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Ecology and diversity of the mangroves on diverse waterways of Coringa Wildlife Sanctuary, India

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ABSTRACT

This study deals with ecology and mangrove biodiversity in a diverse net work of rivers and streams of the Coringa Conservation Area, a major mangrove ecosystem in the Godavari Delta complex in Andhra Pradesh, India. The mangrove area is high in .humidity and rainfall during the southwest monsoon season. The area has a diverse net work of 33 streams, colonized with 11 mangrove species with predominance of *Excoecaria agallocha, Avicennia* spp. and *Rhizophora apiculata* that supports a rich variety of flora and fauna. In addition to biodiversity conservation, the mangrove help in coastal protection and carbon sequestration. The study underscores the importance of much more conservation efforts and sustainable management practices in the area.

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1. Introduction

Mangroves, as special salt-tolerant forest ecosystems in tropical and subtropical intertidal regions, have enormous ecological importance in coastal environments. They represent vital natural intertidal wetlands worldwide in tropical and subtropical regions (Tomlinson, 1986; Duke, 1992; Ricklefs and Latham, 1993). These coastal plant formations are self-regenerating and self-sustaining and consist of dynamic ecosystems inhabited by complex assemblages of flora and fauna. Mangrove forests exhibit remarkable productivity (Clough, 1992) because their food chains and nutrient cycles are closely connected to adjacent coastal waters (Alongi, 1996). In the Indian context, the Godavari Delta Complex in East Godavari and West Godavari districts of Andhra Pradesh hosts significant mangrove forests associated with estuaries. This article explicitly addresses the ecological dynamics of the Coringa Conservation Area, which encompasses the diverse mangrove vegetation of the Godavari Estuary. Unfortunately, the global survey of mangrove ecosystems shows alarming degradation, often due to uncontrolled exploitation (Saenger et al., 1983), and the mangrove regions of India are no exception to this trend. The Krishna-Godavari mangrove complex, covering an area of about 12,800 ha, forms a crucial part of the mangrove vegetation of India, which covers about 356,500 ha. This study aims to provide insights into the ecological importance and conservation requirements of the Coringa Mangrove Conservation Area. Through thorough research and analysis, this article contributes to understanding mangrove ecosystems and promotes sound conservation and management practices to conserve these vital coastal habitats.

2. Methodology

2.1 Analysis and sedimentological investigations:

Soil samples were systematically collected from different locations in the Coringa Conservation Area to assess the sediment composition. Climate data, including temperature and precipitation metrics, were obtained from weather stations strategically positioned in the study area.

