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RECENT EVOLUTION OF MANGROVE VEGETATION IN THE CAUVERY DELTA : A PALYNOLOGICAL STUDY

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ABSTRACT

Palynological analyses have been carried out on sequences of sediments, cored in two estuaries of the Cauvery delta (Tamil Nadu) and they are estimated to be about 2000 years old. A detailed account on this subject is already been given by C. Tissot (1980).

In Muthupet (southern part of the delta), the investigations were made near a lagoon far from the present shoreline. Four periods in the evolution of the mangrove vegetation may be recognized. These are in accordance with geomorphic processes of the estuary as well as the resulting sedimentation pattern, both being dependent on the seaward setting up of sand bars.

In Pichavaram (northern part of the delta), the cores were taken near the present shoreline and only three periods can be distinguished. In the two older periods, the evolution of the mangrove vegetation is the same as that of Muthupet. In the upper part of the sequences, the evolution is highly disturbed : decrease in pollen representation of the arborescent genera *Sonneratia* and *Rhizophora* ; increase in the herbaceous taxa such as *Suaeda*.

These disturbances are obviously due to local human activity : selective wood cutting, grazing in the mangrove forest. The development of fresh water damming, widespread in inland areas, seems to have had a deteriorating effect on the mangrove vegetation, causing higher salinity in the soil as a consequence of diminished fresh water flow in the delta.

INTRODUCTION

THE DEVELOPMENT and rational use of an ecosystem may be validly undertaken only when its evolution is known, particularly during the last centuries. This remark is especially true of the mangroves which are fragile ecosystems because they are dependent on a number of very variable parameters. The monitoring process is even more important where there is human pressure and forest exploitation such as is found in the Cauvery delta.

In South India, the mangrove vegetation which grows now in the Cauvery delta estuaries (Fig. 1) has been studied in detail. Although this mangrove is considered one of the most beautiful forests on the east coast of India, several authors have emphasized the degraded aspect of these formations (Blasco and Caratini, 1973 ; Krishnamurthy and Sundararaj, 1973 ; Maher-Homji, 1974 ; Blasco, 1975 ; Krishnamurthy *et al.*, 1981 ; Meher-Homji, 1985).

To evaluate the causes of this degradation, it is necessary to know the floristic associations which existed earlier in these areas.

From the investigation carried out by C. Caratini *et al.* (1973), it is well known that, in Pichavaram, there is a strong correlation between the mangrove vegetation and its pollen

