Phylogenetic Studies of Newly Isolated Freshwater Magnetospirilla Using cbb and mam Genes

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Abstract

The phylogeny and general relationship of prokaryotes is determined by comparisons of the sequences of RNA genes, most commonly the 16S rRNA gene. Comparisons between the gene sequences have been used for taxonomy and nomenclature for a long time. Recent advances in the sequence of DNA for some groups of bacteria and archaea have led to a more refined understanding of their relationships. Magnetospirilla (MTB) is a group of bacteria that are characterized by the presence of magnetosomes, which are membrane-bounded crystals of magnetic minerals. Magnetosomes are structurally similar to magnetosomes found in other bacteria and archaea. The presence of magnetosomes is thought to be distributed between non-magnetotactic organisms (Mms) and magnetotactic organisms (Mam). Several others have not yet been shown to grow autotrophically but show a strong magnetospirilla (Mam) phylogenetic signal. Based on the 16S rRNA gene sequences, the magnetospirilla phylogenetically span a range of species, among which is the widely studied magnetotactic strain of Magnetospirillum gryphiswaldense. Phylogenetic studies of newly isolated freshwater magnetospirilla are critical as they help to understand the evolution of these organisms and their ecological impact. Methane (CH4) is a greenhouse gas and a major contributor to global warming. The presence of Magnetospirillum gryphiswaldense in freshwater environments is thought to be a significant factor in the production and release of CH4. Future developments in the understanding of the mechanisms of CH4 production and release in freshwater environments will contribute to the development of strategies for mitigating global warming.

Methods

Isolation of new strains of magnetospirilla. Magnetically-purified MTFs from various freshwater environments were isolated from cold-water lakes and streams by magnetic separation and cultivated on defined medium containing 7% (w/v) agar and 0.4% (w/v) yeast extract. All cultures were maintained in the cold and at a pH between 6.5 and 7.5. Cells were grown at temperatures ranging from 10°C to 20°C. Phylogenetic relationships of the newly isolated freshwater magnetospirilla were determined based on 16S rRNA gene sequences. The presence of magnetosomes was determined by electron microscopy. The presence of Rubisco (ribulose-1,5-bisphosphate carboxylase/oxygenase) was determined by Western blot analysis. These techniques were used to confirm the magnetospirilla phylogenetic signal and to determine the ecological and physiological characteristics of the newly isolated freshwater magnetospirilla strains.

Results

Figure 4. Phylogenetic tree of magnetospirilla and other MTB based on 16S rRNA gene sequences. The newly isolated freshwater magnetospirilla strains are shown in black, and the known Magnetospirillum gryphiswaldense strain is shown in orange. The tree was constructed using the neighbor-joining method and bootstrapped with 100 replicates. The bar represents 2% sequence divergence.

Discussion

Phylogenetic and relatedness studies of Magnetospirillum gryphiswaldense. Magnetospirilla (Mam) are a group of bacteria that are characterized by the presence of magnetosomes, which are membrane-bounded crystals of magnetic minerals. Magnetosomes are structurally similar to magnetosomes found in other bacteria and archaea. The presence of magnetosomes is thought to be distributed between non-magnetotactic organisms (Mms) and magnetotactic organisms (Mam). Magnetospirillum gryphiswaldense is a well-studied magnetotactic strain that is often used as a model for the study of Magnetospirilla. The presence of magnetosomes in Magnetospirillum gryphiswaldense is thought to be important for the bacteria's ability to align with the Earth's magnetic field and to move in the direction of the magnetic field. Magnetospirillum gryphiswaldense is thought to be a significant factor in the production and release of CH4 in freshwater environments.

Future Directions for Research

In this study, we have shown some interesting genetic trends. However, before major conclusions can be drawn from the data, further research is needed to understand the ecological and physiological characteristics of the newly isolated freshwater magnetospirilla strains. The presence of magnetosomes in Magnetospirillum gryphiswaldense is thought to be important for the bacteria's ability to align with the Earth's magnetic field and to move in the direction of the magnetic field. Magnetospirillum gryphiswaldense is thought to be a significant factor in the production and release of CH4 in freshwater environments. Future developments in the understanding of the mechanisms of CH4 production and release in freshwater environments will contribute to the development of strategies for mitigating global warming.