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POSSIBLE EVIDENCE OF PRE-COLUMBIAN TRANSOCEANIC VOYAGES BASED ON CONVENTIONAL LSC AND AMS ^{14}C DATING OF ASSOCIATED CHARCOAL AND A CARBONIZED SEED OF CUSTARD APPLE (*ANNONA SQUAMOSA* L.)

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ABSTRACT. An attempt was made to trace the antiquity of custard apple in India on the basis of accelerator mass spectrometry (AMS) and liquid scintillation counting (LSC) radiocarbon dates. Recently, seed remains of custard apple (*Annona squamosa* L.) in association with wood charcoals were encountered from the Neolithic archaeological site of Tokwa at the confluence of the Belan and Adwa rivers, Mirzapur District, in the Vidhyan Plateau region of north-central India. The wood charcoal sample was dated at the ^{14}C laboratory of the Birbal Sahni Institute of Palaeobotany (BSIP), Lucknow, by conventional LSC ^{14}C dating. The sample dated to 1740 cal BC (BS-2054). A seed sample of custard apple was dated by AMS at the Institute of Physics ^{14}C laboratory, Bhubaneswar, India (3MV tandem Pelletron accelerator). Interestingly, the AMS date was given as 1520 cal BC (IOPAMS-10), showing a reasonable agreement with the LSC date carried out at BSIP. On botanical grounds, the custard apple is native to South America and the West Indies and was supposed to have been introduced in India by the Portuguese in the 16th century. The present ^{14}C dates of the samples pushes back the antiquity of custard apple on Indian soil to the 2nd millennium BC, favoring a group of specialists proposing diverse arguments for Asian-American transoceanic contacts before the discovery of America by Columbus in AD 1492.

INTRODUCTION

Scientific data reveal that nearly 100 species of fauna and flora were shared between the Old and New worlds before the discovery of America by Columbus (Sorenson and Johannessen 2006). Here, we document the pivotal evidence of custard apple—evocative of some pre-Columbian network of contacts between Asia and America—favoring a group of specialists proposing Asian-American transoceanic contacts before AD 1492.

Annona squamosa L. (custard apple) is native to South America and the West Indies and belongs to Annonaceae, a difficult family from the point of view of its numerous genera and species, and one that is still undergoing revision (cf. Bailey 1949; Usher 1974; Allaby 1992; Brako and Zarucchi 1993). Custard apple was grown throughout the tropics in the Old World (Oliver 1868; Baker 1877; White 1962; Backer and Bakhuizen van den Brink 1963; Mabberley 1997; Swaminathan and Kochhar 2003; Anonymous 2005). No species of *Annona* have been reported as indigenous in continental Asia (Oliver 1868; Mabberley 1997; Anonymous 2005). Custard apple is best suited for a hot and relatively dry climate. Cultivation is extensive in India for its fruits; the tree is also very common in the dry deciduous forests of central India, Rajasthan, Gujarat, West Bengal, Assam, Andhra Pradesh, and the Deccan Plateau. At least 3 species of the tropical fruit *Annona* have been identified in ancient Indian art and referenced in mythic literature (Gupta 1996). *A. squamosa* found in India at Bharhut stupa, Madhya Pradesh, place the plant in India by the 2nd century BC (Cunningham 1879). The fruit is also seen carved on the Gateways at Sanchi in Madhya Pradesh, and on the sculptures dug up in Mathura in Uttar Pradesh and at the Ajanta caves (Watt 1889). The Bharhut and Sanchi bas-reliefs are the earliest examples of Indian sculptors' work in stone (Marshall et al. 1940; Brown 1949). Johannessen and Wang (1998) discovered *Annona squamosa* fruit depicted in the hands of a sculptured goddess from the 10th century AD, at Durga temple at Aihole, Karnataka, India. The custard apple was thought to be native to India from its occurrence in ancient literature, paintings, and sculptures.

