LATE QUATERNARY HISTORY OF THE GHOD VALLEY, MAHARASHTRA*

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ABSTRACT

The Ghod is one of the typical easterly flowing rivers from the upland parts of western Maharashtra. The river is more or less straight with a low sinuousity index and the drainage pattern is dendritic. The Quaternary formations are represented by alluvial fills, less than 20 m thick and 2 km in lateral extent. These fills have preserved at least three major cut and fill phases. On the basis of palaeontological evidence represented by *Elephas, Bos, Equus, Hexaprotodon*, cervids and carnivores, the earliest of the fill appears to be later than the older alluvium of central Narmada, which has been dated to Middle Pleistocene on palaeontological grounds. The most important palaeontological finding from the Ghod is that of the *Hexaprotodon*, being reported for the first time from the terrain, south of Godavari river A few ^{14}C dates of fresh water shells belonging to the family Uniodae from the fluvial gravel of the earliest fill indicate a late Pleistocene age, around 20,000 B.P. The presence of Early man during this period is confirmed by the occurrence of Middle/Upper Palaeolithic tools in the late Pleistocene alluvial gravels. The dominance of montmorillonitic clay mineral, the heavy calcification and the overall predominance of coarser facies in the Late Pleistocene alluvial fill suggest a semi-arid climate during this period. This is supported by the occurrence of a few pollen grains of *Acacia, Eugenia, Holoptelea* in organic rich clay bands around Inamgaon.

During the Early Holocene the Ghod was rejuvenated and the black soil developed on the terrace surface of the older alluvial fill. It is this black soil which was intelligently cultivated by early farmers about 3500 B.P. to produce wheat, barley, lentil, pea, horse-gram, wal (hyacinth bean). This first impact of human interference with nature was reflected in greater soil erosion and more wide spread floods by about 3300 B.P. The Late Quaternary history of the Ghod valley is thus closely associated with the cultural story of Early man

INTRODUCTION

The Quaternary history of the Indian subcontinent is closely linked with the history of rivers and fluvial morphology. Whether it is a study of fluctuations in the Himalayan glaciations or of lost drainage lines of the Thar desert or of cut and fill alluvial terraces of the Peninsular rivers or of the coastal marine terrace-like surfaces, the fluvial processes and morphology play a vital role in shaping the Quaternary landscape. The broad outline of Quaternary events in the sub-Himalayan parts of north-west India is well known because of the richness of their palaeontological material of fairly thick (1000 to 1300 m) Upper Siwalik fluvio-lacustrine deposits and also because of conspicuous development of the Late Pleistocene fluvial terraces of tectonoclimatic origin. Both the tectonic and climatic factors play a relatively less spectacular role in shaping the cut and fill terraces of the Peninsular rivers. Hence the Quaternary studies in the Deccan offer a challenging field of investigation to natural scientists, particularly geologists, palaeontologists and palaeobotanists.

In recent years, there have been some attempts of multidisciplinary studies of Quaternary formations of Central Narmada (KHATRI, 1966; SUPEKAR, 1968) and of the Upper

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Godavari (Joshi, Sali & Bopardikar, 1966; Corvinus, Rajaguru & Mujumdar, 1973; Tripathi, 1967) valleys. On the basis of these studies, the exposed alluvial deposits do not appear to be older than the Middle Pleistocene. In the absence of precise chrono- and bio-stratigraphy for the Late Pleistocene and Early Holocene alluvial fills, it is somewhat difficult to reconstruct the palaeoecology of this period. Almost total absence of pollen grains and spores in these oxidised alluvia and paucity of data on modern fluvial processes, the earlier palaeoclimatic interpretation of alluvial facies of post Middle Pleistocene age has been in most cases vague. It is against this background of present stage of research in Quaternary studies in the Peninsular India that our interdisciplinary investigations in a small valley of the Ghod, a tributary of the river Bhima, assume some importance.

The Ghod originates in the Western Ghats, about 75 km northwest of Poona and flows over Deccan Trap of Cretaceous-Eocene age almost in a straight course (Text-fig. 1) for a distance of about 160 km before its confluence with the Bhima. The drainage pattern is dendritic and the present course is confined to either low (<20 m) alluvial or rocky cliffs. The alluvial plain does not exceed 2 km in lateral extent on either bank and is discontinuous. There are well developed erosional surfaces at elevations of about 800 m, 750 m and 650 m in the valley and the major part of the present course of the Ghod is confined to 650 m and 600-650 m erosional plains. The major knick point in the form of a gorge has developed a little downstream of the Chinchni Dam.

The Ghod valley shows distinct changes in vegetation and soil from west to east, mainly due to marked change in rainfall. The source region in the Western Ghats receives 5000 mm of rainfall during four monsoon months (June-September) and is covered by semi-lateritic pedalfer type reddish soils which nourish semi-evergreen to wet deciduous forests. The rainfall drops to about 750 mm within 70 km away from the source. The soils in this low rainfall zone are pedocal type black soils or vertisols. The vegetation is dry deciduous to thorn and scrub type in typical semi-arid parts (with a mean annual rainfall of less than 500 mm) downstream of Kalamb.

An attempt has been made in this area to study the surface exposures of alluvial formations particularly around Inamgaon where our Institute has conducted detailed horizontal excavations of a Chalcolithic site (Sankalia, Ansari & Dhavalikar, 1971).

