Pak. J. Bot., 39(6): 2097-2102, 2007.

EPIPHYTIC ALGAL BIOMASS ON PNEUMATOPHORES OF MANGROVES OF KARACHI, INDUS DELTA

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Abstract

The epiphytic algal biomass on pneumatophores of the grey mangrove *Avicennia marina* (Forssk.) Vierh., was estimated for the first time from the Indus Delta region during the northeast monsoon season. Its average value was 8.38±0.27mg DW cm^{-2} of pneumatophores surface area and 132.84±7.79 gm DW m^{-2} of mud surface comparable to some other areas in the world. The algae formed a thick felt-like covering on the entire length of the pneumatophores except for a small portion at the tip. *Vaucheria karachiensis* was the most prominent and dominant alga. The algae were more common in shaded areas and also during colder months.

Introduction

Food chains in mangrove habitats have long been supposed to be based on detritus derived from mangrove litter (Odum & Heald, 1972; Lugo & Snedaker, 1974). Recent studies have revealed that algae may also serve as an additional important source of carbon in the mangrove food web (Rodriguez & Stoner, 1990; Ewa-Oboho & Abby-Kalio, 1993). These algae are microscopic and grow very abundantly as benthic or epiphytic forms. Their rate of turnover is several times higher than that of the mangroves and as such contribute as much or even more to primary production than them (Rodriguez & Stoner, 1990). The Cyanobacteria (blue green algae) also serve as an extra and significant source of nitrogen in the oligotrophic mangrove habitats of arid climate regions (Potts, 1979).

A number of studies have been carried out to describe the composition of different types of epiphytic algae of aerial roots of the grey mangrove *Avicennia marina* (Venkataraman, 1961; Taylor, 1960; Islam, 1973; Lambert *et al*., 1987; Mandura *et al*., 1987; Tanaka & Chihara 1998; Saifullah *et al*., 1997) and also to estimate their biomass (Davey & Woelkeling 1985; Rodriguez & Stoner, 1990; Steinke & Naidoo, 1990; Narasimha Rao, 1995; Laursen & King, 2000). Taxonomy and morphology of the epiphytic algae on the mangroves in the Indus Delta have been reported recently (Tanaka & Shameel, 1992; Saifullah & Taj, 1995). The present work is a first attempt to assess the epiphytic algal biomass of pneumatophores of this species in the Indus Delta region.

Material and Methods

The present study was carried out in the backwaters of Karachi harbour (Lat. 24°, 49′ N; Long. 66°, 58′ E), Pakistan (Fig. 1 in Hassan & Saifullah, 1974) which forms the western most part of the Indus Delta (Saifullah *et al*., 1994) during the period 15.10.1995-08.02.1996, which includes mostly the northeast monsoon season. Although four species of mangroves have been reported to occur in the Delta only *Avicennia marina* (Forssk.) Vierh., dominates (Saifullah *et al*., 1994) and in fact it is the only species present in the area of study. The study area is highly polluted with the city's immense industrial and municipal wastes (Saifullah *et al*., 2002). The substrate is muddy with a large proportion of silt and clay and also rich in organic matter (Saifullah *et al*., 2002). Pneumatophores were sampled from near the low water mark in the shaded areas where mangroves were dense and also the algal epiphytes abundant.

Nine quadrants of size 25x25 cm^2 were sampled at different locations randomly on each occasion. Density and size of pneumatophores were recorded. The epiphytic biomass was measured in terms of length and breadth (diameter) of algal mass surrounding the pneumatophore (Fig. 2) and also as dry weight. The pneumatophores were counted, measured for size and cut off from the base and brought to the laboratory where the epiphytic algae were carefully removed. They were repeatedly washed to get rid of the mud and detrital particles as much as possible. Algae were then placed in an oven and left to dry at 80°C to a constant dry weight for one day it was collected. No attempt was, however, made to weigh the different species separately.

The average weight of epiphytic algae was divided by surface area of the pneumatophore to obtain dry wt., cm^{-2} of the pneumatophore surface. Surface area of the pneumatophore was calculated by the formula $2\pi rh = \pi dh$, Steinke & Naidoo, 1990). Similarly, the average algal dry weight per pneumatophore was multiplied by the number of pneumatophores present in a square meter area to get the dry wt. m^{-2} of the mud surface. Simultaneous observations on temperature and salinity values of seawater were also made employing a thermometer and a refractometer respectively.

