

PLANT REMAINS FROM ATRANJI KHERA PHASE III* (1200-600 B.C.)

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ABSTRACT

Atranji Khera, on the bank of the river Kalinadi, a tributary of the Ganga, is in Etah district of Uttar Pradesh. The site was excavated from 1962 to 1966 by the History Department of Aligarh Muslim University, Aligarh. It has revealed a chronology of human habitation from C. 2,000 to 200 B.C., determined by radio carbon method. The plant remains recovered from Phase III, i.e., C. 1,200-600 B.C., are rice, barley and wheat as well as two different plant fibres. The archaeological and botanical significances of these finds in relation to plant remains of earlier age are discussed in some detail.

INTRODUCTION

ATRANJI KHERA is in the District of Etah in western Uttar Pradesh. It is 15 Km. north of the District headquarters, on the bank of the river Kalinadi, a tributary of the Ganges. Historians (Cunningham, 1862; Fuhrer, 1891) have taken note of this mound, and were of the opinion that it had been abandoned by its inhabitants some time prior to nineteenth century. The History Department of Aligarh Muslim University carried out excavations at this site from 1962-1966. This has been done by Prof. S. Nurul Hasan and Mr. R. C. Gaur. The excavations have revealed successive habitations starting from 2000 B.C. up to 200 B.C., and later. The site is unique in the sense that it exhibits a chronology of human habitation in the Ganges Valley for about 3,700 years.

During excavation some plant remains have been recovered from different depths. The material reported here is from Phase III, the age of which, by C^{14} determination, is 1200-600 B.C. These finds are associated with the Painted Grey Ware (P.G.W.). This has enabled us to compare the significance of this phase with those from elsewhere in the Ganges Valley, known to be of the same age. The P.G.W. has been ascribed to be associated with the advent of the Aryans in North India. The study of

these plant remains would therefore appear to be of some importance.

Three cereals, namely paddy (*Oryza*), wheat (*Triticum*) and barley (*Hordeum*) and two fibres have been discovered. Of the latter, one is from the bark of *Boehmeria* and the other also from bark, but not identifiable.

MATERIAL

There were altogether nine lots of plant material of which seven were from trench number ARJ-4 and two from ARJ-3. The layers of deposit were indicated by excavators by numbering them from bottom to top as I-VII. The greater portion of plant remains was in the form of caryopses, bits of leaves embedded in mud clods. The remains in layer No. VII were, however, different. Here the grains were individually separate as well as embedded in a tar-like mass (Pl. 1, Figs. 1, 2). The material Nos. II and III did not contain any cereals. No. II was a hard mud clod of 6×5 cm. in size, with a groove all round, thought to be a 'net-sinker', by the excavators (Pl. 3, Fig. 14). No. III was a portion of a potsherd with impression of textile (?) (Pl. 3, Figs. 12, 13).

From the trench ARJ-3 individually separate cereals were recovered (Pl. 2, Figs. 9, 10, 11). Incidentally, the numbering on this material is not in any way related to the numbers given to the material from ARJ-4. Table 1 shows the position of the material in different trenches.

For comparative study of these materials, we had at our disposal some authentically identified material of extant plants from the following sources. Samples of cereals were obtained from the Indian Agriculture Research Institute, Pusa, New Delhi; Plant Breeding Institute, Cambridge, England; Swedish Seed Association, Svalof, Sweden; and the herbarium collection of the Botany Department, Aligarh Muslim University. We also received *Boehmeria* bark fibres

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TABLE 1 — SHOWING PLANT MATERIALS FROM PHASE-III, WITH THEIR LOCATION

TRENCH NUMBER	LOCATION	OUR LABORATORY NUMBER	REMARKS
ARJ-4	VII	Arch. 21a	Charred grains from a pit
ARJ-4	VI	Arch. 21b	Mud clods
ARJ-4	V	Arch. 21c	" "
ARJ-4	IV	Arch. 21d	" "
ARJ-4	III	Arch. 21e	Potsherd with impression of textile
ARJ-4	II	Arch. 21f	Mud clod, "Net-sinker"
ARJ-4	I	Arch. 21g	Mud clods
ARJ-3	IX-XIV	Arch. 13c	Charred grains individually separate

from the Indian Museum, Calcutta; Jute Research Institute, Barackpur, West Bengal and Forest Research Institute, Dehra Dun.