OBSERVATIONS ON QUATERNARY FORMATIONS

The Quaternary formations which are predominantly fluvial in origin rest unconformably on the Deccan Trap (Text-Fig. 2). They can be formally subdivided into the following major litho-units (from bottom to top):

(1) Coarser gravels with subfacies of bouldery pebbly gravel and sandy pebbly gravel.
(2) Finer sands, silts and clays.
(3) Palaeosol represented by vertisol type of black soil.

Coarse Gravels

The gravels vary in thickness from about a meter to about 5 m and range in elevation above the modern bed from 0.5 m to 14 m with a common elevation of 2 to 3 m. Generally they occur within a distance of 0.5 km from the modern channel of the Ghod.

(a) Colluvial gravels—They are common in the upper reaches of the Ghod between Shinoli and Ghodegaon, within first 70 km from the source. Predominant litho-

components are amygdaloidal, compact, porphyritic and brecciated basalts, varieties of chalcedony, zeolite and quartz. Most of these rocks are locally derived from the surrounding outcrops in the valley. The gravels are poorly consolidated in a sandy silty matrix by microcrystalline calcite.

The gravels are subangular to subrounded. These are dominated by pebbles, transported by rolling motion over the channel bed under short lived turbulent flow of water. Extremely poor sorting and crude stratification of these gravels indicate their deposition by ephemeral streams. These observations are further supported by the frequent interfingering of these gravels with finer silts and sands. The colluvial gravels pass imperceptibly into alluvial deposits exposed on the banks of the Ghod at many places between Shinoli and Ghodegaon. So far these formations have not yielded any palaeontological and cultural material.

(b) Alluvial gravels—These gravels are better developed in the lower reaches of the Ghod between Sangvi and Sirsagaon than in the middle and upper parts of the valley. This unusual phenomenon of the occurrence of these coarser gravels is mainly due to the steeper gradient of the Ghod downstream of Chinchni dam-site and also due to higher rate of physical disintegration of the rolling plateaux of compact basalts, exposed in the area. The alluvial gravels can be separated into bouldery pebbly gravel and sandy, pebbly gravel. Both the varieties are dominated by compact basalt, dolerite, zeolite and different types of chalcedony. These pebbles are subrounded to rounded and seem to have been dominantly moved by the rolling motion of transport under upper part of turbulent flow regime. Crude stratification, absence of imbrication, poor sorting and grading and the lenticular form of bouldery, pebbly gravels, suggest their deposition either as a channel bar or a braid bar. Low angle bedding in these gravels is due to migration of bars with a low channelward dipping slopes. High angle planar cross stratification is not common in the bouldery gravel while interlayering with silts and sands is common around Inamgaon.

On the other hand sandy pebbly gravels are well sorted, graded and show strong planar cross stratification. These gravels seem to have been deposited either as a point or channel bar under upper part of the turbulent flow regime. Absence of ripple marks in these gravels also confirms this mode of deposition.

Briefly, both the varieties of alluvial gravels seem to have been transported as 'short burst' eroded from one place and deposited little downstream. Occurrence of red tachytitic basalt pebbles in gravels exposed around Inamgaon clearly indicates the transportation of these pebbles for a distance of at least 70 km, as these rocks occur only around Sirur.

The limonitic and manganiferous coating on the surface of these gravels and the overlying carbonacious clay bands (as at Inamgaon) or an unoxidised greyish sandy clay (as at Sirur and Kalamb) speak of the existence of pools in and around gravel bars. On the whole these gravels are moderately consolidated by calcitic cements but they are extremely well cemented around Sirur. These gravels have yielded slightly rolled fossil bones of mammals like *Elephas*, *Equus*, *Bos*, *Bubalus*, *Cervus*, *Hexaprotodon*, etc. at Kalamb, Chandoli, Khadki, Chinchni, Sirasgaon, and Inamgaon. Large number of molluscan shells have been collected from sandy, pebbly gravels at various places such as Annapur (18°51′:74°18′), Chinchni and Inamgaon. The shells belonging to *Unio* sp. have been found in the sandy, pebbly gravel exposed 1 km upstream from Inamgaon. They have been dated to about 20,000 B. P. by 14_C method (Agrawal & Kusumgar, 1975). Only a few Middle

Palaeolithic scrapers and flakes made on chalcedony were collected from these gravels at Inamgaon.

Finer sands, silts and clays

This group forms the most conspicuous litho-unit in the Ghod valley. The thickness of this unit varies from about 5 m to 10 m around Ghodegaon and it extends laterally to a maximum of about 2 km on either bank of the Ghod. The top surface forms a distinct depositional terrace in this area. Intergrading of the finer unit with the coarser gravelly unit is common throughout the valley, particularly around Inamgaon and Ghodegaon.

(a) Finer sands—They are composed of basaltic and zeolitic constituents and are moderate to well cemented by crypto-crystalline calcite. They are well sorted, at times finely laminated and generally occur as lenticular bodies in the finer alluvium. Thinness of laminae (< 5 cm), alternations with silty and clayey bands (as observed near Inamgaon and Sirur) and the presence of ripple marks suggest their deposition under low energy turbulent flow conditions.