Results and Discussion

The higher values of water temperature and salinity values recorded during the period of study are typical of warmer areas of the world (Fig. 1). There was a significant decrease in temperature from 33°C to 23°C with the onset of the winter or the northeast monsoon season, but salinity values on the contrary did not show any specific trend and varied between 34‰ to 38‰, which may be a result of interaction between periodic influx of runoff from the land and daily tidal fluctuations.

The epiphytic algal flora of pneumatophores of *A. marina* of Karachi area has already been described by Tanaka & Shameel (1992), Saifullah & Taj (1994) and Saifullah *et al*., (2003). Fourteen species belonging to phyla *Chlorophyta, Phaeophyta, Xanthophyta* and *Cyanobacteria* were reported: *Boodleopsis pusilla* (Collins) Taylor, *Chaetomorpha gracilis* Kutzing, *Entropmorpha torta* (Mert.) Reinbold, *Hincksia terminalis* (Krishnamurthy & Baluswami) Silva, *Rhizoclonium kerneri* Stockmeyer, *Bostrychia moritziana* (Sonder in Ktzing) J. Ag., *Caloglossa leprieurii* (Mont.) J. Ag., *Herposiphonia secunda* (C. Ag.) Amber, *Herposiphonia tenella* (C. Ag.) Schmitz, *Polysiphonia abscissa* Hooker and Harvey, *Hydrocoleum lyngbaceum* Kutzing, *Lyngbya majuscula* Gomont. *Phormidium ambiguum* Gomont, and *Vaucheria karachiensis* Saifullah, Nizamuddin and Gul.

The algae grew abundantly on the pneumatophores of *A. marina* in shaded areas of mangrove stands near the low water mark, which indicates that they avoid both exposure and desiccation. Davey & Woelkerling (1985) also found the same situation in Victoria, Australia. They grow all along the length of the pneumatophores except for a small part at the tip and occupy 70% to 81% of the surface (Fig. 2). The tips are devoid of algal growth most probably because of longer exposure than the lower part. The tubular filaments of the most abundant V*aucheria karachiensis,* adhered to pneumatophores on all sides forming a thick felt-like covering with a breadth ranging between 2.7 and 4.1 cm (Table 1). The fine mud particles deposited within the meshes of the thallus gave it a firm spongy consistency.

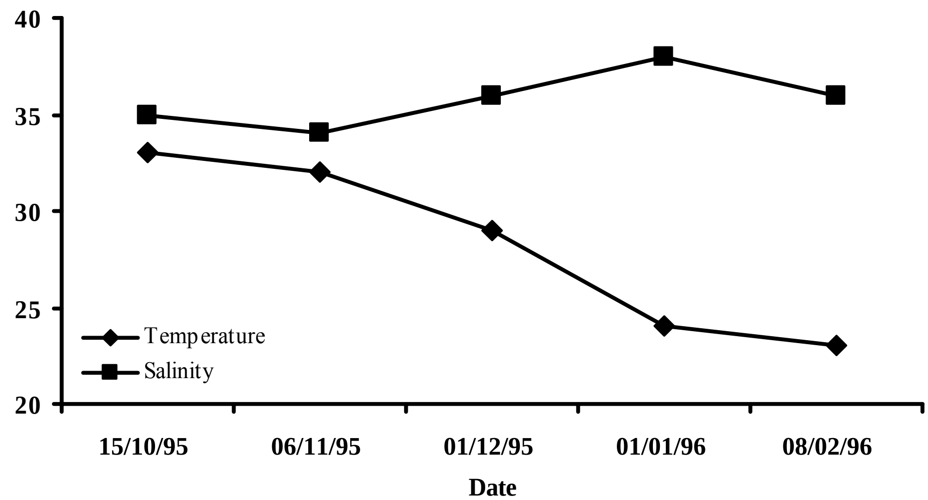

Fig. 1. Variations in water temperature (°C) and salinity values (‰) during the period of study.

Table 1. Average length and breadth of epiphytic mass (±SE) on pneumatophore.

