SUPPOSED REMAINS OF RICE (*ORYZA* SP.) IN THE TERRACOTTA CAKES AND PAI AT KALIBANGAN, RAJASTHAN

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ABSTRACT

The remains of husk and chaff in the terracotta cakes from the Harappan site, Kalibangan, earlier reported by Sarma (1972) as those of rice (*Oryza* sp.), have on cuticular examination been found to belong to wheat (*Triticum* sp.).

INTRODUCTION

SARMA in 1972 (pp. 98, 106) reported the occurrence of rice husk and chaff present ubiquitously in terracotta cakes discovered from Kalibangan, a Harappan site in district Ganganagar, Rajasthan. However, he (Sarma, *op. cit.*) neither supported his report with photographs nor with morphological data of the plant remains identified by him as of rice.

During our recent examination of archaeobotanical remains from Kalibangan, we did not recover any evidence of rice in them. The carbonized food grains from this site were found to belong to barley, wheat, *Cicer arietinum* and *Pisum arvense*. The absence of rice in the carbonized plant remains from this site necessitated the reinvestigation of plant remains embedded in terracotta cakes and pai from this site. The present communication concerns the re-examination of plant remains from the terracotta cakes and pai.

Two terracotta cakes, numbered KLB/20/566 and KLB 2/XBI respectively, both from stratum 7, and a fragment of terracotta pai, numbered KLB 2/Qdr. from Stratum 1, were examined for the purpose. These together with the carbonized plant materials from this site were kindly placed at our disposal by Shri B. K. Thapar, Joint Director General, Archaeological Survey of India, New Delhi for examination and report. We are indeed highly obliged to Shri Thapar for the opportunity to examine materials from this site.

MATERIAL AND METHODS

The terracotta cakes and pai after examining externally, were broken open in various planes to study the plant remains mixed with clay before making cakes and pai. On their examination under a binocular microscope, it was discovered that the impressions and compressions of fragmentary spikelets, grains, kernels and chaff abounded in them (Pl. 1, figs. 1-4), yet they were devoid of the typical chess-board pattern, a characteristic feature of the palea and lemma of rice. A single complete grain was recovered on a split open piece (Pl. 1, fig. 1) which broke up into fragments under the gentle pressure of the dissecting needle because it was reduced to ash. Several partially or completely burnt away fragments of grains and chaff were also observed (Pl. 1, figs. 1-4). The completely burnt ones were as usual reduced to white ash but again devoid of the chess-board pattern. In rice grains reduced to ash, the chess-board pattern is always retained, and easily discernible under a low power binocular microscope. A few of the partially burnt remains of grains were released from the matrix with the help of a dissecting needle and a fine brush. They were boiled with conc. nitric acid for 15 minutes and repeatedly washed with water, to rid them of the acid. The cuticles so released were stained with safranin and temporary slides prepared in glycerine for examination. For the identification of the sub-fossil cuticles cuticular preparations of palea and lemma of modern grains of wheat (*T. compactum* Host.), barley (*Hordeum hexastichum* L.) and rice (*Oryza sativa* L., *O. perennis* Moench., *O. rufipogon* Griff., *O. granulata* Nees et Arn. ex. watt.) were prepared by the same method as used for sub-fossils.

OBSERVATIONS

1. Comparative studies of epidermal characters of palea and lemma of modern wheat, barley and rice

Pl. 2, fig. 8; Pl. 3, figs. 11-16

Both palea and lemma in the species of wheat, rice and barley examined by us have been found to possess identical epidermal characters. Instead of describing the epidermal characters of every species examined, an account is given below of the comparative and contrasting features utilized subsequently for the identification of sub-fossil cuticles released from terracotta cakes and pai.

