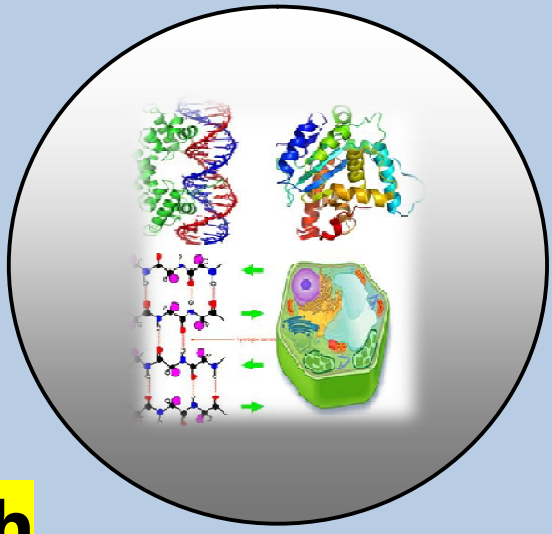
# Distribution, density and conservation of mangroves in the Godavari estuary, Andhra Pradesh, India

By

G.M. Narasimha Rao

ISSN 0970-4973 (Print)
ISSN 2319-3077 (Online/Electronic)

Index Copernicus International Value
IC Value of Journal 4.21 (Poland, Europe) (2012)
Global Impact factor of Journal: 0.587 (2012)
Scientific Journals Impact Factor: 2.597



J. Biol. Chem. Research
Volume 31 (2) 2014 Pages No. 614-622

# Journal of Biological and Chemical Research

(An International Journal of Life Sciences and Chemistry)

Published by Society for Advancement of Sciences®

**J. Biol. Chem. Research. Vol. 31, No. 2: 614-622 (2014)**
**(An International Journal of Life Sciences and Chemistry)**

**ISSN 0970-4973 (Print)**
**ISSN 2319-3077 (Online/Electronic)**

**Dr. G.M.Narasimha Rao**
**http:// www.jbcr.in**
**jbiolchemres@gmail.com**
**info@jbcr.in**

**RESEARCH PAPER**

**Received: 06/04/2014 Revised: 01/05/2014 Accepted: 03/05/2014**

# Distribution, density and conservation of mangroves in the Godavari estuary, Andhra Pradesh, India

**G.M. Narasimha Rao**

**Department of Botany, Andhra University, Visakhapatnam-530 003, India**

**ABSTRACT**

***Mangroves are the peculiar tropical formations which distributed in the estuarine habitats of the aquatic ecosystem. Mangrove species are able to cope up the fluctuations in salinity, temperature and organic matter by its special adaptations such as vivipary, prop roots, silt roots and special physiology. Mangrove forests act as coast guard in coastal areas to protecting the people from severe cyclones and tidal waves. Godavari mangroves are second largest mangroves in India. Structure and composition of the mangrove species are vanishing day by day due to activities of aqua culture and urbanization. Several authors studied the distribution, conservation and antimicrobial studies on mangrove species of Godavari estuary. Present communication deals with the current scenario of mangrove structure, composition and its conservation in the different distributaries of River Godavari. Five study sites were selected in the estuarine habitats of the Godavari estuary. Transect studies were made to collect the information on distribution and density of mangroves. Quadrate (4x4m) were marked along the transect line at 5m intervals from water front to inside of the forest. Density of the individual plant species was estimated based on the collected quadrate samples from different study sites of the estuary. Station wise total number of quadrate samples in all transects were pooled and calculate the number of plant species per hectare. In Godavari estuary, forest cover was dominated by the species of halophytes and associated mangroves. Awareness programmes were conducted in the local villages to motivate the public towards the conservation and restoration of the mangrove ecosystems in the Godavari estuary. With help and cooperation of the local people and NGOs these beautiful natural coast guards can be protected.***

