



Full length article

## The earliest directly dated saddle for horse-riding from a mid-1st millennium BCE female burial in Northwest China

Patrick Wertmann<sup>a,\*</sup>, Maria Yibulayinmu<sup>b</sup>, Mayke Wagner<sup>c</sup>, Chris Taylor<sup>d</sup>, Samira Müller<sup>a</sup>, Dongliang Xu<sup>b</sup>, Irina Elkina<sup>e</sup>, Christian Leipe<sup>f,g</sup>, Yonghong Deng<sup>b</sup>, Pavel E. Tarasov<sup>g</sup>

<sup>a</sup> Institute of Asian and Oriental Studies, University of Zurich, Zürichbergstrasse 4, 8032 Zurich, Switzerland

<sup>b</sup> Academia Turfanica, 1268 Muna'er Rd., Gaochang District, Turfan, Xinjiang 838000, China

<sup>c</sup> Eurasia Department and Beijing Branch Office, German Archaeological Institute, Im Dol 2–6, 14195 Berlin, Germany

<sup>d</sup> Saddlers Den, 60 Norwood Avenue, Southport, PR9 7EQ, United Kingdom

<sup>e</sup> Archaeological Institute, Russian Academy of Science, Ul. Dmitriya Ulyanova 19, 117036 Moscow, Russia

<sup>f</sup> Department of Archaeology, Max Planck Institute of Geoanthropology, Kahlaische Strasse 10, 07745 Jena, Germany

<sup>g</sup> Paleontology Section, Institute of Geological Sciences, Freie Universität Berlin, Building D, Malteserstr. 74–100, 12249 Berlin, Germany



## ARTICLE INFO

## Keywords:

Early equestrian practices  
Horse-powered mobility  
Turfan basin archaeology  
Yanghai archaeological site  
Subeixi archaeological site  
Scythian type saddle

## ABSTRACT

The invention of the saddle substantially improved horseback-riding, which not only revolutionized warfare, but also eased long-distance speedy movement across Eurasia. Here we present the first detailed construction analysis and absolute age determination of a well-preserved soft leather saddle recovered from the tomb of a female deceased at the Yanghai cemetery site in the Turfan Basin at the eastern end of the Tian Shan mountains. Compared with the oldest known saddle from the Scythian Pazyryk culture site Tuekta barrow no. 1 (430–420 BCE) in north-western Altai, the Yanghai specimen radiocarbon dated to 727–396 BCE (95.4% probability range) is contemporaneous or possibly older. The saddle features the basic elements of soft saddle construction that are still used today: two stuffed, wing-shaped hides sewn together along the outer edges and separated by a central gullet-like spacer and lens-shaped support elements, resembling knee and thigh rolls of modern saddles. Being a masterful piece of leather- and needlework, it is, however, less complex compared to Scythian saddles from the 5th–3rd centuries BCE. Another specimen from nearby Subeixi site, which is also described in detail for the first time in the present study, much closer resembles the Pazyryk saddles in shape, size and structure. In Yanghai, equestrian paraphernalia appear in the grave assemblages during the entire burial period (ca. 1300 BCE to 200 CE), although in higher numbers only from ca. 300 BCE. In the same way, the burial of horses was not common until then. Despite the generally very good preservation of leather, only two saddles were discovered in Yanghai which makes them an exception rather than the norm and raises the question of whether these saddles were acquired from more specialized horse breeders, riders, and saddlers in the North.

## 1. Introduction

In Eurasia horsepower was extremely important for long-range transport of people and goods for civil and military purposes until it was replaced by fuel-powered engines, making it equally beneficial and desirable for mobile and sedentary societies. The prerequisites for its ubiquitous use were (1) the domestication, training, and availability of a sufficiently large number of horses and (2) the invention of associated technology for controlling the horse to enable horseback-riding and the use of horses for traction. Intensified research activities spawned numerous publications presenting the results of osteological, genetic,

isotopic, and proteomic analyses as well as pictorial evidence, which contribute to the discussion of where and when horse domestication and riding began and under which conditions and with what social consequences domestic horses spread to different regions of Eurasia (e.g. Anthony, 2007; Delpout, 2021; Drews, 2004; Rawson et al., 2021; Taylor et al., 2021; Yuan, 2021). However, direct evidence of earliest riding is still rare.

Bridles, particularly bone-, horn-, antler-, or metal-made cheekpieces of different type and shape are used as chronological markers and indicators of either bridling horses or riding horses (Chechushkov et al., 2018). However, leather made items such as saddles, bridles and their

\* Corresponding author.

E-mail address: [patrick.wertmann@aoi.uzh.ch](mailto:patrick.wertmann@aoi.uzh.ch) (P. Wertmann).

<https://doi.org/10.1016/j.ara.2023.100451>

Received 22 February 2023; Received in revised form 5 May 2023; Accepted 8 May 2023

Available online 23 May 2023

2352-2267/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

associated paraphernalia that revolutionized the effectiveness of horse-riding particularly in battle (Edwards, 1977, 194–199), are hard to trace because they decay under most soil conditions. A well-fit saddle is crucial for an optimal performance and the wellbeing of both the horse and the rider (Bondi et al., 2020). It must fit the horse at different gaits and the rider for maintaining balance and comfortable seat at different paces (Greve and Dyson, 2013, 276). Manufacturing such an item requires a craftsman not only to master leather- and needlework, but also to have a deep understanding of the interrelationship between saddle, horse, and rider.

Still, the intriguing question of when and where horse-riding and the use of saddles started is far from resolved. The number of early saddles is limited as is the study of their technological construction. The most recent bioanthropological study concludes from changes in human bone morphology and distinct pathologies that horseback-riding was common for at least some individuals ca. 3000 BCE in Yamnaya culture (Romania, Bulgaria, Hungary) (Trautmann et al., 2023). Librado et al. (2021) argue that horseback-riding drove the dispersal of modern domestic horses (DOM2 lineage) to Anatolia, Mesopotamia, and Eastern Europe in the late 3rd and early 2nd millennium BCE, which is synchronous with the earliest evidence for the light spoke-wheeled chariot in the context of the Sintashta-Petrovka cultural complex in the trans-Ural region (Kuznetsov, 2006) dated to ca. 2000 BCE (Lindner, 2020) or 2025–1850 BCE (Chechushkov et al., 2018). Among the earliest pictorial evidence of horse-riding is a Mesopotamian terracotta plaque dated to ca. 1750 BCE (see British Museum online collection, number 22958). It shows a rider with reins and a whip, but no saddle, instead a simple surcingle-like strap, i.e. a separate belly strap encircling the saddle and the thorax of the horse to stay in seat. A horse without saddle-cloth controlled by a rider with bridle and whip is shown in the tomb of Egyptian pharaoh Horemheb (ruled 1319–1292 BCE; Hornung et al., 2006, 493) in Saqqara (Fig. 1) (Delpout, 2021, 36). Beginning in the 9th century BCE and increasing through the 7th and 6th centuries BCE, cavalry became a disciplined strike force in the Assyrian Empire (Dezső, 2012, 16). Numerous depictions on stone reliefs from the royal Assyrian palaces at Nimrud and Nineveh (Fig. 1), however, show that bridles were used, but not saddles. Assyrian riders sat on fringed, carpet-like saddle-cloths or pads in the shape of animal skins fixed with breast straps and cruppers (Dezső, 2012, 24). The same applies for the Achaemenid Persians ruling over the ancient Near East from 550 BCE as a bronze figurine (Curtis and Tallis, 2012, 150) and depictions of

Achaemenid riders in the pile carpet from barrow no. 5 (Rudenko, 1970, 304, pl. 160) at the Pazyryk site demonstrate (Fig. 1).