METHODS

The materials listed in Table 1 have been sorted out under the categories given below:

- Grains in tar-like mass,
- Grains individually separate,
- Mud clods of different size and shape with embedded plant remains,
- Hard mud pieces with groove all round,
- Potsherd with textile-like impression.

The first stage in the method of study was to recover plant remains from the associated material. For this, different technique had to be used to obtain the entire remain without any damage. Grains associated with tar-like lump were treated with 3-4% acetic acid for 2-6 hours depending on the condition of material. When the grains could be dislodged easily, they were taken out from acid and washed repeatedly in water. The next stage was to centrifuge the grains in water for 5 minutes in order to get rid of all the extraneous matter. They were then washed in distilled water and left for further treatment. The individually separate grains required 0.5-1% acetic acid treatment for 2 hours. No further physical or chemical treatment was necessary for them. After washing them in distilled water repeatedly, they were put away for further processing. Some mud clods had natural colour of soil, while others had a look of burnt mud. Both contained charred

grains and bits of stem or leaf. Small pieces of soil containing plant material were scooped out from the big pieces and soaked in water for 6-8 hours. After removing soil particles attached to the material with a light brush, they were treated with 10% acetic acid for ten minutes. This treatment removed almost all dirt. The material was then placed in water and centrifuged for 15 minutes. Small pieces of charred remains were then picked up with a pipette and then washed repeatedly. All the material were fragile and had to be kept in a desiccator. The next stage was to prepare peels, maceration, and sections for microscopic examination after double embedding (Chowdhury & Ghosh, 1955; Chowdhury & Buth, 1970, 1971a, 1971b).

The technique used for recovering fibres from the 'net-sinker' and potsherd was different. In both cases at first 10% acetic acid was applied for 10-15 minutes. Attempt was then made to dislodge the fibres from the surrounding soil first with a fine needle and then with a soft camel-hair brush. These operations had to be carried out under a binocular dissecting microscope. What looked like plant remains was transferred to distilled water. Then they were dehydrated and brought to absolute alcohol and mounted. No risk was taken to stain these remains.

RESULTS

The results of investigation are presented here under botanical classification and do not come under any particular category of material given earlier in this paper.

Rice, *Oryza* spp.
(ARJ-4: VII, VI, V, IV & I)

Pls. 1 & 2, Figs. 1-8

Morphology

There is a great deal of similarity between the individually separate grains found in heaps, and the grains that are embedded in a tar-like mass (Pl. 1, Figs. 1 & 2). Both these have been grouped together as a distinct lot and are reported here. The spikelets vary in length from 5-6 mm. and in breadth 2.4-3.3 mm. Some of them show two glumes — one on either side of the caryopsis (Pl. 1, Fig. 3). These glumes are lanceolate in shape and originate from a slightly different level of the rachilla. In length, the glumes vary from 1.5 to 2 mm. and show a smooth outer surface. The lemma and paleae are boat shaped, the former partially covering the latter. The charred condition of the material has not allowed us to determine accurately the number of veins on lemma-palea surface. All the same, the outer surface of the lemma-palea shows clearly a chess-board pattern (Pl. 1, Fig. 5). The apiculus is short and often blunt. We have come across in this material a large number of rachilla with associated organs.

Among the material examined there are many grains without husk. Some of them are comparatively broader in the middle than the rest. This has enabled us to put them under two categories, i.e. broad and narrow (Pl. 1, Fig. 4). The position of the embryo is well marked on the lateral side of the caryopsis (Pl. 1, Fig. 4).

Anatomy

The cross-sections of the caryopses have not revealed any characteristic structure. However, the peels do. Here the epidermis shows squarish cells with thick, sinuous walls. Some epidermal cells also show hairs with bulbous base and pointed apex (Pl. 2, Fig. 7). Peels from the glume have only long cells but no short cells nor stomata.

The peels from leaf-like fragments exhibit some interesting anatomical structure. Here the epidermis reveals long and short cells. (Pl. 2, Fig. 6). The long cells with thick, sinuous walls occupy the groove along with the short cells. The short cells are single or in pairs, showing both cork and silica cells.

An important difference between the short cells in this region and those that occur on the ridges has been observed. In the latter, the short cells are distributed in a long row, with dumb-bell like silica bodies (Pl. 2, Fig. 8). Metcalfe (1960) has described these short cells as "Oryza type". The stomata are strictly confined to the groove and there is none on the ridges. They are in rows of 2-4 in between the ridge. The subsidiary cells are triangular or low domed (Pl. 2, Fig. 6).

