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MANGROVES OF MIANI HOR LAGOON ON THE NORTH ARABIAN SEA COAST OF PAKISTAN

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Abstract

The mangrove stand of Miani Hor, a subtropical lagoon located within the coastal belt of Pakistan bordering North Arabian sea, is small yet the most diverse in the area and comparable with other mangrove stands of the world. Of the 3 species viz., *Avicennia marina* (Forssk.) Vierh. *Rhizophora mucronata* Lam., and *Ceriops tagal* (Perr.) C.B. Robinson present in the area, the first two were found to be dominant. Their zonation pattern is not uniform but changes with the topography of the habitat. The mangroves are facing serious problems of over exploitation and progressive sedimentation in the lagoon.

Introduction

The coastline of Pakistan is 1050 km. long out of which 800 km belongs to Balochistan province and 250 km to Sindh province. Sindh's coast is covered with dense growth of mangroves in the Indus Delta (Saifullah, 1982), while the former has poor growth. There are only three small pockets of mangroves along the Balochistan coastline covering a total area of only 18,350 acres (Mirza *et al.*, 1988). These are Miani Hor, Kalmat Khor and Gawatar Bay. The mangroves of Balochistan so far have received little attention by ecologists (Saifullah, 1992). Rasool & Saifullah (1996) and Saifullah & Rasool (2001) studied mangroves of Kalmat Khor and Gawatar Bay respectively while Kogo *et al.*, (1980) made a few observation on the mangroves of Miani Hor. The present report describes the mangroves of a subtropical lagoon Miani Hor, on the North Arabian sea coast of Pakistan.

Material and Methods

Study area: Miani Hor (25° 31' N, 66° 20 ' E) is a lagoon situated some 90 km away from Karachi on the eastern part of the Balochistan coast (Fig 1). It is a 60 km long 4-5km wide tortuous and contorted body of water, which is connected to the sea by a 4-km wide mouth. The lagoon takes a sharp left turn in western direction, a short distance from its entrance and then runs parallel to the shoreline in the shape of an arc. The average width of the lagoon including mangrove belt is 7 km but it may be as wide as 10 km at some locations. The total area of the bay is 363.3 sq.km and the shelf adjacent to it is only 80 km wide. Two ephemeral rivers, Porali and Windor, enter into the bay in the centre and near its mouth respectively (Fig.1). The basin of the Porali river is 11,500 sq. km with a runoff of 70 mm and an average outflow of 900 cusecs, which is the largest for any other rivers in Balochistan (Verheijen, 1998).

Two sites Gut and Bargashi were studied in Miani Hor (Fig 1). The vegetation analysis was carried out during September and December 1993, following the methods of Curtis (1959), Curtis & McIntosh (1951) and Cintron & Novelli (1984). At all sites usually three quadrats of 10 x 10 m were taken along a vertical transect from waterfront towards the land. All the trees within the quadrats with (diameter at breast height) dbh more than 3 cm for *Avicennia marina* (Forssk.) Vierh, 2.5 cm for *Rhizophora mucronata* Lam., and 2 cm for *Ceriops tagal* (Perr.) C. B. Robinson were counted and measured for their canopy height, canopy cover and basal area. Canopy cover was determined by the formula C= ¶ [(a×b)/4] where a and b are two perpendicular diameters. Complexity indices were calculated on 0.1 ha basis for each of the sites (Holdridge, 1967). This index is traditionally used to compare structural patterns and relative vigour of different mangrove forests. The complexity index was computed as the product of s, d, b, h, 10^{-3}, where (s) is number of species, (d) stand density, (b) basal area and (h) height.

Temperature and salinity measurements were made both of sea water and pore water employing a thermometer and refractometer, respectively. Dissolved oxygen was measured with the help of Hanna Marine Science kit.

Soil samples were collected from each quadrat with a corer from a depth of 20 cm and were studied for soil texture. They were first treated with H_2O_2 then HCl and finally washed with water to get rid of chlorides. The cleaned soil was then wet filtered through a sieve of 60 μm mesh size. The amount retained belonged to sand fraction and that passed through the filter to mud fraction, which according to Tait (1981) includes only silt and clay fraction. Organic content of the soil was determined by dry oxidation method (Snedaker & Snedaker, 1984).