(b) Silty sands, sandy silts and clayey silts—This unit varies in thickness from about 10 m around Inamgaon to 15 m at Ghodegaon. On the basis of colour and degree of kankarisation, following subfacies can be recognised:

(I) Yellowish brown (10 YR 5/4) to brown (10 YR 5/3) moderate to well calcreted (with $CaCo_3$ percentage varying from 5 to 20%) silty sands or sandy silts.

(II) Reddish brown (5 YR5/4) weak to moderately calcreted sandy silts or silty sands.

(III) Brown (10 YR5/3) to dark brown (10 YR 4/5) weak to moderately calcreted sandy silts or silty sands.

Chemical and mineralogical characters (Text-fig. 3)—But for the silts deposited in the very source region, all the above mentioned subfacies are moderate to strongly alkaline (pH varying from 7 to 8.5). The organic matter is low ($\sim 1\%$). Silica sesquioxide ratio is between 3 to 6 thereby indicating non lateritic weathering conditions in the source region of the sediments.

Reddish brown silts contain weathered calcic felspar, altered zeolites and opaque minerals. They are dominated by montmorillonite and illite type of clay minerals. Brown and dark brown silts show more or less similar mineralogical composition. Yellowish brown silts contain considerable proportion of fresh to slightly altered calcic felspars and traces of altered augite in addition to minerals mentioned above It is thus clear that the yellowish silts are less weathered than brownish and reddish brown silts.

Textural characters and nature of bedding—These silts are either sandy silts or silty sands and are partly laminated. The thin horizontal lamination is observed locally in yellowish brown silt around Inamgaon. The alternations between organic rich ($\sim 2\%$) dark brown silty clay bands with coarse sand laminae are well preserved in the basal part of the yellowish brown silt exposed 2 km upstream of Inamgaon. The horizontal lamination is more common in brown to dark brown moderately calcreted silt than in the strongly calcreted one.

Mode of deposition of finer silts—These silts have been essentially deposited as monsoon flood deposits in low energy environment during the waining stages of the floods. The frequent occurrence of gravelly lenticular bodies in association with them suggests

deposition of silts either on the abondoned surface of the braid bar or in the pools commonlyobserved in a braided river. There are pockets of carbonate rich clays (~25 to 30%) around Inamgaon. The high carbonate content suggests precipitation in standing waters, primarily through inorganic agencies. Absence of pyrite stains in their clayey formations indicates abundant water with a non acidic oxidising environment. Presence of desication cracks, relatively low content of organic matter and the general brownish colour of silts indicate periodic drying of the silt surface. This post depositional oxidising environment also explains rarity of pollen grains and spores in them.

Biological and cultural contents—Interestingly, from the excavations carried out by one of us (GLB: 1975) in the yellowish brown silty sands exposed just on the opposite bank of the Chalcolithic habitational mound at Inamgaon, some unrolled mammalian fossil bones (Pl. 1, Fig. 2) have been found along with a few unrolled chalcedony blades of the Upper (?) Palaeolithic cultural phase. The organic rich dark brown silty clay bands at Inamgaon has yielded a few pollen grains of *Acacia*, *Eugenia*, and abundance of *Holoptelea* (pers. comm. VISHNU MITTRE).

PALAEOSOLS

By and large, weathered horizons are not observed in the alluvial formations of the Ghod valley thereby suggesting a fairly rapid deposition without much time gap in two successive periods. The most conspicuous palaeosol is developed on brownish silt and is buried under Chalcolithic habitational mound at Chandoli and Inamgaon. The soil is about 1.5 m thick, dark brown (10 YR 4/5) in colour and contains organic matter varying from 1 to 2%. The crumb or coarse prismatic structure is developed in the soil. The illuvial horizon at a depth of about 1 m is characterised by fine powdery carbonate and brownish colour. The distinction between illuvial horzion and the parent material, which is alluvial silt, is extremely difficult to make out. Mineralogically the soil is characterised by highly altered calcic felspar, zeolite, quartz and opaque iron minerals. Montmorillonite is the most dominant clay mineral present. It is distinctly alkaline. High silica sesquioxide ratio indicates minimum leaching soil-environment.

Pedologically this soil can be classed as 'vertisol' and indicates semi-arid environment characterised by short wet and long dry periods. It is this vertisol, popularly known as "Black Soil" which was cultivated by early farmers of the Ghod valley, some 3600 B.P.

