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Early Farming at Lahuradewa

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ABSTRACT

This paper embodies an outcome of investigations emanated from the excavations carried out at the lakeside settlement of Lahuradewa, from 2001 to 2006, in district Sant Kabirnagar, Uttar Pradesh, India. The continuous occurrence of micro-charcoal in the lakebeds justifiably mitigate the human activities that persistently set fire to the vegetation in the area during past *ca.* 10,000 years. Palynological studies from lakebeds helped in reconstruction of vegetational history, sequential changes in the climate and early agricultural activities from early Holocene and onwards in Middle Ganga Plain. The human groups at that early date, who subjected the vegetation to fire for environmental management, were those who brought into being a settled early farming culture at Lahuradewa – characterised by cord-impressed pottery. Primordially, the record of domesticated rice in the opening phase of Lahuradewa settlement, prima facie constitutes the evidence of early Holocene agriculture in Middle Ganga Plain.

Introduction

The outcome of the Archaeological and Palynological investigations, carried out at Lahuradewa (district Sant Kabirnagar (U.P.), India between 2001-2006, were presented in the 'International Seminar on the First Farmers in Global Perspective' at Lucknow in January 2006. On the basis of the consistent presence of microcharcoal in the nearby lake sediments, human activity was considered to be going on in this area since 10,000 yrs BP; while carbonised grains of domesticated rice datable to mid ninth millennium BP in the archaeological excavations, was another important feature of the Lahuradewa site. Apart from that cultural sequence of the site, geomorphological features along with pollen and phytolith studies in the adjacent lake profile were also elaborated. These presentations generated a lot of discussion amongst the delegates during the Seminar, and in the field trip to Lahuradewa as well. In the meantime, the continued investigations at Lahuradewa have revealed additional evidence after January 2006, which have attested our earlier conclusions and provided new insight regarding the early farming cultures of this site. First and second sections of this paper outline in brief the results of the investigations so far carried out. Discussion on relevant issues and conclusions follows in the third and fourth sections respectively.

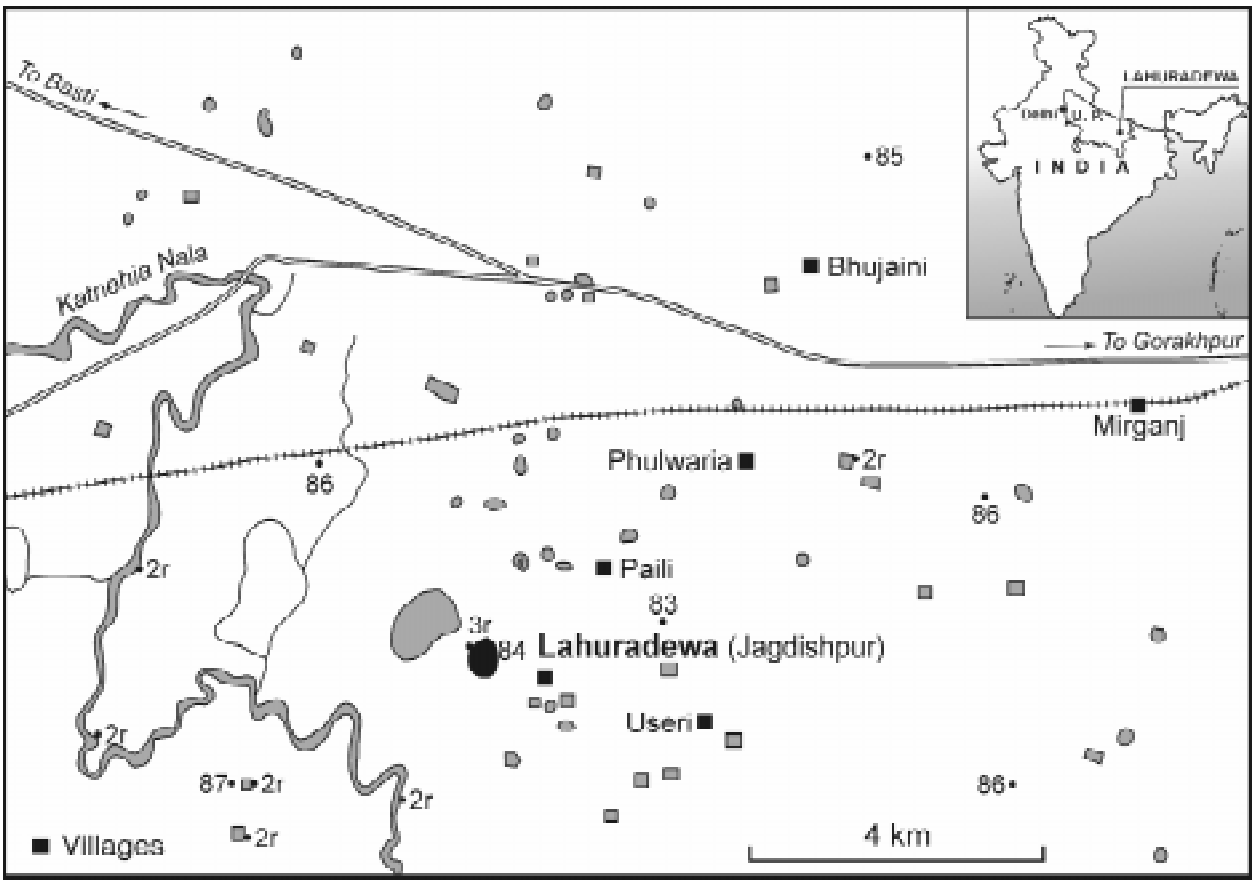


Fig.1. Location of Lahuradewa, southwest of Gorakhpur and northeast to Katnehia drainage

Lahuradewa (Lat. 26^0 46' N; Long. 82^0 57' E) is located in Sant Kabir Nagar District, in Sarayupar (Trans-Sarayu) region of the Middle Ganga Plain (Fig.**1**). The sarayupar Plain is bounded by the Sarayu River in the west and south, Nepalese *Terai* in the north and the Gandak River in the east. The first significant archaeological excavations at a protohistoric site in this region was carried out at Sohgaura, at the confluence of the Rapti and the Ami Rivers during early sixties, by the University of Gorakhpur.[1] This excavation revealed a pre-chalcolithic early farming phase represented by the cord impressed pottery. On the basis of stratigraphic considerations this phase was placed in 3rd-millennium BC. Quite a good number of sites in this area were subjected to archaeological excavations in the subsequent period, namely Chirand,[2] Chechar Kutubpur,[3] Khairadih,[4] Imlidih Khurd,[5] Dhuriapar,[6] and Waina.[7] However, the problem of absolute dating of this cultural phase with cord impressed pottery could not be resolved with certainty. With an objective to address this problem and other related aspects an extensive exploration in the region ultimately led us to the ancient site of Lahuradewa (also spelt as Lohra Dewa and Lahuradeva) surrounded by a lake from three sides. This site was brought to light by Krishnanand Tripathi, a resident of Lahuradewa Village. It was reported by Chaturvedi[8] and subsequently its archaeological potential was also assessed and reassessed by other scholars.[9] We selected Lahuradewa for systematic excavations after examining the surface finds to assess its cultural potentiality.

With an objective of multidisciplinary approach in the investigations, the experts were included from the Directorate of Archaeology, Government of Uttar Pradesh; Birbal Sahni Institute of Palaeobotany (BSIP), Lucknow; Department of Geology, University of Lucknow; University of Erlangen-Nuremberg; and the Deccan College, Pune. Two-fold investigation involved the archaeological excavations at the site, and the palaeobotanical and sedimentological studies in the adjoining lakebeds.

I

Archaeological Excavations at Lahuradewa: Status at the time of Seminar in Jan. 2006

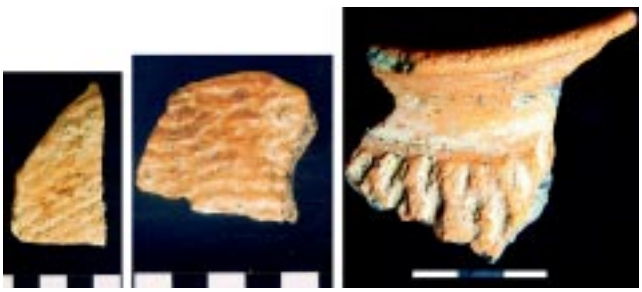
By the time of Seminar the excavations at Lahuradewa had completed almost four seasons: 2001-02, 2002-03, 2004-05, 2005-06. First Preliminary Report on this work was published in 2003.[10] Significant results had also been published and presented in different Seminars.[11]

(A) Excavations

In order to probe the cultural sequence a good number of trenches measuring 10 x 10 m were laid down at different locations. The excavations revealed about 4.00 m thick habitation deposit representing the five-fold cultural sequence. Their representative finds and radiocarbon dates available till January 2006 are shown in Table 1. The culture related to Period I (*ca.* 7th - 2nd millennia BC) represented by about 1.20 m thick deposit had been designated as Early Farming. On the basis of the nature of deposits, cultural material and the coherent radiocarbon dates it is further divided into two sub-periods, IA and IB. Periods II and III had been designated to represent Developed Farming Phase and Advanced Farming Phase, respectively. Period IV correspond to well known NBPW phase. Period V represents the cultures from post-NBPW to Gupta times. This paper is aimed to discuss only the Early Farming Phase, i.e. Period I.

