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Short Communication

Growth of *Rhizophora apiculata* in degraded areas of Ariyankuppam estuary along Pondicherry coastline, southeast coast of India

(K. Kathiresan, N. Rajendran & V. Palaniselvam)

Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai - 608 502, Tamil Nadu, India

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Rhizophora apiculata seedlings, planted artificially in a degraded mangrove area, were studied for growth as well as some physico-chemical parameters of the plantation site, in monthly intervals for two years. The plant growth was at higher rates in the first year of plantation and the growth rates of leaf and stilt roots were more in the following year. Thus the mangrove adapted with the degraded site within a year of transplantation, with an average growth rate of 3.6 cm/month. The plantation coincided with an increased bacterial load in sediments, without significantly influencing other physico-chemical parameters.

Mangrove forest is under great threat of disappearance along the Pondicherry coastline. The coastline from Marakkanam to Karaikal was once covered with thick mangrove vegetation¹. Their remnants as relics can be seen even now in the Marakkanam area, the Arasalar estuary in Karaikal and in Ariyankuppam river banks. Of these three areas, Ariyankuppam is worst-affected². Therefore, a mangrove plantation has been raised in a degraded site of the Ariyankuppam. Growth responses of *Rhizophora apiculata* and consequential physico-chemical changes were assessed for two years and is presented here.

The study area is Ariyankuppam estuary (lat. 11°54' N; long. 79°50' E), located in southern part of Pondicherry (Fig.1). The estuary is seasonally bar-built and it flows eastwards and empties into the Bay of Bengal at Veerampatinam on southeast coast of India, carrying the wastes from the adjacent agriculture lands and industries in addition to domestic municipal and distillery effluents.

Mature propagules of *Rhizophora apiculata* Blume (length of 28 ± 2 cm) were collected from Pichavaram mangrove forest in Tamil Nadu State (lat. 11°27' N; long. 79°47' E) and raised in a nursery at our Centre for 6 months. These seedlings were transplanted to the intertidal area of Ariyankuppam estuary during July 1995, with 1 m spacing between the seedlings. Growth of the mangrove seedlings was studied by measuring plant height, leaf characters (no. and area), shoot branch (no. and length), stilt root (no. and length), at monthly intervals for two years from 15th July 1995 to 15th June 1997. Physico-chemical parameters like salinity (using Hand Refractometer, Erma, Japan), pH

(pH pen, Hanna Instruments, Mauritius), silicates, nitrite, nitrate, ammonia and total phosphate³ were analysed in water, besides total heterotrophic bacterial counts⁴ in sediments of the plantation site.

The water salinity showed significant variation between months, but not between years of study (Table 1). The water pH remained almost constant at 7.7 ± 1.3 throughout the study. Similarly there was

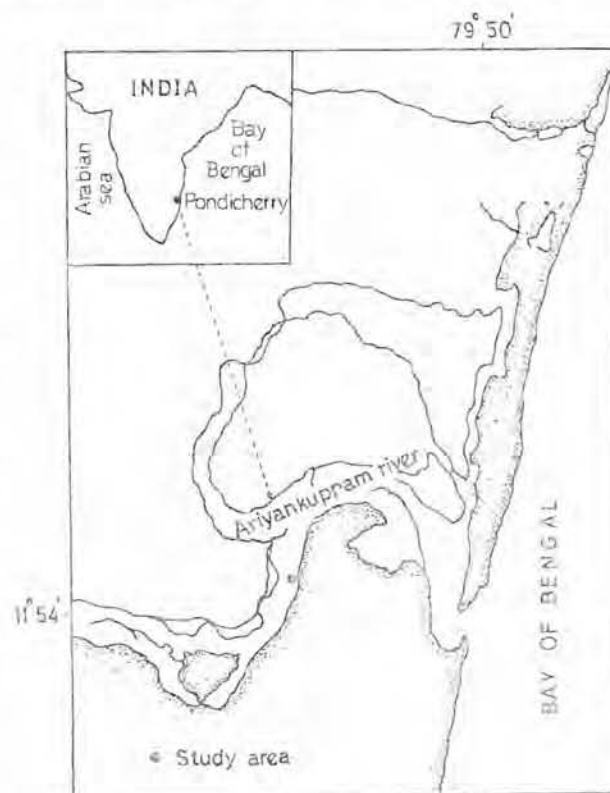


Fig. 1 — Map of the study area

neither monthly nor annual variation in the concentrations of silicate, nitrite, nitrate, ammonia and total phosphate in waters of the plantation site (Table 1). The bacterial counts during low tides were significantly higher by about 2-fold in the second year than the first year of plantation. However, the counts during high tides were neither significant between years nor months (Table 1).