In the Altai mountain area, horse dairying, albeit not riding, has been confirmed ca. 1350 BCE (Ventresca Miller et al., 2022). But further south to the eastern Tian Shan mountain range, the Tarim Basin, and the western end of the Hexi Corridor domesticated horses and horse-riding seem to have arrived only by the late 12th century BCE, as a decorated horse tail and a whip from grave IM157 at the Yanghai site <sup>14</sup>C-dated to 1261–1041 BCE (date on wool, Kramell et al., 2014) and 1127–931 BCE (date on horse hair, Wertmann et al., 2020), a bridle with wooden cheekpieces from Yanghai grave IM21, 1074–926 BCE (dates on wool, Kramell et al., 2014) (Fig. 1), a wooden cheekpiece from grave 86HWM3 of the Wupu cemetery in Hami (Fig. 1) directly dated to 1107–901 BCE (Schröder et al., 2016) (all dates represent 95.4% confidence interval of calibrated ages), and a number of other but less precisely dated finds (e.g. Li, 2022) prove. The so far oldest dates from the northern slopes of the Kunlun Shan come from the Liushui burial site (ca. 2850 m a.s.l.) of mounted pastoralists (Fig. 1). Horse skulls, bits, and cheekpieces were recovered from burials representing the earliest phase of use dating to 1108–893 BCE (Wagner et al., 2011). In addition, palaeopathological features on human remains were detected, which provide circumstantial evidence of regular horse-riding (Wu et al., 2006; Schultz et al., 2008; Wagner et al., 2011). Although a recent osteological study on horse remains from the sites of Shirenzigou and Xigou in eastern Xinjiang confirms horseback-riding only for a later time period, i.e. since ca. 350 BCE (Li et al., 2020), the numerous older finds (e.g. Cai, 2021; Wagner et al., 2011) emphasize that Xinjiang played an important role in the history of equestrian practices and technologies already during the first half of the first millennium BCE.

In Mongolia the transition to a fully developed horse-based pastoral economy related to the innovation of horseback-riding is attested for ca. 1200 BCE by tooth wear and osteological changes in horse bones indicative of bridling and riding (e.g. Levine et al., 2005; Taylor et al., 2015) as well as pathologies in human bones pointing to frequent riding (Grupe et al., 2019). Notably, this is concurrent with the beginning of the use of horse-drawn spoke-wheeled chariots in the realm of the Shang Kingdom in the Central Plains of China (Taylor et al., 2021). Domesticated horses suddenly appear in great numbers alongside chariots in separated burial pits during the late Shang dynasty (1350–1046 BCE), almost exclusively in the political center Yinxu and associated with the Shang elite (Fig. 1; Yuan and Flad, 2005; Wu, 2013; Yuan, 2021). They



Fig. 1. Map showing the location of the Yanghai cemetery site (yellow dot) near modern Turfan in Northwest China and other sites referred to in this article (white dots). Map: Ch. Leipe.



are interpreted as being introduced by non-Chinese horse breeders from the north (Rawson et al., 2020, 2021). Since no pathological changes were identified on their bones, it is currently assumed those horses were not ridden (e.g. Yuan, 2021). However, Wang et al. (2007) interpret two bronze horse sculptures with oval-shaped covers resembling saddle-cloths from the site of Yanjiagou (Fig. 1), Ganquan county, Shaanxi province, typologically dated to the interval 1191–1148 BCE, as the earliest depictions of riding horses in China. The first written reference to the beginning of horseback-riding in China dates to 307 BCE, when the King of the northern state of Zhao adopted horse-riding in response to the rise of neighbours with mounted forces on the northern and north-western borders (e.g. Goodrich, 1984; Sinor, 1990; Whitfield, 2020; Shelach-Lavi et al., 2021).

Unlike the bridle, the saddle was a relatively late development when riders began to care more about comfort and safety and the health of the horses (Drews, 2004). The history of saddle-making seems to start with buckles perceived as parts of former saddles found at the archaeological sites Tunnug 1 and Arzhan 1 in southern Siberia (Fig. 1) together with horse remains, cheekpieces, bits, and bridle ornaments associated with the earliest Scythian horizon, ca. 9th–7th centuries BCE (Gryaznov, 1984; Sadykov et al., 2020). However, saddles were not found (Chugunov et al., 2010). The first archaeologically confirmed saddles come from sites of the Scythian Pazyryk culture (Fig. 1; Stepanova, 2021) in the Altai region and eastern Kazakhstan. The term Scythian in this paper is used as a generic term to refer to the early nomadic cultures that flourished across the entire Eurasian steppe zone approximately between the 9th and 2nd century BCE (on the distinction of the various Scythian groups, see for example Cunliffe, 2019, chapter 2). Currently the oldest of these preserved saddles from barrows nos. 1 and 2 at the Tuekta site (Fig. 1) have been dated to 430–420 BCE by applying dendrochronology to wood of the barrows' burial chambers (Rudenko, 1953; Stepanova, 2006, 104). Soft saddles assigned to the 5th–3rd centuries BCE were found in graves 1 and 3 at the Ak-Alakha site (Fig. 1; Polos'mak, 1994, 45; Levine et al., 2005, 103) and barrow no. 11 at the Berel site in eastern Kazakhstan (Fig. 1; Francfort, 1999, 49–57; Samashev, 2006, 35–44). The best studied Scythian saddles so far are those discovered in barrows nos. 1–6 at Pazyryk (Fig. 1), which were produced between the late 4th and the middle of the 3rd century BCE (Rudenko, 1970; Stepanova, 2006). A depiction of a hobbled horse equipped with a Scythian soft saddle with a girth and chest strap on a 4th century BCE gilded silver vase from the Chertomlyk kurgan in Dnepropetrovsk, Ukraine, (Fig. 1; Cunliffe, 2019, plate 9.1a) attests that during the 4th–3rd centuries BCE the Scythian saddle had already spread across Eurasia as far west as the northern Black Sea region. The spread in opposite direction is documented by a mounted warrior seated on a saddle depicted on a bronze mirror from the Jincun cemetery in Luoyang, Henan province (Fig. 1; Chinese Bronzes Committee, 1998, 33), indicating the use of saddles during the Warring States period (475–221 BCE) in the Chinese Central Plains.

In this study, we present the first detailed construction analysis and absolute age determination of a leather saddle from the Yanghai cemetery site in Northwest China dated to the 1st millennium BCE (Turfan Administration of Cultural Relics et al., 2019). We further compare this saddle with a possibly contemporary saddle from the nearby Subeixi site. Finally, we discuss the importance of these finds and other items recovered from Yanghai that were identified as equestrian paraphernalia within the context of early horse-riding and saddlery in Central and Eastern Asia.

## 2. Material and methods

### 2.1. The leather saddle from the Yanghai archaeological site tomb IIM205

Yanghai, 43 km southeast of modern Turfan (Fig. 1), is mainly associated with the Subeixi culture dated to the 1st millennium BCE (Chen, 2002; Han, 2007). In Chinese written sources, the area was

described as part of the agro-pastoral Cheshi (Jushi) state that existed in and north of the Turfan Basin (Sinor, 1990; Zhang and Rong, 1998; Wang, 1999a; Ghosh et al., 2008). The Subeixi culture weaponry, horse gear and garments (Mallory and Mair, 2000; Lü, 2001) resemble those of the Pazyryk culture (Molodin and Polos'mak, 2007), suggesting contacts between Subeixi and the Scythians living in the Altai mountains (Li et al., 2013). Since 2003, 531 graves of commoners (elite graves were not found) spread over about 5.4 ha have been excavated at Yanghai, representing the interval ca. 1300 BCE–200 CE (Turfan Administration of Cultural Relics et al., 2019). Due to the extreme arid climate (Domrös and Peng, 1988), a large quantity of organic remains is naturally preserved and already triggered various studies (e.g. Beck et al., 2014; Kramell et al., 2014; Wertmann et al., 2020, 2021; Wagner et al., 2022).

Grave IIM205 is a rectangular pit (depth 0.7 m, length 1.68 m, width 1.12 m), which opens 0.2 m below the topsoil (Turfan Administration of Cultural Relics et al., 2019, 434). It contains the burial of four persons in two layers separated by a ca. 30 cm soil layer.

