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RESEARCH ARTICLE

Royal burials and chariots from Sinauli (Uttar Pradesh, India): Radiocarbon dating and isotopic analysis based inferences

Shalini Sharma[1,2], Anil K Pokharia[2], S K S Gahlaud[2], Nikhil Patel[2], S K Manjul[3], Ruchita Yadav[2,4] and Rajesh Agnihotri[2]

[1]Institute of Tibetan Plateau Research, Chinese Academy of Sciences, 16 Lincui Road, Chaoyang District, Beijing 100101, P.R. China, [2]Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow-226007, Uttar Pradesh, India, [3]Archaeological Survey of India, 24 Tilak Marg, New Delhi-110001, Delhi, India and [4]Department of Botany, D.G.P.G. College (Affiliated to CSJMU), Kanpur-200801, India

Corresponding author: Shalini Sharma; Email: sharma_bot@itpcas.ac.cn

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Abstract

For the first time in the Indian subcontinent, a series of royal burials with chariots have been recovered from the Chalcolithic period at the archaeological site Sinauli (29°8′28″N; 77°13′1″E), Baghpat district, western Uttar Pradesh, India. Eight burials were excavated from the site; among them a royal burial with copper decorated legged coffin (lid with a series of anthropomorphic figures) and headgear has also been recovered. Among these remarkable discoveries, three full-sized chariots made of wood and copper, and a sword with a wooden hilt, made this site unique at historical ground. These cultural findings signify that the ancients from this place were involved in warfare. All these recovered exclusive antiquities also proved the sophistication and the high degree of craftsmanship of the artisans. According to the ^{14}C radiocarbon dating and recovered material culture, the site date back to 4000 yr BP (~2000 BCE) and is thought to belong to Ochre-Coloured Pottery (OCP)/Copper Hoard culture. This culture was believed to develop in the Ganga-Yamuna Doab and was contemporary to the late phase of the Indus civilization. Altogether, the findings indicate that the time period of this culture is plausibly contemporary to Late Indus, Mesopotamian and Greece civilizations.

Introduction

Explorations and subsequent excavations in Northern India brought to light an important culture that has been variously labelled as "Ochre Coloured Pottery" and "Copper Hoards." The Ochre Coloured Pottery (OCP) culture has been first identified by B.B. Lal during his excavations at Hastinapur (Lal 1951), in the same stratification as the copper hoards (Lal 1971), thereby placing these copper hoards within the OCP period. The people belonging to OCP used primitive types of copper implements and an ill-fired and thick Ochre-Washed Pottery. The copper hoard implements have been discovered all over India, however, the culture mainly concentrated in the Ganga-Yamuna Doab regions of western Uttar Pradesh and Bihar (Lal 1951). It is believed that the upper region of the Ganga-Yamuna Doab was first colonized by the people of OCP culture. However, this region was climatically drier and more arid in comparison to the Middle and Lower Ganga plains. Recently the presence of OCP culture has also been sought in another states such as Haryana, Rajasthan, and Punjab (Ansari 2009). Bharadwaj places OCP culture period between 1100–800 BCE, while thermoluminescent dates from several OCP sites indicated a time bracket from 2650 BCE to 1180 BCE (Lal 1951). The copper hoards usually contain implements like celts, hatchets, harpoons, spearheads, antennae swords, rings, anthropomorphic figures, etc. Numerous copper hoard objects recovered from different North Indian sites, among them anthropomorphic figures are more distinctive and significant in OCP culture. A number of primitive type of copper implements of proto-historic significance were discovered in caches from the surface soil, or in possessions of individuals and temples from various parts of India, mainly Uttar Pradesh, Bihar and Madhya Pradesh. Large number of sites have been reported in the upper Gangetic valley, the Sutlej-Yamuna divide which consists of the modern states of Punjab, Haryana and Delhi. From northeastern Rajasthan, the so-called OCP sites have been reported in large number. Some of the sites have also been excavated such as Ahichchhatra, Ambkheri, Bargaon, Daulatpur, Hastinapur, Lal Qila, Noh, Saipai, Ganeshwar, Jodhpura and Madarpur (IAR 1954). The OCP sites are generally very small in terms of area (Nair 2012), with 40 cm to 1.5 m of occupational deposit. Most of the OCP sites mainly recovered potteries in relatively substantial quantities, however, the presence of other material remains were meagre. Earlier, the OCP was considered only as an ill-fired, fragile, and rolled pottery but later a good number of well slipped and painted pottery was also unearthed from some sites such as Lal Qila. The artifacts include rings, harpoons, flat and shouldered celts, anthropomorphs, bar-cells and trunnion axes, socketed axes, double axe, antennae swords, hooked swords, spear heads, etc. Most of these implements were chance discoveries without any associated artifacts from sites such as Bithur, Hardoi, Manpuri, Dhaka, RajpurParsu, Indilapur, Bahadrabad, sartholi, Seorajpur, Bisauli, Fatehgarh, Kiratpur, Saipai, Navadatoli, Gungeria, etc. (Jafri 2017).