Results and Discussion

Chaudhri (1961) categorised the Balochistan coastal area climatically as a subtropical maritime desert while Köppen (1936) referred it as arid and hot desert. The annual rainfall is very low and never exceeds an average of 200 mm per year. The monsoon does not affect Balochistan coast directly but indirectly and therefore the rainfall occurs in winter. However, Miani Hor is an exception where rainfall occurs during the Southwest monsoon season, most probably due to proximity to Karachi, which is influenced by the monsoon. Air temperature is high with a mean value ranging between 20-28°C.

Seawater temperature in the vicinity of mangrove stands was not recorded throughout the year and, therefore, nothing can be said about its annual distribution. The values obtained (Table1), however, are indicative of the tropical climate. The temperature on the adjacent continental shelf has been described (Anon., 1997). Pore water temperature (Table 1) is generally lower than the water temperature by one or two degrees, most probably due to shading by plant cover (Saifullah, 1994).

Salinity values are as high as 41 ppt as compared to a low value of 36 ppt recorded on the shelf (Saifullah, 1982), which may be due to intense evaporation in a very shallow habitat (Table 1, Fig. 1). Soil salinity is usually higher than water above due to exposure at low tide (Table 1). The pH remains around 8, indicating alkaline nature of seawater. Dissolved oxygen concentration ranged between 4.0 and 5.9 ml l. The soil is mainly muddy and also organic (Snedaker & Snedaker, 1984).

