

POLLEN ANALYSIS OF THE SALT FLAT AT MALVAN, GUJARAT

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ABSTRACT

The paper describes results of the pollen analytical investigations carried out at the 'ox-bow' lake adjoining the archaeological site at Malvan, Gujarat. The pollen sequence reveals the prevalence of open conditions with the vegetation consisting largely of grasses and Cheno-Amaranths, along with several other herbaceous elements. The presence of low percentages of high pollen producers, such as of *Holoptelea* and Myrtaceae suggests the occurrence of distant arboreal vegetation. Microforaminifera of the coiled and biserial forms have been found in abundance in most samples. Their absence at certain depths suggests the intermittent occurrence of estuarine conditions in the 'ox-bow' lake. The pollen sequence suggests hardly any change in climate.

The pollen grains of *Pinus*, *Cedrus*, *Alnus* and *Betula* were incorporated in the sediments due to long distance transport from Himalaya or Baluchistan either by sea or by wind.

INTRODUCTION

THE salt flat dissected by meandering drainage channels at Malvan (Lat. 27°07'N, Long. 72°42'E) is situated on the lower estuary of river Tapti, east of Dumas, District Surat, Gujarat State (Allchin & Joshi, 1970). Formerly it was an 'ox-bow' lake, more or less kidney-shaped and covering more than one square kilometre area. A cause-way recently built across the mouth of the basin to reclaim the land, restricts the entry of the tide, which today flows, up to a distance approximately half way between the mouth of creek and the mound at Malvan lying on the inner side of the salt flat. On the outer side of this mound, remains of Late Harappan to medieval cultures have been discovered by Allchin and Joshi (1970).

The local vegetation consists of mostly Acacias, *Aegle marmelos* and thorny bushes. A large Baobak tree (*Adansonia digitata*) also grows in the vicinity. The uncultivated banks are overgrown with grasses. Cotton, millets and *Sesamum* are grown in the area.

The western side of Surat District adjoining the Arabian Sea is devoid of forests

but towards the east moist deciduous and dry deciduous forests occur. These forests are constituted by *Terminalia tomentosa* (dominant), *Tectona grandis* (co-dominant), *Dalbergia latifolia*, *Ougeinia dalbergioides*, *Pterocarpus marsupium*, etc. The undergrowth comprises *Bauhinia racemosa*, *Acacia intsia*, bamboos and grasses. The important crops in the district are millets (jowar, bajra, ragi), rice, wheat, maize, and pulses (Anonymous, 1962)

A large number of the plant species distributed in this region is pollinated by insects, consequently their representation in the pollen rain is either nil or negligible. We have no positive knowledge of the composition of pollen rain at the site or in the region; in the light of preponderance of insect-pollinated species we expect the pollen rain to be too highly dominated by pollen of grasses to give a false representation of local vegetation.

POLLEN ANALYSES

The samples for pollen analysis were collected from the 'ox-bow' lake by Dr. F. R. Allchin and Mr. Cyrus Guzder. In all 34 samples collected at an interval of 5 cm from one of the pits (MVN-5), were sent for palynological investigations.

Each sample was first boiled with 10% potassium hydroxide solution for about five minutes in order to deflocculate the matrix. The material was then sieved and the residue examined for seeds, fruits and megascopic remains. The filtrate was kept in 40% hydrofluoric acid for a week to remove silica. After decanting off hydrofluoric acid, the material was washed with a few ccs of dilute hydrochloric acid (1 part acid +2 parts water) followed by 3-4 washings with water. The residue was then acetolysed following usual technique of Erdtman (1943) and the slides prepared in 50% glycerine.

About 150-300 pollen grains were counted per sample, and percentage of each were calculated in terms of total land plants pollen. Microforaminifera of Rotaloid and Rectilinear forms comprising loose-coiled, compact-coiled and biserial types have been found in abundance and their frequencies per sample are shown on the extreme right of the pollen diagram. The microforaminifera in samples barren in pollen grains were not counted: their presence is cited as moderate, abundant etc. in the pollen diagram.

