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Palaeoethnobotanical and palaeoecological investigations based on plant remains from Neolithic-Chalcolithic Tokwa, Uttar Pradesh, India

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ABSTRACT

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The investigations of carbonized remains from an ancient site, Tokwa on the confluence of Belan and Adwa rivers in Mirzapur District of Uttar Pradesh, have brought to light the agriculture based subsistence economy during the Neolithic and Chalcolithic cultures. The crop-remains are represented by *Oryza sativa*, *Triticum aestivum*, *Hordeum vulgare*, *Lens culinaris*, *Pisum arvense*, *Lathyrus sativus*, *Vigna radiata*, *Macrotyloma uniflorum*, *Linum usitatissimum* and *Brassica juncea*. Remains of weeds and wild taxa recovered as an admixture are denotative of the surrounding ground vegetation. The anatomical investigation of wood charcoals revealed the trees of *Tectona grandis*, *Syzygium* cf. *cumini*, *Streblus* cf. *asper*, *Dalbergia* sp., *Madhuca indica* and *Bambusa* sp. On the grounds of these remains some consideration has been weighed upon the ecological conditions of the surrounding.

Key-words—Carbonized remains, Tokwa, Neolithic, Chalcolithic, Vindhyan region.

भारत में उत्तर प्रदेश के नवपाषाणयुगीय-ताम्रप्रस्तरयुग तोकवा से प्राप्त वनस्पति अवशेषों पर आधरित पुरामानवजनित एवं पुरापारिस्थितिकीय अन्वेषण

अनिल के. पोखरिया, चंचला श्रीवास्तव एवं जे.एन. पाल

सारांश

उत्तर प्रदेश के मिर्ज़ापुर जिले में बेलन व अदवा नदियों के संप्रवाह पर प्राचीन स्थल तोकवा से प्राप्त कार्बनीकृत अवशेष के अन्वेषणों से नवपाषाणयुगीय और ताम्रप्रस्तरयुग सभ्यताओं के दौरान अस्तित्व गृहव्यवस्था आधारित कृषि का पता चला है। फसल अवशेष *ओराइज़ा सैटाइवा, ट्रिटीकम ऐस्टिवम, हॉरडियम वल्गेर, लेन्स कुलिनेरिस, पाइसम अर्वेन्स, लैथीरस सैटाइवस, विग्न रैडिएटा, मैक्रोटीलोमा यूनीफ्लोरम, लाइनम यूसीटैटीसियम* एवं *ब्रेसिका जुनेसिया* द्वारा रूपायित हैं। अधिमिश्रण के रूप में प्राप्त खरपतवार चहुंओर स्थलीय वनस्पति की द्योतक हैं। काष्ठ कोयले के शारीरीय अन्वेषण से *टेक्टोना ग्रांडिस, सायज़ीजियम* के तुलनीय, *कुमिनि, स्ट्रेब्लस* के तुलनीय *एज्पर डल्बर्जिया* जाति, *मधुका इंडिका* और *बम्बुसा* जाति के वृक्षों की प्राप्ति हुई है। इन अवशेषों के आधार पर आस-पास की पारिस्थितिक स्थितियों पर कुछ चिंतन किया गया है।

संकेत-शब्द—कार्बनीकृत अवशेष, तोकवा, नवपाषाणयुगीय, ताम्रप्रस्तरयुग, विंध्य प्रदेश ।

INTRODUCTION

The aim of this paper is to present the results of the examination of charred plant remains recovered from the Neolithic and Chalcolithic levels at Tokwa and discuss them in the light of the information on ancient agriculture in the Vindhyan region.

The Archaeological Site

Tokwa (Lat. 24°54'20" N; Long. 83°21'65" E) is situated on the confluence of the Belan and Adwa rivers in Mirzapur District of Uttar Pradesh (Figs 1-3). The northern margin of the site is flanked by the Belan River while the southern margin is facing the Adwa River. The western margin of the site looks like the peak of a triangle (Misra *et al*., 2001). The archaeological excavations at this site was carried out by Drs V.D. Misra, J.N. Pal (one of the authors) and M.C. Gupta of the Department of AIH, Culture and Archaeology, University of Allahabad, Allahabad during 2000 to 2003. The combined testimony of the excavations of trenches H-8, H-9, I-8, I-9 and control pits brought to light the archaeological evidence of three cultures namely Neolithic, Chalcolithic and Iron Age. The occupational strata divisible into as many as 16 layers measured 4.00 m. The botanical samples studied from the Neolithic and Chalcolithic cultures reveal grains, seeds, fruits and wood charcoal (Fig. 4).

Chronology

Six radiocarbon dates of the charcoal samples from different layers belonging to the Neolithic (Layers: 16, 14 and 12), Chalcolithic (Layer: 6) and Pre NBPW with Iron Age (Layers: PSB 4 and 3) levels from Tokwa are available. Their calibrated values in BP and BC are set out in Fig. 5.

Among the dates from the Neolithic level only one (BS-2369) gives an early date which corresponds to other dates from Koldihwa, Jhusi and Lahuradewa (Misra, 2006; Tewari *et al*. 2003, 2005). Other two dates (BS-2370 and BS-2054) from this level fit with the Chalcolithic dates from other sites of the Vindhyas and the Ganga Valley. There is a sharp slope in the layers at the site and these are considerably thin in the northern and eastern area of the trenches. Moreover, the site was disturbed during Chalcolithic and Iron Age due to deep undercut pits, therefore, there is possibility of mixing of the material. Possibly, this may be the reason for early dates corresponding to Neolithic culture from Chalcolithic phase (BS-2464) and pre-NBPW Iron Age level (BS-2417 and BS-2419). In the light of these dates, the antiquity of the Neolithic culture of the Vindhyans may be traced back to 7th millennium BC. Based on radiocarbon dates of other Neolithic and Chalcolithic Cultural settlements in this region, the botanical remains from this site have been discussed within a time range of 7th-2nd millennium BC.

