Pak.J.Bot., 24(1): 5-10, 1992.

PNEUMATOPHORE DENSITY AND SIZE IN MANGROVES OF KARACHI, PAKISTAN

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Abstract

Pneumatophore density of mangrove *Avicennia marina* from different locations of Karachi ranged from 56-520 m^{-2} with a mean value of $278m^{-2} \pm 135$ SD, their height ranged from 2-32 cm with a mean value of 11.8 ± 3.2 SD and maximum thickness from 2-11 mm with a mean value of 6.3 ± 1.57 SD. Pneumatophore density was positively correlated with tree height, tree girth and negatively with its own height. There was a positive relationship be tween the density and mud content in mangrove soil suggesting that mangroves adapt to anaerobic and water- logged conditions by increasing their numbers and hence large surface area for maximum aeration.

Introduction

Pneumatophores are aerial roots which protrude outside from underground as pencil like projections and are possessed by some mangroves like *Avicennia, Sonneratia* and *Xylocarpus* (MacNae, 1968). Their function is to provide aeration to underground parts of the plant which are otherwise completely surrounded by anaero bic environment (MacNae, 1963). Little information is available on the density and size of pneumatophores and their relation with other morphological features of the mangroves. Such studies have been made in muddy and rocky habitats of Saudi Arabian coast (Mandura *et al.,* 1987, 1988). Dicks (1986) reported more pneumatophores in water-logged and polluted soils than in well drained and clean soils. While dealing with the anomalous roots in *Avicennia* height and diameter of pneumatophores have been discussed (Snedaker *et al.,* 1981). The present paper describes the density and size of pneumatophores and their relationship with other features of mangrove morphology and soil characteristic.

Materials and Methods

As many as 10,000 pneumatophores were counted in 35 quadrats of 50x50 cm made under mangrove cover of *Avicennia marina* on 9 different sites at Karachi both seaward and landward on the coast of Karachi. Height and maximum diameter above the ground were measured. Soil samples collected from all such locations to a depth of 20 cm with a corer were dried in the laboratory and the mud content determined by passing it through a 0.06 mm sieve which includes both silt and clay fractions (Tait, 1981). Tree height and girth were also measured.

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Table 1. Average values of different parameters of pneumatophore morphology and related features in mangroves from 9 different sites in 3 localities of Karachi.

Site No.	Locality	Position on shore	Pneumat. density [m^{-2}]	Pneumat. height [cm]	Pneumat. dia. [mm]	Tree height [m]	Girth size [cm]	Mud Content % soil
1.	Sandspit	Landward	146	14.5	8.9	1.0	21.9	35.5
2.	Sandspit	Seaward	350	13.0	6.4	6.0	42.0	49.0
3.	Sandspit	Landward	304	15.5	6.6	1.5	24.0	52.0
4.	Sandspit	Seaward	486	09.5	6.7	6.0	43.7	51.0
5.	Sandspit	Seaward	314	08.0	4.6	2.5	34.5	50.1
6.	Sandspit	Landward	175	09.7	5.2	2.5	29.0	29.8
7.	Korangi Creek	Isolated stand	452	13.5	7.1	6.0	63.8	52.1
8.	Port Qasim	Seaward	271	10.3	4.7	3.0	34.5	42.9
9.	Port Qasim	Landward	142	18.8	5.8	1.0	23.0	37.5

Observations and Discussions

Overall density of pneumatophores at all sites excluding depressions and ditches in mangroves of Karachi varied between 56 and 520 m^{-2} with a mean value of 278±135 SD; their height between 2 and 32 cm with a mean value of 11.8±3.2 SD and their maximum diameter between 2 and 11 mm with a mean value of 6.3±1.57 SD (Table 1).