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THE ARCHAEOLOGICAL SITE

The Tokwa site (24°54′20″N, 83°21′65″E) is situated at the confluence of the Belan and Adwa rivers in Mirzapur District, India, southeast from the city of Mirzapur (see Figure 1). At present, the ancient mound covers an area of about 27,597 m^2. The northern margin of the site is flanked by the Belan River, while the southern boundary faces the Adwa River (see Figure 2). The western margin of the site looks like the peak of the triangle (Misra et al. 2001). Archaeological excavations at this site began in 2000 by the Department of Ancient Indian History, Culture and Archaeology, University of Allahabad, and continued until 2003. The combined findings of the excavations of trenches H-8, H-9, I-8, I-9 and control pits brought to light the archaeological evidence of 3 cultures: Neolithic, Chalcolithic, and Iron Age. The occupational strata are divisible into as many as 16 layers, totaling 4.00 m. The botanical samples were collected by the water flotation technique in order to study the ancient plant economy. However, in this paper our main objective is to highlight the finding of *Annona squamosa* in pre-Columbian times in India.

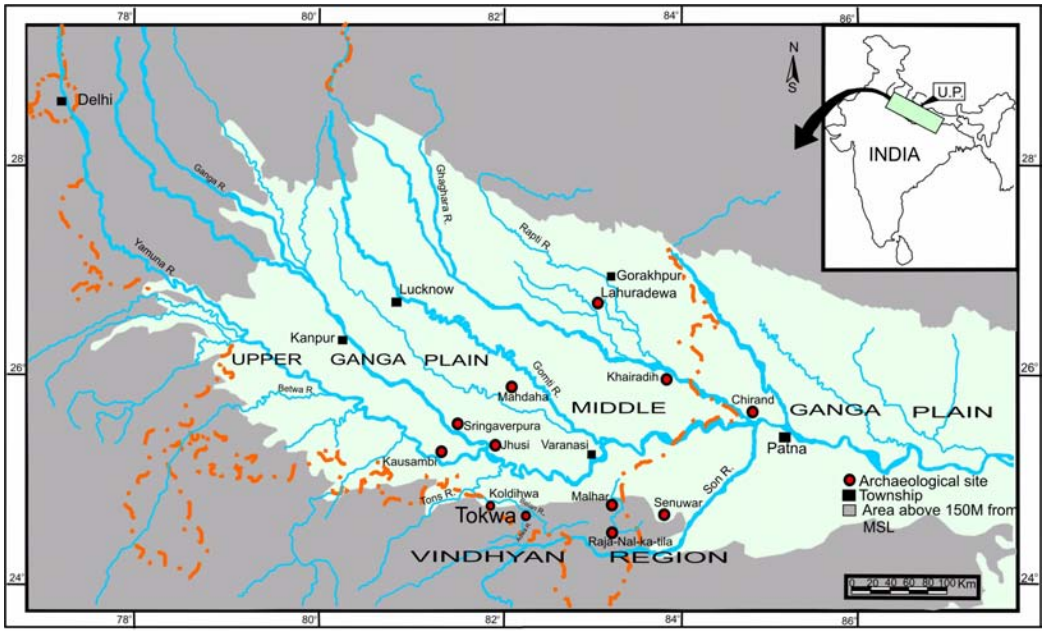

Figure 1 Map of Uttar Pradesh showing archaeological sites and townships (modified after Tewari 2004)

RADIOCARBON DATING

The seed sample and wood charcoals were dated by the accelerator mass spectrometry (AMS) facility of the Institute of Physics, Bhubaneswar, India (3MV tandem Pelletron accelerator) and by conventional liquid scintillation counting (LSC) ^{14}C dating at the Birbal Sahni Institute of Palaeobotany, Lucknow, India, using standard procedures (Rajagopalan et al. 1978) (see Table 1).