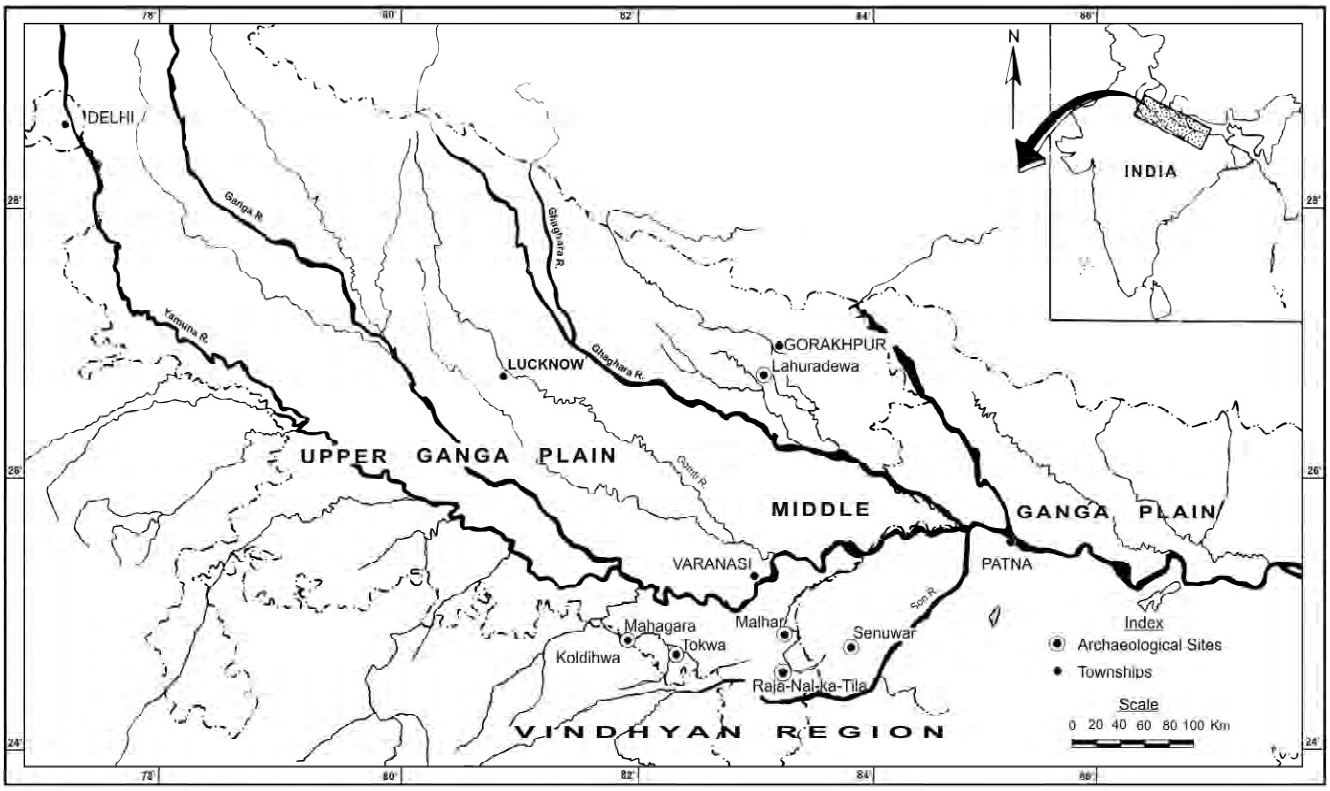

Fig. 1—Map showing Tokwa and other archaeological sites (modified after Tewari, R 2004).

Fig. 2—Showing the archaeological mound and the Belan River.

Fig. 3—General layout of the trenches.

MATERIAL AND METHODS

The plant material for the present investigation was obtained by water floatation technique during the course of excavations in 2000 and 2003. Water floatation provided a means of fast and efficient separation of carbonized and silicified plant material. Soil from varied successive horizons at different depths in the cultural deposits was poured into a body of water, allowing light (organic) botanical material to float. Floats were then collected in a hand held 25 mesh geological sieve. Some of the grains, seeds or fruits might have got burnt and became wholly or partly carbonized and, thus, imperishable. This is unquestionably the reason for the presence of some carbonized material. It would, of course, be quite uncertain which food grains or the other seeds and fruits of weeds and other wild taxa became carbonized. However, all the samples from both the cultural periods have brought out an average composition of ancient food-stuffs. Scrutiny of contexts in which the seed and fruit assemblages occur, is also critical in deducing the sources from where and through what sort of human activities these were deposited in the strata. Equal chances of the exposure to fire do not necessarily lead to equal chances of preservation. Therefore, certain types of remains were accidentally carbonized and preserved. Some remains have also been recovered from the pits.

By and large the grains, seeds and fruit remains in carbonized state were found in a better state of preservation from the deposits with little or no ash. In some cases, severe carbonization of the grains and seeds could not reveal diagnostic features. The fragments of carbonized woods were the most abundant macro-remains recovered through water floatation. Wood charcoals were processed and sectioned by conventional techniques. Strengthening of the charcoal fragments in better state of preservation was done by impregnating them in celloidin dissolved in acetone in order to fill the air spaces and to harden the tissue. The charcoal pieces were subjected to embedding in histo-wax and the blocks were prepared to obtain the sections by rotary microtome. A few charcoal pieces with preserved anatomical structures allowed the eventual identification. Quantitative and qualitative measures have been found to be of little meaning, in view of the biases introduced during carbonization and preservation.

THE PLANT REMAINS

Field-crops, weeds & wild taxa

Oryza sativa L. (Rice, Pl. 1.1, 1.3; Pl. 2.1)

118 more or less complete and some broken grains could be segregated from the mixture. Practically all the grains are without husk. Grains are elongate to narrowly oblong, flattened and ribbed. Ribs vary from 3-4 in number.

Morphologically, the grains are comparable with those of cultivated form of rice (*Oryza sativa*). However, grains of some perennial and annual species of wild and weedy rice also exhibit more or less similar features, hence, the definite identification of *Oryza sativa* on the basis of grains without husk becomes difficult. The husk impressions of rice on pot-sherds and burnt-mudclods were collected to study the pattern of epidermal tissue of lemma and palea (glumes). The tissue gives an appearance of a chess-board pattern under low magnification, leaving fine slits between their alignments in rows. Under high magnification, the granules in the husk impression appear somewhat cubicular in shape and show their sharp alignment in anastamosing and horizontal wavy rows (Pl. 1.3). These features noticeable in the glumes of a number of cultivated forms of *Oryza sativa* have been advantageous to refer the carbonized grains to some cultivated form of rice.

Measurements: L (4.00-5.40) 4.70 x B (2.00-2.50) 2.30 x T (1.40-2.00) 1.85 mm.

Indices: L/B= 2.04 mm, L/T= 2.54 mm, B/T= 1.24 mm.