***Key words: Distribution, Density, Conservation, Mangroves, Godavari estuary and India.***

**Published by Society for Advancement of Science®**

## INTRODUCTION

Mangroves are tropical formations growing in swampy soils and covered by the salt water during the high tides of the sea. Godavari mangroves are distributed from Chollangi near Kakinada to Anthervedi near Narasapur, spreading an area of 316.21km² (Umamaheswara Rao and Narasimha Rao, 1988). Mangrove ecosystems of the different geographical regions were studied by several investigators. Mangrove ecosystems of the globe divided into two categories, viz, the old world mangroves and the new world mangroves. Chapman (1976) reported the existence of 68 species of mangroves in world wide. Saenger *et al*. (1983), observed the 6 distinct mangrove regions in the world mangrove ecosystem. The total mangrove cover was estimated by several authors (Bunt, 1992; Twilley, 1998; Spalding *et al*, 1997; Valiela *et al,* 2001; IUCN, 2006) According to FAO (2007), the most extensive mangrove areas are found in Asia, followed by Africa and North and Central America. Duke (1992) has reported the 68 true mangrove plant species in the world mangrove species. Mangrove populations of the Godavari estuary has been studied by several investigators ( Mathuda,1959; Rao, 1959; Sidhu, 1963, Raju,1968; Blasco,1975; Umamaheswara Rao and Narasimha Rao,1988, Bhaskara Rao et al 1992; Narasimha Rao and Dora, 2009; Narasimha Rao and Subba Rangaiah,2010; Narasimha Rao and Murty,2010 a and Narasimha Rao, 2012). Significant work has been done on the mangroves of Krishna estuary, Andhra Pradesh (Venkanna and Narasimha Rao,1993; Krishna Rao and Narasimha Rao,1992), mangrove regions of North coastal Andhra Pradesh such Sarada and Varaha estuarine complex, Meghadrigedda back water and Vamsadhara estuary were studied (Narasimha Rao and Venkanna, 1996, Narasimha Rao,2008 and Narasimha Rao and Murty, 2010 b). Considerable work has been done on the mangrove ecosystems of Mahanadi, Bhitarkinika and Chudamani mangrove of the Orissa state (Banerjee and Rao, 1985; 1990; Narasimha Rao and Murty, 2012). Most of these studies related to qualitative and quantitative studies on the mangrove populations of the different distributaries of the estuarine waters. In the present investigation data was collected on the distribution, density and conservation of mangroves in the river mouths of Gautami and Vainateyam branches of the Godavari estuary.

## MATERIAL AND METHODS

Mangrove forests of Godavari estuary spreads from Chollangi near Kakinada to Pandi back waters near Amalapuram and mangrove forests distributed in the estuarine regions of Vashista and Vainateyam rivers of Godavari River. Five study sites (Station 1- Coringa, Station 2- Ramannapalem, station 3- Pedagadimoga, station 4-Pandi and station 5 Vainateyam estuary) were selected in the Godavari estuary for collection of data on distribution, density and conservation studies of mangroves populations. Environmental, hydrographical and chemical parameters such as air, water temperatures, salinity, pH, D.O and water transparency were collected at five study sites from January to December 2012. Surface water samples were taken near the study sites for collection of data.

Temperature, salinity and pH were measured with the help of thermometer, salinometer and portable pH meters respectively; transparency of water was estimated by dropping Secchi disc. Dissolved oxygen was estimated by the method followed by Strickland and Parsons (1972). Quadrate samples were collected by placing transect from the shore to interior of the forest and extending transect up to the barren zone to obtain the real status of the forest cover; quadrate of (4X4M) was marked along the transect line at 5M interval from water front to end of the forest. A total of 20 transects (4 at each station) were collected and plants present at each quadrate were counted. Quadrate samples collected from the different stations were analyzed and densities of the different plant species were estimated. DBH of all plants present in all quadrates were measured to estimate the relative abundance of different diameter classes of mangroves in all stations.

## RESULTS AND DISCUSSION

### *Environmental and Hydrographical features of the Godavari estuary*

Seasonal data collected on environmental, hydrographical and chemical features of the five stations of the Godavari estuary. No significant variations were noticed among the these stations so average values from these stations were presented in the Table.1 During this period of observation maximum air temperature was reported in the months of June and May ( 32.5 and 32°C ) and minimum air temperature in the months December and January (25.5°C). Similarly surface water temperature in the Godavari estuary varied from 21.0 to 26.0°C with maximum temperature in the month of May and minimum temperature in the month of December. Water transparency in the estuary varied from 16 to 32 cm, during monsoons due floods and heavy rains estuarine waters are more turbid so minimum transparency was observed in the months of August and September and transparency was maximum in the months of April and May due to minimum influx of fresh water.