The pit MVN-5, a profile from which has been pollen analysed, is about 1.7 m deep. Beneath the modern top soil light brown and dark brown clay extends down to 85 cm. This is followed by blackish and then brownish clay. No radiocarbon date is available for the pollen profile. There is a single C-14 date for the archaeological site excavated on the mound, and it dates one metre depth to 2750 ± 95 B.P. (TF-1084) i.e. 800 B.C. There are reasons to believe, unless evidence contrary to that is found that the development of the 'ox-bow' lake was contemporary with the cultural development at the mound. However, this does not permit us to extrapolate the date from the mound to the lake. The rates of sedimentation were obviously different at the mound and at the 'ox-bow' lake.

Vegetational Development

Text-fig. 1

The pollen diagram reveals considerable lack of arboreal pollen and depicts an open vegetation dominated by grasses and Chenopodiaceae. The lack of arboreal pollen derived from the upland is obviously due to prevalence of insect-pollinated species in the district. In view of estuarine environment the Chenopodiaceae pollen among pollen grains of Chenopodiaceae may be largely of local origin here. Owing to the presence of open conditions or poor representativity of local vegetation in pollen rain, the pollen rain has been influenced by pollen transported from long distances as evidenced by the recovery of pollen of *Pinus*, *Cedrus*, *Alnus*, *Betula* transported by wind from the Himalaya.

The pollen diagram shows predominance of Gramineae, suggesting the occurrence of vast open areas inhabited by grasses.

On the face value of the pollen diagram, it may be correct but considered together with the prevalence of insect pollinated species, this face value interpretation may be misleading. The other prominent curve is that of Chenopodiaceae, suggesting the occurrence of Chenopods perhaps characteristic of brackish water situations. In the lower half of the pollen diagram pollen grains of *Holoptelea*, and Myrtaceae seem to be comparatively better represented than in the upper half of the diagram. Both *Holoptelea* and members of Myrtaceae family are high pollen producers. The occurrence of their pollen about or under 5% suggests their transport from a distance in the vicinity, but their further reduced frequencies in the upper half of the diagram are indeed suggestive of their transport from a much longer distance. The upper half of the diagram is further characterized by increased values of Chenopodiaceae, slight increase in *Artemisia* and a corresponding decline in Gramineae. Towards the extreme top there is increase in Cyperaceae, slight decrease in Chenopodiaceae and appearance of spores of Ferns suggesting change in the composition of open vegetation. These three phases stand out prominently in the diagram and suggest recognizable changes in the open vegetation otherwise dominated by grasses. These three phases recognized here are designated as three stages.

'Stage a' comprising the lower half of the diagram; 'Stage c' the extreme top of the diagram; and 'Stage b' the upper half of the diagram below 'Stage c'.

Dominance of microforaminifera is seen in the lower and upper half of the diagram, but in the lower middle, extreme top and extreme bottom they are either rare or extremely poor in frequency. Their rarity or dominance is not correlatable with the fluctuations in the curves suggesting that the local edaphic situations either did not have any marked influence upon vegetation or else the pollen assemblage is derived from upland in the vicinity.

Potsherds have been found at varying depths in the sediments of the 'ox-bow' lake suggesting incorporation of sediments from the mound at Malvan. It has not been possible to detect which of the pollen grains might have been incorporated through the sediments derived from the mound.

Large-Sized Grass Pollen Grains

Attempts have been made to specially record the large-sized pollen grains of Gramineae in a separate curve under the Cerealia type. Pollen grains larger than 50 μ were not encountered. The Cerealia type pollen curve represents pollen grains ranging in size from 40 to 50 μ . Pollen grains of wheat, barley and rice fall within this range, but at the same time a large number of wild grasses such as *Pennisetum orientale*, *Brachypodium sylvaticum*, *Hordeum murinum*, *Agropyron repens*, *Imperata cylindrica*, *Saccharum* spp. and *Themeda triandra* have pollen falling within this size range (Vishnu-Mittre, 1973). The Cerealia type pollen grains could belong to the Cereals or to the wild grasses or to both.

The Cerealia type pollen curve starts from the base of the diagram and fluctuations in it are not correlatable with those of the other curves to suggest any clearance phase. And there is practically no indication of farming activity.

