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What is the Significance of Mangrove Forests: A Note

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Abstract

Mangroves occur almost exclusively in the tropics. Mangroves are found in a relatively small area of originally 17 to 20 million hectares. Mangrove area is used to refer to large variety of coastal systems which vary in productivity and in their makeup and which have differing hydrological and ecological features, depending upon the coastal morphology. They act as "coastal stabilizers, shelter belt areas, barrier of the sea erosion and as a nutrient export zone to open ocean. With regards to animal and plant resources, there occurs a total number of 193 plant species, 397 fish species, 259 crab species 256 mollusk species and 450 insects, more than 250 species of mammals, other plants and animals species diversity world wide. With respect of global warming, mangroves play a major role in controlling the concomitant sea level rise, coastal erosion and long-term community stability and also have an excellent potential of medical values. In the monetary term, the market value assessment of mangrove areas is available for entry into a coast-benefit analysis, mangrove forest will be regarded as a high-value ecosystem such as above sources of these long-term utilization of mangrove is only possible if one takes the ecological, economic and social value of this ecosystem into consideration as most essential for the eco-balance.

Keywords: Mangrove, importance, resource, community stability, significance

INTRODUCTION

Wetlands, recently identified as one of the most useful natural resource systems, are "essential life" support system and plays a vital role in controlling water cycles and cleaning the coastal environment and also it is an open ecosystem which is sustained by the flow of energy and nutrients (e.g. fresh water delivery and tidal flow) from the neighboring marine and land systems and in turn influences them. The tidal forest is used as a synonym of mangrove (Uthoff, 1996; Kathiresan, 2000). Further, it is a most important and unique ecosystem by virtue of its inter-tidal position, species composition and its distribution in the tropical and sub-tropical region and also it is a unique habitat for crustaceans and planktor's (Govindasamy et al., 1998). They act as "coastal stabilizers, shelter belt areas, barrier of the sea erosion and as a nutrient export zone to open ocean. Unfortunately, very little attention has been paid to this important ecosystem in the past. In respect of global warming, mangroves play a major role in controlling the concomitant sea level rise, coastal erosion and long-term community stability. Moreover, the mangrove forest provides to humans resources such as fuel, building materials for house, boats and fishing equipments, food stuffs such as fish, mussels, leaf vegetables, honey, sugar, vintage and alcoholic drinks and traditional medical remedies (Masteller, 1996). The title, while, documenting "What is the Significance of Mangrove Conservation?" at the natural products level in different angles, suggests that further scientific work is essential to highlight its current role in socio- economic development.

Worth of Mangrove Forest

Before using a resource, people usually ask what it is worth, and how its value can be determined. To come straight to the point: despite numerous attempts, so far nobody has succeeded in putting a financial value on mangrove forests which would be accepted by all who have vested interests in this system. This is not surprising when one consider the wide range of ecological, economical and cultural values provided by this habitat. However, with this anthropocentric way of viewing things we often run the risk of highhandedly overestimating our role as users and consumers of a natural system. It is an extremely one-sided approach to evaluate natural goods solely on their marketability. All too often in our industrial culture we tend to apply value scale to natural resources and products which do not take adequate account of their true importance in the country of their origin. There, market value is essentially determined by the users themselves, depending exclusively on the availability and cost of procuring these goods.

In the case of the mangrove forest it is difficult, for several reasons, to employ conventional economic criteria in achieving a proper valuation. On the one hand, the majority of mangrove forest products do not find their way into usual market outlets, i.e. where they are converted into cash; instead, their distribution is limited to the financially weak part of coastal population which collects these products chiefly to cover their own needs or to engage in barter. On the other hand, many of the goods and services origin in the mangrove ecosystem are found outside the forest complex. Think for example of the marine products which originate in or are indirectly related to mangrove difficult to calculate the financial value of mangrove in terms of their function as productive barriers against hurricanes and coastal erosion, as stabilizers of coastal climate and groundwater tables, or when one considers the value of all products which traditional mangrove dwelling communities gain from the forest.