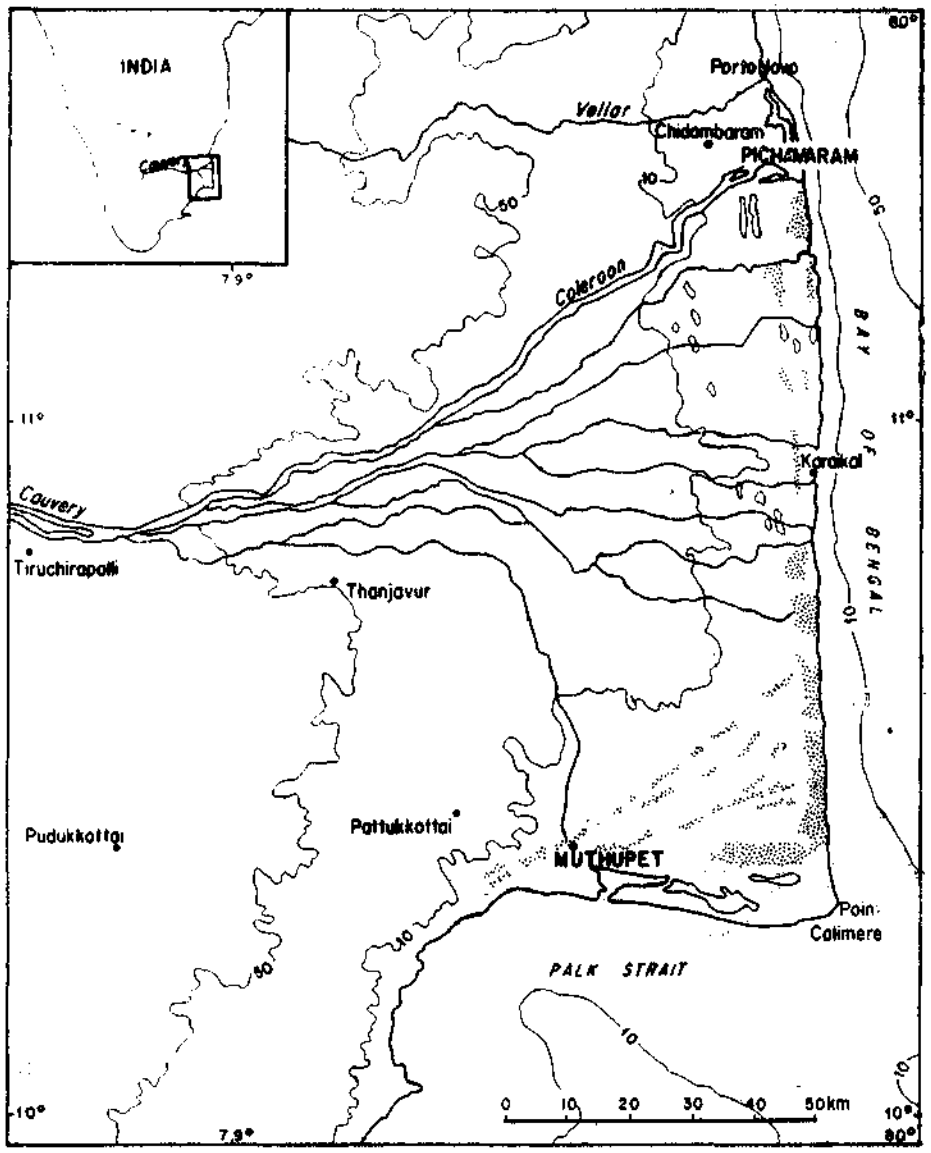

FIG. 1. Cauvery delta and area studied.

representation in the sediments. In addition, the detailed palynological analysis of sedimentary sequences deposited in the Cauvery delta, have led to the reconstruction of the history of this vegetation (Tissot, 1980).

From these findings, it becomes possible to specify the causes governing the evolution of the vegetation while trying to discern those that were natural events from those due to human impact.

Research on the Cauvery mangroves has been carried out by the scientists of the French Institute of Pondicherry for more than 20 years and the author wishes to thank all the members of this team, both for assistance during field-work and later for their constant help in the laboratory. The manuscript has been reviewed by Dr. F. Blasco, Dr. C. Caratini and Dr. G. Thanikaimoni.

Present Vegetation in the Cauvery Mangroves

In the Cauvery delta, the mangrove vegetation is spread irregularly and mainly grows close to Pichavaram and Muthupet lagoons. In Pichavaram mangroves, where some arboreal associations are still well preserved, several vegetational zones have been defined according to tidal rhythm and the duration of their immersion in sea water (Blasco, 1975). The *Rhizophora* zone, reduced to a fringe of 3-4 m width and submerged daily by the tide. The two main species, *Rhizophora apiculata* and *R. mucronata* are observed and slightly inland occur *Bruguiera cylindrica* and *Ceriops decandra*. Some rare *Sonneratia* can also be seen.

The *Avicennia* zone, which exists on soil invaded only by seasonal high tides ;

The **back-mangrove**, mainly populated by *Suaeda maritima*, with large areas of bare soil (blanks), where some other crassulescent halophytes can be recognized : *Sesuvium portulacastrum*, *Heliotropium currassavicum* and *Salicornia brachiata*. In this zone, two other halophyte species are present : *Excoecaria agallocha* and *Acanthus ilicifolius*, which may sometimes extend further inland.

In Muthupet, the mangrove is an *Avicennia marina* dominant forest spreading around the lagoon *Excoecaria agallocha* grows along with *Avicennia*, *Clerodendrun inerme*, *Acanthus ilicifolius* and *Derris uliginosa*, a climber also noticed in Pichavaram, are observed. In the back-mangrove, *Suaeda maritima is* found, either in pure formations, or associated with *Excoecaria agallocha*. There is no Rhizophuraceae growing now in Muthupet.

Palynological Study of Cores in Muthupet Area

Palynological analyses

Two cores, 1.50 m and 6 m deep taken at Muthupet, about 3 km from the shoreline and from the present opening of the lagoon to the sea.

