

Palynoflora and radiocarbon dates of Holocene deposits of Dhamapur, Sindhudurg district, Maharashtra

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Radiocarbon dates of carbonized wood (2110 ± 80 yr BP) and oyster shells (7620 ± 110 yr BP) obtained from the sub-surface sediments of Dhamapur well fall within the Holocene period and the environments in which the above got deposited, might have been subjected to the sea-level oscillations of the past. The big oyster shells with barnacle growth, reminiscent of rocky intertidal environment, have shown to be related to *Saccostrea* sp. of Indo-West Pacific affinity. Presence of salt glands, presumably of mangrove plants, dinoflagellate cysts and organic-walled foraminiferal linings in the palynoflora assemblage infers that these elements must have been recruited from a shallow marine intertidal environment through creek channels. However, the carbonized wood materials and the palynoflora are essentially that of a lowland vegetation deposited in a freshwater facies. Further, larger proportion of pteridophytic spores, reflects a swampy and marshy habitat. The abundance of particulate organic matter (palynodebris), including various fungal elements suggests that the area had been under dense forest cover, receiving heavy precipitation with greater atmospheric moisture at the time of deposition.

THERE is very little information about the Late Quaternary vegetational history and palaeoecological aspects from the Maharashtra coastal region^{1,2}. The pollen analytical data of the Holocene sediments are also very scarce and only very few sketchy reports have been published³⁻⁵. We have yet to document the impact of sea-level and neotectonic activity that might have brought in climatic variations, which in turn affected the flora and fauna of the coastal ecosystem, despite the fact that Indian sub-continent has an extensive coastline with evidence for prehistoric cultures. There is a need to generate enough data on the Holocene sediments of the Indian coast in order to address problems related to climatic vicissitudes, as the low lying coastal regions and islands are threatened to be affected due to sea-level rise in the near future. While studying the coastal deposits of the Konkan coastal tract, the authors have come across sub-surface sediments excavated from a

well section in Dhamapur, which is the focus of attention of this communication.

The main objective of the present report is to highlight the details of palynoflora recovered from the carbonaceous clays and the radiocarbon dates of the carbonized wood and that of oysters obtained from the Dhamapur well section. The sampling location (lat. $16^{\circ}2'N$; long. $73^{\circ}36'E$) is in Dhamapur, situated at about 20 m above sea level and closer to the local Panchayat office. The location is approachable from Malvan along Chauke–Kudal route and is about 15 km inland from the sea-coast (Figure 1a and b). The samples were retrieved from a well that was drilled to a depth of 8.5 m for constructing a water tank. The well is located in a nearby stream flowing towards a small creek that eventually leads to Karli River. In fact, the site is closer to the lower reaches of Karli River.

The reconstructed lithologic column (Figure 1c) consists of black plastic clayey clay (1.25 m), dark grey clay with abundant oysters (4.75 m), black clay with bivalve shells and gastropods (0.75 m) and grey clay with carbonized wood fragments (1.00 m) from the base of the well to the top. The total vertical thickness of the lithologic sequence is about 8.5 m and the major portion of it is represented by dark grey clay containing fairly large oyster shells. Many of these oyster shells of *Saccostrea* sp. are found at a depth interval 6.00–7.25 m and some of them have barnacle growths and basalt pebbles attached to them. The clay varies from black clayey clay at the bottom to very fine silty clay towards the top. The topmost clay (0.75 m) is overlaid by lateritic soil. The samples used for radiometric dating, viz. carbonized wood material (1.75–2.00 m interval) and the oyster shells (7.00–7.25 m interval) have been shown in Figure 1c.

The carbonaceous clay samples were processed by conventional method of maceration using hydrofluoric acid (HF) and 40% nitric acid in order to separate the particulate organic materials, collectively known as palynodebris. The oyster shells and carbonized wood logs obtained from the well section have been used for radiocarbon dating. The ^{14}C age measurements on both oyster shells (BS 1475) and carbonized wood logs (BS 1487) recovered from the clayey layer were carried out at the Radiocarbon Laboratory at Birbal Sahni Institute of Palaeobotany, Lucknow using experimental procedure described elsewhere^{6,7}. The dates of samples were based on a half-life value 5570 ± 40 yr for ^{14}C . Examination of the recovered residue mounted on micro-slides shows abundance of palynodebris, including a rich assemblage of spores and pollen grains.