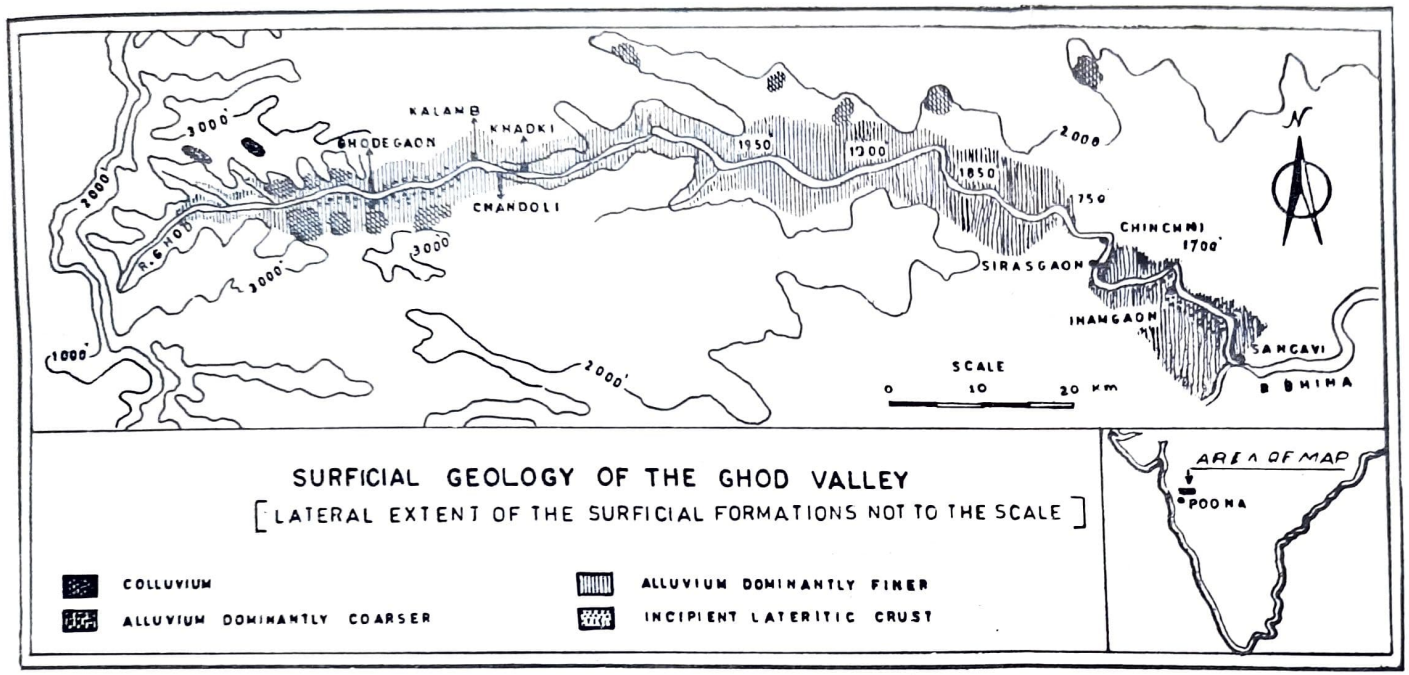
INTERPRETATION OF THE EVIDENCE

CHRONOLOGY

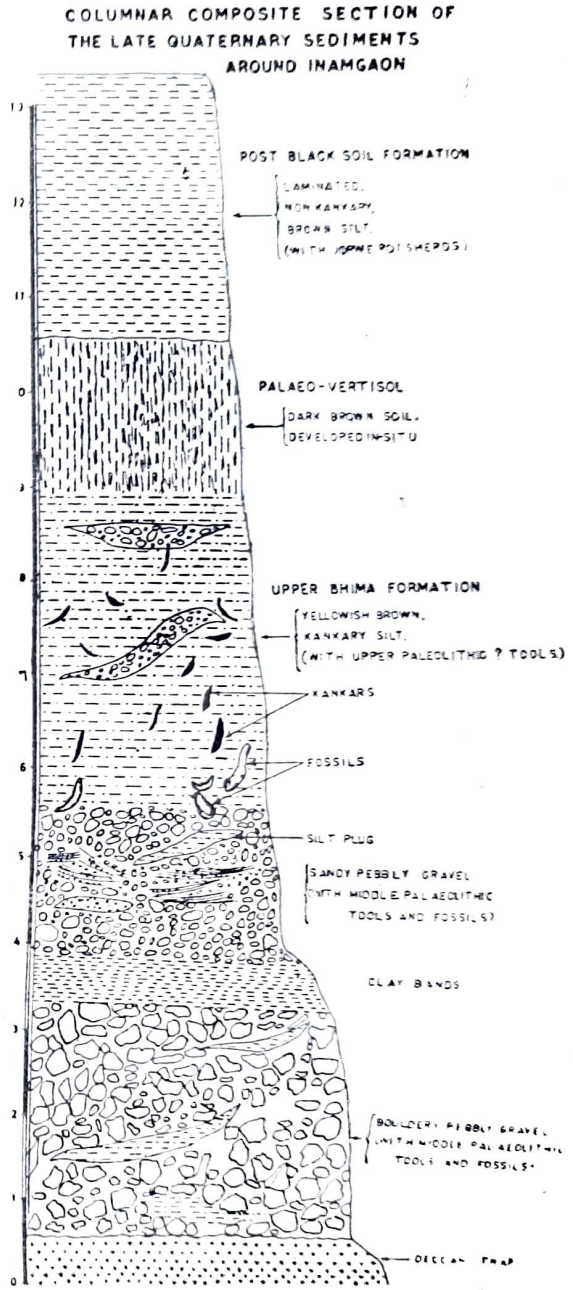
For the first time in western Maharashtra, lithostratigraphic evidence has been well integrated with biostratigraphic and chronostratigraphic data. The lithostratigraphy is based on field relationships of alluvial fills and their mineralogical properties. The geomorphic evolution of the Ghod valley during the Quaternary can briefly be reconstructed as follows:

(1) The Ghod carved its valley bottom almost upto or slightly below the present bed level, during the earlier part of Quaternary, which is not well represented by any datable sedimentary formation.

