Palaeomangroves of Kanara coast, Karnataka, India and their implications on Late Pleistocene sea-level changes

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Along the Kanara coast, some wells show an organic clay layer, 1.5 to 7 m thick, between a layer of 2 to 6 m of coarse yellow sand above and white sand and pebbles below. The altitude of this intermediate organic clay formation is more or less at the present mean sea-level. Palynological analyses reveal that this sediment had been deposited within a mangrove environment, *i.e.*, at sea-level, while the ^{14}C datings give ages older than 40,000 years B.P. No proof of vertical movements after the deposit of the intermediate organic clay formation has been put forward up to now. Therefore it can be accepted that the present elevation of this formation is more or less the same as its original altitude, *i.e.*, the present sea-level. Comparison of this altitude with the curves of global sea-level changes indicates that the period of deposition of these organic sediments should be around 125,000 years B.P., during the last Interglacial (Eemian) when the sea-level was ± the same that it is today. The main characteristics of "Eemian" flora were the same as the present. The climatic regime may have been slightly different with less contrasting seasons.

Key-words—Palynology, Mangrove, Sea-level changes, Upper Pleistocene, Karnataka (India).

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सारॉंश

कर्नाटक (भारत) में कनारा तट के पुरामैंग्रोव तथा अनंतिम अतिनूतन काल में समुद्र-तल परिवर्तनों पर उनका प्रभाव

सी० केरातिनी, जी० डेलिब्रियास एवं गोविन्दराजा राजगोपालन

कनारा तट के संग-संग कुछ कुओं में ऊपर 2 से 6 मीटर की मोटी पीली बालु तथा नीचे गुटिकाओं युक्त सफेद बालु के बीच में 1.5 से 7 मीटर मोटी एक कार्बनिक मृत्तिका की तह विद्यमान है। इस माध्यमिक कार्बनिक मृत्तिका का तल वर्तमान समुद्र तल से लगभग मिलता-जुलता है। परागकण विश्लेषण से व्यक्त होता है कि ये अवसाद मैंग्रोव वातावरण में समुद्र-तल पर निक्षेपित हुए थे जबकि कार्बन^{14} कालनिर्धारण के आँकड़े 40,000 वर्ष पूर्व की आयु प्रस्तावित करते हैं। इस माध्यमिक कार्बनिक मृत्तिका के निक्षेपण के बाद इसके उर्ध्वाधर स्थिति में स्थापित होने का अभी तक कोई प्रमाण नहीं मिल पाया है। अतएव यह माना जा सकता है कि इस कार्बनिक तह का वर्तमान तल उस समय के समुद्र तल के लगभग बराबर है। भूमण्डलीय समुद्र-तल परिवर्तनों से इस तह की ऊंचाई की तुलना से इंगित होता है कि इन कार्बनिक अवसादों के निक्षेपण का समय पिछले अन्तरहिमानी (एमियन) के समय लगभग 1,25,000 वर्ष पूर्व रहा होगा जबकि समुद्र-तल लगभग आज जैसा ही होगा। 'एमियन' वनस्पतिजात के मुख्य लक्षण वर्तमान से मिलते-जुलते थे और जलवायु सम्भवतया थोड़ा भिन्न प्रकार की लेकिन कम मौसम वाली रही होगी।

THE question of high sea-levels during the Late Pleistocene is yet to be solved despite the vast data dealing with this "puzzling problem" (Giresse & Davis, 1980). This awkward situation is mainly due to the difficulty, and generally even the impossibility, of obtaining satisfactory answers to the following two questions:

—determination of the altitude of littoral sediments at the time of their deposition; this uncertainty is mostly due to the difficulty in estimating the effects of possible neotectonics;

—estimation of the absolute age of these sediments; the reliability of ^{14}C datings becomes low for values near or older than 30,000 yrs B.P. with a physical limit of around 40,000 years B.P.; for earlier periods it is often difficult or even impossible to carry out other isotopic methods, such as $^{230}Th/^{234}U$ or $^{231}Pa/^{235}U$.