The epidermis in the cuticles of extant wheat and barley are made up of sinuous cell walls with the sinuousities narrow or round and swollen filling three-fourth of the lumina of the cells in barley (Pl. 3, fig. 12), but moderately wavy cell walls are seen in wheat (Pl. 2, fig. 14). In rice on the other hand, the epidermal cell walls are thrown up into long, acute, pointed and straight projections spread out in the entire space of the lumina of the cells and dovetailing with the projections of the opposite cell wall (Pl. 3, fig. 15). Owing to the round and swollen sinuosities and the spread out projections of the cell walls the open space in the lumina of both barley and rice epidermal cells are much narrower in contrast to much wider lumina seen in those of wheat except towards the base and apex of the lemma or palea where they are comparatively narrower though still devoid of the characters of cell walls of barley or of rice. Whereas no scattered granules occur in the lumina of epidermal cells of rice (Pl. 3, fig. 15), very few occur in barley (Pl. 3, figs. 12,13), but several of them occur scattered throughout the lumina of epidermal cells in wheat (Pl. 2, fig. 8; Pl. 3, fig. 16).

The stomata in rice are typically of *Oryza* type, i.e. the subsidiary cells are triangular and horizontally elongated (Pl. 3, fig. 15). In contrast both wheat and barley have the subsidiary cells of the stomata vertical and parallel to the length of the epidermal cells (Pl. 3, fig. 16).

The silica bodies in the epidermis of rice husk are wanting. However, silica deposits have been observed on the acute, straight projections of the cell walls (Pl. 3, fig. 15); In contrast, barley and wheat have distinct silica bodies which are round to elliptical in barley (Pl. 3, figs. 11 & 13) and oval, rounded or slightly crescent-shaped in wheat (Pl. 3, figs. 14, 16).

The hair-bases in barley are oval, round, or spheroidal with granules usually towards the periphery (Pl. 3, fig. 13); in wheat they are spheroidal, oval to squarish with granules appearing scattered all over the surface (Pl. 2, fig. 8; Pl. 3, fig. 16); and in rice they are ±triangular to rhomboidal and without any granules (Pl. 3, fig. 15).

The comparative study of the epidermal characters of palea and lemma of modern wheat, barley and rice, based upon the species examined, reveals that the epidermal characters in rice are much different from those of wheat and barley, which differ from one another in certain minor characters.

2. The Identification of subfossil cuticles recovered from the terracotta cake and pai

Pl. 2, figs. 5-7, 9, 10

Several fragmentary cuticles recovered from grains or husk in both the terracotta cake and pai as shown in figs. 5-7, 9, 10 in Plate 2, show within themselves certain variations ranging from much convoluted and much sinuous epidermal cell walls in Pl. 2, figs. 7-9 to comparatively less wavy epidermal cell walls (Pl. 2, fig. 6). All of them are characterized by such common characters as sinuous cell walls (Pl. 2, figs. 5-7, 9, 10), broad lumina each with several scattered granules (Pl. 2, figs. 9, 10), crescent-shaped silica bodies (Pl. 2, fig. 5) and round or spheroidal hair-bases (Pl. 2, figs. 6, 9). A combination of such characters has been observed in cuticles of wheat only. The absence of round and swollen sinuosities, or of the stiff, acutely pointed spread out projections characteristic of the cell walls of barley and rice in the subfossil epidermal cells readily suggests the absence of rice and barley remains in the terracotta cakes and pai. We are, therefore, convinced that the subfossil cuticles belong to wheat rather than to barley or rice.

CONCLUSION

The absence of chess-board pattern characteristic of rice on the husk remains in

terracotta cakes and pai is highly suggestive of the absence of rice remains in them. The identification of sub-fossil cuticles derived from the terracotta cakes and pai to wheat (*Triticum* sp.) establishes beyond doubt that the husk impressions in terracotta cakes and pai do not belong to rice. This fact is further supported by the absence of rice in the carbonized food grains. Hitherto in Ancient India, grains and chaff of millets and rice have been found mixed with potter's clay (Vishnu-Mittre, 1969, 1974). The present investigation places on record that at Kalibangan grains and chaff of wheat were also used for the same purpose.

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EXPLANATION OF PLATES

Plate 1

1-4. Impressions and compressions of grains and chaff of wheat (earlier identified as of rice by Sarma 1972) on split open pieces of terracotta cake and pai.