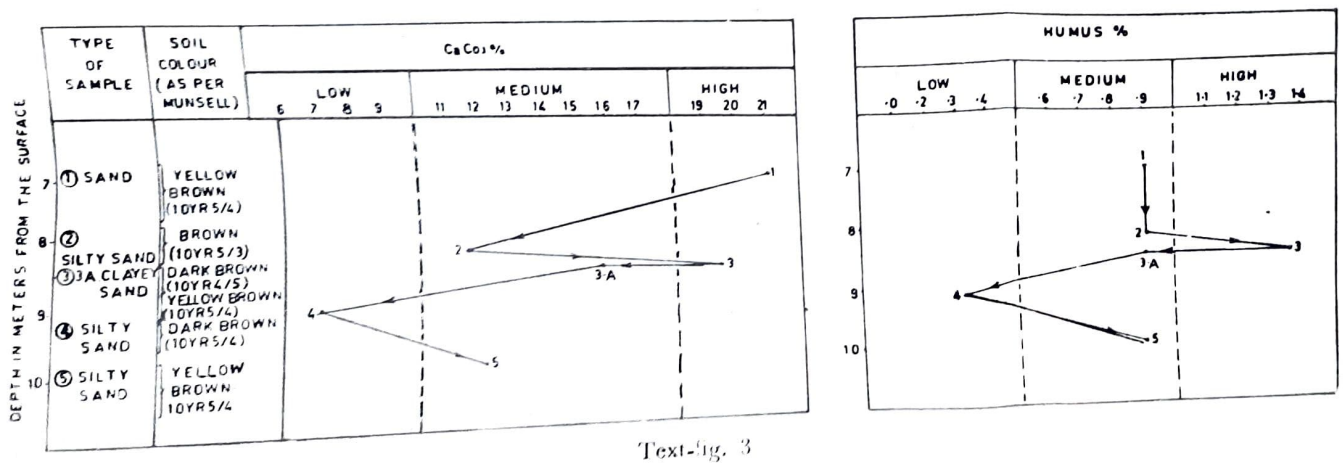
(2) There is a distinct phase of large scale alluviation during the later Quaternary. The alluvial facies associated with this phase are coarser in the lower part



Text-fig. 1



Text-fig. 2



Text-fig. 3

and predominantly characterised by channel and near channel environment. The colluvial and alluvial processes are dominated in the upper and lower reaches of the valley respectively. The facies of this phase are well calcreted and moderately weathered. The top surface of this unit has formed a distinct terrace surface (18 to 20 m high) in the valley. The whole process of valley alluviation was discontinuous, probably with minor erosive phases, difficult to be ascertained at this stage. The lithounit belonging to this later Quaternary alluviation phase has been designated as "Upper Bhima Formation" because of the occurrence of more or less similar alluival formations in the adjacent valleys of Mula-Mutha, Bhima, Nira, etc. in western Maharashtra (RAJAGURU, 1970).

(3) The major alluviation phase, represented by the "Upper Bhima Formation" is followed by a strong rejuvenation phase, during which the Ghod attained its present bed level. This downcutting phase was an interrupted one as is indicated by minor alluviation phase represented by dominantly finer brownish, less kankary, better laminated alluvium. The top surface of this alluvium forms an inset terrace (5 to 8 m high) cut into the "Upper Bhima Formation". This alluvial unit has been designated here as "Post Black Soil Formation".

On the basis of the above geomorphic features it is clear that the "Upper Bhima Formation" and the "Post Black Soil Formation" are the earliest and latest litho-stratigraphic units respectively. These rock units are separated by a palaeosol of vertisol type.

BIOSTRATIGRAPHY OF QUATERNARY FORMATIONS

Most of the animal fossil bones collected from the "Upper Bhima Formation" (Pl. 1, Fig. 1) are fragmentary but complete jaws, isolated teeth and complete limb bones are not uncommon. On the basis of morphological studies of the fossils made by one of us (GLB) the following important species have been identified: *Hexaprotodon palaeindicus*, (BADAM & KAJALE, 1975), *Equus namadicus*, *Elephas*, *Bos*, *Bubalus*, *Cervus*, etc. *Hexaprotodon palaeindicus* is represented by a well preserved left mandibular ramus (Pl. 1, Fig 3) with well developed 2nd and 3rd molars. This species was hitherto known from the Central Narmada alluvial formations and the Godavari valley of the Mid-Pleistocene and Late Pleistocene age respectively. The Ghodfind is characterised by a short mandibular symphysis and square jaw, while *Hexaprotodon namadicus* (of the Narmada deposits) has an elongated mandibular symphsis. The Ghod find is little older than the modern African type *Hippopotamus amphibius* which has only 4 sub-equal incisors. *Hexaprotodon palaeindicus* is therefore, younger than the Middle Pleistocene Narmada species and older than the modern African variety.

Another important find is that of *Equus namadicus*, which is characterised by sharp crenulations in the enamel borders of the fossettes of teeth indicating a highly evolved form of horse. The morphological characters of these and other fossils thus show that the "Upper Bhima Formation" is definitely later than the Mid-Pleistocene Narmada alluvium and earlier than the early Holocene Kurnool cave breccias as studied by MURTY (1974).

The morphological changes from Middle to Late Pleistocene have taken place mainly due to natural conditions whereas those from Late Pleistocene to Holocene have been motivated by domestication (BADAM, 1974). Some of the animals like elephant, cattle, sheep, goat, horse, etc. were intimately associated with man since Mesolithic times.