The amount of services provided by mangrove forest was always appreciated after the ecosystem had been damaged or eliminated. Usually it was by then too late, because even with

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expensive corrective measures the essential functions of this forest could only be restored in a few exceptional cases. For example, to construct artificial means, not to speak of the coast for repair and maintenance. Natural mangrove belts may exert the same protection on these facts in mind; the authorities in Hawaii drew relevant conclusions a few decades ago. To protect the island of Molokai against tsunamis, the dreaded tidal waves that are triggered by submarine earthquakes, new mangrove belts have been planted extending over many kilometers. Similar measures were initiated late in the day in Bangladesh, after a cyclone devastated the southern coast of the country in 1970, where more than 300,000 people lost their lives (Mastaller, 1995). Since that time, the government has undertaken intensive reforestation programs and recently planted a total 25,000 hectares of mangrove forest which had been cleared there for decades, exposing the coast without protection against storm and wave forces. Moreover in India, in the delta of Ganges and Brahmaputra it has been found that during the recurring flood related catastrophes, the damage caused was particularly high in those area where mangrove swamps have been drained or converted into agricultural and prawn form ventures.

Mangroves are also of undeniable value in culture terms. Many coastal people have intimate traditional links with this habitat. Mangrove forest provide important direct and indirect food and ornamental items (Fish, meat, feathers, ornamental flowers etc.,). For example, some countries, mangrove product are a regular part of people's diet; in Southeast Asia and Columbia the seeds of Avicennia and Nypa are consumed; in Malaysia and Indonesia, young leaves and the seeds of Sonneratia trees are boiled as vegetable, in Thailand, people eat the root tips of Buguiera and make salad out of leaf shoots of Cosperma (Saha et al., 1979). Some Indians kitchens use mangrove fern for the same purpose. Moreover, honey and wax harvested from mangrove - visiting bees are particular popular products in some coastal regions. Bangladesh produces about 180 tones of honey and 50 tones of wax from these bees each year (Masteller, 1995). Further, mangrove have educational and recreational (tourism) values. With their relatively few but exotic and highly specialized fauna and flora, mangrove forests serves ideally for imparting environmental education.

Mangrove forest is a source of future asserts, at present, can hardly be expressed in cash terms. For science, too, this ecosystem has rich perspectives. Most animals and plants have barely been studied. Nobody knows about the dormant potentials, these biota have and perhaps some of them in one way or another may yield new food supplies, medicines or raw materials for innovative industries. There are most rewarding aspects to be expected when current biotechnical studies find ways to transplant the genes responsible for salt resistance into new crops that could be cultivated on hypersaline coastal soils. This article highlighted some of the socio-economic important aspects of the mangals. Let us give an opportunity for our future generations to enjoy the benefits of these precious wetlands.

Sedimentation and Costal Hydrodynamic of Mangrove

Mangrove area is used to refer to large variety of coastal systems which vary in productivity and in their makeup and which have differing hydrological and ecological features, depending upon the coastal morphology. Based on functional, tidal rhythms, seasons and geomorophological terms, mangle is classified as riverine, basin, fringe, over wash and scrub forests (Schwamborn and Paul, 1996). In biological, ecological and geological research, there are different nations as regards the function of mangrove (Woodroffe, 1992). In a biological terms mangrove ecosystem is primarily a source of organic matter and sink in which sediment accumulates over long period of time. It may be likely that roots of mangrove tree trap sediment in their prop roots thus functioning as land builders and also mangroves acts as builders and also of mangrove acts as a barrier to control the sea erosion. In numerous cases there has been proof of an enormous sedimentation rate in mangroves areas, ranging between 1 mm/a to 8 mm/a (Bird and Barson, 1977). High sedimentation rates have probably been measured frequently because mangroves are primarily found in places where there is a large degree of sedimentation i. e. in regions like estuaries, lagoon and protected bays. Presumably mangroves protect coastal areas from constant erosion.