On the west coast of India, some organic clay layers recorded in several parts along coastal Kanara (Karnataka) are investigated in this paper. As they are older than 40,000 years B.P. they are not exceptions to this rule of incertitude. Nevertheless, our study will lead towards a better understanding of the age and conditions of their deposition as well as on the regional evolution of Late Pleistocene.

GEOGRAPHICAL AND GEOLOGICAL BACKGROUND

Kanara, in coastal Karnataka, extends from the shoreline to the great escarpment of the Ghats. Its geology and geomorphology are complex as already emphasized by W. T. Blanford as early as 1869. The most distinctive features are the numerous lateritic terraces with some sporadic emergences of the crystalline substratum. In the absence of true fossils, the age of the detrital sediments as well as their tectonic movements have never been precisely known (for bibliography see Chatterjee, 1961; Mehr, 1987). These lateritic terraces which are dissected by a large number of rivers running from the Ghats slope gently towards the sea where they often end as cliffs. Estuaries are numerous and hence the coast is irregular in both plan and elevation with a characteristic pit-and-lagoon shoreline. The estuaries sometimes penetrate deep inland and these embayments, filled by younger deposits, have a definite ria aspect. In most cases the paleoreliers surrounding the lowest terraces comprise low and smooth mounds only a few metres high and this does not help in elucidating the relationship between the lowest terraces and the surrounding paleoreliefs.

These low terraces seem to constitute a geomorphologic and lithologic unit, but actually there are at least two generations of deposits which are merged and hence not easily distinguishable. It is only from the study of wells that it becomes possible to recognize an older generation of sediments with the following layers.

From the surface downwards:

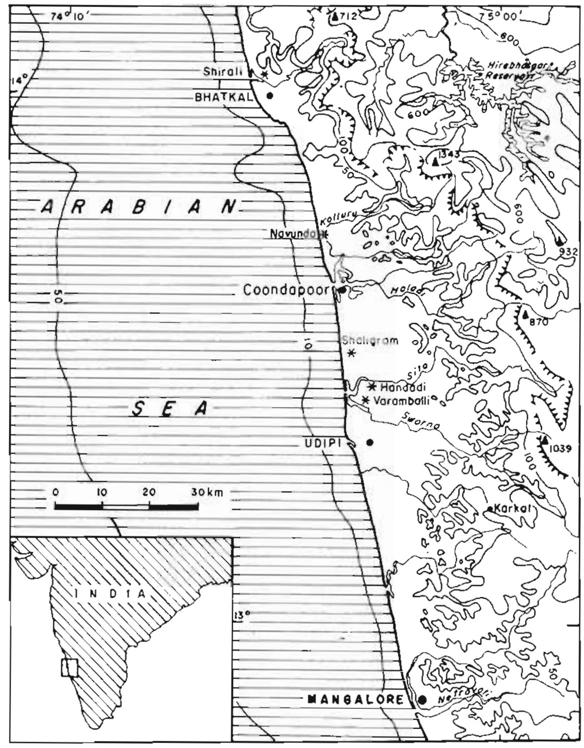
—coarse red mottled sand partly cemented by ferrugineous concretions;

—black organic clay with vegetal fragments;

—white sand with pebbles: aquifer.

Each layer is only a few meters thick.

Such a stratigraphy of great petrological uniformity can be found all along the Kanara coast despite the discontinuities between the estuaries. This paper reports studies on this particular sedimentological feature with palynologic and geomorphologic investigations as well as ^{14}C ages.



Text-figure 1—Coastal Kanara: Location of the investigated wells.

STUDY OF WELLS

In the low terrace of the Sita and Swarna estuary, two wells were investigated at Handadi and Varambali. Another well was studied a few kilometers away, at Shaligram. Two wells in Navunda and one well near Bhatkal, about 70 km north, also present the same characteristics (Text-fig. 1).