Date	Length (cm)	Breadth (cm)
15/10/95	69.0 ± 4.8	2.7 ± 0.03
11/06/1995	71.4 ± 3.8	3.1 ± 0.17
12/01/1995	79.0 ± 3.9	3.4 ± 0.13
01/01/1996	81.0 ± 2.3	3.9 ± 0.33
08/02/1996	81.3 ± 4.9	4.1 ± 0.23
Mean	**13.97 ± 1.76**	**3.44 ± 0.11**

Table 2. Average pneumatophore density and average dry weight (DW) of epiphytic algae (±SE).

Sampling date	No. pneum. m^{-2}	DW mg / pneum.	DW mg cm^{-2} pneum. area	DW gm m^{-2} substrate
15/10/95	379 ± 17.83	260 ± 47	6.0 ± 1.10	098.50 ± 21.80
11/06/1995	408 ± 13.85	390 ± 23	8.9 ± 0.50	161.25 ± 13.36
12/01/1995	368 ± 33.34	400 ± 20	9.6 ± 0.70	148.33 ± 15.84
01/01/1996	331 ± 14.12	350 ± 19	8.7 ± 1.14	116.64 ± 02.98
08/02/1996	384 ± 33.34	360 ± 39	8.7 ± 0.90	139.50 ± 04.97
Mean	**374 ± 10.02**	**352 ± 12.64**	**8.38 ± 0.27**	**132.84 ± 7.79**

Observations were taken between October 15 and February 8, a period which includes the most favourable period of growth of intertidal seaweeds in the region (Anand, 1940; Saifullah, 1973, Narasimha Rao, 1995). Table 1 and 2 show the range in values of all the three parameters of epiphytic algal biomass. In general an increasing trend in all these values with the progression of the winter season is quite evident. Narasimha Rao (1995) also noted maximum biomass in winter in Godaway Estuary, India. On the contrary Steinke & Naidoo (1990) and Laursen & King (2000) reported higher values in summer in the southern hemisphere.

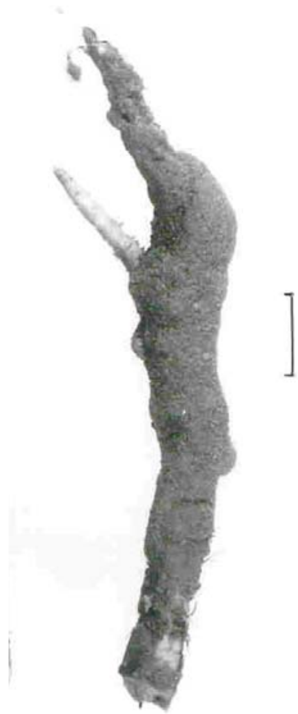

Fig. 2. Epiphytic algal growth on the pneumatophores of *A. marina* (scale =3 cm).

The dry weight of the epiphytic algae calculated per unit surface area of pneumatophores surface was comparable with those reported by other studies carried out in other areas. Laursen & King (2000) reported values of 6.25 to 16.00 mg DW cm^{-2} of pneumatophore surface form Woolware Bay, Australia as compared to values of 6.00-9.60 mg DW cm in the present study. Davey & Woelkerling (1985) also found similar values 7.18 mg DW cm^{-2} in Victoria, Australia. The value reported by Narasimah Rao (1995) as calculated by Laursen & King (2000) was more or less similar. However, when values were calculated per unit area mud surface they differ The average value in the present study is 132±11.79 SE gm DW m^{-2} mud surface (=1.33 tonnes DW ha^{-1}) (Table 2) which is more or less similar to that recorded by Laursen & King (2000) but significantly lower than reported by Steinke & Naidoo (1990). The difference may be accounted for in the variation in number and size of pneumatophores per unit area in the different localities and also different characteristics of the environment (Saifullah & Elahi, 1992; Laursen & King, 2000).

Rodriguez & Stoner (1990) reported the standing crop of the epiphytic algae approximately of same order of magnitude as that of the annual litter production in a Puerto Rican estuary and suggested that algal production could surpass the total mangrove input several times. If the turnover rate of algae be taken as 4 to 5 times per year as suggested by them, the standing crop of epiphytic algae in the present study will certainly be higher than the annual litter production estimated by Siddiqui & Qasim (1990) in mangroves of Karachi. Epiphytic algae, therefore, provide an important source of energy in the mangrove ecosystem in addition to the detritus as suggested by Odum & Heald (1972).

Acknowledgements

The authors would like to acknowledge the assistance of Mr. M. Khalid & Ms. Sadaf Gul in the laboratory and the field.

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(Received for publication 22 September 2007)