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Plant macroremains from Sarethi: An Early Historic site in Saryu region of Ganga Plain, Uttar Pradesh

ANIL K. POKHARIA[1*], PUSHP LATA SINGH[2], NEELAM MISHRA[1], ANOOP KUMAR[2], UPENDRA SINGH[2], ALKA SRIVASTAVA[3], ANJALI TRIVEDI[1], HIMANI PATEL[1], DIPAK KUMAR SHUKLA[2], CHANDRA BHUSHAN GUPTA[2] AND MD. AFROZ[2]

[1]*Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow 226 007, India.*
[2]*Department of AIHC and Archaeology, Banaras Hindu University, Varanasi 221005.*
[3]*Department of Botany, Dayanand College, Kanpur 208001.*
[*]*Corresponding author: pokharia.anil@gmail.com*

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ABSTRACT

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The paper highlights additional data on the carbonized remains of crop plants, weeds and wild taxa recovered from excavations at Sarethi, a multicultural site in district Faizabad, Uttar Pradesh. The field–crops are represented by the grains and seeds of *Oryza sativa* (rice), *Hordeum vulgare* (barley), *Triticum aestivum* (bread wheat), *T. sphaerococcum* (dwarf wheat), *Pisum arvense* (field pea), *Lens culinaris* (lentil), *Lathyrus sativus* (grass pea), *Vigna* sp. (green/black gram), *Macrotyloma uniflorum* (horse gram), *Linum usitatissimum* (linseed), and *Gossypium arboreum/herbaceum* (cotton) dating back to 200 BCE–700 CE. In addition, few weeds and wild taxa denotative of cultivated fields and surrounding vegetation have also been recorded in the assemblage. The plant remains have been discussed and compared with the information on plant based subsistence economy from other sites in the region.

Key–words—Sarethi, Archaeobotany, Early Historic, Ganga Plain, Double–cropping.

सरेठी से प्राप्त पादप स्थूल अवशेषः गंगा के मैदान, उत्तर प्रदेश के सरयू अंचल में प्रारंभिक ऐतिहासिक स्थल

अनिल के. पोखरिया, पुष्प लता सिंह, नीलम मिश्रा, अनूप कुमार, उपेन्द्र सिंह, अल्का श्रीवास्तव, अंजलि त्रिवेदी, हिमानी पटेल, दीपक कुमार शुक्ला, चंद्र भूषण गुप्ता एवं मो. अफ़रोज

सारांश

उत्तर प्रदेश में जिला फ़ैजाबाद के बहुसांस्कृतिक स्थल, सरेठी में उत्खनन से प्राप्त फसली पौधों, खर पतवार एवं जंगली टैक्सा के कार्बनीकृत अवशेष पर यह शोध पत्र अतिरिक्त आंकड़ा विशेषताएं प्रदान करता है। 200 बी.सी.ई.–700 सी.ई. पूर्व आयु निर्धारित खेत की फसलें *ओराइज़ा सैटाइवा* (चावल) *हॉर्डियम वल्गरे* (जौ), *ट्रिटीकम एस्टीवम* (गेहूं), *टी. स्फेयरोकोकम* (बौना गेहूं), *पाइसम अर्वेन्स* (मटर), *लेन्स कुलीनेरिस* (मसूर), *लेथीरस सैटाइवा* (मटर), *विग्ना* जाति (हरा/काला चना), *मैक्रोटीलोमा यूनीफ्लोरम* (कुलथी), *लाइनम उसीटेटीस्सियम* (अलसी) एवं *गॉसीपियम अर्बोरियम/हर्बेसियम* (कपास), के दानों एवं बीजों से रूपायित हैं। इसके अतिरिक्त, समुच्चय में खेती किए हुए खेत और आस–पास वनस्पति के सूचक कुछ खर–पतवार एवं जंगली टैक्सा भी अभिलिखित की गई हैं। अंचल में अन्य स्थलों से पादप अवशेषों पर चर्चा की गई है तथा पादप आधारित निर्वाह अर्थव्यवस्था पर जानकारी से तुलना की गई है।

सूचक शब्द—सरेठी, पुरातत्व वनस्पतिविज्ञान, प्रारंभिक एतिहासिक, गंगा के मैदान, दोहरी फसल।

INTRODUCTION

THE Ganga Plain, one of largest alluvial tracts of the country, is densely inhabited fertile terrain. This region has been constantly under human occupation right from the advent of sedentary lifestyle, most likely since the termination of harsh Great Ice Age, i.e. Pleistocene and the beginning of the Holocene. The archaeobotanical investigations (Pokharia, 2008; Pokharia *et al.*, 2009, 2016) from different sectors of this region have provided precious database concerning the plant–based subsistence economies and cultivation approaches during different cultural settlements. In addition, the botanical remains retrieved have also unfolded the timing of dissemination of crops from one region to another in relation to cultural shifts (Pokharia *et al.*, 2016). Recently, the temporal and spatial impact of climate change on the magnitude of agricultural practice in the Ganga Plain has been confirmed through the pollen analytical investigation of lacustrine deposits (Chauhan *et al*., 2004, 2009, 2015; Wasson *et al.*, 2013), located close to archaeological sites. Here, we infer the crop economy based on the plant remains recovered, in relation to the cultural history through a systematic excavation carried out at archaeological site Sarethi under the supervision of Prof. Pushp Lata Singh, and her team members during 2016–2017. In the present communication, the botanical remains (seeds/fruits) retrieved from Sunga–Kushana and Gupta periods are presented and discussed in the light of the information on crop remains from the Ganga Plain region.

ARCHAEOLOGICAL SITE AND ITS ENVIRONS

The ancient mound of Sarethi (26°44'19" N; 82°12'45" E) is situated in District Faizabad, Uttar Pradesh at a distance of 5 km south of Ayodhya, the capital city of Koshal during the sixth century BCE (Fig. 1a–c). The site is locally known as 'Mira Pahalwan Baba Ka Sthan'. The main mound measures 150 x 130 m and its height is approximately 3.5 m from the ground level. A series of horseshoe–shaped lakes are located northeast and southwest of the mound. These lakes are the abandoned channels of River Ghaghara (Saryu), which is presently flowing 5 km northeast of the site. Sarethi is located in the Middle Ganga Plain in the Koshal region. The surrounding alluvial soil in the vicinity of Sarethi is very fertile, suitable for cultivation of all kinds of cereals but, paddy is the main crop of the area. At present, large portion of the mound is being cultivated and inhabited by villagers. The excavation revealed a continuous cultural sequence from Late Northern Black Polished Ware (NBPW) to Medieval times (Singh *et al*., 2018).

