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Mangroves Response to Sea Level Changes at Chilka Lake, Orissa

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Abstract: ***Chilka is a very rich preserve of ecological biodiverstity both backish and freshwater species, including several endangered, threatened, and vulnerable species. Presently, the mangroves are totally lacking around Chilka Lake owing to the excessive biotic pressure that was otherwise festooned by the mangrove forest in the near past. The paper embodies the results obtained from the fine resolution playnostratigraphy from Solari, Chilka lake coveing a time span of 2,000 years B.P. and highlighted the significance of mangroves in unfolding the fluctuations in the sea margin. Based on the subtle changes in the composition of vegetation, efforts are made to evaluate depositional environments, trangressive and regressive facies, etc. The extermination of mangroves at Solari since 1,250 years B.P. could be assigned to the human holocaust.***

Keywords: Mangroves, Sea Level, Chilka Lake

1. Introduction

On the Western flark of Chilka lake in Mahanadi delta, Solari village is situated. The geology is quite interesting as it consists of a wide range of sediments varying from ancient hard rock to recent alluvial deposits. The khondalites of Archean age occur as isolated peaks within and at the margins of the delata. Next to khondalites, are the upper Gondwana rocks which are extensively found within Mahanadi delta head and are represented by sandstones and shells forming hills which have been intruded by dolerites of late Cretaceous age. The Quaternary deltaic sediments are laid down on either khondalites or upper Gondwana sediments (Mahalik 1983). The general topography of Mahanadi delta is marked by mangrove swamps abutting the sea shoes but towards inland, it is plain country traversed by the distributaries of Mahanadi River. The land surface along north-east and east of Chilka Lake is low plai but the north-western and south-western ends of the lade abound in rocky projections.

The geomorphology of the delta head is governed by contempo raneous deposition and erosion of sediments and therefore, the principal textures are denuded hills and erosion plains. Along the coastal deltaic tract, both fluvial and marine processes operate concurrently but the marine activities predominate as the sea approaches. Thus, a variety of features are developed in this landform such as estuaries, lagoons, spits, islands, salt marshes, mangrove swamps, beaches, coastal dunes, etc, which are the testimony to Mahanadi delta.

The data on limnological characteristics of the Chilka Lake are gathered through Orissa Remote Sensing Application Centre. The depth of Chilka varies from 0.5 to 3, 2 m and the maximum depth is found near Rambha at the southern end of the lake. The water temperature varies from 24.5°C to 35.5°C. Three salinity zones i.e. O to 7 ppt at north-western sector, 4 to 8 ppt at central sector and 7-11 ppt at the southern sector are recognized. Similarly, pH ranges from 7.3 to 9.3 with higher at southern sector of the lake. The biomass accumulation is the highest at the central area of the lake. The water spread of the lake shows a gradual shrinkage of lake margins @ 1.45 sq km per annum for the last 75 years and the present water spread area is left only 805 sq km.

Chilka is a very rich preserve of ecological biodivèrsity both brackish and freshwater species, including several endangered, threatened, and vulnerable species. Presently, the coastal vegetation commonly referred to as mangroves are totally lacking in and around Solari village owing to the excessive biotic pressure that was otherwise festooned by the mangrove forest in the near past. Nevertheless, a few remains of mangroves, albeit in degraded form, such as *Avicennia* sp., *Acanthus ilicifolius*, *Excoecaria agallocha*, etc. are often found growing along the water body.

Several attempts have been made to investigate Chilka sediments from various places such as Balugaon (Gupta and Khandelwal 1990; Khandelwal and Gupta 1994), Nalabana Islarnd (Gupta and Khandelwal 1992), Rambha (Khandelwal and Gupta 1993), Bhowania (Khandelwal and Gupta 1999), Dangmal (Khandelwal and Gupta 2000) and Chandrapur (Kohli 1996) in order to regionalize palynostratigraphy and its application to reconstruct the mangroves and work out the depositional environment with an emphasis on sea-level fluctuation during mid-late Holocene.

2. Material and Method

One 3.00 m deep sediment profile was produced with the help of Hiller's peat-auger and the samples were collected at an interval of ten centimetres each. The sediments are mostly comprised of organic mud with abundance of plant debris. The nature and texture of sediments in the profile are almost alike throughout. However, sediments between 0.3-0.4 m depth are composed of black humified peat whereas between 2.0-2.10m depth shells and fish scales are recovered. The Solari profileThe Solari profile is, however, not radio metrically dated but she whole sequence is correlated with other well dated profiles from Chilka lake and estimated that the total sediments were laid down for the last about 2,000 years B.P.

The sediments were first treated with 10 per cent aqueous solution of KOH in order to deflocculate the sediments and later followed by HF treatment for about 48 hours in order to

remove silica from the matrix. Thereafter, the process of acetolysis was followed as devised by Erdtman (1943).

