# Scientists discover first multicellular life that doesn't need oxygen

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Light microscopy image of the undescribed species of Spinoloricus, stained with Rose Bengal. The scale bar is 50 micrometers. Image credit: Danovaro, et al.

(PhysOrg.com) -- Oxygen may not be the staple of modern complex life that scientists once thought. Until now, the only life forms known to live exclusively in anoxic conditions were viruses, bacteria and Archaea. But in a new study, scientists have discovered three new multicellular marine species that appear to have never lived in aerobic conditions, and never metabolized oxygen.

The discovery of the new species, which live buried in sediment under the Mediterranean seafloor, is significant in that it marks the first observation of multicellular organisms, or metazoans, that spend their entire lifecycle under permanently anoxic conditions. A few metazoans have been known to tolerate anoxic conditions, but only for limited periods of time.

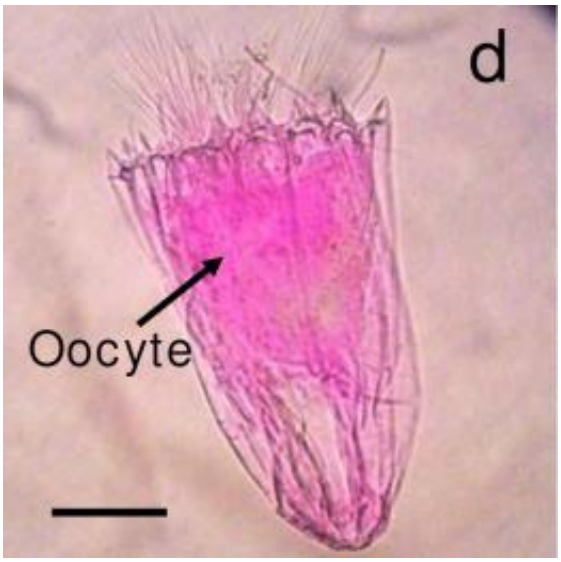
The team of Italian and Danish researchers, Roberto Danovaro, et al., that discovered the new life forms has identified the creatures as belonging to the animal phylum Loricifera, the most recently described animal phylum. Loriciferans, which have a length of less than one millimeter, typically live in sediment. The three new organisms belong to different genera (Spinoloricus, Rugiloricus, and Pliciloricus), although their species have not yet been named.

Despite belonging to previously known taxonomic groups, the new species possess some radical differences compared with other metazoans. Most significantly, the new species do not have mitochondria, the cellular organelles that use oxygen and sugar to generate the cell's energy. Instead, the new loriciferans have organelles that resemble hydrogenosomes, which are used by some single-celled eukaryotes to generate energy without oxygen. However, this is the first time that these organelles have been observed in multicellular organisms. Previous research has indicated that hydrogenosomes may have evolved from mitochondria, while other research suggests they evolved independently.

To find the new species, the researchers carried out three oceanographic expeditions from 1998 to 2008 to search for life in the extreme environments located more than 3,000 meters (about two miles) under the Mediterranean Sea. The researchers focused on an area called the L'Atalante basin, which is located off the southern coast of Greece. As the scientists explain, this type of "deep hypersaline anoxic basin" was

created by the flooding of mineral sediments from 5.5 million years ago. For the past 50,000 years, the basin has possessed a dense hypersaline brine layer up to 60 meters thick. The brine serves as a physical barrier that prohibits oxygen exchange between the water and sediment, making the basin completely oxygen-free. In addition, the basin is rich in methane and hydrogen sulphide, and is also home to a diverse assembly of prokaryotes that have adapted to these conditions.

Because previous studies have reported the presence of cadaverous metazoans that had sunk to anoxic deep-sea sediments in the Black Sea, the researchers here stained the newly collected specimens with Rose Bengal, a protein binding stain that colors living organisms with a much greater intensity than deceased organisms, demonstrating that the new species were indeed alive. In addition, the scientists observed specimens of the undescribed species of both genera Spinoloricus and Rugiloricus that had a large oocyte in their ovary, which showed a nucleus containing a nucleolus, providing evidence of reproduction.




LM image of the undescribed species of Spinoloricus stained with Rose Bengal showing the presence of an oocyte. Image credit: Roberto Danovaro.

"The results reported here support the hypothesis that the loriciferans inhabiting the anoxic sediments of the L'Atalante basin have developed an obligate anaerobic metabolism and specific adaptations to live without oxygen," the researchers conclude. "Although the evolutionary/adaptative mechanisms leading to the colonization of such extreme environments by these metazoans remain an enigma, this discovery opens new perspectives for the study of metazoan life in habitats lacking molecular oxygen."

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**More information:** Roberto Danovaro, et al. "The first metazoa living in permanently anoxic conditions." *BMC Biology* 2010, 8:30 doi:10.1186/1741-7007-8-30