PHOTOSYNTHESIS OF SEAGRASS, *THALASSIA HEMPRICHI* IN OXYGEN ENRICHED AND DEPLETED ENCLOSURES

**ABSTRACT**

Photosynthetic release of oxygen by *Thalassia hemprichii* shoots incubated at various levels of dissolved oxygen at Minicoy lagoon was reported. Dissolved O$_2$ levels enriched to almost saturation caused very low rate of net photosynthesis (63%) over the normal dissolved O$_2$ levels. Whereas low levels of dissolved oxygen in the ambient water enhanced the net photosynthesis to 205%.

The results are discussed with reference to the Warburg effect and the similar situation that occur in lagoon systems.

Complete absence of O$_2$ often brings photosynthesis to a standstill; while an excess of O$_2$ invariably reduces the rate of this process (Gibbs, 1969a). Seagrass beds in some atoll systems do experience conditions of oxygen maximum during peak sunshine hours and its minimum after the dawn (Kaladharan, 1998).

Enhancement in the rate of photosynthesis at very low levels of oxygen does vary from species to species of terrestrial grasses (Gibbs, 1969b) and within species of halophyte *Atriplex* (Gauhl and Bjorkman, 1969). However, such information on submerged vegetation especially on seagrass are highly uncommon. The present study is aimed at understanding the rate of photosynthetic O$_2$ release during active photosynthesis at varying levels of dissolved ambient oxygen as well as the Warburg effect in *Thalassia* shoots.

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**MATERIAL AND METHODS**

The seagrass *Thalassia hemprichii* belongs to Angiosperm family, Hydrocharitacea which is a predominant species forming dense beds in Minicoy atoll (8 15' N & 73 03' E) of Laccadive Archipelago.

*Enrichment and depletion of O$_2$: *The enrichment and depletion of dissolved oxygen in sea water were achieved by light and dark incubation of *Thalassia* leaves in air-tight polythene bags in the in situ environment for 2 hours duration. After the end of incubation period the light and dark bags were opened and the shoots incubated were discarded. The ambient O$_2$ levels in both the light and dark incubated bags after the incubation period were determined. The water obtained from the light incubated bags provided O$_2$ enriched water and from the dark incubated bags supplied O$_2$ depleted water at the ambient temperature of the seagrass bed.

**RESULTS AND DISCUSSION**

Dissolved O$_2$ in Minicoy lagoon waters during the bright, noon hours registered 3.5 to 6.0 ml O$_2$/l at the surface. The O$_2$ release from light incubated *Thalassia* shoots in various O$_2$ levels as an index of photosynthesis were
performed during the peak sunshine hours. Levels of ambient dissolved O\textsubscript{2} of 4.0 ml/l in lagoon water were considered as normal (100%); 1.0 ml/l as low oxygen levels (25%) or depleted O\textsubscript{2} levels and 7.0 ml/l as high levels (175%) or enriched O\textsubscript{2} levels (Table 1). The enriched O\textsubscript{2} levels ranged from 6.0 to 7.5 ml/l and the ‘depleted’ or low levels varied from 0.5 to 3.0 ml O\textsubscript{2}/l. The O\textsubscript{2} released during photosynthesis of Thalassia shoots at various ambient O\textsubscript{2} levels were plotted in Fig. 1 and the percent enhancement or decrease at low or high levels were given in the Table 1.

**Table 1. Rate of enhancement and reduction in O\textsubscript{2} released during photosynthesis at various levels of ambient dissolved O\textsubscript{2}.**

<table>
<thead>
<tr>
<th>Level of ambient O\textsubscript{2}</th>
<th>O\textsubscript{2} released during photosynthesis (ml O\textsubscript{2} g f.wt./hr)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal 4.0</td>
<td>100</td>
<td>1.5</td>
</tr>
<tr>
<td>Low 1.0</td>
<td>25</td>
<td>3.3</td>
</tr>
<tr>
<td>High 7.0</td>
<td>175</td>
<td>0.95</td>
</tr>
</tbody>
</table>

The highest rate of net photosynthesis (3.4 ml O\textsubscript{2}/g f.wt./hr) was recorded at the dissolved ambient O\textsubscript{2} levels of 0.55 ml/l in the enclosed water. Change in the rate of net photosynthesis in varying O\textsubscript{2} concentrations was studied in Chlorella (Warburg and Krippahl, 1960), in excised leaves of some field crops (Zelitch, 1971) and in isolated chloroplasts of spinach (Gibbs, 1969b). In the present study inhibitory effect of O\textsubscript{2} levels 75% lesser than the normal levels showed 220% of net photosynthesis in shoots of Thalassia hemprichii and O\textsubscript{2} levels 75% higher than the normal levels registered only 63% at the normal level (Table 1). Lowering the O\textsubscript{2} level from the 21% to less than 2% increased net photosynthesis 53% in Atriplex rosea which has low photorespiration and only 4% in A. patula which has low photorespiration (Gauld and Bjorkman, 1969) indicating photorespiration to be the primary effect.

As the O\textsubscript{2} enriched and O\textsubscript{2} depleted water used to incubate Thalassia shoots were obtained by incubating Thalassia shoots in light and dark respectively, the O\textsubscript{2} depleted (dark incubated) water may have high levels of CO\textsubscript{2} (respired) one might argue that the enhancement of net photosynthesis at low levels of O\textsubscript{2} may also be due to high CO\textsubscript{2} content and vice-versa. However, it is proved beyond doubt that CO\textsubscript{2} assimilation is 54% higher in low CO\textsubscript{2} (75 ppm) than in 275 ppm (Forrester et al., 1966a). Inhibition in the rate of net photosynthesis by high O\textsubscript{2} levels in the environment known as Warburg Effect is probably reported for the first time in seagrass, Thalassia hemprichii. This grass is a predominant species forming large meadows in the Minicoy lagoon (Kaladharan et al., 1998). The present study is interesting to understand the productivity of atoll systems, as similar situation might occur in Minicoy atoll.

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