About 45-50 cm thick sediments of **sub-period IA** composed of clayey sand and *kankar* nodules. Radiocarbon dates on the carbonized remains collected from the deposits of this sub-period ranged between *ca.* 7th millennium BC to the beginning of 3rd millennium BC. Remains of rammed clay-floors, burnt clay chunks bearing reed impressions and post-holes, collectively indicated that the settlers of this period erected circular or oval huts using wooden posts and having reed-screens plastered with clay. An irregular channel (drain), traced in length of about 12 m, connecting two large and deep depressions (ditches), is a notable structure in this sub-period. It is dug through the lowest layer and the natural soil. The channel is 30-50 cm broad and about 50-60 cm deep.

Hand made coarse variety of red and Black-and-Red wares, often with cord impressions on their exterior surface, are the characteristic pottery of sub-period IA (Figs. **2-4**). Incised decoration and fine red slip on some of the potsherds are also found. Water vessels, pedestal and knobbed bowls, sometimes decorated with applied rope-pattern, are the important shapes, in the ceramic assemblage of this sub-period.



Figs. 2, 3,4: Potsherds of coarse variety corded ware, Period IA, Lahuradewa

Table 1 : Radiocarbon dates from Lahuradewa, district Sant Kabir Nagar (U.P.)

Cultural Periods	Important features	14C dates BC/ BP
Period IA	Presence of domesticated and wild rice along with foxtail grass and job's tear, and a few other wild taxa; red and Black-and-Red wares often bearing corded patterns; Steatite beads in upper levels.	BS-2145: cal. BC 3090 (2916) 2879; BS-2148: cal. BC 3363 (3328, 3323, 3174, 3159, 3119, 3106, 3105) 3020; BS-2151: cal. BC 3654 (3635, 3553, 3542) 3382; BS-1951: cal. BC 4220, 4196, 4161; BS-1967: cal. BC 5298; ERL-6442: cal. BC 6442-6376 (AMS);
Period IB	Introduction of copper artefacts, cultivated barley, wheat and lentil. Continuation of red and Black-and-Red wares often bearing corded patterns, a few paintings and incised designs; Slipped pottery. Inclusion of pedestal bowl and dish or bowl-on-stand. Steatite beads and domesticated and wild *rice* continued.	BS-1950: cal. BC 2135 (2078) 2056; BS-2274: cal. BC 2919 (2700) 2570; ERL-6903: cal. BC 2345 (2273) 2200 (AMS)
Period II	Marked by the appearance of earthen bins, enhanced quantity of painted and plain black slipped and Black-and-Red wares, steatite beads, dish-on-stand, bowl-on-stand, pedestal bowl.	BS-1938: cal. BC 1519 (1435) 1399; BS-2150: cal. BC 2012 (1884) 1750;
Period III	Continuity of earlier cultural assemblage and introduction of Iron	BS-1939: cal. BC 1205 (1205) 1188
Period IV	Painted/Plain Northern Black Polished Ware etc.	
Period V	Red ware and brick structures	

K.S. Saraswat studied the carbonized plant remains collected systematically by water-sieving. The presence of carbonized grains of wild or weedy and domesticated rice (*Oryza rufipogon* and *Oryza sativa*) were the most important finds of this period A. husk-clot of domesticated rice was dated to 6,409 BC (ER-6,442: cal. BP 8,359 yr) by AMS method. Remains of foxtail-millet (*Setaria* cf. *glauca*), goose-foot / *bathua* (*Chenopodium album*), job's tear (*Coix lachryma-jobi*), Artemis (*Artemisia* sp.), flatsedge (*Cyperus* sp.) and catchfly (*Silene conoidea*) had also been recovered (Figs.**5, 6**).

The important **associated cultural components** of sub-period IA included a few lithic artefacts. One of the lithic-components, a sand stone piece, seemingly from the Himalayan foot-hills, and the other one, a small flake appearing to be from Vindhyan hills are

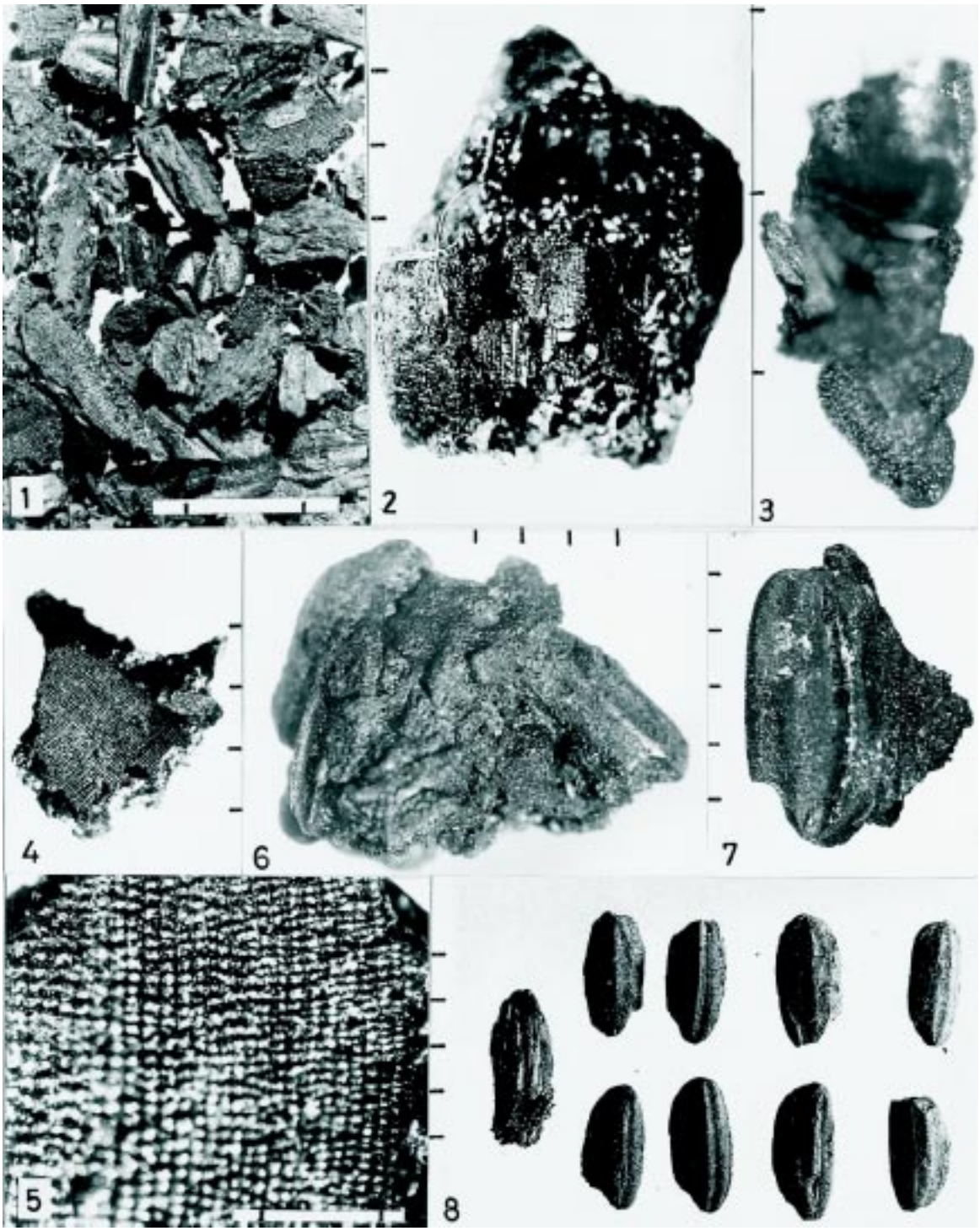


Fig.5. Period IA, Lahuradewa - 1. Remains of rice-husk in the charcoal pieces from bottom layer; 2. A clot of husk comparable to that of domesticated rice (*Oryza sativa*); 3. Rachis unfastened from the rice-husk clot in Fig. 2; 4-5. Husk fragment showing surface-tissue ornamentation alike to domesticated rice; 6. Five grains of domesticated rice congealed in a carbonised lump; 7. A grain of domesticated rice from the deepest layer in a trench; 8. Domesticated rice (*Oryza sativa*) grains. Scale in mm. (After K.S. Saraswat).

