Pak. J. Bot., 39(2): 577-582, 2007.

DISPERSAL AND ESTABLISHMENT OF MANGROVE PROPAGULES IN AN EXPOSED COASTAL HABITAT OF INDUS DELTA

S.M. SAIFULLAH[1], F. CHAGHTAI[2] AND S. AKHTAR[1]

[1]Mangrove Ecosystem Laboratory, Department of Botany, University of Karachi, Karachi-75270, Pakistan, E-mail: smsaifullah2001@yahoo.com
[2]Centre of Excellence in Marine Biology, University of Karachi, Karachi, Pakistan.

Abstract

Dispersal and establishment of propagules and seedlings of the grey mangrove *Avicennia marina* (Forssk.) Vierh., were studied in a small exposed coastal area of the Indus Delta near Karachi. The propagules appeared on the shore in early August 1999. They were recruited into the area from neighboring mangrove inhabited islands and were concentrated in depressions, among rocks and already existing young mangroves. They increased in numbers until late September and later declined and disappeared by the end of October. Their average fresh weight and length increased continuously but gradually showing little difference between the initial and final values. The seedlings appeared about two months later with decline in numbers of the propagules and increased sharply to a peak density in the last week of October and later gradually declined in numbers until they disappeared by the end of December. The mortality of both propagules and seedlings may possibly be attributed to several environmental vicissitudes including exposed nature of the habitat, hyper salinity, grazing by herbivores, etc.

Introduction

Mangroves of Indus Delta are faced with severe anthropogenic stresses including over exploitation, hyper salinity, pollution, shore erosion and urban development (Saifullah, 1997) and as a result are declining in their cover (Pernetta, 1993; Saifullah, 2004). Few decades ago they occupied an area of 265,000 hectares (Mirza *et al*., 1983) but now only 160,000 hectares are left (Kella, 1999; Keerio, 2004). Every year numerous propagules of the gray mangrove *Avicennia marina* (Forssk.) Vierh., the overwhelmingly dominant species in the area (Saifullah, 1997), are dispersed and cast ashore during the fruiting season but only a very small fraction germinates to become an adult tree otherwise a majority of them perish either before or after geminating into a seedling within few months due to several environmental stresses. The mortality is, therefore, very high, especially in exposed areas. Although there exist many studies dealing with ecology of mangroves in the area, there is hardly any on their dispersal and establishment (Saifullah *et al*., 1994). The present study was carried out in an exposed site of Indus Delta near Karachi with the aim to find out the density of propagules that are dispersed and also their establishment in the area. This information will be useful in managing and conserving the fast declining mangroves of Indus Delta.

Material and Methods

The present study was carried out in a coastal strip of Korangi Creek area of Karachi (lat.24° 51′ N; long.67° 02′ E) near Salt Work which has already been described elsewhere (Saifullah *et al*., 1994). The sampling site was gradually sloping seaward and

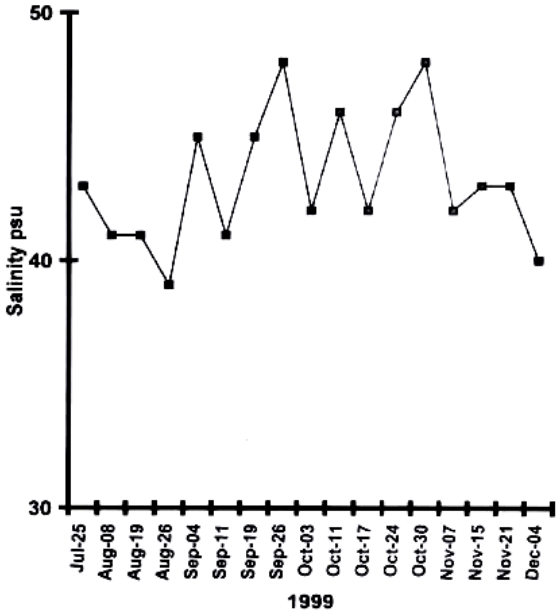

Fig. 1. Variation in salinity values (‰) in the area during the study period.

becoming completely exposed at low tide. It is barren with mangroves except for scattered small bushes of *Avicennia marina* (Forssk.) Vierh., at the extreme high water mark where small rocks and shallow pools were also present. The small islands facing the study site were, however, covered with luxuriant growth of the gray mangroves (Saifullah *et al*., 1994).