**Table 1. Seasonal changes in the hydrographical features of Godavari estuary.**

| Month | Air Temperature | Water Temperature | Salinity | pH | Secchi disc | D.O |
|---|---|---|---|---|---|---|
| **January** | 25.5 | 22.5 | 18.0 | 6.8 | 26 | 7.3 |
| **February** | 27.0 | 24.0 | 19.5 | 6.8 | 26 | 7.2 |
| **March** | 28.5 | 24.0 | 21.5 | 7.0 | 28 | 7.4 |
| **April** | 30 | 25.5 | 23.5 | 7.1 | 30 | 7.6 |
| **May** | 32 | 26.0 | 25.0 | 7.2 | 32 | 7.5 |
| **June** | 32.5 | 25.0 | 24.5 | 7.2 | 27 | 7.8 |
| **July** | 31.5 | 24.5 | 23.5 | 7.1 | 25 | 7.9 |
| **August** | 29.0 | 24.5 | 16.5 | 6.6 | 16 | 8.0 |
| **September** | 26.5 | 22.5 | 17.5 | 6.6 | 16 | 7.3 |
| **October** | 26.0 | 22.0 | 18.0 | 6.7 | 19 | 7.1 |
| **November** | 26.0 | 21.5 | 17.5 | 6.8 | 21 | 7.8 |
| **December** | 25.5 | 21.0 | 18.5 | 6.7 | 23 | 7.6 |

Turbidity of the estuarine waters was decreased from November onwards with maximum transparency in summer months. Salinity of the estuarine water in study area varied form 16-25 ppt with maximum salinity was recorded in the month of May and minimum salinity in the month of August. pH values in the present study showed positive correlation with salinity values. Maximum pH values were reported in the months of May and June similarly minimum pH values were reported in the months of August and September which correlates the values of Salinity. Dissolved oxygen of the surface waters varied from 7.1 to 8.0 without any seasonality, maximum DO in the month of September and minimum in the month of November. Among these stations only station Kandikuppa shows some dissimilarity regarding salinity and Secchi depth readings. In Kandikuppa station, salinity ranged from 8 to 28 ppt and turbidity values were also more in these estuarine waters. Narasimha Rao and Subba Rangaiah (2010) studied the hydrographical and ecological studies on mangroves of the Pandi back waters very near to the Kandikuppa back water system. Present observations at Kandikuppa agrees with the studies of Narasimha Rao and Subba Rangaiah (2010).

**Table 2. Mangroves and halophytes present in various study sites of the Godavari estuary.**

| S. No | Name of the species | Family |
|---|---|---|
| 1 | *Acanthus ilicifolius* L. | Acanthaceae |
| 2 | *Aegiceros corniculatum*(L.) Blanco | Myrsinaceae |
| 3 | *Avicennia marina* (Forsk)Vierh | Verbenaceae |
| 4 | *Avicennia officinalis* L | Verbenaceae |
| 5 | *Bruguiera gymnorrhiza*(L.)Lamk. | Rhizophoraceae |
| 6 | *Clerodendron inerme* (L.) Gaertn. | Verbenaceae |
| 7 | *Ceriops decandra* (Griff.) ding Hou | Rhizophoraceae |
| 8 | *Derris trifoliata* Lour | Fabaceae |
| 9 | *Excoecaria agallocha* L | Euphorbiaceae |
| 10 | *Ipomoea tuba* (schlect.) G.Don | Convolvulaceae |
| 11 | *Lumnitzera racemosa* Willd. | Combretaceae |
| 12 | *Rhizophora mucronata* Lamk. | Rhizophoraceae |
| 13 | *Salicornia brachiata* | Chenopodiaceae |
| 14 | *Sonneratia apetala* | Sonneratiaceae |
| 15 | *Sesuvium porstulacastrum* (L) L. | Aizoaceae |
| 16 | *Suaeda maritima* (L.) Dumm. | Chenopodiaceae |
| 17 | *Suaeda monoica* Forsk.ex. Gmel | Chenopodiaceae |

Environmental, Hydrographical and chemical features of the mangrove habitats of the Godavari estuary have not studied in detail. Narasimha Rao (1989) has collected the information on environmental, hydrographical and chemical characteristic features of the Godavari estuary, and reported that air and water temperatures, salinity and pH were high during summer and early summer months. Water transparency was low in rainy season.