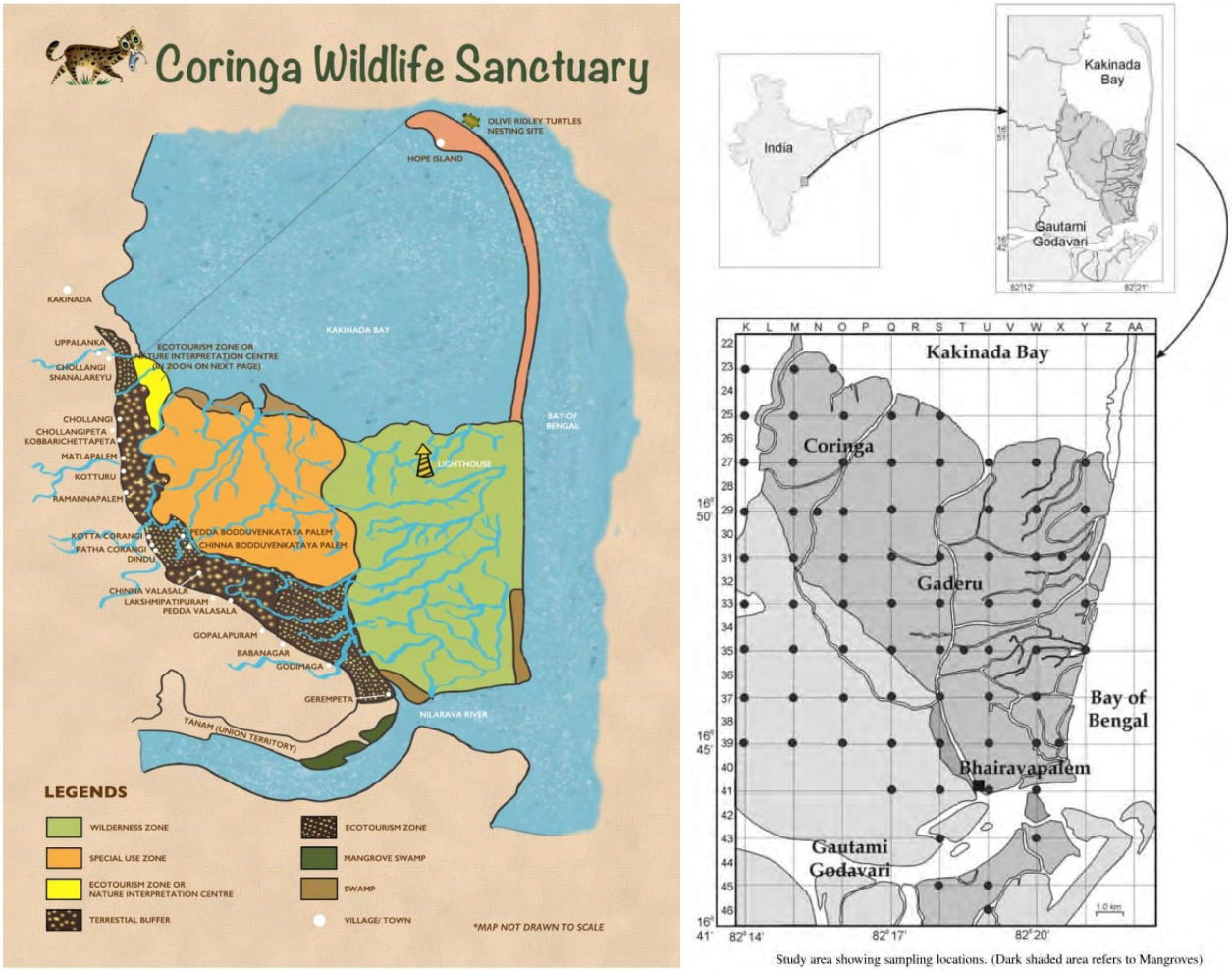
2.2 Study area and topography:

The study area is characterized by the bifurcation of the Godavari River into two main branches, namely Goutami Godavari and Vasishta Godavari. The east-flowing Goutami Godavari branch meanders into various tributaries, agricultural canals and small streams before emptying into the sea. In contrast, the west-flowing Vasishta Godavari branch separates the East and West Godavari districts. The Dhawaleswaram Dam, designed by Sir Arthur Cotton, significantly impacts the mangrove ecosystems in the Godavari Delta complex. Topographically, the confluence of the Godavari River and the sea occurs at Bhairavapalem and marks the southern boundary of the bay-mangrove complex, which covers an extensive area of approximately 333 km^2 (Banerjee et al., 1998). The total drainage area covers about 290,400 km^2, with the river's normal discharge estimated at about 460,316,106 cubic feet (Rao, 1998).