Triticum* cf. *aestivum L. (Bread wheat, Pl. 1.4; Pl. 2.3)

Elongated grains with thickest portion just above the embryo have been encountered. Dorsal side is rounded and the cheeks to the ventral furrow are also rounded. Therefore,

Archaeological provenance	Grains/Seeds/Fruits	Wood charcoal
	Neolithic period	
Trench/Locus: I8 Stratum: 16 Depth: 2.53-2.43 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Vicia sativa, Chenopodium album, Ziziphus nummularia*	
Trench/Locus: I8 Stratum: 15 Depth: 2.43-2.14 m	*Oryza sativa, Hordeum vulgare, Macrotyloma uniflorum, Vicia sativa, Chenopodium album*	
Trench/Locus: I8 Stratum: 14 Depth: 2.14-2.02 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Vigna radiata, Brassica juncea, Vicia sativa*	
Trench/Locus: I8 Stratum: 13 Depth: 2.02-1.92 m	*Hordeum vulgare, Triticum aestivum, Oryza sativa, Lens culinaris, Chenopodium album*	
Trench/Locus: I8 Stratum: 12 Depth: 1.92-1.84 m	*Oryza sativa, Lens culinaris, Linum usitatissimum, Vicia sativa, Setaria* sp.	
Trench/Locus: I8 Stratum: 11 Depth: 1.84-1.73 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Vigna radiata, Vicia sativa*	
Trench/Locus: I8 Stratum: 10 Depth: 1.73-1.63 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Linum usitatissimum, Vicia sativa, Chenopodium album*	
Trench/Locus: I8 Stratum: 9 Depth: 1.63-1.48 m	*Hordeum vulgare, Lens culinaris, Chenopodium album*	
Trench/Locus: I8 Stratum: 8 Depth: 1.48-1.33 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Vigna radiata*	
Trench/Locus: I9 Stratum: 16 Depth: 2.14-2.05 m	*Oryza sativa*	
Trench/Locus: I9 Stratum: 10 Depth: 1.45-1.36 m	*Hordeum vulgare, Oryza sativa, Vigna radiata*	
Trench/Locus: I9 Stratum: 8 Depth: 1.24-1.13 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Brassica juncea, Vicia sativa*	
Trench/Locus: H9, A11 Stratum: PSB (16) Depth: 2.55 m	*Annona* cf. *squamosa*	
Trench/Locus: H9 Stratum: 15 Depth: 3.02 m		*Syzygium* cf. *cumini, Madhuca indica*
Trench/Locus: H9 Stratum: 13 Depth: 2.25 m	*Annona* cf. *squamosa,*	*Tectona grandis, Bambusa* sp.
Trench/Locus: H9 Stratum: 11 Depth: 1.80 m		*Streblus* cf. *asper*
Trench/Locus: H9 Stratum: 9 Depth: 1.60 m		*Streblus* cf. *asper, Madhuca indica*
Trench/Locus: H8 Stratum: 12 Depth: 2.20 m	*Annona* cf. *squamosa*	*Tectona grandis, Bambusa* sp.

Trench/Locus: H8 Stratum: 11 Depth: 2.10 m		*Bambusa* sp., *Dalbergia* sp.
Trench/Locus: Control pit Stratum: 15 Depth: 3.65 m	*Hordeum vulgare*	
Trench/Locus: Control pit Stratum: 14 A Depth: 3.40 m	*Triticum aestivum, Oryza sativa, Lens culinaris, Vigna radiata, Setaria* sp.	
Trench/Locus: Control pit Stratum: 14 B Depth: 3.30 m	*Hordeum vulgare, Triticum aestivum, Vigna radiata, Macrotyloma uniflorum, Setaria* sp.	
Trench/Locus: Control pit Stratum: 13 Depth: 3.02 m	*Hordeum vulgare, Triticum aestivum, Oryza sativa, Lens culinaris, Vigna radiata, Linum usitatissimum, Annona* cf. *squamosa, Vicia sativa, Setaria* sp.	
Trench/Locus: Control pit Stratum:12 Depth: 2.80 m	*Hordeum vulgare, Triticum aestivum, Oryza sativa, Setaria* sp.	
Trench/Locus: Control pit Stratum: 12 Depth: 2.80 m	*Oryza sativa*	
Trench/Locus: Control pit Stratum: 8 Depth: 1.90 m	*Hordeum vulgare, Setaria* sp.	
	Chalcolithic period	
Trench/Locus: I8 Stratum: 7 Depth: 1.33-1.23 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Vigna radiata, Fimbristylis* sp.	
Trench/Locus: H9, B7 Stratum: 5 Depth: .90-1.10 m	*Vigna radiata*	
Trench/Locus: H9, A9 Stratum: 5 Depth: .90-1.10 m	*Hordeum vulgare, Pisum arvense, Vigna radiata, Lathyrus sativus, Setaria* sp.	
Trench/Locus: H9, A11 Stratum: 5 Depth: .90-1.10 m	*Hordeum vulgare, Vigna radiata, Setaria* sp.	
Trench/Locus: H9, A11 Stratum: 5 Depth: .90-1.10 m	*Oryza sativa, Vigna radiata, Ziziphus nummularia*	
Trench/Locus: H8 Stratum: PSB (6) Depth: 1.60 m		*Madhuca indica, Syzygium* cf. *cumini*
Trench/Locus: H8 Stratum: PSB (5) Depth: 1.50 m		*Bambusa* sp., *Madhuca indica*
Trench/Locus: I8 Stratum: PSB (6) Depth: 1.30 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Vigna radiata, Coix lachryma-jobi*	
Trench/Locus: I8 Stratum: PSB (4) Depth: 1.00 m	*Hordeum vulgare, Oryza sativa, Lens culinaris, Vigna radiata, Macrotyloma uniflorum, Fimbristylis* sp.	

Fig. 4—Plant remains recovered from Tokwa, Mirzapur District, Uttar Pradesh.

Trench	Depth (cm)	Layer	Lab No. BSIP	^{14}C date (yrs BP)	Calibrated date (BP)	Calibrated date (BC)
I-8	243-253	16	BS-2370	3300±80	3635-3414	1685-1464
H-8	300-330	14	BS-2369	6850±200	7926-7511	5976-5561
H-8	220-225	12	BS-2054	3410±70	3810-3572	1860-1622
I-8	105-123	6	BS-2464	5620±310	6747-6001	4797-4051
H-9	105-120	PSB (4)	BS-2417	7530±230	8541-8056	6591-6106
H-9	80-100	3	BS-2419	3770±90	4256-3986	2306-4156

Fig. 5— ^{14}C Radiocarbon dates of charcoal samples from Tokwa.

on the basis of shape and other morphological features, grains closely resemble with those of bread-wheat (*Triticum aestivum*).