As regards hydrodynamics, the mangrove plants which grow in this environment has a decisive effect on the dynamics of the tidal currents (Wolanski et al.,1992). For the formation of asymmetrical tidal currents, the ebb current being as much as 50% stronger than that flood current, when low tide has already been reached beyond the river mouth, the upper area of the river and the mangrove swamps still have high tide. The tidal influence exerted by the mangroves reached a distance of 20 km from the continent. The tidal asymmetry leads to the formation of deep channels due to erosion. The deforestation of neighboring mangrove region (for example, for aquaculture) and dicing changes the tidal asymmetry may lead to a reduction in the depth of the channels until a new balance between the remaking stand of mangroves and the cross- section of the tidal creeks is reached.

Interactions with Adjacent Ecosystems

Mangrove ecosystems are open systems, which exchange matter and energy with the adjacent marine and terrestrial ecosystem. It is also an effective ecosystem since large amount of inorganic and organically bounded nutrients are washed into mangroves from the continent. This happens either via rivers or continental drainage, the nutrients are salt accumulated. They are washed into the mangrove forests by the river water run off. The extent of wave and tidal coping between mangrove and offshore marine biotopes controls the intensity of interaction between the systems (Wolanski et al., 1992). Presumably inorganic and organic matter in the mangrove ecosystems is rebuilt to a large extent, i. e. autochthonous organic matters is re-mineralized microbially and then organically bound in the mangroves by primary and secondary producers, thus becoming sediment in the mangroves. Thus apart from transporting matter, mangroves are also involved in various biological interactions with ecosystems which are in part quite for away from them.

Besides the natural import of matter from the content, large amounts of organic matter (waste Water) dissolved nutrients (manure) and pesticides from the content are washed into mangrove area as a result of human intervention. It is possible that mangrove areas which, are relatively closed ecosystems, in hydrographical terms(lagoons and estuaries which branch out widely) from sinks with regard to these materials, thus protecting the offshore ecosystem (Morell and Corredor, 1993). Thus apart from transporting matter, mangroves are also involved in various biological interactions with ecosystems which are in part quite far away from them.

Mangrove Plants and Animals

Accordingly, the total worldwide are of mangrove occur almost exclusively in the tropics and in a relatively small area of originally 17

to 20 million hectares, (Uibrig, 1996) Based on the climate, the mangrove either merge inland into terra firma vegetation or they are visibly separated from the mainland by an almost vegetation-free strip of land. The largest mangrove area occur in Indonesia (30%), Brazil (10%), Australia (8%) and Nigeria (7%), But in India having only 3% of mangroves (Mastaller, 1996)

A salient feature of most mangrove forests is their zonation (Smithy 1992) One can usually tell immediately that along the shore, there are alternating belts of different vegetation which run parallel to the coast According to the traditional diversity of utilization in the horizontal and vertical differentiation of the mangrove forests have been developed to explain here The horizontal differentiation is expressed in clear zonation as the results of different duration of water submersion and corresponds to the transition from the marine to the terrestrial habitat Vertical differentiation is expressed in a clear layered structure, in which eight futuristic habitats are arranged one above the other.

-the canopy of the trees as a habitat for birds, insects and fungi
-the trunk and branch area, where rainwater collects in the branch holes and axis, making a fresh-water, marine and brackish water, as a habitat for mammals, reptiles and birds
-the sub-aerial soil surface as a habitat for mammals, reptiles, snails and arthropods
-the permanently or periodically filled ground, as a habitat for crabs, snails, frogs and shrimps
-the channels and tidal channels, as a habitat for pelagic fishes and reptiles.
-the submarine soil surface as a habitat for benthic organisms like demersal fishes, shrimps, crabs, molluscs and macro algae and also bacteria and fungi.
-the entire water body as a habitat for planktor's and other different larval forms.

In a horizontal differentiation, it is not expressed in a clear layered structure for which the causes of Zonation still remain obscure. Probably the factors which lead to Zonation of the types of mangroves are determined in great part by the specific features of the regions in which such Zonation occurs. Further more, factors such as the structure of sediment, pH, frequency of inundation, tidal nature and salinity are dependent upon One another and usually covering along the seaward gradient, so that the interpretation of field Observations is difficult. At present, various procedures are being developed in order to describe the Zonation of mangroves in any complex system (Williams et al.,1991). A precise numerical description of the distribution of mangroves in as many regions possible will facilitate the search for the causes of Zonation in the future. In order to obtain a better understanding of the natural dynamics of mangrove forests, further field experiments in this area of research are also necessary.