1-2. From terracotta cake and figs. 3, 4 from terracotta pai.

Fig. 1 $\times 2\frac{1}{2}$; Fig. 2 $\times 2\frac{1}{2}$; Fig. 3 $\times 2\frac{1}{2}$; Fig. 4 $\times 2\frac{1}{2}$

Plate 2

5. Sub-fossil cuticle released from a grain from terracotta cake, showing sinuous cell walls, broad lumina with crescent-shaped silica bodies (S.B.). $\times$ 224.

6. Another sub-fossil fragment from terracotta cake showing sinuous cell walls and broad lumina of epidermal cells with hair bases (H.B.). $\times$ 896

7. Another sub-fossil fragment showing highly convoluted (C) sinuous cell walls. $\times$ 896.

8. Epidermal cells of lemma of modern wheat (*Triticum compactum*) showing sinuous cell walls, broad lumina with hair bases (H.B.) and scattered granules (G) inside the lumina and inside the hair bases. $\times$ 896.

9. Another sub-fossil cuticle from terracotta pai showing sinuous cell walls, broad lumina with hair bases (H.B.) and scattered granules (G) in both the lumina and hair bases. $\times$ 896.

10. Another sub-fossil cuticle showing broad epidermal cells separated from one another by septa (S), broad lumina with granules (G). The sinuousity of cell walls is variable but different from those in epidermal cells of barley and of rice shown in Pl. 3. $\times$ 896.

Plate 3

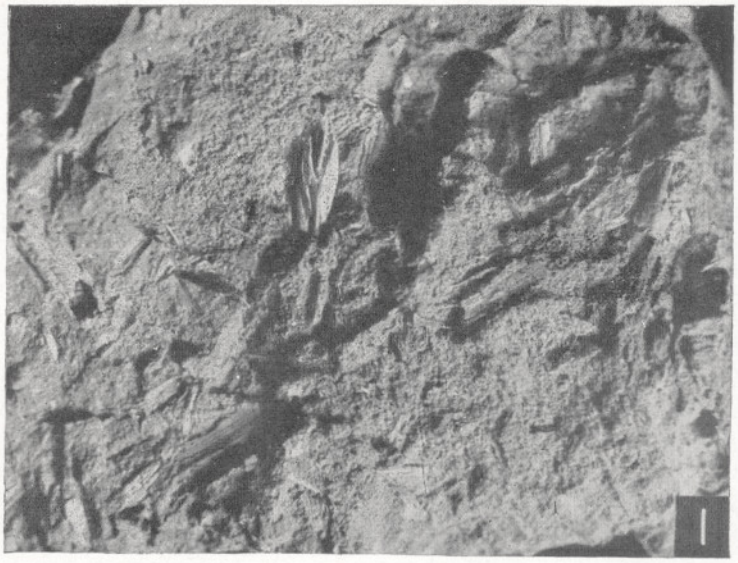
11, 13. Cuticle of lemma of modern barley showing hair-bases (H.B.) and biconvex silica bodies (S.B.). Fig. 3 shows granules (G) inside the narrow lumina and in the hair bases. Fig. 1 $\times$ 71.7; Fig. 3 $\times$ 896.

12. Cuticle of lemma of modern barley showing convoluted (C) swollen thick-walled sinuous cell-walls with narrow lumina and with elliptical silica bodies (S.B.). $\times$ 896

14. Cuticle of lemma of modern wheat showing sinuous cell walls with broad lumina, hair bases (H.B.) and crescent-shaped silica bodies (S.B.). $\times$ 224.

15. Cuticle of lemma of modern rice showing long, acute, pointed and straight projections of the epidermal cell walls. Fig. 5 also shows a typical *Oryza* type stoma (S) and a hair base (H.B.). $\times$ 896.