Four periods can be identified according to : the representation of mangrove pollen observed in the sediments and the importance of marine influence indicated by the more or less high percentage of Foraminifera organic test and dinoflagellate kysts (*Spiniferites* sp.), *Operculodinium centracarpum*, *Lingulodinium machaerophorum*. These periods, from the oldest to the most recent (Fig. 2) are :

Period A : Mangrove and back-mangrove species are poorly represented, some pollen of *Rhizophoraceae* and *Sonneratiaceae*, families totally absent from the landscape nowadays, are observed.

Marine influence is clear and constant.

Period B : Marine influence increases ; we also witness the progressive extension of the mangrove.

Period C : Marine influence decreases substantially, when the mangrove, with *Avicennia* being dominant, reaches its maximum extension.

Interpretation

a. Age of studied sediments :

Various arguments such as ^{14}C Radio Carbon dating in the Cauvery delta (Kerrest, 1980), maximum Holocene transgression occurring about 5000 years BP and appearance in the cores of pollen of *Casuarina* which was introduced in India in 1798 (Santapau, 1966), enable us to estimate the age of the oldest sediments at about 2000 years.

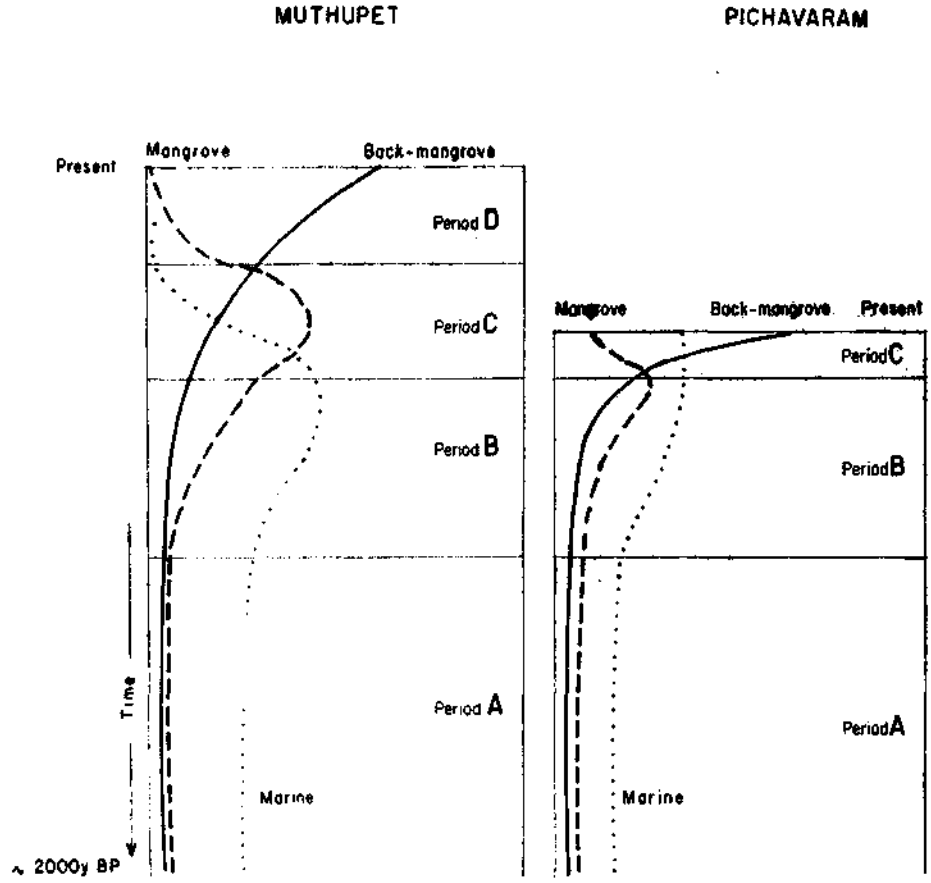

FIG. 2. Vegetational and marine evolution at Muthupet and Pichavaram.

Period D : Marine influence disappears and herbaceous halophytes of the back-mangroves spread widely to the detriment of arborescent genera of the mangrove which obviously decrease (*Avicennia*) or disappear completely (*Rhizophora, Sonneratia*).

b. Interpretation of the results :

To understand the vegetational evolution

observed in the cores of Muthupet, it is necessary to understand the lagoon formation and the different steps in its evolution.

