Community Response to Organic Nutrient Amendment
CORONA
Sampling

Agouron cruise, University of Hawaii
Background

- Bacterial growth limitation
- Organic vs Inorganic
- Organic Carbon Quality / Lability

Carlson & Ducklow, 1996
### Background

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>N</th>
<th>P</th>
<th>C:N</th>
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<td>385</td>
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<td>15:1</td>
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<td>7:1</td>
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<tr>
<td><strong>S6, 25M, POM</strong></td>
<td>21</td>
<td>3</td>
<td>1</td>
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### Perturbation Experiment

<table>
<thead>
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<th>Substrate</th>
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<tr>
<td>Glycolate</td>
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<td></td>
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<tr>
<td>Methionine</td>
<td>10</td>
<td>2</td>
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</table>

<table>
<thead>
<tr>
<th>Carboy, T0</th>
<th>DNA</th>
<th>Glycolate</th>
<th>Methionine</th>
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<tbody>
<tr>
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<td>6</td>
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<td></td>
<td>10:1</td>
<td>24:1</td>
<td>15:1</td>
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</tbody>
</table>
Experimental flow

Sampling → Add Substrates → Mix?

Incubation
Materials and Methods

Community structure (T-RFLP)*
Enumeration: Bacteria, Picoeukaryotes, Virus
Activities: Bacterial production, Primary production
*sampled every 2 days
Results Overview

1. Follow the Carbon Road...
   A. Timepoint Trends
      - Primary Production
      - Increase in mortality
      - Primary production consistent (except DNA)
      - High respiration
   
   B. DNA Treatment
      - Most productive
      - Driven towards N-Limitation?
   
   C. Other treatments
      - P-limitation?

2. Community Shift
   - Prochlorococcus ➔ Eukaryotes (Picoeukaryotes & Diatoms)
   - Divergence
Timepoint Trends

- Increase in DNA Treatment 1° Production

- Increase in bacterial production supported by 1° Production
Follow the Carbon Road...

No significant change in POC
Complete use of labile substrate + some of semi-labile pool

<table>
<thead>
<tr>
<th></th>
<th>DOC Consumed (μM)</th>
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<tbody>
<tr>
<td>Control</td>
<td>17</td>
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<tr>
<td>DNA</td>
<td>20</td>
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<tr>
<td>Glycolate</td>
<td>32</td>
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<tr>
<td>Methionine</td>
<td>30</td>
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</table>
Timepoint Trends

**Bacterial Production**

Leucine-Dark

<table>
<thead>
<tr>
<th>Timepoint</th>
<th>Control</th>
<th>DNA</th>
<th>Glycolate</th>
<th>Methionine</th>
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</thead>
<tbody>
<tr>
<td>T0</td>
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<td>T1</td>
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<td>T5</td>
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</table>

**Heterotroph Cell Abundance**

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<th>Methionine</th>
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<tbody>
<tr>
<td>T0</td>
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<tr>
<td>T1</td>
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<td>T4</td>
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<tr>
<td>T5</td>
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</tbody>
</table>

**Bacterial Specific Growth Rate**

<table>
<thead>
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<th>Timepoint</th>
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<th>DNA</th>
<th>Glycolate</th>
<th>Methionine</th>
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</thead>
<tbody>
<tr>
<td>T0</td>
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<td></td>
<td></td>
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<tr>
<td>T1</td>
<td></td>
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<tr>
<td>T2</td>
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<td>T3</td>
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<tr>
<td>T4</td>
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<td>T5</td>
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</tbody>
</table>
Timepoint Trends

Bacterial Mortality

Mortality (cells L day)

Control
DNA
Glycolate
Methionine

Constant Specific Growth & Increasing Production ➔
Mortality (Grazing + Viral Lysis)
Bacterial Growth Efficiency

\[ \text{BGE} = \frac{\text{BP}}{\text{BP} + \text{BR}} = \frac{\text{BP}}{\Delta \text{DOC}} \]

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Control</td>
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<td>DNA</td>
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<tr>
<td>Glycolate</td>
<td>4</td>
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<tr>
<td>Methionine</td>
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**DNA Story**

- Most N,P-enriched substrate
- Highest Stimulation of Production
- Driven to N-limitation
  - P-replete

**Glycolate and Methionine**

- P-limitation
  - Low production relative to DNA

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**Graph:**
- Y-axis: Total P (uM)
- X-axis: Time points (T0, T2, T5)
- Data points include Control, DNA, Glycolate, Methionine
- Colors: DP (uM), SRP (uM), PP (uM)
Community Shift

Prochlorococcus Cell Abundance

Cell Abundance (cells mL⁻¹)

T0 T1 T2 T3 T4 T5

Picoeukaryote Cell Abundance

Cell Abundance (cells mL⁻¹)

T0 T1 T2 T3 T4 T5

Incubation Experiment
Chlorophyll c Concentration

[Chl c] (µg L⁻¹)

T0 T1 T2 T3 T4 T5

- Methionine diatom bloom
- Photoheterotrophy
- Amino acid transporter

Armbrust et al., 2004
Community Shift

T=0
- P34 - Mixed group
- P114 - SAR11 subgroup
- P190 - Unknown
- P224 - SAR11 subgroup
- P287 - Prochlorococcus
- P289 - SAR11

Control T=5
- P34 - Mixed group
- P114 - SAR11 subgroup
- P190 - Unknown
- P224 - SAR11 subgroup
- P287 - Prochlorococcus
- P289 - SAR11

DNA T=5
- P34 - Mixed group
- P114 - SAR11 subgroup
- P190 - Unknown
- P224 - SAR11 subgroup
- P287 - Prochlorococcus
- P289 - SAR11

Glycolate T=5
- P34 - Mixed group
- P114 - SAR11 subgroup
- P190 - Unknown
- P224 - SAR11 subgroup
- P287 - Prochlorococcus
- P289 - SAR11
Conclusions - A Carbon Story...

- High respiration throughout
  - DNA has greatest assimilation
- Mortality increase
  - Grazing + Viral Lysis
- Community shift
  - Prochlorococcus → Eukaryotes
  - Nutrient Uptake (SA/V)
- DNA...The choice of microbes everywhere
  - Phosphorus is key
- Stimulated use of semi-labile DOC pool by organic substrate addition