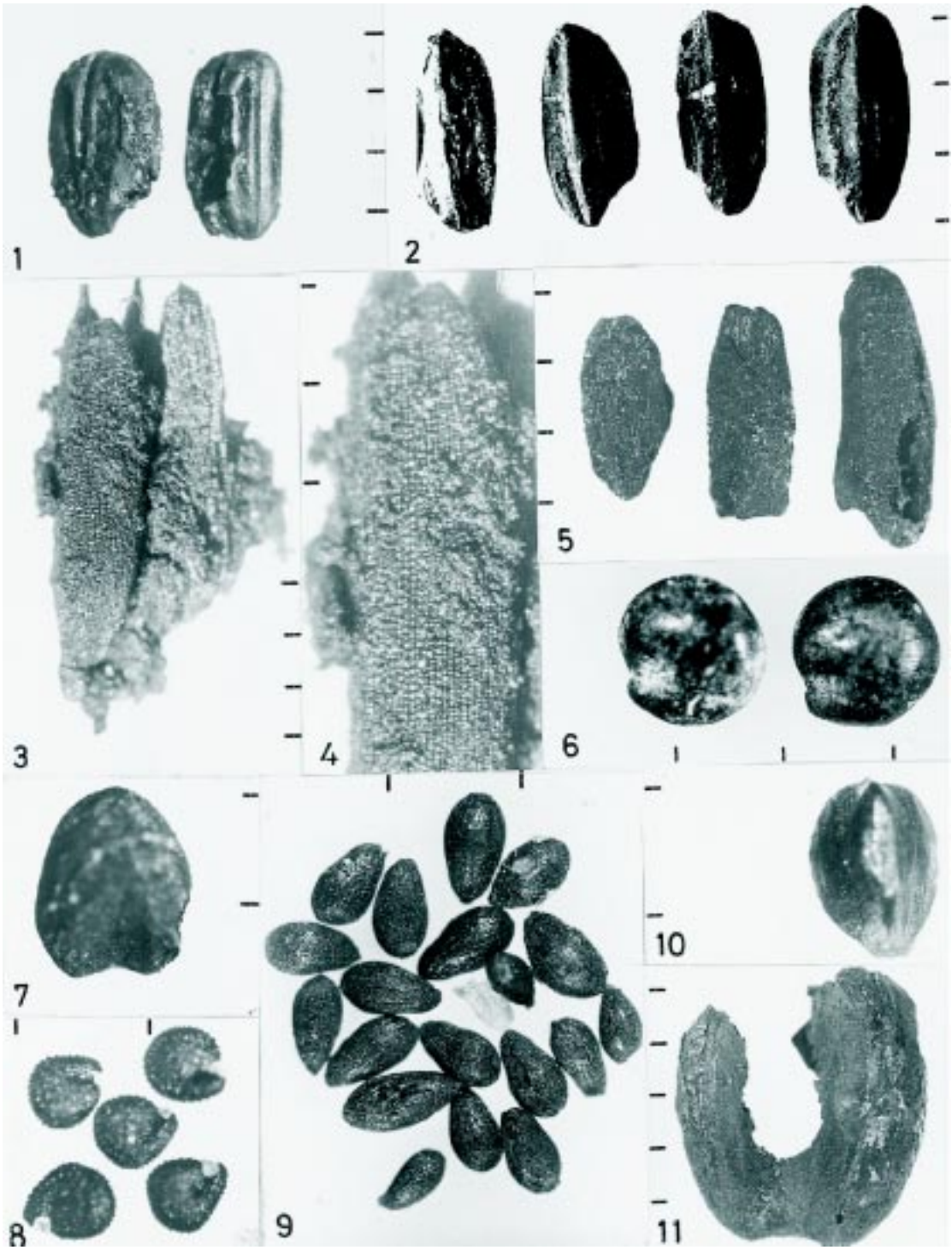


Fig.6. Period IA, Lahuradewa: 1. Grains of domesticated rice with puffing during carbonization; 2. Domesticated-rice grains; 3. Caryposis of wild or weedy rice - *Oryza rufipogon;* 4. Husk-surface tissue of *Oryza rufipogon*; 5. Grains of *Oryza rufipogon;* 6. Goosefoot (*Chenopodium album*) seeds; 7. Foxtail-millet (*Setaria* cf. *glauca*); 8. Catchfly (*Silene conoidea*); 9. Mugwart (*Artemisia* sp.) nuts; 10. Flatsedge (*Cyperus* sp.) nut; 11. Job's-tear (*Coix lachryma-jobi*) grain. Scale in mm. (After K.S. Saraswat).

significant to deduce their exploitation from distant northern and southern regions.

Sub-period IB represented by a cultural deposit ranging between 50-60 cm in thickness. On the basis of radiocarbon dates it is placed between *ca.* 3,000-2,000 BC. The beginning of sub-period IB is marked by the introduction of bowl or dish-on-stand (Fig. **7**) and barley. Wheat, lentil and kodon-millet were also found in addition to the rice (Figs. **8, 9**). The appearance of some new shapes in pottery such as beaker, perforated vessel and spouted pot, is also marked in this sub-period. The quality of pottery shows improvement over Period IA. Red and Black-and-Red wares of coarse variety continued, and some Black-and-Red ware sherds sometimes comprising black or red slip on one side, and quite often burnishing on one or both sides have also been found. Some of them are also comprised with painted, applied and incised decorations.

Most important amongst the **associated cultural material** of sub-period IB, included beads made of terracotta, steatite - micro-to-medium sized (Fig. **10**), carnelian and semiprecious stones, and charred and un-charred bones (often bearing cut-marks). As implied by the post-holes and burnt mud-clots with reed-marks, the earlier tradition of wattle-and-daub dwellings of sub-period IA continued.

Lower levels of Period II exhibit an enhanced agricultural production as evidenced by a good number of earthen storage bins, almost in every part of the excavated settlement and a larger concentration of carbonised of grains and seeds remains. Appearance of tiles, terracotta *chaukis*, along with the painted black slipped ware (thin variety) and other painted potteries from the very beginning of this period were noticeable finds.

(B) Palynological studies

A small trench measuring 1.00 x 1.00 m was excavated to a depth of about 2.80 m on the dried-up lakebed, at a distance of about 75 m from the archaeological site. Twenty-eight soil samples were collected from the sediments at an interval of 20 cm. The 2.80 m thick lake-deposit (Fig. **11**) revealed a succession of about 80 cm thick peat deposit followed by 2 m thick muddy sediments. Six radiocarbon dates determined a time span of about 10,000 years for the deposition of successive sediments.