On the grave floor was buried a 20–30-year-old male in stretched supine position, head pointing west. Next to his right hand lay the skull of a 35–40-year-old female, next to his left hand the skull of a non-adult of undetermined sex. The bones of these two people lay scattered at the man's feet, indicating that they died some time before him and were either placed in this tomb first and their skeletal remains rearranged when he was added to it, or they were buried in another tomb and their remains relocated here when he was interred. The burial items include pottery (a cauldron, bowls, cups), a wooden drill, spindle whorl and a stick, a stone pestle, an iron awl, woolen bands as well as two leather pillows and a leather bridle (Turfan Administration of Cultural Relics et al., 2019, table 31.4).

Separated from the lower layer interments by ca. 30 cm soil, just below the opening of the tomb, was the burial of an adult woman in flexed position, head pointing east. The excavators reported a hide coat, woolen trousers (without details and picture), and short leather boots, most of which had decayed. The layer further contained a single-handled pottery cup, a braided woolen band, remains of a woolen fabric, and a leather saddle placed on her buttocks as if she was seated on it (Fig. 2, Turfan Administration of Cultural Relics et al., 2019, table 31.3).

According to the excavation report, the saddle found in the upper layer I of grave IIM205 (IIM205:20) is formed of two cushions made of cow hide and filled with a mixture of deer and camel hair as well as straw (Turfan Administration of Cultural Relics et al., 2019, 437, fig. 755, table 224.8). Despite partial deterioration and various degrees of wear, it is fairly well-preserved. In 2015, the saddle was examined by a



Fig. 2. Yanghai cemetery tomb IIM205 with the position of the leather saddle indicated by the red circle. After: Turfan Administration of Cultural Relics et al., 2019, plate 31.3. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

joint team of the Turfan Museum and the German Archaeological Institute in a training workshop on the restoration and conservation of ancient leather finds. The technical data provided in this paper result from the observations and documentation made during the workshop and in follow-up research and discussions by the authors. For the determination of the absolute age of the leather saddle, permission was granted to obtain one direct AMS radiocarbon ( $^{14}\text{C}$ ) date from the filling material of the saddle. In order to better understand the technical details and use of the saddle, we collected data on the dimensions, materials used, construction methods including sewing techniques, and observed all signs of wear and repair.

Only one more saddle was found in Yanghai grave IIM138 (typologically dated to ca. 700–300 BCE) next to a 35–45-year-old man (Turfan Administration of Cultural Relics et al., 2019). Because it was preserved in a very fragmentary condition, no reliable information on its construction could be obtained.

## 2.2. The leather saddle from Subeixi archaeological site tomb M10

The Subeixi site in Shanshan county, Turfan, which gave the name to the archaeological culture, was first excavated in May 1980 (Lü and Zheng, 2002; Xinjiang Institute of Cultural Relics and Archaeology and Turfan Museum, 2003, 53–54, 56; Lü, 2002). Since then, the remains of three house foundations (F1–F3) and three cemeteries (nos. 1–3) were identified. In 1999, at Subeixi cemetery no. 1 (Fig. 1) with 52 tombs spread over 0.3 ha, 13 of which have been excavated, a leather saddle (M10:8), bridle and whip were discovered in tomb M10. Tomb M10 was a vertical pit (length 216 cm, width 182 cm, depth 182 cm) originally covered with a pile of gravel stones. The tomb occupant was an adult male placed on a woolen rug in stretched supine position (Fig. 3). He was dressed in a leather coat, leather boots, woolen trousers, and a felt hat. According to the excavation report, the saddle was found next to the deceased who was further equipped with a knife and a quiver.

In 2008, the saddle was examined by master saddler Chris Taylor at the Xinjiang Institute of Cultural Relics and Archaeology in Urumqi. The aim was to collect data on the dimensions, materials used, and construction methods of the saddle intended for a later reconstruction and pressure testing.

## 3. Results and interpretations

### 3.1. Dating of the leather saddles

Based on the tomb construction and typology of the burial items, tomb IIM205 from Yanghai is dated by the excavating archaeologists to the 7th–4th century BCE (Turfan Administration of Cultural Relics et al., 2019, 632). Calibration of the radiocarbon date of the straw filling ( $2395 \pm 30$   $^{14}\text{C}$  BP, Poz-74,943) revealed an age range of 727–396 BCE (95.4%

probability) or 514–403 BCE (68.2% probability). This date approves the typologically assigned age of the saddle, which is to our knowledge the only directly dated archaeological saddle from China.

The M10 grave and saddle from the Subeixi site have only been tentatively dated. The archaeological team suggested the interval between the 5th and 3rd centuries BCE based on the typology of burial items and three  $^{14}\text{C}$  dates ( $2480 \pm 85$ ,  $2395 \pm 80$ , and  $2280 \pm 80$   $^{14}\text{C}$  BP) obtained on wood samples from typologically similar graves (Xinjiang Institute of Cultural Relics and Archaeology and Turfan Museum, 2003, 141–142). Calibration of these dates reveal a broad age interval of 790–60 BCE (95.4% probability) or 769–200 BCE (68.2% probability), which indicates a similar or younger age of the Subeixi saddle compared to the one from Yanghai. The latter scenario would agree with the age (ca. 350 BCE) suggested by Li et al. (2020) for the Subeixi saddle.

### 3.2. The saddle from Yanghai

#### 3.2.1. Construction

The IIM205 saddle is a soft leather saddle composed of two oval-shaped cushion pads (hereafter referred to as panel A for the left cushion and panel B for the right cushion) with four lens-shaped support elements in each corner and a gullet-like central channel. Considering the identical size and shape of the hides that form the upper and underside of the saddle, they were most likely made from a single template. No traces of fastening straps such as a girth, chest strap, or crupper are visible on the saddle in its present state of conservation. Each component will be described in the following.

#### 3.2.2. Saddle panels

The lengths of the two panels that form the upper side of the saddle (Fig. 4.1) range between 42.5 cm (panel A) and 44.5 cm (panel B). The panels are slightly wider at the front than in the rear. The width of panel A ranges between 25 cm at the top and approximately 21.4 cm at the rear. Due to the deformation of panel B, the width differs slightly (19.5 cm at the front, 19.6 cm at the rear). However, due to the symmetrical construction of the saddle, it can be expected that both panels were originally identical in size and shape. The hide forming the upper side of the saddle is sewn to the underside along the outer edges with sinew thread using a very fine and strong running stitch.

The upper side of the saddle is made up of five pieces of hide sewn together with fine running stitches using sinew thread (Fig. 5.1). The largest hide (no. 1) forms the seat and the front supports. Each two smaller pieces of hide were cut in shape and attached to complement the back supports (nos. 2–3 on side A, nos. 4–5 on side B). Apart from a tear in the upper section of side B, both panels are relatively well preserved. Except for one seam connecting pieces nos. 2 and 3, which is sewn from the outside, all other pieces are sewn together from the inside. A small repair executed with a fine herringbone stitch can be noted on the inner side of the back support on side B (no. 5). Four horizontally-aligned holes without remains of a thread can be further observed in the left front support (Fig. 5.2). The original function of these holes is unclear. In addition, each two holes are present on the outer side of either back support (Fig. 5.3). Possibly, they once served as connecting points to either a breeching or a crupper-strap as known from saddles found at sites such as Pazyryk, Berel, or Subeixi (Lü and Zheng, 2002; Samashev, 2006; Stepanova, 2016). This, however, cannot be confirmed.