With regards to species, distribution, Indian Ocean and pacific region have a large diversity of species where as low diversity of species distinguish the America and West Africa regions (Jordan, 1991). According to species lists published by Rao (1987), there occurs a total number of 193 plant species, 397 fish species, 259 crab species 256 mollusk species and 450 insects, more than 250 species of mammals, other plants and animals species diversity world wide. In India, there are no uniformity on the mangrove species distribution The flora is composed of more than 60 species belonging to 41 genera, 29 families and 26 species in the East coast. It is interestingly to note that, eight species, that are present in the West Coast are absent in the East West (Untawale, 1984) of these 60 species, 30 and 18 species are found in Soundrabons and Tamil Nadu respectively. Azariah et al. (1992) reported that at present more than 13 species of true mangrove plants were available in Coringa mangrove forest in Andhra Pradesh in India. Further, Azariah et al. (1992) observed the presence of only 4 species of exclusive mangrove species many Avicennia marina, Excoecria agallocha, Aegiceral corniculatum and Acanthus ilicifolius in this ecosystem. Of these 4 species A. marina is the dominant species in Muthupet mangrove. So this mangrove is called as "Black Mangrove". In Pitchavaram Mangrove the species richness of phytoplankton was high. There were 82 species constituted by 67 species of diatoms, 12 species of dinoflagellates and 3 species of blue green algae observed 35 species of and one variety of rotifers belonging to 17 genera more identified from the Pitchavaram mangroves. Very recently, Banerjee (1997) made extensive surveyed the coastal regions and reported that the distribution and Zonation of the mangrove species, in relation to the variation of topographic features and major ecological process A total of 65 mangrove species has been recorded throughout India of these, 62 are found in Sundarbans, 63 in Mahanadi, 29 towards the Godavary-Krishna-Cauvery and West coast regions and 30 in the Andaman and Nicobar Island.

A diverse fish and prawn species are to be found in all mangrove areas of the world (Blaber and Milton, 1990). In tidal forest, a total number of 26 to 197 species exists, the number of species inhabiting them usually amounts to around 100 Robertson and Blaber, 1992) Odum and Heald (1972), investigated that the some of over 10,000 fish, crabs and insect larvae were reported from Southern Florida. Of these more than 53 species of fish, 5 species of Decapoda 5 species of Amphipoda and each 3-80 species of Isopod, Cumacea, Mysidecca, Copepoda, Ostrcoda, Mollusca, Ciliata and Chironomid larvae etc. were identified and reported from Florida.

Medical Values of Mangroves

Traditional use of Mangroves as Medicinal plants

Of the 65 species of mangrove plants, 12 species are found to be widely used by local medical practicinars in many countries like Africa, South East Asia, South America and Australia. These 12 species viz. Acanthus clicifolius, Aegiceras majus, Avicennia africana, A. marina, A. officinalis, Ceriops caudolleana, Exocoecaria agallocha, Kandelia rhecdi, Nypa fruticans, Rhizophora mangle, R. mcronata and Sonneatia caseolaris are used to cure some deeded diseases like leprosy, elephantiasis, tuberculosis, malaria, dysentery, ulcers and some skin diseases.

Balsco (1976) and Banerjee and Gosh (1998) reported that 27 and 65 species of mangrove are present in India respectively. Mangrove forests are distributed in various deltaic regions of the east coast. However, 78% and 12% of the Indian mangrove are found in the east coast and (including Andaman and Nicobar) and west coast respectively (Katherisan, 1998). Out of total 65 species, only 18 species are being traditionally used by the people living in the vicinity of mangrove forests. Moreover, etanobotanical records regarding medical use of mangrove plants are very limited.