CULTURAL SEQUENCE

The excavation at Sarethi has brought to light the cultural sequence ranging from 400 BCE to 1500 CE based on ceramic analysis: Period I: Late Northern Black Polished Ware (400 BCE–200 BCE) Period II: Shunga–Kushana (200 BCE–300 CE) Period III: Gupta and Post Gupta (300–700 CE) Period IV: Medieval Period (1100–1500 CE) (excavator personal communication).

Period I–The earliest habitation about 84 cm of deposit in trench XA–1 belonging to Late NBPW in Layers 13, 14 and 15 is composed of dark yellow compact to light yellow compact soils (Fig. 1d and 1f). The main ceramics, viz. Northern Black Polished Ware (NBPW), Black Slipped Ware (BSW), and Red Ware were recorded. Bowls, basins, miniature pots, vases, and handis are the main shape types.

Period II–Sunga–Kushana culture was exposed in trenches XA–1, AA–3, XB–5 and Z–1 (Fig. 1e, f, g, h). The maximum thickness of the deposit of this period was found to be 2.80 m in trench XA–1. Similarly, a 2.76 m thick deposit of this period was found in trench AA–3. Red Ware is the dominant ceramic of this period. The main pottery types are ink pot knobbed lids, constricted–necked jar, bowls with everted rims, vases of different types, flared basins, storage jars, carinated handis, lids and sprinklers. A glass furnace along with huge quantity of slag was an important discovery of this period. The other finds of this period comprised terracotta figurines, terracotta beads, terracotta discs, beads of semi–precious stones, and glass, stone pestles, stone balls, antimony rods, rattles, glass slag, iron objects (nails), and copper bangles. The excavation also yielded sealings and copper coins.

Period III–The Gupta and Post–Gupta Period (300–700 CE) deposits were recorded in trenches XA–1, AA–3, XB–5 and Z–1. The colour and composition of the soil is greyish to yellowish in all the trenches. The total thickness of the deposits varied from 86 to 206 cm. The ceramic comprised essentially of Red Ware with some pot–sherds of Red Slipped Ware. The principal potsherds include various types of vases, incurved bowls, large basins, carinated handi, knobbed lid, storage jars and miniature vessels. The pottery of this period is mainly utilitarian in character and some potsherds are heavily decorated, particularly with incised designs. The important antiquities of this period are beads of semi–precious stones, glass bangles, terracotta balls, terracotta pestles, discs, human and animal figurines, copper and iron objects. Stone objects include grinders, pestles and skin rubbers. The other objects of interest were silver coins of Gupta emperor–Kumargupta–I.

Period IV–The ceramic assemblage of the Medieval Period (1100–1500 CE) comprises mainly Red Ware and

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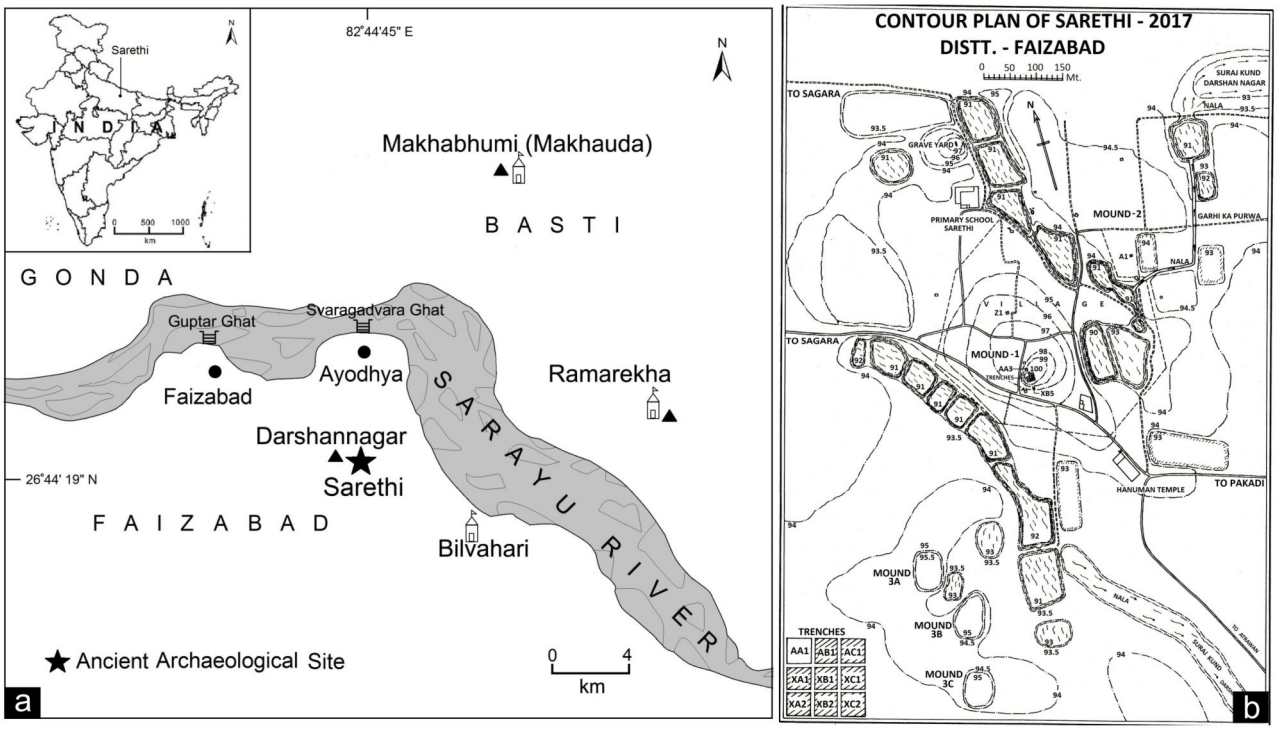
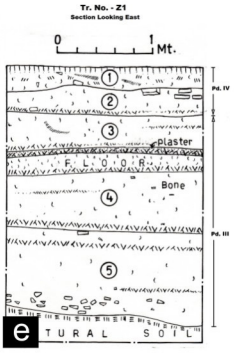
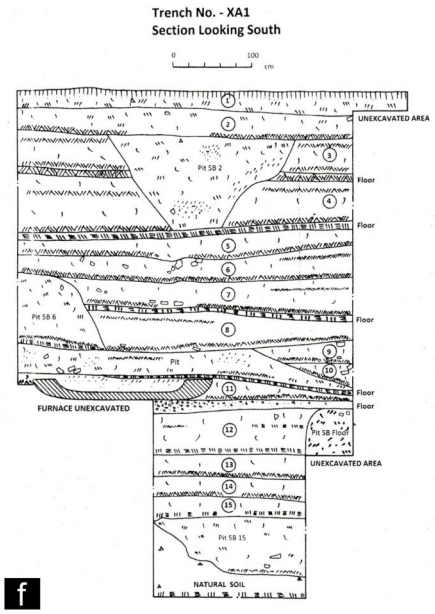
Fig. 1—a. Location map of archaeological site; b. Contour map of the mound Sarethi, c. Panoramic view of the archaeological mound and excavated trenches laid out, d. Excavated trench XA 1 showing stratified layers and other features; e–h, Section drawing of different trenches from which carbonised remains were collected for the present study.