Two slits measuring 14 cm (panel A) and 11 cm (panel B) in length appear to have been deliberately cut into the upper side of the saddle panels at about 5–7 cm apart from the central axis (Fig. 6). Both cuts were closed with leather strips in a coarse and seemingly provisional way using a loose herringbone stitch. This type of stitch, which is made in a staggered arrangement featuring a zipper-like seam which allows the edges of the cut to be pulled together to form a flat surface (see for example Ulloa, 2008; today also called baseball stitch as in Desvergues, 2020). Different qualities of leather were used for the strips, i.e. an even thread of untanned leather on panel A (ca. 0.3 cm wide), and a coarse,

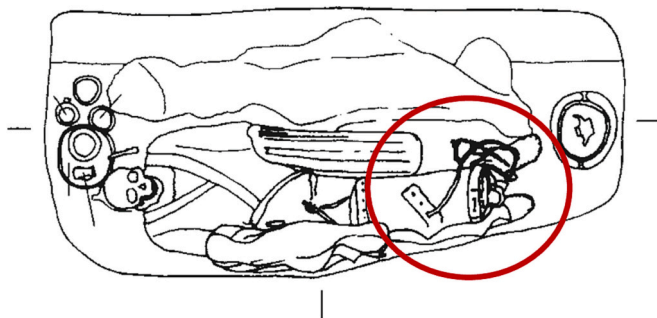


Fig. 3. Subeixi tomb M10 with the location of the leather saddle and bridle marked by the red circle. After: Xinjiang Institute of Cultural Relics and Archaeology and Turfan Museum, 2003, fig. 13. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



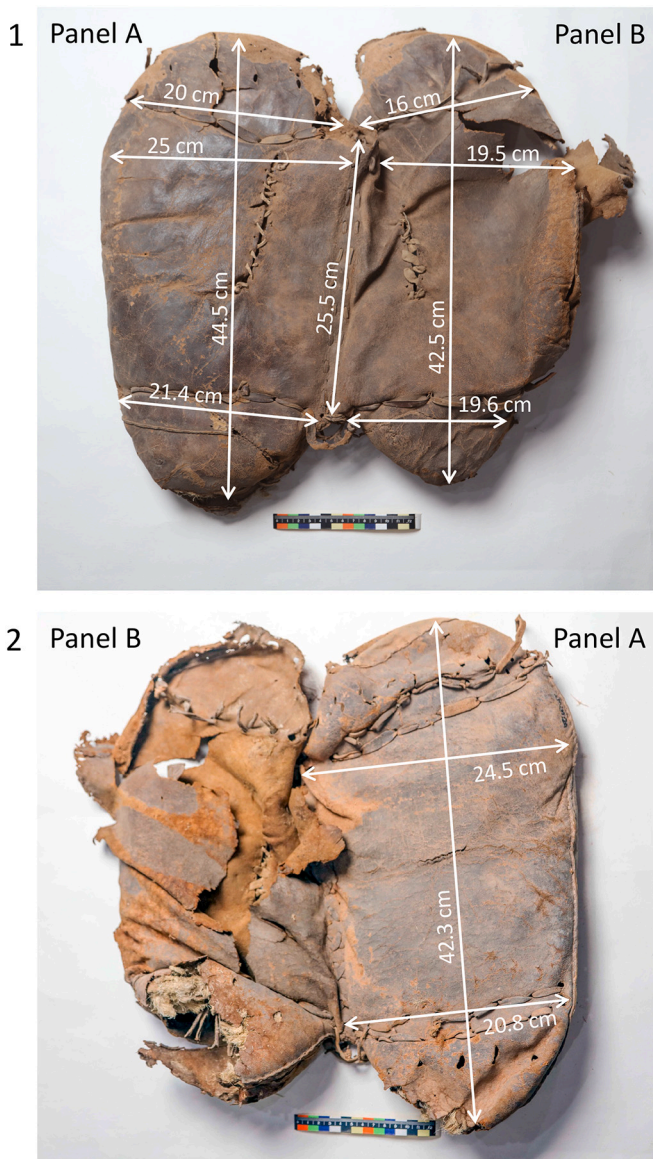


Fig. 4. Measurements of the Yanghai leather saddle (IIM205:20). 1 - Upper side; 2 - Underside. Photos: P. Wertmann.

possibly tanned leather strip of uneven width on panel B (up to 0.8 cm wide). The ends of the strips are fixed with knots. These provisional seams indicate that they were occasionally opened to renew the filling of the saddle, in particular the seat area on which the greatest pressure was exerted. This is further supported by the fact that unpicked stitching holes of former seams are visible along both sides of the slits.

Two corresponding holes in the upper and underside of the saddle can be observed at the outer edges of the back supports (Fig. 7.1). The fact that these holes are slightly bend outwards implies that a certain pull was originally exerted on them. Notably, a rectangular-shaped area of flaked-off leather is further visible around these holes, which possibly results from a now missing component once attached here (Fig. 7.2). The Pazyryk barrow no. 1 saddle shows that strings might have been attached at these points used to tie up certain things for reasons of transport such as a quiver or other everyday items like bags or blankets (see Stepanova, 2016, 16). As no strings are preserved, this can only be speculated.

Looking at the underside of the saddle, while panel A is well preserved (length 42.3 cm, width at the front 24.5 cm, width at the rear 20.8 cm), panel B is torn open, deformed, and partially incomplete,

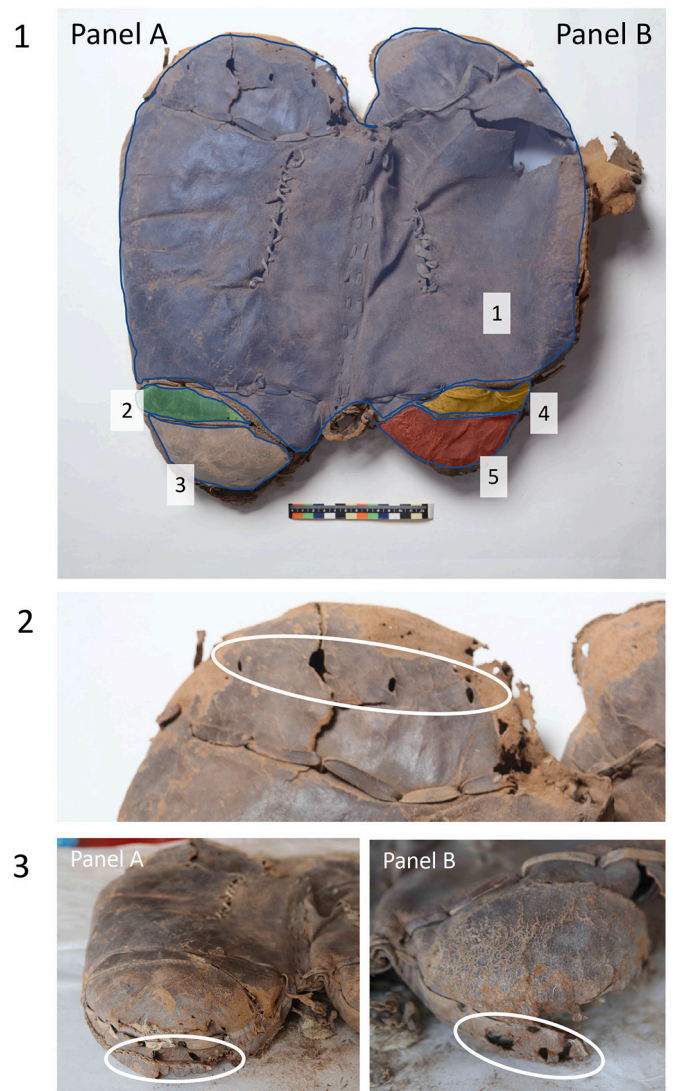


Fig. 5. View of the upper side of the Yanghai leather saddle (IIM205:2). 1 - The upper side is composed of five hide pieces (nos. 1–5); 2 - Four unpicked holes are visible in the front part of saddle panel A; 3 - Each two empty holes are visible on the back supports. Photos: P. Wertmann; M. Yibulayinmu.

especially the upper section (Fig. 4.2). Considering the symmetry of the saddle, however, the size and shape of the underside should have been equal to the upper side. The overall composition is unclear due to its state of conservation. From what can be observed, it was likely made of one large piece of hide (no. 1). On panel A, a smaller piece was attached at the top (no. 2, 12 × 4.7 cm; Fig. 8.1). In contrast to the smaller hides of the upper saddle side, this piece appears to have been sewn onto the saddle at a later point, possibly as a repair patch indicated by the different look of the leather as well as the execution of the running stitch, which appears less fine (Fig. 8.2).

