is shared among other hadal creatures. If not, what are their secrets to live under immense pressures?

(By YAN Fusheng)

References:

Kun Wang *et al.*, Morphology and Genome of a Snailfish from the Mariana Trench Provide Insights into Deep-Sea Adaptation. *Nature Ecology & Evolution* 3, 823 (Published: April 15, 2019). doi: 10.1038/s41559-019-0864-8.