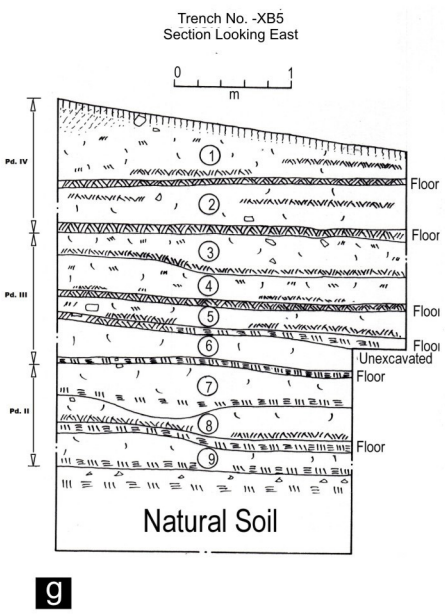

Sarethi
INDIA
0 500 1000 km
82°44'45" E
N
Makhabhumi (Makhauda)
BASTI
GONDA
Guptar Ghat
Svaragadvara Ghat
Ayodhya
Faizabad
Ramarekha
Darshannagar
Sarethi
26°44' 19" N
FAIZABAD
Bilvahari
SARAYU RIVER
Ancient Archaeological Site
0 4 km
a
CONTOUR PLAN OF SARETHI - 2017
DISTT. - FAIZABAD
0 50 100 150 Mt.
TO SAGARA
SURAJ KUND
DARSHAN NAGAR
NALA
GRAVE YARD
PRIMARY SCHOOL SARETHI
MOUND-2
GARHI KA PURWA
MOUND-1
AA3 TRENCHES
XB5
HANUMAN TEMPLE
TO PAKADI
MOUND 3A
MOUND 3B
MOUND 3C
TRENCHES
AA1 AB1 AC1
XA1 XB1 XC1
XA2 XB2 XC2
b

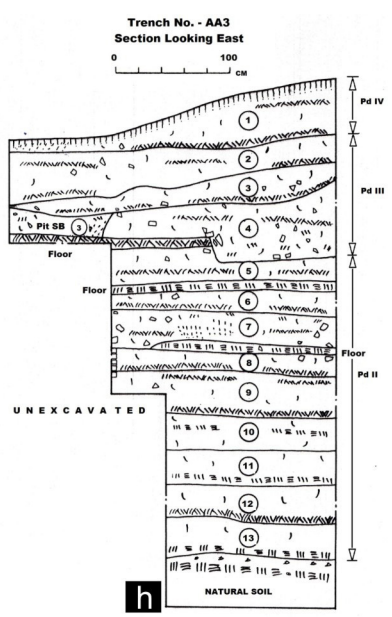

c


d


Tr. No. - Z1
Section Looking East
0 1 Mt.
Plaster
FLOOR
Bone
Pd. IV
Pd. III
e


Trench No. - XA1
Section Looking South
UNEXCAVATED AREA
Pit SB 2
Floor
Pit SB 6
Pit
FURNACE UNEXCAVATED
Pit SB Floor
Pit SB 15
NATURAL SOIL
f


Trench No. -XB5
Section Looking East
0 1 m
Pd. IV
Pd. III
Pd. II
Floor
Unexcavated
Natural Soil
g


Trench No. - AA3
Section Looking East
0 100 CM
Pd IV
Pd III
Pd II
Pit SB
Floor
UNEXCAVATED
NATURAL SOIL
h

Muslim Glazed Ware. The important shapes of the Red Ware type include spouted pots, vases, bowls, lid–cum–bowls, and carinated handis. The glazed ware is red, green or chocolate red. The antiquities include animal and human figurines, iron objects, glass bangles and beads, glass slag, terracotta beads, terracotta pestles, and semi–precious stone beads. The most important findings of this period are copper coins and terracotta sealing with a legend in Nagari script of the 11–13 Century CE.

MATERIAL AND METHODS

In all, 25 samples for archaeobotanical study were collected from Trench XA1, XA2, AA3, XB5 and Z1 during the course of excavations by the standard water floatation technique (Pearsall, 2001). Soil samples from varied successive horizons at different depths were floated to retrieve the carbonized plant remains by 0.5 µm geological sieve. Most of the plant remains were found in a good state of preservation from the deposits with little or no mud attached to them. The remains were examined under stereo–binocular microscope (Leica Z6APO) and sorted into categories of distinctive morphological types as listed in Table 1.

RESULTS

Radiocarbon dating

The charcoal amount in the sample was not enough to facilitate bulk sample dating. However, the carbonized seeds from one sample (AA3/385 cm) representing the Sunga–Kushana Period was used for dating and yielded a radiocarbon age of 1560 ± 29 BP (D–AMS 028245, 1sigma error). Furthermore, the archaeological artefacts from different cultural layers testify the cultural authenticity.

Macroremains

Five hundred and nine carbonized remains were segregated from all twenty–five samples belonging to Sunga–Kushana, and Gupta–Post Gupta Periods. The abundance, ubiquity and diversity index of charred remains from occupational phases in given in Table 2. The morphological descriptions of the identified macroremains from both the above cultural periods are given under separate categories as below:

Major cereals

Oryza sativa L. (rice, Fig. 2a)

In all, 102 carbonized grains without husk were recorded. Grains are elongate to narrowly oblong, flattened and ribbed. Ribs vary from 3–4 in numbers. Morphologically, they compare with the grains of cultivated form of rice (*Oryza sativa*). However, bold grains of some perennial and annual species of wild and weedy rice also give more or less similar look; the definite identification of cultivated rice on the basis of grains without husk is difficult. The remains recovered here are from Historic Periods, the agriculture was well established by this time. Therefore, the rice remains can safely be identified as of *Oryza sativa* type. Rice is an important crop of the Ganga Plain and its presence is known since the Neolithic times (Saraswat, 2004; Pokharia *et al*., 2009; 2016).