Bioactive Compounds Isolated From Mangrove Plants

Studies on the bioactive compounds of mangrove plants often lead to the discovery of new therapautic agents. Also a new chemical structure isolated from is used as a lempelate for the prepatation of a series of snthetic analoges with effective medicinal value. Some of the isolated bioactive compounds from mangrove plants which have

pharmacological values. Loder and Russel (1969) initiated the study of biological active compounds of smangrove plants. They showed that the extracts of barks of Bruguiera sexangula are active against two human tumor, sarcoma 180 and Lewis lung carkinoma. Fractinatian studies of the extract showed that the activity is partly associated with a tannin free aqueous and tropine esters of acetic, propionic,- butyric, isobutyric and benzoic acid from the bark of the B. sexangula. A new alkaloid, brusine, (+) - tropine 1, 2 - ditholan - 3 - carboxylate is also separated the bark. From the root of A. ilicifolius, Kokpol et al. (1984) isolated a number of compounds such as octacoyslalcohol, stigmasterol, benzoxazoline-2-one and stigmasterol -ß -D- glncopyraroside. A new alkaloid acanthiafoline has been separated from the root. The roots of A. ilicifolius acts against a number of diseases and the medicine properties of this plant may be attributed the presence of benzoxazoline-2- one. The roots extract has been shown to exhibit biological activity against leukemic in mile. Benzoxazoline-2- one has been extensively studied as a central nervous system depressor which exhibit analgesic, antipyretic, anticonvulsant, hypnotic and muscle relaxant activity. It has also been reported to possess a resistance factor against fungi Ribose derivatives of benzoxazoline-2- one has been shown as an active anticancer and anti viral agent. Stigmasterol has been shown to have slight hyper cholesterolinic effect which exerts no effect on heart or liver (Chandler et al. 1979).

Prospects of Mangroves as Medicinal Plants

Many species of family rhizophoraceae are good sources of tannin and it has also been observed that Ecocoecaria agallocha can yield high amount of tannin than Rhizophora sp. and Ceriops sp. (Macnae, 1968). One to its astringent property, tannin is suitable in the treatment of tonsilitis, pharyngeatis, haemmorjoids. slaik eruion and burns. It is taken internally, to diarrohea and intestinal bleeding. Tannin is also used as an antidote for metallic, alkaloidal and sylycosidic poisons with which it forms a soluble precipitate (Kokpol, 1984). Some Indian mangrove plants such as Rhizophora mucronata, Ceriops candalleana, C. tagal and Ecocoecaria agallocha are good sources of tannin. Despite the fact that the traditional use of mangroves in Unani medicine has not been documented; its pharamacological value has been recognised Unani medical practices. Ethanobotanical studies of mangrove plants in various diseases, particularly to cure leprosy. However, systematic scientific study in this aspect is lacking and such a study may reveal the importance of mangroves in curing leprosy. In addition, a number of chemical products have also been isolated from different mangrove species and their importance i Unani medical practice. It is suggested that more importance is to be givento this field of emerging research to as to open up in Unani medicalpractices.

Mangroves as Makers of Wetland Ecosystem

From the above view point of the mangroves different aspects, the sea level rise will modify the productivity and nutrient flures in the mangrove ecosystem The vegetative production rate of mangrove will affect organic sedimentation rate and litter fall (Ellison, 1989) The response of each mangrove species is terms of mangrove functioning and making of wetland ecosystem need to be investigated based on current knowledge of hydrology, productivity, nutrient fluxes amount and patterns of sedimentation (autochthonous and allochthonous) and oceanographic and geology and Zonation pattern studies have been made. These included climatic conditions, freshwater balance, water quality, tidal current dynamics and modelling, material fluxes, estimation of litter flu and estuarine dynamics during the dry and wet seasons.

Mangroves trap fine sediments that are carried into the coastal zone by flood waters, and there is a significant net export of nutrients from the mangroves into the coastal zone, which act as a source of enrichment for the marine environment. Nutrients derived from Non-Mangrove sources upstream accounted for less than 10% of the total nutrients exported. Consequently 90% of nutrients are believed to come from the Mangrove area (Aksornkoae and Papharasit, 1996) Thus the role of mangroves to makers of wetland ecosystem.

