

The Black Queen Hypothesis

Evolution of Dependencies through Adaptive Gene Loss

J. Jeffrey Morris, Richard E. Lenskia and Erik R. Zinser

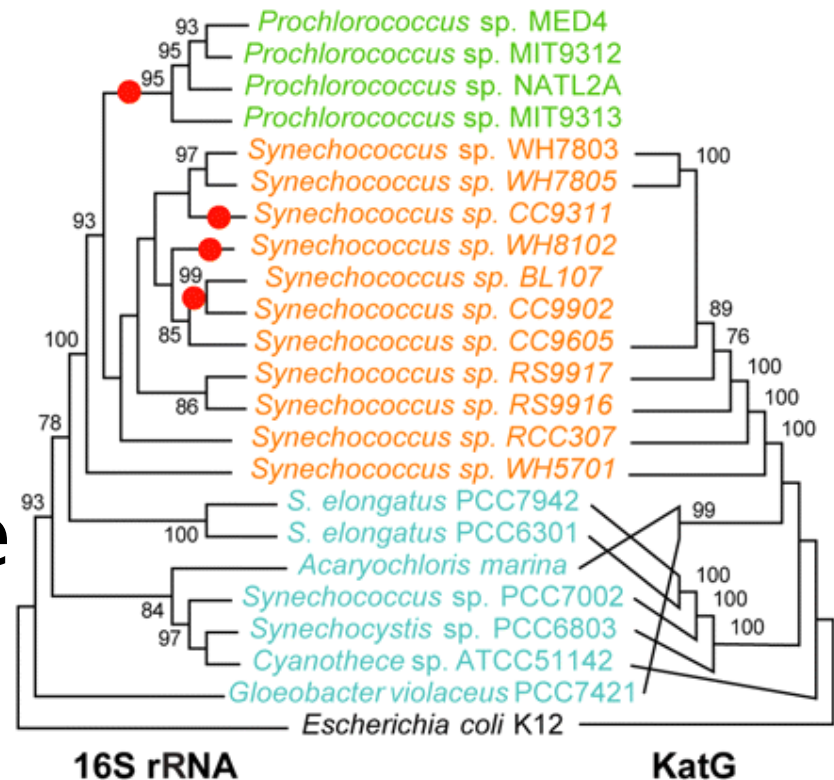
doi: 10.1128/mBio.00036-1223 March 2012 mBio vol. 3 no. 2 e00036-12

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
- H₂O₂ membrane permeability



Black Queen Hypothesis

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

Dynamics

- Relative fitness benefit :
 - $B = (Q_a - Q_m) / Q_a$
- Relative fitness cost:
 - $C = (K_m - K) / K_m$ for $0 \leq K \leq K_m$ where K is the sum of community density, functional rate, and functional leakiness and K_m 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