A small repair done with a very fine running stitch using sinew thread can be seen in the center of side A (Fig. 8.3). Furthermore, holes punched into the leather of all remaining supports in horizontal lines are visible, i.e. 6 holes in the front support of panel A, 5 holes in the back support of panel A, and 4 holes in the back support of panel B (Fig. 4.2). If something was originally attached here, perhaps straps, or if these are the remains of former seams is unclear and can only be guessed.

### 3.2.3. Gullet

A ca. 1 cm wide unstuffed channel resembling a gullet separates the two saddle panels and links the hides of the upper and underside of the





Fig. 6. Two slits were cut into the upper side of the saddle panels A and B. They were provisionally closed with herringbone stitches. Photo: P. Wertmann.

saddle (Fig. 9). When the saddle is in place, this channel rests on the horse's spine. Later gullets are designed to keep the saddle clear of the animal's spinal processes, which reduces discomfort and allows the

horse to move freely. At the same time, the small gap created between the two front supports allows the saddle to be positioned at the correct point on the horses back and ensures that the rider sits directly behind the withers, i.e. the position best suited for riding without stirrups (Stepanova, 2016, 4).

The channel is created by the sewing of a continuous leather thong (0.4–0.5 cm wide) likely by using a combination of two types of firm stitches performed with two needles, i.e. a running stitch on the upper side and a cross stitch on the underside of the saddle (Fig. 9). One possible reason for that might be the fact that a singular running stitch would cause the leather to wrinkle as can be seen in some places along the outer edges of the saddle panels, which is sewn in running stitch. The cross stitch helps to keep the leather between the running stitches even. The ends of the leather thong are visible between the front supports of the saddle.

#### 3.2.4. Lens-shaped support elements

Lens-shaped supports were formed in each corner of the saddle using ca. 0.5–1-cm-wide leather thongs (Fig. 10.1a-d). Their thickness was determined by the amount of filling material which was kept in place by the leather thongs. The thongs were sewn in saddle stitch, i.e. with two needles attached to either end of the leather thong. As the needle with one end of the thong is passed through the hole from one side, the other is pulled through the same hole from the other, hence creating two rows of stitching in one single row of holes (Darke, 2006, 109–110). This stitching technique is very strong and durable, which was essential for an item such as a saddle. If the thread breaks, it is only loosened on one side, whereas the stitch running on the opposite side continues to keep the hides together. In the case of the Yanghai saddle, the thongs were stitched starting from the outside, and then proceeding towards the inside where their ends were fixed with a knot as still visible at the rear of the saddle (Figs. 10.2, 10.3). Some of the stitches had broken inside the saddle due to decay of the leather.

The size and position of the support elements in relation with the



Fig. 7. 1 - Corresponding holes are visible at the outer edges of the back supports of the saddle; 2 - A rectangular area of flaked-off leather surrounding these holes indicates a now missing component of the saddle. Photos: P. Wertmann; M. Yibulayinmu.



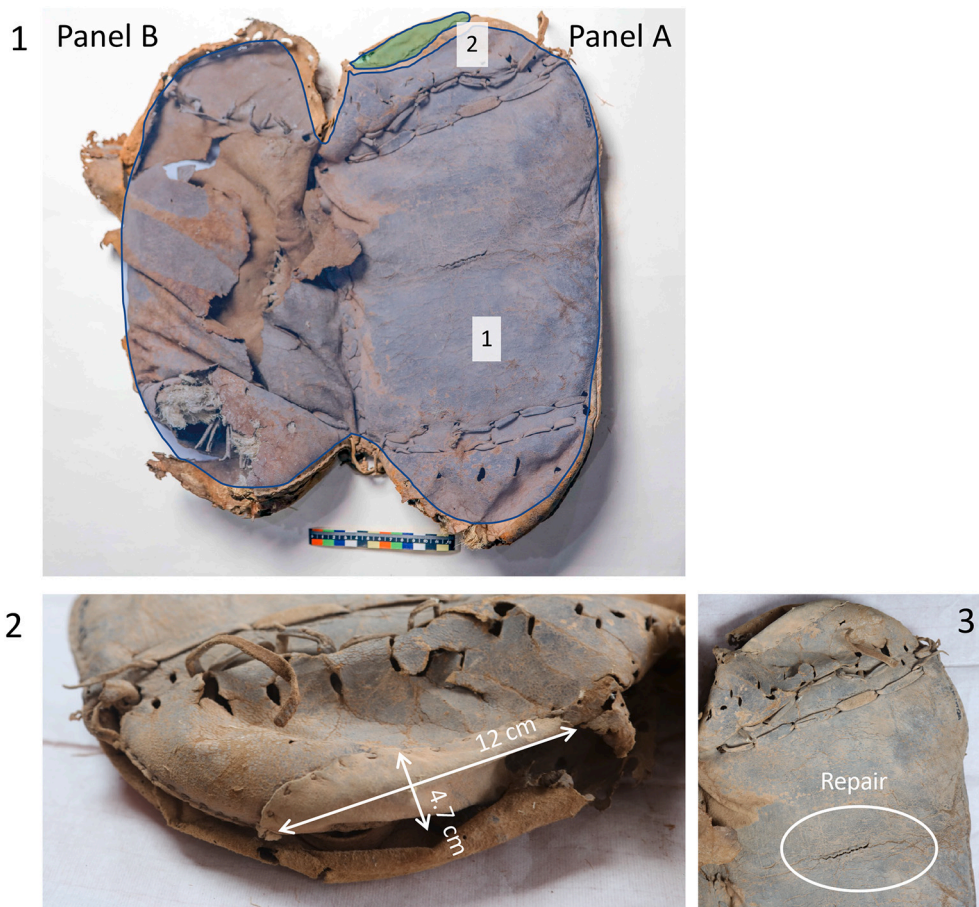


Fig. 8. View of the underside of the Yanghai leather saddle (IIM205:2). 1 - The underside is formed of two hide pieces (nos. 1–2); 2 - A repair patch was attached to the front of panel A; 3 - A small repair in the center of panel A was done with a running stitch. Photos: P. Wertmann; M. Yibulayinmu.