ARCHAEOBOTANICAL EVIDENCE AND IDENTIFICATION

Carbonized seeds of custard apple (a single complete piece and a few broken pieces) were encountered in association with crop remains, weeds, and other wild taxa, as well as wood charcoals from systematically collected samples from the Neolithic stratigraphic sequence: trench H8, layer 12A,

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Figure 2 General view of the archaeological mound at Tokwa with the Belan River in the foreground and Adwa River in the background.

Table 1 LSC and AMS ^{14}C dates of charcoal and seed of *Annona* cf. *squamosa* from the Iron Age Raja-Nal-ka-tila (RJN) site and the Neolithic Tokwa (TKW) site and their calibrated individual distribution (68.2% probability).

Stratigraphic data	Depth (cm)	Layer	BSIP lab #	^{14}C age (yr BP)	Calibrated age (BC)	Calibrated age range (BC)
RJN-1997 U-19, Qdt. 1	130–140	5	BS-1988 (charcoal)	2690 ± 70	740	900–800
TKW-2000 H-8	220–225	12A	BS-2054 (charcoal)	3410 ± 70	1740	1860–1622
TKW-2000 H-8	220–225	12A	IOPAMS-10 (*Annona* seed)	3280 ± 140	1520	1740–1410

2.20–2.25 m depth (see Figures 3 and 5a,b); control pit, layer 13, 3.02 m depth; and trench H9, pit sealed by layer 16, 2.55 m depth at Tokwa. To better identify the carbonized seeds, the seed size (length × breadth × thickness) of 4 common species of *Annona* in the Indian region was measured on the collection provided by the Herbarium of National Botanical Research Institute, Lucknow (see Table 2). *A. squamosa* has oblong seeds that are 13–16 mm long (see Figure 4), whereas *A. cherimola* seeds are 15–21 mm long, *A. muricata* seeds are 15–18 mm long, and the *A. reticulata* oblong seeds are <13 mm long. The ancient oblong seed collected by the excavators (15 mm long) shows a close resemblance with that of extant seeds of *A. squamosa*. In addition, the characteristics of the fruit coat surface were studied. The fruit coat shows projecting and somewhat ovoid to narrowly oblong aureoles in *A. squamosa* L. Among the other closely related species, the fruit of *A. reticulata* L. have a characteristic network of lines indicating the edges of individual fruits; *A. cherimola* Mill. show a scaly surface; *A. glabra* L. have a smooth or faintly reticulate surface; and *A. muricata* L. are covered with recurved fleshy spines (Swaminathan and Kochhar 2003; Anonymous 2005). The carbonized fruit coat shown in Figure 6c,d, recovered from Sanghol and dated to the Kushana period (AD 100–300), has projecting ovoid-oblong aureoles (Pokharia and Saraswat 1999) resembling that of extant *A. squamosa* fruit as shown in Figure 6a, b, and e1. Thus, the seeds from Neolithic Tokwa have been identified as *A. squamosa*, which is also supported by the seed-size statistics.

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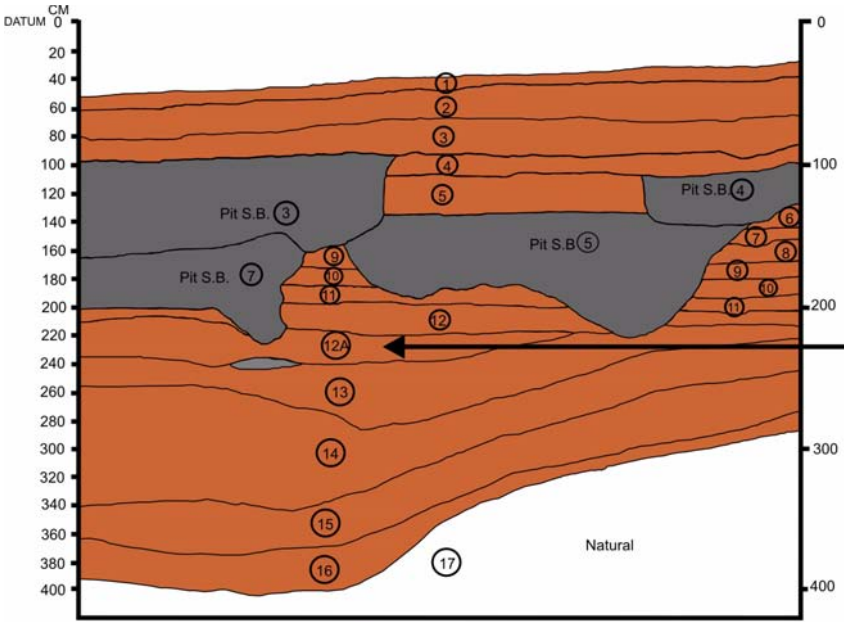