In order to identify these unknown caryopses, let us now consider the likely cereals that might have been in existence in north India some 3,000 years ago. The presence of chess-board pattern on the lemma-palea of the caryopses will lead one to think that the unknown belongs to *Oryza* spp. The other morphological characters, such as the position of the glumes on the rachilla, and the shape and size of the apiculus, also supports this view. Furthermore, the anatomical study of the peels from leaf-fragments, leaves one in no doubt that these plant remains from Atranji Khera are nothing but *Oryza* spp. (Chowdhury & Ghosh, 1955; Prat, 1948).

The genus *Oryza* is at present distributed throughout the tropics of the Old and the New World. All the cultivated species are believed to have originated from two species namely, *O. sativa* L. in south-east-Asia, and *O. glaberrima* Steud. in west Africa. The former is very widely cultivated, while the latter grows in restricted areas. There are also some wild species, which characteristically shatter grains before they are mature. The wild species are quite common in many countries of east Asia, including India (Chatterji, 1951).

Taking into consideration the age of Atranji Khera and the distance between India and west Africa, there does not appear to be any likelihood of our material being *O. glaberrima*. We are now left with *O. sativa*, both wild and cultivated, for comparison. Before a comparison is attempted, it should be pointed out that the ancient rice, since its domestication, has gone through repeated selections and probable mutations for thousands of years before any attempt was made for its systematic classification. The classification we have now is mainly based on morphological and cytogenetic characters (Hector, 1937; Ghosh *et al.*, 1960). This has resulted in having

grains under different groups with only a limited variation in their morphology. On the other hand, our experience in handling ancient cereals has given us the impression that seldom all the grains are similar. They, as a rule, show considerable variation in shape, size and other morphological characters. Under these circumstances, all that can be done with the Artanji Khera material is to indicate the greatest similarity that it shows to one or more modern species or their varieties. We cannot, however, overlook the state of deposition and the bulk remains recovered from this site. Repeated occurrence of *Oryza* from Phase I and II (C. 2000-1500 B.C. and C. 1500-1200 B.C.) of the same site and the state of deposition (unpublished) have led us to think that this *Oryza* spp. is most likely to be one of the cultivated rice.

Wheat, *Triticum compactum* Host.

and

Barley, *Hordeum vulgare* L.

(ARJ-3: IX to XIV)

Pl. 2; Figs. 9, 10, 11

About 200 grains have been recovered from Trench No. ARJ-3. Of these, 50 are entire and the rest broken. Among the entire grains, two distinct types are discernable. We shall call them sample A and B.

Sample A consists of 20 caryopses. They are oval to subglobular, varying in length from 4.5 to 6.3 mm. and in breadth 2 to 3 mm., with blunt ends (Pl. 2, Fig. 9). They show deep ventral furrow with raised cheeks. The caryopses are without any covering.

A comparative study of *Avena*, *Hordeum* and *Triticum* indicates the greatest resemblance of the unknown with the *Triticum*. The genus *Triticum* has been classified under two main groups — glume and naked wheat. In the former, the glume remains firmly attached to the kernel during processing operations, while in the latter the glume is loosely held and easily comes off. There is also some difference between these two groups in the method of fracture of the rachis. In the glume wheat the rachis remains attached to the kernel along with the glume but in the naked wheat the rachis is usually absent after processing, indicating its strong attachment to the stalk. Considering the morphological characters of the Artanji Khera wheat, it will be seen that it comes under the naked wheat group.

Now the naked wheat can be placed under two cytogenetic categories, namely, tetraploids and hexaploids. The tetraploid includes *T. durum* Desf., *T. turgidum* L., and the hexaploid, *T. vulgare* (vill.) Host., *T. compactum* Host. and *T. sphaerococcum* Perc. The cytogenetic difference of these two lots, is exhibited in their morphological characters (Peterson, 1965). There is always a tendency for the hexaploid to be shorter and plumper (Helbaek, 1964). This shows that our material belongs to the hexaploid groups. The dimensions of naked hexaploid group given in Table 2 show that the Artanji Khera material resembles most *T. compactum*, even after taking into consideration the possible shrinkage in the size of grain during carbonization. It would, therefore, appear that the material under investigation is *T. compactum* Host.

