Organic matter cycling in the upper ocean

Redfield, Azam, Dugdale, and Jenkins

THE REDFIELD PAPER (Redfield et al. 1963)

REDFIELD STOICHIOMETRY

$1P:16N:106C:138O_2$

Graphs of N vs. P and N vs. O_2 utilized removed due to copyright restrictions.

Redfield, A.C. (1934), On the proportions of organic derivatives in seawater and their relation to the composition of plankton, *James Johnston Memorial Volume*, 176-192

THE REDFIELD PAPER (Redfield et al. 1963)

- Redfield ratios: N and P are available in the ocean in the same ratios in which they are utilized
- Preformed vs. remineralized nutrients
- Preferential remineralization of P
- Nutrient limitation (Excess P in surface waters, therefore N ultimate limiting nutrient)

Table of ratio of change in the atomic concentration of products of decomposition of organic matter in the presence of oxygen and under anoxic conditions removed due to copyright restrictions.

A BIOLOGIST'S PERSPECTIVE (Azam et al. 1983)

- MICROBIAL LOOP

  "Energy released as DOM by plankton is rather inefficiently returned to the main food chain via a microbial loop of bacteria-flagellates-microzooplankton"

- Bacteria consume 10-50% fixed carbon.
- Correlation between chl, DOM and bacterial abundance

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Graphic showing trophic level vs. length removed due to copyright restrictions.

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- Bacteria grazed by heterotrophic microflagellates (preditor-prey cycles)

Defining “new” vs “regenerated” production
(Dugdale and Goering, 1967)

- **NEW PRODUCTION uses NO_3 and N_2**
- **REGENERATED PRODUCTION uses NH_4^+ and Norg**

Graphic depicting new production, regenerated production and export production after Casciotti.

Defining “new” vs “regenerated” production

(Dugdale and Goering, 1967)

- **NEW PRODUCTION uses NO_3^- and N_2**
- **REGENERATED PRODUCTION uses NH_4^+ and Norg**
- Measure nitrogen uptake using ^{15}N additions
- Light and dark assimilation of NH_4^+ and NO_3^-
- Suggest Nitrogen limiting primary production in Bermuda

N_2 fixation

Graph for 1962 and 1963 removed due to copyright restrictions.

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RICH SEAS ARE RICHER,

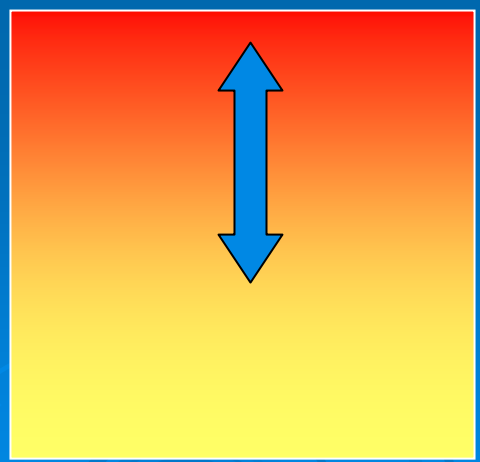
POOR SEAS ARE POORER

Poor Seas are RICHER
(Jenkins and Goldman, 1985)

- New Estimates of primary production in oligotrophic regions
- Three independent methods all show significantly higher levels of productivity.

Poor Seas are RICHER
(Jenkins and Goldman, 1985)

- If system looks like a steady state system on long time scales, then inputs=losses
- Method 1: Heat fluxes. To account for temperature changes at 50m, there has to be a downward transport of heat through mixing.



Flux brings head down,
Brings O_2 up -> escapes

"leaky system"

Poor Seas are RICHER
(Jenkins and Goldman, 1985)

- If system looks like a steady state system on long time scales, then inputs=losses
- Method 2: Deep Oxygen profiles. Changes due to O_2 consumption during remineratlization. Integrate oxygen utilization rates to estimate O_2 consumption rate

Graph of oxygen anomaly vs. January removed due to copyright restrictions.

Poor Seas are RICHER
(Jenkins and Goldman, 1985)

- If system looks like a steady state system on long time scales, then inputs=losses
- Method 3: Tritium-^{3}He dating. Calculate O_2 loss.

Graph of depth vs. oxygen anomaly removed due to copyright restrictions.

Poor Seas are RICHER
(Jenkins and Goldman, 1985)

- New Estimates of primary production in oligotrophic regions
- Three independent methods all show significantly higher levels of productivity.
- Nutrient fluxes are event-dominated- short time periods of rapid mixing.
- “Spinning Wheel”- rapid regeneration in the upper ocean

Poor Seas are RICHER
(Jenkins and Goldman, 1985)

- New Estimates of primary production in oligotrophic regions
- **"the oligiotrophic ocean is not at steady state, that far higher new primary production occurs than previously measured, and that this increased productivity is fueled by heterogenous inputs of new nutrients."**
- the upper ocean

ΔO_2

Table depicting the ratio of change in the atomic concentration of products of decomposition of organic matter in the presence of oxygen and under anoxic conditions removed due to copyright restrictions.

Other discussion questions

- Affect of cycling on ^{15}N uptake measurements
- How does ignoring nitrigication affect Dugdale's arguments?