Pak. J. Bot., 36(2): 463-466, 2004.

ANOMALOUS AERIAL ROOTS IN GREY MANGROVES OF AN ARID CLIMATE LAGOON

S. M. SAIFULLAH, SADAF GUL AND F. RASOOL*

Mangrove Ecosystem Laboratory,
Department of Botany, University of Karachi, Karachi 75270, Pakistan
E-mail: <smsaifullah2001@yahoo.com>*

The mangrove genus *Avicennia* possesses pencil like aerial roots called pneumatophores which are first order laterals of the subterranean cable roots and protrude vertically above the sediment surface (Chapman, 1976). However, anomalous positively geotropic aerial roots are reported in the black mangrove *Avicennia germinans* (L.) L., from Florida and Costa Rica (Snedaker *et al*., 1981) which unlike the normal pneumatophores grow downwards from the exposed basal part of the trunk. This was considered to be an exception among mangroves and a consequence of oil pollution and acute anoxia. But the present study shows that such abnormal roots may also occur in the pan-tropical grey mangrove *Avicennia marina* (Forssk.) Vierh. growing in apparently unpolluted areas.

The study site Miani Hor (Lat. 25° 31' N, long. 66° 10' E) is a small subtropical lagoon (363 km²) with a mangrove cover of 31 km² and is located along the North Arabian Sea coast of Pakistan, about 100 km west of Karachi (Saifullah & Rasool, 2002; Spalding *et al*., 1997). The climate is subtropical arid and maritime desert type (Chaudhri, 1961) with minimum rainfall of less than 200 mm per year. This is the only locality along the entire 1000 km long coastline of Pakistan, including the luxurious mangrove forest of the Indus Delta, where three species coexist in a small area. These include *Avicennia marina* (Forsk.) Vierh., *Ceriops tagal* C. Robinson and *Rhizophora mucronata* Lam. (Saifullah & Rasool, 2002; Saifullah *et al*., 1994). The lagoon is relatively pristine being free from any kind of pollution (Saifullah *et al*., 2002). There is a fishing village nearby with a small fish harbour and there does not exist any industry for considerable distance from the area. There is one small river, the Porali river, which is ephemeral and discharges its runoff only when there is rainfall, otherwise it remains dry most of the year to the extent that it is named as 'river of sand' (Hussain, 1998).

Salinity of seawater in the channels fluctuates around 40 psu with higher values occurring in shallow pools in the mangrove habitat due to intense evaporation (Saifullah & Rasool, 2002). The anomalous aerial roots were observed on 15. 02. 2001 in a monospecific stand of *A. marina* with a density of 13.2 trees/100m². The trees, which possessed them, were very tall (upto 12m) and thick with dbh greater than 20 cm reaching up to 65cm and devoid of normal pneumatophores. The aerial roots grew downward from the lowermost basal aerial part of the trunk, some of them even penetrating the ground (Fig. 1) as against the normal negatively geotropic pneumatophores of other trees (Tomlinson, 1986). They were also thicker (diameter upto 15 mm) than the latter (upto 7mm) and were very similar to those reported from Florida and Costa Rica (Snedaker *et al*., 1981) except that they were not as longer and measuring only up to 15 cm most probably because they emerged right near the base of the trunk. The anatomy of these roots has not yet been studied before (Snedaker *et al.*, 1981).

*WWf-Pakistan, PECHS, Karachi 75400, Pakistan

Preliminary microscopic study of cross sections of anomalous roots and pneumatophores of adjacent trees revealed significant differences between them. The numbers of vascular bundles were as many as 40 and the pith about twice as wide as the cortex in the former whereas the vascular bundles were as few as 14 and the pith as wide or smaller than the cortex in the latter. The periderm was also comparatively thicker in the former (Table 1) similar to tree branches (Gill & Tomlinson, 1977).

Table 1. Comparsion between pneumatophores and anomalous aerial roots.