Measurements: L (4.30-4.70) 4.50 x B (3.00-3.50) 3.25 x T (2.00-2.60) 2.30 mm.

Indices: L/B= 1.38 mm, L/T= 1.95 mm, B/T= 1.41 mm.

Hordeum vulgare L. emend. Bowden (six-rowed hulled barley, Pl. 1.2; Pl. 2.2)

78 elongated grains tapering towards the apex with a widening ventral furrow have been encountered from Neolithic and Chalcolithic cultural periods. Some of the grains show traces of longitudinal ridges along the flanks and the shallow ventral-furrow, caused by lost husk. Since the grains are either partly asymmetrical or show slight ventro-lateral twist, the barley is identified as the six-rowed hulled type.

Measurements: L (4.50-5.00) 4.70 x B (3.00-3.70) 3.35 x T (2.00-2.50) 2.25 mm.

Indices: L/B= 1.40 mm, L/T= 1.48 mm, B/T= 1.48 mm.

Lens culinaris Maedik. (Lentil, P. 1.5; Pl. 2.8)

33 leguminous seeds which are circular and flattened with keeled margins, appear lenticular in shape. Hilum is very small and lanceolate. In shape and size, the carbonized seeds are comparable to those of *Lens culinaris*.

Measurements: 2.50-3.00 mm in diameter.

Pisum arvense L. syn. *P. sativum* var. *arvense* (L.) Poir (Field-pea, Pl. 1.9; Pl. 2.6)

Three rounded to hemispherical seeds with small ovate hilum have been recorded along with some broken-pieces from both the cultural phases. Seed coat is blurred and rubbed off at places.

Measurements: 3.00 mm in diameter (seed); 1.00 mm in length (hilum).

Lathyrus sativus L. (Grass-pea, Pl. 2.9)

Single seed, somewhat squat and wedge-shaped. Rough textured seed coat is blurred at places.

Measurements: 4.00 (L) x 3.80 (B) x 2.00 (T) mm.

Vigna radiata (L.) Wilczek (Green-gram, Pl. 1.6, 1.7; Pl. 2.4, 2.5)

The lot comprises 72 complete seeds and 1060 complete and partly broken cotyledons. Seeds are somewhat cylindrical with rounded to angular ends. Hilum is elliptical, about 1.00 mm long and evenly flat on the surface of seed coat.

Measurements: L (3.30-3.75) 3.52 x B (2.25-3.00) 2.62 x T (2.00-3.00) 2.50 mm.

Indices: L/B= 1.34 mm, L/T=1.44 mm, B/T= 1.04 mm.

Macrotyloma uniflorum (Lam.) Verdcourt (Horse-gram, Pl. 2.7)

Ellipsoidal to somewhat kidney-shaped seeds with small elliptical hilum have been encountered. They have smooth surface and resemble with those of horse gram.

Measurements: L (3.00-3.50) 3.25 x B (2.30-2.60) 2.45 x T (1.50) mm.

Indices: L/B=1.32 mm, L/T=2.16 mm, B/T=1.63 mm.

Brassica* cf. *juncea (L.) Czern and Coss. (Field brassica, Pl. 1.10)

Five seeds showing six-sided polygonal areas form a characteristic reticulum on the surface. These were compared with similarly looking seeds of *B. juncea* (L.) Czern & Coss, *B. napus* L., *B. nigra* Koch, *Brassica oleracea* L., *B. rapa* L., and cultigens of *Brassica campestris*. *Brassica napus* and *Brassica oleracea* have no polygonal reticulations. Reticulations are 5-sided in *B. campestris* var. *toria*, 7- sided in *B. campestris* var. *sarson* and 6-sided in *B. campestris* var.