Long Distant Pollen Grains

The recovery of pollen grains of Himalayan spp., such as *Pinus*, *Cedrus*, *Alnus* and *Betula* is of considerable interest. The values are sporadic except that of *Alnus*, the values of which reach 10% just below 50 cm depth. These genera do not occur in south and central India though species of some of these were planted in some south Indian hills during the last hundred years. Their pollen has obviously been derived from Himalaya either through wind or water currents. The high values attained of *Alnus* below 35 and 75 cm in the pollen diagram is indeed very interesting.

Pollen grains of Himalayan species have earlier been recovered by Singh (1970) in pollen-analysis of Rajasthan lakes. One of us (Vishnu-Mittre, 1957) recovered Pine pollen grains in Archaeological sediments of Maski, Deccan and also in marshes bearing wild rice from Cuttack, Orissa (Vishnu-Mittre, unpublished). Pollen grains resembling *Abies/Picea* have been encountered during pollen analysis of mangroves in Bombay (Vishnu-Mittre and Guzder, 1971, 1975). Pollen grains of *Pinus*, *Betula* and *Alnus* the Himalayan elements in the

Rajasthan diagrams appear right from the base of diagrams dated to about 10,000 B.P. and unlike our diagram *Pinus* is the most frequent in the Rajasthan diagram than the other elements and its high values are attained about 6000 B.P., 4600 B.P. and 3000 B.P. (Singh, 1970; Singh *et al*, 197+).

Climatic Inference

Local estuarine conditions have prevailed for a long time except for some short intervals of time.

From the face value interpretation of the pollen sequence, it appears that open land conditions prevailed for a long time. Vast stretches of grassland existed. If the Chenopodians type is derived solely from Chenopodiaceae then there is evidence of increase in salinity in the soil during Stages 'b and c'. It may also reflect increased concentration of salt in the soil as a result of high evaporation/precipitation ratio. The Myrtaceae pollen curve in the lower half is, however, suggestive of occurrence of comparatively moister climate in the region though far from the site from which its pollen was derived. The climate during 'Stage a' was probably moist. During this stage the values of Chenopodiaceae are considerably reduced which on their own suggest a low evaporation/precipitation ratio. Extreme bottom samples tend to show higher values of Chenopodiaceae suggesting higher evaporation/precipitation ratio. The distribution of Chenopodiaceae may be due to local edaphic situation created by the influence of tides bringing in salt water.