TABLE 2 — CHARACTERS OF CARYOPSIS OF SOME NAKED *TRITICUM* SPP. (AFTER PETERSON, 1965)*

SPECIES	AVERAGE L × B mm	REMARKS
1. <i>Triticum durum</i> Deaf	7 × 3.3	Tetraploid (4 × 7)
2. <i>Triticum turgidum</i> L.	7 × 3	Tetraploid (4 × 7)
3. <i>Triticum carthlicum</i> Nevski (= <i>T. persicum</i> Vav.)	6.6 × 3.3	Tetraploid (4 × 7)
4. <i>Triticum vulgare</i> (Vill.) Host.	6.3 × 3.5	Hexaploid (6 × 7)
5. <i>Triticum compactum</i> Host.	5.6 × 3	Hexaploid (6 × 7)
6. <i>Triticum sphaerococcum</i> Perc.	4.6 × 2.6	Hexaploid (6 × 7)
Sample A (Artanji Khera)	5.4 × 2.6** (6.3-4.5 × 3-2 mm)	

*The number of grains examined is not given.

**Average of 20 grains.

Sample B—Sample B consists of 30 grains. In comparison to wheat caryopses described earlier, they are hulled showing longitudinal striations under a low-power microscope (Pl. 2, Fig. 11). The grooves are shallow and the dorsal surface is flat. Some of the grains show a clear twist (Pl. 2, Fig. 10) at the anterior, near the embryo, while others do not show any such character.

When the covering is removed, a smooth surface of the kernel is visible. Peels from the covering show long and short cells, both having thick, sinuous walls. The short cells are single or in pairs with clear cork and silica cells. These anatomical details lead us to the hulled group of the genus *Hordeum*. Amongst the hulled *Hordeum* there are two groups—two-row and six-row. The presence of twist in some of the grains shows that they are the lateral caryopses of six-row hulled barley (Chowdhury, 1963; Chowdhury & Buth, 1971b; Helbaek, 1964, 1966). We therefore place the Atranji Khera barley under hulled six-row barley—*Hordeum vulgare* L.

Fibres of *Boehmeria platyphylla* D. Don.
(ARJ-4: III; Sample A.)
Pl. 3; Figs. 12, 13, 15

Fibres of unknown origin
(ARJ-4: II; Sample B.)
Pl. 3; Figs. 14, 16

Sample A—These fibres are from a potsherd which carries an impression of some woven material (Pl. 3, Figs. 12, 13). It has been possible to recover 4 broken fibres from the impression, one of which shows the terminal part. Under a high power microscope they appear to be round in cross-section with very thick wall and small lumen. The peculiarity of these fibres is that they exhibit node-like fructures (Carpenter & Leney, 1952) on the wall at frequent intervals (Pl. 3, Fig. 15). A single piece shows a blunt end.

It may seem to be a formidable task to trace the origin of these fibres, for two reasons. Firstly, the anatomical data available to us are rather scanty. Secondly, in a country like India where thousands of plants grow, it would take many years' research to find out the particular plant from which these fibres were obtained. However, there

is another way to look at the problem. The unknown might belong to one of the present commercial fibres, which are not many in India. Let us first consider the wood fibres from Conifers and Dicotyledons. The thin wall of these fibres often with characteristic pits, enables us to eliminate this lot as a possible source of the unknown. In the same manner, we can discard the fibres from the monocotyledonous plants such as bamboo, sugar cane, rice, barley, wheat, etc. We are now left with the bark fibres of commercial value. Here, the most common fibres of north India are jute (*Corchorus* spp.) and hemp (*Canabis sativa* L.). These fibres, no doubt, have very thick wall with small lumen but there is no node-like fracture on their wall like the unknown. We can, therefore, discard these too. The only commercial fibres that are known to us to have node-like fructures on their walls are flax (*Linum usitatissimum* L.) and ramie (*Boehmeria nivea* (L.) Gaud. Flax has an ancient history. It is known to have been used by the Egyptian in C. 5,000 B.C. (Helbaek, 1964). To think that flax fibres from North Africa have come to a village settlement in the Ganges Valley in C. 1,000 B.C. will be to let loose one's imagination. Then, the unknown can only be ramie. But even here there are difficulties. Ramie is said to have been introduced into India from China sometime at the beginning of the present century (Kanjilal, 1962). Then the question arises what is this unknown fibre? However, it is known that two species of bark fibre bearing *Boehmeria* are indigenous to India (Duthie, 1960; Kanjilal, 1962). There are *B. macrophylla* D. Don. and *B. platyphylla* D. Don., and known to grow at the foothills of the Himalayas near Dehra Dun. A comparative study of these bark fibres along with those from Atranji Khera shows that the unknown fibres resemble most *B. platyphylla* (Table 3). We are, therefore, led to identify Atranji Khera fibres sample as belonging to *Boehmeria platyphylla* D. Don.