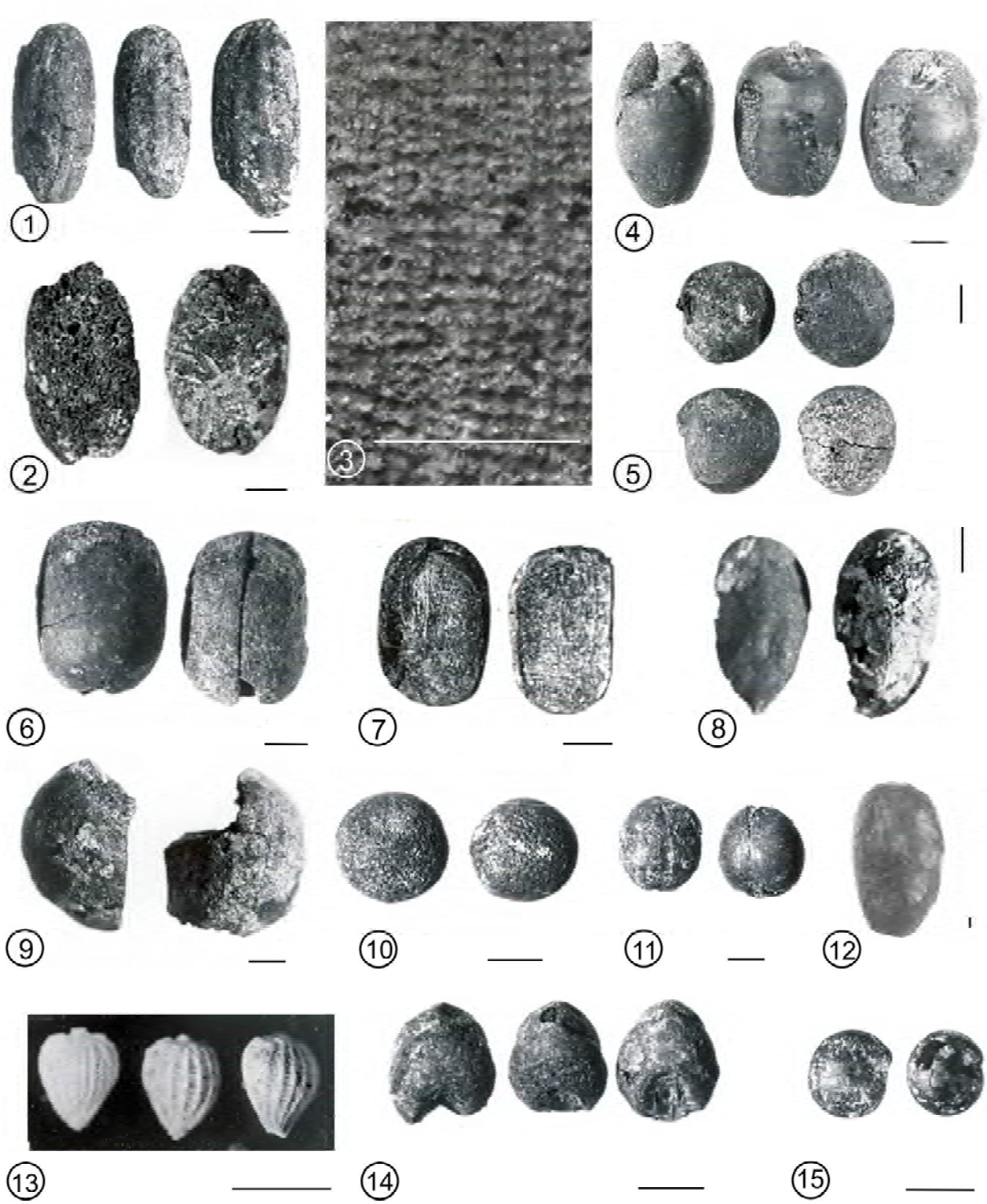

PLATE 1

(Bar = 1 mm)

1. *Oryza sativa* (rice)
2. *Hordeum vulgare* (hulled barley)
3. *Oryza* husk impression
4. *Triticum aestivum* (bread wheat)
5. *Lens culinaris* (lentil)
6. *Vigna radiata* (green gram)
7. *Vigna radiata* (cotyledon)
8. *Linum usitatissimum* (linseed)
9. *Pisum arvense* (field-pea)
10. *Brassica juncea* (Indian mustard)
11. *Vicia sativa* (common vetch)
12. *Annona* cf. *squamosa* (custard-apple)
13. *Fimbristylis* sp.
14. *Setaria* cf. *glauca* (foxtail grass)
15. *Chenopodium album* (goose foot)

dichotoma and *B. juncea*, 5-6 sided in *B. nigra*, 6-7 sided in *B. Rapa* (Buth & Roshan Ara, 1983). Seed samples having strictly 6-sided reticulations may belong to either *B. campestris* or *B. juncea* forms. The cultivation of *Brassica juncea* goes back to Harappan times. Therefore, the ancient *Brassica* seeds from Tokwa have tentatively been referred to *Brassica* cf. *juncea*.

Measurements: 1.90-2.10 mm in diameter.

Linum usitatissimum L. (Linseed/Flax, Pl. 1.8)

Three elongated seeds relatively narrower at one end have been recorded.

Measurements: L (3.50-4.00) x B (2.00-2.50) x T (1.20) mm.

Annona* cf. *squamosa L. (Custard-apple, Pl. 1.12)

One complete and some half broken seeds were recovered from the Neolithic phase. Seeds smooth and oblong with ruminate endosperm resemble to those of *Annona* cf. *squamosa*.

Measurements: L (16.00) x B (10.00) x T (6.00) mm.

Vicia sativa L. (Common vetch, Pl. 1.11)

Seeds globular to some what cubicular measure 1.90-2.10 mm in diameter. Small, ovate hilum is raised along the median grove. These seeds are comparable to those of *Vicia sativa*.

Setaria glauca (L.) P. Beauv. (Foxtail-grass, Pl. 1.14; Pl. 2.11)

Grains are ovoid to somewhat oblong with narrow upper end and dorsal curved side. Hilum is conspicuously broad and occasionally covers upto half of the length of the grains which are comparable to those of *Setaria* cf. *glauca*.

Measurements: L (1.70-2.00) x B (1.50-1.70) mm.

Coix lachryma-jobi L. (Job's tear, Pl. 2.10)

The evidence is furnished by silicified involucres. Involucres, false fruits or pseudocarps connote the bead-like oval-cylindrical structures of *Coix* grass, formed from hard shell-like bracts or metamorphosed leaf sheaths, which enclose the female spikelets (Haines, 1910, 1924; Bor, 1960). *C. aquatica*, *Coix gigantean*, and *C. lachryma-jobi* are three species, commonly occurring in the regions of Bihar and Orissa (Haines, 1924). The involucres show striations and conform to those of the var. *ma-yuen* of *Coix lachryma-jobi*. In other variety, *lachryma-jobi* involucres are hard and polished. Both the varieties of this species grow commonly in wild state along the water-courses, ditches, etc. and are also cultivated by hill-tribes in the eastern region of India.

Measurements: L (6.50-8.25) x B (5.50-6.50) mm.

Chenopodium album L. (Goosefoot/Bathua, Pl. 1.15)

Circular and compressed-lenticular seeds having rounded margin and a characteristic marginal notch measure 1.00-1.20 mm in diameter. On comparative grounds they are referred to the seeds of *Chenopodium album*.

***Fimbristylis* sp.** Vahl. (Pl. 1.13; Pl. 2.12)

Nuts are orbicular to ovate and stalked measuring about 1.00-1.30 x .90-1.20 mm in size (L x B). Surface cells are quadrate-hexagonal and aligned in 5-12 longitudinal rows on each face of the nut. It is large genus of annual or perennial sedges are found throughout the warmer regions. About 60 species of it are reported from India and most of them occur as weeds in moist soils and rice fields. These have, therefore, been referred to *Fimbristylis* sp.

Ziziphus Mill. (Jujube)

Some broken pieces of stones have been encountered in the mixture. They exhibit characteristic tuberculate surface. On morphological ground these are comparable to *Ziziphus nummularia*.

Wood charcoal

Tectona grandis L.f. (Teak/Sagaun, Pl. 3.1-3.6)

Wood ring-porous. Growth ring distinct, large-early wood vessels enclosed in parenchymatous zone, followed by small late-wood vessels in fibrous tissue. Early-wood vessels solitary or in multiples of 2-3, oval to round; 80-280 μm in tangential diameter; late-wood vessels, solitary and in multiples of 2-3, av. 180 μm in tangential diameter. Parenchyma paratracheal sparse, confined to immediate vicinity of vessels and vessel-groups; paratracheal zonate parenchyma restricted to early-wood zone, forming a band in which large vessels wholly or partly embedded; apotracheal parenchyma in the form of scattered cells in fibrous tissue. Fibres non-libriform, septate, aligned irregularly. Rays broad, 1-5 seriate, 62-135.5 μm wide, 10-80 cells or 280-1050 μm in height.