It will be of interest to see whether the changes on account of domestication are reflected in these animals. Such changes may throw some light on the rates of evolution of these animals from Pleistocene to present day—a study that has not been undertaken in India so far.

Chronostratigraphy of Quaternary Formations

Two 14_C dates (around 20,000 B. P.) of fresh water molluscan shells from the middle portion of the "Upper Bhima Formation" place it in the later Pleistocene. In the light of some more 14_C dates of alluvial formations, from other river valleys in Maharashtra having more or less similar mineralogical and morphological characters, the dating of the "Upper Bhima Formation" to later Pleistocene is within the expected range,

The palaeosol separating the "Upper Bhima Formation" and the "Post Black Soil Formation" is certainly older than 3600 B.P. as this soil is buried under well dated Chalcolithic habitational debris. Thus the "Post Black Soil Formation" is of Mid Holocene age.

ENVIRONMENT

Almost near absence of pollen grains and spores, the wide adaptibility of mammals and the poor knowledge of modern fluvial processes in monsoonic tropical climate make the palaeoclimatic interpretation of the Late Quaternary formations of the Ghod valley difficult. Our attempt to reconstruct the Quaternary palaeoclimate is,therefore, tentative.

Late Pleistocene Environment

Predominantly coarser nature of the fluvial deposits, interfingering of colluvial deposits with alluvial formations, the dominance of rolling motion of transport for the pebbles during floods and the occurrence of fluvial deposits even in lower (2nd and 3rd) order streams or nalas, indicate that there was an intensive denudation in upland and alluviation along the entire length and breadth of the valley. This valley aggradation was possibly due to accelerated fluvial activity and stronger as well as more frequent monsoonal floods. Increase in fluvial activity can be explained in terms of some change in precipitational regime in the entire valley. Dominance of montmorillonitic clay in the fluvial deposits, presence of kankars and caliche layers in the deposits exposed downstream of Ghodegaon and the brownish colour of the observed sediments almost throughout the valley suggest that the climate was semi-arid like that of today in the major part of the Ghod valley. In other words, the precipitational pattern was more or less like that of today in the entire valley. The source region in the Western Ghats was an area of higher precipitation and the rainshadow parts of the valley were regimes with low monsoonal rainfalls. The accelerated fluvial activity during the Late Pleistocene only suggests that the flood amplitude and velocity was higher than that of today, due to increased frequency of short and strong spells of monsoons almost throughout the valley. It is, however, difficult to say at this stage whether the mean annual rainfall figures were higher than that of today. The Late Pleistocene alluviation period is categorised here as a phase of more floods in the valley.

During the valley alluviation phase the channel shifting was more frequent than today. The aggradation in the valley possibly raised soil moisture due to rise in water table. Naturally the valley slopes and terraces must have been covered by better vegetation. It is this closely vegetated flats that attracted herbivorous mammals like elephants, horses and

bovids. Local pools and swamps associated with the braided channels provided ideal environment for hippopotamus. Early man, who was making blades and flake tools from locally available veins and pebbles of chalcedony, possibly made the best use of this ideal environment during the Late Pleistocene. More or less similar environment existed in other parts of western Maharashtra during this period (RAJAGURU, 1973).

EARLY MIDDLE HOLOCENE ENVIRONMENT

Owing to decrease in sediment load as a result of lesser floods in the entire valley, the Ghod straightened its thalweg and started downcutting, leaving the Late Pleistocene aggradational surface for pedogenic weathering. The top surface of the "Upper Bhima Formation" weathered into fairly matured vertisol. The pedological characters only indicate a period of geomorphic stability during the Early Holocene. The higher proportion of organic matter and better development of soil profile, than that is observed in modern black soil of this region, possibly indicate greater age of the vertisol and better vegetational cover. Whether a more mature Early Holocene vertisol is indicative of slightly higher rainfall, as argued by MUJUMDAR AND RAJAGURU (1965) or it is suggestive of only better soil climate (RAJAGURU, 1970) are difficult propositions to be tested at this stage of our knowledge of pedogenesis in semi-arid parts of the Deccan. This clay rich moisture retaining black soil attracted the early food producers to settle in the Ghod valley by about 1600 B.C. They produced wheat, barley, lentil, hyacinth, bean (wal), horsegram, pea, etc. (KAJALE, 1974) by cultivating black soil (DHAVALIKAR, 1972). It is this first impact of human interference with the nature that was strongly felt in the entire valley by 1300 B.C.

The minor alluviation phase representing "Post Black Soil Formation" is dominantly finer in texture and confined only to the Ghod and to some of its higher order tributaries. This alluviation was in response to floods of the Ghod and the tributaries having their catchments in higher rainfall zone of the Western Ghats. In contrast to the Late Pleistocene, tributaries from the semi-arid parts were almost defunct and contributed very little sediment load. This linear fluvial activity is essentially similar to the modern flood regime of the Ghod, excepting that it was more intense than today. As the overall evidence, palaeobotanical, palaeontological and geomorphological, does not suggest any significant departures from the present climate in the Ghod, the reasons for such accelerated linear fluvial activity during the Mid-Holocene, are to be searched in factors other than the climate.