This is due to more rainfall and more water discharge during monsoons. In the present study water temperature, salinity, pH and water transparency were more during summer months and low in monsoon and post monsoon seasons as reported by Narasimha Rao (1989).

***Species composition of Mangrove and other halophytes in the Godavari estuary***

A total of 17 plant species were recorded in the quadrate samples collected from the mangrove populations of the Godavari estuary (Table 2). Out of these, 9 mangrove species, 4 associated mangroves and remaining 4 were halophytes, besides some plant species such as *Rhizophora apiculata, Xylocarpus granatum Avicennia alba* and *Sonnerratia capsularis* were not recorded in the quadrate samples but rarely found in the mangrove regions of the Godavari estuary.

***Species composition and density of mangroves and halophytes in Godavari estuary***

Data collected on density of various mangrove species from different stations of Godavari estuary was presented in the Table-3. Densities of the individual plant species was estimated based on the collected quadrate samples in all transect were pooled and calculated the number of plant species per hectare. Maximum density was recorded for the species *Suaeda maritima* and *Suaeda monoica* in all stations of the Godavari estuary whereas minimum density was reported for the species *Rhizophora apiculata.* In general mangrove cover was reduced by comparing the earlier studies of Sidhu (1963), Raju (1968), Mathuda (1959), Blasco (1975). Among these stations, Vainateyam region having more density of halophytes and associated mangroves while presence of true mangroves and its frequency and density was very low. Hydrographical conditions of the estuary and density of the mangrove species agrees with earlier observations of Narasimha Rao and Murty (2010) and Narasimha Rao et.al (2012). In the station Kandikuppa, density of true mangrove was more than Vainateyam estuary as well as cover of the halophytes also higher but forest height was not more than 12 to 16 meters. These results are in agreement with the earlier studies of Narasimha Rao and Subba Rangaiah (2010) on mangrove populations of the Pandi back waters.

Maximum number of mangrove species were reported from Coringa to Masinitippa region where true mangroves and some other species which are not recorded in the transect/quadrate samples but observed in the Coringa and Pedagadimoga regions of the estuary. Diameter classes of mangroves, associated flora of all study sites revealed that nearly 50 percent plants growing in this estuary are comes under 0-10 cm diameter class. Plants such as *Avicennia officnalis, A.marina, A. alba, Bruguiera gymnorrhiza, Excoecaria agallocha, Sonneratia apetala, Rhizophora apiculata, Rhizophora mucronata* and *Xylocarpus granatum* are larger tree species and their average diameter was more than 30 cm and few plants with more than 40 cm class. Information on DBH classes of the mangrove species indicated that mangrove forest in Godavari estuary indicated that forest is above medium and medium type, but mangrove forest at Vainateyam estuary is bushy type.

Due to illegal activities such as aquaculture and conversion of mangrove forest into construction of small scale units, human settlements may further degrade the structure and composition of the beautiful mangrove in coastal zones.

During our survey and investigation we have conducted many awareness camps at each station and raised the seedlings along the mudflats and canals of the estuarine regions. We motivated the public regarding the importance of the mangroves in their daily life and for fetching their livelihood. We explained the locals, how much loss will happen if mangroves are destroyed and what measures will be taken for its conservation and management of the mangrove ecosystem.

**Table 3. Density of mangrove species in different stations of the Godavari estuary (Density/Individual/hectare$^{1}$).**