The palynoflora recorded from the subsurface sediments of Dhamapur well is heterogeneous and is mainly represented by the plant groups of pteridophytes and angiosperms. Abundance of fungal remains represented by hyphae, spores and fruiting bodies has been recovered

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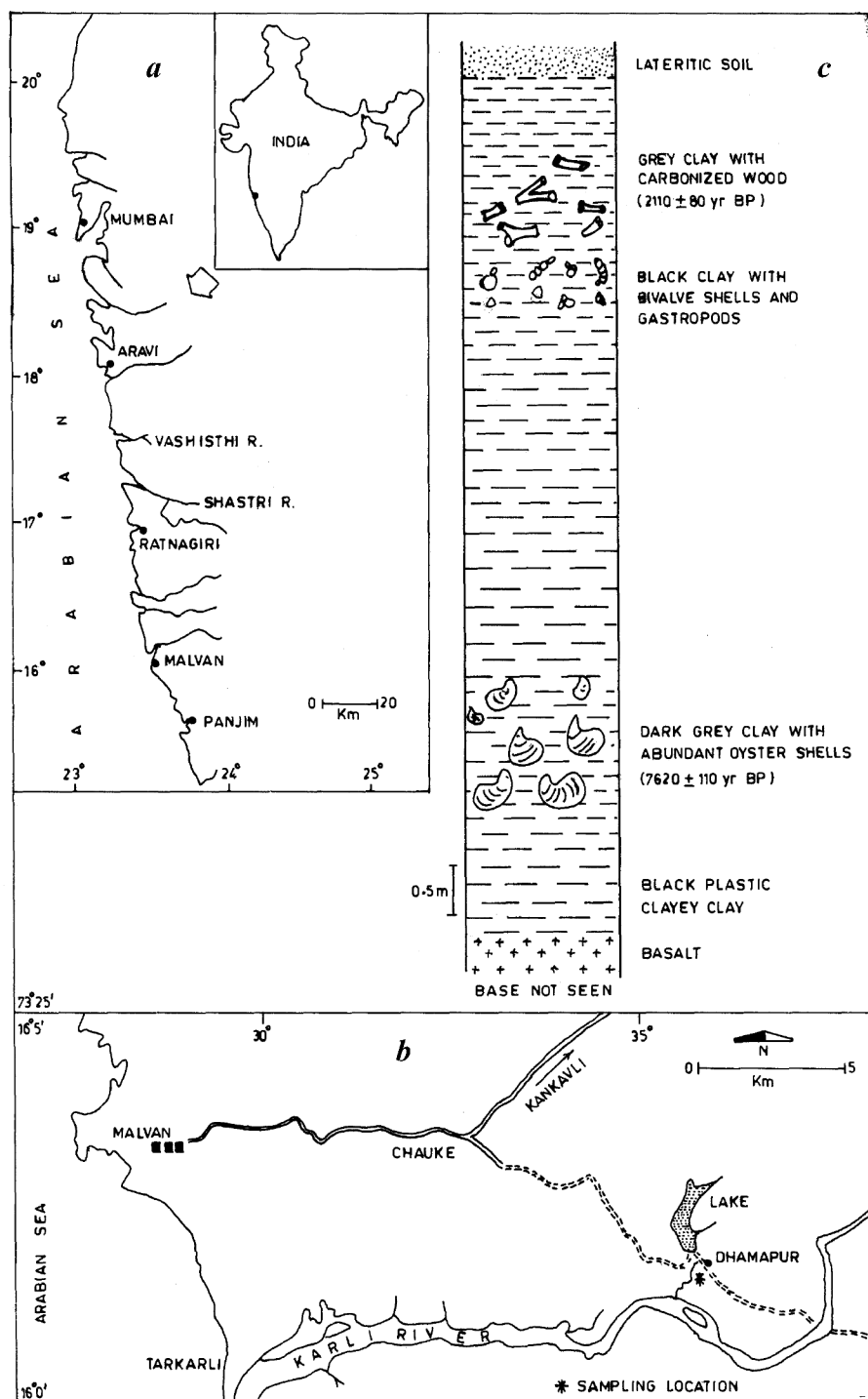