Sample B—This was from a "net-sinker" believed to have been used by the fishermen of Atranji Khera during P.G.W. phase. Tying some sort of weight on the lower portion of a net in order to make it sink deep in the water, is a common practice even to day in many parts of India. In this case the sinker used was a mud clod

TABLE 3 — SHOWING AVERAGE WIDTH OF BOEHMERIA FIBRES

SOURCE	NAME	WIDTH IN MICRONS OF 80 MEASUREMENTS	DISTRIBUTION
Indian Museum (Calcutta)	<i>Boehmeria nivea</i> (L.) Gaud.	37.9	Introduced
(a) Jute Research Institute (Calcutta)	<i>Boehmeria nivea</i> (L.) Gaud.	34.9	do
(b) Jute Research Institute (Calcutta)	<i>Boehmeria nivea</i> (L.) Gaud.	34.9	do
Indian Museum (Calcutta)	<i>Boehmeria macrophylla</i> D. Don	24.7	Indigenous
Indian Museum (Calcutta)	<i>Boehmeria platyphylla</i> D. Don.	18.1	Indigenous
Sample A	Atranji Khera material	14.8*	—

*Average of 42 measurements.

(Pl. 3, Fig. 14) on which mark of something that will keep the sinker attached to the net, is quite clear.

Some broken fibres (Pl. 3, Fig. 16) recovered from the "net-sinker" were fairly thick-walled almost round in cross-section but without any node-like fracture. They might have come from bark of any of the local plants easily accessible to the fisherman. It has not been possible to match these fibres with any of the local fibres but there is no doubt that these are not fibres of *B. platyphylla*.

Archaeological Significance

The Phase III of Atranji Khera has revealed Painted Grey Ware. Since Lal's report (1955) on P.G.W. from Hastinapur, quite a number of sites have yielded this type of pottery, in the Upper Doab area. Atranji Khera is the first site in the Lower Doab to show P.G.W. deposit (Wheeler, 1966). The main findings from Atranji Khera are that the inhabitants lived in thatched houses which possibly had mud plastered walls. They used no brick. They had a somewhat advanced metallurgical industry. Evidence of use of iron for spear-heads, arrow-heads, knife, chisel and house-hold tong is there. Copper rings, bangles and hooks were also found. The latter articles gave an impression of limited knowledge on copper (Table 4).

The plant remains include rice (*Oryza* spp.), wheat (*Triticum compactum* Host.), barley (*Hordeum vulgare* L.), fibres of *Boehmeria platyphylla* D. Don. and some fibres of unknown origin. Of these, rice is known to have been in use in North India about

1000 B.C. at Hastinapur, and the possibility of its use at an earlier date has also been indicated (Chowdhury & Ghosh, 1954-1955). Presence of rice in the phase III of Atranji Khera is, therefore, understandable. But when it comes to wheat and barley, it is certainly a new record of the use of these two cereals in the Ganga Valley. The earliest occurrence of wheat and barley in India, based on present information, is in the Indus Valley Civilization (Marshall, 1931). The source of diffusion of these cereals to Atranji Khera from Harapan centres or elsewhere is not clear at present, due to lack of supporting archaeological evidence. It is interesting to point out that Vishnu-Mittre (1961) has reported presence of rice and wheat from Navdatoli (1500-1000 B.C.) on the bank of the Narmada. It is not at present possible to explain how cultivation of wheat and barley from West Asia spread in the Indian continent. Because we do not yet have enough data to build up a chronological history of cultivation of these cereals in the Indian region.

