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Research Article

# SURVEY OF SALT MARSHES AND ASSOCIATED COASTAL PLANTS IN COLEROON AND VELLAR ESTUARY SOUTHEAST COAST OF INDIA

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## ABSTRACT

Salt marshes are native plants of saline soil all around the world and somewhere they are associated with mangrove forest. We surveyed the plant species of two tidal marshy environments of Coleroon and Vellar estuary drained to Bay of Bengal in the Southeast coast of India. Coleroon river is one of the most diverse mangrove ecosystems of India located in Pichavaram coastal area which is rich in biodiversity .Vellar river is ended at Parangipettai coast which has a huge area of marshy bare land consisting a wide range of marshy plants and some artificially developed mangrove vegetation. The Colenoo river at Pichavaram mangrove forest showed highest abundance of species and decreased complexity than the Vellar estuary and this might be attributed to the variation in physicochemical parameter, fresh water flow and nutrition level. The present study is focused on the species abundance, physicochemical and Nutritional parameters of the salt marshes of Coleroon and Vellar estuaries.

## INTRODUCTION

The salt marshes are the group of plants, taxonomically isolated and successfully adopted with a peculiar environmental condition that shows wide variations in several environmental factors. Salt marshes are now recognized as important intertidal wetland plant community that survive with various adaptations to overcome the salt toxicity. They are growing in the upper tidal zones between mangroves and terrestrial vegetation. Due to the limited tidal influence, salt marsh areas usually have high salt content in the soil therefore it is also called 'halophytes' meaning 'salt loving' plants. They have adapted in different ways to manage with salty soil. To reduce water loss succulent plants like 'bead weed' have fleshy branches and stems, rather than leaves. Some succulent species are accumulating salt in their leaves, which plant discard or drops to reduce its salt load. Salt marsh habitats have flexible salinity influenced by marine water serving as nursery ground for many aquatic organisms. The soft-bottomed tidal mud flats where fine sediments have accumulated in thick layer along the shoreline and estuaries. Huge quantity of blackish brown sediments are also flooded by estuarine fresh water flow over vast areas of coastal mud flats twice each day. Much of this sediment is deposited in the estuarine bank and shoreline and forms thick mudflats. Initially, a soapy mud settle and firm marsh grasses (*Cyperes members*) and some herbs (*Sessuvium portulacastram*) from surrounding area gradually creep out on to the flats. Due to the ecological succession the marsh plants are acting as bridge between land and Sea. They are succulent in nature and are highly adopted to survive in saline habitats. Most of these areas are occupied by facultative and euhalophytic vegetations (*Suaeda*and Salicornia). However, they have well developed root systems to reduce the saline water.

Salt marshes are coming under the true halophytes, which can able to withstand in high salt concentration in their body and environment. The salt marsh habitat has salt and may even have crystals of sodium chloride due to excessive evaporation saline water. The flora of saline soils contain solution with a Psi of at least 3.3bar, being equivalent 70mM monovalent salt (Greenway and Munns, 1980) About 9.5 hundred million hectares of the world's soils existing under saline condition (Wang, 1993). They occur in estuaries where sedimentation rates typically high, thus the subtraction is usually a mixture of sand, silt, and mud. They produce large quantity of organic matter and release dissolved organic carbon from salt marsh biomass due to the high detritus. These plants are highly valuable to human either directly or indirectly by serving as nursery ground for invertebrates, fishes, and birds. It is home to many marine animals such as burrowing crabs, marine snails and juvenile fish and prawns. Apart from providing shelter salt marshes produce detritus or decaying plant materials to enter the local food web. Marine snails graze the mud for food and produce large numbers of offspring, which are a major food source for visiting juvenile and small fishes. Feeding occurs when the high tide over the salt marsh, then when the tide falls again, the small fish go back to the nearby mangrove creeks and inlets. Many fish and prawn species migrate between salt marsh, mangroves and sea grass habitats during their lifecycle. So maintaining these links is vital for sustainable fishery productivity (Odum, 1961). Thus the conservation and management of salt marshes ecosystem used the fruitful knowledge on the present condition of the ecosystem and its organisms. Despite, various study described the mangrove vegetation of Coleroon and

Vellar estuary, there is no a clear-cut status of salt marshes vegetation in Pichavaram and Parangipettai coast. Thus the present study has investigated distributions of salt marsh plants in both Pichavaram and Parangipettai coastal areas.