All along the coast of the Cauvery delta (Ahmed, 1972), the dominant action of waves and coastal currents induce the formation of a sand bar behind which a lagoon is created. Then this lagoon is filled up more or less quickly by fluvial deposits. Beyond this sand bar, fluvial sediments continue to be brought to the sea, and by reworking them, the waves cause the formation of a new sand bar. Hence, a new lagoon is created and fluvial supplies are sedimented in it in the same way.

This process has been summarized in Fig. 3. The four steps demonstrate the evolution illustrated in Fig. 2.

At the bottom of the core (period A), the site is located near the sea, as indicated by the clear and constant occurrence of marine microorganisms. In the lagoon, the mangrove which has only limited areas for spreading, expands to a very small extent. As the lagoon fills up with fluvial supplies, the mangrove begins to spread out on the banks of the recently formed channels (period B) ; marine influence also increases. Filling up continues, the channels become more and more numerous and the mangrove colonizes their banks, reaching its maximum extent, while marine action decreases.

Then, on a surface where the sea has practically no action, arborescent halophyte species of mangrove disappear and are replaced by salt-marsh species (period D). It is possible that, during the period D, human impact has slightly hastened this natural process, but palynological results do not show evidence of it.

Palynological Study of Cores in Pichavaram Mangrove

Palynological Analyses

As in Muthupet, two cores were taken, but in an area closer to the shoreline : one in the *Avicennia* forest, about 50 m from a channel bank, at a depth of 3.90 m and the other, 6.90 m deep, was cored on the opposite bank, very close to the channel, under *Rhizophora*, *Bruguiera* and *Ceriops*.

At the bottom, we can once again distinguish the periods A and B which are practically identical to these described in Muthupet. On the other hand, from the beginning of period C, dated from about 150 years BP due to the presence of *Casuarina* pollen, the evolution of palynological assemblages is different. Whereas, in Muthupet period C corresponds to the maximum extension of the mangrove, here pollen percentages of the three main genera, *Sonneratia*, *Rhizophora* and *Avicennia* decrease, while pollen of back-mangrove salt-marsh species quickly reach high percentages. The abundant marine microfossils in these levels clearly proves that it is the bottom of period C defined in Muthupet.

Therefore, period D, which in Muthupet corresponds to a rapid decrease of arborescent mangrove species and favours large scale extension of salt-marsh species, is not observed in Pichavaram.

Evidences of human impact

As seen above, sedimentary deposits progressively fill the lagoons and then induce a multiplication of channels and islets favouring the extension of the mangrove forest because of the increase in areas that can be colonized.

In Pichavaram, the present morphology of the lagoon should lead to such an evolution, but the palynological results obtained in the deeper levels of the period C do not correspond to this type of evolution. On the contrary, it is a regression of the mangrove vegetation which appears in the diagram.

Although the Pichavaram mangrove has been protected since 1880 with the official statute of ' Forest reserve ', it has long been