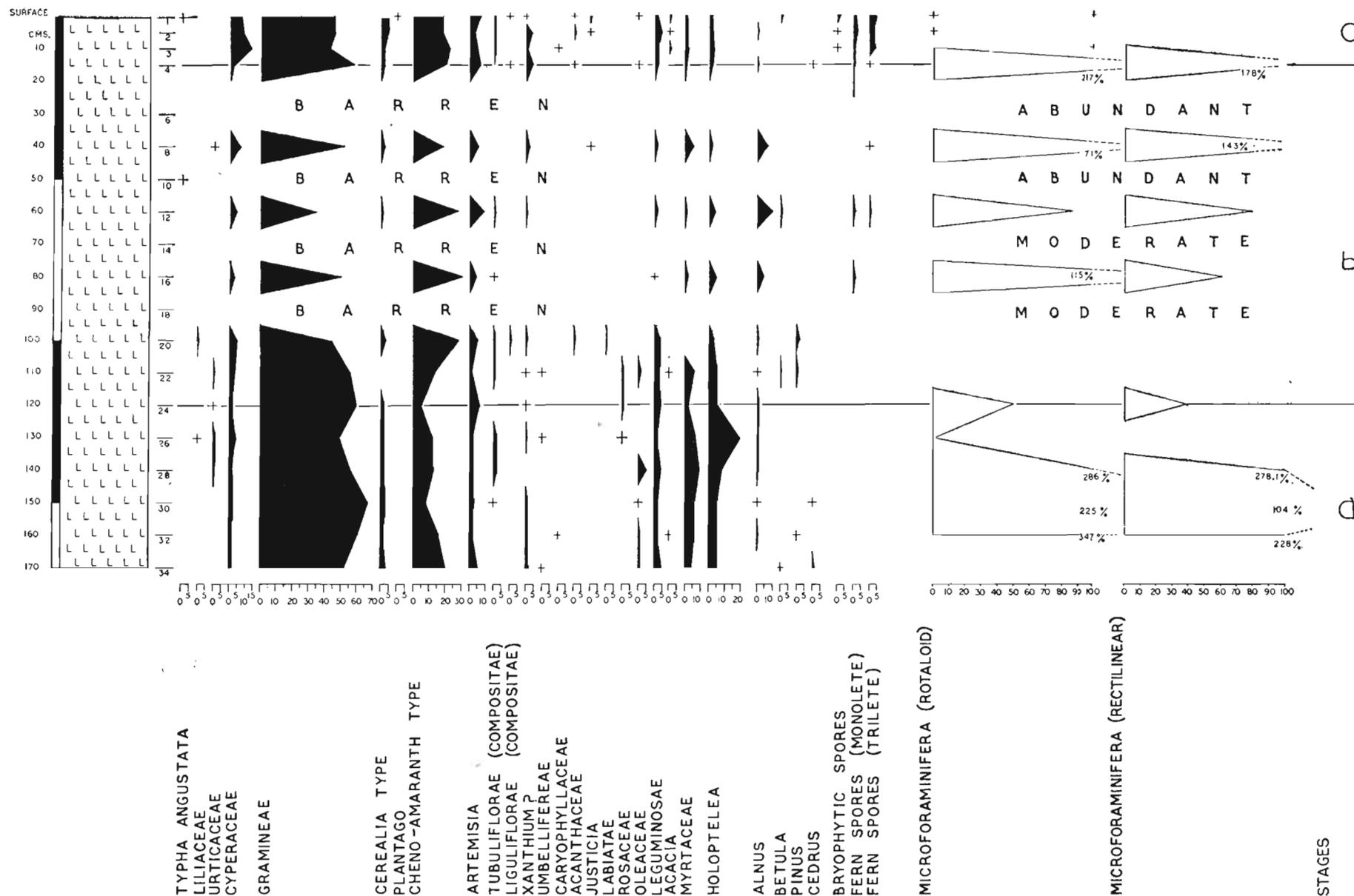
CONCLUSION

To support the above interpretation of the pollen diagram and inferences arrived at, we have no information of the modern pollen spectra in relation to modern vegetation in this area. The conclusions offered here can not be stretched any further. There is need to evaluate the extremely sporadic and poor frequencies of insect-pollinated species so as to properly assess their factual occurrence in the past. The polyads of *Acacia* suggest that acacias might have existed locally and in much greater frequency than represented in the

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TOTAL POLLEN DIAGRAM

PERCENTAGES CALCULATED IN TERMS OF TOTAL LAND PLANTS
 POLLEN EXCLUDING FERNS AND BRYOPHYTES



TEXT-FIG. 1 — Pollen diagram from Malvan, Gujarat.

diagram. The pollen of Leguminosae at the same time might indicate the occurrence of leguminous trees, which today are the constituents of deciduous forest in the Surat district.

The present aspect of open conditions dominated by Gramineae is due to lack of pollen of arboreal vegetation in this region. If due allowance is made for the pollen of insect-pollinated species in regard to their present distribution, and percentages of various kinds of pollen grains recalculated, the high values of Gramineae indicating open conditions will be considerably depressed. Thus, there is great need for detailed study of pollen content of modern surface samples in relation to present day vegetation.

The past environmental conditions interpreted do provide a background for the

evolution of human cultures unearthed at the mound at Malvan. It is highly desirable to date the pollen sequence through radio-carbon to precisely apply the information of environmental background to the cultural evolution at the site. The events of cessation of tidal influence as brought to light through pollen analysis must be dated and their significance properly assessed.

ACKNOWLEDGEMENT

We wish to express our thanks to Dr. F. R. Allchin, Cambridge University for kindly providing us the material for the present investigations and to Shri J. P. Joshi, Superintendent Archaeological Survey, Nagpur for supplying the stratigraphical details.

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