Within the framework of this article, the structure of mangroves as systems and their function, stability can be properly utilized in certain ways is sound management principles and followed A long term utilization of mangroves is only passible if one takes the ecological, economic and socio-cultural functions of theses systems into consideration. In order to quantify the role played by the mangroves, which was postulated in the theses brought forth in this article, and to determine the buffering capacity of this system, inter and multidisciplinary cooperation among scientists and different fields of scientific research and the integration of their research findings on this system is necessary Only in this way it will become possible to do justice to the ecological and economic significance of this makers of wetland ecosystem.

Destruction of Mangrove Wetlands

Mangrove areas are a natural feature of the tropical forests and form one of the most extraordinary ecological formations occurring in coastal lowlands of the tropics. Largest mangrove areas occur in Indonesia, Brazil, Australia and Nigeria. Reliable estimation of mangrove forests range from 17 to 20 million hectares all over the world. Worldwide a good 80% of the previously existing mangrove forests have been devastated. On global scale, the cumulative effects of natural disasters, clearcutting, overlogging, fish and shrimp farming, industrial and domestic pollution, dredging and industrial and agricultural land reclamation as well as fragmentation threaten their continued existence. In the past, 100 years about 1,50,000 ha. of mangrove forests disappeared at the largest delta region of the world, extending between India and Bangladesh. The Philippines lost 3,155 km2 of mangrove from 1968 to 1990, that is about 70.40% of the initial stand or about 145 km2 a year or 39 ha. day-1. Followed by Thailand lost 1,96,422.8 ha. of mangroves from 1979 to 1986. This corresponds to a reduction of the stock by 53% within the 30 years. The average annual reduction is 12,982 ha. year-1 or 35,56 ha. day-1.Vietnam of 2,49,000 ha. mangrove from 1943 to 1991 and to a reduction of stock by 40.9 within the 28 years. In India's southern state of Kerala were the rate of population increase is the highest in the country, some of 79,000 ha. of mangrove were cleared by the turnoff the century. Now India has only the 6,740 sq. km areas of mangrove. Typical consequences of systematic mangrove destruction can be witnesses the world over. Increased flooding and coastal erosion lead to loss of crops, villages, and lives, local substance fisheries decrease or social changes relating to loss income through loss of resources and in addition to creating the ecological imbalance.

Need For Mangroves

Mangrove forests are among the most naturally fertile and biologically productive area of the estuarine ecosystem Mangroves colonize the strip of land between the lowest and highest water levels determined by the changing tides along the sheltered tropical and subtropical wetland ecosystems (Alfred Bittner, 1996). Extremely high amounts of fish ad shrimps biomass are to be found in

mangrove areas (Blaber & Milton 1990) More than 1145 species of plants and animals were distributed around the world mangroves (Rao, 1987) The tidal forests provide the human society essential material like fuel, building materials for houses, boats and fishing equipment, honey, sugar, vinegar, and alcoholic drinks, raw materials for household utensils and clothing, tanning agents and traditional medicinal remedies. Further, the economically important species are the milkfish (Chanos chanos), mullets (Mugilidae), various tropical perch species (Epinephelus; spp.) and crustaceans (Crassostra sp.) has the highest market value From the palm (Nipa) - leaf the mats baskets, hats and rain capes are also woven made from above the tree. Young leaves are used to trap, food, while the ribs are used as fuel. In the monetary term, the market value assessment of mangrove areas is available for entry into a coast-benefit analysis, mangrove forest will be regarded as a high-value ecosystem such as above sources of these long-term utilization of mangrove is only possible if one takes the ecological, economic and social value of this ecosystem into consideration as most essential for the eco-balance.

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REFERENCES

Aksornkoal, S. and N. Paphavasit, 1996. Effect of sea level rise on the mangrove Ecosystem in Thailand, Natl. Resour. and Develop. Vol-43/44. 95-104.

Azariah, J., H. Azariah, S. Gunasekaran and V. Selvam, 1992, structure and species distribution in Coringa mangrove forest, Godavari Delta, Andhra Pradesh, India. Hydrobiologia, 247:11-16.