Figure 1. *a*, West coast of India showing Malvan; *b*, Location map showing Dhamapur and sampling site; *c*, Reconstructed lithosection of Dhamapur well.

ered from the clay samples. Salt glands, dinoflagellates and foraminiferal linings have also been observed in the assemblage. Woody materials, cuticles, amorphous materials and structured aqueous materials are well represented. The details of particulate organic materials and their significance from an environmental standpoint will be dealt separately elsewhere.

The palynoflora essentially constitutes that of a low-land vegetation. The pteridophytic spores identified are *Cyathidites australis*, *Gleicheniidites* sp., *Lycopodiumsporites*, *Crassoretitrites*, *Osmundacidites* sp., *Polypodiaceasporites* sp., *Pteridiacidites* sp., *Schizaeoisporites granditriatus* and *Striatrites susanae* sp. (Figure 2 *a-h*). These spores show affinity with

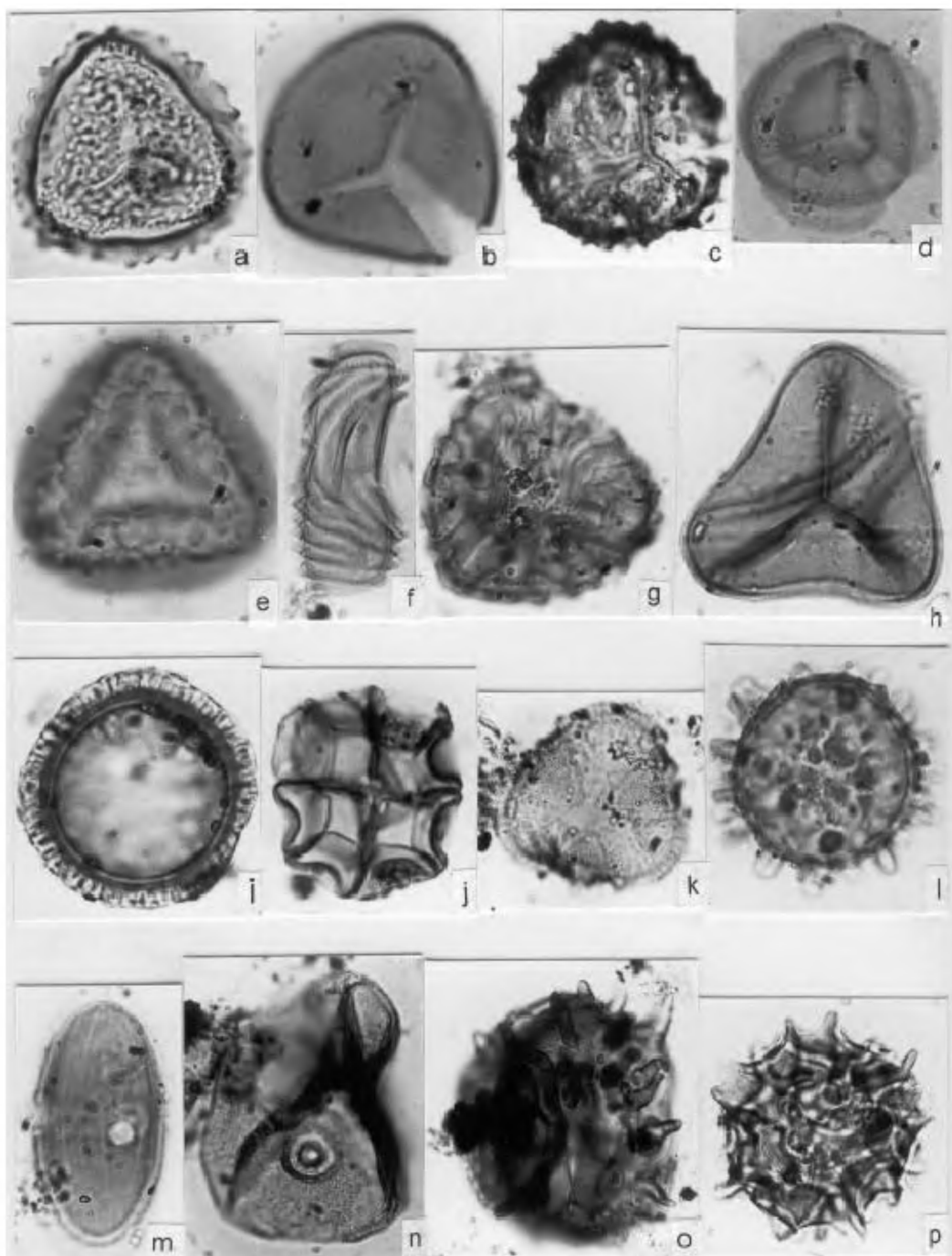


Figure 2. *a*, *Pteridacidites robustus*; *b*, *Cyathidites australis*; *c*, *Lycopodiumsporites* sp.; *d*, Tetrad of *Osmundacidites* sp.; *e*, *Pteridacidites* sp.; *f*, *Schizaeoisporites* sp.; *g*, *Crassoretitiletes* sp.; *h*, *Gleicheniidites* sp.; *i*, *Crotonipollis* sp.; *j*, *Polyadopollenites* sp.; *k*, *Bombacacidites* sp.; *l*, *Compositoipollenites conicus*; *m*, *Striacolporites* sp.; *n*, *Graminiidites* sp. (Poaceae); *o*, *Hibisceapollenites robustispinosus*; *p*, *Malvacidites spinosus*. All photographs are ca $\times 600$.

families of Cyatheaceae, Lycopodiaceae, Lygodiaceae, Osmundaceae, Polypodiaceae, Parkeriaceae, Schizaeaceae and Selaginellaceae. These families are suggestive of a freshwater swampy and marshy habitat, thriving under a thick canopy of forest cover, greater atmospheric moisture and increased stream activity during the time of their deposition in the sediments. The

characteristic angiosperm pollen recorded in the palynoflora include: *Bombacacidites* sp., *Borassus flabellifer*, *Crotonipollis* sp., *Compositoipollenites conicus*, *Graminiidites media*, *Hibisceapollenites robustispinosus*, *Malvacidites spinosus*, *Petalidium barlerioides*, *Polyadopollenites* sp., *Retistephanocolpites williamsii* and *Striacolporites* sp. (Figure 2 i–p). These