The two plant fibres recovered from Atranji Khera are interesting. *Boehmeria platyphylla* grows at the foothills of the Himalayas (Duthie, 1960; Kanjilal, 1962) not far from the sites of P.G.W. recently discovered in the district of Saharanpur. There is every likelihood that these settlements of P.G.W. culture were in contact with one another. In that case, presence of *B. platyphylla* D. Don fibre could be easily explained. The other bark fibre, though not definitely identified, is also interesting. Because fibres of *B. platyphylla* which come from a distance of 200 Km or so was used

TABLE 4—SHOWING RESULTS OF ARCHAEOLOGICAL INVESTIGATION OF HASTINAPUR AND ATRANJI KHERA

SITE	SETTLEMENT	WAY OF LIFE	CULTIVATION	ANIMAL HUSBANDARY	METALS
Hastinapur Phase II P.G.W. C. 1100-800 B.C.	Sign of mud houses with thatched roof	Farming and hunting	Paddy (<i>Oryza</i> sp.)	Cow, buffalow, horse, sheep, pig	Copper as chief metal for arrow-head, nail-parer; antimony rod; lumps of iron ore and slags
Atranji Khera Phase III P.G.W. C. 1200-600 B.C.	Signs of mud houses	Farming and hunting	Paddy (<i>Oryza</i> sp.); club wheat (<i>Triticum compactum</i> Host.) six-row hulled barley (<i>Hordeum vulgare</i> L.) Bark fibres (<i>Boehmeria platyphylla</i> D. Don.)	Cow, buffalow, horse, sheep, pig	Iron as chief metal for spear-heads, arrow-heads, tongs etc. pieces of rings, bangles, hook, and rod of copper

for the making of fishing net, while a local fibre not so strong but easy to obtain was used for net-sinkers. This is definitely a sign of economy in the use of raw material.

ACKNOWLEDGEMENTS

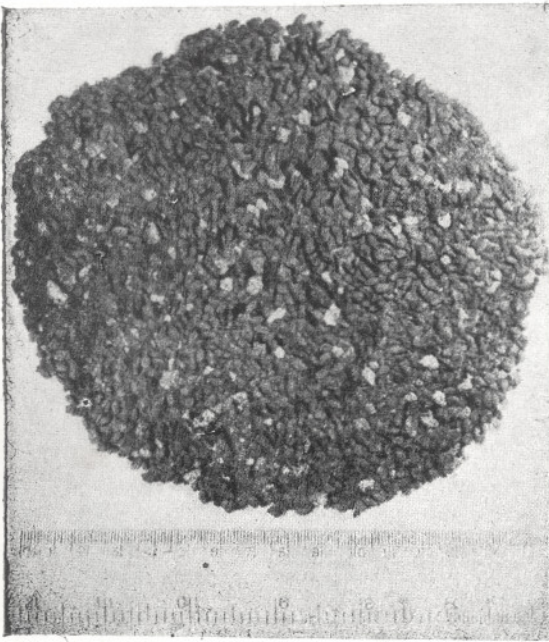
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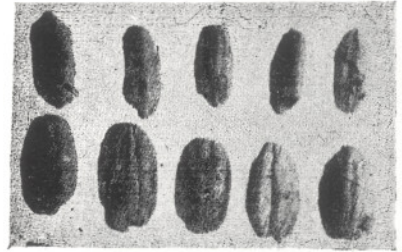
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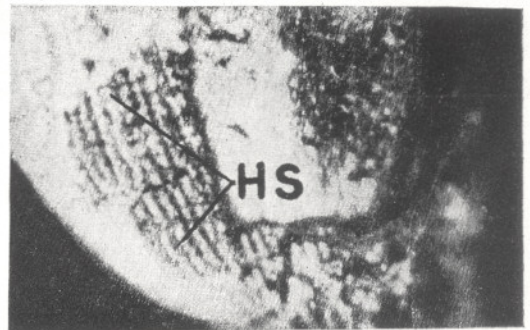
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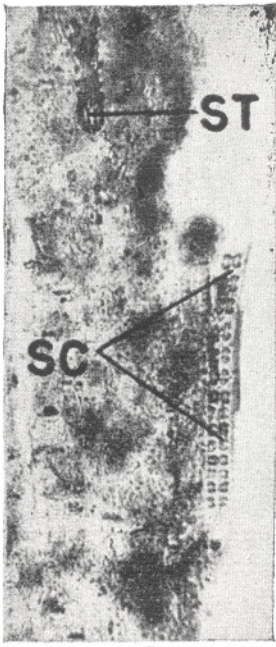
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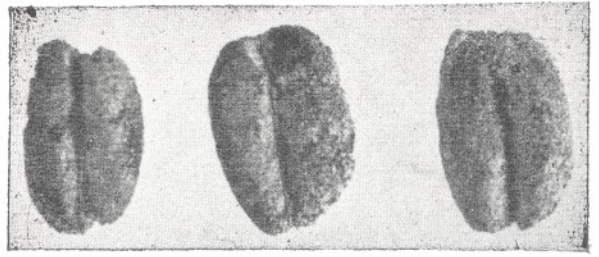
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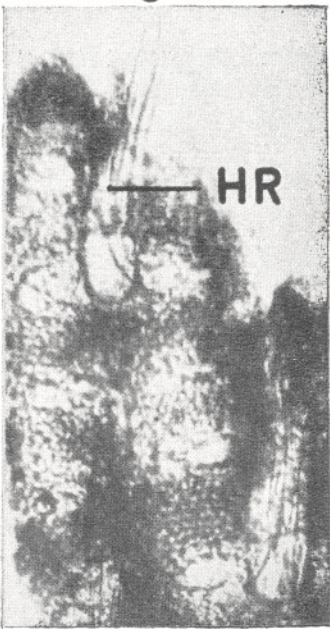
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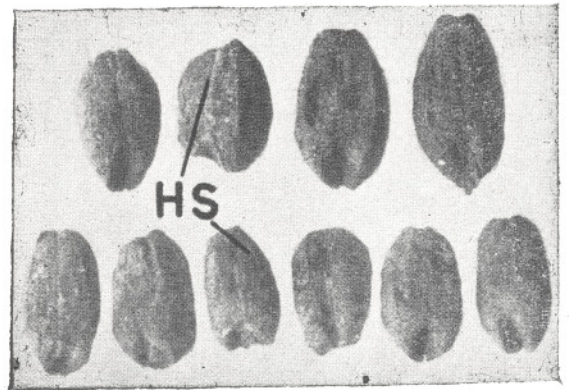
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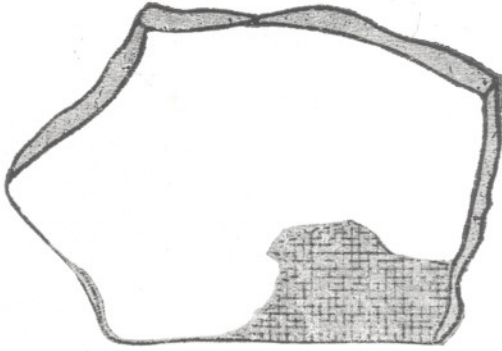
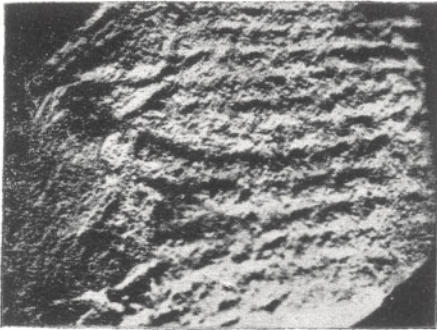