| S. No | Name of the species | Coringa | Ramannapalem | Pedagadi moga | Kandikuppa | Vainateyam |
|---|---|---|---|---|---|---|
| 1 | *Acanthus ilicifolius* L. | 542 | 478 | 568 | 876 | 964 |
| 2 | *Aegiceros corniculatum* (L.) Blanco | 688 | 582 | 428 | 694 | 368 |
| 3 | *Avicennia marina* (Forsk)Vierh | 426 | 642 | 586 | 578 | 438 |
| 4 | *Avicennia officinalis* L | 542 | 478 | 436 | 648 | 348 |
| 5 | *Bruguiera gymnorrhiza*(L.)Lamk. | 98 | 72 | 48 | 82 | -- |
| 6 | *Clerodendron inerme* (L.) Gaertn. | 462 | 378 | 482 | 566 | 842 |
| 7 | *Ceriops decandra* (Griff.) ding Hou | 364 | 464 | 416 | 528 | -- |
| 8 | *Derris trifoliata* Lour | 86 | 78 | 142 | 92 | 156 |
| 9 | *Excoecaria agallocha* L | 1962 | 1542 | 2266 | 2164 | 2564 |
| 10 | *Ipomoea tuba* (schlect.) G.Don | 746 | 548 | 646 | 878 | 1124 |
| 11 | *Lumnitzera racemosa* Willd. | 872 | 764 | 534 | 960 | 64 |
| 12 | *Rhizophora mucronata* Lamk. | 42 | 36 | 88 | 62 | -- |
| 13 | *Salicornia brachiata* | 1262 | 874 | 692 | 2172 | -- |
| 14 | *Sonneratia apetala* | 642 | 764 | 596 | 682 | -- |
| 15 | *Sesuvium porstulacastrum* (L) L. | -- | 1262 | 972 | 1162 | 2162 |
| 16 | *Suaeda maritima* (L.) Dumm. | 1568 | 1682 | 1896 | 2264 | 2674 |
| 17 | *Suaeda monoica* Forsk.ex. Gmel | 2176 | 1868 | 1682 | 2684 | 2886 |

## CONCLUSIONS

Mangroves are beautiful tropical formations between land and sea. These aquatic ecosystems act as coastal barrier and protecting the coastal inhabitants during cyclonic storms and tidal waves from the sea. This wonderful ecosystem provides livelihood for poor people who are residing since long back, besides due to rich organic matter and nutrients it attracts number of migratory birds and fish. But due to urbanization and other developmental activities these ecosystems are degrading slowly without any notice of the public. During our study we inculcate the important points in the minds of the public through the small workshops and power point presentations. We raised and plan to develop nurseries for conservation and management of the mangroves along the mudflats and creeks of the estuarine water. In India, states such as Tamil Nadu and Gujarat, NGOs were involved in conservation of the mangrove ecosystems and increase the mangrove cover in those states. If Govt. of India provides funding for conservation and restoration of Mangroves in Godavari estuary it will be helpful for the local inhabitants and also for prevent the natural calamities.

## ACKNOWLEDGEMENTS

Grateful thanks are due to the Department of Science & Technology, Technology Bhavan, New Delhi for the Financial assistance Under the Project " Distribution, cultivation and conservation of *Salicornia brachiata*: a potential halophyte for bio-fuels". Sanction order No. WTI/ WAR-W/13/2011 (G) dated 14-11-2011.

## REFERENCES

Banerjee, L. K. and Rao, T. A.,1990. *Mangroves of Orissa* coast *and their ecology*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India. 1-118.

Banerjee, L. K. and Rao, T. A., 1985. Mangals of Mahanadi delta. Cuttack dist. Orissa. All India Symposium on Marine plants, Dona Paula, Goa, India. 137-152.

Blasco, F., 1975. *The Mangroves of India*, Pondicherry, French Institute, Fr.Sect.Sci.Tech.14: 1-175.

Bhaskara Rao, V., Narasimha Rao, G.M., Sarma, G.V. S. and Krishna Rao, B.,1992. Mangrove and its sediment characters in Godavari estuary, east coast of India. *Indian J.Mar.Sci*. 21: 64-66.

Bunt, J. S., 1992. Introduction to mangrove ecosystem. In: *Tropical Mangrove Ecosystem*, (Eds. A. I. Robertson and D. M. Alongi ) American Geophysical Union, Washington. D.C.1-6.

Chapman, V.J., 1976. *Mangroves Vegetation.* Cramer, Vaduz. 1-326.

Duke, N.C., 1992. Mangrove floristics and biogeography. In: *Tropical Mangrove Ecosystem*, (Eds. A.I.Robertson and D.M. Alongi,) American Geophysical Union, Washington. D.C. 63-100.

F.A.O. , 2007. The *worlds mangroves 1980-2005*. FAO Forestry paper 153. Rome.1-124.

International Union for Conservation of Nature and Natural resources, 2006. Mangroves for the Future: Reducing vulnerability and sustaining livelihoods. *Coastal Ecosystems*.1: 1-4.