Measurements: L (5.3–5.4) 5.35 x B (2.3–2.5) 2.4 x T (1.4–2.0) 1.7 mm

Indices: L/B= 2.2, L/T= 3.1, B/T= 1.4

Hordeum vulgare L. emend. Bowden (six–rowed hulled barley, Fig. 2b)

Fifty–six elongated grains, tapering towards the apex and with a widening ventral furrow have been encountered. Some of the grains show partly asymmetrical or slight ventro–lateral twist, therefore identified as the six–rowed hulled barley. Barley, a winter–crop of west Asian origin was one of the staples of the Indus civilization and known from Neolithic, Chalcolithic and Iron Age sites in the Ganga Plain (Saraswat, 2004; Pokharia 2011; Pokharia *et al*., 2009, 2016).

Measurements: L (5.2–5.6) 5.4 x B (3.0–3.3) 3.1 x T (2.0–2.4) 2.2 mm

Indices: L/B= 1.7, L/T= 2.2, B/T= 1.4 mm

Triticum sphaerococcum Perc. (dwarf wheat, Fig. 2c)

The short, broad and more or less rounded grains compare in all morphological features with caryopses of dwarf–wheat. *T. sphaerococcum* has long been considered as a staple crop of the Harappan/Indus civilization (Pokharia *et al*., 2011, 2017 and references therein).

Measurements: L (3.2–3.7) 3.5 x B (2.5–3.1) 2.8 x T (2.2–2.6) 2.4 mm.

Indices: L/B= 1.2, L/T= 1.4, B/T= 1.1

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Fig. 2—a. *Oryza sativa* (cultivated rice); b. *Hordeum vulgare* (barley); c. *Triticum sphaerococcum* (dwarf wheat); d. *Triticum aestivum* (bread wheat); e. *Cicer arietinum* (gram), f. *Gossypium arboreum/herbaceum* (cotton); g & h. *Lens culinaris* (lentil); i. *Pisum arvense* (field pea); j. *Macrotyloma uniflorum* (horse gram): k. *Cajanus cajan* (pigeon pea); l. *Vigna* sp. (black gram on left side and green gram on right side); m. *Linum usitatissimum* (linseed); n. *Pennisetum glaucum* (pearl millet); o & p. *Paspalum scrobiculatum* (kodon millet husked and dehusked); q. *Panicum miliaceum* (proso millet); r. *Setaria* sp. (foxtail millet); s. *Vicia sativa* (common vetch); t. *Oryza rufipogon* (wild rice); u. *Andropogon* sp.; v. *Trianthema triquetra;* w. *Ziziphus nummularia* (jujube).

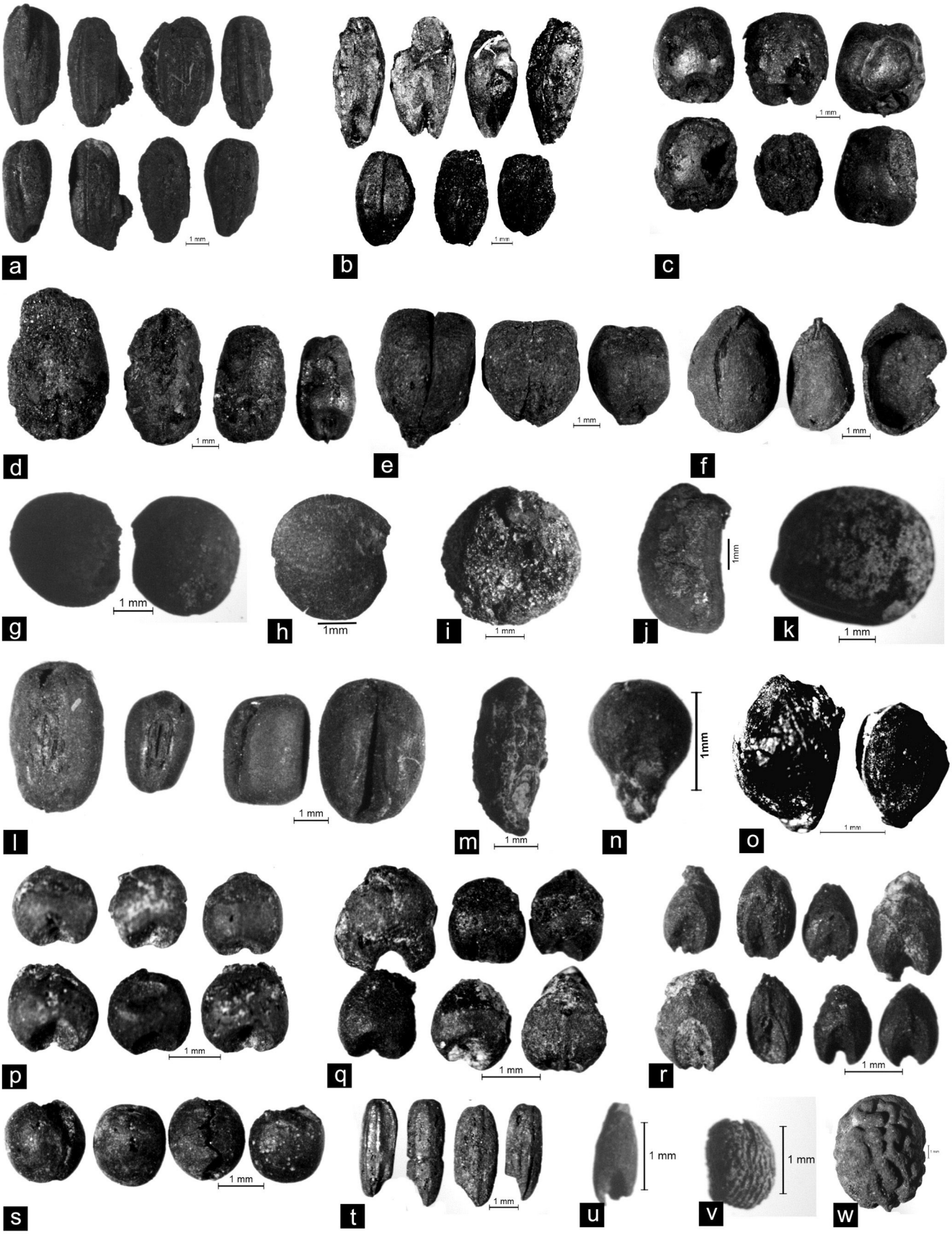
a
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Table 1—List of botanical remains recorded from Sarethi Archaeological site.