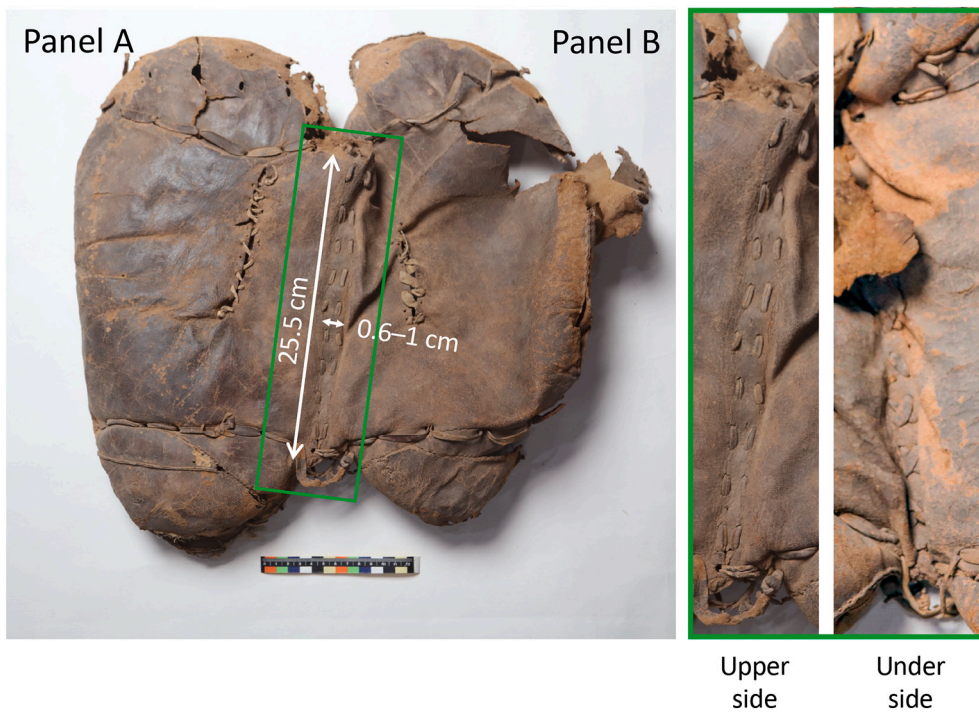
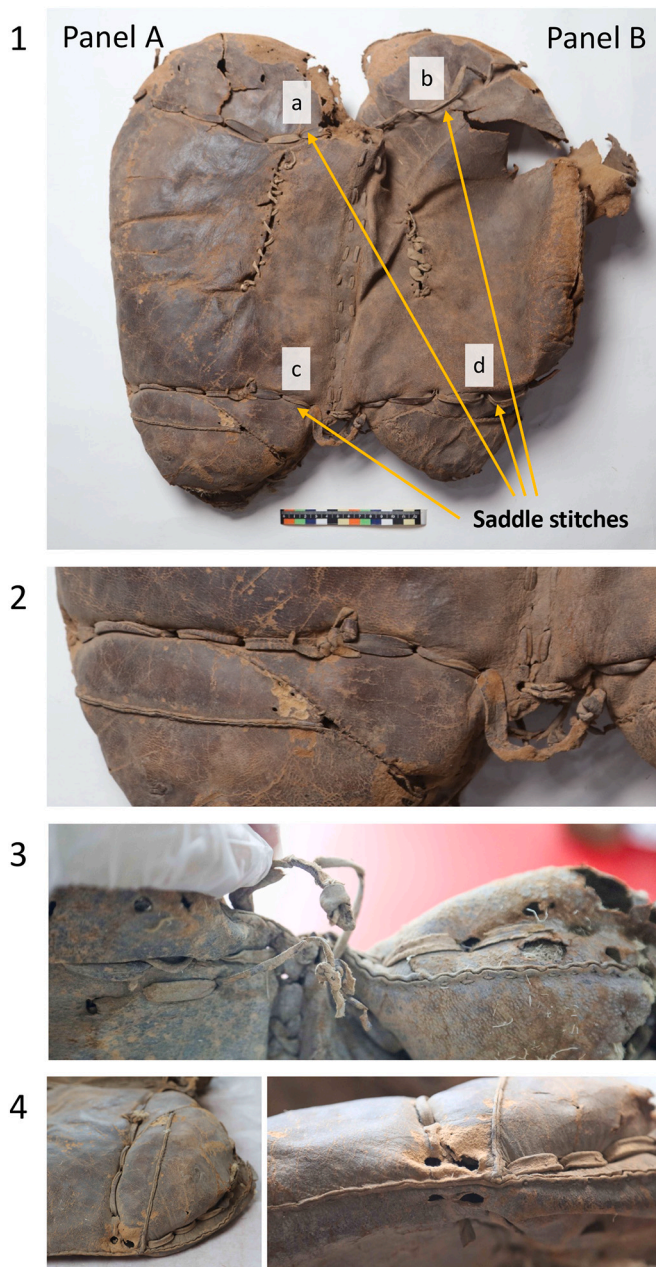


Fig. 9. The central, gullet-like channel marked by the green frame divides the saddle into two panels. It is formed by a combination of a running stitch on the upper side and a cross stitch on the underside. Photos: P. Wertmann; M. Yibulayinmu. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



**Fig. 10.** 1 - The front and back supports (nos. a-d) are formed by leather thongs sewn with a saddle stitch. The saddle stitches are indicated by the yellow arrows; 2-3 -The leather thongs were stitched starting from the outside, and further towards the inside where their ends were fixed with knots; 4 - The bulging effect of the back supports is enhanced by a leather thong sewn in saddle stitch. It runs from the front to the underside of the saddle. Photos: P. Wertmann, M. Yibulayinmu. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

back of the horse was essential for the comfort of the horse as well as the rider to maintain a stable seat balance (Bondi et al., 2020, 163). The bulging of the support elements in the back was enhanced by another leather thong of the same width on each side using a saddle stitch. This leather thong is not visible on the upper saddle side, but it runs from the front to the underside of the saddle (Fig. 10.4). As another effect of these thongs, the edges of the supports were slightly lifted, hence avoiding uncomfortable friction on the back of the horse (Bondi et al., 2020, 163).

Notably, the leather thongs in the front spread at an angle of approximately 50°, whereas the thongs at the back side of the saddle run nearly vertical to the central channel (Fig. 10.1). Though less

elaborated, these four lens-shaped sections resemble the front and back supports with gussets known from the Pazyryk saddles for which Stepanova (2016) demonstrated in a reconstruction and test that the angle formed in the front and the axis of the saddle corresponds to the position of the rider's thighs, hence providing support and helping to maintain a firm position in the saddle when riding without stirrup, as the knee roll and thigh cushions of modern saddles do.

### 3.2.5. Type and preservation of leather

The leather used for the manufacturing of the saddle was identified as cattle by the excavators (Turfan Administration of Cultural Relics et al., 2019) and by examination of the leather grain by the authors. However, a recent study on ancient DNA of domestic animals used for making leather items in Central Asia during the Bronze Age (Schröder et al., 2016) demonstrates that besides domestic cattle, sheep and goat were also used for leather production in the Turfan and Hami oases around 800–400 BCE (95.4% probability range of <sup>14</sup>C-dated leather and leather-related objects). In order to clearly identify the leather type as ox (cow) and to exclude other origins such as sheep and goat, DNA analysis of the leather is needed.

The thickness of the leather varies between 0.253 and 0.528 mm. Various degrees of wear can be observed depending on the position on the saddle. The central part of the upper side is comparably well preserved, with tears concentrating on the upper section and flaked-off areas especially towards the outer sides. The leather in the center, which served as the main seating area, appears more worn than the leather towards the sides. A small repair is visible on the inner side of the back support on side B, which must date to the time when the saddle was still in use.

The underside of the saddle is in a worse state of preservation, in particular that of panel B. The leather is brittle with cracks, and parts of the leather surface are flaked-off. A long tear extends almost along the entire length of panel B, and large parts of the leather forming the top and bottom supports are missing. An ancient repair is visible in the center of panel A.

### 3.2.6. Saddle filling

According to the excavation report, the saddle panels were filled with a mixture of deer and camel hair as well as straw. Given the state of conservation, most of the filling is not preserved. It can be expected that both panels contained about the same amount of filling, which would have determined the level of support and cushioning. To allow for asymmetry of the horse's shoulders, the pads had to maintain a certain degree of pliability (on the suitability of a saddle see for example Bondi et al., 2020, 163). The type of filling material may have been chosen based on the local availability and/or depending on the weight the saddle had to carry and the impact activities for which it was needed. Generally, heavier weights and higher impact activities require a less compliant filling material (Bondi et al., 2020, 163). Irrespective of the filling material, the cushions would have been compressed and lost their shape over time, therefore making it necessary to re-flock the saddle at certain times as suggested above.

As is the case with the leather type, the identification of the filling material is so far only based on a preliminary examination and therefore inconclusive. A future analysis aimed at identifying the different types of animal hair may lead to new insights into the saddle making technology in the Turfan Basin. The Pazyryk saddles were stuffed with deer hair, but also with reindeer hair, which is considered one of the best filling materials for saddles (Stepanova, 2016, 12). Yet other saddles include straw fillings, which was the least expensive and the most accessible material available (Stepanova, 2016, 5).

### 3.2.7. Fastening of the saddle

The saddle in its current state of preservation does not show any clear signs of former fastening straps such as a girth, breast strap, crupper, or breeching strap. The row of horizontally-aligned holes in the upper



section of the underside of the saddle may indicate where former fastening straps may have originally been attached.

The earlier described holes visible on either side of the saddle's back supports might further imply that the saddle also included either cruppers or breeching straps. This, however, cannot be confirmed. Finds of actual saddles from sites including Berel (Samashev, 2006) and Subeixi (Lü and Zheng, 2002, 56) as well as depictions on objects such as the gilded silver vase from Chertomlyk kurgan (ca. 4th century BCE; Cunliffe, 2019, plate 9.1a), Ukraine, the felt carpet from barrow no. 5 at Pazyryk (ca. 3rd century BCE; Rudenko, 1970, plate 154), or the cavalry horse from pit no. 2 of the terracotta army of the First Emperor of China (late 3rd century BCE; Archaeological Excavation Team of the Terracotta Warriors Pit, 1978) provide good reference to understand where and how these straps were attached to the saddle.