Pneumatophores are breathing adaptations of mangroves and are meant for aeration of their underground parts (MacNae, 1968) which would suggest that their density could be used as an index of anaerobic status of the soil they are in. The more anaerobic a substrate is the more will be their density and vice versa. This hypothesis seems to hold good in the present study as well. Thus, the correlation coefficient between pneumatophore density and % mud content (silt + clay) in soil was positive and highly significant (Table 2, Fig.1). The presence of mud in the soil decreases its porosity and hence quantum of air in it. As the mud content increased in the soil it became progressively anaerobic and hence possessed increasing number of pneumatophores. Muddy subtrates in mangrove areas are water-logged, whereas sandy soils are well drained and it is probably for this reason that pneumatophore densities reported in mangroves of sand dominated habitats are relatively lesser (Dicks, 1986; Mandura *et al.,* 1988). Dicks (1986) also found more pneumatophores in polluted than in clean habitats suggesting a need for more aeration in the former areas than in the latter.

Another evidence which supports the above hypothesis is the presence of abnormally high concentration of pneumatophores in depressions and gulleys, which represent pockets of extreme anaer obic conditions as a consequence of large deposition of organic debris and detritus. The tidal flow cannot remove them from the place, as it moves back and forth. The density of pneumatophores recorded in such spots in the present study was 1168 m^{-2} which is many times higher than the normal average (Table 1). Mandura *et al.,* (1987, 1988) also reported similar observations from the Red Sea area.

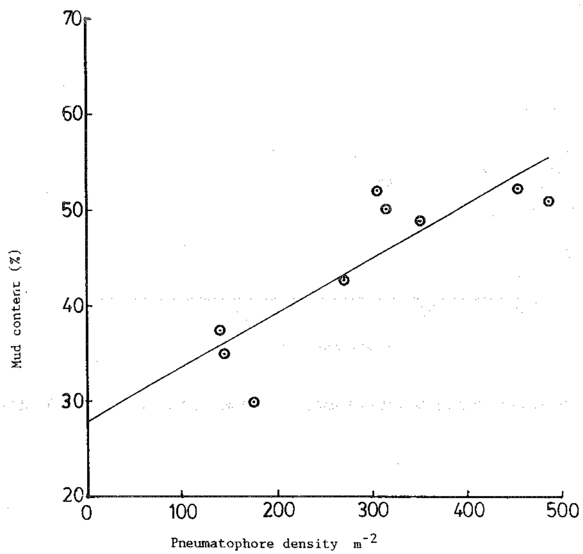

Fig.1. Relationship between mean pneumatophore density and mean mud content. $Y = 27.8 + 0.06X$; $r = 0.849$; $P = < 0.05$

Pneumatophore density was also positively correlated with tree height and girth size (Table 2; Fig.2, 3), which in turn are also correlated with each other (Table 2), suggesting that it increases with age of mangrove as both the parameters ought to increase with time. In fact, a very close relationship between the age of mangroves and their height and girth size in Qeshm Island, Iran has been reported (Kogo *et al.,* 1980).

Tree height, girth size and pneumatophore density were all negatively correlated, though not significantly, with pneumatophore height (Table 2; Fig.4) suggesting that trees gain large surface area by producing large number of short pneumatophores as they grow older. Another possible explanation may be that the pneumatophores wither at their tips with age.

Table 2. Correlation coefficient values (r) between different parameters of mangrove morphology.

	P.Dn	T.H.	P.H.	P.Dm	G.S.
T.H	0.861				
P.H	-0.381	-0.370			
P.Dm	0.044	0.042	0.461		
G.S	0.822	0.883	-0.293	0.037	
M.C.	0.849	0.569	-0.127	0.042	0.582

P.Dn = Average Pneumatophore density; T.H. = Average Tree height; P.H. = Average Pneumatophore height; P.Dm. = Average maximum pneumatophore diameter; G.S. = Average maximum girth size of tree; M.C = Average percent mud content in mangrove soil.