Handadi Village

Lithology of the well (Text-fig. 2)

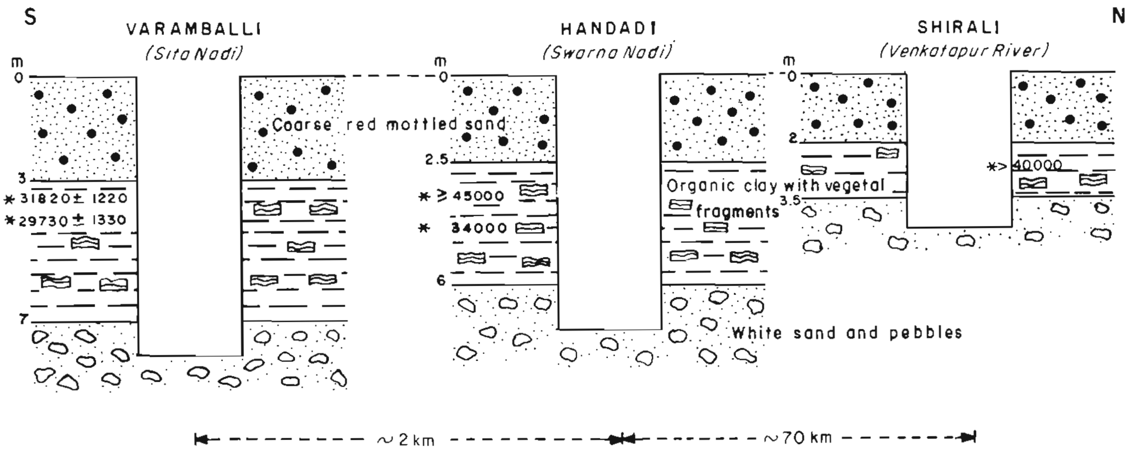
—Surface to 2.5 m (the elevation of the surface of this terrace is approximately 4 m): irregular coarse sand, red mottled and slightly cemented;

—2.5 to 6 m: black organic clay with numerous vegetal fragments of various sizes, some of them measuring several decimeters. The line of contact with the layer above is distinct;

—6 m to bottom, 7 m: aquifer; white, coarse sand with pebbles.

Palynological data (Text-fig. 3; Table 1)

Two samples collected at depths of 3.5 and 4.5 m have been studied. Both were deposited within a mangrove environment, their palynological assemblages being dominated by Rhizophoraceae (mostly *Rhizophora* and some *Ceriops, Bruguiera*) with some rare *Avicennia* and *Aegiceras*. In both the samples, *Pandanus* which normally grows along



Text-figure 2—Section of three wells in the coastal plain of Kanara.

Table 1—Intermediate organic clay formation: Palynological assemblages (% calculated from the total pollen + spores)

	Vara mbali 3.5 m	Handadi 4.5 m		Shaligram I*	II*	Shirali
Mangrove						
Rhizophoraceae	67.2	51.2	68.7	81.9	90.9	67.6
Avicennia	0.6	0.5	0.4	1.9	0.7	
Aegiceras		1.5		1.0	0.7	0.3
Total mangrove	67.8	53.2	69.1	84.8	92.3	68.0
Back mangrove						
Acanthus ilicifolius			0.4	1.9		
Calophyllum			0.4			1.0
Excoecaria			1.1			
Heliotropium			0.4			
Miscellaneous						
Arisaema	4.5	6.0	9.0			3.0
Asteraceae		0.5				
Calamus		0.5				0.3
Caryota				1.0	0.7	
Cyclea peltata	0.3					
Elaeocarpaceae	0.3	3.5	3.6			0.3
Flacourtia indica			0.4			
Gardenia type	0.3					
Melastoma	0.3		0.4			
Myrtaceae 15µ	1.3	0.5				
Nauclea	0.3					1.0
Oldenlandia			0.4			
Pandanus	0.6	0.5	0.7			0.5
Phoenix	0.3	0.5	0.4			
Phyllanthus		0.5	0.4	0.5	0.5	0.5
Sapotaceae	0.3					
Strobilanthes	0.3	0.5				
Syzygium	0.3	2.0	0.7	1.9		1.6
Terminalia type	0.3	0.5		4.8		1.6
Urticaceae	0.6	0.5	0.7			1.9
Ventilago	0.3					
Xylia	0.3					0.3
Xylocarpus			0.4			
Poaceae	0.3	0.6		2.8	1.4	3.9
Cyperaceae	1.6	1.0		1.0		1.3
Varia	15.5	18.9	5.8	2.9	5.6	9.7
Unidentifiable	2.8	5.0	4.3			2.9
Ferns						
Spore 1lete psilate	0.6	2.5	1.1			
Spore 1lete ornam.	0.6	2.0	0.4			0.3
Spore 3lete psilate	0.3	0.5	0.4	1.0		
Spore 3lete ornam.						0.3
Total spores	1.6	5.0	1.9	1.0		0.6
Total P × Sp.	317	201	278	107	143	309
Foraminifera	2.3	8.5	4.0	2.9		8.4
Pseudoschizaea		0.5				

