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

ANIL K. POKHARIA1, PUSHHP LATA SINGH2, NEELAM MISHRA1, ANOOP KUMAR2, UPENDRA SINGH2, ALKA SRIVASTAVA3, ANJALI TRIVEDI1, HIMANI PATEL1, DIPAK KUMAR SHUKLA2, CHANDRA BHUSHAN GUPTA2 AND MD. AFROZ2

1Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow 226 007, India.
2Department of AHHC and Archaeology, Banaras Hindu University, Varanasi 221005.
3Department of Botany, Dayanand College, Kanpur 208001.

*Corresponding author: pokharia.anil@gmail.com

(Received 09 October, 2018; revised version accepted 11 January, 2019)

ABSTRACT


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.

© Birbal Sahni Institute of Palaeosciences, India
INTRODUCTION

THE Ganga Plain, one of the 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 Shan’. 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 Slippered 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 knobbled 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, heads of semi−precious stones, and glass, stone pestles, stone balls, antimony rods, rattle, 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, knobbled 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...
Oryza type. Rice is an important staple crop of the Harappan/Indus civilization (Pokharia 2001, 2011, 2017 and references therein). The importance of rice as a staple crop of the Harappan/Indus civilization has long been considered as a staple crop of the Harappan/Indus civilization (Pokharia et al., 2011, 2017 and references therein).

**MATERIAL AND METHODS**

In all, 25 samples for archaeobotanical study were collected from Trenches XA1, XA2, AA3, XA5 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, 1 sigma error). Furthermore, the archaeological artefacts from different cultural layers testify the cultural authenticity.

**Macromains**

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 macromains 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).

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

**Measurements:** L (3.2–3.7) 3.5 x B (2.5–3.1) 2.8 x T (2.0–2.4) 2.2 mm

**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).

**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).

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

**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. _Macroryzoma 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. _Paniceum miliaceum_ (proso millet); t. _Setaria sp._ (foxtail millet); s. _Vicia sativa_ (common vetch); t. _Oryza rufipogon_ (wild rice); u. _Andropogon sp._; v. _Trianthema triquetra_; w. _Ziziphus nummularia_ (jujube).
Table 1—List of botanical remains recorded from Sarethi Archaeological site.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Archaeological provenience</th>
<th>Cultural phase</th>
<th>Botanical remains documented</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trench: XA1</td>
<td>Sunga–Kushana</td>
<td><em>Hordeum vulgare, Vigna radiata</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 178–190 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Trench: XA1</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Pisum arvense, Vigna radiata, Setaria sp., Paspalum scrobiculatum, Vicia sativa</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 232 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Trench: XA1</td>
<td>Sunga–Kushana</td>
<td><em>Triticum aestivum, Pennisetum glaucum, Vigna radiata, Macrotyloma uniflorum, Setaria sp., Chenopodium sp., Abutilon sp.</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 243–252 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth: 262–266 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Trench: XA1</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Triticum aestivum, Cicer arietinum, Vigna radiata, Paspalum scrobiculatum, Vicia sativa, Oryza rufipogon, Scleria sp.</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 294–298 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Trench: XA1</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Cajanus cajan, Linum usitatissimum, Setaria sp., Vicia sativa</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 393–397 cm (Kiln)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Trench: XA1</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Triticum aestivum, Cicer arietinum, Vigna radiata, Setaria sp., Panicum miliaceum</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 410–418 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth: 180–184 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Trench: AA3</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Lens culinaris, Vigna radiata</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 307 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Trench: AA3</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Vigna radiata, Setaria sp., Paspalum scrobiculatum, Vicia sativa, Oryza rufipogon</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 428 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth: 225–232 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Trench: XB5</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Lens culinaris, Vigna radiata, Vicia sativa</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 248–252 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Trench: XB5</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Triticum aestivum, Paspalum scrobiculatum, Setaria sp., Panicum sp., Vicia sativa</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 260–262 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth: 268–271 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Trench: XB5</td>
<td>Sunga–Kushana</td>
<td><em>Oryza sativa, Hordeum vulgare, Triticum aestivum, Lathyrus sativus, Vicia sativa, Oryza rufipogon</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 277–281 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Trench: XA2</td>
<td>Gupta and Post</td>
<td><em>Oryza sativa, Vigna radiata, Setaria sp., Panicum miliaceum</em></td>
</tr>
<tr>
<td></td>
<td>Depth: 170–174 cm</td>
<td>Gupta</td>
<td></td>
</tr>
</tbody>
</table>
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) × B (2.4–2.7) × T (2.0–2.5) 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 Kammer (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 settlers 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

Oryza sativa, Triticum aestivum, Vigna radiata

Oryza sativa, Hordeum vulgare, Lens culinaris, Lathyrus sativus, Vigna radiata, Panicum sp., Setaria sp., Vicia sativa

Oryza sativa, Hordeum vulgare, Triticum aestivum, Gossypium herbaceum/arboreum, Paspalum scrobiculatum, Vicia sativa

Oryza sativa, Triticum aestivum, Vigna radiata, Paspalum scrobiculatum, Vicia sativa

Oryza sativa, Cicer arietinum, Panicum miliaceum, Vicia sativa

Oryza sativa, Hordeum vulgare, Cicer arietinum, Vigna radiata, Setaria sp.

