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EVALUATION OF THEGROWTH PERFORMANCES OF THE PROPAGULES OF SELECTED MANGROVE SPECIES ALONG KADALUNDI-VALLIKKUNNUCOMMUNITY RESERVE, KERALA, INDIA.

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ABSTRACT: The contribution of mangroves in enhancing biodiversity and stabilizing coastal environments is widely accepted. The present study has been undertaken to demarcate regions ideal for the introduction of species of *Rhizophora* and *Bruguiera* in the core as well as buffer areas of Kadalundi Bird Sanctuary and Community Reserve, falling in Kozhikode and Malappuram districts of Keralastate India.

Collection of sediment and water samples was carried out for analytical purposes and growth studies from various zones of the reserve in pre monsoon and monsoon seasons. The physico-chemical characteristics of water and sediment samples were analyzed following standard procedures.For growth studies, mature propagules of *Rhizophora*and *Bruguiera*were planted in respective sediment samples collected from varying zones of the reserve, retained in plastic pots under laboratory conditions. Water samples collected from respective zoneswere frequently fed to the sediment samples for maintaining adequate water levels. Growthparameters like height and weight of propagules, number of roots, leaves and leaf area were carried out at various stages of growth.

Analytical results of water qualityrevealed comparatively higher concentrations of salinity, chloride and hardness in pre-monsoon than monsoon season. The spread of salinity and associated parameters were noted to be in accordance with the proximity of the zone under study with respect to the sea. Also the organic carbon and percentage clay content of the sediment samples were noted to be higher in the premonsoon than monsoon season.Results of germination studies showed that pre monsoon season is ideal for the introduction of both Rhizophora and Bruguiera species. Zone I is observed to be ideal for the introduction of*Rhizophora* species, whereas zone IV is unsuitable. Almost all zones, except IV were noted to be ideal for the introduction of *Bruguiera* species.

Key words: Mangroves, afforestation, *Kadalundi Bird Sanctuary and Community Reserve*, *Rhizophora* and *Bruguierasps.*

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INTRODUCTION

The ecotones between aquatic and terrestrial environments are unique habitats. Mangroves are plant formations of the tropical and subtropical regions, predominantly occupying at the interface between land and the sea [1]. These unique plant communities also occur in estuarine habitats created by the confluence of inland water bodies like rivers, lakes and backwaters with the sea. They form patches of vegetation of salt-tolerant species, with complex food webs and ecosystem dynamics [2, 3, 4].

Mangrove ecosystems are highly productive, but extremely sensitive and fragile. In spite of their immense role in protecting human resource as well as biodiversity, these unique habitats have been facing tremendous threats due to various factors. Mangrove forests continue to disappear all over the world. They were estimated to cover 18.1 million km^2[5] but a recent estimate indicates that the figure is nearing 15 million km^2.Conservation of mangrove vegetation need to be given top priority in the context of the predicted scenarios of global warming, sea level rise and other natural as well as manmade disturbances [6].

Mangrove forests in Kerala, which once occupied to an extent of 700km^2, have dwindled to 17 km^2[7]. As in other parts of the world, the vegetation has diminished in its extent drastically and has acquired a threatened state in Kerala [8]. Most of the mangrove areas (89%) in Kerala are owned by private owners. A survey of mangroves has been conducted in the maritime districts of Kerala during 2001-2003. It has been observed that mangroves South of Cochin is in highly degraded condition, mainly due to anthropogenic interferences. Coastal areas of Kerala are thickly populated and hence encroachments into the mangroves are rampant, besides overexploitation of forest and aquatic resources.

The goal and objective of mangrove rehabilitation programs vary widely from case to case, including commercial forestry purposes, restoring fisheries habitats, shoreline protection, sustainable multiple community use purpose and ecological restoration. In the site selection for mangrove planting, numerous site characteristics should be considered, including the stability of the site, rate of siltation, soil and water characteristics, degree of exposure to waves and tidal currents, depths and tidal inundation, height of water table, availability of fresh / marine water, presence of pests, availability of propagules, signs of natural regeneration etc. In the present study, a preliminary attempt has been carried out to assess the possibilities of introducing *Bruguiera sp*. and *Rhizophora sp*., based on water and sediment characteristics, in heterogeneous habitats of Kadalundi–Vallikkunnu Community Reserve, which is facing ecological disturbances from various directions.