16. Cuticle of lemma of modern wheat showing a non-*Oryza* type stoma (S), hair base (H.B.) and crescent-shaped silica bodies (S.B.). $\times$ 896.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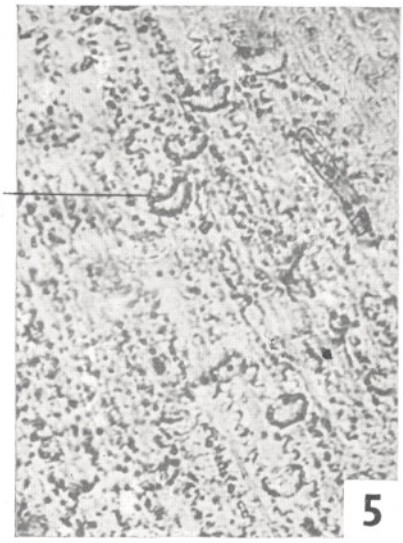
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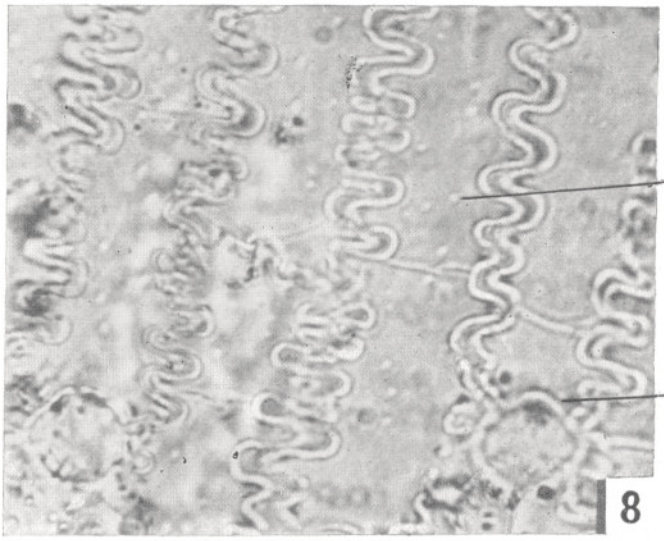
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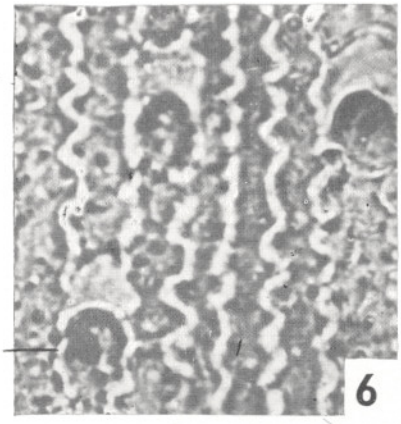