Here, we present the preliminary scientific analyses including radiocarbon dating and stable carbon and nitrogen isotopic measurements to peek inside into a remarkable pre-historian era of northern India, which has potential to answer intriguing questions pertaining to ancient human movements in the Indian subcontinent. Limited available samples allowed preliminary investigations such as cultural chronology, paleodiet, craftmanship, burial rituals etc. from the site.

Geology and climate

The archaeological site Sinauli (29°8′28″N; 77°13′1″E), is located in the village in Baghpat district of western Uttar Pradesh, India (Figure 1A). The district Baghpat is situated on the Doab of Yamuna and Hindon on the western side of the state. It is 50 km away from Meerut and around 40 km away from Delhi. The district is characterized by cultivated plains and has a tract of extraordinary fertile soil. On the basis of geology, the district may be divided into three parts: First, Khadar (lowland) of the river Hindon and Yamuna which has great impact on the topography of the region. Second, the central part of the Hindon region, a flat area with very minute variations in slope, however, physiographically this area is dull and covers a major part of the district. Third, Doab of the rivers Hindon and Yamuna is the most fertile portion of the district.

The area has climatic variations of extreme kind, ranging from extremely hot in summer and extremely cold in winter. The temperature starts rising from the beginning of March signifying the onset of summer. The western winds locally known as "Loo" begin to blow from April last. The heat is maximum in May and June when the temperature rises up to 40–45°C. January is the coldest month when the minimum temperature goes down to 4–5°C. Season of monsoon is humid. Thus, the region goes through various seasonal vagaries. Thunderstorms occur in the summer and monsoon seasons; their frequency is higher in the months of June and September. Dust storms are common in the summer afternoons. The average rainfall is more than 720 mm.

Archaeological background

The excavations in Sinauli (Figure 1) were conducted by the Archaeological Survey of India (ASI) earlier in 2005–2006 followed by excavation in 2018. The excavation yielded 116 burials which belong to the Late Bronze Age and identified as Harappan remains by Dr. DV Sharma (Sharma et al. 2005). However, no coffins were found during the 2005–2006 excavation. Later on, the excavation conducted during mid-2018 led to the discovery of several royal burials with chariots, swords and helmets, belong