*analyses: G. Thanikaimoni

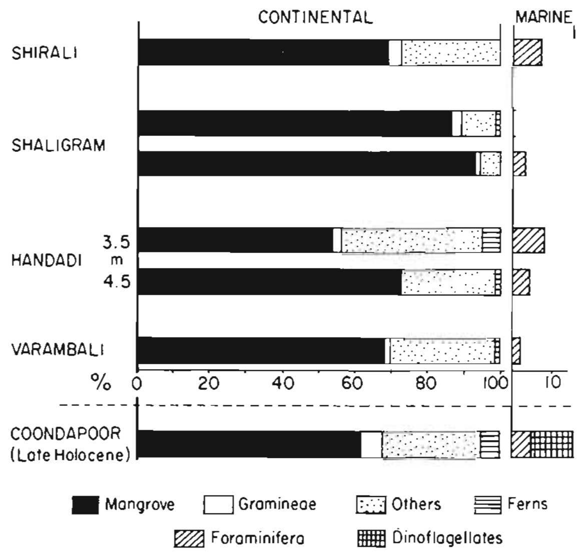
river banks is well represented; the marine influence is marked only by the presence of organic tests of Foraminifera. During the deposition of this organic sequence, the paleoenvironmental conditions were subjected to the usual and characteristic changes, well-known in mangrove sedimentation (Thanikaimoni, 1987). From 4.5 to 3.5 m, the environment became more open, i.e., subjected to influences external to the mangrove ecosystem, as attested by a greater pollen diversity, the occurrence of some herbaceous plant pollen, such as Poaceae and Cyperaceae, as well as a large number of fern spores and more marine microfossils.

Chronological data—Two dates were obtained from this well:

—3.5 m: ⩾ 45,000 years BP (GIF 7249)

—4.5 m: 34,000 ± 1500 years BP (GIF 7251).

The 3.5 m deep sample is estimated to be very old, beyond ^{14}C age range. The other sample is 1 m deeper to the first one. Hence the result of 34,000 years to this sample constitutes an obvious anomaly which can be explained by contamination with younger material such as humic acids which were not properly eliminated during chemical pretreatment. Since an older date of the upper sample cannot be envisaged, it may be concluded that the age of the entire organic layer is older than 45,000 years B.P.



Text-figure 3—Simplified palynological diagram of some intermediate organic clay formation samples and comparison with the mean values from Late Holocene of Coondapur (Tissot, 1990).

Varambali

A 6 m deep well near the All India Radio tower, less than 2 km from Handadi well (Text-fig. 1), is closely comparable. Located in the same terrace, it has the same lithology (Text-fig. 2), the correlating layers being a little thicker and deeper. The palynological content (Text-fig. 3 and Table 1) is also similar with a strong dominance of Rhizophoraceae.

Two dates were obtained:

—from an organic clay sample: 31,820 ± 1220 years B.P. (BS 681)

—from a wood fragment: 29,730 ± 1310 years B.P. (BS 680).

The exact depths of these two samples are not known because the well was already walled and the samples were collected from the earth recently dug out from the well. However, because of the regularity of the arrangement of the sediments out of the well, it can be assessed that the wood fragment was deeper than the organic clay sample. Here again such results are not compatible and as in the case of Handadi, a rejuvenation of these two samples must be suspected. Hence, the same age, i.e., older than 45,000 years B.P., may be retained.

