Skeleton formation in young corals documented for first time in multidisciplinary study

June 25 2018

Prof. Gil Goobes, of the Department of Chemistry, standing by an 11.74 Tesla Bruker Avance III Spectrometer used for the solid state NMR experiments that were performed in the study. Credit: Bar-Ilan University

The skeleton formed by a coral plays a key role in the storage of atmospheric carbon dioxide. Previous studies have focused on the process by which adult corals produce minerals that harden existing tissues to form the skeleton, but the exact stage at which corals initiate the entire mineralization process has remained a mystery—until now.

For the first time researchers have identified the biological process of mineralization that occurs in a young coral that shifts from the plankton (swimming) stage to the "settled" stage in which it forms the skeleton from minerals that protect its colony. The discovery is important for understanding the process of coral reef formation and protecting marine creatures from the ecological damage associated with global warming. It also carries implications for new biotechnological developments using coral extractions to regenerate and reconstruct human bones.

The research was conducted by Prof. Gil Goobes, of the Department of Chemistry at Bar-Ilan University, Dr. Tali Mass, of the Leon H. Charney School of Marine Sciences at the University of Haifa, and Dr. Anat Akiva and Dr. Iddo Pinkas, of the Weizmann Institute of Science in Israel. Their findings were recently published in *Nature Communications*.

Corals begin their lives as plankton polyp which "swim" freely in the sea. At some point the polyp moves into a "settled" stage in which the formation of the skeleton begins. This is a process in which the polyp secretes calcium carbonate very rapidly in order to form and protect the reef colony. Proper development of polyps to the settled stage is crucial for the proper development of coral reefs.

In the current study the researchers examined the biological process that occurs throughout these two stages. For this purpose, they applied a multidisciplinary approach using advanced electron microscopy, micro-Raman spectroscopy, and nuclear magnetic resonance (NMR) spectroscopy techniques for the first time to test the internal processes

involved in skeleton production.

The researchers analyzed gene expression in both the swimming and the settled stages and saw the maturation of minerals. Through gene analysis they were able to determine that different proteins had been generated.

They found that specific genes activate glutamate-rich proteins in the first (swimming) phase, but as soon as the polyp settles and rapidly begins to secrete calcium carbonate, different genes activate aspartate-rich proteins. "Using NMR we've shown the presence of glutamate-rich proteins within the immature calcium carbonate mineral material and proteins rich in aspartate within the crystalline calcium carbonate of the skeleton, says Prof. Goobes. "In other words, we have demonstrated the relationship between genetic information and regulation activity performed by proteins. The immediate significance of these findings is in understanding the process of coral reef formation and in conserving marine creatures from the ecological damage associated with climate change."

Knowing exactly which proteins are used to accelerate mineral growth in corals has important bearings for understanding what accelerates bone growth in humans, as many of the coral skeletal proteins bear striking similarity to bone proteins in humans. Understanding the biological process is also an essential step in mimicking and adapting it to humans in terms of healing fractures or even treating deeper skeletal and spinal problems. "In this study we have discovered how skeletal growth can be regulated. This will advance the development of new, bio-technological techniques for bone transplants in the human body. Although we are a long way from understanding the mechanism by which humans form a skeleton, the present study is an important step in identifying the genes and proteins responsible for this process," conclude Dr. Mass and Prof. Goobes.

More information: Anat Akiva et al, Minerals in the pre-settled coral Stylophora pistillata crystallize via protein and ion changes, *Nature Communications* (2018). DOI: 10.1038/s41467-018-04285-7

Provided by Bar-Ilan University