MATERIALS AND METHODS

Study area

The Kadalundi estuary (75^o 49$'$ 20$'$ E longitudes and 11^o 07$'$ 20$'$ N latitudes)is located at the mouth of Kadalundi River, which debouches into the Arabian Sea in the west. The estuaryhas been officially declared as a Bird Sanctuary and also as Kadalundi-Vallikunnu community reserve in 2007.The reserve occupies and area of 1.5 sq. km. of Kozhikode and Malappuram districts of Kerala state (Figure 1). The region harbors high extent of avifaunal diversity, represented by 110 species of water birds of which 53 are migrants (ENVIS Centre, Kerala). Considering various pressures on this unique habitat, including anthropogenic, several management measures are proposed of which mangrove afforestation is of top priority. The present study attempts to demarcate regions ideal for species specific mangrove afforestation in Kadalundi-Vallikkunnu community reserve for the enhancement of its biodiversity.

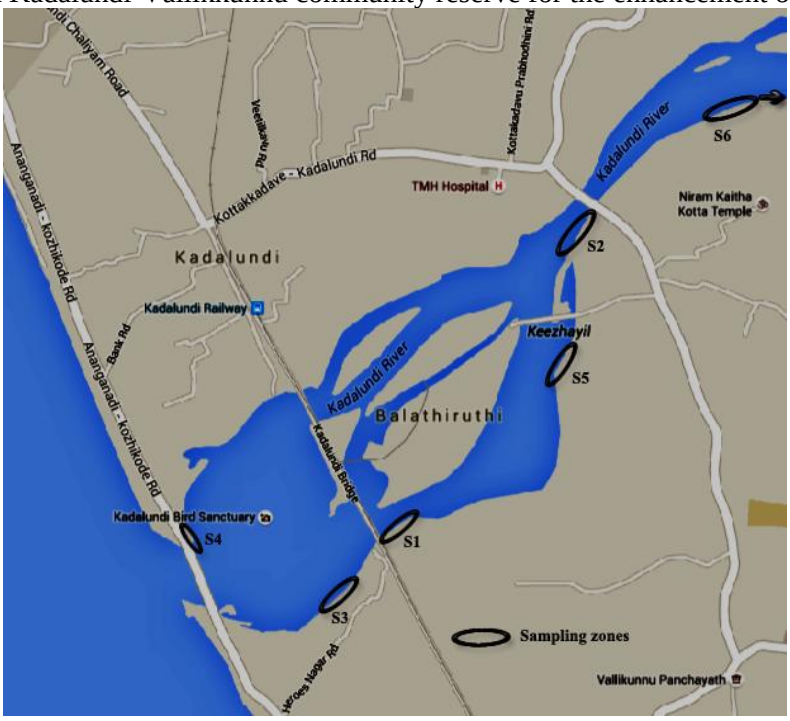

Figure-1. Sampling Locations

Sample collection, analysis and laboratory trials

Regions of the community reserve were assessed and zones apparently ideal the growth of mangroves were selected. Details of zone selected for the study are given in Table 1. Both water and sediment samples in bulk from all the six zones were collected during pre-monsoon and monsoon seasons. Representative samples, both water and sediment, from the bulk samples were subjected to the analysis of various physico chemical parameters following standard methods [9,10,11].

Table-1 Description of sampling zones

Sampling zones	Description of the sampling zones
S -1	Regions adjoining Kadalundi railway bridge
S -2	Regions on either sides of Kadalundi river, upstream to the estuary
S -3	Regions adjoining Kadalundikadavu canal
S -4	Regions west to the reserve near to beach
S -5	Mudflats of the river nearer to Balathuruthi pipe bridge
S- 6	Regions on either sides of the river at Olipramkadavu, much upstream to the estuary