3. Results

3.1 Topography and Habitat:

The Coringa Conservation Area is located in East Godavari District and covers an area of 235.7 km^2. It includes the Coringa Reserve Forests, Coringa Extension Reserve Forests and Bhiravapalem Reserve Forests. Specifically, It is home to the Coringa Mangrove Reserve Forest, the largest (124 km^2) mangrove ecosystem, located in the Kakinda-Godavari Estuary (N: 16-41_-1653_ and E: 8214_-8221_). Coringa Wildlife Sanctuary was designated as a wildlife sanctuary by the Government of Andhra Pradesh in 1978 under Section 18 of the Wildlife Protection Act 1972 Backwaters. The dominant species in mangrove vegetation include *Excoecaria agallocha, Avicennia* spp., *Rhizophora apiculata* and *Sonneratia apetala*, which contribute significantly to the ecological dynamics of the protected area. An interesting geographic feature is the presence of Hope Island, which acts as a natural barrier, impeding direct connections between the sea and the waters of Godavari. Tailored for a scholarly journal publication, this description provides a concise and accurate account of the topography and habitat of the Coringa Game Reserve, highlighting its ecological importance and diverse mangrove flora.



Study area showing sampling locations. (Dark shaded area refers to Mangroves)

Fig. 1. Study area

Table 1. Study area

S.No.	Particulars of the area	Extent (sq.kms.)
1.	Coringa Reserve Forests	31.56
2.	Coringa Extension Reserve Forests	194.42
3.	Bhiravapalem Reserve Forests	9.72
	Total	**235.70**

Table 2. Soil

Year	Sand	Silt	Clay
2020	1-18%	7-63%	15-90%
2021	1-19%	12-78%	19-84%
2022	1-21%	15-59%	34-85%

3.2 Climate:

The Coringa Wildlife Sanctuary has a typical coastal climate characterized by high temperatures and humidity. The proximity to the sea influences the temperature regime, with the annual mean temperatures being around 25 °C and maximum temperatures reaching 43.5 °C. The southwest monsoon season dominates the region's precipitation patterns, with average annual precipitation ranging between 800 mm and 1100 mm. The coastal landscape ensures a constantly high humidity level of over 80%. Mangrove vegetation in the Godavari Delta Complex supports a unique and complex ecosystem. The soils of the region are characterized by high salinity and water content, enriched with abundant hydrogen sulphide. The presence of mangrove peat, consisting of roots, wooden structures, and alluvial deposits, provides nutrients and promotes diverse flora and fauna. The average temperature of the water remains relatively low at certain times, accompanied by a moderate average temperature (31.9°C) and 36.1 °C during the very hot season (April-June). The strong evaporation leads to a significantly increased salinity (33.24_ppt; Murthy, 1997)., while Dipti Raut (1997) documented the mean monthly air temperatures in Kakinada in 1994-96, which ranged from 19.7 °C to 38.4 °C.

3.3 Soils and Sediment Composition:

The soils in the mangrove ecosystem of the Godavari Delta complex have distinctive characteristics characterized by increased salinity and water content. These soils consist mainly of clayey, slushy and silty components with reduced oxygen content and a notable occurrence of hydrogen sulphide. A key component of these soils is mangrove peat, which includes roots, wood structures, silt, shells, and other organic debris. The analysis of the sediment composition shows temporal fluctuations in the proportions of sand, silt and clay over the years.

Fig. 3. Rivers

3.4 River and Stream Network:

The Godavari Estuary in the Coringa Conservation Area features a complex network of rivers and streams, which contribute significantly to the diverse topography of the region. This article overviews the major rivers and streams, usually named kalvas for their origins, directions, and confluence points. This will provide valuable information on the hydrological dynamics of the mangrove ecosystem in the Godavari estuary, as described below.