Cultivation and the pressure of live-stock grazing during the Chalcolithic times might have marked the first serious impact on ecosystem and disturbed the delicate balance amongst vegetational cover, soil mantle and the water runoff. Owing to disturbance in ecosystem by human interference since 1600 B.C. till about 1300 B.C., the rate of soil erosion might have been accelerated and the Ghod was possibly overloaded with finer sediment loads. In order to adjust its hydrological characters, the Ghod developed a smaller width/depth ratio, low gradient and higher and wider floodplains. Naturally the Ghod increased the flood danger to the Chalcolithic habitation of Inamgaon by about 1300 B.C. The Early Jorwe people from Inamgaon intelligently harnessed these changed local hydrological conditions by constructing a guide bund and diversionary channel. They stored the flood waters in the channel and probably used it for growing winter crops such as wheat, barley, lentil, pea, etc. (Pl. 2, Figs. 4 to 11).

This aggradational phase probably did not last long. The Ghod assumed its present rejuvenated course sometimes in the Early Historic times, as some of the Late Historic sites have been located on the flood plains belonging to the modern course.

CONCLUSIONS

Our interdisciplinary studies have shown that the fluvial formations exposed in the Ghod valley are not earlier than the Late Pleistocene. The accelerated fluvial activity and general valley alluviation characterised the Late Pleistocene period while the limited fluvial activity and the rejuvenation of the drainage system predominated during the Early and Late Holocene. Slightly accelerated fluvial activity marked the limited alluviation phase of the Mid Holocene. Palaeontological and palaeobotanical data and the general mineral characters of the fluvial deposits do not suggest significant departures during the Quaternary from the present semi-arid monsoonic climate. The change in the flood regime of the Ghod suggests some fluctuations in the climate particularly in rainfall patterns as the features observed in the Ghod valley are of regional significance. At present the exact interpretation of these geomorphic features is not possible in view of the complexity of the problem, because different changes in different areas can lead to identical results and also because the events are not precisely documented.

Possibly for the first time in this part of the country we have tried to focus the attention on the role of man in changing the natural ecosystem. Such palaeoenvironmental studies are particularly vital as they may help in understanding the modern environmental problems in proper perspective of man-land relationships.

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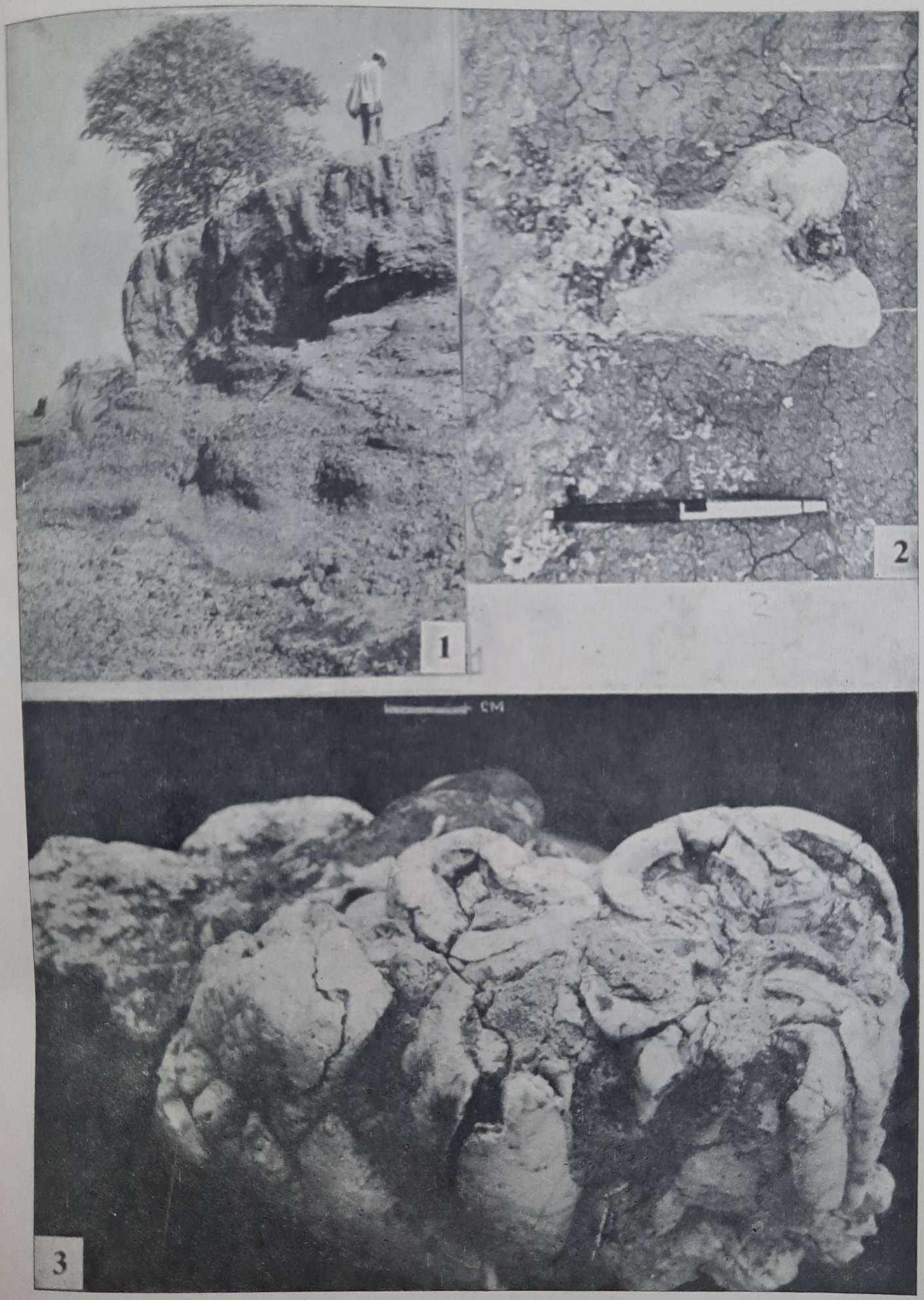
EXPLANATION OF PLATES