## MATERIALS AND METHODS

### Study area:

Pichavaram is situated in the southeast coast of India in the Tamil Nadu State. It is Located about 225 km south of Chennai, the capital of Tamil Nadu State. It receives brackish water from Vellar estuary in the north and Coleroon estuary in the south. The mangrove area of Pichavaram consists of a number of small and large islets traversed by numerous creeks and canals. Substratum is mostly muddy, semidiurnal type of tides characteristic in the mangrove area. The Vellar estuary opens into the Bay of Bengal at Parangipettai and links with the Coleroon back water system, which is a distribute of the river Cauvery. Mixing of three types of waters influences the mangrove area: (1) Neritic water from adjacent Bay of Bengal through a mouth called 'Chinnavaikkal', (2) Brackish water from the Vellar and Coleroon estuaries, and (3) Fresh water from an irrigation channel ('Khan Sahib canal'), as well from the main channel of the Coleroon river. The tides are semi-diurnal and varying in amplitude from about 15 to 100 cm in different regions during different seasons, reaching a maximum during monsoon and post-monsoon and a minimum during summer. The rise and fall of the tidal water is through a direct connection with the sea at the Chinnavaikkal and Annang koil mouth.

### Data collection and duration:

This survey was made along the beaches, and banks of Coleroon and Vellar estuaries, in Tamilnadu, South east coast of India. The habitats of estuaries to explore the successful results of the salt marshes and other associated coastal plant species. The nomenclature of the specimens were identified using Gamble (1957) and Matthew (1983). The collected specimens have been manually curate and deposited in CAS in Marine biology, Annmalai University, Parangipettai, Tamil Nadu, India.

### Physicochemical parameters:

The soil samples were collected from at a depth of 5–10 cm. The physicochemical parameters, and floral resource were analyzed. The floral species were analyzed for height and species composition. The physicochemical factors analyzed were solar radiation, Soil temperature, humidity, tidal amplitude, pH, electrical conductivity, levels of Na, K, N, P, Ca, Mg and trace elements (Pb, Cd, Cu, Co, Mn, Fe, Ni). The following standard methods were used:

1. Total organic carbon by chromic acid method (El Wakeel and Riley, 1961)
2. Salinity using hand refractometer (Erma, Japan)
3. pH using a pH Pen (Hanna instruments, EN 50081-1);
4. Electrical conductivity and total dissolved solid using a EC-TDS analyzer (CM 183 Elico, India);
5. Trace elements estimated using an Inductively Coupled Plasma Spectrophotometer (Japan);
6. Sodium, potassium, calcium using a flame photometer (Elico Cl 22D, India);

7. Nitrogen and phosphorus analyzed in Sugarcane Breeding Research Institute, Cuddalore
8. Total sugar (Dubois et al., 1956);
9. Total amino acids (Moore and Steine, 1948)
10. Tannin (Muniyandi, 1986)

## RESULTS

In this survey, 12 plants species belonging to 8 families could be collected at Pitchavaram and Parangipettai coastal areas. The family wise (alphabetical order) list of plants was given in table1. Of this 12 species, six are belonging to one family and another six species belonging to five different families in the Pitchavaram area(Fig,1A-J). Where Cyperes spp., and *Sesuvoum portulacastraum* were collected near the water stream. *Salicornia brachitata, Suaeda monoica, S. nudoflora, S. maritima* were collected from the upper rachis. *Arthrocnemumindicum* only one species occur in the mangrove degraded areas of Pitchavaram. However, *Salicornia brachitata, Arthrocnemum indicum* were not recorded in the Parangipettai saltmarsh region(. Almost all the plants species recorded in both estuaries were succulent in nature except *Aeluropus lagopoides*. However, the plants from Vellar estuary showed more succulent and stunted growth than the Coleroon estuary at Pichavaram. Moreover, the hyper salinity from soil and water were recorded from Vellar estuary (Table 2). The maximum plant height, leaf length, inter node length of the plants, were recorded from Coleroon estuary (Table 1).

The Level of organic contents is lower in Vellar estuary than in Coleroon estuary. For instance, total organic carbon is lesser by14.30%, total sugars by 30.76%, and total amino acids by 18.73%. There is also a reduction of soil nitrogen by 22.95%, phosphorus by 7.84%, and potassium by 9.37%, Tanin 54% in Vellar estuary (Table 2). The Level of salinity, pH, and Electrical conductivity were higher in Vellar estuary than Colerron estuary. For instant, soil pH higher by 2.11% salinity 24.32% soil, EC by 31.46%. Moreover, the soil tends to become sandy in vellar estuary with lower water-holding capacity and lesser soil moisture than Pichavaram mangrove forest, which on the contrary are silt clay with high water holding capacity and moisture content.