Shaligram

A little northwards, near 42° 42′ : 13° 29′ (Text-fig. 1), in the coastal plain, a comparable black organic clay layer is found below coarse sands in a 6 m deep well. Palynological analyses were carried out on two samples from this layer (data from Late Dr G. Thanikaimoni). Prof. B. G. L. Swamy has identified some wood fragments as *Calophyllum* and given a dating of "barely 40,000 years B.P.".

The two samples investigated for palynology (Text-fig. 3 and Table 1) are dominated by pollen of *Rhizophora*. Hence, they were also deposited within a mangrove ecosystem. One of the two samples is marked by marine influence since it contains organic tests of microforaminifera.

Navunda

Similar black organic clay was observed in two wells located (74° 35′.7 : 13° 45′) in Navunda (Text-fig. 1). The thickness of the layers is more than in the previous wells: 7 to 8 m of coarse mottled sand; 5 to 6 m of black organic clay. Palynological analyses show that this clay was sedimented in a mangrove environment. Two samples from this layer were dated (Murthy, 1977) and were found to be about 40,000 years B.P. These values are at the limit of the feasibility of the ^{14}C method and hence cannot be retained without reservations.

Shirali

North of Bhatkal (Text-fig. 1), near a channel of Venkatapur River in the low plain (74° 31 : 14° 03), an equivalent organic clay layer is seen in well excavations. Despite the distance between this site and those from Udipi Taluk, more than 70 km away, the lithology is similar; only the thickness of the upper two layers, coarse yellowish sand and black organic clay, is slightly less.

Vegetal fragments are numerous in this clay. Among them, a leaf of *Calophyllum* has been identified.

Palynological analyses once again reveal a mangrove environment (Text-fig. 3; Table 1) still dominated by *Rhizophora*. The assemblage resembles those obtained in the southern wells. However, the Shirali assemblage may be distinguished from the others by the little higher percentage of Gramineae: 3.9% *versus* 0.3 to 2.8 per cent. The age of a sample collected in the middle part of the organic layer has been determined as >40,000 years B.P. (BS 805).

Uniformity of the organic clay layers

In spite of the wide geographical distribution of the investigated wells and the discontinuity between the wells, the organic clay layers belong to the same generation because of their similarities in stratigraphy, lithology, palynology, ^{14}C datings and also their location at the same altitude. The deposits investigated here are roughly at about 0 m now, i.e., the present mean sea-level.

Hence they can be considered to belong to the same lithologic formation which will be named "intermediate organic clay formation" because it is always within the same sequence of coarse yellowish sands above and while sands and pebbles below. The intermediate organic clay formation should not be confused with the more recent organic black clay found in most of the recent lagoons. The sedimentation of this younger black clay started during the Late Holocene transgression and is still continuing.

Organic clay formation in Kanara: Data from literature

Some comparable sediments lying more or less near the present sea-level, rich in organic fragments and dated older than 40,000 years B.P., have been reported in Kanara. Lack of sufficient data makes it difficult to include them in our study. They are cited here only to show the large number of these organic deposits which, despite their overall similarity, can hardly be correlated with the organic layers described above without a reappraisal and further investigation.

"Kulur submerged forest" (Agarwal & Gudzer, 1974)

At Kulur, near Mangalore, the authors have mentioned a "submerged forest" without indicating the precise location (a village named Kulur lies about 5 km north of Mangalore) or altitude. The age of this formation (TF 966) is "beyond the dating range of radiocarbon"

Netravati River (Murthy, 1977)

During the construction of the road-bridge over Netravati River, "lignitised wood with clay" was discovered in the foundation wells. This layer was found in several bore-holes at depths ranging —25 m to 30 m. Since the level of the 0-mark above mean sea-level was not specified, the exact elevation of this layer cannot be estimated. No isotopic age was given. Due to the lack of any precise data on the elevation, age and also lithology, this very interesting occurrence cannot be considered in detail.

ESTIMATED AGE OF THE INTERMEDIATE ORGANIC CLAY FORMATION

From the above it can be stated that (1) the discontinuous layers of the intermediate organic clay formation belong to the same generation of sediments, (2) these sediments have been deposited ± at sea-level, (3) the period of deposition is older than 45,000 years B.P. as ascertained by ^{14}C data. It is possible to obtain, at least approximately, an indication on the age of the deposition of this coastal formation by plotting its original altitude against those of the curves of sea-level changes defined for periods older than 45,000 years B.P.