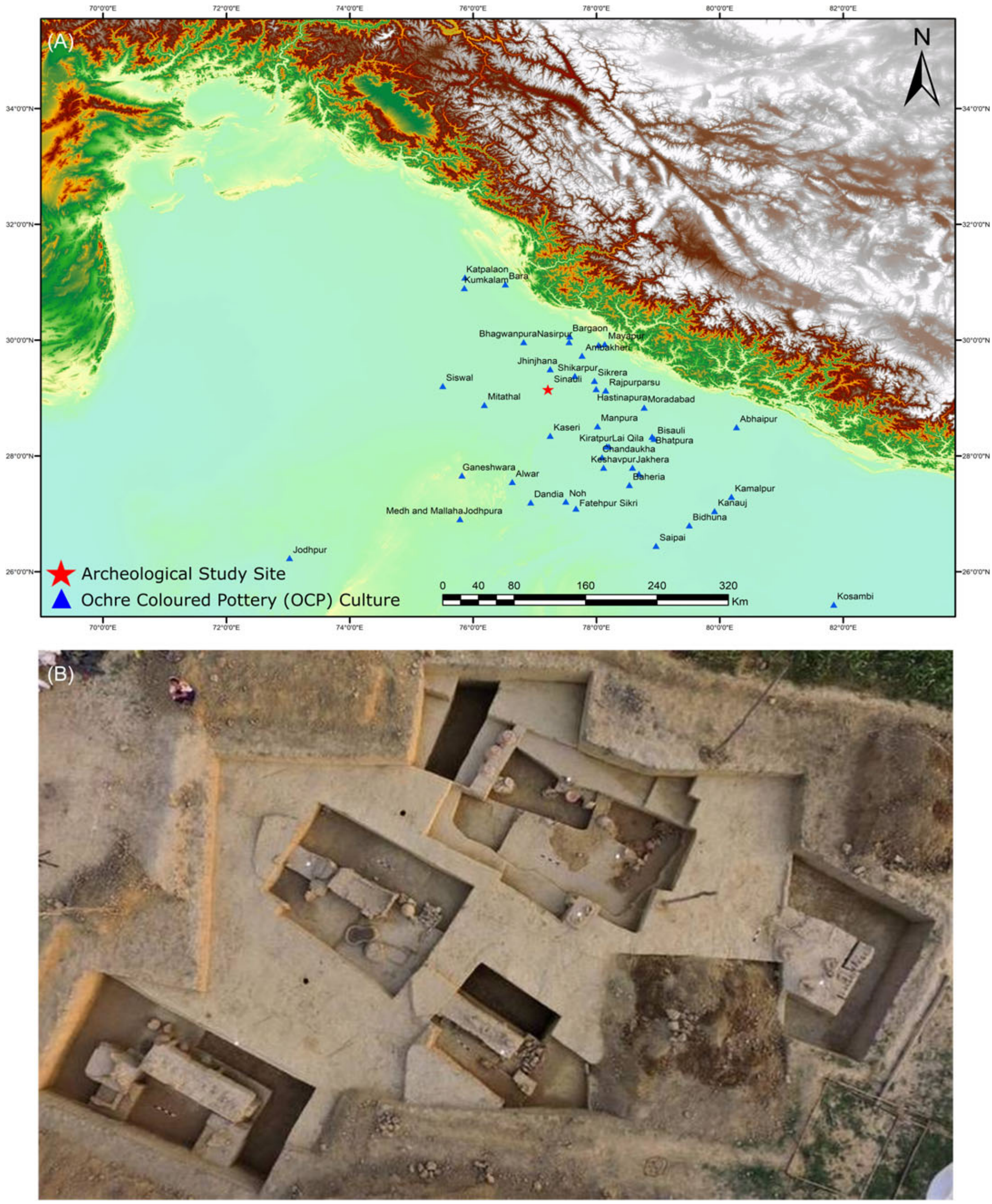

Figure 1. *(A) Map showing location of archaeological study site Sinauli, Uttar Pradesh along with other OCP sites (created by using mapping software ArcGIS 10.3). (B) Aerial view of the study site shows excavated trenches taken by drone (Picture courtesy: Archaeological Survey of India, New Delhi. Adopted from Manjul and Manjul 2018).*

to the Ochre-Coloured Pottery/Copper Hoard culture (contemporary to Late Harappan culture), developed in the Ganga-Yamuna Doab (Figures 1 and 2). This excavation was led by Dr. S.K. Manjul, ASI and his team and the recovered cultural remains were believed to be associated with the OCP/ Copper Hoard culture. Eight burials have been excavated so far, among them there was one unique royal burial with a copper decorated legged coffin and a lid that has carvings in high relief with a series of

