IDENTIFICATION OF PROKARYOTIC COMMUNITIES IN ANOXIC ESTUARINE SEDIMENT BASED ON 16S rRNA GENE SEQUENCE DATA

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THE BLACK BOX

Residence Time (d) = \frac{\text{Reservoir (g)}}{\text{Flux (g/d)}}
Phylogenetic Tree of Life

Eukaryota

EUKARYOTES

- Entamoebae
- Slime molds
- Animals
  - Fungi
  - Plants
  - Ciliates
  - Flagellates
  - Trichomonads
  - Microsporidia
  - Diplomonads
Phylogenetic Tree of Life

Bacteria
- Spirochetes
- Cyanobacteria
- Planctomycetes
- Bacteroides
- Cytophaga
- Thermotoga
- Aquifex
- Green Filamentous bacteria
- Gram-positive

Archaea
- Methanosarcina
- Methanobacterium
- Thermoproteus
- Pyrodicticum
- T. celer

Eucaryya
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PROKARYOTES

EUKARYOTES
Oxidation of organic matter

**WATER**

- \( \text{O}_2 \text{ Fe}^{3+} \)
- \( \text{NO}_3^- \text{ SO}_4^{2-} \)

**MUD**

- \( \text{Eh} \)
- \( \text{sediment} \)
- \( \text{column} \)

**Energy**

- **Yield**
- **aerobic resp. 686**
- **dissimilatory nitrate red. 649**
- **iron red. 300**
- **sulfate red. 190**
- **methanogenesis 8.3**

Due to reduction of organic matter

**Chemical Reactions**

- \( \text{O}_2 \rightarrow \text{CO}_2 \)
- \( \text{NO}_3^- + \text{H}^+ \rightarrow \text{N}_2 \)
- \( \text{Fe}_2(\text{OH})_3 + 2\text{H}^+ \rightarrow \text{Fe}^{2+} \)
- \( \text{SO}_4^{2-} + 2\text{H}^+ \rightarrow \text{HS}^- \)
- \( \text{H}_2 + \text{CO}_2 \rightarrow \text{CH}_4 \)
GOALS

• Identify geochemical gradients in Hudson’s Landing sediments using multiple proxies
• Identify members of the prokaryotic consortia along these gradients using molecular methods
• Address the hypothesis that prokaryotes are distributed across these gradients in a regular and predictable manner
• Discuss implications for managed estuaries
SEDIMENT SURFACE

Hydrogen Sulfide Bubbles

Tubeworm

Hydrogen Sulfide Bubbles

Tubeworm Burrow
OXIDATION-REDUCTION POTENTIAL AND PH
Increasing Dissolved Recalcitrant Material With Depth

POC/N Negatively Correlated with C:N

POC:N Positively Correlated With C:N
CARBON: NITROGEN

Blue Bar- C:N characteristic of autochthonous carbon (algae)

Green Bar- C:N characteristic of allochthonous carbon (external carbon sources)

Redfield Ratio

Redfield Ratio = 6.6
Cellulosic Material

Minerals

Isthmia

Chaetoceros

2.6CM
DGGE RESULTS

A. Raw Image
B. All Bands
   Highlighted
C. Excised Bands
   Highlighted
SEDIMENT COLUMN

SULFATE REDUCERS

SULFIDE OXIDIZERS
SEDIMENT COLUMN

METHANOGENS

METHANOTROPHS
FERMENTERS REDUCE H⁺

METHANOGENS OXIDIZE H₂ (G)
THE SHIFT

- Proteobacteria dominate surface
- Degradation of macromolecules
- Denitrifying bacteria
- Metal Reducers
- Sulfate Reduction
- Sulfide Oxidation
- Methanogenesis/ Methanotrophy
The Shift

- Fermenters dominate the deep
- Increased degradation of recalcitrant organics
- Sulfate Reduction
- Sulfide Oxidation
- Methanogenesis/Methanotrophy
ESTUARINE MANAGEMENT

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• Mercury methylation tied to iron/ sulfate reducing communities (Kerin et al. 2006)
• Management plans should consider microbial consortia in an effort to maximize beneficial processes while minimizing those that are detrimental
THE END

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