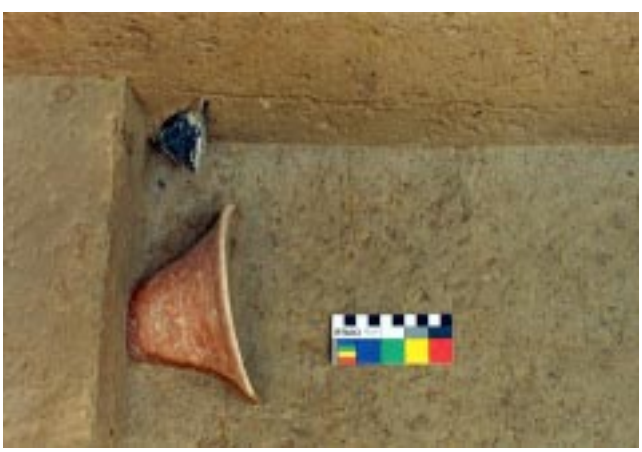


Fig. 7: Dish-on-stand, Period IB, Lahuradewa

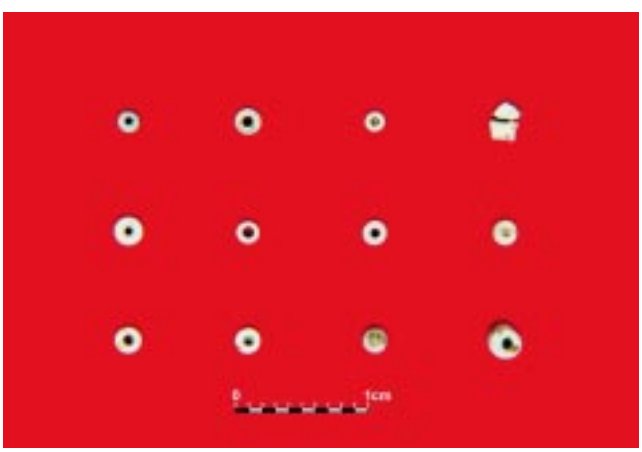


Fig. 10. Steatite beads, Periods IA/IB, Lahuradewa

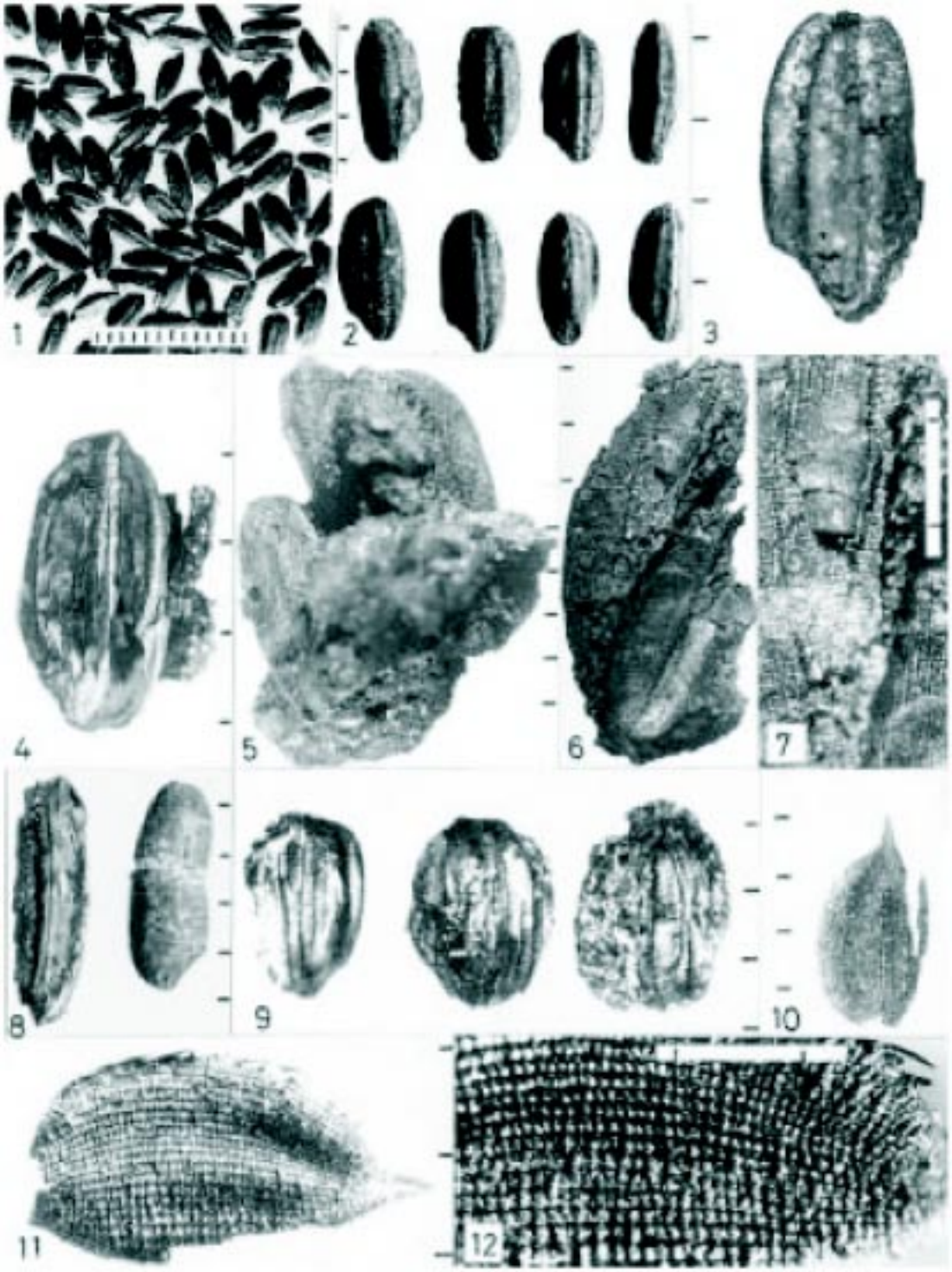


Fig. 8. Period IB, Lahuradewa: 1-4. Grains of domesticated rice (*Oryza sativa*); 5. Two grains of domesticated rice congealed in carbonised content; 6-7. Husk-remains of domesticated rice, in carbonised matter; 8. Grains of *Oryza* cf. *rufipogon*; 9. Grains of wild rice (*Oryza officinalis*); 10-11. Husk of *Oryza officinalis*; 12. Surface tissue (enlarged) of *Oryza officinalis*. Scale in mm. (After K.S. Saraswat).

Fig. 9. Period IB, Lahuradewa: 1. Bread-wheat (*Triticum aestivum*); 2. Dwarf-wheat (*Triticum sphaerococcum*); 3,4 & 5. Barley (*Hordeum vulgare*); 6. Flatsedge (*Cyperus* sp.); 7. Lentil (*Lens culinaris*); 8. Job's tear (*Coix lachryma-jobi*) grain; 9. Nuts of mugawort (*Artemisia* sp); 10. Foxtail-millet (*Setaria* cf. *glauca*) grains; 11. Husk-pieces of kodon-millet (*Paspalum scrobiculatum*). Scale in mm. (After K.S. Saraswat).

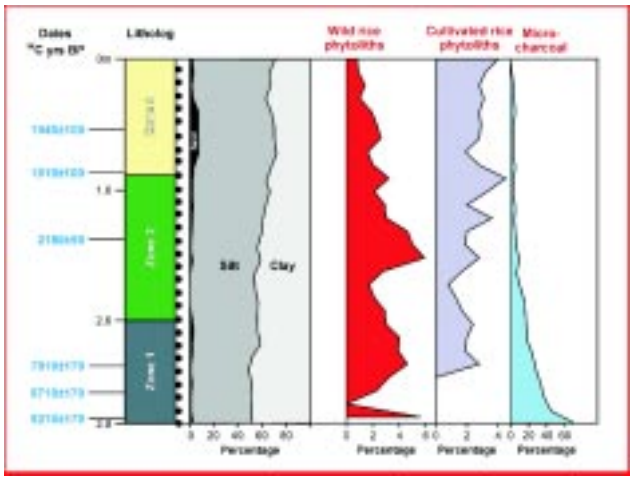


Fig.11. Lahuradewa lake profile showing distribution of grain size, wild rice phytoliths, cultivated rice phytoliths and microcharcoal. The Lake Profile represents approximately 10 kyrs history (After I.B. Singh).

Singh, *et al*,[12] based on their study of the **Lithological Succession** of the lake profile, observed that about 80 cm thick peat deposit at the base, representing a time span of *ca.* 10,000 to 5,800 yr BP, was accumulated at a rate of deposition of 1mm/100yr. The peat was formed under very humid conditions with prominent swampy areas similar to present-day *Bils* (*Beels*) in Ganga delta region. During 5,800 - 2,188 yrs BP, lake accumulated sediments at a rate of 1.7mm/100 yr. Rate of sedimentation increased to 4 - 7 mm/100yr in the last about 2,000 yrs. Stable carbon isotope studies indicate that initially lake and surrounding area sustained C-4 type grasses. Later C-3 type vegetation became profusely abundant.

Chauhan, *et al.*[13] carried out the **Pollen Analysis** of the Lahuradewa lake-sediments which showed that the grasses dominated in the open vegetation between *ca.* 9,500 and 8,700 yrs BP, together with a meagre expanse of the trees, in cool and dry climate. The invasion of the open vegetation by a few more trees envisaged an amelioration of the climate between *ca.* 8,700 and 5,700 yr BP. Expansion of lake due to increase of monsoon rainfall is also suggested during this period. Appearance of cerealia pollen from *ca.* 7,500 years BP onwards has been suggested as an indication of the anthropogenic pursuits. Considering the enhancement of *Bombax* and advent of *Madhuca indica* as well as better representation of shrubby and certain other taxa, an open vegetation with patchy occurrence of forests has been suggested with further increase of monsoon rainfall during 5,700-2,600 yrs BP. Alternatively, increase in the tree population in about *ca.* 5,700 yrs BP, may also be related due to some change in the landforms. The time of 5,000-4,000 yrs has been considered a period of reduced southwest monsoon. The consistent presence of cerealia pollen along with some other cultural pollen taxa from *ca.* 5,000 yrs BP is considered to be suggestive of the expansion of agricultural practices in the area. Presence of *Cannabis sativa* has also consistently been noticed at this time. The presence of *Trapa* (singhara) pollen in good numbers suggests that it would have been consumed by the local inhabitants.

The **Phytoliths** throughout the lakebed profile revealed the pronounced variations in shape and size.[14] Dominance of grass phytoliths was marked over non-grassy phytoliths. Changes in grass phytoliths through times had been considered as related to the changing palaeovegetation, in response to the climatic shifts, especially the rainfall. Differentiation was established between the leaf-phytoliths of wild and domesticated forms of rice. In wild forms of rice, number of scales on the edge of fan-shaped phytoliths has been counted eight, while in those of domesticated form the scales are nine and even more. The presence of wild-rice phytoliths were

observed since *ca.* 10,000 yr BP, while domesticated rice phytoliths appeared in the deposits from *ca.* 8,300 yr BP and onwards.

The presence of **micro-charcoal** observed in all the 28 sediment samples of Lahuradewa Lake, is considered to be indicator of regular fire-events caused by human activity in the catchment area of the lake, during last *ca.* 10,000 yr BP (Fig. 2).[15] The charcoal fragments in the bottom peat sediments of the succession occurred in large proportion and almost all of them belonged to some grasses, indicating thereby that open grass vegetation was dominant in the region, during 10,000 - 7,822 yrs BP. This indicates that the human groups at that early date can initially only be the predecessors of Lahuradewa settlers during Period IA.

Prasad *et al.*[16] on the basis of their study on **fossil diatoms** from Lahuradewa Lake sediments, recorded rich and diverse forms in almost all the samples. The enhancing presence of various euterrestrial diatom species present in the upper horizon of peat and mud sediments, is considered to be indicator of rice growing fields in the vicinity of the lake since 9,720 BP (in calibrated radiocarbon terms).

(C) Emergent Picture

On the basis of the evidence made available by the time of Seminar (January 2006), it was concluded that:

- The area around Lahuradewa was largely a grassland with only a few thickets of trees and shrubs, at least since the beginning of Holocene. The proportion of trees and grasses, however, changed with the increase and decrease in rainfall during the fluctuating climatic conditions, in the times to follow.
- As indicated by the consistent presence of micro-charcoal in the lake sediments, human activities continued in Lahuradewa region since the early Holocene time.
- The exploitation of wild rice and other plants by the early inhabitants of Lahuradewa would have culminated in the cultivation of rice and possibly the other minor cereals, since 9th millennium BP.
- At least by the mid seventh-millennium BC, the evidence of the fully domestication rice became established. However, gathering of wild plants, fishing and hunting also continued for food resources.
- The settlers at Lahuradewa used coarse variety of Red and Black-and-Red wares decorated with cord marks and dwelled in wattle and daub shelters.
- By the time not earlier than 5,000 BP the barley and other crops of Harappan agricultural economy, along with rice and local millets, and also the domesticated animals made entry in the fold of economy at Lahuradewa. Earlier tradition of hunting and gathering continued.

II

Results of excavation at Lahuradewa: after the Seminar (January 2006).

We extended our area of investigation by excavating balk-line and left out portions further down to obtain better insight about the settlement. This rewarded in the recovery of more carbonised floral and other antiquarian remains, and in getting more radiocarbon dates which enabled us to have better understanding, particularly about the early age of farming phase. During this work, we got benefitted by the discussions and questions raised by the respective delegates

during the Seminar as well as during the field-trip to Lahuradewa. Some details regarding these finds have already been published in the Second Preliminary Report on the excavations at Lahuradewa.[17] The outcome of further studies has also been incorporated here.

