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LITTER PRODUCTION AND TURNOVER IN THE MANGROVES OF NORTHWEST INDUS DELTA, PAKISTAN

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ABSTRACTS

Litter production was studied in mangroves of North-western part of Indus Delta. Litter fall in grey mangrove forests (*Avicennia marina*) was studied at two sites, Sandspit and Rehdri Goth. In the study, litter traps were used to monitor monthly rates of litter fall per m2 at two sites. The rates of litter fall were found to be 6.920 t/ha/year and 6.78 t/ha/year at the two sites which were within the range of other arid zone mangroves. Largest component of the litter were leaves (56.5 % and 59.6 %). While in the fruiting season, fruits were the major component. The greatest rate of leaf litter fall coincided with the rainy season. Litter turnover rate, K_t, was 16.53 at Sandspit where the residence time was 0.06 years. At the Rehdri Goth, the turnover rate was 12.42 while the residence time was 0.08 years.

Key-words: Litter production, Mangroves, Indus delta, Pakistan

INTRODUCTION

Mangroves sustain a variety of marine and estuarine ecosystems and most of the primary production, consisting primarily of mangrove leaves, becomes available to consumers in the form of litter. Decomposition of this litter is one of the prime functions of ecosystems (Harley 1971). Leaf litter production has a significant effect on nutrient cycling in mangrove ecosystems. Generally, inorganic nutrients come from landwards to the mangroves and organic matter from the mangroves is exported to the sea (Christensen, 1983). Litter fall is a good indicator of the mangrove productivity, and its decomposition rate is of great significance as it reflects the nutrient recycling in the estuarine ecosystems (Saifullah *et al*., 1989). The present study is aimed to find the litter fall pattern in the mangroves of Indus Delta. The rate of decomposition and the effect of heavy metals on litter decomposition rate has been examined by Ahmed and Shaukat (2012).

MATERIALS AND METHODS

Two mangrove forests in the vicinity of the coastal city of Karachi were selected for this study. One site was Rehdri Goth and the other was Sandspit. Both the sites are considered as affected by marine pollution (Saifullah et. al. 2002). Litterfall was measured using square PVC baskets (0.5 x 0.5 m, 2 mm mesh) suspended above the highest tide at a height of 1 m above the ground level. In each study site, 10 traps were randomly placed (a total of 20 traps), at Sandspit and Rehdri Goth, in monospecific stands of Avicennia marina. The selected sites were similar in tidal elevations so as to reduce differences in litter fall due to tide-level position of trees. The litter was collected every month, from April 2010 to March 2011, following the method by Heald (1971). The collected litter was washed with freshwater to get rid off any salt in excess and subsequently leaves, flowers, propagules, twigs and branches were segregated from each other. The dry weight (DW) of sorted litter was found by drying the different components at 70oC for a 24 h period and then weighed. The values were converted from litter mass per 0.25 m^2 to 1 m^2.

Litter standing crop from the sediments was also collected monthly during the same time period from the two sites. Three 0.25m2 litter samples were collected (horizon L) nearby each litter trap and gently shaken to remove sediments. Material was oven-dried at 70oC for 24 h and weighed.

Litter turnover rate was calculated (i.e. considering the rate of replacement of the amount of litter fallen, by an equal amount in a given period of time) for one year. The mathematical model proposed by Olson (1963) and successfully applied to mangroves by Twilley *et al*. (1986, 1997) was used as follows

$$K_t = L/X_{ss},$$

where K_t is the rate of turnover in unit time, L is the rate of leaf litter fall (g/m2/day), and X_{ss} is the leaf litter mass on the sediment. Assumption of this model is that leaf litter losses and litter input are equal. On each site, residence time (of litter) on the sediment was calculated as the inverse of the turnover rate, i.e. $1/K_t$.

RESULTS

The pattern of litterfall was observed (Fig 1., a & b) to be similar at both sides. The fruiting season showed the highest rate of litter fall. In Rehdri Goth, the highest rate of litterfall was observed in August 2010, which is the fruiting season. However, the highest leaf litterfall was observed in September. The daily average was 1.90 g/m2/day whereas the total annual litterfall was observed to be 6.920 t/ha/year. Similarly, the highest rate of litter fall in Sandspit was also in the fruiting season but here it was spread over 2 monthly observations, i.e. August and September 2010 as the fruiting started late in this forest. Here, the annual daily average was 1.86 g/m2/day and the total annual litterfall was 6.78 t/ha/year.