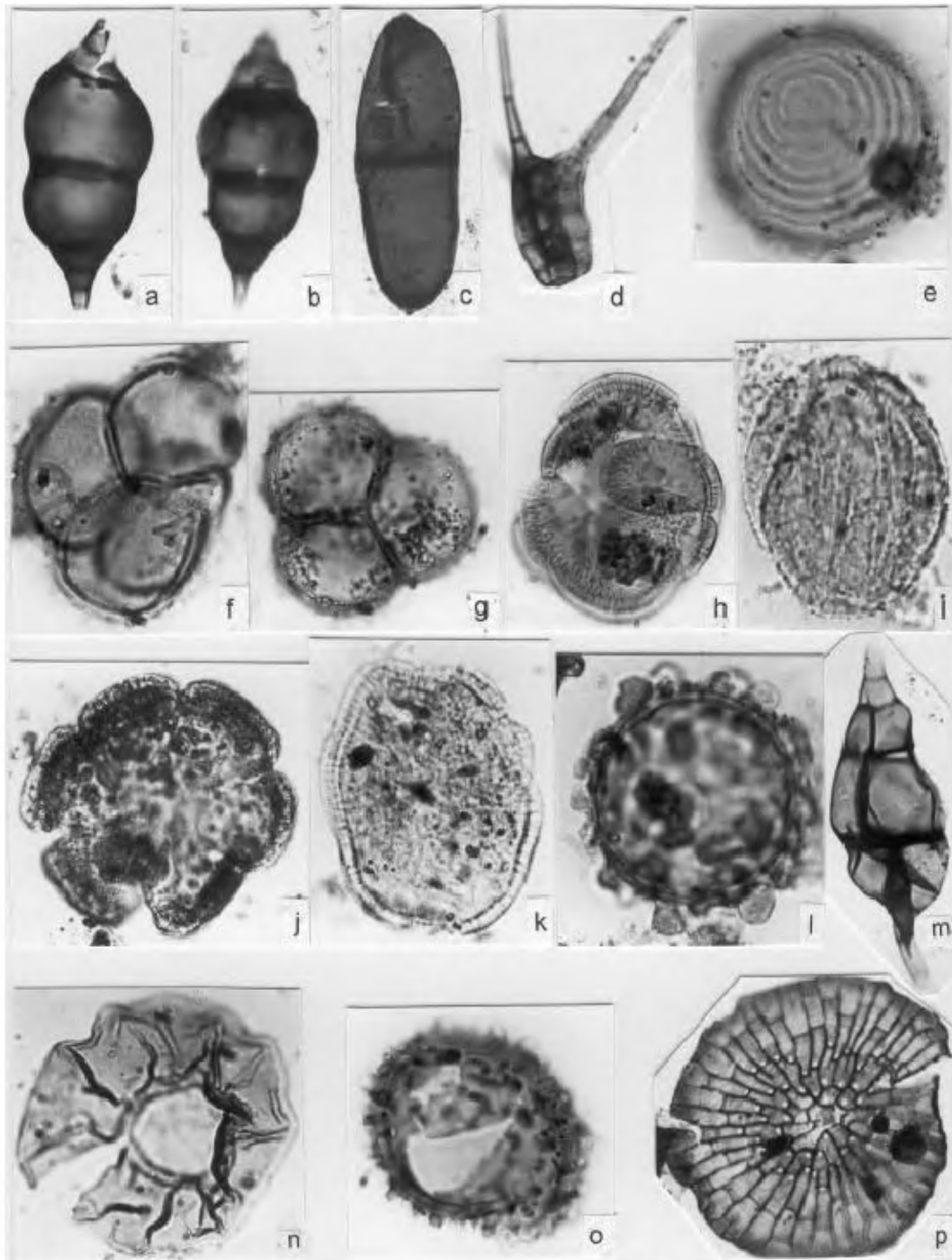


Figure 3. *a* and *b*, *Phragmospore* type; *c*, *Dyadosporonites* sp.; *d*, *Frasnacritetrus* sp.; *e*, *Chomotriletes* sp.; *f*, Pollen tetrad type; *g*, Pollen tetrad B (? *Droseraceae*); *h*, *Retistephanocolpites* sp.; *i*, *Petalidium barlerioides*; *j*, *Retistephanocolpites williamsii*; *k*, *Retistephanocolpites* sp.; *l*, *Verrualetes* sp.; *m*, *Dictycospore* sp.; *n*, *Pterospermopsis* sp.; *o*, *Asteraceae* pollen; *p*, *Phragmothyrites* sp. All photographs are ca $\times 600$.

pollen grains show affinity with families of *Acanthaceae*, *Arecaceae*, *Bombacaceae*, *Asteraceae*, *Euphorbiaceae*, *Fabaceae*, *Malvaceae* and *Poaceae* that are indicative of lowland vegetation.