FIG. A POTTERY
SHERD

12



13



14



15



16

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*Original copy could not be consulted.

EXPLANATION OF PLATES

PLATE 1

(All from ARJ-4)

1. A mass of rice (*Oryza* sp.) deposit.
2. Rice caryopses embedded in tar-like material. $\times 4$.
3. Rice caryopsis showing glumes (GL) apiculus (AP). $\times 10$.
4. Rice without husk; note difference in size and shape. $\times 3$.
5. Surface view of rice husk, note chess-board pattern. $\times 30$.

PLATE 2

6. Peel from rice leaf. Note distribution of stomata (ST) and Short cells (SC). $\times 300$.
7. Peel from rice husk. Note the shape of hair (HR). $\times 600$.

8. Portion of specimen in photograph 6, showing dumb-bell shaped silica body. $\times 600$.

9. Wheat (*Triticum compactum* Host.) grains from ARJ-3. $\times 4.4$.

10. Lateral grains of six-row barley (*Hordeum vulgare* L.) from ARJ-3, showing twist. $\times 3.5$.

11. Median grains of six-row barley from ARJ-3, showing portion of husk (HS). $\times 3.5$.

PLATE 3

(All from ARJ-4)

12. Diagrammatic sketch of potsherd showing marks of woven material. $\times 1.5$.

13. Higher magnification of marks on potsherd. $\times 5$.

14. Photograph of a net-sinker. Normal size.

15. Fibre of *Boehmeria platyphylla* D. Don from potsherd. $\times 300$.

16. Fibre from net-sinker. $\times 360$.