PLATE 1

1. "Upper Bhima Formation" showing locality (Inamgaon) of fossil Hippopotamus.
2. *In situ* fossil bone from yellowish brown silt at Inamgaon.
3. Part of lower jaw of *Hexaprotodon palaeindicus*.

PLATE 2

4 Grains of barley. ×2
5 Grains of barley with base of awn. ×2.5
6 Grains of rice. ×5
7. Grains of wheat, dorsal view. ×5
8. Grains of wheat, ventral view. ×5
9. Grain of horse-gram, side view. ×6
10. Grains of horse-gram, top view, showing hylum scar. ×6
11. Grains of lentil. ×2.5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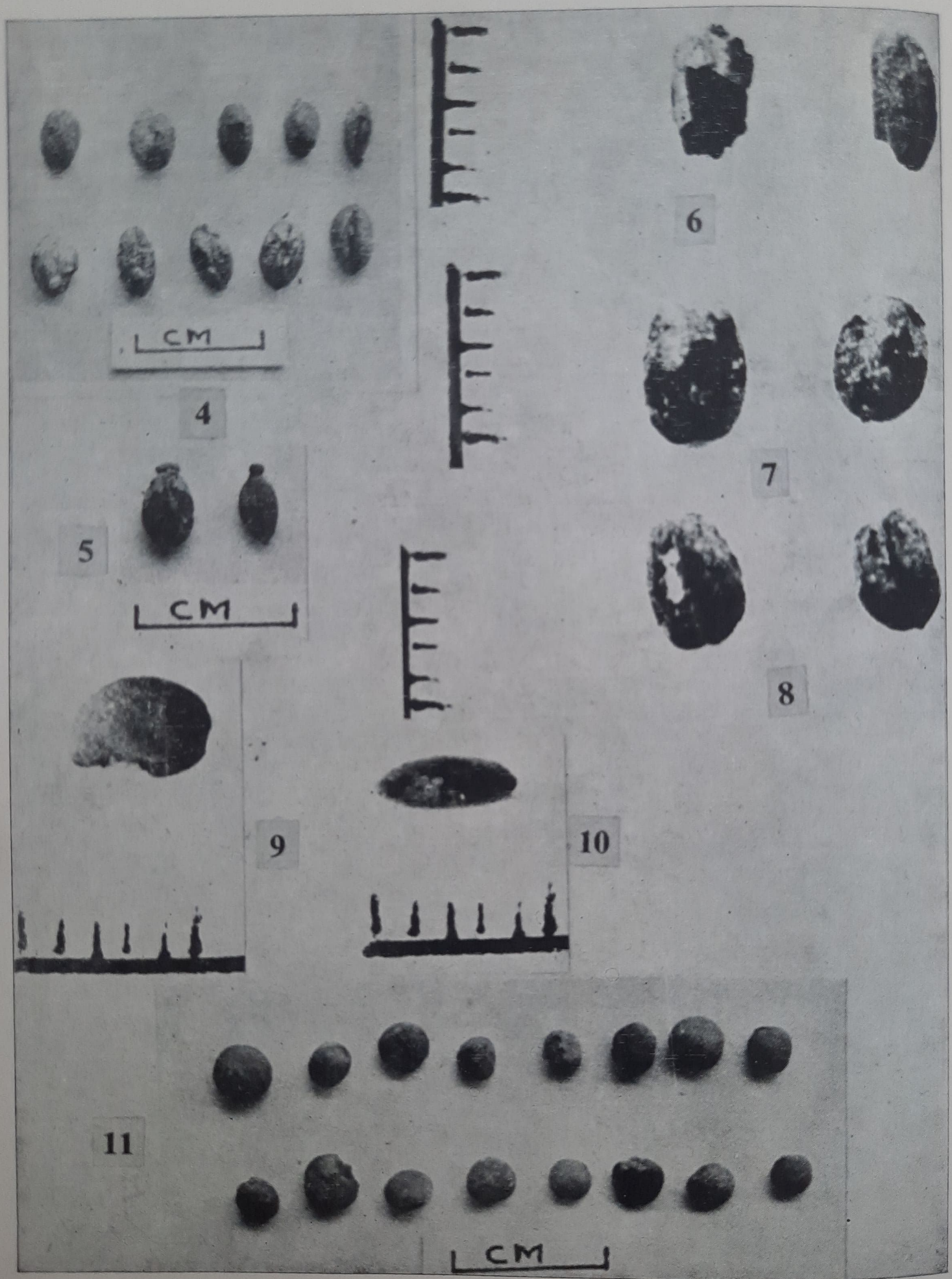

Kajale *et al.*—Plate 2