Figure 3 Section of trench H8 showing the different layers and pits, with the arrow pointing to layer 12A from where the *Annona* seed and associated charcoal were recovered and dated.

Table 2 Measurement of seeds of *Annona* sp. commonly occurring in India in relation to the carbonized seed of *Annona* from the Tokwa site.

Seed	Length	Breadth	Thickness
A. cherimola	15–21 mm	11–13 mm	5–6 mm
A. muricata	15–17 mm	10–12 mm	10–12 mm
A. squamosa	13–16 mm	8–9 mm	5–6 mm
A. reticulata	10–13 mm	5–7 mm	4–5 mm
Carbonized seed (*Annona*)	15 mm	9 mm	5 mm

Figure 4 Half-split and complete extant seeds of *Annona squamosa* (scale in mm)

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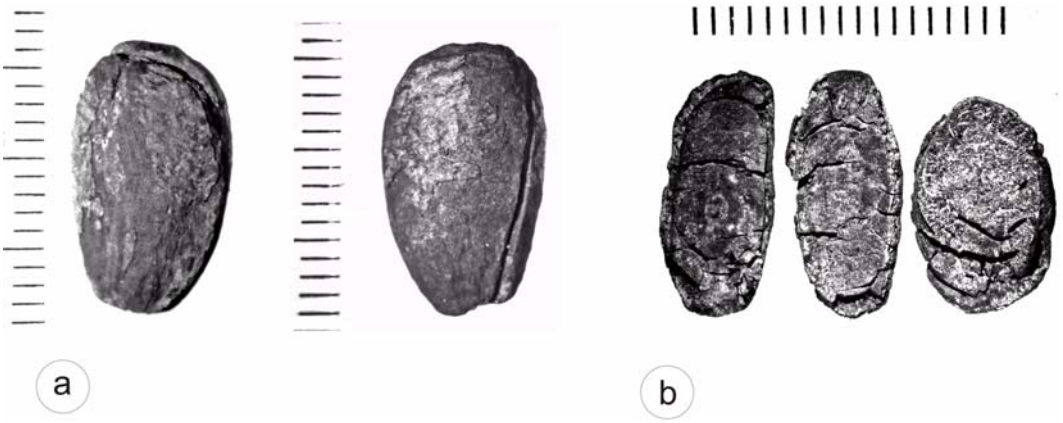

Figure 5 Complete single seed seen from both sides (a) and half-split seeds (b) of *Annona squamosa* from the Neolithic layer at the Tokwa site (scale in mm).

DISCUSSION AND CONCLUSION

According to Sorenson and Johannessen (2006), organisms, whether plants or animals, hold special significance as evidence for the history of long-distance human movement. Biologists believe that a given species arise only once in the course of evolution because new species develop within a unique set of environmental parameters found in only a single geographical location (Zohary 1996). Polunin (1960) states that "The chances that two isolated populations will evolve in exactly the same way are incalculably low," since, as Wulff (1943) has pointed out, "No two localities on earth are exactly alike in all physico-geographical conditions." The remains of custard apple found in Indian archaeological contexts require plausible explanations and are not to be ignored. The LSC and AMS ^{14}C dating of the charcoals and seed sample pushes back the existence of custard apple on the Indian soil to about 1740 cal BC.