Figure 2. *Excavated trenches at Sinauli shows the recovered burials and cultural artifacts. (A) Royal burial with a coffin and a helmet. (B) Chariot exposing the wheels and copper pillar. (C) Burial with human skeleton and pots positioned above the head. (D). Variety of pots and bones from the burials. (E) Cylindrical bead. (F) Sword (G) Wooden comb. (H). Torch (Mashaal). (Picture courtesy: Archaeological Survey of India, New Delhi. Adopted and modified after Manjul and Manjul 2018).*

anthropomorphic figures, all of which have headgear that has two horns and a *Ficus religiosa* (peepal leaf) in the center of a burial; Figure 2A). Besides the face, the figures have broad shoulders and a torso. This burial also recovered two chariots, a copper pot, a helmet, two stick tops, a copper channel, a copper decorated whip, gold-steatite beads, and potteries, seems to belong to a royal person, possibly a chief or a clan leader (Manjul and Manjul 2018). This hitherto discovery in the Indian subcontinent provided three full-sized chariots with these royal burials suggesting occurrence of warfare in the region. The wheels were decorated with three rows of copper triangles radiating from the center. The whole composition looks like the sun's emanating rays (Figure 2B). This discovery of chariots positions India at par with ancient civilisations in Mesopotamia and Greece, where chariots were used extensively. This suggests that Indians were also using the chariots (Figure 2B), helmets and swords (Figure 2A and 2F) in war activities around 4000 yr BP like contemporary Mesopotamian civilization. Other than chariots, the antiquities like antenna swords with wooden hilt and copper spiral wiring was the first discovery of its kind in the entire Copper Hoard culture (Figure 2F).

There were three types of burials found at Sinauli excavation: primary, secondary and symbolic (Figure 1B). In the primary burial, the full body of the dead man was buried. In the secondary burial, the body was exposed to the elements and the bones that remained were placed in a burial. The third symbolic burial was made when the body of a dead person was not available for cremation. In total, eight burials were unearthed at the site, among them three were coffin burials, three were secondary burials, and two were symbolic burials which did not recover any human remains except a bird and a dog skeleton (Manjul and Manjul 2018). The recovered coffins had intricate carvings on them showing the sophistication and high degree of craftsmanship of the artisan during the Chalcolithic period. Textile impressions have also been evidenced on top of the coffin suggesting that the rituals have been performed first before burying the coffin. One burial pit from where sample have been collected, revealed a chariot, a coffin (Figure 2C), variety of pots (Figure 2C), hundreds of beads (Figure 2E), an

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antenna sword (Figure 2F), a shield and dagger, a torch (mashaal; Figure 2H), etc. (Manjul and Manjul 2018).

A helmet was kept upside down at the base of the coffin. There was a channel-like copper object below the coffin. The chariot is identical to the chariots found in the royal burial except for the pole and yoke, which have decorations with copper triangles. The shield was also decorated with geometrical patterns in copper. The burials of a nobleman, common man, a woman, a dog and a bird were also recovered from the excavation. All eight burials have their own qualities and unique features. The ritual pottery was also placed above the head (Figure 2C). The copper objects were kept below the coffins (Manjul and Manjul 2018). Since copper was not available in the surrounding areas, they had used it sparingly. Many beads were also recovered from the coffins. No iron implement has been recovered from excavation, hence, it is certainly identified as a pre-Iron Age culture. Recovered pottery with elongated legs and rims found along with the coffin, were not reported from the Harappan context to date, suggests that this site was associated with the OCP/Copper Hoard culture. To locate the habitational site, a trial trench was excavated at Sinauli around 800 m from the burial site. The earliest levels of the trial excavation recovered potteries and habitational deposits such as hearths (Manjul and Manjul 2018). However, the material from the habitational site has yet to be dated.

Material and methods

Radiocarbon dating

Total four samples (SNLRC-1 to SNLRC-4; Table S1) were selected in order to determine the chronology at the archaeological site Sinauli. Among them three samples were collected from the same burial (Figure 2C); SNLRC-1: decomposed coffin wood, SNLRC-2: calcareous sediment near the coffin, and SNLRC-3: sediment collected from the burial pot, found next to the coffin. Since, SNLRC-3 was collected from the pot, hence used to investigate the food/plant remains using stereo binocular microscope (Leica Z6APO). The microscopic analysis of SNLRC-3 recovered archaeobotanical remains which were identified on the basis of morphological details preserved in the carbonized grains/seeds (Fuller 2018; Martin and Barkley 1961; Pokharia et al. 2011). The identified carbonized grains/seeds were then used for the radiocarbon dating. The sample SNLRC-4 was soil-sediment, which has been collected from another burial.