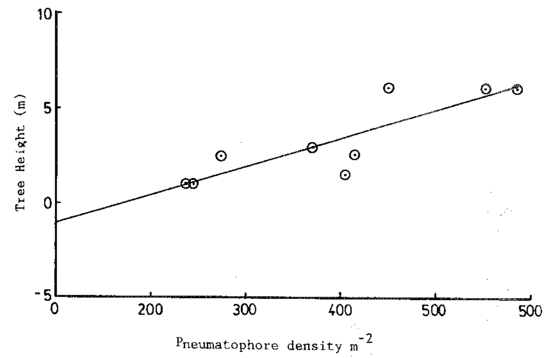

Fig.2. Relationship between mean pneumatophore density and mean tree height. $Y = -1.07 + 0.015X$; $r = 0.861$; $P = < 0.05$

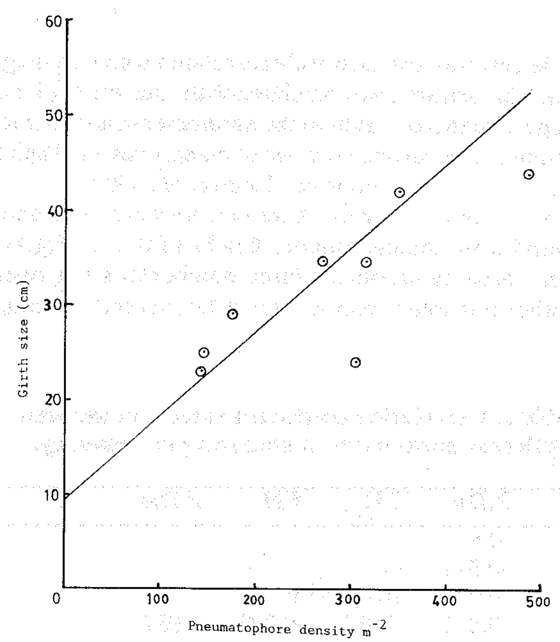

Fig.3. Relationship between mean pneumatophore density and mean girth size. $Y = 9.42 + 0.087X$; $r = 0.822$; $P = > 0.05$

A distinct zonation was noticeable in the monospecific stands of *A. marina* with regard to its differing structure (Khan, 1966, Snedaker, 1984). The trees were larger in size with more pneumat ophores seaward than landward, probably because of the fact that soil salinity increases with distance from shore in dry and arid regions (Mandura *et at.*, 1988), and Karachi also happens to be such an area. An inverse relationship between salinity and its size has already been reported by MacNae (1968) and *Poole et al.*, (1987). Mandura *et al.*, (1987, 1988) and Zahran *et. al.*, (1983) also found the same type of zonation on Red Sea shores of Saudi Arabia. The pneumatophore density could thus be used as an index to predict the size of mangroves and also the soil characteristics.

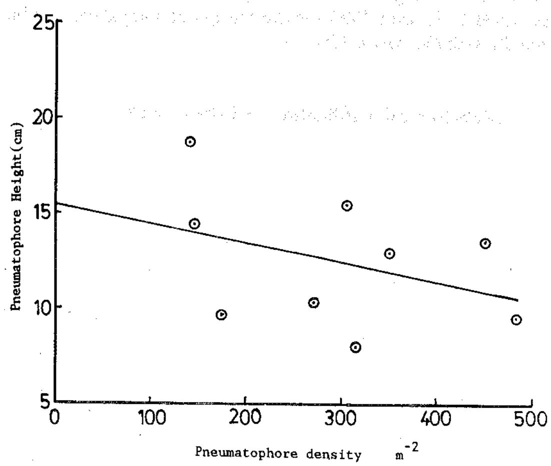

Fig.4. Relationship between mean pneumatophore density and mean pneumatophore height. Y = 15.6-0. 01X; r = -0.381; P = 0.05.

Acknowledgments

The authors are grateful to Dr. A. Burney of the Department of Statistics, Karachi University for his help in computation of correlation coefficient values and also to Mohd. Shafiq, Tariq Jahangir and Miss F. Chaghtai for their assistance in field and laboratory. Thanks are also due to Dr. E. Lahmann of IUCN, Costa Rica and Prof. Dr. S. Shaukat of Botany Department, University of Karachi for their criticism and suggestions in interpretation of the results.

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(Received for Publication 13 February 1992)