Krishna Rao, B. and Narasimha Rao, G.M., 1992. Mangrove Resources in Godavari and Krishna estuaries: Management and perspectives. *Indian J. Landscape systems*, 15: 96-99.

Mathuda, G.S., 1959. Mangrove vegetation of Godavari delta. In: Proceedings of the mangrove symposium, Calcutta, 66.

Narasimha Rao, G.M., 1989. *Ecological studies on some estuarine and marine algae,* Ph.D. Thesis, Andhra University. Andhra Pradesh. 1-129.

Narasimha Rao, G.M., 2008. Mangrove populations of Visakhapatnam and Sarada and Varaha estuarine complex, India. *International Journal of Plant Sciences.* 3 (2): 686-687.

Narasimha Rao, G.M., 2012. Distribution pattern and present scenario of mangroves and associated flora of Andhra Pradesh In: Biodiversity of Aquatic Resources, Chapter 3, 29-49.

Narasimha Rao, G.M. and Dora, S.V.V.S.N.,2009. An experimental approach to Mangroves of Godavari estuary. *Indian Jour. For*. 32(3): 263-265.

Narasimha Rao, G.M. and Venkanna,P., 1996.Macro algae of the Sarada and Varaha estuarine complex. *Indian Jour. For*. 19: 157-158.

Narasimha Rao, G.M. and Murty,P.P., 2010a. Mangroves and associated flora of Vashista and Vainateyam estuaries, Andhra Pradesh. India. Not Sci Biol 2(4) 40-43.

Narasimha Rao, G.M. and Murthy, P.P, 2010b. Mangrove populations of Vamsadhara estuary. *International Journal of Plant Sciences*. 3 (2) 686-687.

Narasimha Rao, G.M. and Subba Rangaiah, G., 2010. Distribution of mangroves and associated flora of the Pandi back waters of Gautami Godavari estuary, Anu. J. Nat. Sci.2 (1) 2010 22-26.

Narasimha Rao, G.M., Lakshminarayana, V. and Reddi,B.N., 2012. Distribution and composition of halophytes at Vainateyam estuary, Andhra Pradesh. Plant Science Research. 34 (1&2) 97-98

Raju, D. C. S., 1968. The vegetation on West Godavari. A study of tropical delta. In: *Proceedings of the Symposium on Recent Advances in Tropical Ecology* (Part 1) Banaras Hindu University, Varanasi. 348-358.

Rao, R.S., 1959. Observations on the mangrove vegetation of the Godavari estuary. In: *Proceedings of the mangrove symposium*, Calcutta. 36-44.

Saenger,P., Hegerl. E.J., and Davie, J.D.S.,1983. *Global status of mangrove ecosystems*. Commission on Ecology Papers No.3. Gland, Switzerland, World Conservation Union (IUCN).

Sidhu, S.A.,1963.Studies on the mangroves of India 1. East Godavari region. *Indian Forester*, 86: 337-351.

Spalding, M., Blasco,F. and Field, C., 1997. *World Mangrove Atlas*. International Society for Mangrove Ecology, World Conservation Monitoring Centre.

Strickland, J.D.H. and Parsons, T.R., 1972. *A practical hand book of sea water analysis:* Fish. Res.Bd.Can.Bull. No.167. 1-311.

Twilley, R. R., 1998. Mangrove wetlands. In: *Southern Forested Wetlands Ecology and Management* (Eds. M.G. Messina, W.H.Conner,). Lewis Publisher, Boca Raton, 445-473.

Umamaheswara Rao, M, and Narasimha Rao, G.M.,1988 .Mangrove populations of the Godavari delta complex. *Indian J. Mar. Sci*., 326-329.

Valiela, I., Bowen,J.L. and York,J.K.(2001). Mangrove forests: one of the world's threatened major tropical environments. *Bio.Sci*.51:807-815.

Venkanna, P, P., and Narasimha Rao, G.M., 1993. Distribution pattern of the Mangroves in the Krishna estuary. *Indian Jour. For.*16(1): 48-53.

**Corresponding author: Dr. G.M. Narasimha Rao,** Department of Botany, Andhra University, Visakhapatnam-530 003, India

**Email: gmnrao_algae@hotmail.com Mobile: 09440559806**