A Comparative Investigation on the Formation of Marine Snow in a Hydrocarbon Contaminated Environment vs. an Uncontaminated Environment

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Thalassiosira weissflogii phytoplankton were used in this study as they grow well in culture and they are found in the Gulf of Mexico (GoM).
Examples of Aggregates Observed in the GoM

Aggregates sink down and become Marine Snow. This example was found in the GoM after the Deepwater Horizon contamination.

Iopscience.iop.org
Create nutrient rich artificial seawater to “grow” a sufficient quantity of phytoplankton.

Wait.

Check every day to see if the inoculated seawater is “growing”.

First Steps in the Quest for Marine Snow
Using the AquaPen, fluorescence is determined. The higher the rate of fluorescence, the higher the rate of photosynthesis. This gives a quick idea of population growth.

http://www.phenovation.com
NASA uses fluorescence to monitor how much CO₂ is removed from the atmosphere by phytoplankton by the photosynthetic process.

Science1.nasa.gov
Magnification is at 800x the actual size of the organism. Phase contrasting was also used as this helped to visually “pop” the image of the phytoplankton (*Thalassiosira weissflogii*) into view.
A hemacytometer slide allows one to calculate the population of cells per Liter of fluid. A count of 200 cells gives an approximate 20% percentage of error.
12 Days have passed and the phytoplankton are not growing as expected. The clarity of the artificial seawater is one indicator that growth is not occurring.
Initial growth was not what I had hoped for. The graph demonstrates linear growth, not exponential.

Total Cell Growth Over Time

\[ y = 21834x - 36516 \]
\[ R^2 = 0.89777 \]
The linear trend is seen again with the quantity of fluorescence (Ft).
To assist the growth of the phytoplankton, CO₂ was bubbled through the media. A higher intensity of light was also used, but not the quantity of light. That remained at 12 hours on and 12 hours off.
The results were immediately visible. The phytoplankton population grew to a density where the media changed to a green color. Note the tube in the flask delivering CO₂.
Approximate Population

Ft measures fluorescence which indicates population size. Population jumped over the July 4th weekend (4 days).
Population Growth Over Time

Total Number of Cells Over Days

\[ y = 19960e^{0.2002x} \]

\[ R^2 = 0.8966 \]

Days

Total Number of Cells (mL)

0 5 10 15 20 25

0 200000 400000 600000 800000 1000000 1200000

Series1

Expon. (Series1)
As the phytoplankton grow, the culture is divided and added to new media. With CO$_2$ and light the phytoplankton continues to grow.
More Phytoplankton is Needed

The process is repeated. This creates just over 6 L of phytoplankton filled media.
Three experimental groups are created. One has Hydrocarbon Contaminated seawater forced into a suspension (WAF).
The six tanks are filled with an equal amount of phytoplankton media that had all been mixed (the 4 flasks) and topped with artificial seawater. Great care is taken to ensure No bubbles are in the tanks. The rolling simulates movement in the deep sea where there are no surfaces.
The first two tanks are controls with NO contamination from hydrocarbons.

The back two are contaminated with hydrocarbons via WAF.
Direct Application of GoM Oil

1 mL of Oil from depth of the Deepwater Horizon was added to each of these two tanks.
Aggregates slowly form over days of undisturbed rolling. The tanks are kept at 13.5°C and in the dark to simulate the deep ocean. Average size of aggregate 1mm x 1mm.
Aggregates are carefully removed. Duplicate dry weights are calculated after filtration. Samples of phytoplankton cells were also collected.
Volume of Aggregates Measured

Volume of Aggregates Over Time

- Control L
- Control R
- WAF L
- WAF R
- Oil L
- Oil R
In my Quest there are two replicates of each: control, WAF, and oil. In reality, there can be more replicates but sometimes not. Plus, the tanks are left in situ far longer than in my Quest.
<table>
<thead>
<tr>
<th>Marine Snow Type</th>
<th>Type of Oil</th>
<th>$\delta^{13}$C determining association oil with marine snow (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. fragilissismus agg.</td>
<td>Spill oil from oil carpet</td>
<td>16% Marine Snow associated with oil</td>
</tr>
<tr>
<td>D. fragilissismus agg.</td>
<td>Macando Oil</td>
<td>65% Marine Snow associated with oil</td>
</tr>
<tr>
<td>T. weissflogii agg</td>
<td>Cold seep oil</td>
<td>91% Marine Snow associated with oil</td>
</tr>
</tbody>
</table>
How does all this scientific information apply to the classroom?

Conceptual Education: Everything Interacts with Everything

http://www.skepticalscience.com/pics/Biologicalcarboncycle.jpg
Photosynthesis is a basic concept and yet my students fail to grasp it as a “fact”.

As a concept, I hope to apply the role of Carbon in the students lives and then expand upon it.

http://courtneystanifer.edublogs.org/files/2010/05/photosynthesis
This lab demonstrates the release of CO$_2$ from burning organic matter and exhalation, plus the release of O$_2$ from plants.
The frog does not drink up the pond in which it lives – Indian Proverb

. . . And as one concept is grasped it will lead to a larger concept. The ultimate goal will be the understanding that all things are interconnected and we are connected too. http://carbon_cycle/carbon_cycle.jpg
Thank You for a Great Summer

RET 2013
Thank you so much for this opportunity.

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Julia Sweet – Wealth of Knowledge

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