1. Coringa River: This is a small river that starts on the east side of the city of Yanam crosses the four eastern delta regions and runs west of the Coringa Sanctuary and, enters the sanctuary near Coringa village on the western side of the sanctuary and travels towards the eastern direction and joins the Kakinada Bay.
2. Gaderu: The Gaderu River originates about 5 km below the town of Yanam near the village of Bhiravapalem. It enters the sanctuary at the southern tip near Bhiravapalem and, divides the sanctuary in two, migrates north, and finally empties into Kakinada Bay. Gaddi Kalva starts from the northwest corner of the sanctuary, travels towards the east and joins the Coringa River western branch.
3. Matlapalem Kalva: This kalva lies on the northwest corner of the sanctuary. It is, in fact, a major drain that drains the surplus waters from agricultural fields into the sea.
4. Chinnavarava Kalva: It starts from Chinna Boddu Venkatayapalem and travels towards east and joins Gullalu Kalva.
5. Jada Kalva: It starts from Chinna Boddu Venkatayapalem and travels towards east and joins Gullalu Kalva.
6. Gullalu Kalva: It starts from the confluence of the Motu Kalva and Jada Kalva, travels north and joins the Coringa river.
7. Motu Kalva: Jada Kalva after travelling about 3 kms widens into Motu Kalva and travels towards east till it joins Nagathorava Kalva and then travels towards east for another 3 to 4 kms before joining Gaderu river.
8. Nagathorava Kalva: This travels towards the northern direction and joins Coringa River near the preservation plot.
9. Sarihaddu Kalva: It starts at the southwest corner of the sanctuary below Bhiravapalem and travels along the sanctuary line of Coringa Reserve Forest and towards southeasternly direction and joins Gaderu River.
10. Gullala Kalva-2: It originates from the confluence point of Sarihaddu Kalva with that of Gaderu (about 2 kms below Jalllu Kalva).
11. Jallala Kalva: This starts from southern boundary of the sanctuary.
12. Chinna Vara Kalva: This also originates to that of Gaderu in the sanctuary above Gullala Kalva and travels towards north and merges with Motu Kalva.
13. Pedavantram Kalva: Starts about 2 kms. above confluence point of Motu Kalva into Gaderu.
14. Chittivantram Kalva: Starts from the mouth of Gaderu river where it joins the Kakinada Bay, and this Kalva travels west and joins Pedavantram Kalva.
15. Gollamandala Kalva (From the high junction point of Pedavantram Kalva and Chittivantram kalva): This stream originates and travels towards the west and joins the Naga-torava Kalva.
16. Bottaleru Kalva: This originates from the southeastern corner of the sanctuary and travels toward the northwest before joining Govvaleru Kalva.
17. Bhiravaswamy Vasamu Kalva: This also originates in the southeastern tip of the sanctuary travelling towards northwestern direction before joining Bottaleru Kalva.
18. Govvaleru Kalva: The above two streams described at 15 and 16 Govvaleru Kalva travels in western direction and joins Gaderu at the southwest corner.
19. Parla Kalva: This Kalva starts just on the coast in the eastern part of Govvaleru Kalva travels towards northeast and joins Ponnala Kalva.
20. Sukkalu Kalva: A small stream originates from Gaderu river below confluence point at Govvaleru and travels towards north.
21. Gudduvarava Kalva: Originates from Guvvalru Kalva parallel to Sukkalu Kalva.
22. Savupillavarava Kalva: This also originates from Gaderu above Cuvvaleru in the west.

23. Kuratalu Kalva: Parallel to the above stream, this also originates from Gaderu travels towards east and joins Pillavarava Kalva.
24. Gollavani Coyya Kalva: This again originates above Kuratalu Kalva west, and travels towards east, cutting across the mangrove swamps.
25. Isaka Kalva: Originates from the same point as that of Gollavani Goyyi Kalva from Gaderu.
26. Pillavarava Kalva: It is one of the major and widen streams forming midway to the sanctuary in the eastern portion.
27. Vennagoyyi Kalva: This starts on the eastern tip of Ponnalu Kalva travels along the Bayin the north by northwest direction and joins Pillavarava Kalva in the north.
28. Bankolu Kalva: This is one of the major streams in the northeast portion of the sanctuary.
29. Inglilava Kalva: Originates on the northeastern tip of the Gaderu river and travels south then turns towards east and joins Bankolu Kalva.
30. Mogalichettu Kalva: This starts in the swamps of the northeastern corner of the sanctuary and travels for about 2 kms in southern direction and takes 'U' turn towards northeast before joining the Kakinada Bay near the neck of the Hope Island.
31. Light house Kalva (Parallel to the above stream): This stream originates above the Coringa Light house, travels north, and joins Kakinada Bay.
32. Dabadi Kalva: Above the light house Kalva, this Dabadi Kalva runs parallel and originates at the Cpromga Light house.
33. Vallakattu Kalva: This originates on southern side of the Coringa light house and travels north, widening the course and joining the Kakinada Bay at the northern end.

