Dissolved oxygen incubation measurements

- Terms
- Methods
- Newer technologies

Joe Salisbury
University of New Hampshire
If we are interested in *carbon available for export* or consumption by higher trophic levels, **NCP** is the key term.

If we want to know how much *total energy was captured by photosynthesis*, we need to know GPP.

If we are interested in the *net total carbon fixed by phytoplankton*, NPP is the key term (GPP- autotrophic R).
The basic concepts of light and dark bottle incubations for productivity measurements

1. Light bottle $O_2$ minus starting concentration over time is $\text{NCP}$. In the absence of a heterotrophic community this would be $\text{NPP}$. (Conversion from oxygen to carbon units requires application of the Photosynthetic Quotient (>1.1 O:C)).

2. Dark bottle $O_2$ minus starting concentration over time is $\text{CR}$.

3. The sum of $\text{NCP}$ and $\text{CR}$ is $\text{GPP}$.
CONSEIL PERMANENT INTERNATIONAL POUR L'EXPLORATION DE LA MER

RAPPORTS ET PROCÈS-VERBAUX DES RÉUNIONS
VOLUME XLII

INVESTIGATIONS
OF THE
PRODUCTION OF PLANKTON IN THE OSLO EJORD

BY
TORBJØRN GAARDER AND H. H. GRAN

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE
Mars 1927.

Fig. 1.
**Typical Light – Dark (GPP) values per mg chl. (J.D.H. Strickland, 1960)**

<table>
<thead>
<tr>
<th>Approximate mg C/hour synthesised per mg chlorophyll at optimum light</th>
<th>Reference</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Gessner, 1949</td>
<td>Mean value for natural lake populations</td>
</tr>
<tr>
<td>1–2</td>
<td>Holmes, 1957</td>
<td>Incubator values for natural marine populations</td>
</tr>
<tr>
<td>1–6.5</td>
<td>Clendenning et al., 1956</td>
<td>Cultures of Chlorophyceae and Myxophyceae</td>
</tr>
<tr>
<td>ca 4.5</td>
<td>Currie, 1957</td>
<td>Maximum in euphotic zone; all pigments added together</td>
</tr>
<tr>
<td>ca. 4.5</td>
<td>Edmondson, 1956</td>
<td>Assuming a tenth of daily value at ca. 0.13 ly/min</td>
</tr>
<tr>
<td>ca. 1</td>
<td>Fleischer, 1935</td>
<td>Light intensity uncertain but probably slightly greater than optimal. <em>Chlorella</em> cultures</td>
</tr>
<tr>
<td>4–6</td>
<td>Gessner, 1943</td>
<td>Lakes</td>
</tr>
<tr>
<td>2</td>
<td>Manning and Juday, 1941</td>
<td>Lakes</td>
</tr>
<tr>
<td>3</td>
<td>Riley, 1941b</td>
<td>Coastal water</td>
</tr>
<tr>
<td>6</td>
<td>Ryther and Yentsch, 1957</td>
<td>Average for coastal waters</td>
</tr>
<tr>
<td>5–10</td>
<td>Ryther and Yentsch, 1957</td>
<td>Various pure cultures</td>
</tr>
<tr>
<td>3</td>
<td>Ryther, 1956a</td>
<td>Culture of <em>Dunaliella euchlora</em></td>
</tr>
<tr>
<td>4.5</td>
<td>Shimada, 1958</td>
<td>Net photosynthesis at a light intensity probably sub-optimal</td>
</tr>
</tbody>
</table>
Some considerations for incubation net-P estimates

- Precision $\sim \pm 0.5$ umol/L for Winkler
- Precision typically $> \pm 1.0$ umol/L for optodes
- Error terms
  - Bubble entrainment/ supersaturation
  - Precision of $O_2$ measurement
  - Temperature effects
  - Presence of heterotrophs
  - Bottle effects
  - Uncertainty in PQ
Brief review of newer automated systems to study dissolved oxygen variability
Langdon Rig
from Langdon et al, 1995

Figure 1. Drawing of a productivity autosampler, showing the layout of the components.
An autonomous, in situ light-dark bottle device for determining community respiration and net community production

James R. Collins, Paul D. Fucile, Glenn McDonald, Justin E. Ossolinski, Richard G. Keil, James R. Valdes, Scott C. Doney, Benjamin A. S. Van Mooy
UNH data from automated incubation chambers

NCP and CR determinations at Fort Point, NH

Respiration experiments on the NASA GOMEX campaign

Net O₂ uptake
~0.7 - 3.5 µmol/kg/hr
VanDermeulen Rig 1
**Vandermeulen Data**

**Oxygen GPP v. \(^{14}\text{Carbon}\)**

*In situ* oxygen and light data were used to construct a photosynthesis versus irradiance (P v. E) curve, by averaging the incident light and biological rates in five minute intervals, and plotting them as a function of one another.
Vandermeulen rig 2
Oxygen-based photosynthetron (under development)

Illustration Credit: Kirsten Carlson
That’s all,
Thanks

Joe Salisbury
University of New Hampshire