The occurrence of salt glands (*Heliospermopsis* sp.), presumably of mangroves, dinoflagellates, viz. *Spiniferites* sp., cysts of *Pterospermopsis* sp. (Figure

3 *n*) and few organic-walled foraminiferal linings in the palynological assemblage suggests that they might have been recruited from a shallow marine intertidal environment through creek channels. The notable absence of foraminifera in the black clay samples indicates that the environment of deposition is away from any marine influence, even though the tidal waters were brought

into the site of deposition where the freshwater facies dominated, thereby affecting the salinity of environment, a crucial factor for the survival or preservation of foraminifera.

The abundance of pteridophytic spores with diverse morphological types along with a good number of pollen grains of lowland vegetation and various well-preserved types of fungal elements (Figure 3 *a-e, m, p.*) in the assemblage show that they were not subjected to long transportation and as such it is of an autochthonous type of deposition in a freshwater facies. Perfect preservation of woody materials, cuticles and other organic materials in abundance in the palynological assemblage

is indicative of source mainly from land which got deposited in a nearby environment. Larger number of fungal elements in the palynodebris indicates intense precipitation and greater humic conditions. The dominance of large number of pteridophytic spores, angiosperm pollen and various fungal elements suggests that the area had been under dense vegetational cover, receiving heavy precipitation along with greater atmospheric moisture at the time of deposition. Further, it is interesting to note that gyrogonite specimens of *Chara* have been observed in the organic residues. Since *Chara* inhabits brackish/lacustrine environment, it is envisaged that deposition of palynodebris of Dhamapur