| **Sl. No** | **Name of the plant species** | **Salt marsh habitat** | | |
|---|---|---|---|---|
| | | **Family** | **Growth of plants (m)** | |
| | | | **Coleroon river** | **Vellar river** |
| 1 | Suaeda monoica (Forsk) ex J Gmeline. | Chenopodiaceae | 1.56±0.20 | 1.35±0.52 |
| 2 | Suaeda maritima L. | Chenopodiaceae | 0.58±0.10 | 0.42±0.15 |
| 3 | Suaeda nudiflora Moq. | Chenopodiaceae | 0.54±0.10 | 0.45±0.16 |

| | | | | |
|---|---|---|---|---|
| 4 | Sesuvium portulacastrum L. | Chenopodiaceae | 0.35±0.05 | 0.22±0.05 |
| 5 | Salicornia brachiata Rox. | Chenopodiaceae | 0.25±0.06 | - |
| 6 | Arthrocnemum indicum Moq. | Chenopodiaceae | 0.16±0.04 | - |
| 7 | Aelurops lagopoides L. | Aleropodeaceae | 0.15±0.08 | 0.12±0.10 |
| 8 | Cressa cretica L. | Crasupaceae | 0.32±0.05 | 0.26±0.05 |
| 9 | Ipomoea pescaprae L. | Convalvulaceae | 3.10±0.25 | 2.50±0.20 |
| 10 | Spinifex littoreusMoq. | Spenocleaceae | 2.89±0.18 | 2.65±0.22 |
| 11 | Heliotropium curassavicum L. | Boraginaceae | 0.35±0.05 | 0.28±0.08 |
| 12 | Cyperes spp. | Cyperaceae | 0.22±0.03 | 0.17±0.03 |

**Table 1:** Checklist of species of the salt marshes in Coleroon and Vellar estuaries

| **Sl.No.** | **Nutritional parameters of soil** | **Salt marsh habitat** | |
|---|---|---|---|
| | | **Coleroon River** | **Vellar River** |
| 1 | Soil salinity (g/kg) | 27.10±3.5 | 35.81±12.63 |
| 2 | Soil pH | 7.55±0.2 | 7.71±0.3 |
| 3 | Total organic carbon in soil (mg/g) | 9.51±1.1 | 6.15±2.2 |
| 4 | Total sugars in soil (mg/g) | 0.26±0.01 | 0.18±0.01 |
| 5 | Total amino acids in soil (mg/g) | 9.61±0.8 | 7.81±0.9 |
| 6 | Tannins in soil (mg/g) | 1.12±0.01 | 0.51±0.06 |
| 7 | Total nitrogen (mg/g) | 75.2±03 | 61.7±03 |
| 8 | Phosphorus (mg/g) | 17.85±2.3 | 16.45±3.1 |
| 9 | Potassium (mg/g) | 2.24±0.1 | 2.03±0.1 |
| 10 | Calcium (mg/g) | 1.15±0.01 | 1.31±0.02 |
| 11 | Copper (ppm) | 8.56±2.2 | 8.16±3.1 |
| 12 | Manganese (ppm) | 84.16±05 | 75.8±04 |
| 13 | Electric conductivity (ms/cm) | 42.15±05 | 61.5±04 |

**Table 2:** Nutritional value of both Coleroon and Vellar River


1A: *Sesuvium portulacastrum* L.

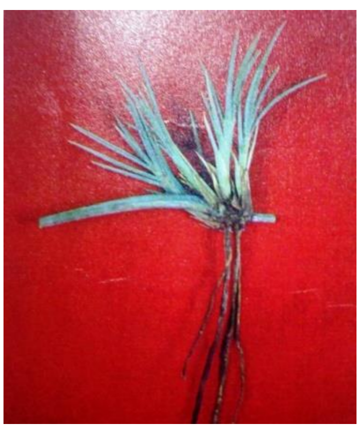

1B:*Arthrocnemum indicum* Moq.


1C:Solicornia brachiata Roxb.


1E:*Suaeda monoica* J.Gmelin.


1F:*Suaeda maritima* Dumart.


1G:*Suaeda nudiflora* Moq.


1H:*Spinifex litoreus* Moq.


1I:*Enicostema hyssopifolium* Wild.

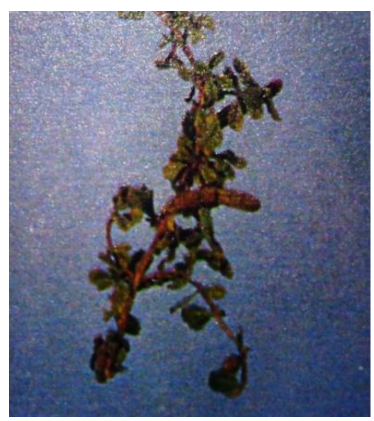

1J:*Lippia nodiflora* L.