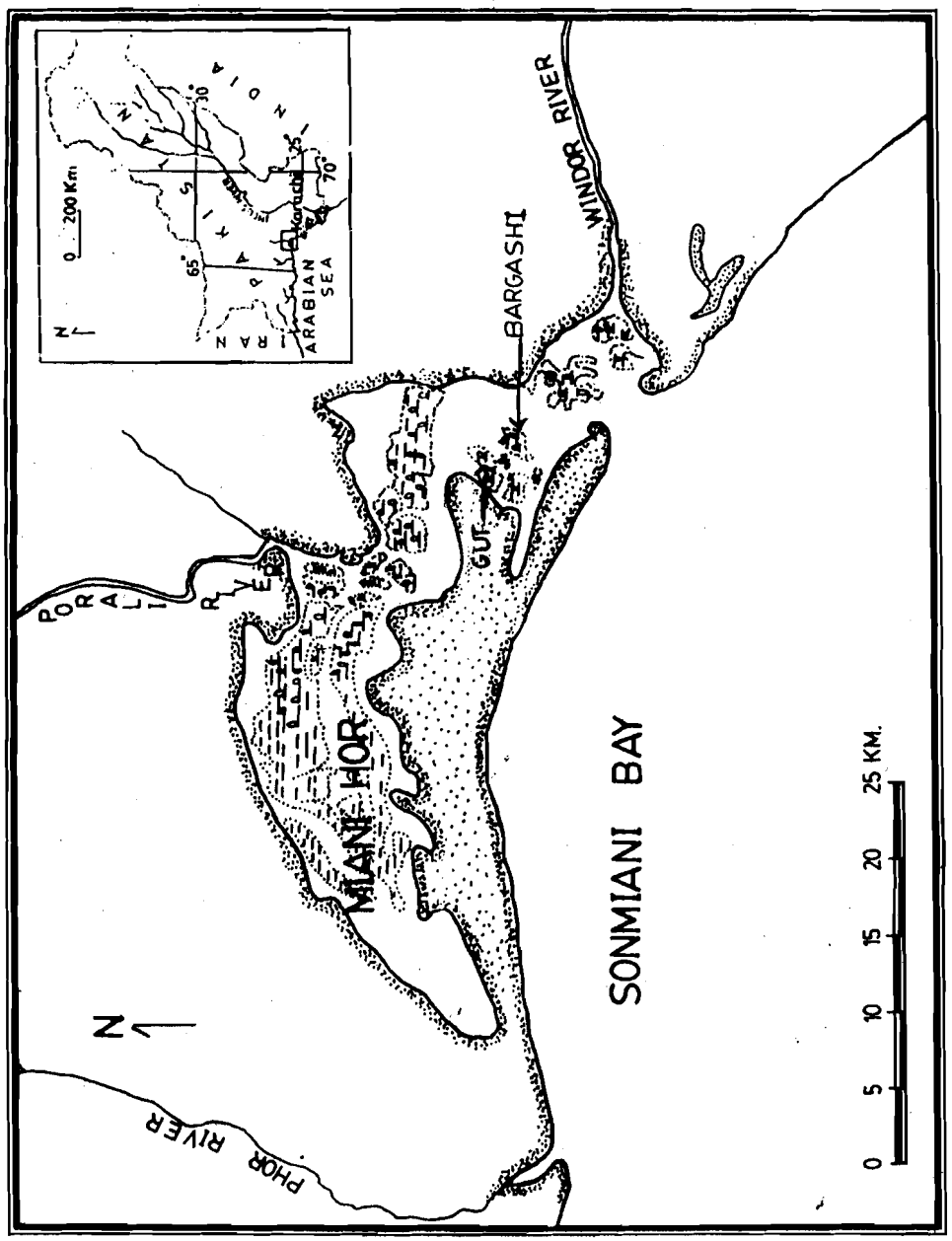

Fig. 1. Map of Miani Hor showing sites of sampling (dashed lines indicating muddy areas). Inset shows location of Miani Hor along Pakistan's coast.

Table 1. Environmental variables in the study area at Miani Hor.

Site	Q. No	Q.P.	Salinity ppt		Temperature °C		pH		Dissoloved Oxygen (mg/l)	Mud% silt + clay <0.062 mm	Sand % >0.062 mm	Organic matter (%)
			Sea water	Pore water	Sea water	Pore water	Sea water	Pore water				
Gut 22-09-93	1	SW	41	40	31	30	8.0	8.0	4.0	34.00	66.00	7.90
	2	MD	40	42	31	29	8.1	8.1	4.0	87.00	13.00	7.34
	3	LW	41	42	30	29	8.0	8.0	4.0	93.00	7.00	-
Bargashi 02-12-93	1	SW	39	41	23	19	8.0	8.1	5.9	80.05	19.95	8.70
	2	LW	39	41	23	19	8.0	8.1	5.9	80.45	10.55	8.70

Q = Quadrat; SW = Seaward; LW = Landward; MD = Mid tidal

Table 2. Structural components of mangrove stand at Miani Hor.

Site	Species	Q. No.	D Trees/0.1 ha	C M^2/0.1 ha	B M^2/0.1 ha	RD (%)	RC (%)	RB (%)	F (%)	RF (%)	I.V (%)	C.I	T.H (m)
Gut	*R. mucronata*	1,2,3	206.6	141.11	0.79	77.77	51.82	55.05	100.00	42.86	58.56	4.68	4.00
	C. tagal	1,3	36.6	37.90	0.09	13.58	13.94	5.94	68.70	28.57	16.03		
	A. marina	1,3	23.3	93.20	0.56	8.64	34.23	39.00	67.70	28.57	25.40		
	Total	3	266.5	272.20	1.4340								
Bargashi	*R. mucronata*	1,2	95.0	85.00	0.6880	35.19	14.43	3.406	100.00	33.33	23.98	7.25	3.00
	C. tagal	1,2	50.0	45.58	0.3770	18.52	7.73	1.865	100.00	33.33	17.91		
	A. marina	1,2	125.0	458.40	1.9147	46.30	77.82	94.73	100.00	33.33	58.12		
	Total	2	270.0	588.90	2.3605								

Q = Quadrat RD = Relative density RF = Relative frequency
D = Density RC = Relative cover IV = Importance value
C = Canopy cover RB = Relative basal area CI = Complexity index
B = Basal area F = Frequency TH = Average tree height of the stand