Azariah, J., R. Mohan, S.R. Sekhar, V. Selvam and S. Gunasekaran, 1987. Hydrobiocoenology of Mangrove Ecosystem Muthupet - Tamil Nadu. Project report submited to Indian Council of Agricultural Research, New Delhi.

Azariah, J., V. Selvam and S. Gunasekaran, 1992. Impact of past management practices on the present status of the Muthupet mangrove ecosystem. Hydrobiologia 247:253-259.

Balber, S. J. M and D. A. Millton, 1990. Species composition, community structure and zoogeography of fishes of mangrove estuaries in the solomon Islands. Mar. Biol., 105:259-267.

Banarjee, L.K., 1997. Distribution of mangroves in India. Inter. Natul. Symp. Mangrove. abstract. 56p.

Bird, E.C.F and M.M. Barson, 1977. Measurement of physiographic changes on mangrove fringed estuaries.

Bittner, A., 1996. Aspects of the Focal theme. Natural. Resource Devlop.43/44:9-12.

Blasco, 1976. Outline of ecology, botany and forestry of the mangals of the Indian subcontinent. Ecosystem of the World No. 1. West coastal ecosystems, V. J. Chapman (ed.) 241-260.

Chandler, R. F., S. N. Hooper and H. A. Ismail, 1979. Antihyper cnliresthoemic. Studies with Sterols. J. Pharm. Sci., 68": 245-247.

Chapman, V. J., 1970. Mangrove phytosocology. Trop. Ecol., 11: 1-19.

Ellison, J.C., 1989. The effect of sea-level rise on mangrove swamps. Review paper of the commonwealth Secretariat Expert. Group on climatic change and sea-Level Rise.

Govindasamy, C. and L. Kannan, 1996. Ecology of the Rotifers of the Pitchavaram mangroves, Southeast coast of Indian Hydrobiol., 2:69-76.

Govindasamy, C., L. Kannan and Jayapaul Azariah, 1998. Conserving a Crucial Wetland Ecosystem. In: Wetland Ecosystem, (Eds) P.K. Jha, et. al., Ecological Society, Nepal. (In Press).

Jangsuvt, Y., 1981. Studies of Toxicity and Antitumor effect of Acanthus icilifolius Lin. M.S. Thesis. Chulalong Korn University. Thailand., 254pp.

Jordan, E., 1991. Die Mangrove Ecuadons, In:Geographlsche Rundschan 43:664-77.

Joseph, N., 1964. Benzoxazoles Potent skeletal muscle relaxants. J. pharm. Sci., 53: 538-544.

Kannan, L and C. Govindasamy, 1992. Rotifers of Portonovo. Monograph, Annamalai University, 45p.

Kannan, L. and K. Vasantha, 1992. Microphytoplankton of the Pitchavaram mangroves, southeast coast of India: species composition and population density. Hydrobiol., 247:77-86.

Kirtikar, K. R,. and B> D. Baru , 1918. Indian Mangrove plants. MIS Bishen Singh Mahendrae Pal Sing, Publisher, Delhi, 223 pp.

Kokol, U., 1984. Chemical of natural products from Mangrove plants. Plesentea at the work shop on mangrove plants held in Singapore. Abstrat. 89pp.

Kokpol, U., V. Chittawong and D.H. Miles, 1984. Chemical constituents of Acanthus ilicifolius and biological activity. Abstract of 5th Asian symposium on medical plants and species. Seoul, Republic of Korea, 115 pp.

Kathiresan, K.,2000. A review of studies on Pichavaram mangrove, southeast India. Hydrobiologia, 430: 185–205

Loder, J.W., and G. B. Russel, 1969. Tumor inhibitory plants The alkaloids of Brugriera sexangula and B. exavistata (Rhizophoraceae). Aust. J. Chem., 22: 1271-1275.

Macnae, W. 1968. A general account of the fauna and flora of mangrove swamps and forests in the Indo- west pacific region. Adv. Mar. Biol., 6: 73-270.

Mastaller, M., 1995. Utilization of mangrove forests. Natural. Resource. Develop., 42: 7-24.