Madhuca indica J.F. Gmel (Mahua, Pl. 3.7-3.10)

Wood diffuse-porous. Vessels small to large, solitary as well as in radial multiples of 2-4; 55.5-200 μm in diameter; inter-vascular pits large, oval, with wide border and linear to somewhat lenticular horizontal orifice. Parenchyma paratracheal and apotracheal in cambiform rows of 4-6 units; paratracheal parenchyma scanty, contiguous to vessels and not differentiable from a few vesicentric tracheids in cross section; apotracheal parenchyma abundant, scattered in fibrous tracts.

PLATE 2

(Bar =1 mm)

1. *Oryza sativa* (rice)
2. *Hordeum vulgare* (hulled barley)
3. *Triticum aestivum* (bread wheat)
4. *Vigna radiata* (green gram)
5. *Vigna radiata* (cotyledon)
6. *Pisum arvense* (field-pea)
7. *Macrotyloma uniflorum* (horse gram)
8. *Lens culinaris* (lentil)
9. *Lathyrus sativus* (grass-pea)
10. *Coix lachryma-jobi* (job's tear)
11. *Setaria* cf. *glauca*
12. *Fimbristylis* sp.

Fibres libriform, non-septate, smaller than parenchyma; aligned in concentric bands alternating with the parenchyma bands. Rays fine, heterogenous, 1-4 seriate, 40-85 μm wide, 10-25 cells or 300-750 μm in height**.**

Syzygium* cf. *cumini (L.) Skeels (Jamun, Pl. 4.1-4.4)

Wood diffuse-porous. Vessels large to medium-sized, solitary as well as in radial multiples of 2-3. Tangential diameter 75-180 μm (av. 150 μm). Parenchyma paratracheal, paratracheal-zonate and apotracheal; paratracheal parenchyma relatively sparse forming uniseriate sheath interrupted by rays or the fibres contiguous to the vessels, paratracheal-zonate parenchyma in the form of more or less continuous bands, apotrachael parenchyma abundant. Fibres semi-libriform and non-septate. Rays fine, 1-3 seriate, heterogenous, 17-45 μm wide, 7-20 cells or 130-350 μm in height.

***Bambusa* sp.** L. (Bamboo, Pl. 4.5, 4.6)

Cross-section shows fibro-vascular bundles scattered in parenchymatous ground tissue. Cells of ground tissue are more or less similar in size. Vascular bundles with two sclerenchymatous caps, one on the outer pole and the other one on inner pole are separated by thin walled ground tissue. In general anatomical features the charcoal resembles with bamboo and therefore, referred as *Bambusa* sp.

Streblus* cf. *asper Lour. (Dahia, Pl. 4.7-4.10)

Wood diffuse-porous. Vessels small to medium, solitary and in radial multiples of 2-3, 25-70 μm in tangential diameter. Paratracheal parenchyma sparse, restricted to immediate vicinity of the vessels, forming a conspicuous one to several seriate sheath around the vessels or vessel-groups, paratracheal-zonate parenchyma very abundant, forming concentric, somewhat undulated, broad bands containing vessels and alternating with the bands of fibrous tissue, apotracheal parenchyma thin, solitary cells scattered in the fibrous tissue. Fibres fine, septate and not aligned in radial rows. Rays, 1-5 seriate, heterogeneous.

***Dalbergia* sp.** (Sheesham, Pl. 4.11-4.14)

Wood diffuse porous. Vessels large to small, oval to round, solitary or in radial multiples of 2-3, 75-300 μm in diameter; inter-vascular pits not seen. Parenchyma paratracheal, paratracheal-zonate and apotracheal; paratracheal parenchyma forming one to several seriate sheath around the vessels or vessel groups, paratracheal-zonate parenchyma forming concentric, more or less continuous bands alternating with the bands of fibres, apotracheal parenchyma scattered throughout the fibrous tissue. Fibres libriform, non-septate. Rays fine, closely spaced, 1-4 seriate, homocellular, 15-70 μm wide, 7-35 cells or 100-525 μm high.

The anatomical characters show its nearest affinity with *Dalbergia* sp. Species like *D. sissoo* Roxb. ex DC. and *D. latifolia* Roxb. commonly occur in the Vindhyan Plateau region. Therefore, the wood charcoal might have belonged to either of the two species.

DISCUSSION AND CONCLUSION

On biogeographic grounds rice crop has wild progenitors in this region. The plant remains recovered from the Tokwa archaeological site are demonstrative of mixed cultivation system from both the occupational phases. Rice (*Oryza sativa*), green-gram (*Vigna radiata*), horse-gram (*Macrotyloma uniflorum*) of the Indian origin were grown in the warm rainy season. Barley (*Hordeum vulgare*), bread-wheat (*Triticum aestivum*), field-pea (*Pisum arvense*), lentil (*Lens culinaris*), grass-pea (*Lathyrus sativus*) and linseed (*Linum usitatissimum*) of Near-Eastern Complex and Indian mustard (*Brassica juncea*) of the Indian origin were grown in the winter season. Similar evidence has also been noticed from other sites in the Vindhyan and Gangetic regions (Harvey *et al*., 2005; Saraswat, 2004a, b; Vishnu-Mittre, 1972; Saraswat, 1992; Mehra, 1997; Srivastava, 2001; Saraswat, 2005; Saraswat *et al*., 2008; Pokharia *et al*., 2009a).

The growing archaeobotanical evidences from Lahuradewa, Senuwar and Mahagara (Saraswat, 2004b; Tewari *et al*., 2006; Harvey *et al*., 2005) in the region of Ganga Plain and Vindhyan region indicate that the earliest crop assemblages were composed of only native species, whereas non-native crops such as barley, wheat and pulses were added later.