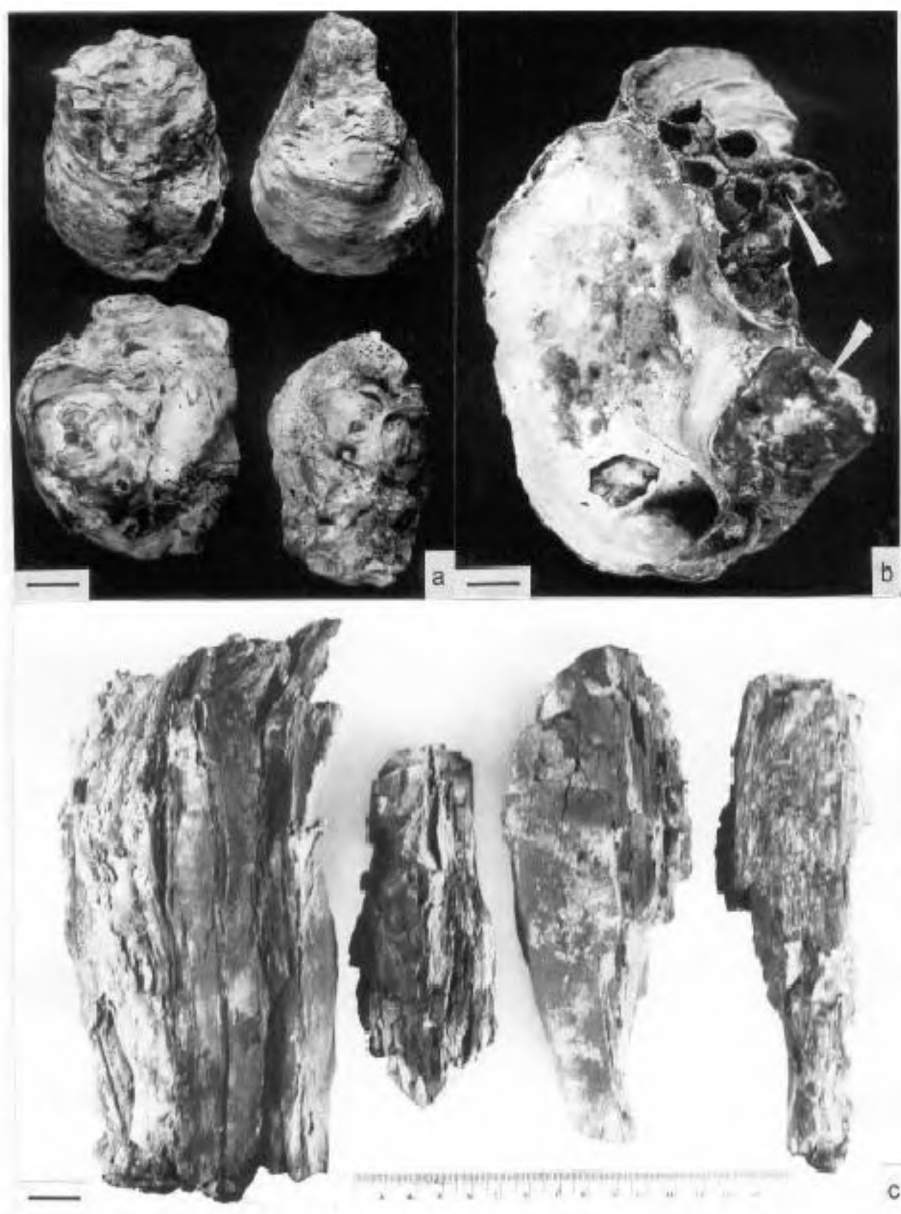


Figure 4. *a*, Shells of oyster resembling *Saccostrea* sp. used for ^{14}C dating (scale bar = 3 cm); *b*, Shell of oyster showing barnacle growth and basaltic pebble as indicated by the arrows (scale bar = 1 cm); *c*, Carbonized wood material recovered from the clay used for ^{14}C dating (scale bar = 2 cm).

well might have taken place in a lagoon or lake type of enclosed environment. However, such a scenario does not exist at present and this may be attributed to local tectonic adjustments resulting in ecological shifts and perhaps may be due to large-scale clearing and felling of the forest cover for land reclamation and agriculture practices in and around Dhamapur, since there has been corroborative evidence for man-land relationship in the environ of Malvan, particularly from the stream bed at Chowke Nullah ($16^{\circ}3'50''\text{N}$, $73^{\circ}35'30''\text{E}$)¹. This may be the reason for abundance of organic matter, including the carbonized wood at shallower depth in the Dhamapur well and perhaps elsewhere in the neighbourhood of Dhamapur, where such carbonized logs do occur, an observation noticed by the local inhabitants, while making trenches for canal and foundation pits for residential constructions.

It is significant to note that the ^{14}C dates of both the oyster shells and the carbonized wood obtained from the black clay of the well section fall under the coastal environment essentially associated with the Holocene events. Since the oyster specimens (Figure 4a and b) occupy and almost represent the basal part of the well section within the black plastic clay, it is presumed that they belong to the older depositional sediment as revealed by their ^{14}C age of 7620 ± 110 yr BP. These fairly