The ^{14}C radiocarbon dating of SNLRC-1 and SNLRC-2 were carried out by the conventional beta counting Liquid Scintillation Counter (LSC) at Radiocarbon dating laboratory of Birbal Sahni Institute of Palaeosciences (Lab code-BS), 53 University Road, Lucknow 226007, Uttar Pradesh, India. However, SNLRC-3 and SNLRC-4 were dated by accelerator mass spectrometry (AMS) radiometric dating technique at DirectAMS – AMS Radiocarbon Dating Service (lab code D-AMS), in Bothell, Washington, USA. The $^{14}C/^{12}C$ ratios of samples were normalized according to the standard procedures detailed in Stuiver and Polach (1977). Calibration was conducted with the probability method of OxCal v 4.4.4 and Calib 8.2 (Stuiver and Reimer 1993) using the IntCal20 data set to assess calendar ages (Reimer et al. 2013). The 2σ range presented in Table S1 corresponds to 95.4% confidence limits.

Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopic analysis

We carried out a detailed stable isotopic analysis of selected set of samples from this burial site. We measured carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope ratio of decomposed chariot wood, coffin wood and human enamel samples by using continuous flow-elemental analyzer-isotope ratio mass spectrometry (CF-EA-IRMS) at Birbal Sahni Institute of Palaeosciences, Lucknow, India. C and N isotopic analysis were intended to assess the (i) signature of wood exploited to make recovered chariots and coffins, and (ii) diet of the ancients at the site. Clean human tooth was used to measure C and N isotopic ratio of enamel. Tooth enamel was extracted using the protocol described in Dunbar

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et al. (2016). To brief, the crown part of the tooth was removed and treated with 10M NaOH solution at ~80°C for 8 hours followed by rinsing sample with 0.5M HCl to remove NaOH and finally rinsed with ultrapure water. The dried enamel sample were weighed and packed in the clean tin cups. The wooden chariot and coffin were recovered in a decomposed state (mixed with sediment), therefore the sediment organic matter of these structures was used to measure C and N stable isotopic ratios. For measuring sediment organic matter, the decalcification of bulk sediment samples was conducted. ~1–2 g of sample was treated with 5% HCl overnight (~8–10 hours) at room temperature to remove carbonates. The decarbonated sediment samples were then washed three times with deionized water to remove any excess of chloride ions. Centrifuged/washed sediment samples were then dried in an oven at ~50°C. After drying, sediment samples were mildly re-powdered in agate mortar and transferred into dried clean plastic vials (Agnihotri et al. 2014; Sawlani et al. 2021). For mass-spectrometric analysis, about 20–40 mg of dried powder was weighed in clean tin cups and sealed into pellets by nicely and gently pushing from all sides to remove any entrapped gases. All the samples were packed in oval shaped pellets. Using auto-sampler, these pellets were dropped into the reactor of the elemental analyzer (Varioisotope Select, Elementar Germany) interfaced with stable isotope mass spectrometer (*Isoprime precision, Elementar Germany*) in a continuous flow mode. The data quality of measured $\delta^{13}C$ and $\delta^{15}N$ data was checked based on various runs of a suite of *in-house* and international IAEA standards. Accuracy of measured isotopic data was found to be better than 0.20‰, and overall reproducibility of generated isotopic data was found to be better than 0.15‰.