3. Result and Discussion

Pollen diagram and its description

Based on pollen data of a 3 m deep vertical sediment profile from Solari, covering a time span of about 2,000 years B.P., one pollen diagram has been constructed. Relative values of each spore/ pollen, calculated in terms of total land plants/pollen, are plotted in the pollen diagram in order to highlight the palaeofloristic development in and around Solari village. To achieve the precision in vegetation shifts, three pollen zones have been proposed in ascending chronological order and they are prefixed with site initials viz., SL-1, SL-2, and SL-3. The zonation has been done to express the fine biostratigraphic units highlighting the palaeo-vegetation and to evaluate them in terms of significant events and episodes that had occurred within the framework of this study, Each zone has been separately evaluated and discussed.

Pollen zone SL-1 (3.0-2.1 m)

This zone encompasses a time span of about 500 years and records predominantly high values of *Rhizophoraceae*, which attains 30 per cent of the total vegetation in the lower part of this zone and thereafter, the values declined slowly and gradually and remained feeble at the close of this zone, Likewise, *Excoecaria* agallocha 7% and *Avicennia* 8% also behaved in the manner as did the *Rhizophoraceae*. However, *Heritiera*, *Sonneratia*, *Acanthus*; *ilicifolius*, *Lumniizera racemosa* remained subdued ranging between 2-4% of the total vegetation. *Acrostickum* is known by its sporadic presence. Peripheral mangrove vegetation is represented in moderately high values by Fabaceae 10%, *Terminalia* and Palmae 6% each. *Tamarix* (4%). *Phoenix paludosa* (3%) and *Barringtonia* (1%) are represented in this zone. *Terminalia* records high values in the lower zone, subdued in the middle and regained higher values in the upper part of this zone.

The ongoing account of vegetation development during this zone is indicative of the direct marine influence in and around Solari village between 2,000-1,500 years B.P. Thus the flourishment and expansion of mangrove forest is envisaged wherein *Rhizophoraceae, Excoecaria agallocha, Avicennia* constituted the frontline forest while Heriteria, agallocha, Avicennia constituted the frontline forest while *Heriteria, Sonneratia, Acanthus iliciflius, Lumnitzera*, etc. fringed them.

Pollen zone SL-2 (2.1-1.6m)

This zone lasted for about 250 years and is marked by steep fall in mangroves and corresponding rise in midland, ubiquitous and fresh water taxa. As a result of this shift in vegetation, *Rhizophoraceae* has tremendously dwindled down recording its stray occurrence, particularly at the upper part of this zone. *Exoecaria agallocha* and avicennia showed a steep decline upward. *Sonneratia* and *Heritiera* have totally vanished from the zone. *Acanthus ilicifolius* remained stray in the lower part of this zone and thereafter vanished from the scene. Likewise *Phoenix paludosa* 2%, *Tamarix* 3%, *Palmae* 2%, and *Barringtonia* 1% also exhibited decline except for *Fabaceae* 12% which improved slightly as compared to the preceding pollen zone SL - 1.

This zone has witnessed the fall in the sea level as a result of which the core mangrove taxa were disappeared from the scene and succeeded by non-mangrove taxa.

Pollen zone SL-3 (1.6-0.0m)

This zone covers a time period of little more than one millennium and signified total extermination of core mangroves. Among peripheral mangroves, Palme 10% and Fabaceae 15% improved their values, whereas, *Terminalia* 3% reappeared after the lapse in the preceding pollen zone. *Pandanus* 2% made its first appearance in this zone. Rest of the peripheral *Pandanus* 2% made its first appearance in this zone. Rest of the peripheral mangrove taxa viz, *Phoenix paludosa, Tamarix* and *Barringtonia* remained more or less same as in the previous phase. Midland componens viz, Sapotaceae Emblica and *Anacardiaceae* reappeared in this zone after the Sapotaceae, *Emblica* and *Anacardiaceae* reappeared in this zone after the lapse in previous zone though in low frequencies. Acacia and *Holoptelea* 2% each, made their first invasion whereas, *Caesalpiniaceae* and *Malvaceae* continued in more or less same order as in the pollen zone SL-2.

This zone has witnessd the total extermination of core-mangrove taxa from in and around Solari village resulting into further fall of sea level since 1,000 years B.P. This environmental change has brought about a noticeable change in the vegetation composition.

4. Conclusion

The overall vegetation sequence obtained from Solari profile has collectively witnessed that around 2,000 years B.P. there was expansion of mangrove vegetation mainly comprised of *Rhizophoraceae, Excoecaria, Sonneratia, Avicennia, Terminalia* and *Fabaceae*, signifying thereby the transgression of sea and as well as increased salinity which provided congenial environment for profuse growth of mangroves. This fact is also corroborated by high values of dinoflagellate cysts, which further envisage more discharge of sea water into the lake. However, it is unequivocal to mention that this feature continued till 1,400 years B.P. Subsequently, between ca 1,400-1,250 years B.P, drastic decline in core mangrove taxa and corresponding, rise in peripheral mangrove and midland plants along with rise in fresh water components, denotes the recession in sea level encouraging self-marshes to develop landward which preclude the growth and spread of mangroves. Thereafter, the core mangroves reduced to fraction and were succeeded by *Palmae*, *Fabaceae*, midland and upland plants. The extermination of mangroves at Solari since 1,250 years B.P. could also be assigned due to the human holocaust.

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