It is, therefore, necessary to specify the original altitude of the intermediate organic clay formation by reconstituting the epeirogenic activity during Late Quaternary and to estimate the possible vertical shift in the altitude of the land.

Another point to be considered while determining the original altitude of the deposits is the rate of compaction which in this type of clayey sediment is always high. It has been suggested that clayey muds can gradually be reduced to 10-25 per cent of their original thickness (Greensmith & Tucker, 1986). Because of the small thickness of these layers which after compaction is only a few meters, this process needs not to be taken into account to assess the original altitude of deposition.

Neotectonics in coastal Kanara and neighbouring areas

Peninsular India is an old craton, devoid of any tectonic activity. This notion which has long been accepted (Vredenburg, 1903) was again demonstrated through the new magnetic maps obtained from satellites (Acache *et al.*, 1988). However, this method of investigation cannot identify the occurrence of faint regional isostatic adjustments. These movements are precisely those which have to be considered for the interpretation of our results in Kanara.

Kanara has formed the subject of numerous and detailed geological studies but only a few have been published on neotectonics in coastal Kanara (Joshi *et al.*, 1973). The feeble interest shown by researchers on this topic is mainly due to lack of data and also because of the absence of any evident neotectonic effects in this area.

In fact, further support can be found to prove the relative stability of Kanara during the Quaternary. A perusal of the recent *"Neotectonic map of India"* (Dhoundial, 1987) confirms this stability since it shows no distinct active process in this part of the western coast, particularly the low heat flow and seismicity contrasting with the higher values of these data north of 16°N, in coastal Maharashtra. It is significant that investigations on neotectonics and eustasy are more frequent in Maharashtra (Agarwal & Guzder, 1974; Vaidyanadhan, 1987) than in the southern regions where very little attention has been given to this subject.

Still in Maharashtra, at about 150 km north of Kanara, another raised beach a few meters above the present sea-level is mentioned near Vengurla, Sindhudurg District (Sukhtankar *et al.*, 1986). This feature is hardly due to a higher relative sea-level stand occurring during the Late Holocene but could be rather a characteristic of neotectonic activity which affects the northern part of the west coast.

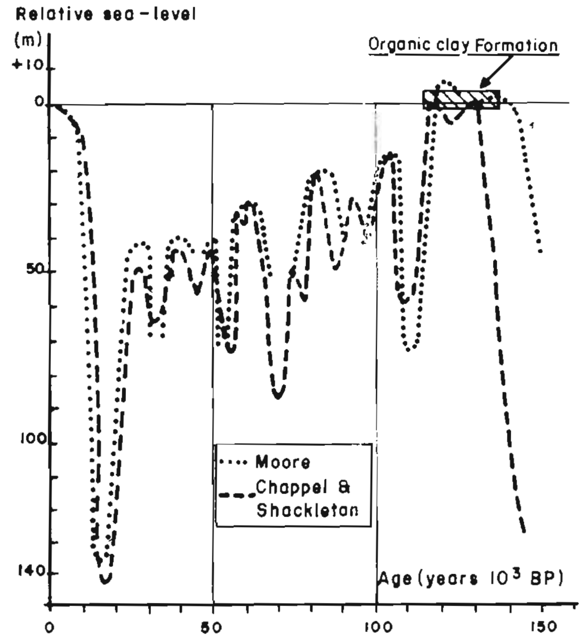
Raised beaches have been described all along the southern part of the west coast but they do not involve recent epeirogenic activity. For example, as early as 1883, R. B. Foote observed beach deposits containing marine shells 5 m above the present sea-level near Cape Comorin. He considered this as clear evidence of either a rise of the coast or a fall in the sea-level. Much later, radiometric date of this same coral was reported to be about 32,000 years B.P. (Rajagopalan *et al.*, 1982; Kale & Rajaguru, 1985), a date which cannot be retained without reservation as with all ^{14}C age data of carbonates deposits (BS 132, BS 133).