S. No.	Archaeological provenience	Cultural phase	Botanical remains documented
1	Trench: XA1 Depth: 178–190 cm	Sunga–Kushana	*Hordeum vulgare*, *Vigna radiata*
2	Trench: XA1 Depth: 232 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Pisum arvense*, *Vigna radiata*, *Setaria* sp., *Paspalum scrobiculatum*, *Vicia sativa*
3	Trench: XA1 Depth: 243–252 cm	Sunga–Kushana	*Triticum aestivum*, *Pennisetum glaucum*, *Vigna radiata*, *Macrotyloma uniflorum*, *Setaria* sp., *Chenopodium* sp., *Abutilon* sp.
4	Trench: XA1 Depth: 262–266 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Vigna radiata*, *Setaria* sp., *Panicum miliaceum*, *Vicia sativa*, *Andropogon* sp., *Trianthema* sp.
5	Trench: XA1 Depth: 294–298 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Cicer arietinum*, *Vigna radiata*, *Paspalum scrobiculatum*, *Vicia sativa*, *Oryza rufipogon*, *Scleria* sp.
6	Trench: XA1 Depth: 393–397 cm (Kiln)	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Cajanus cajan*, *Linum usitatissimum*, *Setaria* sp., *Vicia sativa*
7	Trench: XA1 Depth: 410–418 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Cicer arietinum*, *Vigna radiata*, *Setaria* sp., *Panicum miliaceum*
8	Trench: XA2 Depth: 180–184 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Triticum sphaerococcum*, *Pisum arvense*, *Cicer arietinum*, *Lens culinaris*, *Vigna radiata*, *Linum usitatissimum*, *Gossypium arboreum/herbaceum*, *Oryza rufipogon*, *Cleome* sp., *Ziziphus* sp., *Setaria* sp., *Panicum* sp., *Paspalum scrobiculatum*
9	Trench: AA3 Depth: 307 cm	Sunga–Kushana	*Oryza sativa*, *Lens culinaris*, *Vigna radiata*
10	Trench: AA3 Depth: 428 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Vigna radiata*, *Setaria* sp., *Paspalum scrobiculatum*, *Vicia sativa*, *Oryza rufipogon*
11	Trench: XB5 Depth: 225–232 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Lens culinaris*, *Vigna radiata*, *Setaria* sp., *Ziziphus* sp.
12	Trench: XB5 Depth: 248–252 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Lens culinaris*, *Vigna radiata*, *Vicia sativa*
13	Trench: XB5 Depth: 260–262 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Paspalum scrobiculatum*, *Setaria* sp., *Panicum* sp., *Vicia sativa*
14	Trench: XB5 Depth: 268–271 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Pisum arvense*, *Lens culinaris*, *Vigna radiata*, *Setaria* sp., *Chenopodium* sp.
15	Trench: XB5 Depth: 277–281 cm	Sunga–Kushana	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Lathyrus sativus*, *Vicia sativa*, *Oryza rufipogon*
16	Trench: XA2 Depth: 170–174 cm	Gupta and Post Gupta	*Oryza sativa*, *Vigna radiata*, *Setaria* sp., *Panicum miliaceum*

17	Trench: XB5 Depth: 94–100 cm	Gupta and Post Gupta	*Oryza sativa*, *Triticum aestivum*, *Vigna radiata*
18	Trench: XB5 Depth: 127–130 cm	Gupta and Post Gupta	*Oryza sativa*, *Hordeum vulgare*, *Lens culinaris*, *Lathyrus sativus*, *Vigna radiata*, *Panicum* sp., *Setaria* sp., *Vicia sativa*
19	Trench: XB5 Depth: 135–140 cm	Gupta and Post Gupta	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Gossypium herbaceum/arboreum*, *Paspalum scrobiculatum*, *Vicia sativa*
20	Trench: XB5 Depth: 160–165 cm	Gupta and Post Gupta	*Oryza sativa*, *Triticum aestivum*, *Vigna radiata*, *Paspalum scrobiculatum*, *Vicia sativa*
21	Trench: XB5 Depth: 165–170 cm	Gupta and Post Gupta	*Oryza sativa*, *Cicer arietinum*, *Panicum miliaceum*, *Vicia sativa*
22	Trench: XB5 Depth: 170–175 cm	Gupta and Post Gupta	*Oryza sativa*, *Hordeum vulgare*, *Cicer arietinum*, *Vigna radiata*, *Setaria* sp.
23	Trench: XB5 Depth: 175–180 cm	Gupta and Post Gupta	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Triticum sphaerococcum*, *Cicer arietinum*, *Vigna radiata*, *Paspalum scrobiculatum*, *Vicia sativa*, *Oryza rufipogon*
24	Trench: XB5 Depth: 180–188 cm	Gupta and Post Gupta	*Oryza sativa*, *Triticum aestivum*, *Cicer arietinum*, *Paspalum scrobiculatum*
25	Trench: Z1 Depth: 92 cm	Gupta and Post Gupta	*Oryza sativa*, *Hordeum vulgare*, *Triticum aestivum*, *Vigna radiata*, *Setaria* sp., *Paspalum scrobiculatum*, *Celosia* sp., *Vicia sativa*, *Chenopodium* sp.

Triticum aestivum L. emend. Thell (bread wheat, Fig. 2d)

Twenty–three grains elongated and relatively narrow towards both the ends were encountered in the mixture. The grains exhibit a hump like circular area raised on their dorsal side. Morphologically grains resemble with those of bread–wheat (*Triticum aestivum*).

Measurements: L (4.0–4.5) 4.2 x B (2.4–2.7) 2.5 x T (2.0–2.5) 2.2 mm.

Indices: L/B= 1.6, L/T= 1.8, B/T= 1.1

Minor cereals

Pennisetum glaucum (L) R. Br. (pearl millet, Fig. 2n)

Caryopsis is with one end narrow and somewhat tapering and the apex broad and rounded has been recorded from Sunga–Kushana period. This minor cereal is of widespread importance in traditional Indian agriculture was obtained from domestication in Africa. Earlier records in Harappan Gujarat (2000–1700 BCE) have been reported from Babor Kot, Rangpur and Kanmer (Reddy, 1994; Pokharia *et al*., 2011).

Measurements: L (1.3) × B (0.8) × T (0.8) mm.

Indices: L/B = 1.3, L/T = 1.4, B/T = 1.0

Paspalum scrobiculatum L. (kodo millet, Fig. 2o & p)

Grains are ovate to elliptical with scutellum length closer to one–third of caryopsis length. The ventral surface is flattened, whereas dorsal surface is dome–like. Caryopses measuring 1.5–2.0 mm in length and 1.2–1.5 mm in breadth compare closely to *Paspalum scrobiculatum*, indigenous millet.

