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Polyphosphate, sulphur and ACC inclusions in magnetotactic bacteria

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We studied intracellular inclusions in uncultured magnetotactic bacteria (MTB). Cells of MTB align along Earth's magnetic field by chains of intracellular, magnetic single-domain crystals of magnetite or greigite. In addition to magnetic nanocrystals, polyphosphate (polyP) granules, sulphur (S) globules and amorphous calcium carbonate (ACC) also occur in some cells, raising the possibility of MTB affecting the cycling of P and S. We studied these inclusions in MTB collected from a pond at a karstic spring. Our primary aim was to enrich bacteria that produce large polyP inclusions.

Samples of sediment with water were collected over a year and then stored in the lab. MTB were magnetically enriched and studied using transmission electron microscopy (TEM). Several strains could be distinguished on the basis of cell morphology (coccus, spirillum, vibrio, rod), magnetite morphology (cubooctahedral, ‘prismatic’, ‘ladyfinger’, ‘bullet’), magnetite chain structure (single, double, disordered), and typical inclusions (polyP, S, ACC). The most abundant cells were cocci, among which S inclusions occurred in strains with either one or two single chain(s) of magnetite. Huge polyP inclusions occurred in two strains of cocci, one with two double chains of magnetite, and another with a slightly disordered arrangement of magnetite nanocrystals.

The dominance of any MTB strain over the others varied seasonally in the pond, as well as over time in the stored microcosms. In autumn, a large variety of MTB strains was present; in spring, cocci with large polyP granules and disordered magnetite chains were typical; in contrast, the winter sample contained almost exclusively cocci with S globules. While the autumn sample was stored in the lab, cocci with large polyP granules became dominant, some of which apparently consumed their polyP reserves, as suggested by empty vesicles in some cells. In the spring sample, after a few months, a rod-shaped strain appeared that had not been found before. Although our attempts to isolate one of the strains that produces the enormous-sized polyP granules have so far not been successful, the observed diversity of MTB and their seasonal changes lay the groundwork for further studies on the environmental significance of their inclusions and for potential applications.