(i) Three more new and early radiocarbon dates determinated by the Physical Research Laboratory (PRL),[18] Ahmedabad are available for the Lahuradewa Period IA (Table 2).

Charcoal samples were first treated with standard acid-base-acid method to remove unwanted organic and inorganic carbon that might have entered during post depositional processes. Treated charcoals were subsequently burnt in an evacuated glass line to get sample carbon dioxide and were used to synthesize benzene following standard methods.[19] Residual radiocarbon activity of benzene was measured using liquid scintillation counter 'Quantulus'. All age estimates are based on assumption that charcoal carbon has $d^{13}C = -25$ per mil. (Communicated by M.G. Yadava, PRL, Ahmedabad).

(ii) The sample size of domesticated and wild rice grains (*Oryza sativa* and *Oryza rufipogon*), husks and their impressions has considerably enhanced. The evidence for the presence of rice (*Oryza sativa*) has been observed in four contexts: (i) carbonised grains; (ii) carbonized rice husk-pieces; (iii) carbonized grains in the matrix of the pottery; and (iv) rice husk/impressions in the matrix and core of the pottery (Figs. **12-15**). The most authentic feature for eastablishing the early domestication of rice during Peiod IA, has been provided by the recovery of a tough rachis segment, with jagged broken point at the lower end of spikelet (Fig. 16). The jaggy nature of scar, even under light microscope, is an absolute index of domestication.

(iii) The seasonality for their fruiting, tentative usage and cultivation covers almost all-the-year-round, which indicates the sedentary nature of the Lahuradewa settlement. The details regarding the morphological features of the plant remains are discussed elsewhere.[20]

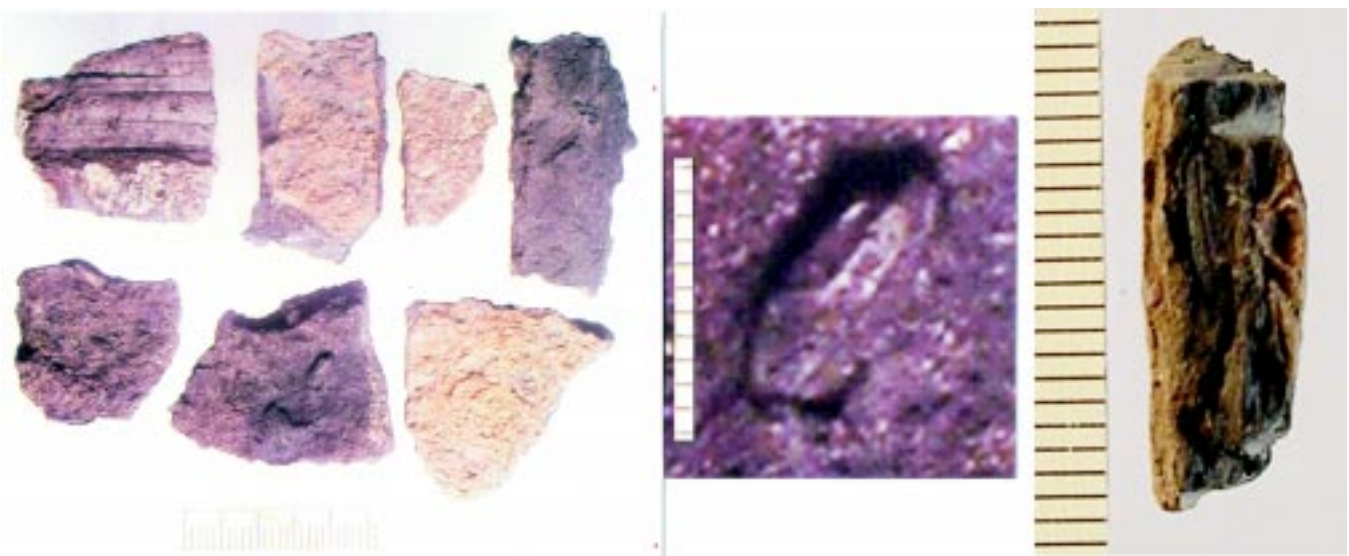
(iv) Anatomical studies of wood charcoal remains have revealed the identification of 12 and 24 timber and shrubby taxa from the deposits of sub-periods IA and IB respectively, suggestive of their exploitation for fuel and other purposes by the Lahuradewa settlers from the surrounding forested zone. This reflects partially on the forest components, in the surrounding areas of Lahuradewa settlement.

Table 2: Radiocarbon dates from Period IA, Lahuradewa

PRL no.	Radiocarbon age (yr BP; based on $t_{1/2}$ = 5568 yr)	Radiocarbon age (yr BP; based on $t_{1/2}$ = 5730 yr)	Calibrated age (yr)# BP	Calibrated age (yr)# BC
3030	9230 ± 100	9510 ± 100	10267 - 10505	8317 - 8555 (8436)
3031	9290 ± 120	9570 ± 120	10290 - 10646	8340 - 8696 (8518)
3032	9590 ± 110	9880 ± 110	10763 - 11121	8813 - 9171 (8992)

Using calib5.1, calibrated age ranges at 1sigma level

Fig.12. Rice husk inclusions in a potsherd from Period IA, Lahuardewa



Figs. 13-15 (left to right): Rice grains and husk marks in the core of potsherds Period IA

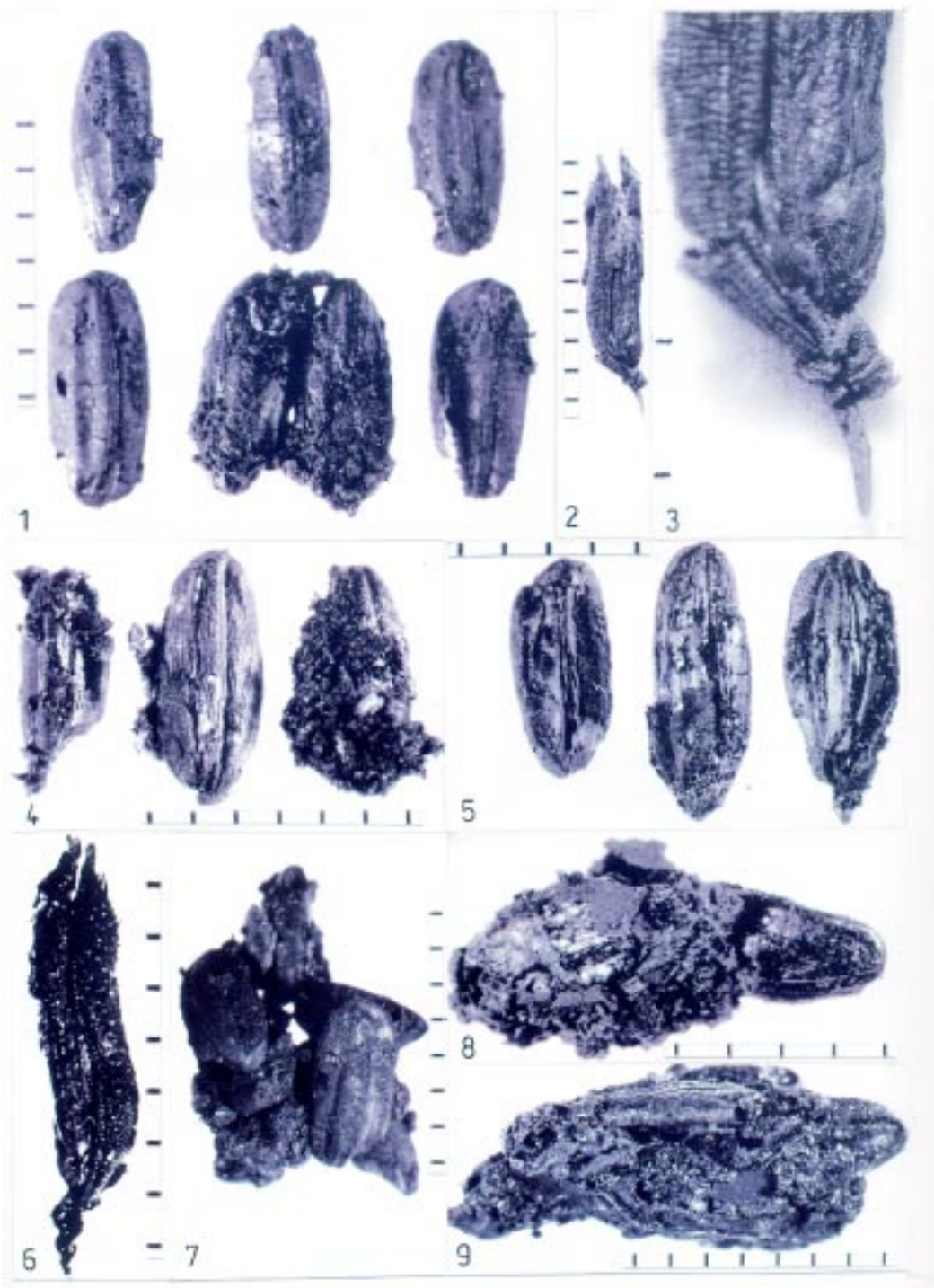


Fig. 16. Period IA, Lahuradewa: Remains of domesticated rice (*Oryza sativa*) – 1,4 & 5. Individual grains; 2. Complete glumes (Lemma and Palea) showing the breaking point of rachis; 3 Enlarged view of rough and jagged breaking point with a small piece of rachis attached (indicative of tough-rachis); 6. Intact glumes with a part of connected rachis; 7. Two grains of *Oryza sativa* congealed in carbonised matter; 8 & 9. Broken grains with adhering parts of husk and organic matter. Scale in mm. (After K.S. Saraswat)