Panicum miliaceum L. (proso millet, Fig. 2q)

Caryopses are elongate–ovate to nearly round with shorter and shallower scutellum, measure 1.2–1.6 mm in length and 1.2–1.7 mm in breadth. The earlier records from archaeological sites during the later 3rd and 2nd millennium BCE suggest that the settelers used it as a minor crop (Saraswat, 2005; Pokharia *et al.*, 2016).

Leguminous crops (Pulses)

Cicer arietinum L. (chickpea, Fig. 2e)

Forty–three complete squat and somewhat triangular seeds, pointed at one end and broad and lobed on the other

Table 2—Abundance, Ubiquity and Diversity index of charred remains from occupational phases at Sarethi.

	Period II: Sunga–Kushana (100 BCE–300 CE)			Period III: Gupta–post Gupta (400–700 CE)				Diversity Index	
Number of samples	**(15)**			**(10)**					
Taxa	**Absolute counts**	**present in samples**	**Ubiquity**	**Absolute counts**	**present in samples**	**Ubiquity**	**Total**	**Period (II)**	**Period (III)**
Oryza sativa	61	13	86.7	41	10	100.0	102	0.13	0.15
Hordeum vulgare	43	13	86.7	13	5	50.0	56	0.11	0.09
Triticum aestivum	15	6	40.0	8	6	60.0	23	0.06	0.07
Triticum sphaerococcum	7	1	6.7	1	1	10.0	8	0.03	0.01
Pisum arvense	10	3	20.0	0	0	0.0	10	0.04	0.00
Lens culinaris	9	5	33.3	5	1	10.0	14	0.04	0.05
Cicer arietinum	36	1	6.7	7	4	40.0	43	0.10	0.06
Lathyrus sativus	1	4	26.7	1	1	10.0	2	0.01	0.01
Vigna radiata/mungo	61	12	80.0	21	7	70.0	82	0.13	0.12
Macrotyloma uniflorum	1	1	6.7	0	0	0.0	1	0.01	0.00
Cajanus cajan	1	1	6.7	0	0	0.0	1	0.01	0.00
Linum usitatissimum	3	2	13.3	0	0	0.0	3	0.02	0.00
Gossypium arboreum/herbaceum	3	1	6.7	1	1	10.0	4	0.02	0.01
Paspalum scrobiculatum	11	5	33.3	10	4	40.0	21	0.05	0.08
Pennisetum glaucum	1	1	6.7	0	0	0.0	1	0.01	0.00
Panicum miliaceum	11	3	20.0	7	3	30.0	18	0.05	0.06
Setaria sp.	20	5	33.3	8	4	40.0	28	0.07	0.00
Oryza rufipogon	24	4	26.7	2	1	10.0	26	0.08	0.02
Vicia sativa	32	7	46.7	24	5	50.0	56	0.09	0.13
Chenopodium sp.	1	1	6.7	1	1	10.0	2	0.01	0.01
Cleome sp.	1	1	6.7	0	0	0.0	1	0.01	0.00
Abutilon sp.	1	1	6.7	0	0	0.0	1	0.01	0.00
Andropogon sp.	1	1	6.7	0	0	0.0	1	0.01	0.00
Trianthema sp.	1	1	6.7	0	0	0.0	1	0.01	0.00
Scleria sp.	1	1	6.7	0	0	0.0	1	0.01	0.00
Celosia sp.	0	0	0.0	1	1	10.0	1	0.00	0.01
Ziziphus sp.	2	2	13.3	0	0	0.0	2	0.01	0.00
Total no. of remains	**358**			**151**			**509**	**1**	**0.91**

have been encountered. The seed coat is undulating. The chalazal plate on the ventral side is noticeably broad. Seeds are comparable to those of chick–pea (*Cicer arietinum*).

Measurements: L (5.2–4.3) mm x B (4.4–3.4) mm x T (3.8–4.0) mm

Lens culinaris Maedik. (lentil, Fig. 2g & h)

Seeds are circular and flattened with keeled margins appear lenticular in shape. Hilum small and lanceolate could be seen. The carbonized seeds are comparable to those of lentil (*Lens culinaris*).

Measurements: 2.8–3.3 mm (approx.) in diameter.

Pisum arvense L., syn. *P. sativum* var. *arvense* (L.) Poir (field pea, Fig. 2i)

Ten complete and broken spherical to hemi–spherical seeds have been recovered. The seed coat is blurred and rubbed off at places. Small ovate hilum measuring about 1.00 mm in length, is flushed with the seed surface. The carbonized seeds are comparable to those of field pea.

Measurements: 3.6–4.5 mm (approx.) in diameter

Vigna sp. (green/black gram, Fig. 2l)

Eighty–two seeds and cotyledons have been recorded in the collection. The complete seeds are elongate and somewhat cylindrical in shape. Both the seeds and the cotyledons have angular to rounded ends. The *V. radiata* (L.) Wilczek and *V. mungo* (L.) Hepper seeds have a number of common characters and even the size and shape overlap. Therefore, the carbonized seeds and cotyledons have been kept under *Vigna* sp. The green gram/black gram, like rice and horse–gram, is also an indigenous field crop and important dietary component since Indus times (Saraswat & Pokharia 2002, 2003; Pokharia *et al*., 2011).

Measurements (seeds): L (3.3–4.0) 3.6 × B (2.4–3.0) 2.7 × T (2.7–3.4) 2.8 mm

Indices: L/B= 1.3, L/T= 1.2, B/T= 0.9

Measurements (cotyledons): L (3.3–3.8) 3.5 × B (2.3–2.8) 2.5 × T (1.2–1.6) 1.4 mm.

Indices: L/B= 1.3, L/T= 2.5, B/T= 1.8

Macrotyloma uniflorum (lam.) Verdcourt (horse gram, Fig. 2j)

Seed is flat, ellipsoidal with hilum on the lateral margin. It is widely cultivated as summer crop in India. Not much is known about its wild progenitors, although they were probably native to the sub–savanna or thorny vegetation of Indian peninsula (Fuller *et al*., 2004).

Measurements: L (4.2) × B (2.9) × T (1.4) mm

Indices: L/B= 1.4, L/T= 3.0, B/T= 2.0

Cajanus cajan (L.) Millsp. (pigeon pea, Fig. 2k)

Seed is lens–shaped with hilum on the lateral margin. It is native to the Indian peninsula, deriving from the species *C. cajanifolia* (Heines) van der Maeson of Orissa and Bastar (van der Maeson 1986, 1995). It can be grown in humid areas, even over 2500 mm of rainfall and is renowned for its drought tolerance. It is the unique jewel in rain–fed cropping systems across the globe. It is rich source of protein and complements well for a balanced diet with cereals.

