The Black Queen Hypothesis

Evolution of Dependencies through Adaptive Gene Loss

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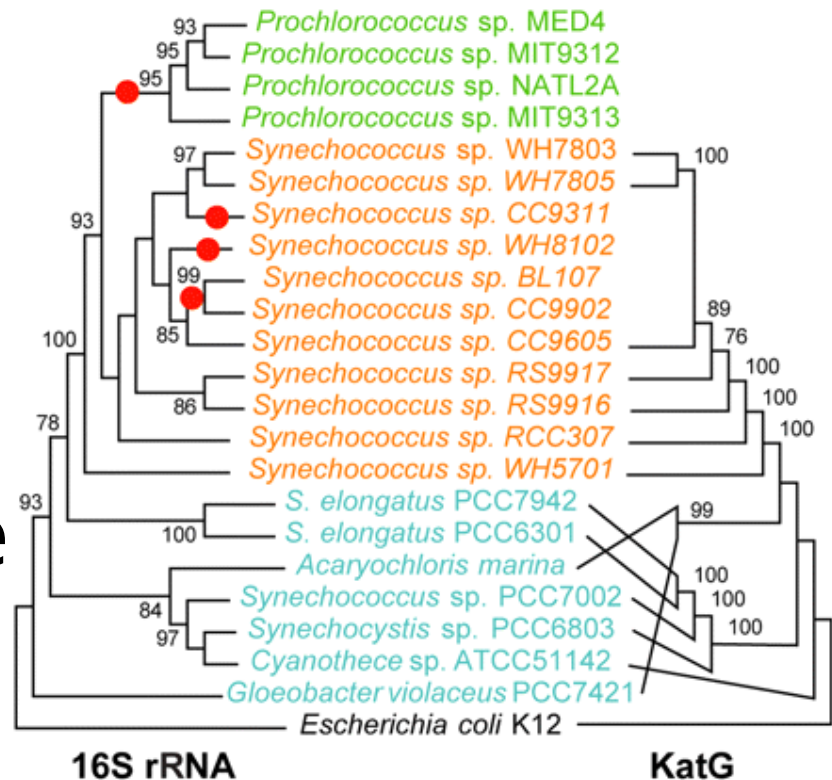
Reductive Evolution

- Parasites and symbionts
  - Genetic drift with reduced gene flow
  - *Salmonella enterica*
- Adaptive gene loss
  - *E. coli* ribose catabolism
  - *Prochlorococcus* and *Candidatus* Pelagibacter

Putative BQH Scenario

- *katG* catalase-peroxidase
- *Synechococcus*
- Pan-genome
- Photo-oxidation
  of DOC
- HOOH membrane
  permeability

Black Queen Hypothesis

- LOF must be advantageous
- LOF must be frequency dependent
- Function must be indispensable and leaky

Dynamics

- Relative fitness benefit :
  - B=(Qa-Qm)/Qa
- Relative fitness cost:
  - C=(Km-K)/Km for 0 <= K >= Km where K is the sum of community density, functional rate, and functional leakiness and Km is K for maximum growth rate
- Assumes
  - Axenic
  - Homogeneity

Other scenarios

- Nitrogen fixation
  - Diazotrophs
- Inorganic nutrient acquisition
  - Iron siderophores
- Biofilm matrix deposition
- Antibiotic detoxification
- "Shooting the moon"-
  - Keystone species
  - K- and r-selected

Altruism and cheaters

- Hamilton's rule
- Leakiness and density-dependence instead of kin selection
- Spatial structure and relatedness
- Multi-species communities
  - Different limiting resources
- Commensalism