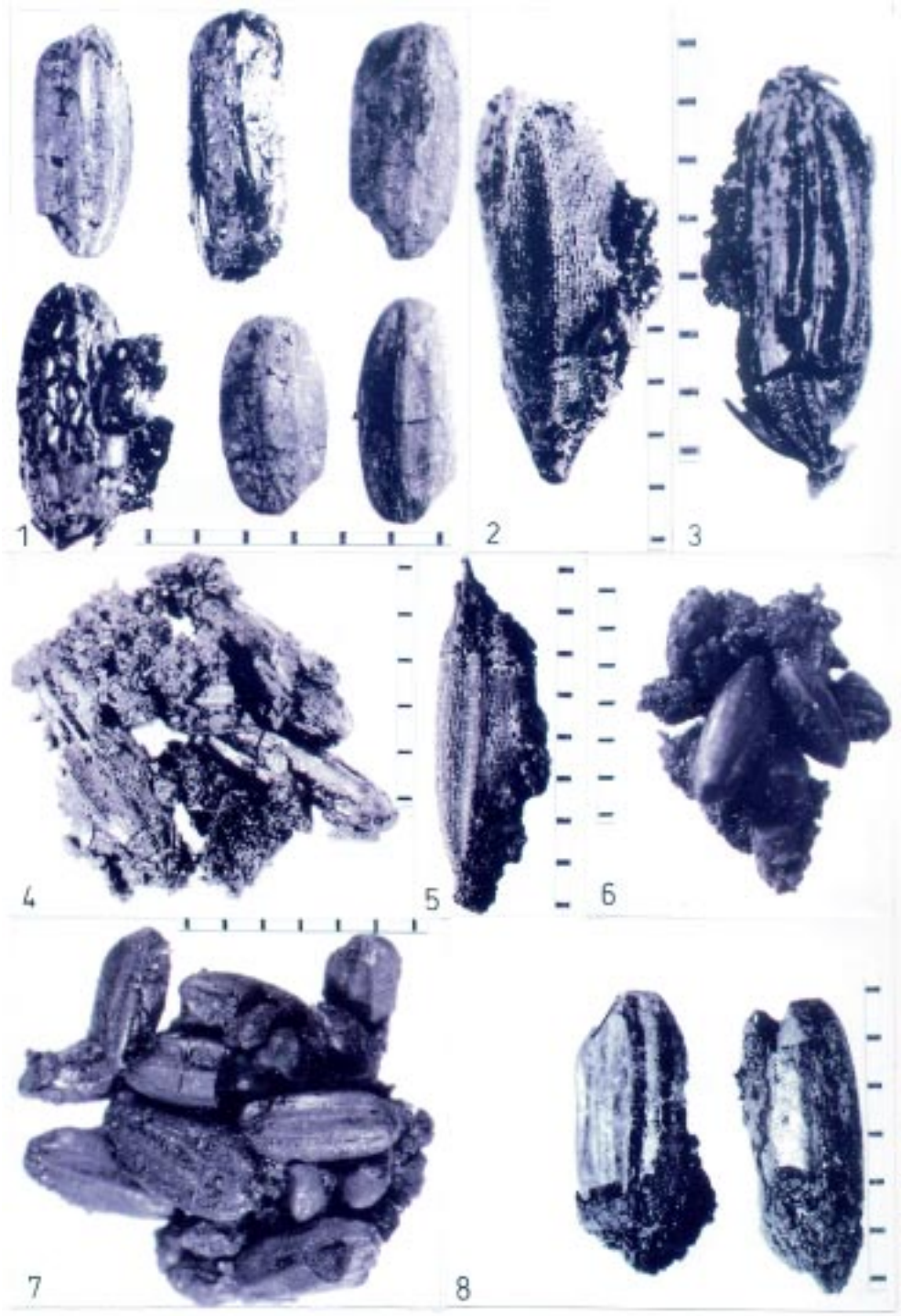
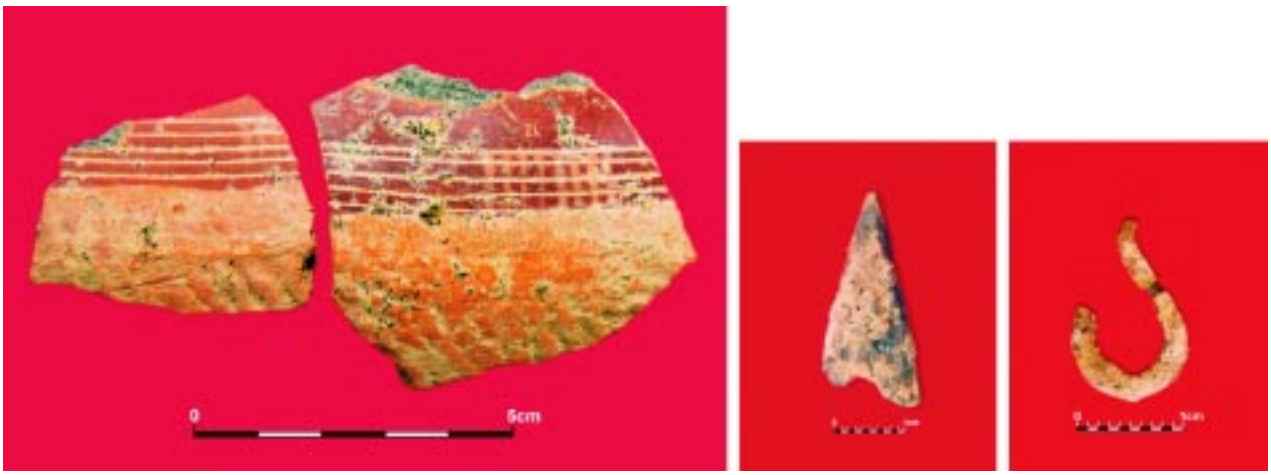


Fig. 17. Period IB, Lahuradewa: Remains of domesticated rice (*Oryza sativa*) - 1 & 8 Individual grains; 2 & 5. Caryopses showing husk ornamentation; 3. A broken caryopsis showing jagged breaking of rachis at lower end; 4. Broken grains and husk-pieces in carbonized matter; 7. Grains in coalesced state; 6. Barley (*Hordeum vulgare*) congealed in carbonized matter. Scale in mm. (After K.S. Saraswat).

(v) The **faunal remains**, studied by Pramod Prabhakar Joglekar (Deccan College, Pune), from Period IA contained mostly small fragments of bones. It is interesting to note that most of bones are charred to various degrees. This phase showed evidence of only wild mammals and a few non-mammalian animals. Wild mammals utilized for food were the gaur (*Bos gaurus*), sambar (*Cervus unicolor*), spotted deer (*Axis axis*), wild pig (*Sus scrofa cristatus*), porcupine (*Hystrix indica*), mongoose (*Herpestes edwardsi*), hare (*Lepus nigricollis*) and common squirrel (*Funambulus pennanti*). One species each of small- and medium-sized bird was present in the assemblage that could not be identified. Bulk of the faunal material contained remains of at least four species of freshwater fishes - *Rita rita, Wallago atta*, *Laubuca laubuca* and *Labeo rohita*. Freshwater mussels (*Lamellidens* sp.) were also a part the diet during Period IA.

(vi) The important **associated cultural components** of sub-period IA include quite a good number of micro-to-medium-sized beads, made of white or cream coloured steatite, which are comparable in size, shape and manufacturing technique with those of Harappan tradition. Besides, an example each of fiance (?) and carnelian is also noteworthy. Though these beads have been found right from the lowest levels, but in the present state of our knowledge it would be reasonable to associate them with the upper levels for accounting their obvious chronology. Two potsherds from the upper most levels bearing cord impressions, red slip and incised decoration on their exterior surface (Fig. **18**) are also associated cultural components.

(vii) The most important additions to the antiquarian remains of sub-period IB, include copper artefacts from its lower deposits. Most significant amongst them are a copper arrowhead (Fig. **19**) and a copper fishing hook (Fig. **20**). The arrowhead made on copper sheet is 3.00 cm in length and 1.4 cm in breadth. Fishing hook is 1.5 cm long and 1.00 cm broad, and appears to be made of wire. Considering the radiocarbon dates and stratigraphic context these finds may safely be placed in early 3rd millennium BC. Third object of copper appears to be a small broken piece of a clamp.



Figs. 18-20 (left to right) . Decorated potsherds from upper level of Period IA; Copper arrowhead and Copper fishing hook, from Period IB.

Other important amongst the **associated cultural material** of sub-period IB are the beads made up of terracotta and steatite, micro-to-medium sized. A finely made small bone-awl, a broken antler-bangle and medium sized broken stone pieces are also added in this sub-period.

Remains of grains and seeds from sub-period IB (Fig. **17**) comprise domesticated rice (*Oryza sativa*), wild or weedy rice (*Oryza* cf. *rufipogon* and *Oryza officinalis*), barley (*Hordeum vulgare*), *dwarf-wheat (Triticum sphaerococcum),* bread-wheat *(Triticum aestivum), lentil (Lens culinaris)* and job's tear (*Coix lachryma-jobi*), foxtail-millet (*Setaria* cf. *glauca*), Artemis/Mugwort (*Artemisia* sp.), flatsedge (*Cyperus* sp.) and Kodon-millet (*Paspalum scrobiculatum*). Turning up of barley in association of a dish-on-stand is important, in a level dated by conventional radiocarbon determination of associated charcoal content to 4,170 ± 180 yr BP: Cal. BC 2,700 yr (BS - 2,274). Precise AMS date of barley at this level, however, is 2,345 (2,273) 2,200 yr BC (ERL - 6903).