Germination studies of selected mangrove species were carried out in the laboratory using sediment and water samples collected from the community reserve, as field level germination studies are likely to be hindered due to anthropogenic disturbances. Germination studies were also carried out for two seasons, representing pre-monsoon and monsoon. Mature propagules of *Bruguiera* and *Rhizophora* were brought from their natural habitats at Kannur District, Kerala. For germination studies, pots of size 20 cm height and 20 cm diameter were properly labeled and each of them was filled with corresponding sediment sample from the respective zone, up to a height of 12 cm. Propagules of *Bruguiera* and *Rhizophora*, each with almost similar height and weight were planted in each pot. The pots were wetted with water samples from the corresponding sites. The treatment sets were maintained in the garden under a net house. A germination trials were carried out for both pre-monsoon and monsoon seasons. The growth parameters of the propagules were analyzed at two stages of growth (initial and 45^{th} day). On 45^{th} day after planting, the propagules were uprooted and their growth attributes like total weight, number of leaves, leaf area, weight of shoot, number and weight of root, etc. were analyzed. The results are reported.

RESULTS AND DISCUSSION

The results of the physico-chemical characteristics of water and sediment samples collected during pre-monsoon and monsoon seasons are represented in Table 2. Results of the germination studies of *Rhizhophora* in pre-monsoon and monsoon seasons are represented in Table 3and that of *Bruguiera* in Table-4.

Upon comparing the water quality, marked differences in the results were noticed in the pre monsoon season compared to monsoon season. Parameters like pH, acidity, total alkalinity, total hardness, chloride and salinity were higher with pre monsoon water samples, whereas conductivity, resistivity and total solids were higher during monsoon season. Increase in hardness, chloride and salinity content can happen in estuarine systems during pre-monsoon season due to low discharge of fresh water into the estuarine systems due to poor stream flow. Upon comparing the water quality of various zones from which water samples were collected during pre-monsoon season, zone IV indicated highest values of salinity and related parameters like electrical conductivity, total dissolved solids, total hardness and chloride content whereas zone VI was found to have lesser salinity. A similar pattern of spread of salinity was also noticed during monsoon season. It is thus evident from the results that the distribution of salinity and associated parameters within the estuary was in accordance with its proximity with the sea.

Similarly, amongvarious physico chemical characteristics of sediment samples studied,moisture percentage, organic carbon and percentage ofsand content was higher inthe pre-monsoon season. Values of pH, percentage content of silt and clay were noticed to be higher in the monsoon season. Organic carbon of sediment has got immense impact on the growth of different mangrove species. The results of the presentstudy showed lower and higher values of sediment organic carbon at Zone IV and V respectively during pre-monsoon season. In accordance with the range of organic carbon, variation in percentage of clay content was also observed in these Zones. In the monsoon season, Zone VI was found to have maximum values for organic carbonand percentage clay content whereas, Zone IV showed lowest values for both.

As far as germination studies concerned, pre monsoon season was noted to be ideal for the growth of *Rhizophora* propagules than monsoon season. This was evidenced by increased weight of propagules, increased number and weight of roots and increased number of leaves. Among various zones supporting growth, sediment and water samples from zone I during pre-monsoon season was found to favour the growth of *Rhizophora* propagules. Least growth was noticed with Trial No. IV. The reasons for the inhibition in growth of the propagules in zone IV might be due to lack of adequate organic matter in the sediment which can support growth. Moreover the osmotic imbalances due to high salinity might have resulted in the poor growth performances of the propagules from trial IV, evidenced by decrease in weight (4.75 and 28.73%) in post planting stage compared to pre planting stage.

Table-2. Analytical results of the physico-chemical characteristics of water and sediment samples collected during pre-monsoon and monsoon seasons.