"Monastirien" raised beaches have been cited (Foote, 1883) near Udipi which is within our study area, but we have not come across such outcrops up to now. Moreover the regular sedimentation observed during Late Holocene in the Coondapoor lagoon nearby (Tissot, 1990) constitutes another argument against any recent marked change of the relative sea-level which would have disturbed the sedimentation process and affected the palynological results.

From the brief outline above, it can be admitted with a reasonable degree of accuracy that the original altitude of the intermediate organic clay formation was roughly that of the present sea-level.

Comparison between the altitude of the intermediate organic clay formation and sea-level curves

Based on various isotope studies, several sea-level curves have been reconstructed for Late Quaternary. Those of Moore (1982) and Chappel and Shackleton (1986) which are very similar, have been considered here (Text-fig. 4). Some authors (Newman *et al.*, 1980; Giresse, 1987) draw attention to the fact that the changes in the sea-level cannot be summarized by a unique global curve because of local or regional events which could produce large distortions, preventing the use of a theoretical global sea-level curve as a correlating tool. However, this method can be validly applied for our study because of the uniformity of the two curves retained here which constitutes good presumption of their accuracy on the one hand and the tectonic stability of the investigated area during the Late Quaternary on the other.



Text-figure 4—Late Quaternary sea-level curves from Moore (1982) and Chappel and Shackleton (1986). The Kanara intermediate clay formation is tentatively plotted on this diagram.

During the Interglacial Riss-Wurm corresponding to Eem, the well-known European terminology for the last major Interglacial at about 125,000 years B.P., the sea-level was at an elevation close to that of the present level. There is a general agreement on this world-wide sea-level stand. Hence the conjunction in both the altitudes, i.e., sea-level and deposits, permit us to accept this date of about 125,000 years B.P. as the age of the deposition of the intermediate organic clay formation. There is no reliable alternative to this proposal. In particular, it is not feasible to accommodate the younger high sea-level stands occurring during the Wurm interstades because such a choice implies an upheaval of the continent younger than the deposition. In fact, this hypothesis cannot be fully excluded since the shifting would be small, only a few tens of meters for some interstades.

PALEOFLORISTICS

A comparison of the palynological assemblages from this intermediate organic clay formation with those from the Late Holocene mangrove deposits (Tissot, 1990) in the same area, near Coondapoor (Text-fig. 1), shows that in spite of overall similarities, some differences exist in the details (Text-fig. 4):

Sonneratia—At present, *Sonneratia* is found in the mangrove communities of Karnataka where it is common but not abundant (Untawale & Wafar, 1986). It is represented by a few pollen grains in the Late Holocene of Coondapoor but its pollen has never been observed in our samples.

Poaceae—The percentages of Poaceae (0.3 to 3.9; average: 1.5) are always smaller in the intermediate organic clay formation than in Coondapoor (2.9 to 12.3, average: 6.5); Poaceae are found preferentially in the savannas or deciduous forests but also in low deciduous thickets (Pascal, 1984). Hence, it is not reliable to draw climatic or paleogeographic clues from such an ubiquitous family, specially when the differences in the palynological results are not sufficiently pronounced.

Cyperaceae—The percentages of Cyperaceae are slightly lower in our samples ranging from 1 to 1.6 (average: 1.2) as against 0.7 to 3.5 (average: 2); Cyperaceae is often considered as a marker of humid conditions.

Fern spores—The fern spores also have smaller representation in "Eemian" (0.6 to 5%; average: 1.7%) than in Holocene samples (1.6 to 9%; average: 6%). It is an accepted fact that the number of fern spores increases with a more humid climate.

Fresh water algae—Practically absent in the intermediate clay formation, *Pseudoschizea* and *Botryococcus* have been consistently recorded in the Late Holocene of Coondapoor but with low values (0.5 to 4.3% of the total pollen + spores).

Hinterland vegetation—It is well known (Thanikaimoni, 1987) that the pollen released by the hinterland vegetation never have a fair representation in mangrove sediments. The mangrove forest itself being a high producer of pollen, the allochthonous pollen are relatively too few and the remote vegetation does not appear clearly in the pollen assemblages. In our study, from the taxa grouped under "miscellaneous" records (Table 1), no significant difference can be seen between the past and the present hinterland floras.