As compared to Period IA, the faunal remains of Period IB show more diversity. The use of wild mammals such as the *gaur*, *sambar*, spotted deer, and wild pig continued. Small wild mammals like mongoose, hare and common squirrel also continued to be hunted/trapped for food. An important feature of Period IB is an entry of domestic goat (*Capra hircus*) on the scene. However, bones of domestic goat are limited in number.

Only one fragment of buffalo bone has been found, but it is unclear whether it was domestic or wild. Further, interesting find of this period is the presence of a panther bone.

Circumstantial evidence is that the panther was also consumed, perhaps after an encounter with this predator during hunting activities. Period IB has a clear evidence of bandicoot rat, a species that survives along with humans, if enough food is available throughout the year. Non-mammals such as birds, reptiles and fishes continued to be used as a major food resource, like the previous phase.

III

Discussion

1. Rice domestication at Lahuradewa

1.1 Objectives to study plant remains in detail were formulated as the excavations envisaged at Lahuradewa in 2001-2002. Water-sieving of deposits provided a means of separation of carbonized plant remains. As observed during the excavations the sequence of lower deposits was unbroken, but the archaeological features in these deposits did not provide any guide to the deposition of plant remains and to distinguish between the high and low yielding areas on the basis of colour, texture or the context of the deposits. Even the dark and ashy patches gave negative results. Unlike the recovery from the Period II, despite the far larger volume of deposits subjected to water-sieving, the recovery of grains and seeds from the deposits of Period IA and IB in the assortment of wood charcoal pieces, remained low. In view of the meagre size of the seed and grain samples, we decided to concentrate on their qualitative nature. Large quantities of deposits processed down during the subsequent excavations in 2002-03 also, but yielded only the limited charcoal content. The impact of differential biases in the archaeological record is of enough consideration here because carbonized remains resulted from

specific human activities and there is nothing we can do about plants which could not survive preservation. Since preservation conditions of the material in the deposits are rather uneven, it was not desirable to retrieve the remains from the equal quantities of mud. When the preservational biases are not constant, the statistical values of the occurrence of different taxa in the samples are not of much significance. Under these conditions, changes in the exploitation of plants may simply be assumed in view of the macro-remains encountered at varying depths of samples. Quantitative measures have little meaning unless the analyst understands the sources of seeds in deposits and cultural context of sampling loci. Such depositional biases are part of analysis. Like many sites, it has not been possible to demonstrate the understanding of factors or the specific human activities affecting the preservation of plant remains at Lahuradewa, especially during the occupation in Periods IA and IB.

1.2 Rice domestication at Lahuradewa is an important issue and needs discussion. Admittedly, in the early part of the investigation sample size, generated by the excavators, was small, and contained a few husk-pieces, a rachis and eight grains (5 in a lump and 3 individual ones) in Lahuradewa Period IA. Excavations at the site and the study of samples were going on when the Seminar was convened in January 2006. Samples of rice were recovered from primary context and dated by AMS radiocarbon determination to 9th millennium BP. The domesticated rice grains were identified on the basis of their elongate to oblongish and laterally flattened shape and presence of four ribs or ridges - out of which usually two (infrequently one also) occur on each flattened side, along with one or two grooves. Tough rachis also revealed an uneven breaking point, in light microscopy. Husk-pieces show smoother profile and arrangement of granules in regular alignment. These characters made convincing ground to consider rice remains from Period IA belonging to domesticated *Oryza sativa*. On the contrary weedy or wild *Oryza rufipogon* show slender or sylph-like grains, which are slightly flattened or roughly round in cross view, normally with two ridges - one on each lateral side and having uneven husk surface due to round and relatively protruding granules. Weedy races of this wild rice with boldness of grains give only superficial appearance of domesticated *Oryza sativa*, but are distinctive.

1.3 It seems reasonable to assume that, about the 7th millennium BC the village farming had become established and agriculture started to spread in the Middle Ganga Plain. We are mainly confined here to consider the status of rice domestication at Lahuradewa where the intact rice grains and occasional finds of rachis and the husk pieces conform morphologically to those of existing domesticated forms of *Oryza sativa*, right from the opening phase of occupation in the Period IA during 7th millennium BC. Subsequent to the presentation of our results during the Seminar in January 2006, investigations on additional samples continued. The new additional data on the rice from Period IA at Lahuradewa supports our earlier conclusions presented already in the Seminar.

One of the bottom layers in the opening phase of occupation excavated during the first season of excavations in 2001-02 and dated by

conventional radiocarbon dating method using charcoal pieces gives an age of 5,320 ± 90 yr BP; cal. BP 6,110 yr and cal BC 4,160 yr (BS-1,951), yielded more than a dozen of rice husk pieces (Fig. 5.1) and an agglomeration of husks in carbonized matter (Fig. 5.2) with a rachis fragment, which got unfastened during handling (Fig. 5.3). Under light microscope the breaking point of this rachis looks rough and irregular as in the case in cultivated rice. In contrast the wild forms of rice have breaking point smooth. It suggests that the spikelet under study detached only when harvested and needed threshing by man. Husk pieces also show similarity to those of some domesticated forms of *Oryza sativa*, showing arrangement of somewhat cubicular granules in regularly aligned and smoother profiles (Figs. 5. 4, 5). The worn-out content of charcoal left unfilled cavity in the clot of rice husk pieces, beneath the unfastned rachis and husk, gave the impression of oblongish shape of rice grain. A solitary complete grain (Fig. 5.7) was recovered in the lowermost and stratigraphically contemporaneous horizon in the adjacent trench. Radiocarbon determination of wood charcoal in this trench dated the horizon to 6,290 ± 140 yr BP; Cal BP 7,247 yr and Cal BC 5,298 yr (BS-1962). Although solitary, this elongate to somewhat oblong, flattenned and conspicuously ribbed grain corresponded to domesticated form. It occurred in association of a few slender and much narrower spikelet and grains of wild or weedy *Oryza* cf. *rufipogon* (Fig. 6. 3, 4, 5). Five grains congealed in a carbonized lump (Fig. 5.6) and two individual grains (Fig. 6.1) of similar shape were also encountered from period IA, but in upper horizon. In view of scant recovery in the lower most levels, solitary grain was saved and husk-clot was used for a precise date by AMS radiocarbon determination. It gave a date of 7,532 ± 58 yr BP; Cal BP 8,259 yr or 6,409 yr BC. This led us to the earliest and first claimed evidence of domesticated rice in the Middle Ganga Plain, as discussed in the 'Seminar on First Farmers in Global Perspective', in 2006.

1.4 Study of additional material from Period IA has enhanced the number of rice grains to more than three dozens. About two dozen grains are almost complete. Remains of the domesticated *Oryza sativa* grains in period IA seem to have derived from more than one populations. They show variations in their shape from broadly oblong to somewhat elongated, with a considerable range in their size. One can make assumption that the samples would have been drawn from populations showing diversity of *Oryza sativa* in the region of Lahuradewa. These grains are identifiable within the range of morphological features. Details of studies are to be published separately. They are morphologically different from the shattering grains of wild species.

Considerable intra-specific variation occurs in cultivated plants. Non-botanists feel that a species of domesticated rice indicates one unvarying entity. Domesticated rice is a species of *Oryza sativa* complex and closely related to its wild progenitors - *Oryza nivara* and *Oryza rufipogon*,[22] and it is well known for its tendency to be accompanied by weed varieties and for crossing with these weeds.[23] Remains of wild or weedy *Oryza rufipogon* (Fig. 6. 3, 4, 5; Fig. 8.8) and *Oryza officinalis* (Fig. 8. 9, 10, 11, 12) have also been recorded from period IA at Lahuradewa. For a great majority of rice domesticates in

South and Southeast Asian regions. We still lack sufficient palaeobotanical information to trace pre-historic distributions as well as sequences of morphological changes, and data are still inadequate to establish genetic relationships between wild and, weedy, and cultivated forms.

Rachis remains can show clearly whether the rice is of wild type with fully brittle rachis – showing smooth scar, or of domestic type with a semi-tough or fully tough rachis with jagged mark at the broken end of spikelet. Fortunately rachis remains have survived preservation at Lahuradewa. Retrieval of intact rice glumes and rachis segments complete with the remains of bristles, demonstrate that it is possible for even highly carbonized remains to survive water-sieving (Fig. **16**. 2, 3, 6).

In one case the disarticulation of spikelet by human activity of threshing has left jagged and irregular scar with a part of rachis still attached, as seen under light microscopy (Fig. **16**. 2, 3). It is the hallmark in the identification of domesticated rice. In another case the domesticated nature of rice is apparent by the intact portion of rachis still attached with the glumes (Fig.**16**. 6). These features well preserved in carbonized state, support the contention that the rachis was tough enough to indicate advance nature of rice domestication. In Fig. **16**. 3 of the same plate the enlarged husk surface displays arrangement of somewhat cubicular granules in regular profiles, as seen in domesticatd forms of rice. The features of tough rachis showing the irregular scar at the breaking point of spikelet indubitably establish the identity of domesticated rice in the lower most levels at Lahuradewa, Period IA.

With the availability of about three dozen rice grains and the remains of rachis segments, and three more radiocarbon dates from Period IA at Lahuradewa, we can safely conclude that the rice domestication was established in the Middle Ganga Plain during early Holocene times.