large oyster shells must have been derived from the basaltic rocky shore, as some of them are being attached to basaltic pebbles and show barnacle growths (Figure 4b), indicating intertidal environment. Initial observations by a malacologist (Shirley Slack Smith, pers. commun.) suggest that these specimens could be of *Saccostrea* sp. showing Indo-West Pacific affinity. The accumulation of fairly large oyster shells and their occurrence in larger numbers in the section may be attributed to a palaeoflood kind of situation as a result of stormy weather, since the site of deposition had been closer to streams and creeks concentrated within the lower reaches of Karli River. Although there had been a rise in sea-level during the early Holocene period along the west coast of India⁸⁻¹⁰, it is premature to relate or conclude the occurrence of oyster shells to a transgression episode, as we need more data of such types from other parts of Maharashtra coast to substantiate the im-

pact of sea-level along the Konkan coast. Besides, bivalves, gastropods and other remains of marine invertebrates were found to be associated with some black clays much higher up in the section, but not obtained in sufficient quantity for radiometric dating. However, the carbonized wood (Figure 4c) does occur in abundance approximately at 2 m depth of the section and has been dated 2110 ± 80 yr BP, indicating that the area had been under good vegetational cover, as supported by palynoflora as well, until the recent past. More ^{14}C dates as well as close sampling of sections along the Maharashtra coast are needed in order to throw light on the impact of sea-level on the flora and fauna and change of coastline during the Holocene period.

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