On botanical grounds, the custard apple is native to South America and the West Indies and is supposed to have been introduced to India by the Portuguese during the 16th century AD. Amazingly, its appearance in the Bharhut and Sanchi sculptures in Madhya Pradesh and in the carvings dug up at Mathura in Uttar Pradesh (2nd–1st century BC) by General Cunningham in 1879 was seriously contested by botanists. Now unexpectedly, the finds of custard apple seeds encountered in the Neolithic Tokwa site support the identification of custard apple in the ancient Indian sculptures. In addition to Neolithic Tokwa, wood charcoal samples associated with the carbonized seeds of *A. squamosa* (see Figure 7a,b) and other botanical remains from the stratigraphic sequence of the iron-using culture at Raja-Nal-ka-tila, Sonbhadra District, Uttar Pradesh, were previously dated at BSIP (see Table 1: 740 cal BC: BS-1988; Saraswat and Pokharia 2002) and also support the pre-Columbian existence of *A. squamosa* in India.

The botanical evidence and firmly established ^{14}C dates, the characteristics of the fruit seed coats, and the seed-size statistics presented here may change the historical accounts of the discovery of America by Columbus in 1492. The occurrence of custard apple in pre-Columbian times is in no way accidental. The questions of how it reached these diverse unconnected zones, when it happened, and who was responsible for its introduction are difficult to establish at present.

In view of the above, the remains of custard apple found on Indian soil should favor the diverse arguments of a group of specialists proposing Asian-American transoceanic contacts before the dis-

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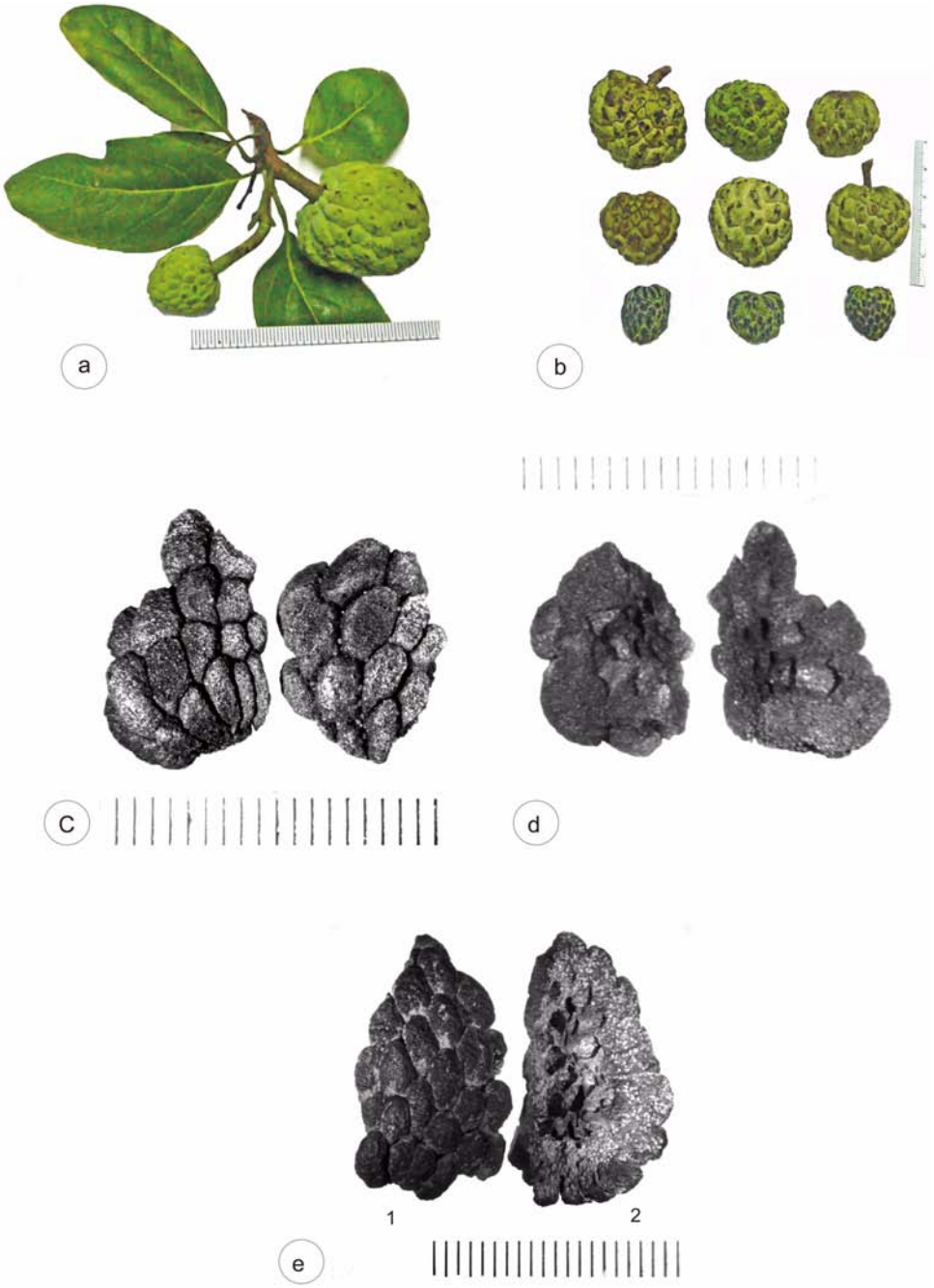