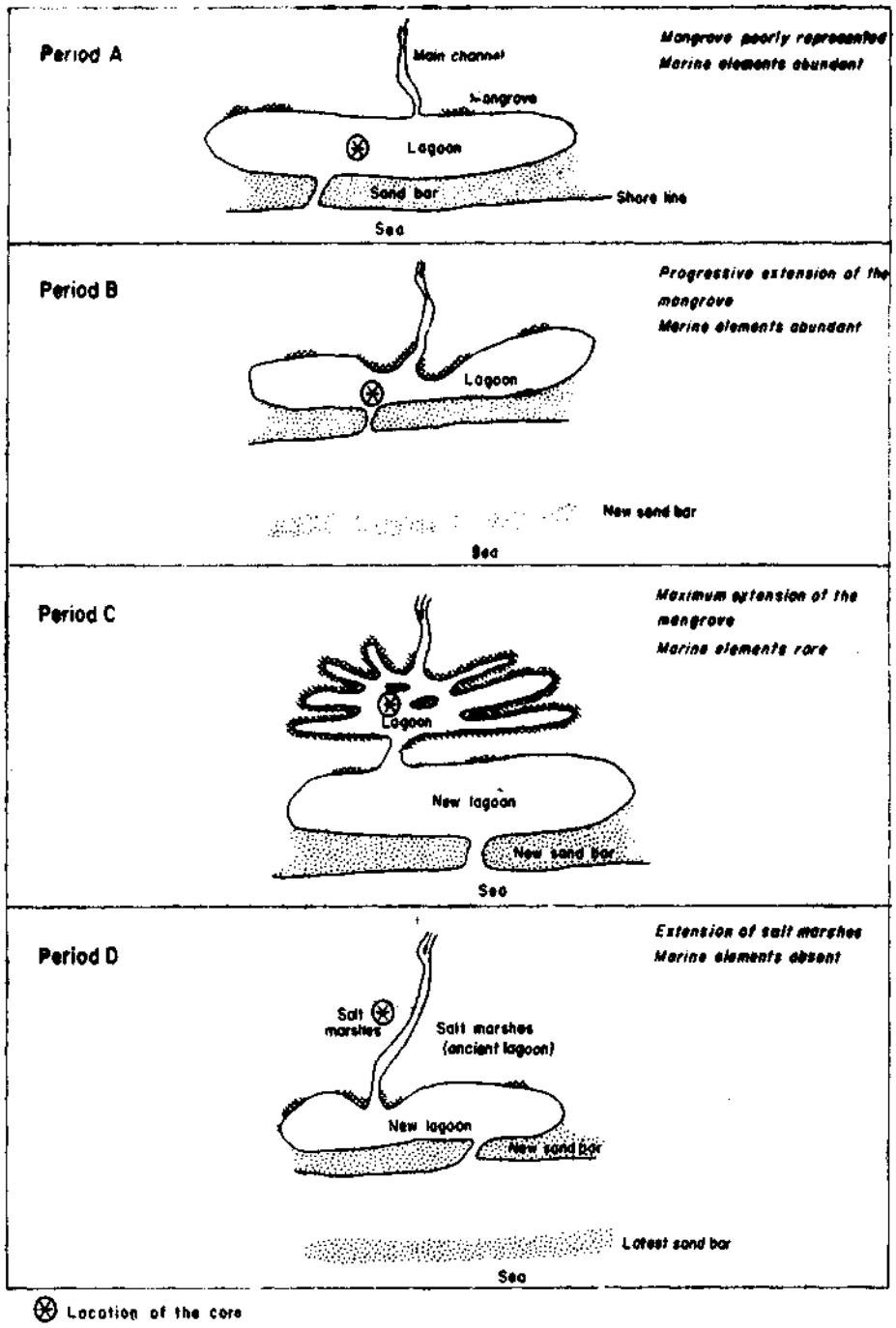

FIG. 3. Geomorphic evolution of a lagoon and associated environmental changes.

submitted to heavy anthropic pressure, due to its being a source of firewood, grazing area and also a transit zone because of fishing which is the main local occupation (Kerrest, 1980).

This human pressure appears in the palynological diagrams with a decrease or even the total disappearance of species such as *Sonneratia* (the most beautiful trees being cut first) and by the extension in recent levels of trees which are less used such as *Excoecaria*. *Rhizophoraceae* are even now present in Pichavaram, but the percentage of their pollen representation decreases in the upper levels. This corresponds to the human activity, the *Rhizophora* having been greatly exploited in the past for their tannin and nowadays for firewood.

Another explanation can be given for vegetational changes. In inland areas, to improve irrigation, water is stored behind numerous dams (Racine, 1976). Then, the freshwater supply to the mangrove decreases and soil salinity has a tendency to increase, inducing the growth of more tolerant halophytic species.

Conclusion

In the Cauvery delta, the development of the mangrove vegetation over the years has been largely influenced by the pattern of sedimentation with successive seaward sand barriers enclosing the lagoons.

Since the last century, it appears that the mangrove evolution has been disturbed. Two main causes, both anthropic, may be mentioned : *local factor :* the recent increase in human activity in the mangrove forest, especially selective wood cutting and grazing and *regional factor :* less obvious ; deterioration of the salt balance in the mangrove soils caused by intense freshwater damming operations in the Cauvery basin.

Thus, the palynological investigations in the mangroves may be highly effective means of retracing local vegetation history by specifying: the interactions between geomorphic processes and the evolution of vegetation and human impact on vegetation.

Such investigations dealing with the past history of mangrove vegetation could be used along with the other available information when planning the management of mangroves.

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