	Normal Pneumatophores		Anomalous Aerial Roots
1.	Negatively geotrophic	1.	Positively geotrophic
2.	Grow from the underground cable roots	2.	Grow from the basal part of the trunk
3.	Thinner, upto 7mm	3.	Thicker, upto 15mm
4.	Vascular bundles fewer	4.	Vascular bundles more
5.	Width of the pith almost equals that of cortex	5.	Width of the pith twice that of cortex
6.	Periderm thinner	6.	Periderm thicker

The development of these anomalous roots was earlier related to the presence of toxic substrates like petroleum residues, anoxia and hydrogen sulfide in the mud which limit the functioning of normal pneumatophores and eventually destroy them (Snedaker *et al*., 1981). The presence of such anomalous roots, therefore, may permit the continued survival of the tree in an altered or otherwise unfavourable habitat. But in the present case the area of study is not polluted. There is also no known record of any oil spill in the area. The substrate was not very muddy but partly consolidated and covered with a thin layer of sand (Fig. 1) and also slightly elevated, which rules out highly anoxic conditions. There was also no odour of hydrogen sulphide in the area as was the case in Costa Rica. Due to a serious drought period for three preceding years, with a mean annual rainfall less than 100 mm yr^1, sand dunes also gradually encroached inside the mangrove stand and some isolated small plants, as a matter of fact, were partly sunk in the sand (Fig. 2). The negligible discharge from Porali river may have also favoured deposition of marine sand in the area. Lacerda & Marins (2002) have also reported sand accumulation in a mangrove area of Brazil due to decrease in freshwater discharge of river. It may be that the normal pneumatophores were withering with age and severe drought conditions or for some reasons other than oil or acute anoxic conditions and, therefore, the anomalous aerial roots have taken over their function. Snedaker *et al*., (1981) studied a different species in different areas, which are not at all arid like the present one. In fact, Costa Rica is extremely wet (3,800 mm yr^1) and, therefore, the causal factors may not be the same in both cases.

Acknowledgements

The authors duly acknowledge the assistance of Dr. Raiha Qadri of the Department of Botany in this study.

Fig. 1. Anomalous aerial roots growing from the basal part of the trunk of *Avicennia marina.* Note the absence of pneumatophores from the surrounding.

Fig. 2. Sand dunes encroaching the mangrove area.
Note the presence of a few shrubs of *A. marina* stranded in the sand.

References

Chapman, V.J. 1976. Mangrove vegetation. *J. Cramer*, Leutershausen. 499pp.

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

Gill, A.M. and P.B. Tomlinson. 1977. Studies on growth of red mangrove (*Rhizophora mangle*). 4. The adult root system. *Biotropica*, 9: 145-155.

Hussain, S. 1998. The river of sand. The Financial Post, Karachi (3rdMarch, 1998).

Lacerda, L.D. and R.V. Marins. 2002. River damaging and changes in mangrove distribution. ISME/GLOMIS. *Electronic Journal*, 2: 1-4.

Saifullah, S.M. and F.Rasool. 2002. Mangroves of Miani Hor Lagoon in the North Arabian Sea coast of Pakistan. *Pak. J. Bot*., 34: 303-310.

Saifullah, S.M., S. H. Khan and Sarwat Ismail. 2002. Distribution of nickel in a mangrove habitat of the Indus Delta. *Mar. Poll. Bull*., 44: 571-578.

Saifullah, S.M., S. S. Shaukat.and S. Shams. 1994. Population structure and dispersion pattern in mangroves of Karachi. *Aquat. Bot.*, 47: 329-340.

Snedaker, S.C., J.A. Jimenez and M.S. Brown. 1981. Anomalous aerial roots in *Avicennia germinans* L., in Florida and Costa Rica. *Bull. Mar. Sci*., 31**:** 467-470.

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

Tomlinson, P.B. 1986. *The Botany of Mangroves.* Cambridge University Press,Cambridge. 413 pp.

(Received for publication 29 March 2004)