Figure 6 Extant immature and mature fruits of *Annona squamosa* on the same twig (a); variation in size of extant fruits of *A. squamosa* (b); carbonized fruit coat of ancient *A. squamosa* with projecting, ovoid-oblong aureoles on the outer side (Pokharia and Saraswat 1999) (c) and seed locules on the inner side (d); carbonized fruit coat of extant *A. squamosa* with projecting, ovoid-oblong aureoles on the outer side (e1) and seed locules on the inner side (e2) (scale in mm).

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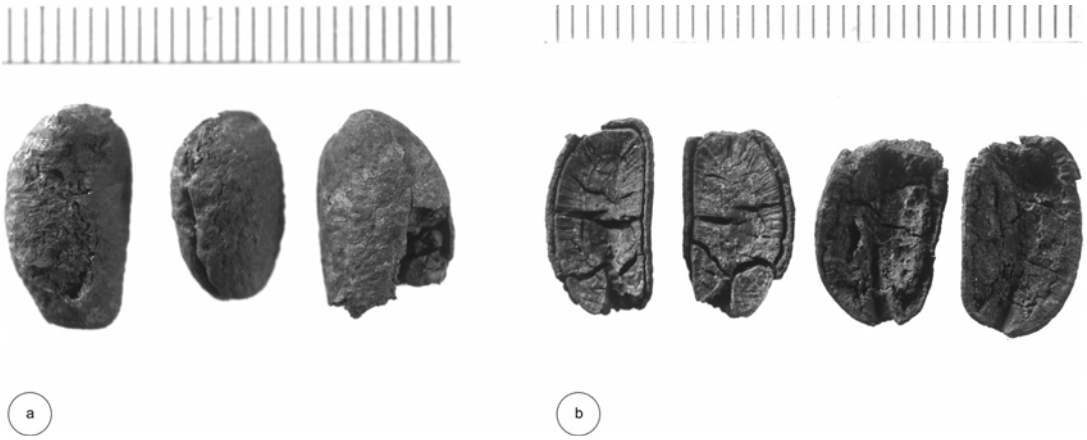

Figure 7 Complete and partly broken seeds (a) and half-split seeds (b) of *Annona squamosa* from the Raja-Nal-ka-tila site (scale in mm).

covery of America by Columbus. With this new archaeological botanical evidence, it should certainly be borne in mind that pre-Columbian contact between the Asian and American regions cannot be ruled out.

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