Dissemination of barley, wheat, lentil, field-pea and grass-pea which are the Harappan crops in the northern and north-western India, is worthwhile to draw meaningful conclusions regarding cultural contacts with communities practising cultivation of these crops. Direct AMS dates of barley from Lahuradewa, Damdama, Mahagara and from stratigraphically

PLATE 3 →

Tectona grandis
1-2. Cross section
3-4. Tangential longitudinal section
5. Radial longitudinal section
6. Vascular pitting

Madhuca indica
7-8. Cross section
9. Tangential longitudinal section
10. Vascular pitting

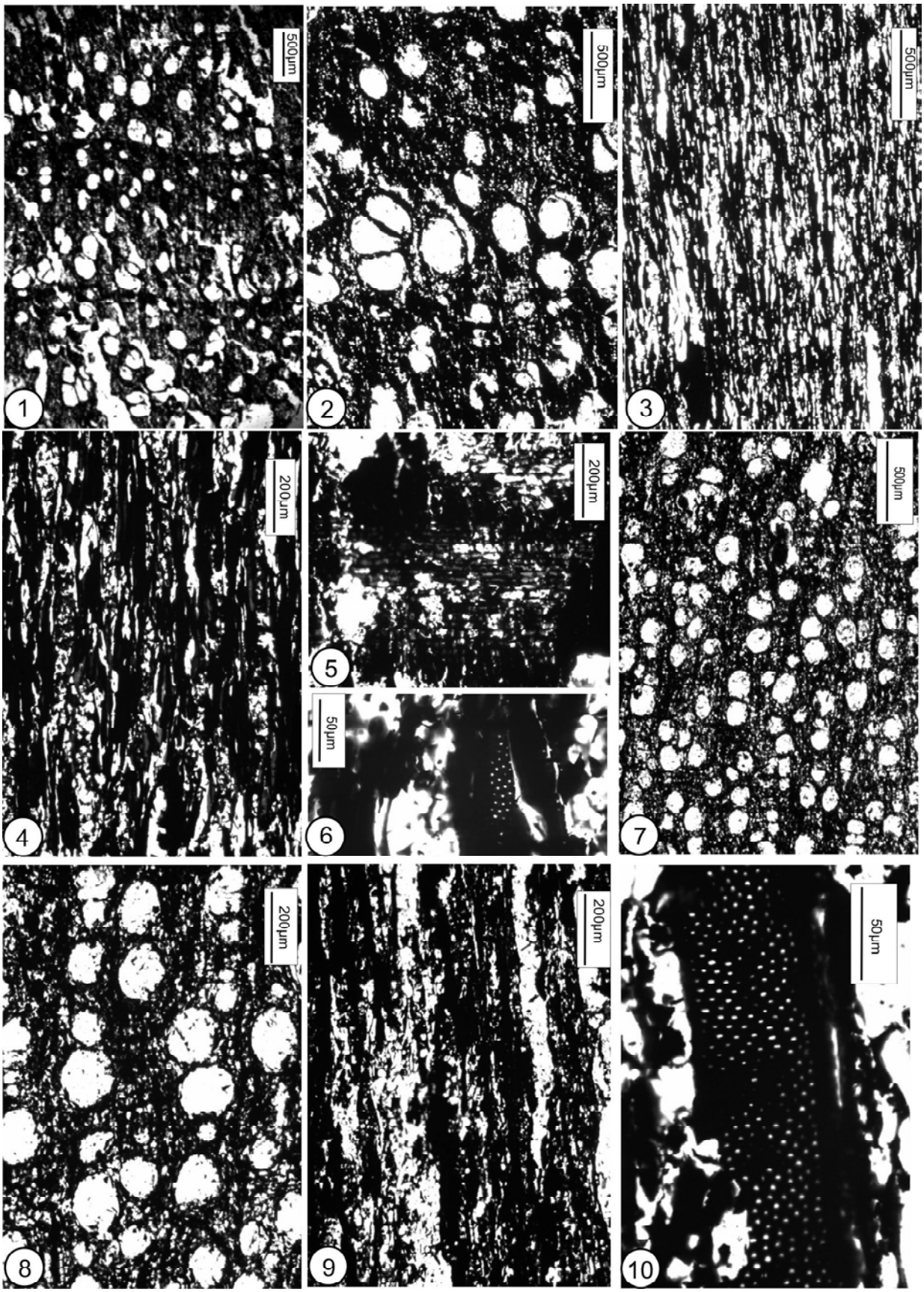
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PLATE 3

well defined Senuwar archaeological sites in the Ganga Plain and Vindhyan regions, the adoption of winter crops by 2400-1800 BC (Harvey *et al.*, 2005; Saraswat, 2004b; Saraswat, 2005; Tewari *et al.*, 2006) is suggested, and that during this time period the Harappan crops became culturally popular in the rice growing zone. The find of rice (*Oryza sativa*) in the food economy of the Early and Mature Harappans is equally important to discuss in terms of far distant movement of different cultural groups (Saraswat & Pokharia, 2002, 2003). It is still needed to infer what conditions led the wide-spread diffusion of the Harappan crops in the Vindhyan region and adjoining areas and *vice-versa* and how and when it actually commenced. This new cropping system might have not been accepted simply for the reason that it became available somewhere through the contact of settlers, but would have also been desirable and advantageous to them in the prevailing ecological situations. The plants and cultural data are not only complementary, but also absolutely interdependent for interpretation purpose.

The earliest evidence of domesticated rice dating back to 7-6th millennia BC has been reported from Koldihwa, Mahagara and more recently at Lahuradewa in the Ganga Plain (Sharma *et al*., 1980; Tewari *et al.*, 2003, 2006). However, more data have to be generated on the early domestication of rice in this region. Only future excavations and more direct dating of the archaeobotanical remains will help in understanding the origin of agriculture, as a whole, in this region.

Remains of weeds and wild taxa are relatively limited in the material analysed from Tokwa. *Vicia sativa* (common vetch) occurs as the most frequent weed in pulse-crops. It is forage legume of rich protein value which is eaten by cattle and also used as hay. This species spread in the Indian region from Europe through the North Temperate Zone in the Old World. *Coix lachryma-jobi* (job's tear) and *Setaria* cf. *glauca* (foxtail-grass) might have played important role in the subsistence economy of Tokwa settlers. Job's tear, a tall erect grass, commonly growing along water courses, ditches, etc. was at one time a fairly important cereal of the wet tropics of South and South-East Asia and is thought to have been an older domesticate than rice (Harlan, 1977). *Setaria* cf. *glauca* is the commonest species of foxtail-grass in the region, occurring in grasslands, self-sown and sometimes cultivated also as a kharif crop on uplands or hilly regions (Haines, 1925; Anonymous, 1972). In all probability, this species along with job's tear would have been a common component in the dietary of ancient people in the past.

