MICROBIAL ECOLOGY

Day-glow coral

The daytime orange glow of Caribbean coral is due to a symbiotic relationship with cyanobacteria, according to a report in *Science*.

Corals are known to require a symbiotic relationship with endosymbiotic dinoflagellates (zooxanthellae), which provide the coral with a source of carbon in the form of glycerol, but now it seems that a cyanobacterium is also involved in a 'three-way' symbiosis.

Michael Lesser and co-workers studied the Caribbean coral *Montastraea cavernosa*, which fluoresces orange during the day. *In vivo* excitation/emission spectra of the coral were found to be characteristic of absorption by the cyanobacterial protein phycoerythrin (a phycobilin protein that acts as a light-harvesting device in cyanobacterial photosynthesis), and the presence of this protein was confirmed by immunoblots of coral homogenates that were positive for the β-polypeptide of phycoerythrin.

The authors then used epifluorescent microscopy to identify many small orange-fluorescing cyanobacterial cells, and transmission electron microscopy showed that these cells are present in the epithelial cells of *M. cavernosa*. Furthermore, immunogold staining was used to demonstrate the presence of phycoerythrin in these cells, and 16S rDNA analysis identified a sequence characteristic of cyanobacteria, all of which point to the presence of cyanobacteria within the coral.

Life-time analyses of the fluorescence indicate that the phycoerythrin of these cyanobacteria is uncoupled from their primary photosynthetic apparatus. Phycoerythrin has been proposed to function as a storage pool for nitrogen in some cyanobacteria and, in attempts to determine whether these cyanobacteria provide a source of nitrogen for the coral, the authors used a polyclonal antibody to the 32-kDa subunit of the nitrogen-fixing enzyme nitrogenase, which gave a strong positive cross-reaction, showing that the nitrogenase enzyme is expressed in the coral.

Interestingly, detachment of phycoerythrin from the photosynthetic apparatus can be caused by glycerol — produced by the zooxanthellae. Taken together, these data indicate the existence of a three-way symbiosis in which corals, zooxanthellae and nitrogen-fixing cyanobacteria all have important roles.

Corals are found in nutrient-poor waters, so an important question in coral biology is how do they obtain nutrients, specifically nitrogen? The discovery of a 'three-way' symbiosis in this coral might provide the answer.

Jane Saunders

References and links

ORIGINAL RESEARCH PAPER Lesser, M. P. *et al*. Discovery of symbiotic nitrogen-fixing cyanobacteria in corals. *Science* **305**, 997–1000 (2004)

WEB SITES

Michael Lesser's laboratory:
http://zoology.unh.edu/faculty/lesser/lesser.html

Paul Falkowski's laboratory:
http://marine.rutgers.edu/faculty_pfalkowski.html

Photograph of *M. cavernosa* courtesy of Michael Lesser.

IN BRIEF

ANTI-INFECTIVES

Ecological theory suggests that antimicrobial cycling will not reduce antimicrobial resistance in hospitals

Bergstrom, C. T. *et al*. *Proc. Natl Acad. Sci. USA* (August 12 2004)
doi:10.1073/pnas.0402298101

Going to hospital should solve medical problems, but the spectre of hospital-acquired infections by antibiotic-resistant bacteria is an increasing concern. Bergstrom *et al.* have developed a mathematical model to test whether a common tactic of healthcare practioners to reduce resistance — cycling of antibiotics — will be effective. Simulations showed that, theoretically, cycling won't reduce the evolution or spread of antibiotic resistance. A different strategy — treating patients with one of several concurrently used antibiotics — was predicted to be successful in preventing resistance. The authors propose that the latter regime provides a more heterogeneous mixture relative to bacterial populations than cycling, thereby reducing instances of resistance.

VIRUS STRUCTURE

Three dimensional rearrangement of proteins in the tail of bacteriophage T4 on infection of its host.

Leiman, P. G. *et al*. *Cell* **118**, 419–429 (2004)

Studying phage built the foundations of molecular biology and there is considerable genetic and biochemical information available for these viruses. Leiman *et al.* have produced a 17-Å three-dimensional reconstruction of the chemically contracted tail of T4 phage using cryo-EM. Analysis of this structure, together with previously solved structures of the hexagonal baseplate, tail and head proteins allowed the structural rearrangements that occur during tail contraction to be visualized for the first time. The baseplate changes from a hexagonal to a star shape, which causes the sheath surrounding the tail tube to contract. After the tail tube protrudes from the baseplate, it pierces the outer and inner cell membranes before viral DNA injection. Biologists can now 'see' the structural transitions that the tail undergoes after surface attachment owing to two excellent movies that accompany this paper.

BACTERIAL PHYSIOLOGY

Complex formation of Vipp1 depends on its α-helical PspA-like domain

Aseeva, E. *et al*. *J. Biol. Chem.* **279**, 35535–35541 (2004)

Assembling a thylakoid membrane in cyanobacteria and chloroplasts requires Vipp1. Cyanobacteria have a second *vipp1* allele (*pspA*) that is conserved in some bacteria and is induced by a range of stresses. How these important proteins function isn't yet clear, but PspA seems to assist in secretion of proteins across the bacterial membrane. Using negative-staining EM and biochemical tools, Aseeva *et al.* show that Vipp1, in common with PspA, forms a huge complex — 400 Å × 140 Å — that is composed of ring assemblies of Vipp1 dimers. These proteins might have more similar functions than previously suspected.