Measurements: L (4.4) x B (3.8) x T (2.5) mm

Indices: L/B= 1.1, L/T= 1.7, B/T= 1.5

Oeliferous crop

Linum usitatissimum L. (linseed, Fig. 2m)

Three carbonized seeds, partly broken are elliptic to elliptic–ovate with one end narrower and characteristic hooked apex similar to *Linum* sp. It is a winter crop requiring moderately high rainfall or irrigation. It can be sown immediately after the monsoon, in an area of high rainfalls or water–retaining clayey soils. Linseed belongs to West Asian group of crops, where antiquity of its cultivation goes back to 7th millennium BCE (Van Zeist & Bakker–Heeres, 1975).

Measurements: L (4.0–4.3) 4.1 × B (1.7–1.8) 1.7 mm

Indices: L/B= 2.3

Fibre–crop

Gossypium arboreum/herbaceum L. (cotton, Fig. 2f)

Seeds have one end rounded and the other end narrow and slightly angular in cross view. Ventral side of the seeds is somewhat flattened and the dorsal side shows bulging. In all morphological features, the seeds compare with that of cotton. The archaeobotanical records from Mehrgarh, Baluchistan, Pakistan (6000–4500 BCE), and Harappan/ Indus sites in India and Pakistan attest its importance in the early development of textile production in the sub–continent (Costantini & Costantini, 1985; Saraswat, 1986; Saraswat & Pokharia 2003; Pokharia *et al*., 2011). Cotton was also grown by early farming communities in the region of Middle Ganga Plain (Saraswat, 2004, 2005).

Measurements: L (4.4–4.6) 4.5 x B (3.2–3.5) 3.3 mm

Indices: L/B= 1.3

Weeds and wild taxa

Setaria sp. (L) P. Beauv. (foxtail grass, Fig. 2r)

Grains ovoid to somewhat oblong measuring 1.5–1.8 mm in length and 1.2–1.3 mm in breadth compare with those of *Setaria* sp.

Vicia sativa L. (common vetch, Fig. 2s)

The seeds varying in diameter from 2.2 to 2.5 mm are globular to somewhat cubicular in shape. Ovate to wedge–shaped hilum is raised along the median groove. These seeds compare with *Vicia sativa*, a common leguminous weed in the winter crop fields.

Oryza cf. *rufipogon* Griffith (wild rice, Fig. 2t)

Grains are relatively much longer than broad and appear slender in shape, measuring 4.4–5.4 mm in length and 1.7–1.9 mm in breadth. They show conformity with the grains of a form of wild rice belonging to *Oryza rufipogon*. It grows as a weed in the crop–fields of *Oryza sativa* and in the natural shallow depressions filled with water.

Andropogon sp. L. (Fig. 2u)

Single grain is somewhat rounded at lower end and gradually tapering towards upper end, measures 1.4 mm in length and 0.6 mm in breadth. The hilum scar on the end of more or less evenly rounded dorsal side can be seen. Grain closely compare with the *Andropogon* sp. and have, therefore, been referred to the same.

Trianthema triquetra Rottle. Ex Willd. (red spinach, Fig. 2v)

The seed discoid in shape with concentric broken undulating raised lines and characteristically beaked near the hilum. The seed on morphological ground closely compare with those of *T. triquetra.*

Ziziphus nummularia (Burm. f.) W. & A. (jujube/jharberi, Fig. 2w)

Globose or somewhat oval stone measuring 6.8–6.9 mm have been encountered from Sunga–Kushana period. The stone comparable to jujube/jharberi exhibit tubercled surface. Its fruits might have been consumed by the settlers.

DISCUSSION

Plant remains from Sunga–Kushana (200 BCE–300 CE) period

A total of 15 samples were analysed from Sunga–Kushana level. About 358 charred remains representing 26 plant taxa were recorded (Table 2). The most abundant cereal was *Oryza sativa* (21%), followed by *Hordeum vulgare* (15%), *Triticum aestivum* (5%), *T. sphaerococcum* (2%), *Panicum miliaceum* and *Paspalum scrobiculatum* (4% each), and *Pennisetum glaucum* (<1%) (Fig. 3a). Pulses are represented by *Vigna radiata/mungo (*21%), *Cicer arietinum* (12%), *Pisum arvense* and *Lens culinaris* (3% each), and *Lathyrus sativus*, *Macrotyloma uniflorum* and *Cajanus cajan* (<1% each). The oil and fibre yielding plants are represented by *Linum usitatissimum* and *Gossypium arboreum/herbaceum* (1% each).

Plant remains from Gupta and post Gupta (300–700 CE) period

The analysed samples (10 in number) yielded 151 charred remains belonging to 16 taxa (Table 2). The cultivated crops during this phase show continuity from the preceding phase. The most abundant among the crops was *Oryza sativa* (33%), followed by *Vigna radiata/mungo* (17%), *Hordeum vulgare* (11%), *Triticum aestivum* (7%), *Cicer arietinum* (6%), *Lens culinaris* (4%), and *Triticum sphaerococcum*, *Lathyrus sativus* and *Gossypium* sp. (1% each). The rain–fed minor cereals are represented by *Paspalum scrobiculatum* (8%), *Panicum miliaceum* (6%) and *Setaria* sp. (7%) (Fig. 3b).

Implications for palaeodiet, palaeoecology and palaeovegetation 200 BCE to 700 CE

The crop plants recorded from Sarethi cultural phases have already been encountered from other sites in the Ganga Plain (Pokharia *et al*., 2016). Their presence at Sarethi, therefore, clearly understood. Direct AMS dating of barley grains (*Hordeum vulgare*) at Damdama (2500–2400 BCE) and Lahuradewa (2300–2000 BCE) demonstrates the introduction of winter crop in the Ganga Plain in the later third millennium BCE (Liu *et al*, 2016, 2017).

From the point of view of agricultural economy, there is enough justification to surmise that the practice of rotation of crops was pursued by the settlers. Rice, green gram/black gram, horsegram and cotton were grown in warm–rainy season, while the wheat, barley, field pea, chick pea, grass pea, lentil, pigeon pea and linseed were the winter crops. The overall trend of agricultural produce represent 58% summer and 41% winter crops during 200 BCE–300 CE, suggesting significant winter precipitation as well as relatively high summer rainfall. Whereas, during 300–700 CE the summer crops accounts for 72% and the winter crops accounts for 28% suggesting settlers during this phase were more dependent on rain–fed crops.