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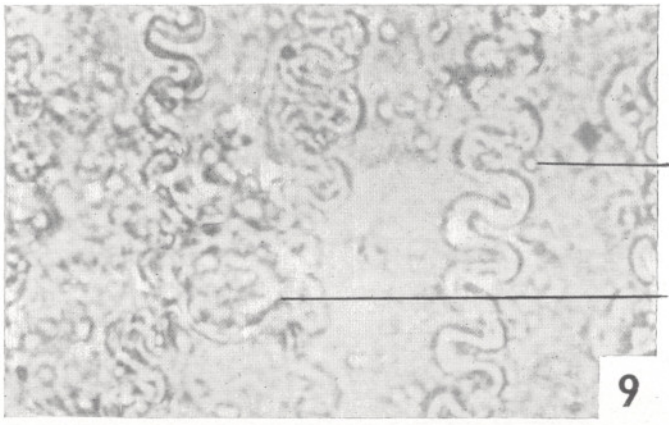
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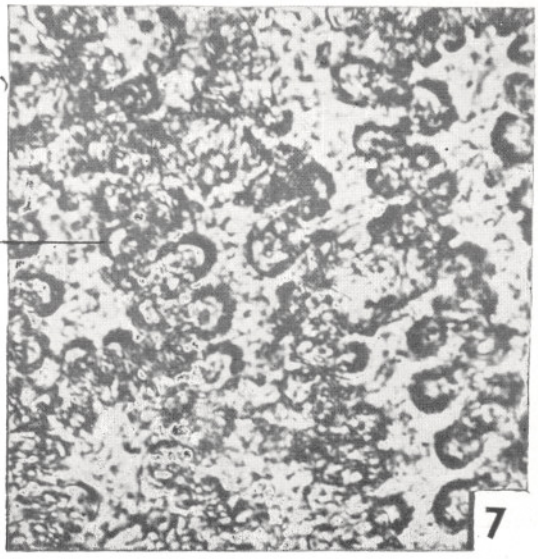
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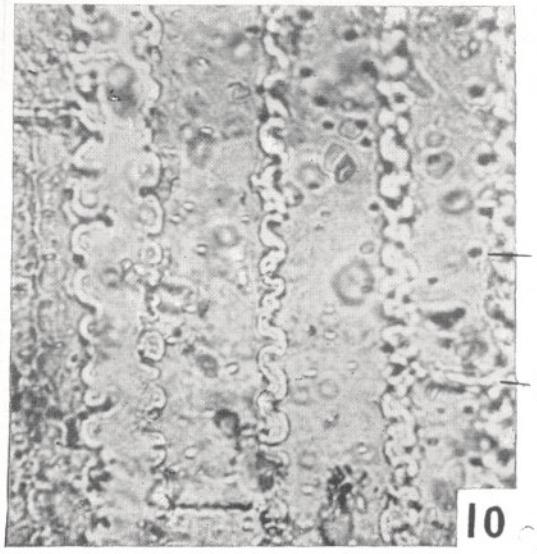
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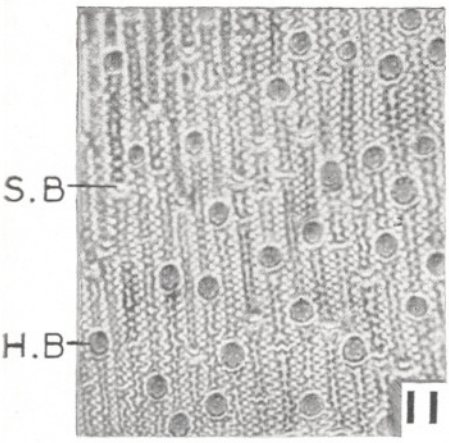
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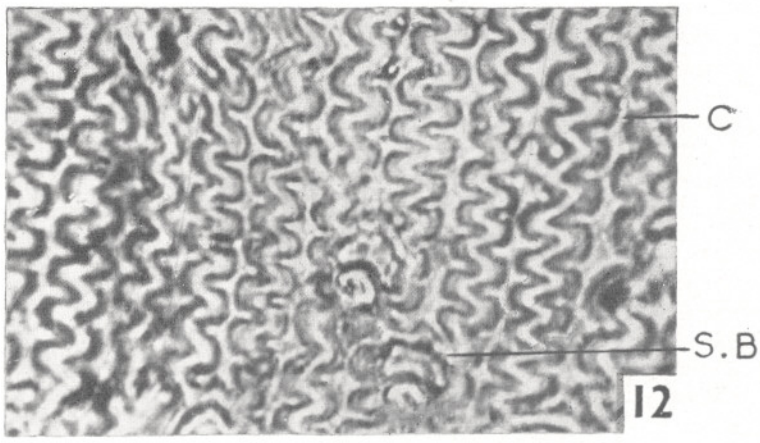