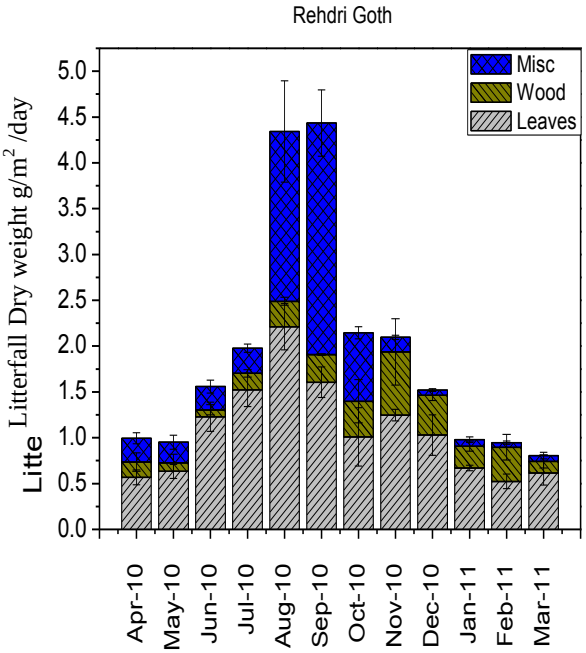

Fig.1a. Litterfall pattern in mangroves of Rehdri Goth.

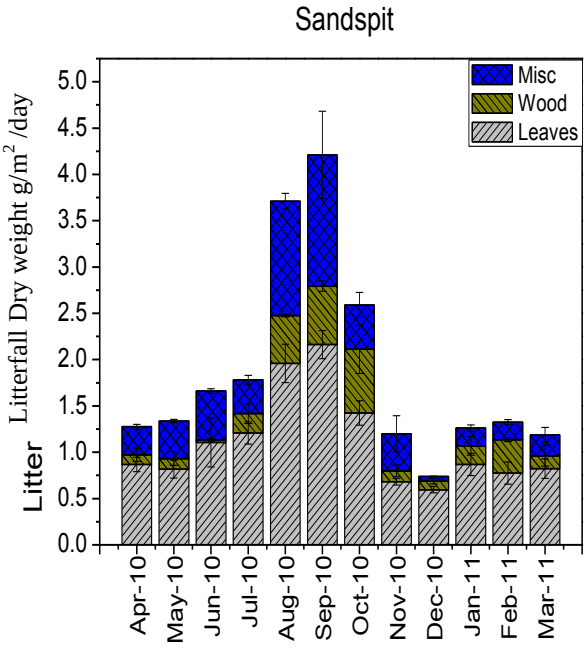

Fig.1b. Litterfall pattern in mangroves of Sands pit.

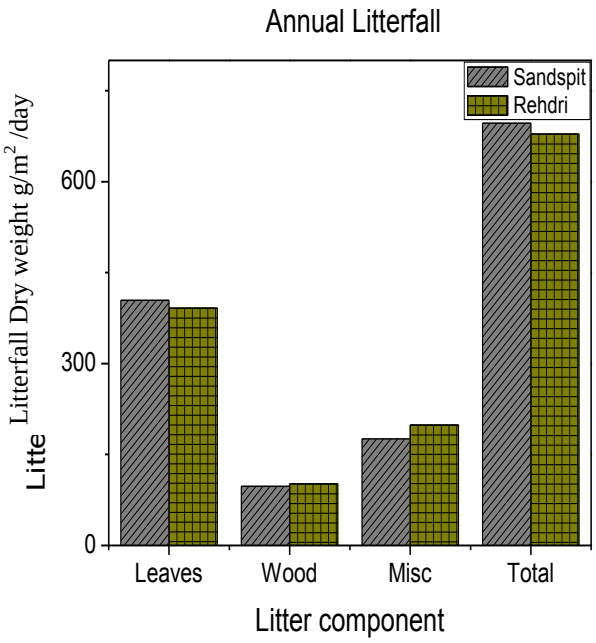

Fig.2. Comparison of Litter components between two sites.

The total litterfall between the two sites was also not much variable (Fig 2). However, there were some differences in different components of litter. In Rehdri Goth, the leaf component was 391.37 g/m2/year which were 56.47 % of total litter. The woody component was 109.43 g/m2/year (15.80 %) and miscellaneous which included fruits, flowers and other parts was 191.51 g/m2/year (27.06 %). Whereas in the Sandspit leaf litter was 404.3 g/m2/year (59.6 % of total) the woody components were 97.32 g/m2/year (14.34 %) and the miscellaneous were 176.04 g/m2/year (26.03 %).

Litter turnover rate and residence time at both the locations were quite different. At the Sandspit, the value of K_t was 16.53 and hence the residence time was 0.06 years While at the Rehdri Goth, the turnover rate was 12.42 while the residence time was 0.08 years.

DISCUSSION

The leaf litter fall at both the sites was markedly similar. Similar results have been reported by (Kathiresan and Bingham, 2001). The production of litter in the studied mangrove forests lies within the worldwide range between 130 to 1870 g m-2 (Kathiresan & Bingham, 2001). The rate of litterfall was highiest in the rainy season as pointed in another study in arid mangroves of Gulf of California (Arreola-Lizarraga *et al*. 2004), which coincided with the fruiting season and thus together with, it made the peak of litter production in July and August in Rehdri and August and September in Sandspit where the fruiting started a bit late.