Weeds and other wild taxa are of particular significance to derive information regarding the general picture of the vegetation cover in and around the settlement area. The weed wild assemblage at Sarethi is very small. Some species occurring in the cultivated fields, may be taken as dependable evidence of crop and weed association. *Oryza rufipogon*, *Trianthema* sp., *Setaria* sp., *Andropogon* sp. and *Vicia sativa* represents the weedy flora of the field–crops. *Ziziphus* cf. *nummularia*, a wild shrub commonly grows as waste land

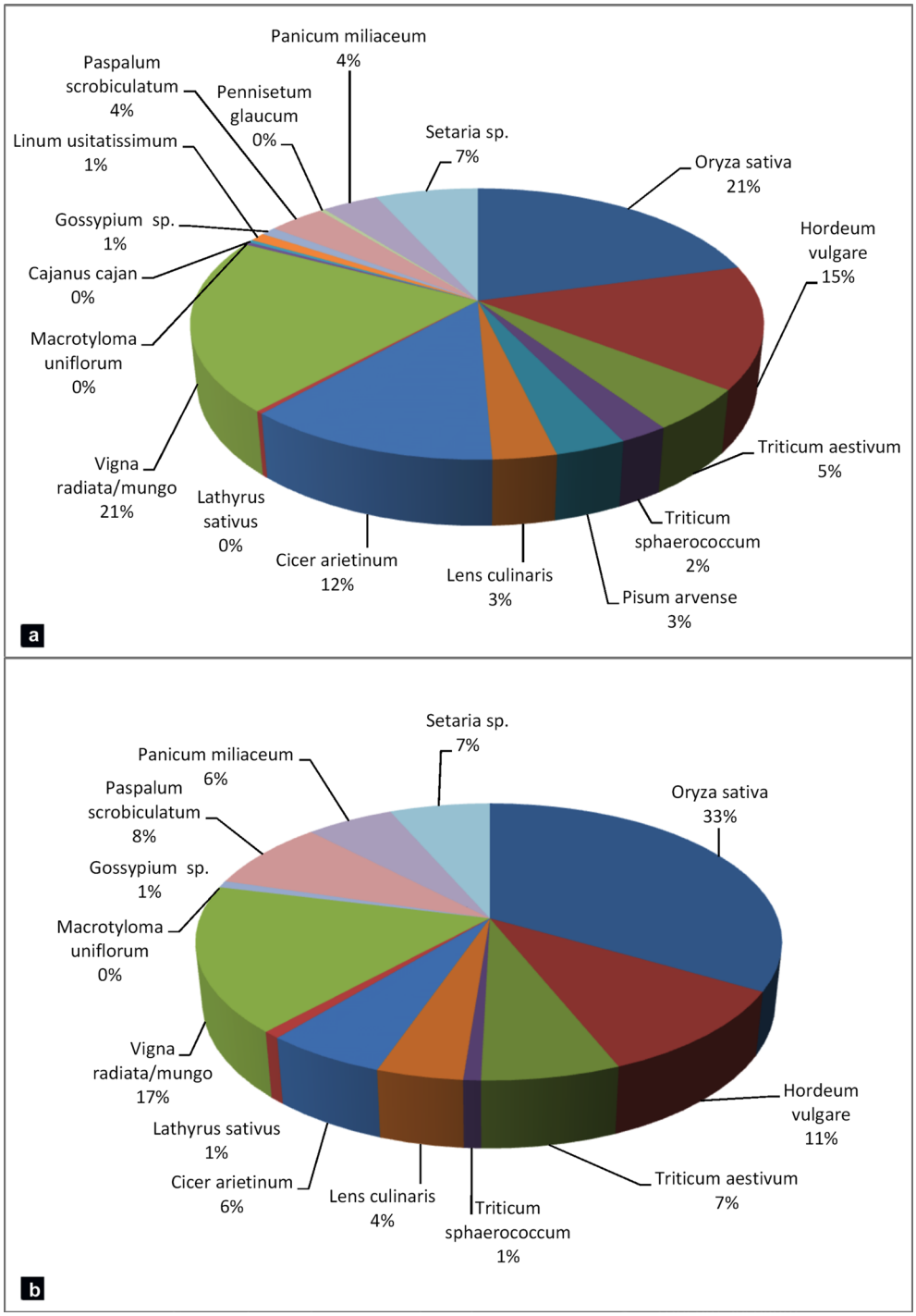

Fig. 3—Relative proportion of field crops: a. Sunga–Kushana period (200 BCE–300 CE); b. Gupta and post Gupta period (300–700 CE).

plant. Its fruits might have been collected and consumed by the settlers.

The pollen analytical investigations of lake deposits in the Ganga Plain has revealed that since 2,000 cal yr BP to present, the significant depletion of trees, occurred and grassland with forest groves were succeeded by the open vast stretches of grassland with a few trees (Chauhan *et al*., 2004, 2009, 2015; Trivedi *et al*., 2011, 2013; Wasson *et al*., 2013). This transformation in the vegetation scenario took place under the influence of warm and dry climate with the weakening of SW monsoon. This is also verified by the reduction in the frequencies of aquatic elements encompassing diatoms and sponge spicules in the lake bed under the similar climatic regime during the time bracket of last 2,000 years

(Tripathi *et al*., 2016). The deterioration of climate also synchronizes with that witnessed in Rajasthan desert since ~2,000 yr BP, where a sharp reduction of trees as well as aquatic vegetation has been documented in the lake deposits (Singh *et al*., 1974).

Thus, the archaeobotanical findings from Sarethi have elucidated that this region was under warm and humid climatic conditions during 200 BCE to 300 CE, however, the climatic deteriorated in response to a gradual decrease in SW monsoon from 300–700 CE. Rice is the most important cereal crop in the Ganga Plain, which is a part of natural habitat of wild rice. The archaeobotanical studies at Lahuradewa, Tokwa, Jhusi, Senuwar and Mahagara denote that the cultivation of *Oryza sativa* was well established prior to 6000 BCE in the Northern India (Tewari *et al*., 2006; Pokharia, 2008; Pokharia *et al*., 2009; Saraswat, 2004; Harvey & Fuller, 2005). Despite evidence of drier climate the cultivation of summer crops might have been preferred due to availability of adequate subterranean as well as surface water in ponds and lakes for irrigation to support the expanding population.

CONCLUSION

The palaeoclimatologists have made intense and concerted efforts to decipher the SASM (South Asian Summer Monsoon) variability using various proxies, viz. pollen, isotopes, diatoms, etc. retrieved from lakes, swamps, oceans, speleothems, due to its direct influence on the socio–economic conditions of billions of people. However, no direct record from archaeological sites of past millennia is available till date. The individual site level study will allow for broader syntheses in near future to understand culture–climate–subsistence relationship. The crop assemblage retrieved from the excavated site here represents only a small fraction of the botanical wealth at Sarethi. However, it adds an additional data to the ancient plant economy of the Ganga Plain, during 200 BCE–700 CE.

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