3.5 Mangrove Biodiversity:

The Coringa Wildlife Sanctuary has a diverse variety of plant species including trees, shrubs, herbs and grasses that contribute to the area's ecological richness. There are 22 plant species including 11 mangroves with predominance of *Excoecaria agallocha, Avicennia* spp. and *Rhizophora apiculata*. Blasco (1975) conducted one of the first explorations of the inner reaches of the Coringa mangroves, observing dense thickets of *Avicennia* (58 m high) and *Sonneratia apetala* (81 m) along the banks of the Coringa River. Rao and Rao (1988) documented 15 mangrove species, while Azariah et al. (1992) found 8 species. The species composition in the Coringa mangroves appears to vary from site to site. Blasco documented the occurrence of *Excoecaria agallocha, Avicennia oficinalis, Phoenix paludosa, Derris* sp., *Dalbergia* sp. and *Ceasalpinia* sp. In addition, Sidhu (1963) identified three major forest communities, namely evergreen, semi-evergreen and tidal deciduous forest communities. These communities included the pure *Avicennia* community, the mixed *Avicennia* community, and the mixed *Aegiceras* community.

3.6 Fauna and Ecological Importance:

The mangroves in the Coringa Wildlife Sanctuary play a crucial role as essential habitats and breeding sites for various animal species, including euryhaline fish, shrimp, crabs, molluscs and fin fish. The mangroves help protect coastal coastal against erosion, storms and tidal waves, and carbon storage in the fight against climate change.

4. Conclusion

This article provides information about distinct topographical features, soil composition, river and stream networks, as well diverse biodiversity of mangroves in the Godavari Delta complex, with a focus on the Coringa Wildlife Sanctuary and also reiterates Importance of effective conservation efforts.

Table 3. Species

Sl.No.	Botanical Name	Local Name	Family
1	*Excoecaria agallocha*	Tilla	Euphorbiaceae
2	*Avicennia officinalis*	Nalla mada	Avicenniaceae
3	*Avicennia marina*	Tella mad	Avicenniaceae
4	*Avicennia alba*	--	Avicenniaceae
5	*Sonneratia apetala*	Kalinga	Sonneratiaceae
6	*Rhizophora apiculata*	--	Rhizophoraceae
7	*Lumintzera racemosa*	--	Combretaceae
8	*Aegiceras corniculatum*	--	Myrsinaceae
9	*Ceriops decandra*	--	Rhizophoraceae
10	*Bruguiera gymnorrhiza*	--	Rhizophoraceae
11	*Acanthus illicifolius*	Alchi	Acanthaceae
12	*Dalbergia spinosa*	Chaillangi	Fabaceae
13	*Suaeda maritima*	--	Chenopodiaceae
14	*Suaeda monoica*	--	Fabaceae
15	*Derris trifoliata*	Nalla teega	Fabaceae
16	*Clerodendrum inerme*	Pisangi	verbenaceae
17	*Sesuvium portulacastrum*	Thikkakura	Aizoaceae
18	*Salicornia brachiata*	Arilia Koyala	Chenopodiaceae
19	*Ipomea tuba*	Climber	Convolulacea
20	*Streblus asper*	Barranki	--
21	*Sarcolobus carinatus*	--	Asclepiadaceae
22	*Ceriops tagal*	--	Rhizophoraceae

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