PHOTOSYNTHESIS OF SEAGRASS, *THALASSIA HEMPRICHII* 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.

The author is grateful to Dr. M. Devaraj, Director, C.M.F.R.I., Dr. V.N. Pillai, Head, F.E.M. Division and to Dr. V.S.K. Chennubhotla, the then O.I.C., Minicoy Research Centre of CMFRI for providing facilities and encouragements.

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.

Determination of O_2 release: Fresh and clean shoots of *Thalassia hemprichii* were weighed (2 g) and incubated with one litre each of O_2 enriched or depleted water remained in the above polythene bags after the determination of initial O_2 levels. These bags were tied air-tight and again incubated in light only in the seagrass bed itself for 2 hours period. Release of O_2 due to organisms other than seagrass shoots were corrected from blank incubations as above. The dissolved O_2 levels were determined titrimetrically using Winkler's procedure.

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_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_2 levels and 7.0 ml/l as high levels (175%) or enriched O_2 levels (Table 1). The enriched O_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_2/l. The O_2 released during photosynthesis of *Thalassia* shoots at various ambient O_2 levels were plotted in Fig. 1 and the percent enchancement or decrease at low or high levels were given in the Table 1.

TABLE 1. *Rate of enhancement and reduction in O_2 released during photosynthesis at various levels of ambient dissolved O_2.*

Level of ambient O_2			O2 released during photosynthesis	
	(ml O_2/1)	(%)	(ml O_2/g (f.wt.)/hr)	(%)
Normal	4.0	100	1.5	100
Low	1.0	25	3.3	220
High	7.0	175	0.95	63

The highest rate of net photosynthesis (3.4 ml O_2/g (f.wt.)/hr) was recorded at the dissolved ambient O_2 levels of 0.55 ml/l in the enclosed water. Change in the rate of net photosynthesis in varying O_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_2 levels 75% lesser than the normal levels showed 220% of net photosynthesis in shoots of *Thalassia hemprichii* and O_2 levels 75% higher than the normal levels registered only 63% at the normal level (Table 1). Lowering the O_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. patual* which has low photorespiration (Gauhl and Bjorkman, 1969) indicating photorespiration to be the primary effect.

As the O_2 enriched and O_2 depleted water used to incubate *Thalassia* shoots were obtained by incubating *Thalassia* shoots in light and dark respectively, the O_2 depleted (dark incubated) water may have high levels of CO_2 (respired) one might argue that the enhancement

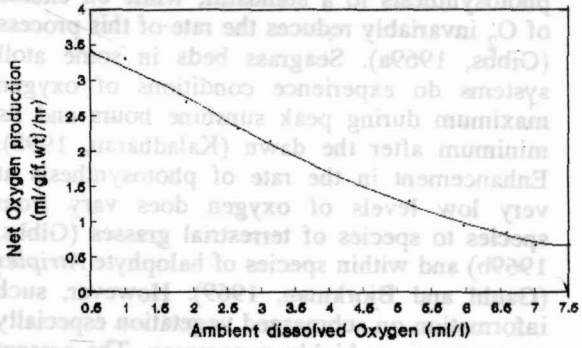

FIG. 1. *Net production of O_2 by Thalassia shoots incubated in O_2 enriched and depleted enclosures.*

of net photosynthesis at low levels of O_2 may also be due to high CO_2 content and *vice-versa.* However, it is proved beyond doubt that CO_2 assimilation is 54% higher in low CO_2 (75 ppm) than in 275 ppm (Forrester *et. al.*, 1966a). Inhibition in the rate of net photosynthesis by high O_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.

P. KALADHARAN

Central Marine Fisheries Research Institute, Cochin-682 014