S.No.	Parameters	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Mean value
I.	Water quality (premonsoon)							
1	pH	7.13	7.61	7.39	7.96	7.57	7.52	7.53
2	Acidity (mg/l)	22.00	17.6	26.4	17.6	22	17.6	20.53
3	Total alkalinity (mg/l)	270	320	190	170	190	170	218.3
4	Electrical conductivity (millisiemens)	48.68	49.14	46.02	92.82	48.61	45.13	55.07
5	Resistivity (ohm)	19.77	19.94	21.19	10.5	20.14	21.7	18.87
6	Turbidity (NTU)	6.6	12	6.5	6.1	7.2	2.9	6.88
7	Total dissolved Solids (ppt)	25.16	25.2	23.58	47.12	24.91	23.08	28.18
8	Total hardness (mg/l)	6450	5950	5650	6650	6000	5750	6075
9	Chloride (mg/l)	15243	15952	14889	18079	13116	13825	15184
10	Salinity (ppt)	33.92	33.66	30.69	34.47	32.71	30.4	32.642
II.	Water quality (monsoon)							
1	pH	6.34	6.51	6.32	7.11	7.50	7.39	6.862
2	Acidity (mg/l)	6.6	4.4	8.8	3.6	4.4	4.4	5.367
3	Total alkalinity (mg/l)	80	50	80	170	50	40	78.33
4	Electrical conductivity (millisiemens)	9.057	3.791	3.942	51.30	3.780	467.4	89.88
5	Resistivity (ohm)	108	257.9	247.7	19.05	259.3	2.09	149
6	Turbidity (NTU)	1.5	7.5	3.9	15.7	3.7	8.7	6.83
7	Total dissolved Solids (ppt)	4.621	1.939	2.015	26.24	1.937	239.6	46.06
8	Total hardness (mg/l)	1100	500	500	6000	600	100	1467
9	Chloride (mg/l)	14995.35	7997.52	8997.21	16348.9	5998.14	3998.76	9723
10	Salinity (ppt)	5.259	2.072	2.172	35.33	2.055	2.323	8.20
I.	Sediment quality (pre monsoon)							
1	pH	8.50	8.07	8.55	9.25	7.33	7.30	8.167
2	Moisture percentage	26.35	13.10	25.20	4.71	25.16	21.10	19.47
3	Organic carbon	2.49	1.56	1.28	0.24	14.15	11.12	5.14
4	Sand (%)	97.39	87.77	86.00	88.81	62.57	45.88	78.07
5	Silt (%)	1.68	11.71	12.51	10.90	15.24	25.43	12.91
6	Clay (%)	0.92	0.50	1.48	0.27	22.17	28.68	9.00
II.	Sediment quality (monsoon)							
1	pH	7.70	7.28	7.40	8.03	6.89	6.75	7.342
2	Moisture percentage	19.32	18.08	19.67	18.38	24.08	23.56	20.52
3	Organic carbon	5.94	1.44	5.83	2.06	11.39	29.70	9.39
4	Sand (%)	50.37	92.49	95.94	97.28	71.56	69.64	80.21
5	Silt (%)	48.42	6.88	3.07	2.59	4.31	2.25	11.25
6	Clay (%)	1.00	0.62	0.97	0.12	23.38	29.11	8.37

Similarly the growth of the propagules of *Bruguiera* species was noted to be higher during pre-monsoon season than monsoon season. Almost all zones under study showed efficiency to sustain the growth of species during pre-monsoon season. However during monsoon season, zone IV is noted to be unsupportive for the growth of *Bruguiera* species. The reasons for the growth of mangrove propagules in specific zones can be attributed to the sediment characteristics of the region together with the presence of salinity and associated parameters in optimum dosages supporting the growth of mangrove propagules.

Table-3. Results of germination studies on *Rhizophora* propagules during pre-monsoon and monsoon seasons