Results and discussion

The archaeological site Sinauli is the first site in an Indian subcontinent which hitherto provided the evidence for chariots with the royal burials along with a series of warfare elements such as sword, shield, helmet, torch, etc. in the Ganga-Yamuna doab region during Chalcolithic period. This unique archaeological discovery revealed a number of burials, last ritual practices of Sinaulians and their cultural material. The cultural material recovered from the excavation indicating highly sophisticated life style and developed wooden and craft cultural practices of ancients in the Ganga-Yamuna doab region. On archaeological grounds, this site was believed to be associated with the OCP/Copper Hoard culture (Manjul and Manjul 2018). To establish actual chronology at the site, we have dated four samples (SNLRC-1 to SNLRC-4) collected from the recovered royal burials. ^{14}C ages of recovered samples from both of the burials has been presented in Table S1. Figure 3 shows the Bayesian model of obtained dates created using OxCal version 4.4.4 (Bronk Ramsey 2017) and IntCal20 calibration curve (Reimer et al. 2013). This model indicates that the time span of the site range between ~5000–3500 yr BP (3077–1466 BC; Table S1).

The AMS date of the carbonized seeds (SNLRC-3) yielded the radiocarbon age 3457 ± 31 yr BP (D-AMS 032053: Figure 3; Table S1), authenticating the actual chronology and time span of cultural practices at the site. Interestingly, the AMS date yielded by carbonized seed (SNLRC-3) is well corroborated by radiocarbon age 3500 ± 127 yr BP (BS-5002: Figure 3; Table S1) of a decomposed coffin wood sediment (SNLRC-1), although obtained using the conventional radiometric method. SNLRC-2 yielded radiocarbon age 3815 ± 295 yr BP (BS-5003: Figure 3; Table S1) also found to be corroborating SNLRC-1 and SNLRC-3, despite being little older. The inconsistency in radiocarbon ages despite of collected from the same burial could be due to the nature of sample type, as the sample SNLRC-1 and SNLRC-3 was majorly organic in nature, hence provided consistent age, however, SNLRC-2 was calcareous and is expected to be relatively older. Overall, all the radiocarbon ages obtained from the same burial (SNLRC-1 to SNLRC-3) were found to be corroborating cultural material and archaeological findings at the site. Based on ^{14}C radiocarbon dating and recovered cultural materials, we estimated the cultural history of the site Sinauli date back to ~4000 yr BP (~2000 BC). The radiocarbon ages and recovered cultural artifacts provide clues about the actual time span of warfare activities of Sinaulians in the Ganga-Yamuna doab region. Further, SNLRC-4 yielded an older AMS radiocarbon age 4798 ± 34 yr BP (D-AMS 032052), most likely due to mixing of older carbon from the

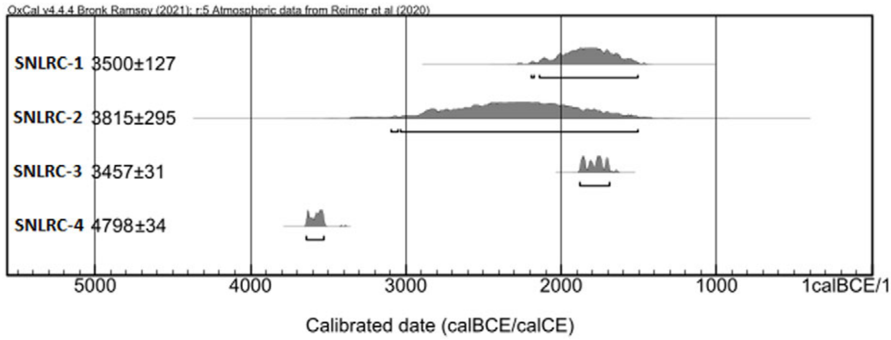

Figure 3. *Bayesian model created by using OxCal v4.4.4 atmospheric curve shows calibrated radiocarbon dates.*

lower levels of cultural sequence, as this was the burial site and had more probability of sediment relocation due to burial activities (Table S1).