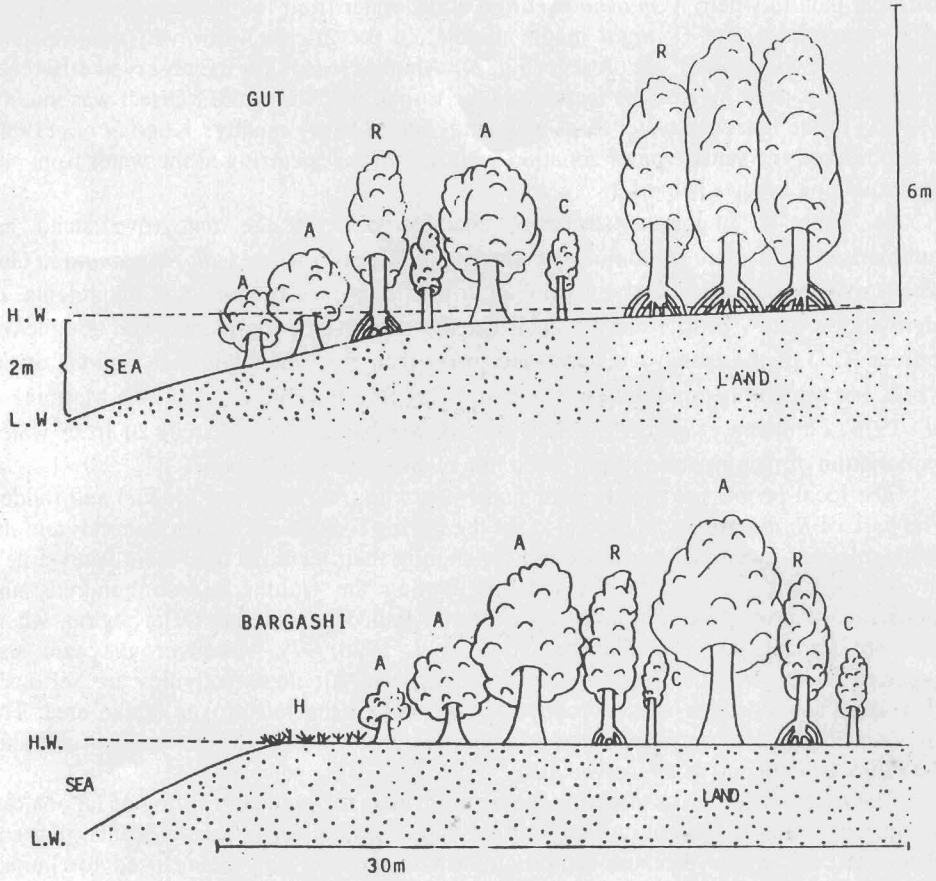

Fig. 2. Vertical zonation of species of mangroves in the two different sites.
A= *A. marina*, C= *C. tagal*, R= *R. mucronata* and H= *A. indicum*.

Miani Hor is the only locality, not only in Balochistan coast but also all along the entire Pakistan's coast, where three species *Avicennia marina*, *Ceriops tagal* and *Rhizophora mucronata* co-exist in a small area. Kogo *et al.*, (1980) erroneously identified *C. tagal* as *Brugiera gymnorrhiza.* It is difficult to account for such high diversity in the lagoon in view of the predominantly monospecific mangrove cover of the country. The presence of *C. tagal* and *R. mucronata* is even more surprising because they are absent in the adjacent sites of Kalmat Khor, Gawatar Bay and eastern part of Indus Delta. Kogo *et al.*, (1982) and Spalding *et al.*, (1997) reported absence of these species also in the adjacent Iranian territory of Qeshm Island. The Sindh Forest Department has recently carried out large scale reforestation of these species in the Indus Delta region with the co-operation of the World Bank.