Trial No	Pre planting	Post planting							
	Total weight of propagule (g)	Total weight of propagule (g)	% increase in weight	Weight of propagule (g)	Weight of shoot (g)	Weight of root (g)	Number of roots	Number of leaves	Leaf area (sq. cm)
I. Premonsoon									
I	50.975 ±6.284	59.158 ±7.591	13.83	52.41 ±6.876	2.043 ±0.173	4.388 ±0.684	24 ±4.082	2.0 ±0	9.308 ±1.474
II	49.02 ±3.811	55.033 ±5.152	10.92	49.755 ±4.081	1.435 ±0.222	3.310 ±0.771	17.5 ±3.873	1.0 ±1.155	2.948 ±3.513
III	54.652 ±11.13	61.853 ±12.40	11.64	55.644 ±11.035	1.94 ±0.451	3.530 ±1.289	22.5 ±7.937	2.0 ±0	7.398 ±1.070
IV	36.60 ±1.555	40.523 ±2.308	9.68	36.750 ±1.614	1.180 ±0.139	2.463 ±0.839	14.5 ±3.416	1.5 ±1	4.328 ±2.888
V	34.632 ±5.366	37.658 ±5.541	8.04	33.333 ±5.240	1.570 ±0.406	2.628 ±0.891	15.5 ±4.5	1.5 ±1	7.215 ±5.157
VI	42.972 ±8.144	48.845 ±9.301	12.12	44.505 ±8.283	1.496 ±0.343	2.610 ±0.942	18.0 ±3.916	1.75 ±0.5	5.870 ±2.283
Mean values	44.81 ±6.043	50.51 ±7.044	11.04	45.399 ±6.188	1.61 ±0.289	3.09 ±0.903	18.66 ±4.621	1.63 ±0.943	6.18 ±2.731
II. Monsoon									
I	44.343 ±3.686	50.430 ±5.635	12.07	45.945 ±4.236	2.048 ±0.711	2.520 ±1.097	12.0 ±3.367	1.5 ±1	10.640 ±7.436
II	42.848 ±18.121	49.925 ±21.934	14.19	45.085 ±19.616	2.418 ±1.007	2.305 ±1.313	20.25 ±6.551	2.0 ±0	14.568 ±7.607
III	46.180 ±16.730	52.430 ±18.590	11.92	48.050 ±17.226	2.028 ±0.802	2.348 ±0.911	25.25 ±16.07	2.0 ±0	9.248 ±2.219
IV	46.928 ±8.348	44.800 ±7.149	-4.75	43.175 ±7.178	0.230 ±6.061	1.395 ±0.816	10.75 ±3.304	0.0 ±0	0.00 ±0
V	41.908 ±14.475	49.480 ±17.330	15.30	44.690 ±15.339	2.453 ±1.331	2.343 ±0.964	15.75 ±4.573	2.0 ±0	12.23 ±7.576
VI	46.680 ±13.206	52.633 ±14.172	11.31	50.065 ±13.728	1.500 ±0.904	1.608 ±0.937	19.25 ±14.0	1.25 ±0.957	7.613 ±7.134
Mean values	46.14 ±12.34	49.94 ±14.14	10.01	46.17 ±14..53	1.77 ±1.80	2.09 ±1.01	17.21 ±7.98	1.46 ±0.24	9.05 ±5.33

Table-4: Results of germination studies on *Bruguiera* propagules during pre-monsoon and monsoon seasons