The growth of stilt root was high in summer. For instance, the length of stilt root was 43.4 cm in April 1997 (summer) and 30.3 cm in March 1997

(postmonsoon) and thus the root elongation increased by 43.2% on the onset of summer over postmonsoon (Fig. 2a). The number of stilt roots produced per sapling was 0.65 per month in 1995-96 and 8.3 in 1996-97 (Fig. 2b) and thus there was 12.8-fold increase in number of roots in the second year of plantation. The average length of stilt root was 14.5 and 49.5 cm respectively in the first and second year of plantation and thus 3.4-fold increase in growth between the two years of plantation.

The number of leaves per sapling was 43.0 and 149.0 respectively during the first and second years of plantation (Fig. 3a) and thus there was 3.4-fold increase in leaf formation in the second year of plantation. The leaf area ranged from 33.9 cm²/sapling in July 1995 to 6013.4 cm²/sapling in June 1997 (Fig. 3b). There was a significant variation in leaf area between two years of plantation; the area per month was 685.2 cm² in the first year and 3788.4 cm² in the second year. Thus there was a 5.5-fold increase in growth of leaves in the second year of transplantation. The number of leaves sprouted between years were statistically significant, but not between months; however, the leaf area was highly significant between either months or years (Table 1).

The number of shoot branches per sapling was 0.69 in July 1995, which increased to 32.6 in June 1997 and thus about 32 branches were produced in two years (Fig. 4a). There was a significant difference in number

Table 1—ANOVA for seedling growth, physico-chemical and microbial counts

Source of variation		Variation ratio and significance
<i>Physico-chemical parameters</i>		
Salinity	(A)	3.6*
	(B)	0.9 NS
pH	(A)	1.1 NS
	(B)	3.0 NS
Silicate	(A)	0.7 NS
	(B)	0.8 NS
Nitrite	(A)	1.0 NS
	(B)	0.0 NS
Nitrate	(A)	1.2 NS
	(B)	2.6 NS
Ammonia	(A)	0.7 NS
	(B)	0.0 NS
Total phosphate	(A)	1.0 NS
	(B)	2.9 NS
<i>Microbial counts in sediments</i>		
Low tide	(A)	1.3 NS
	(B)	6.4*
High tide	(A)	0.9 NS
	(B)	2.5 NS
<i>Growth attributes</i>		
Number of stilt root	(A)	2.5 NS
	(B)	1119.7**
Stilt root length	(A)	4.9*
	(B)	131.7**
Shoot length	(A)	7.3**
	(B)	178.5**
Number of leaves	(A)	2.5 NS
	(B)	85.7**
Leaf area	(A)	5.2**
	(B)	153.8**
Number of branch	(A)	4.0*
	(B)	167.2**
Branch length	(A)	1.9 NS
	(B)	2.5 NS

A—Among month of analysis (Degree of freedom = 11)

B—Between two years of studies (Degree of freedom = 1)

*—5% Significant

**—1% Significant

NS—Non-significant

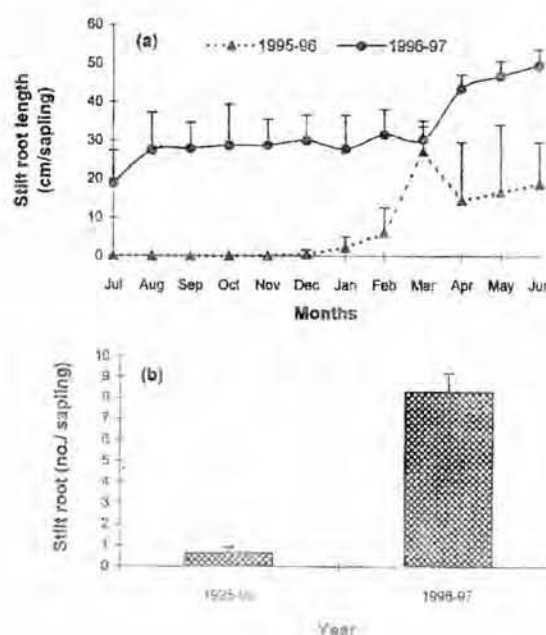


Fig. 2—Length of stilt root (cm/sapling) (a) and number of stilt roots (no./sapling) (b) produced by *Rhizophora apiculata*.