**Figure1A-J** are salt marshes and other coastal plants recorded in Coleroon and Vellar rivrers

## DISCUSSION

Salt marsh environment is a typical habitat for living organisms. However, some species have special adaptation to survive this unfavorable condition. Salt marsh vegetation has higher ecological significance by serving the food and shelter for other animals. In this study, we try to survey the diversity of salt marsh and associatd plant species and how physicochemical parameters inflence the diversity and growth. Among the study area, the Coleroon river at Pichavaram exhibited a luxuriant vegetation than the Vellar estuary and constitute tow more important species i.e. *Salicornia brachiata and Arthrocneemum indicum* in different rachis in Pichavaram. These two species are withstood in the hyper saline area especially the *A. indicum* was recorded in the degraded mangrove forest. The species collected from Vellar estuary showed more succulent, stunted in growth and profound root system (Suaeda sp. and *Sesuvium Portulacastrum*).

The species of Chenopodiaceae were the predominant group of vegetations in both Pichavaram and Parangipettai marshy area. They tolerate the high external salt concentrations by osmotic adjustments that most commonly with $Na^+$ and $Cl^-$. As these are toxic, their concentration in the cytoplasm is maintained substantially lower than in the vacuole. Osmotic adjustment of the cytoplasm is maintained with compatible organic solutes such as glycine betaines and proline (Storeyet al., 1977). It was concluded that transport and regulation of $Na^+$ and $Cl^-$ ions is of primary importance of the salt tolerance of halophytes (Flowers, 1985). Among the recorded species, the Chenopodiaceae members (*Suaedamonoica, S. maritima, Sesuvium portulacastrum*) are highly dominated in both Pichavvaram and Parangipettai saltmarsh areas. However, the preferential halophytic species, *Arthrocnemum indicum* and *Salicornia brachiata* were recorded only in Pichavaram degraded areas.

Salt toxicity is one of the major edaphic factors limiting crop production in saline and sodic soils throughout the world (Gupta and Abrol1990; Garcia and Hernandez 1996). Both salinity and sodicity can affect physical and chemical properties of soil as well as structure and activities of soil microbial communities, which play a crucial role to control and regulate the soil functions (Zahran, 1997; Rietz and Haynes 2003; Tripathi et al. 2006; Wong et al. 2008). Growth of many halophytic species is maximal /optimal under relatively low salinities (Flowers and Yeo, 1986). The density and diversity of the species are negatively proportional to the salinity.

The coastal lagoon covers an area of about 8.4 $km^2$ surrounded by vast area agriculture land in the northern part of the Pichavaram wetland area. This deltaic region is formed by rapid deposition of stream borne sediments into a still body of water. The river brings sand, silt and other materials, which are deposited. This is a very fertile area in the Cauvery delta region. Flood plains are predominant along the rivers, which are linear and parallel to the river course. Thus the adequate fresh water flow often decreases the salinity and enhances the levels of nutrients consequently support the luxuriant vegetation in Pichavaram (Table 1&2). Different plant species exhibit different tolerances to salinity stress and the ability to cope with salinity stress may change over the course of development. The salt marsh vegetation usually started on upper rachis of mangrove vegetation. The area that is generally hyper salinity and sandy soil which get submerged during high tides has mostly *Suaeda* vegetation and some other saltmarsh species such as *Sesuvium portulacastrum, Salicornia brachiata, Suaeda maritima* and *Suaeda monoica*. These species are also present along with core mangroves.

Vellar has an estuarine type of drain in to the Bay of Bengal at Parangipettai and also links with the Coleroon River, which is a distributary of the river Cauvery. Three sources of waters mixing together to influences the mangrove and associated saltmarsh area (1) Neritic water from adjacent Bay of Bengal through a mouth called 'Chinnavaikkal', (2) Brackish water from the Vellar and Coleroon estuaries, and (3) Fresh water from an irrigation channel('Khan Sahib canal'), as well from the main channel of the Coleroon river (Kathiresan, 2000). However, due to the increased mud flats, less fresh water flow and less nutritional value, the Parangipettai area has less diversity of halophytic plants when compared to Pichavaram back water system (Table 1&2). An artificially developed mangroves forest in Vellar estuary by Centre of Advanced Study in Marine Biology is being productive and protective to the local people. The Vellar estuary at Parangipettai area has less vegetation than the pichavaram and it is highly deserved to establish more vegetation for the enrichment of diversity.

## CONCLUSION

The present study concluded that the diversity of salt marsh and associated plants in the two different back water systems was varried based on the physicochemical parameters and nutraceutical levels. Among the study areas, the Pichavaram backwater system has more diversity than Parangipattai back water system. It is highly attributed to rich in nutrient supply by freshwater flow and moderate salinity of Coleroon river. Therefore, the present study concluded that physicochemical parameters play a major role in the diversity of salt marsh vegetation.

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