Propagules and seedlings of the mangroves were sampled almost weekly in twenty quadrates (25x25 cm) selected randomly along a 250m long horizontal strip near the high tide mark during 1999. Their size, weight and abundance were recorded. The propagules were heart shaped and their length was measured between its tip and the broad base. Salinity values were recorded using a refractometer during the period 25.07.99 - 04.12.99.

Results

Salinity values of seawater showed irregular variation between 39‰ and 48‰ and were generally higher than 40 ‰ (Fig. 1). The propagules increased in numbers from 25 ± 4.72 on 12th August to 52 ± 6.28 m^{-2} on 26th August, showing a two-fold increase in about two weeks. Later the numbers remained high until 11th September and then declined gradually until they all disappeared after 30th October (Fig. 2). On the other hand the fresh weight of the propagules showed little variation with time between 1.39 ± 0.85 gm and 2.21± 0.71 gm. It was less than 2.0 gm until 26th September but later remained above this value (Fig. 3). The length of the propagules showed even lesser variation between 1.77 ± 0.05 and 2.19 ± 0.07 cm with larger ones being present during the later period of the study (Fig. 3).

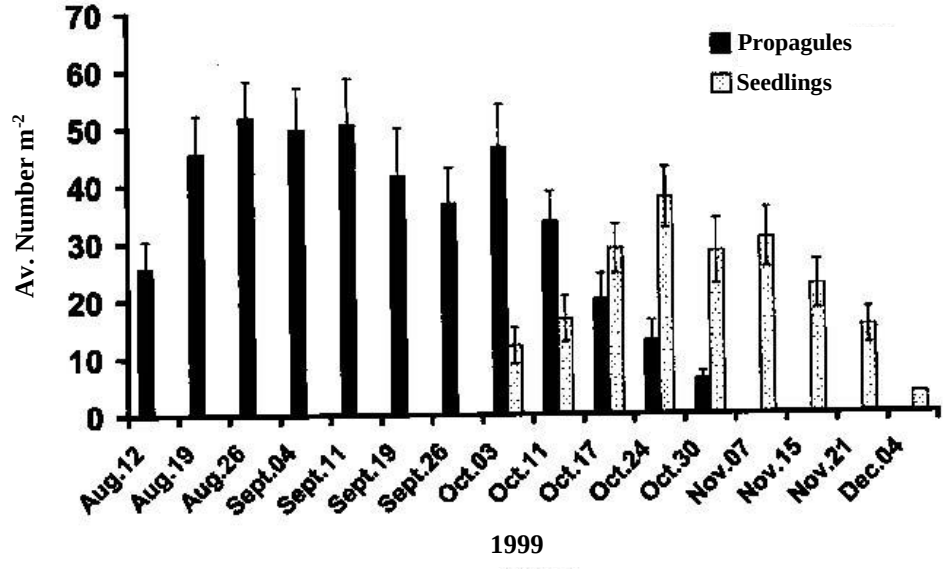

Fig. 2. Variation in average numbers of propagules and seedlings per m^2 in the area during the study period. Vertical line indicates ± SE.