There is no clear evidence for the use of a girth. It is possible that the saddle was further secured by some form of surcingle as is still done by nomad people in parts of Northwest China today (Li, 2019, 78). If this was the case, however, wear lines would be expected on the cushions. Based on a personal conversation with Dr. Sue Dyson from the Centre for Equine Studies in Suffolk, a skilled rider may in fact also be able to ride at a reasonable pace by balancing on the horse's back without the saddle cushions being secured.

### 3.3. The saddle from Subeixi

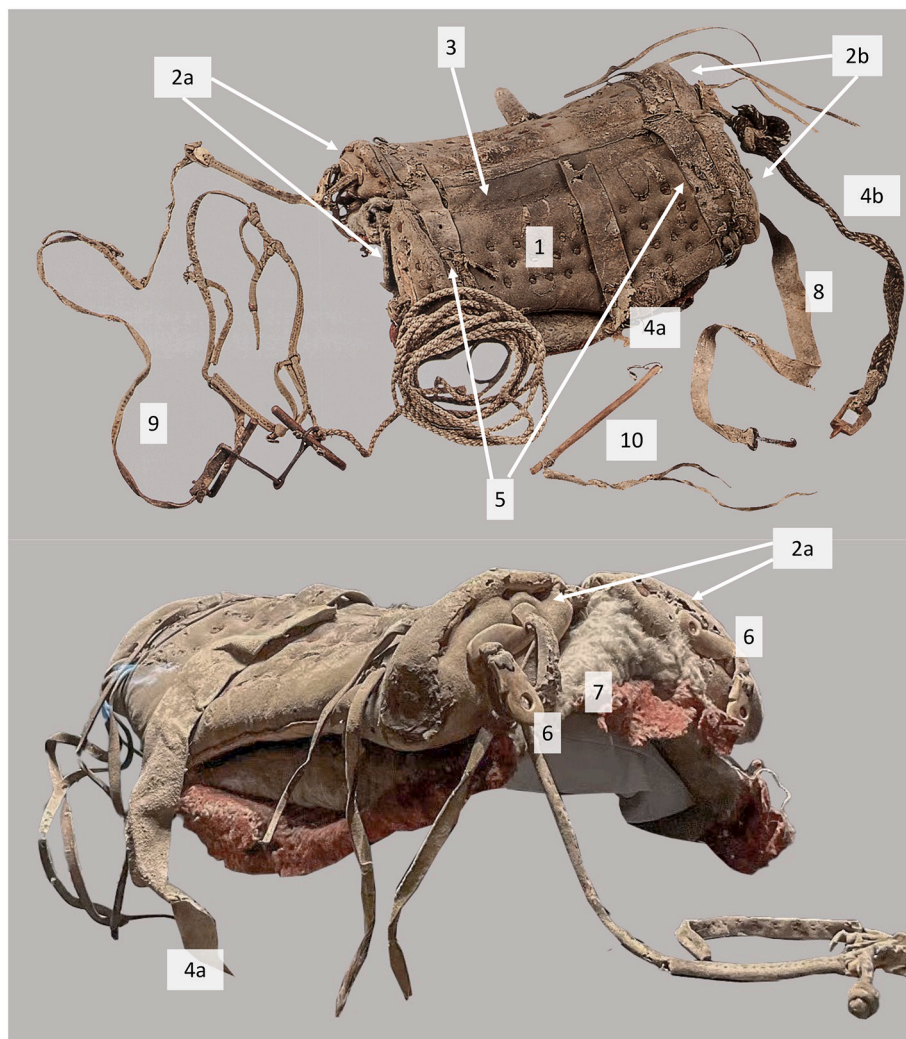
#### 3.3.1. Construction

The Subeixi saddle is a soft quilted saddle comprising two stuffed panels with four lens-shaped gussets at either end, a central gullet, a girth and crupper, a felt pad attached to the underside of the saddle, and a bridle (Fig. 11). The saddle is generally well preserved, with some damage evident on the central girth strap and the bridle straps.

Evidence of repair work in the form of patches and alterations can be observed on some parts of the saddle. While some of the patches display the same fine stitching as the original, others appear cruder, suggesting that they were executed by different people at a later stage.

#### 3.3.2. Saddle panels and gullet

Each panel (length 52 cm, width 17–18 cm) was made from two pieces of leather sewn together along the outer edge using a fine running stitch (Figs. 11.1, 12.1–3). The panels were stitched together down a central seam to form a gullet with connecting straps passing over both panels at the front and the rear for added strength (Figs. 11.3, 11.5, 12.2, 12.3). The panels are wing-shaped, being wider at the front than at the rear. Their panel filling was held in place by rows of quilting stitches finished on the top surface of the saddle with coloured felt disc. Each panel has four rows of quilting stitches, starting and ending



**Fig. 11.** The leather saddle and bridle from Subeixi tomb M10. 1 - Saddle panel; 2a - Rear lens-shaped gussets; 2b - Front lens-shaped gussets; 3 - Gullet (flat area of leather created between the two outer stitch lines when panels were joined); 4a - Girth, leather part; 4b - Girth, plaited horse hair strap; 5 - Connecting straps; 6 - Bone attachments (front); 7 - Felt pad; 8 - Crupper; 9 - Bridle; 10 - Whip. Photos: Wang, 1999b, 110 (top); X.J. Kang (bottom).

approximately 8 cm from the front and rear ends of the saddle.

The gullet has a length of 38 cm and a width ranging between 4.5 cm at the front, 10 cm in the middle, and 6 cm at the rear (Fig. 12.2). A square of 4 cm was cut out of the front and a gap of 6 cm was left open at the rear.

The front and rear connecting straps are approximately 4.5 cm wide (Fig. 12.3). One strap running from the gullet to approximately 2 cm from the outer edge was placed on the underside of the panels and threaded between two slits. On the top surface, straps varying in lengths between 35 and 40 cm ran from approximately 2 cm from the gullet edge and over the end of the panel. They were folded under the panel, where they were split into three thongs of equal widths, which then passed back through the panels and the straps to the upper side. A connecting strap placed across the gullet was secured by a leather thong passing through the panel, bottom strap, and both top straps. The connection made by these straps was extremely strong. We assume that the main purpose of this construction was to add stability and prevent the front and rear of the saddle from spreading when the rider sat on it.

### 3.3.3. Gussets and bone attachments

Lens-shaped gussets or supports were attached to the front and the rear of the saddle panels (Figs. 11.2a, 11.2b). While the front gussets (17

× 19 cm at the widest point) appear to have been cut as a pair from a single piece of leather (Fig. 13.1), the rear gussets (18 × 10 cm at the widest point) were cut as single pieces (Fig. 13.2). S-shaped attachments (ca. 8 cm long, 2.5 cm wide) made of bone were placed on the front and rear gussets, probably to reinforce the leather where straps pass through them. These straps are terminated with shield-shaped bone pendant plaques with a hole (5 cm long, 3 cm wide) which should have served to secure parts of the saddle harness, i.e. the breast strap and crupper (Fig. 11.6).

### 3.3.4. Girth

The girth was attached 18 cm from the front end of the saddle (Fig. 11.4). A lighter shaded line with remains of a leather strap can be observed at this point (Fig. 12.3). It was made up of two parts, i.e. a leather strap (4.5 cm wide) (Fig. 11.4a) and a plaited horse hair strap (4.5 cm wide, 100 cm long) (Fig. 11.4b). The leather strap was laid across the panels and fastened with a leather thong 6 cm from the panel edges. One end of the strap formed an ‘eye’ through which the plaited horse hair strap was fastened using a quick release knot. The ‘eye’ was made up of a double thickness of leather, presumably to strengthen the fixing point.

