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CHAPTER 8

NITROGEN FIXING ACTIVITY ASSOCIATED WITH SUBTIDAL MACROPHYTES OF THE SEYCHELLES ISLANDS

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NITROGEN FIXING ACTIVITY ASSOCIATED WITH SUBTIDAL MACROPHYTES OF THE SEYCHELLES ISLANDS

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INTRODUCTION

The ability of microorganisms to fix dinitrogen has significance for the functioning of marine offshore ecosystems in oligotrophic oceanic regions. The most effective utilization of fixed nitrogen occurs in associations of nitrogen-fixing microorganisms with macrophytes where direct contact is present. There are many examples (e.g., Harlin and Craigie 1975, Wetzel and Penhale 1979) of intensive exchange of nitrogen, phosphorus and carbon between epiphytes and their host macrophytes. It is known (Jones and Stewart 1969) that macrophytes consume fixed nitrogen released by nitrogen-fixing epiphytes. In some macrophyte communities, the correlation between productivity and epiphytic nitrogen fixation has been shown (Capone et al. 1979). Epiphytic nitrogen fixing activity associated with brown algae such as *Sargassum* may be so high that 40% of the nitrogen requirements of the algae can be met by such nitrogen fixation, assuming that all of the fixed nitrogen is consumed (Carpenter 1972, Hanson 1977, Odintsov and Lapteva 1984, Odintsov 1988).

The objective of this work was to determine the significance of nitrogen-fixing epiphytes on subtidal seagrasses and seaweeds of the Seychelles Islands in regard to their role in providing island ecosystems with nitrogen nutrients.

METHODS AND MATERIALS

Abundant macrophytes such as *Thalassodendron ciliatum*, *Sargassum cristaefolium*, *Sargassum microcystum*, *Halimeda gracilis*, as well as the more uncommon algae *Caulerpa brachypus*, *Padina* sp., *Turbinaria ornata* and *Lobophora variegata*, were used in the experiments. Nitrogen fixing activity of epiphytes was determined by the acetylene reduction method (Stewart et al. 1967), except the samples were incubated without a gas phase and sampling for gas chromatography was done with evacuated vials (Odintsov 1981). The samples were incubated in natural light. During one experiment, half of the *Sargassum* samples were washed to remove epiphytes and determine the nitrogen fixation role of symbionts living inside the thalli, the other half were used to compare the levels of the more common epiphytic nitrogen fixation. Following the experiments, portions of the samples incubated were fixed for electron microscopic study.

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RESULTS AND DISCUSSION

The levels of nitrogen fixing activities associated with Seychelles subtidal macrophytes are presented in Table 1. Negligible nitrogen fixation was detected in the samples of *Thalassodendron ciliatum* and *Lobophora variegata* collected near Desroches Island, as well as in samples of *T. ciliatum* from Cöetivy Island (depth 26 m) and in samples of *Turbinaria ornata* incubated in the dark. Great differences in nitrogen fixation rates were observed in all other samples. The greatest activity was shown in specimens of *Sagassum cristaefolium* from Praslin Island and *Padina* sp., which was approximately the same as that shown by *Thalassia testudinum* and *Zostera marina* populations from temperate waters (Capone and Taylor 1979, Odintsov and Lapteva 1984). The rate of nitrogen fixation of the seagrass *T. ciliatum* was higher than that of pelagic *Sargassum* (Carpenter 1972, Hanson 1979) but lower than the rates recorded for temperate seagrasses. Therefore, populations of *T. ciliatum* do not appear to serve as an important nitrogen nutrient source for surrounding areas. Conversely, communities of *S. cristaefolium* with high biomass (Table 1) can show considerable N-fixation, similar to that of *Sargassum ilicifolium, S. polycistum* and *S. feldmannii* from the Thou Island area in the South China Sea (Odintsov 1988). Nitrogen fixing activity in a *Sargassum microcystum* community was comparable to that of temperate seagrasses having smaller biomass. Epiphytic nitrogen fixation in *Padina* sp. was high, but probably is important only for the host plant, because *Padina* sp. does not form communities. The same can be said concerning nitrogen fixation associated with *Turbinaria ornata, Halimeda gracilis* and *Caulerpa brachypus*.

Statistically significant decreases of nitrogen fixing activity in the dark was noted only in *Sargassum cristaefolium* from Praslin Island and *Padina* sp., in which photosynthetic nitrogen fixing epiphytes appear to be predominant. Nitrogen fixing epiphytes of *S. cristaefolium* are present in lightly washed mucous extracts and are not firmly attached to thalli. The exact location of such epiphytes awaits further electron microscopy study. It may be concluded that only *Sargassum* communities serve as important sources of nitrogen nutrients for surrounding ecosystems.

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Table 1. Epiphytic nitrogen fixation associated with macrophytes of the Seychelles Islands. * = values for dry weight; ** = data based on average fresh biomass of macrophytes in a community; *** = data based on average fresh biomass of macrophytes not forming community.

Species Place, Date	Depth(m)	Light	Nitrogen fixation ng $N_2 \cdot g^{-1} \cdot h^{-1}$*	 mg $N_2 \cdot g^{-1} \cdot day^{-1}$**	Number of measurments
Thalassodendron ciliatum					
Cöetivy, 17 Jan 89	3	+	5.6±7.0	0.5	3
	3	-	8.4± -0.1	0.75	3
	6	+	4.2±1.4	0.38	3
	6	-	21.8±10.9	2.47	3
	11	+	3.64±4.48	0.33	3
	11	-	3.36±1.96	0.30	3
	26	+	0	0	3
	26	-	13.1±162	1.18	3
Sargassum cristaefolum	washed				
Praslin, 13 Feb 89	2	+	368±128	9.85	10
	2	-	13.4±3.08	2.14	6
	unwashed				
	2	+	2017±259	63.5	9
	2	-	53.5±13.4	0.97	7
Sargassum microcystum					
Mahé, 17 Feb 89	1	+	255±70	3.75	10
	1	-	624±262	9.05	6
Sargassum cristaefolum					
Mahé, 17 Feb 89	1	+	2.24±6.72	0.03	3
	1	-	13.7±8.12	0.20	4
*Turbinaria ornata****					
Mahé, 17 Feb 89	1	+	0.28±1.4	0	6
	1	-	0	0	4
Padina sp.***					
Mahé, 17 Feb 89	0.5	+	2678±238	0	10
	0.5	-	12.0±5.04	0	4
Halimeda gracilis gracilis					
Cosmoledo, 9 Mar 89	5	+	15.3±4.14	0.32	9
Caulerpa brachypus					
Cosmoledo, 9 Mar 89	5	+	46.8±9.24	0	9