Trial No.	Pre planting	Post planting							
	Total wt. of propagule (g)	Total wt. of propagule (g)	% increase in weight in %	Weight of propagule (g)	Weight of shoot (g)	Weight of root (g)	Number of roots	Number of leaves	Leaf area (sq. cm)
I. Pre monsoon studies									
I	4.57 ±0.622	4.92 ±0.710	7.46	4.44 ±0.624	0.0675 ±0.053	0.362 ±0.160	16.25 ±12.59	1.5 ±1.0	0.572 ±0.460
II	3.962 ±0.311	4.087 ±0.550	2.89	2.8421 ±1.926	0.075 ±0.071	0.287 ±0.211	13 ±17.83	1.01 ±1.15	0.468 ±0.559
III	3.63 ±0.335	4.22 ±0.369	13.9	3.66 ±0.041	0.167 ±0.020	0.392 ±0.051	10.74 ±5.38	2 ±0.0	0.902 ±0.052
IV	4.39 ±0.257	4.63 ±0.352	5.07	3.215 ±2.153	0.058 ±0.071	0.323 ±0.215	9.25 ±13.26	0.5 ±1.0	0.223 ±0.448
V	4.16 ±0.282	4.37 ±0.503	4.75	3.022 ±2.02	0.113 ±0.076	0.3075 ±0.220	9.25 ±6.449	1.5 ±1.0	0.685 ±0.497
VI	3.87 ±0.227	4.33 ±0.298	10.69	3.762 ±0.188	0.2 ±0.159	0.3675 ±0.188	12.75 ±6.24	3.0 ±1.15	0.917 ±0.446
Mean values	4.097 ±0.34	4.426 ±0.46	7.465	3.49 ±1.15	0.113 ±0.448	0.339 ±0.17	13.54 ±10.29	1.59 ±0.708	0.627 ±0.412
II. Monsoon studies									
I	3.50 ±1.49	3.82 ±1.815	8.38	3.17 ±1.55	0.342 ±0.124	0.312 ±0.142	33.2 ±7.085	2 ±0	2.805 ±0.611
II	2.82 ±0.372	2.86 ±0.448	1.39	2.45 ±0.33	0.184 ±0.102	0.228 ±0.053	28.6 ±16.056	1.6 ±0.894	1.802 ±1.285
III	4.06 ±0.682	4.388 ±0.796	7.47	3.65 ±0.77	0.386 ±0.064	0.35 ±0.033	42.2 ±10.780	2 ±0	3.035 ±0.612
IV	4.48 ±1.148	3.48 ±0.939	-28.73	3.31 ±0.91	0.014 ±0.019	0.164 ±0.018	1.6 ±1.345	0	0
V	4.29 ±0.778	4.548 ±0.743	5.86	3.85 ±0.82	0.358 ±0.205	0.342 ±0.033	32.8 ±8.229	1.6 ±0.894	2.836 ±1.708
VI	3.867 ±0.227	4.478 ±0.656	6.88	3.83 ±0.53	0.302 ±0.161	0.33 ±0.070	41.4 ±2.408	1.6 ±0.894	2.27 ±1.544
Mean values	3.836 ±0.78	3.93 ±0.897	0.21	3.33 ±0.81	0.264 ±0.113	0.288 ±0.058	29.97 ±7.77	1.46 ±0.59	2.12 ±0.958

SUMMARY AND CONCLUSION

Upon generalization of the experimental trials, it has been noticed that soil / sediment / water samples from all sites, except those from zone IV are found to enhance the early growth of propagules of *Rhizophora* sp.and*Bruguiera* sp. Pre monsoon samples, rich in all quality parameters analyzed, were found to enhance the growth of mangrove propagules. The inhibition in growth of the propagules in zone IVmight be due to the lack of adequate organic matter in the soil / sediment sample and also due to the osmotic imbalances due to high salinity in water.

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REFERENCES

[1] Shali John. 2012. Inter-variability of Phosphorous speciation in selected mangrove ecosystems around Greater Cochin. Ph.D Thesis submitted to Cochin University for Science and Technology.

[2] Macnae, W. 1968. A General account of fauna and flora of mangrove swamps in the Indo West Pacific region. Advances in marine biology, 6:73-270.

[3] Lugo, A. E. and Snedaker, S.C. 1974. The ecology of mangroves. Annual review of Ecology and systematics, 5:39-64.

[4] Tomlinson, P. B. 1986. The Botany of Mangroves, Cambridge University Press, Cambridge, pp. 274–282.

[5] Spalding, M. 1997. The global distribution and status of mangrove ecosystems. International News Letter of Coastal Management-Intercoast Network, Special edition 1, Pp. 20-21.

[6] Deshmukh, S.V. 1991. Mangroves of India: Status Report. Global Network of Mangrove Genetic Resource Center.

[7] Ramachandran, K. K., Mohanan, C. N., Balasubramonian, G., Kurian, J., Thomas, J. 1986. The mangrove ecosystems in Kerala, its mapping, inventory and some environmental aspects, A project progress report submitted to the State Council for Science, Technology and Environment.

[8] Basha, S. C. 1991. Distribution of mangroves in Kerala. Indian Forester 117 (6):439-448.

[9] APHA. 2005. Standard method for the examination of water and waste water, 21st edition. American Public Health Association, Washington, DC.

[10] Ehrhardt, M. and Koeve, W. 2007. Determination of particulate organic carbon and nitrogen, in Methods of Seawater Analysis, Third Edition (eds K. Grasshoff, K. Kremling and M. Ehrhardt), Wiley-VCH Verlag GmbH, Weinheim, Germany.

[11] Trivedi, R.K., Goel, P.K. and Trishul, C.L. 1987. Practical methods in Ecology and environmental science. Environmental Publication, Karad, Pages 340.

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