This is an arid region, and therefore rainy season has its own importance. Similar studies in India on Avicennia marina showed high rates of litter fall after monsoons and lower rates before the monsoon season (Ghosh *et al*., 1990). However other studies revealed that litterfall may take place all round the year with little (Shunula and Whittick, 1999) or noticeable (Day *et al*., 1996; Wafar *et al*., 1997) seasonal deviation, depending on the influencing factors and their force in each region. Other factors influencing litterfall found between mangrove sites may be attributed to tidal flushing (Mackey and Smail, 1995; May, 1999; Twilley *et al*., 1997).

As far as the difference in standing crop is concerned, several factors may be responsible for the removal of standing crop of litter, including factors like tidal flushing (Flores-Verdugo *et al*., 1987; Boulton and Boon, 1991)., macrofaunal consumption and even waste input may be the major factors responsible for removal of detritus.

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REFERENCES

Ahmed, W. and S. S. Shaukat (2012). Effect of heavy metal pollution on leaf litter decomposition of two species of mangroves, Avicennia marina and Rhizophora mucronata. *J. Basic App. Sci*., 8: 696-701.

Arreola-Lizárraga, J.A., F.J. Flores-Verdugo and A. Ortega-Rubio (2004). Structure and litterfall of an arid mangrove stand on the Gulf of California, Mexico. *Aquatic Bot.*, 79: 137-143.

Boulton A.J. and P.I. Boon (1991). A review of methodology used to measure leaf litter decomposition in lotic environments: time to turn over an old leaf? *Australian Journal of Marine and Freshwater Research*, 42: 1-43.

Christensen, B. (1983). Mangroves, what are they worth. *Unasylva*, 35(139): 2-15.

Day, Jr., J.W., C. Coronado-Molina, F.R. Vera-Herrera, R. Twilley, V.H. Rivera Monroy, H. Alvarez-Guillen, R. Day and W. Conner (1996). A 7 year record of above-ground net primary production in a southeastern Mexican mangrove forest. *Aquatic Bot*., 55: 39–60.

Flores-Verdugo, F.J., J.W. Day and R. Briseno-Duenas (1987). Structure, litter fall, decomposition, and detritus dynamics of mangroves in a Mexican coastal lagoon with an ephemeral inlet. *Mar. Ecol. Prog*. Ser. 35: 83-90.

Ghosh, P.B., B.N. Singh, C. Chakrabarty, A. Saha, R.L. Das and A. Choudhury (1990). Mangrove litter production in a tidal creek of Lothian Island of Sunderbans, India. *Ind. J. Mar. Sci*., 19 (4): 292-293.

Harley, J. L. (1971). Fungi in ecosystems. *J. Applied Ecol.*, 8: 627–642.

Heald, E. J., (1971). The production of organic detritus in a South Florida estuary. *Sea Grant Tech. Bull. Miami Univ*., 6: 110.

Kathiresan, K. and B.L. Bingham (2001). Biology of mangroves and mangrove ecosystems. *Adv. Marine Biol*., 40: 81-251.

Mackey, A.P. and G. Smail (1995). Spatial and temporal variation in litter fall of Avicennia marina (Forssk.) Vierh. in the Brisbane River, Queensland, Australia. *Aquatic Bot*., 52: 133-142.

May, J.D. (1999). Spatial variation in litter production by the mangrove Avicennia marina var. australasica in Rangaunu Harbour, New Zealand. *New Zeland J. Mar. Fresh. Res*., 33: 163-172.

Olson, J.S. (1963). Energy storage and the balance of producers and decomposers in ecological systems. *Ecology*, 44: 327-332.

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., A.K. Khafaji and A.S. Mandura (1989). Litter production in a mangrove stand of the Saudi Arabia Red Sea Coast. *Aquatic Bot.*, 36: 79-86.

Shunula, J.P. and A. Whittick (1999). Aspects of litter production in mangroves from Unguja Isalan, Zanzibar,Tanzania. *Estur. Coastal Shelf Sci*., 49: 51–54.

Twilley, R.R., A. Pozo, V.H. Garcia, V.H. Rivera-Monroy, R. Zambrano and A. Bodero (1997). Litter dynamics in riverine mangrove forests in the Guayas River estuary, Ecuador. *Oecologia*, 111: 109-122.

Twilley R.R., A.E. Lugo and C. Patterson-Zucca (1986). Litter production and turnover in basin mangrove forests in Southwest Florida. *Ecology*, 67: 670-683.

Wafar, S., A.G. Untawale and M. Wafar (1997). Litter fall and energy flux in a mangrove ecosystem. *Estuar. Coastal Shelf Sci*., 44: 111-124.

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