1.5 Size of prehistoric grains has also been used as a criterion for differentiating between domesticated and wild forms of rices. The course open is to look into the size statistics of modern and carbonized grains. Although in this approach the size difference to some extent in the carbonized grains is expected due to shrinkage and puffing. Vishnu-Mittre,[24] Savithri[25] and Sharma[26] carried out an intensive work at BSIP to establish Length/ Breadth x Thickness indices for broadly differentiating the cultivars and spontanea forms of rice from those of wild *Oryza perennis* complex, *Oryza officinalis* and *Oryza rufipogon*, commonly occurring in India. After Vishnu Mittre, the Length/Breadth x Thickness (L/B x T) indices are as follows:

Oryza perennis complex	2.20, 2.21
Oryza officinalis	2.36
Oryza rufipogon	2.64
Oryza sativa var. *spontanea*	1.77, 1.79
Oryza sativa var. *japonica*	1.70
Oryza sativa var. *indica*	1.71

Twenty-six carbonised grains from Lahuradewa period IA have been subjected to measure their L/B x T indices, which in most of the grains fall below 2 . Only a few grains show their indices

slightly above 2. This slight change in some grains in their size may be attributed to the factor of carbonization. Further, early cultivars of rice were different from modern genetically improved forms and remained in genetic contact with their wild and weedy ancestors, in the early stages of their cultivation. The L/B x T indices of individual grains, given in the Table 3. Except 5 grains having their indices approaching to 2 and slightly above 2, rest of the grains have their indices below 2. Size variation only is not safer criterion for specific identification, and may be considered with the morphological features of the grain. All the 26 grains measured here for thier size statistics, are morphologically comparable to those of *Oryza sativa* complex.

Table 3: Size statistics of carbonised rice grains from Lahuradewa, Period IA

S. No.	Length (L) (mm)	Breadth (B) (mm)	Thickness (T) (mm)	Length/Breadth x Thickness (L/B x T) (mm.)
1.	4.50	1.75	1.25	1.98
2.	4.00	1.80	1.20	1.85
3.	5.00	1.90	1.50	1.75
4.	2.70	1.30	1.00	2.07
5.	2.70	1.40	1.00	1.92
6.	3.00	1.40	1.20	1.78
7.	2.60	1.30	1.20	1.66
8.	2.70	1.40	1.25	1.54
9.	3.00	1.40	1.20	1.78
10.	3.00	1.50	1.00	2.00
11.	3.00	1.70	1.25	1.41
12.	3.20	1.50	1.25	1.71
13.	3.00	1.40	1.20	1.78
14.	3.00	1.25	1.10	2.18
15.	3.20	1.40	1.10	2.07
16.	4.90	1.76	1.40	2.00
17.	5.00	1.90	1.50	1.75
18.	4.75	2.00	1.25	1.90
19.	5.00	2.30	1.50	1.44
20.	4.70	2.20	1.25	1.70
21.	5.60	2.50	1.50	1.49
22.	5.00	2.20	1.25	1.81
23.	6.00	2.30	1.60	1.63
24.	5.40	2.60	1.50	1.38
25.	5.00	2.40	1.20	1.73
26.	5.00	2.00	1.30	1.90
Average	4.30	1.79	1.31	1.83

2. Impact of Lahuradewa on the archaeology of Middle Ganga Plain

In the light of early evidence of domesticated rice from Lahuradewa, we think the picture is now clear with regard to the beginning of agriculture in the Middle Ganga Plain during early post-glacial times, as in West Asia and China. On the basis of present evidence, this is the region of innovation in the origin of agriculture. Essentially, however, we have no facts concerning pre-agricultural state which led to agriculture, and in that near-vacuum of data at present, speculations would be useless. This aspect is left for future researches. In the following we summarize some of the salient points.

2.1 It is noteworthy that the palaeolithic artefacts found from the Siwalik Hills in Nepalese Terai,[27] Bahadrabad (Upper Ganga Plain), Mau and Kalpi (Middle Ganga Plain)[28] and presence of micro-charcoal at Sanai Tal[29] demonstrate that human activities were going on in the Ganga Plain from the Palaeolithic times. However, the consistent hunting-gathering and exploitation of the flora and fauna seems to have been continuing from Terminal Pleistocene times in this region.

2.2 The antiquity of *ca.* 7th millennium BC for the domesticated rice at Koldihwa, a site located far away, in the northern Vindhyan flanks, was claimed by G.R. Sharma and his colleagues much earlier.[30] Some of the scholars have raised their doubts about this claim.[31] While others find no reason for not accepting this early date.[32] The context of the archaeological material and charcoal samples (collected for C^{14} dating) and well thought interpretation submitted by the excavators for computing the chronology seems quite convincing. A perusal of the related publications clearly demonstrates that the doubts expressed in this respect hold no ground. Now the evidence from Lahuradewa firmly corroborate the views of Sharma and his colleagues regarding the early beginning of rice cultivation in the Middle Ganga plain.

2.3 The presence of Corded – Pottery right from the lowest levels at Lahuradewa, Jhusi and Koldihwa, etc., datable to *ca.* 7th millennium BC is an evolved form. It is logical to surmise that the ceramic traditions had an even earlier beginnings in the region. However, the available radiocarbon dates for the associated charcoal found in the horizons containing Corded-Ware show that the antiquity of this characteristic pottery in eastern Middle Ganga Plain, Lower Ganga Plain, North-eastern India and adjoining areas does not appear before the middle of 3rd millennium BC, in the state of our existing knowledge.

2.4 Excavations during the last decades carried out on the archaeological sites in the Middle Ganga Plain, e.g. Sohgaura, Chirand, Koldihwa, Imlidih Khurd, Jhusi, Lahuradewa, have furnished evidence much older than believed so far on the basis of surface finds. Even Lahuradewa, before the excavations, was not considered earlier to chalcolithic and the Jhusi not even before *ca.* 1,000 BC. At both of these sites, evidence of human activity have gone back to early Holocene times. This has opened up the possibility for searching some other early settlements in the region, instead of drawing conclusions on the basis of surface finds.

2.5 At present the sites which have revealed the deposits of Early Farming culture are, however, very limited. Lahuradewa, Jhusi, Hetapatti, Koldihwa, Tokwa, Kunjhun and Taradih are some

earlier representatives in this category. Further excavations of some other potential sites and the determination of their secure chronological sequences, supported by the radiocarbon dates, are certainly expected to change the present picture. Such sites would however remain lesser in number than those with beginning from 3,000 BC onwards. The present situation demonstartes that the number of sites spanning after 3,000 BC, show an increasing number.[33] As against a few well-established early farming sites (about half a dozen), the number of sites datable from *ca*. 3,000 to 1,500 BC is about two dozen, including those with early farming deposits. Sohgaura, Imlidih Khurd, Narhan, Dhuriapar, Golrihwa Ghat, Banwaria Ghat, Waina, Bhuna dih, Khairadih, Mahagara, Raja-Nala-ka-tila, Malhar, Agia Bir, Senuwar, Chirand, Chechar Kutubpur, Pana, Sonpur, etc., fall in this category. At present more than 160 sites (identified as Neolithic or Chalcolithic, comprising cultural deposits of pre-NBPW period) are known from the Middle Ganga Plain, suggesting the considerable expansion in area of occupation and accelerated agricultural production from much earlier to early historical times.

2.6 Considering the introduction of new cultural traits around 3,000 BC at Lahuradewa, such as copper artefacts, steatite, goat and barley, and enhancing interaction with the western part of the Indian region, the continuity in ceramic industry, earlier agricultural practices and structural activities show consistent indigenous developments. It may also be noted that the use of terracotta tiles, footed terracotta objects (*chauki*) and earthen silos could survive only for a short duration. It seems that only for a short span of time local traditions prevailed upon them. The shapes such as dish/bowl-on-stand also show distinct regional variations. Much is still left to understand the changing cultural variables, over a larger area of Middle Ganga Plain.

Conclusion

On the basis of the authentically identified remains of domesticated rice, we expect that the picture of early beginning of agriculture in the region will be changed further, if some evidence are moved backward in time. Nature of tough rachis remains and grains by which the rice has been identified, seems to be sufficiently advanced. It is surmised that certain level of cultural complexity and agricultural practices would have been a necessary prerequisite in still earlier stages of cultural evolution somewhere in Middle Ganga Plain, otherwise this status of rice domestication could not have appeared at Lahuradewa during 9th millennium BP. The additional dates on the wood charcoals associated with rice remains, give calibrated radiocarbon ranges in 10th and even 11th millennium BP. Radiocarbon dates obtained by AMS and by traditional radiocarbon dating do not always disagree. Nor, when they disagree, are the AMS dates always more recent.[34] However, keeping in view the nature of deposits in Lahuradewa Period IA, as discussed above, and also the occurrence of phytoliths of cultivated rice in the lakebed sediments datable to 8,300 yr BP as well as the AMS date of rice husk-clot, we place confidence to regard the rice cultivation at Lahuradewa during 9th millennium BP. The preceding generations of Lahuradewa settlers in the initial stages of occupation were possibly practising rice cultivation for a long time, else where. We are left with a void for still earlier evidence of domesticated rice, yet with no connecting interpretations or speculations of how,

where and when in the Middle Ganga Plain the domestication of rice emerged. The foremost essential of this paper is to discuss only the observed facts about the earliest agricultural settlement in the region. We need identification and study of more such sites before making a hypothesis for the beginning of rice domestication in the Ganga Plain.

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