The three species show different zonation patterns with different topographies of the habitat. Thus on elevated banks (Bargashi), the halophyte *Arthocnemum indicum* occurred at the shore front followed by *A. marina* and *R. mucronata* and finally *C. tagal* towards the interior of the stand (Fig. 2). But on the low-lying shore (Gut) it showed a

different picture where *A .marina* occurred at the water front followed by the mixed belt of *R. mucronata* and *C. tagal* in the middle. In the interior, however, monospecific clusters of *R. mucronata* are present (Fig. 2). Another reason for the observed difference in zonation pattern may be the fact that in the formal type the entire transect was muddy, whereas in the latter the water front was sandy but to partly muddy. Kogo *et al.*, (1980) also observed the same type of zonation with *A. marina* occurring at the water front and the remaining species behind it.

In Table 2 important structural characteristics of the mangrove stand are summarised. *A. marina* is dominant in the site of Bargashi whereas *R. mucronata* in Gut, which may be due to selective exploitation of the species by the local inhabitants. *C. tagal* shows a low profile due to small density and size of the plants. The complexity indices (C.I) of the mangrove stands are lower than those of favourable regions of the world and are comparable only to stressed dwarf forests (Pool *et al.*, 1977, Martniez *et al.*, 1979, Lahmann *et al.*, 1987). This may be attributed to the scarcity of fresh water, exploitation of mangroves and increased rate of siltaion in the lagoon.

The local people are mostly poor fishermen who use mangrove for fuel and fodder. The bark of *R. mucronata* is used also for the dyeing fishnets and other materials and the propagules for medicinal purposes and for shining their teeth. In the recent years a new stress has been imposed in the locality. During the fruiting season hundreds and thousands of propagules are taken away from Miani Hor to Indus Delta region, where they are transplanted for reforestation (Rasool, 1996, 97). Moreover, they are also exported to the Middle East for the same purpose. All these activities are seriously affecting the seed bank and reproductive potential of the mangroves of the area. The lagoon of Miani Hor may be treated as a natural nursery ground of the three species and, therefore, be declared as a reserved area.

The other major stress affecting the mangroves is the gradually filling of lagoon due to increased rate of siltaion (Alizai *et al.*, 1988). Porali River is hardly discharging any water into the lagoon because its meagre water supplies now being used for human consumption. Moreover absence of any significant rainfall in the area has converted it into a river of sand (Hussain, 1998). Huge quantities of sand and silt are blown by the wind and deposited into the lagoon, which is already incompletely flushed by seawater due to a very narrow entrance (Fig. 1). Occasional flow of turbid streams and runoff into the lagoon (Alizai *et al.*, 1988) also aggravate the situation. The cutting of entire trees for obtaining wood for construction of thatched houses and other purposes by local people has also resulted in soil erosion of the mangrove habitat. This is another significant source of siltaion in the lagoon. According to Mirza *et al.*, (1988) the rate of sedimentation is alarming and the lagoon has already reduced to 25% of its original size within the last century. If this problem is not looked after soon the lagoon will disappear and the only natural source of three important mangrove species in the region will also be lost for good. There are a number of strategies to address this problem, but the most effective and immediate solution is perhaps periodic dredging of the lagoon.

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References

Alizai, S.A.K., J. Ali and M.I. Mirza. 1988. Role of satellite remote sensing in monitoring sedimentation processes in lagoons along the coast of Balochistan, Pakistan. pp. 359-372. In: *Marine Science of the Arabian Sea.* (Eds.): M.F. Thompson and N.M. Tirmizi. Washington D.C.

Anonymous. 1978. Survey results of "Dr. Fridtjof Nansen", January-June 1977, Joint Norad/Pakistan Project, and Fish Assessment Survey of Pakistan Water, Bergen. pp. 12.

Chaudhri, I.I. 1961. The vegetation of Karachi. *Vegetatio*, 10: 229-246.

Cintron, G. and V.S. Novelli. 1984. Methods for studying mangrove vegetation structure. pp. 91-113. In: *The Mangrove Ecosystems Research Methods.* (Eds.): S.C. Snedaker and J.G. Snedaker. UNESCO, Paris.

Curtis, J.T. 1959. *The vegetation of Wisconsin.* An ordination of plant communities. University of Wisconsin Press, Madison. WI. pp. 627.

Curtis, J.I. and R.P. Intosh. 1951. An upland forest continum in the Prairie Forest border regions of Wisconsin. *Ecology*, 32: 76-496.