Interestingly, the burial site Sinauli also recovered carbonized crop remains of rice (*Oryza sativa*) and masha/urad pulse (*Vigna radiata/mungo*) from the burial pot (Figure S1). The recovery of carbonized seeds/grains led us to use them as a potential sample for AMS radiocarbon dating to provide actual chronology of the site (D-AMS 032053; Table S1). Few weeds such as *Cleome* sp., *Andropogon* sp., *Vicia* sp. and *Trianthema portulacastrum* (Figure S1), were also recovered in association with the crop remains. These weeds seem to be deposited and mixed with the crop remains due to post-depositional activities. The usage of food crops from Sinauli during funeral practices could be supported by the information from ancient literature which mentioned rituals involving offerings of food grains and have been practiced since time immemorial. Many of the processes have also been described in the literature (Muller 1859; Sen 1971; Tilak 1893; Winternitz 1959). It is well recorded that the traits of ritualism, religion etc. goes back to Indus (Harappan) times (Agrawal 1984; Atre 1987; Lal 1979; Rao 1973). For instance, fire-altars have been reported from Kalibangan in Rajasthan and Lothal in Gujarat, plausibly a sign of cultural rituals (Atre 1987; Lal 1979; Rao 1973). It is noteworthy that the crops recovered from pot of burial number 3 are valuable and rare source of the usage of plant products in the funeral practices during second millennium BC. However, it is difficult to interpret these findings for clear understanding of actual ritual practices. In this regard linguists, indologists and botanists can co-operate to unravel the wealth of information from ancient literature to correlate botanical findings used in sacrificial and religious contexts in ancient times.

We also carried out a preliminary stable C and N isotopic analysis of selected set of samples to assess the (i) type of wood exploited to make recovered chariot and coffin, and (ii) diet type of the ancients. $\delta^{13}C_{TOC}$ of decomposed wooden chariot (Figure 2B, Table S2) and coffin (Figure 2A, Table S2) recovered from the royal burial (number 6) showed overlapping values $-16.9 \pm 0.4‰$ (Table S2), indicating possibly the same wood was exploited to made these wooden structures. The earlier evidence of wooden coffins from the Indian subcontinent was recorded from the Indus civilization site Harappa, located in present day Pakistan (Kenoyer and Meadow 2016). The excavation at Harappa revealed the number of wooden coffins made up of rosewood (*Dalbergia latifolia*) and cedar (*Cedrus deodara*) wood (Kenoyer and Meadow 2016; Wheeler 1947). Similarly, the Egyptians also exploited cedar wood other than the local available trees such as sycamore fig, acacia, tamarisk, and Christ's thorn, to made wooden coffins (Arbuckle 2018; Dodson 2015). In this preliminary approach, we used an analytical method to assess the type of decomposed wood from the coffin and chariot which cannot be identified by the wood anatomical analysis. However, in the absence of a modern analogue of stable C and N isotopes of the woods, it is difficult to provide the identification of tree taxa exploited to make these wooden structures. Further, our study floats the idea to use analytical methods to identify the type of woods found in decomposed state from the burial sites. The $\delta^{13}C_{TOC}$ value of human enamel is measured −9.13 ± 0.3‰. The obtained value falls under the range of C_4 type of dietary pattern, indicating possibility of exploitation of C_4 type of plants. (Ambrose 1990; Knipper et al. 2013; Macko et al. 1999; Touzeau et al. 2014) (Table S2). Consequently, $\delta^{13}C_{TOC}$ value of human enamel suggests possible C_4 type of food consumption of Sinaulians during the second millennium BC.

Conclusion

Sinauli is the first archaeological site in the Indian subcontinent which provides evidence of chariots, royal burials with the warfare elements during OCP/ Copper Hoard culture in Ganga-Yamuna doab. The set of ^{14}C dates presented in this study authenticates the chronology of the site which date back to ~4000 yr BP (~2000 BC) and identified OCP occupation in northern India. The recovered material culture at the site indicate that the Sinaulians were involved in warfare activities. The recovered antiquities indicates their high degree of sophistication in wood and copper craftsmanship. Besides establishing chronology, the present study proposes the idea of utilising scientific analytical methods to address key questions arising from the burial sites such as exploitation of raw materials for rituals practices, subsistence, material culture, ancestry etc. This study provides a platform for the researchers to evaluate evidence of royal burials, the use of chariots and other warfare elements in relation to contemporary civilizations in other part of the world.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2024.89

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