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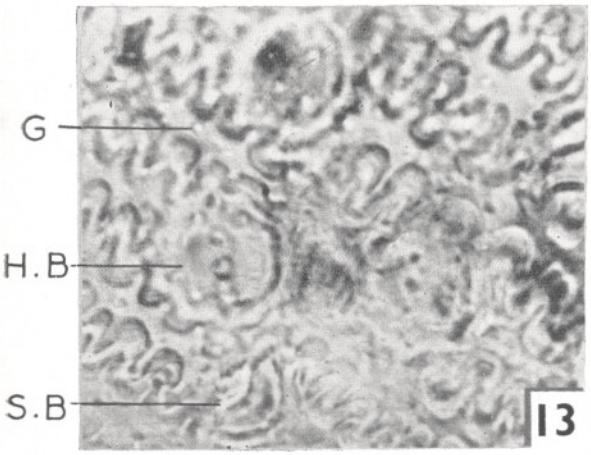
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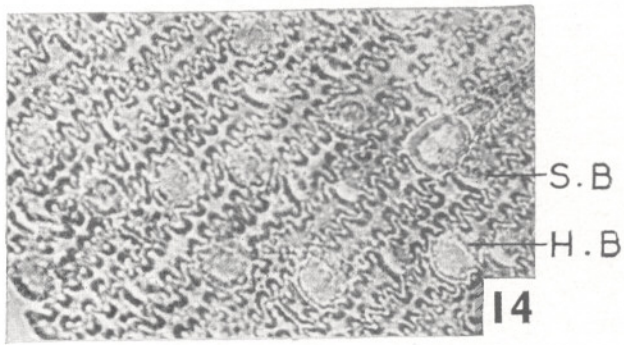
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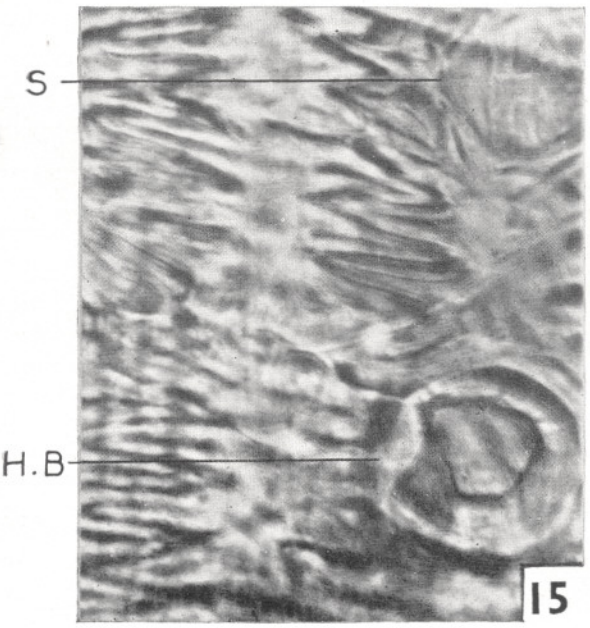
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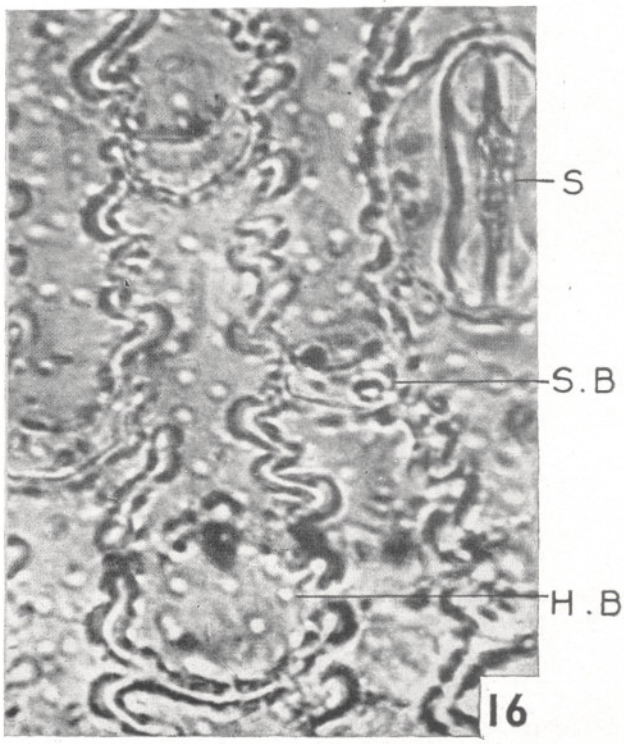
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