Holdridge, L.R. 1967. *Life Zone Ecology.* Tropical Science Center, San Jose, Costa Rica. pp. 206.

Hussain, S. 1998. The River of Sand. The Finacial Post. Karachi. 03-03-98.

Kogo, M., K. Sato, S. Takatrki and R. Takashi. 1980. An ecological survey on the mangrove forest of Persian (Arabian) Gulf and Pakistan. Japanese co-operation center for the Middle East, Publication No. 100. pp. 96.

Köppen, D.W. 1936. *Das Geographische Systems der Klimat.* Handb. Der. Klimatologie, Berlin.

Lahmann, E.J., S.C. Snedaker and M.S. Brown. 1987. Structural comparison of mangrove forests near shrimp ponds in southern Ecuador. *Interciencia*, 12(5): 240-243.

Martinez, R., G. Cintron and L.A. Encarnacion. 1979. *Mangroves in Puerto Rico: A structural inventory.* Final report to the office of coastal zone management, NOAA Department Natural Resources, Area of Scientific Research. Government of Puerto Rico, pp. 149.

Mirza, M.I., J. Ali and A. Rangoonwala. 1988. Marine application of landsat images with particular reference to the Arabian Sea coast of Pakistan. pp. 309-324. In: *Marine science of the Arabian Sea.* (Eds.): M.F. Thompson and N.M. Tirmizi. Washington D.C.

Mirza, M.I., M.Z. Hassan, S. Akhtar, J. Ali and M.A. Sanjrani. 1988. Remote sensing survey of mangrove forests along the coast of Balochistan. pp. 339-348. In: *Marine Science of the Arabian Sea.* (Eds.): M.F. Thompson and N.M. Tirmizi. Washington D.C.

Pool, D.J., S.C. Snedaker and A.E. Lugo. 1977. Structure of mangrove forests in Florida, Puerto Rico, Mexico and Costa Rica. *Biotropica*, 9: 195-212.

Rasool, F. 1996. Trafficking of mangrove seedlings. In: Letter to Editor, Daily Dawn, Karachi. 08-07-1996.

Rasool, F. 1997. More about mangroves. In: Letter to Editor. The News International, Karachi. 14-06-1997.

Rasool, F. and S.M. Saifullah. 1996. Mangroves of Kalmat Khor, Balochistan. *Pakistan Journal of Botany*, 28: 143-149.

Saifullah, S.M. 1982. Mangrove Ecosystems of Pakistan. In: *The third research on mangroves in the Middle East, Japan co-operation center for Middle East.* Publication Number 137. Tokyo. pp. 69-80.

Saifullah, S.M. 1992. Future prospects of mangrove of Makran coast. In: *Proceedings of National Conference on Problem and Resources of Makran Coast and Plan of Action for its Development.* 28-30 September, 1991. Quetta. pp. 63-68.

Saifullah, S.M. 1994. Seasonal and spatial distribution of chlorophylla `a' in the North Arabian Sea bordering Pakistan. *Pakistan Journal of Marine Sciences*, 3: 25-31.

Saifullah, S.M. and F. Rasool. 2001. Mangroves of Gawater Bay, Makran coast near Gulf on Oman. In: *Mangrove Ecosystems: Natural Distribution, Biology and Management.* (Eds.): N.R. Bhat, F.K. Taha and Nasser. Kuwait Institute for Scientific Research, Kuwait. pp. 17-24.

Snedaker, S.C. J.G. Snedaker. 1984. *The Mangrove Ecosystems Research Methods*. UNESCO. Paris. pp. 251.

Spalding, M., F. Blasco and C. Field. 1997. *World Mangrove Atlas*. ISME Okinawa, Japan. pp. 178.

Tait, R. 1981. *Elements of Marine Ecology: An Introductory Course*. Butterworth, London. pp. 356.

Verheijen, O. 1998. *Community Irrigation Systems in the Province of Balochistan*. Balochistan Community Irrigation and Agriculture Project. Halcrow Euroconsult Nespak Technoconsult, Quetta, Balochistan. pp. 85.

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