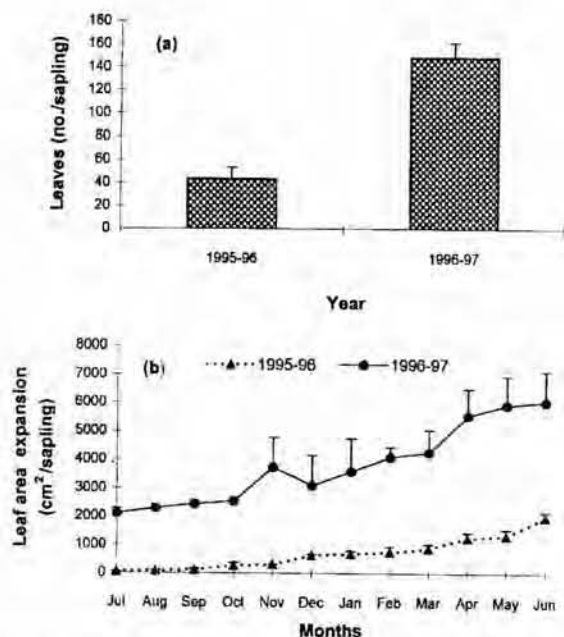


Fig. 3—Number of leaves (no./sapling) (a) and leaf area (cm²/sapling) (b) produced by *Rhizophora apiculata*

of shoot branch: in the first year the sapling produced 4.2 branches per month and in the second year the sapling developed 21.7 branches per month. Thus there was a 5.2-fold increase in initiation of shoot branches in the second year as compared to the first year. However, the data of number of shoot branch were alone showed statistical significance either between months or years, but not the data of length of shoot branch (Table 1).

The shoot length during the time of transplantation was 21.4 cm in July 1995, which enhanced to 109.8 cm in June 1997 (Fig. 4b). Thus the shoot grew by 88.4 cm within 24 months. Average shoot height was 51.5 cm/month in 1995-96 and 92.9 cm/month in 1996-97. Thus there was 1.8-fold increase in shoot growth in the first year than in second year. The data were statistically significant between either months or years of analyses (Table 1).

The growth rate of the mangrove species *R. apiculata* in Ariyankuppam was 3.6 cm/month, which is lower, perhaps due to the degraded site, than that in other places of Tamil Nadu coast : 6.3 cm/month in Pichavaram mangrove estuary⁵ and 9.83 cm/month in Vellar estuary^{5,6}.

It is clear from the data that the sapling showed several fold higher growth in the second year than the

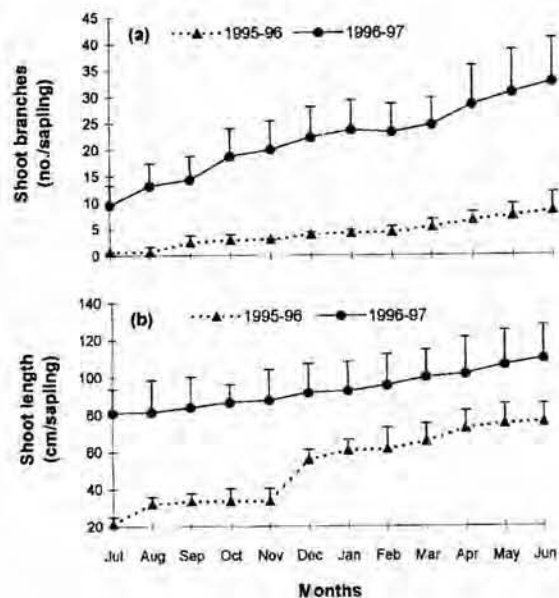


Fig. 4—Number of shoot branch (no./sapling) (a) and shoot length (cm/sapling) (b) produced by *Rhizophora apiculata*

year of transplantation. Thus the mangroves adapt with new environment within a year of transplantation, perhaps a unique feature of mangrove seedlings for establishment. The mangrove plantation coincides with an increased bacterial load in sediments in the plantation site, without significantly influencing other physico-chemical parameters, in a two year-period of plantation.

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