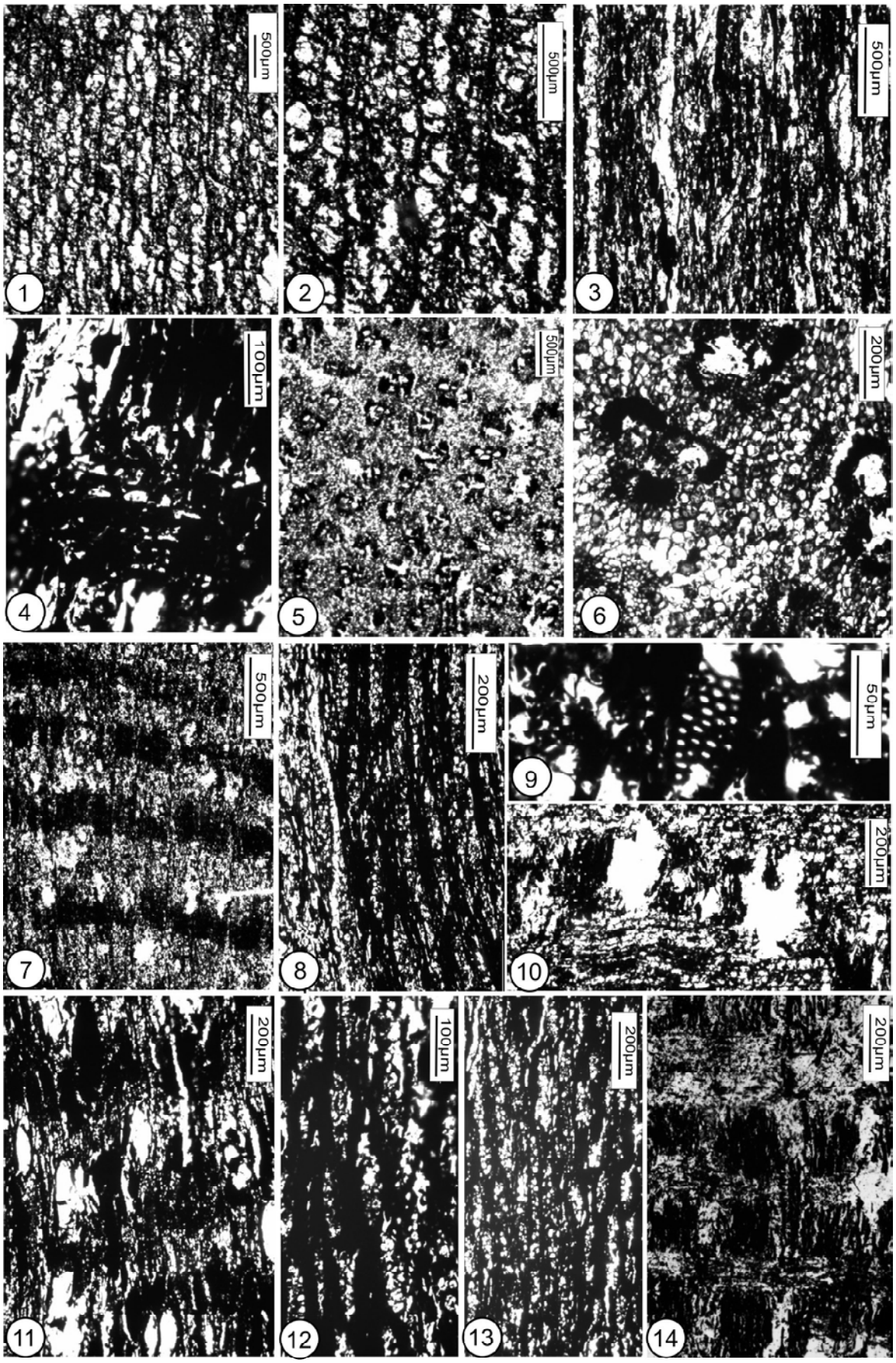
Chenopodium album is common in the moist places, occurs as weed in the cold season field-crops. It is eaten as a vegetable. *Fimbristylis* sp. grows in open wasteland and passage sides often in rice-fields. *Ziziphus nummularia* (jharberi), represented by one complete and some broken pieces of stone, is of common occurrence throughout the region and the area of study. Its fruits are eaten and bark containing tannin is powdered by the natives and used for dressing the wounds (Haines, 1925). This species is the component of scrubby vegetation. Among these remains some reflect moist localities, while others reflect grassy and scrubby places.

The most important find from the Neolithic deposit dated to 1740 BC is the seeds of South American *Annona squamosa* (custard-apple). An Indian origin of custard-apple is discounted and it has certainly been regarded by large number of botanists, plant geographers, ecologists, etc. to be American. The credit of its introduction in the 16th Century AD is given to the Portuguese (Watt, 1889; Mehra, 1965; Kapil, 1970; Randhawa, 1983). The occurrence of custard-apple in the form of fruit coats from Sanghol, Punjab during Kushana times (100-300 AD), seeds from Raja-Nala-ka-tila in Sonbhadra District, U.P. dated to 740 BC and now from the Neolithic Tokwa is to be reckoned with (Pokharia & Saraswat, 1999; Sekar *et al.*, 2007). The factual remains of custard-apple from archaeological sites in Indian soil favour a group of specialists supporting with diverse arguments, the reasoning of Asian–American contacts, before the discovery of America by Columbus in 1498. Plants do supply absolute evidence because they are not human inventions. It is matter of chance that factual evidence of custard-apple has been reported from three above archaeological sites in the Indian subcontinent. The kind of the evidence of *Annona* in authenticity and abundance has led us to sum up the discussion on direct or indirect communication between South Asia and America (for details see Sekar *et al*., 2007; Pokharia *et al.*, 2009b).

The wood charcoal belonging to six tree taxa represents a small fraction of forest components. Their retrieval is suggestive of sectorial reconstruction of forest around the habitational site. *Dalbergia* sp., a fast growing tree, occurs frequently in riverine forests, along with the moist loving trees such as *Syzygium* sp. and *Bambusa* sp. As the mound is on

PLATE 4 →

Syzygium sp.
1-2. Cross section
3. Tangential longitudinal section
4. Radial longitudinal section
Bambusa sp.
5-6. Cross section
Streblus sp.
7. Cross section
8. Tangential longitudinal section
9. Vascular pitting
10. Radial longitudinal section
Dalbergia sp.
11. Cross section
12-13. Tangential longitudinal section
14. Radial longitudinal section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10
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11
200µm
12
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13
200µm
14
200µm

PLATE 4

the confluence of the Belan and Adwa rivers, it is thus surmised that these taxa might have been growing gregariously in the vicinity of the ancient settlement. Other taxa, viz. *Streblus* sp., *Madhuca indica* and *Tectona grandis* associated with these trees occurred in varying proportion in the adjoining area of the investigation site, forming mixed-moist deciduous forest.

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