Mastaller, M., 1996. Destruction of Mangrove Wetlands causes and consequences. Natural. Res. Devlop., 43/44:37-57.

Medeifos, C.Q and B. Kjerfre, 1993. Hydrology of a tropical estuarine system: Itamaraca, Brazil. Est. Coast. Shelf Sci., 36:495-515.

Mercer, D. E., and L. S. Hamulton, 1984. Mangrove ecosystems Some economic and natural serebils. Nature and Resources. 20: 6-13.

Morell, J.M. and J.K. Corredo, 1993. Sediment nitrogen trapping in a mangrove lagoon. Est. Coast. Shelf. Sci.,37:203212.

Navalkar, B. S., 1973. Ecology of mangrove. M. Mishra, B. Gopal, K. P. Singh and J. S. Singh. Today and tomorrow's printers and publisher, New Delhi.

Odum, W.E. and E.J. Heald, 1972. Trophic analysis of an estuarine mangrove community. Bull. Mar. Sci., 22:671-738.

Odum. W. E., C. C. McIvor and T. J. Smith, 1982. The ecology of mangroves of south Florida: a community profiles. U. S. Fish and Wild life Service, office of Biological Service, Washington, D. C. FWS/OBS- 81/24: 144pp.

Okarie, D. A., and D. A. H. Taylor, 1970. Limonoids from xylocarpus grahatum. Koeing. J. Chem. Soc., 2: 211-213.

Prain, D., 1903. Flora of the Sunderbans. Bot. Surv. India., 2: 231-270.

Rao, A.N., 1987. Mangrove ecosystems of Asia and Pacific. Umali, R.M.(ed). Mangroves of Asia and the Pacific: status and management. Technical Report of the UNDP/UNESCO Research and Training Pilot Programme of Mangrove ecosystems in Asia and the Pacific, Quezon city, Metro Manila. 1-48.

Robertson, A.I and S.J.M. Blaber, 1992. Plankton, epibenthos, and fish communities. Robertson, A.I. and D.M. Alongi (eds.) Tropical mangrove ecosystems coastal and Estuarine studies, 41. American Geophysical Union, Washington. 173-224.

Saha, P.K., T. Ganguly, S.N. Ganguly and S.M. Sagar, 1979. Rhizophorinae - A new Indole acid plant growth from Rhizophora mucronata. Plant Biochem. J., 5:65-68.

Sasekumar, A., V.C. Chong, M.U. Leh and R. D'Cruz, 1992. Mangroves as a habitat for fish and prawns, Hydrobiologia, 247:195-207.

Schwamborn, R. and V.S. Paul, 1996. Mangroves-Forgotten Forests. Naturl. Res. Develop.,43/44:13-36.

Smith, T.J., 1992. Forest structure(mangrove) Robertson, A.I and D.M. Alongi (eds.) Tropical mangrove ecosystems. Coastal and Estuarine studies, 41. Ammesical Geophysical Union, Washington. 101-136.

Uibrig, H., 1996. The mangrove populations of Vietnam and the development of their exploitation. Natural Res. Develop.105-126.

Untawale, A.G., 1984. Present status of mangroves along the west coast of India. Proc. As. Symp. Mangr. Env. Res. Monogr. 57-74.

Uthoff, D., 1996. From Traditional use to total Destruction Forms and Extent of Economic Utilization in the southeast Asian mangroves.

Williams, W.T., J.S. Bunt and H.J. Clay. Yet another method of species - sequencing. Mar. Ecol. Prog. Ser. 72:283-287.

Wolanski, E.Y. Mazda and P. Ridd., 1992. Mangrove hydrodynamics. Robertson, A.I. and D.M. Alongi (eds.) Tropical mangrove systems. Coastal and Estuarine Studies, 41. American Geophysical Union, Washington. 43-62.

Woodroffe, C., 1992. Mangrove sediment and geomorphology. Robertson, A.I. and D.M. Alongi. (eds.). Tropical mangrove systems. coastal and Estuarine Studies, 41. American Geophysical Union, Washington. 7-42.