Oryza sativa, Hordeum vulgare, Triticum aestivum, Triticum sphaerococcum, Cicer arietinum, Vigna radiata, Paspalum scrobiculatum, Vicia sativa, Oryza rufipogon

Oryza sativa, Triticum aestivum, Cicer arietinum, Paspalum scrobiculatum

Oryza sativa, Hordeum vulgare, Triticum aestivum, Paspalum scrobiculatum, Celosia sp., Vicia sativa, Chenopodium sp.
### Table 2—Abundance, Ubiquity and Diversity index of charred remains from occupational phases at Sarethi.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Number of samples</th>
<th>Period II: Sunga–Kushana (100 BCE–300 CE)</th>
<th>Period III: Gupta–post Gupta (400–700 CE)</th>
<th>Diversity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(15)</td>
<td>(10)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taxa</td>
<td>Absolute counts</td>
<td>Ubiquity</td>
<td>Absolute counts</td>
</tr>
<tr>
<td>Oryza sativa</td>
<td></td>
<td>61</td>
<td>13</td>
<td>86.7</td>
</tr>
<tr>
<td>Hordeum vulgare</td>
<td></td>
<td>43</td>
<td>13</td>
<td>86.7</td>
</tr>
<tr>
<td>Triticum aestivum</td>
<td></td>
<td>15</td>
<td>6</td>
<td>40.0</td>
</tr>
<tr>
<td>Triticum sphaerococcum</td>
<td></td>
<td>7</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Pisum arvense</td>
<td></td>
<td>10</td>
<td>3</td>
<td>20.0</td>
</tr>
<tr>
<td>Lens culinaris</td>
<td></td>
<td>9</td>
<td>5</td>
<td>33.3</td>
</tr>
<tr>
<td>Cicer arietinum</td>
<td></td>
<td>36</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Lathyrus sativus</td>
<td></td>
<td>1</td>
<td>4</td>
<td>26.7</td>
</tr>
<tr>
<td>Vigna radiata/mungo</td>
<td></td>
<td>61</td>
<td>12</td>
<td>80.0</td>
</tr>
<tr>
<td>Macrotyloma uniflorum</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Cajanus cajan</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Linum usitatissimum</td>
<td></td>
<td>3</td>
<td>2</td>
<td>13.3</td>
</tr>
<tr>
<td>Gossypium arboreum/herbaceum</td>
<td></td>
<td>3</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Paspalum scrobiculatum</td>
<td></td>
<td>11</td>
<td>5</td>
<td>33.3</td>
</tr>
<tr>
<td>Pennisetum glaucum</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Panicum miliaceum</td>
<td></td>
<td>11</td>
<td>3</td>
<td>20.0</td>
</tr>
<tr>
<td>Setaria sp.</td>
<td></td>
<td>20</td>
<td>5</td>
<td>33.3</td>
</tr>
<tr>
<td>Oryza rufipogon</td>
<td></td>
<td>24</td>
<td>4</td>
<td>26.7</td>
</tr>
<tr>
<td>Vicia sativa</td>
<td></td>
<td>32</td>
<td>7</td>
<td>46.7</td>
</tr>
<tr>
<td>Chenopodium sp.</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Cleome sp.</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Abutilon sp.</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Andropogon sp.</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Trianthema sp.</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Scleria sp.</td>
<td></td>
<td>1</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Celosia sp.</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Ziziphus sp.</td>
<td></td>
<td>2</td>
<td>2</td>
<td>13.3</td>
</tr>
</tbody>
</table>

| 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 Maesen of Orissa and Bastar (van der Maesen 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

*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

*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

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

Grains ovoid to somewhat oblone 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 cubic in shape. Oval 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** Rottl. 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...
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.

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

Acknowledgements—We are grateful to the Director, BSIP, Lucknow for the present collaboration and providing facilities to carry out study. Thanks are also due to all the team members of the excavation camp for rendering technical help during course of collection.

REFERENCES

Chauhan MS, Pokharia AK & Srivastava RK 2015. Late Quaternary vegetation history, climatic variability and human activity in the Central Ganga Plain, deduced by pollen proxy records from Karela Jheel, India. Quaternary International 371: 144–156.
Saraswat KS & Pokharia AK 2003. Palaeoethnobotanical investigations at...