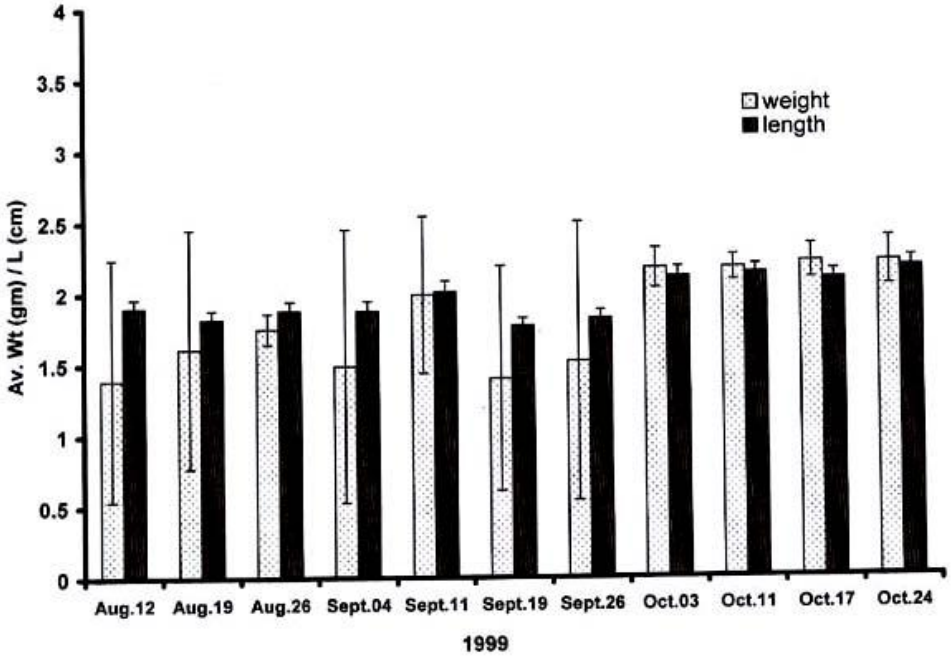

Fig. 3. Variation in average weight and length of propagules during the period of study. Vertical line indicates ± SE.

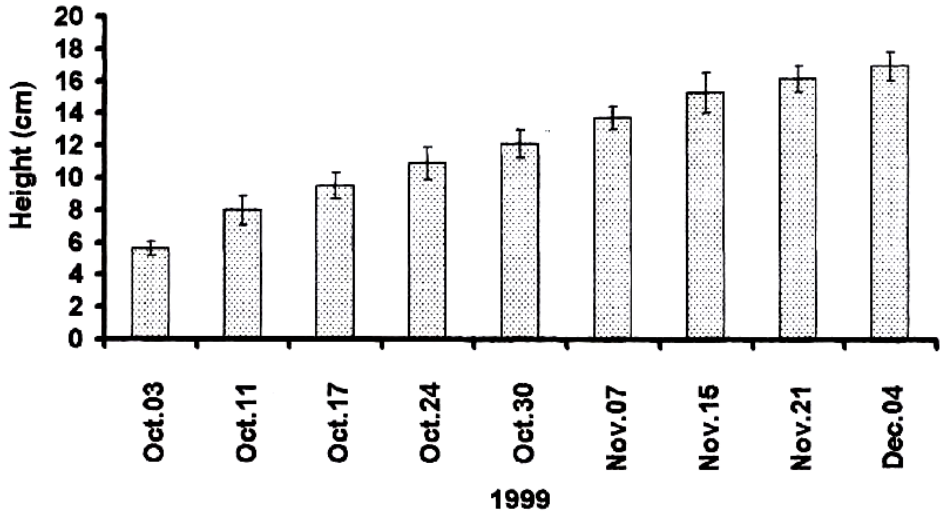

Fig. 4. Variation in average length of the seedlings. Vertical line indicates ± SE.

Seedlings appeared in the area on 31.10. 99 with decline in density of propagules as a result of germination of the propagules, and their numbers increased linearly to a peak density of 37.6 ± 5.34 individuals m^{-2} on 24th October. Thereafter, their numbers declined until they all disappeared on 12th December (Fig. 2). The height of the seedlings however increased continuously and linearly from 4 cm on 26th September until they reached a maximum length of 17 cm ± 0.90 on 4th December (Fig. 4).

Discussion

Salinity values in the study area were generally higher than 40 ‰ (Fig. 1) as against lower values on the shelf (Saifullah, 1979), which may be due to excessive evaporation at low tide when the area is exposed to direct sun. Another reason may be the drastic cut in the supply of Indus River water into the delta over the years due to increased irrigation and industrialization in the country. A few decades ago the Indus discharge was as much as 100 MAF annually but now it has reduced to insignificant amounts except during occasional floods (Saifullah, 1997).

