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Keio University

Thesis Abstract

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Thesis Title

Features and evolution of ribosomal genes in Candidate Phyla Radiation (CPR) bacteria

Thesis Summary

The Candidate Phyla Radiation (CPR) is a large bacterial group consisting mainly of uncultured lineages, characterized by small cells and small genomes. CPR accounts for a large proportion in the bacterial domain and cannot be omitted from the discussion of prokaryotic evolution. However, our knowledge of the biological characteristics and evolutionary background of CPR bacteria is still limited. In this study, I attempted to characterize the features of ribosomal genes in CPR bacteria and their evolutionary process by comprehensive analysis of their genome sequences. In Chapter 2, I analyzed the profile of ribosomal protein gene losses in CPR bacteria and the size of the ribosomal protein and ribosomal RNA (rRNA) genes in comparison to non-CPR bacteria. I found that some ribosomal proteins were partially or completely lost in CPR bacteria, and some regions of rRNA were also missing. This suggested that ribosomes are smaller in CPR bacteria than those in canonical bacteria, with simplified surface structures. In Chapter 3, we systematically analyzed the insertion sequences (IS) within the rRNA genes in CPR bacteria. The analysis of hundreds of rRNA gene sequences revealed that ISs like group I or II introns are broadly distributed across the CPR clade, and they frequently encoded single-domain LAGLIDADG Homing Endonuclease (LHE)-like proteins. I also prepared the recombinant LHE-like protein I-ShaI, which is encoded in the rRNA IS from CPR bacteria, and demonstrated biochemically that the enzyme has sequence-specific endonuclease activity. These results provide robust evidence supporting the hypothesis that the explosive proliferation of rRNA ISs in CPR bacteria was facilitated by mechanisms involving LHEs. This study provides new insights into the characteristics, evolution and biochemistry of ribosomal genes in CPR bacteria, and enables us to consider the origins and evolution of the ribosome based on specific observations.

Keywords:
CPR bacteria, ribosome, rRNA, ribosomal proteins, homing endonucleases