PALEOCLIMATE

In the absence of concrete evidence, it is difficult to accurately reconstruct the paleoclimate. However, some reliable indications and clues can be obtained from our palynological results.

Palynological assemblages

The overall resemblances between "Eemian" and Late Holocene palynological assemblages makes it possible to postulate that during these periods the general climatic features were not very different. This conclusion agrees well with the climatic pattern of Quaternary which is closely related to global sea-level changes: lowstand sea-levels occur during cold stades when the climate became drier, whereas highstand sea-levels correspond to warm and more humid stades, a scheme which has been confirmed by the study of oceanic cores in the Arabian Sea (Caratini *et al.*, 1981; Van Campo E., 1986). The intermediate organic clay formation having been deposited during a highstand sea-level, the climate prevailing at that time would have been basically warm and humid, comparable to the present.

Marine microplankton

The occurrence of dinoflagellates in Late Holocene mangrove deposits is variable along the west coast; in Coondapoor (Tissot, 1990), Dinoflagellate cysts are numerous (5 to 20.7% of the total palynomorphs; average: 12.3%) and are also common in Vembanad Lake, Kerala (work in progress). Yet dinoflagellate cysts have rarely been recorded in "Eemian" samples. Only some rare cysts of *Operculodinium* are present in Navunda samples. Hence, it seems necessary to take a climatic factor into account, viz., the rainfall regime, to explain the occurrence of dinoflagellates cysts in mangrove sediments.

The current monsoon regime with its alternation of a long dry season and a shorter rainy season enables the sea water to penetrate into the lagoons, permitting the growth of dinoflagellates. Thus the quasi-total absence of dinoflagellate cysts in "Eemian" sediments could be the consequence of a wetter climate with a greater supply of fresh water in the lagoon where the sea water-fresh water limit is pushed seawards. However, as seen above, we have no proof of such a wet climate. The low occurrence of marine microfossils could be explained by a more regular rainfall distribution during the course of the year and a less contrasted regime; in this case the lagoons may have been flooded with fresh or brackish water for a longer period than at present.

The oceanic core OSIRIS 77202

Lack of sufficient data on the last Interglacial in and around India (Williams, 1985) makes it difficult to place our results in a more general frame. A marine core taken off shore Oman, in the Indian Ocean (19° 13′ 3 N : 60° 40′ 9 E; 2427 m) was studied by means of the oxygen isotope ($^{18}O/^{16}O$) and palynology (E. Van Campo, 1983). From this the regional climatic evolution is known from about 150,000 years B.P. It has been emphasized that the climatic conditions of the Late Pleistocene were the wettest during the last Interglacial, centred around 125,000 years B.P. This period is marked by high values of the $^{18}O/^{16}O$ ratio and among palynological characteristics, by the dominance of humid pollen taxa, such as Cyperaceae, as well as a few *Rhizophora* resulting from the development of mangroves on the shorelines nearby; in this core, mangrove pollen were observed only twice; during this Interglacial and at about 10,000 years B.P. Such results are probably the consequence of a slightly wetter climate than to-day.

In the "Eemian" of Kanara, it is hard to state a wetter climate than at present from our palynological observations because Cyperaceae pollen, pteridophytic spores and fresh water algae, all considered as markers of humid conditions, are slightly more abundant during Late Holocene than during "Eemian".

The difference in the climate could be rather linked to the rainfall regime, the alternating seasons being less pronounced at that time.

CONCLUSION

No irrefutable argument can be advanced to state that the intermediate organic clay formation along the Kanara Coast was deposited at about 125,000 years B.P. However, the combination of facts assembled here, even with their hypothetical aspects, provides a result which may not be considered as accurate reference mark but constitutes an useful chronological guide for a period where hardly any information is available in this part of India. The comparison between "Eemian" and Late Holocene spectra in Kanara leads to remark that: (1) the floristic differences between the two periods are few; (2) regarding the general concept of humidity the "Eemian" climate was not quite distinct from Late Holocene conditions but it could present a difference in the regime with less pronounced alternating seasons.

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