The fruiting season in the area starts in July and the propagules (mature fruits with developed embryos) are available in the area from August to September (Rasool & Saifullah, 2002). *A. marina* is crypto-viviparous (Tomlinson, 1986), therefore, it is difficult to differentiate between a fruit and a propagule. When the propagules fall into water their pericarp ruptures (Steinke & Charles, 1987) and they float because they are buoyant (Clarke & Myerscough, 1991) and are dispersed off to different places by water movements (Clarke 1993; Breitfuss *et al*., 2003). According to Abdel-Razik (1991) buoyancy is an adaptation by propagules to save themselves from adverse effects of waterlogging and stagnation. The propagules appeared in the area of study in beginning of August and gradually increased in numbers. They did not germinate into seedlings until after about two months and from then on their numbers decreased gradually and eventually disappeared a month later (Fig. 2). Their average length and weight did not show as much increasing trend with time as their numbers because the propagules usually

fall off from the tree when they are mature. There may, however, be some increase in the dimensions with delay in the falling from the tree and also with the period they are lying on the ground submerged under water.

The seedlings appeared two months after the appearance of the propagules in the area. This is because of the fact that they do not germinate readily into seedlings but require time. As the propagules started germinating into seedlings their numbers declined with consequent increase in numbers of seedlings. The peak density of seedlings therefore, followed the peak density of propagules with two months interval of time (Fig. 2). The increase in number of seedlings showed a smooth bell shaped curve with numbers increasing linearly reaching a peak value in the last week of October and then declining gradually until they disappeared within a period of two months. The seedlings however increased in their height continuously (Fig. 4) and might have grown into saplings and eventually into mature trees had they survived.

It is apparent from the foregoing observations that both the propagules and the seedlings all disappeared from the area within a period of four and a half months. This may be accounted for several factors, the foremost being the exposed nature of the habitat, which do not allow their retention for longer periods. The propagules and seedlings generally tend to accumulate in depressions where they are protected from being carried away by the tidal water (Breitfuss *et al*., 2003). In the neighboring islands some mangrove seedlings do survive (Saifullah *et al*., 1994) because of thick mangrove growth, which provides shelter to them through dense growth of pneumatophores and uneven substrate (Abdel-Razik, 1991). According to Siddiqui (1999) failure of seedlings to survive and establish is also a major problems in mangroves of Bangladesh. There is also grazing by crabs and cattle, which are common in the area (Qureshi, 1993; Saifullah & Chaghtai, 2005). Significant herbivory of propagules by crabs has been reported in the mangroves of Costa Rica (Delgadon-Sanchez *et al*., 2001) and by buffalos in India (Dahdough-Guebas *et al*., 2006). The green alga *Enteromorpha* grows abundantly in the area and masks completely the propagules and seedlings at low tide depriving them from illumination thus inhibiting their photosynthesis. Clarke & Myerscough (1993) have shown that presence of algae in stranding sites may influence seedling recruitment. Finally high salinity values may also be a factor. Diop *et al*., (1996), for example, observed that re-plantation of mangroves in Senegal suffered because of hyper salinity. Some of these stresses may be removed by providing some shelter to the drifting propagules and by screening the seedlings from herbivory and overshadowing by algae (Qureshi, 1993)

Further studies are, however, needed in other sites in the Indus Delta including mangrove-covered areas to achieve an overall estimate of propagule mortality and survival in the Indus Delta area in order to conserve and manage the mangroves.

Acknowledgements

We acknowledge herewith the assistance of Ms Sadaf Gul and Mr. Khalid Khan in this study.

References

Abdel-Razik, M.S. 1991. Population structure and ecological performance of the mangrove *Avicennia marina* (Forsk.) Vierh. on theArabian Gulf Coast of Qatar. *J. Arid Environ*., 20: 331-338.

Breitfuss, M.J., R.M. Conelly and P.E.R. Dale. 2003. Mangrove distribution and mosquito-control; transport of *Avicennia marina* propagules by mosquito control-runnels in southeast Queensland. *Est. Coast. Shelf Sc*., 56: 573-579.

Clarke, P.J. 1993. Dispersal of grey mangrove (*Avicennia marina*) propagules in southeastern Australia. *Aquat. Bot*., 45: 195-204.

Clarke, P.J. and P.J. Myerscough. 1991. Buoyancy of *Avicennia marina* propagules in south-eastern Australia. *Aust. J. Bot*., 39: 77-83.

Clarke, P.J. and P.J. Myerscough. 1993. The intertidal distribution of grey mangrove (*Avicennia marina*) in south-eastern Australia; the effect of physical conditions, interspecific competition and predation on establishment and survival. *Aust. J. Ecol*., 18: 307-315.

Dahdough-Guebas, F., Vranken, D., Ravishankar, T. and Koedam, N. 2006. Short-term mangrove browsing by feral water buffalo; conflict between natural resources, wildlife and subsistence interests? *Environ. Conserv*., 33: 157-163.

Delgadon-Sanchez, P., P.F. Hensel, J.A. Jimenez-Ramon and J.W. Day. 2001. The importance of propagule establishment and physical factors in mangrove distribution pattern in a Costa Rican estuary. *Aquat. Bot*., 71: 157-178.

Diope, E.S., N. Diallo, A. Guisse and A. Soumare. 1996. Replantation in Senegal, W. Africa, Mangroves. *ISME Newsletter*, 17: 4-5.

Keerio, G.R. 2004. Riverine and coastal forests of Indus Delta-Eco-Region. (Eds.): J. Ahmed, S. Omar, F. Rasool. *Proc. Consultative Workshop on Indus Delta Eco-region* (IDER), pp. 47-58.

Kella, L. 1999. Protective role of Indus Delta mangroves with particular reference to cyclone mitigation. *Proc. Nat. Sem. Mangrove Ecosystem Dynamics of the Indus Delta*, pp.86-90.

Mirza, M.I., M.Z. Hasan, S. Akhtar and J. Ali. 1983. Identification and area estimation of mangrove vegetation on the Indus Delta using Landsat data. *ESCAP Regional Workshop on Remote Sensing applications for Vegetation Mapping. Colombo, Sri Lanka*, pp. 19-21.

Pernetta, J.C. 1993. *Marine Protected Area Needs in the South Asian Seas Region*, vol. 4. Pakistan. A Marine Conservation Development Report. IUCN, Gland, Switzerland. 42 pp.

Qureshi, M.T. 1993. Rehabilitation and management of mangrove forests of Pakistan. In: *Towards the Rational Use of high Salinity Tolerant Plants*, vol.1 (Eds.): L. Lieth & A. Al Masoom, pp. 89-95. Dordrecht, The Netherlands. Kluwer Academic Publishers.

Rasool, F. and S.M. Saifullah. 2002. Establishment of field nursery for cultivation of mangroves at Miani Hor. In: *Prospects for Saline Agriculture*. (Eds.): R. Ahmed & K. Malik, Kluwer Acad. Press. The Netherlands, pp. 439-446.

Saifullah, S.M. 1979. Occurrence of dinoflagellates and distribution of chlorophyll 'a' on Pakistan's Shelf. In: *Toxic Dinoflagellates Blooms*. (Eds.): D.H. Taylor & H.H. Seliger. Elsevier North Holland Inc. pp. 203-208.

Saifullah, S.M. 1997. Management of Indus Delta Mangroves. In: *The Coastal Zone Management Imperative for Developing Maritime Nations*. (Eds.): B.U. Haq, S.M. Haq, G. Kullenberg, J.H. Stel. Kluwer Academic Press, Amsterdam, pp. 336-346.

Saifullah, S.M. 2004. Exploitation of mangroves in Pakistan. *ISME Newsletter*, 27: 2-4.

Saifullah, S.M. and F. Chaghtai. 2005. Effect of 'Tasman Spirit' oil spill on marine plants in the coastal area of Karachi. *Int. J. Bio. Biotech*., 2: 299-306.

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

Siddiqui, N.A. 1995. A review on the regeneration problems of the mangroves with particular reference to Bangladesh Mangroves. *ISME Newsletter*, 6: 2-8.

Steinke, T.D. and L.M. Charles. 1987. The utilization of storage compounds during early growth of *Avicennia marina* seedlings under laboratory and field conditions. *S. Afr. J. Bot*., 53(4): 271-275.

Tomlinson, P.B. 1986. *The Botany of Mangroves*. Cambridge University Press, Cambridge. 419 pp.

(Received for publication 20 December 2006)