A form of fastening was attached to the opposite end of the plaited

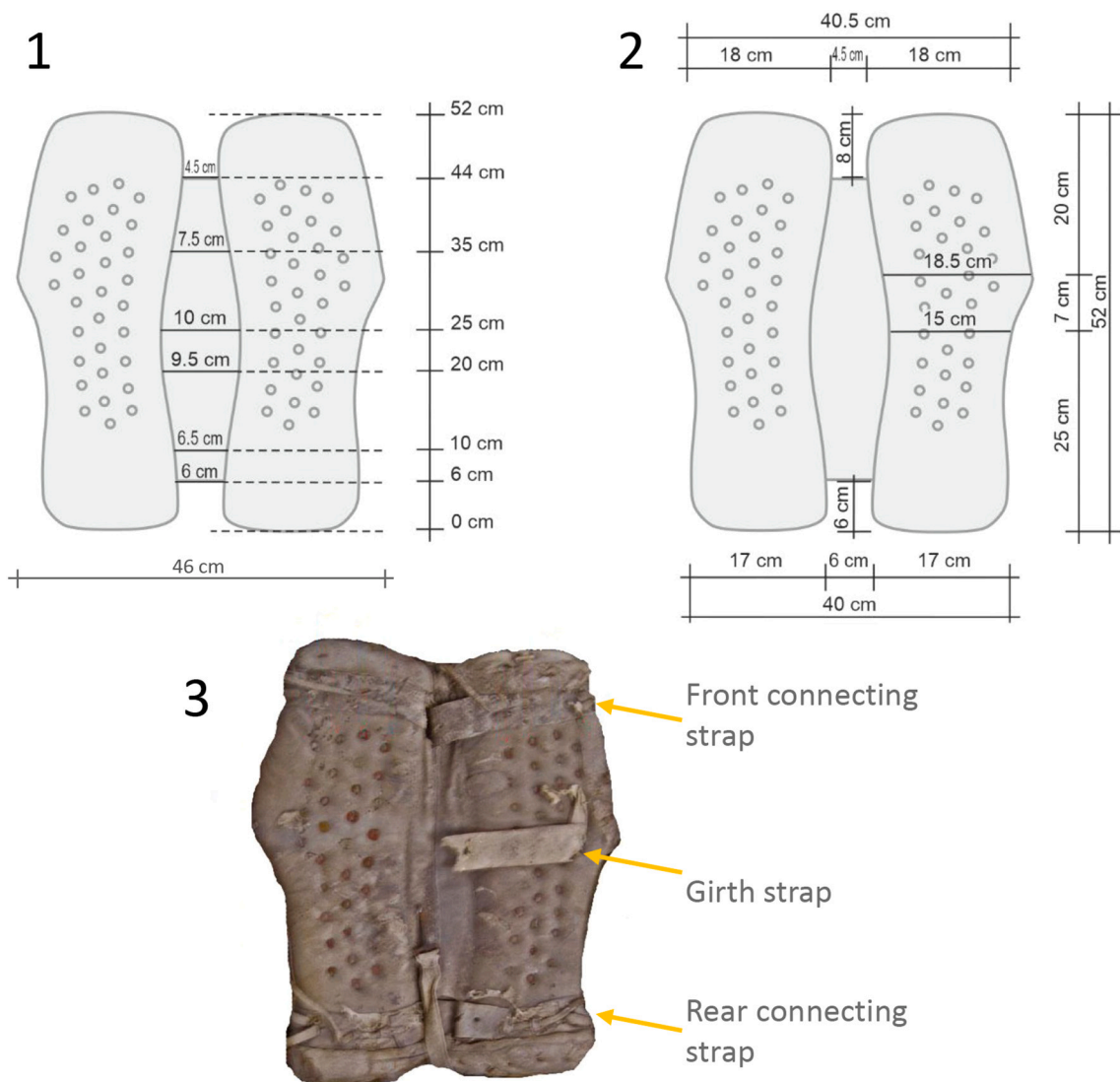


Fig. 12. Dimensions of the Subeixi saddle. 1 - Panels; 2 - Gullet; 3 - Dimensions and placement of girth and connecting straps. Photos and drawings: Ch. Taylor, I. Elkina.



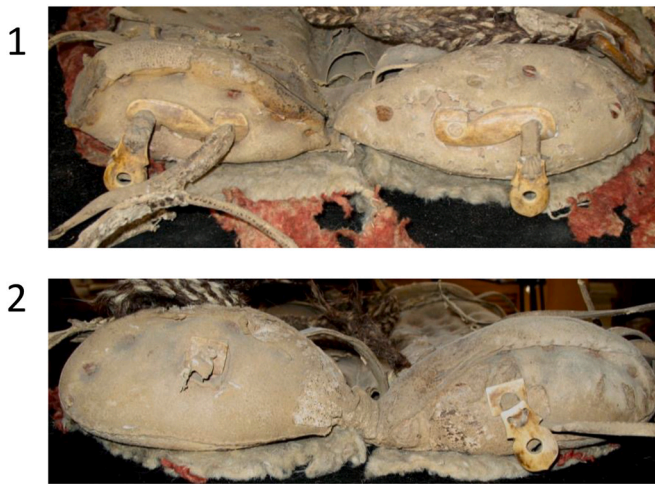


Fig. 13. Lens-shaped gussets with bone attachments. 1 - Front; 2 - Rear. Photos: Ch. Taylor.

horse hair strap by means of a piece of leather folded around the base of the fastening and stitched directly to the plaited strap. The material of the fastening (ca. 7.5 cm long, 5.5 cm wide), either bone, hoof, or horn, could not be determined during inspection.

Assumingly, the girth strap would have been passed through the fastening, tightened, and then the prong of the fastening hooked through one of the slits in the leather strap. There is evidence that the girth was repaired several times. Both these repairs and the fastening did not display the same level of craftsmanship as the saddle itself. The latter appears cruder than the attachments on the gussets, suggesting that it was made later as a replacement.

### 3.3.5. Crupper

The crupper is made of a leather strip measuring 98 cm in length and 4 cm in width (Fig. 11.8). It has an iron hook attached to one end and a series of slits on the other. It has been suggested that the leather was passed around the dock of the horse tail and through one of the slits in the crupper, and the hook attached to a loop of leather positioned at the rear on the underside of the saddle.

There are, however, a number of issues which raise doubts about the operation of the crupper. Firstly, as the saddle slipped forward, the crupper would act like a noose and gradually tighten, thus causing discomfort and pain to the horse. When the strain on the crupper was removed, the loop around the dock would not loosen as the leather would lock on itself. Secondly, the leather loop to which the crupper was supposedly hooked is positioned on the underside of the saddle. This would create a pressure point on the back of the horse. Thirdly, the leather of the crupper is very thin and would have probably broken under the strain caused by the saddle slipping forward.

The construction and craftsmanship observed suggest that the saddle makers had a basic knowledge of horse husbandry, so it seems unlikely that the above issues would have gone un-noticed. It is more likely that this strap, which has deteriorated, functioned as a breeching strap. Breeching straps are typically attached to the rear of the saddle, from where they run back along the flanks of the horse and pass around the buttocks, designed to prevent the saddle from moving forward. How this may have looked like is indicated by the saddles on some of the Qin dynasty terracotta cavalry horses guarding the Mausoleum of the First Emperor in Xi'an (Archaeological Excavation Team of the Terracotta Warriors Pit, 1978), which appear identical in style to the Subeixi saddle.

It is further possible that this strap was either used to attach certain items to the saddle such as bags or blankets, or to wrap around the saddle when not in use and folded in half. In this case, the hook could

have served to hang the saddle out of the way.

### 3.3.6. Felt pad

A pad made of white woolen felt (56 × 48 cm) was attached to the underside of the saddle (Figs. 11.7, 14.1). Visible along its edge is a red border stitched in place with a woolen thread using a whip stitch (Fig. 14.2). Due to deterioration, the original width of the border cannot be accurately determined. Only 5.6 cm of the total width is left.

### 3.3.7. Bridle

The bridle consists of a headpiece with a bit and two cheekpieces, a throat lash, a noseband, and reins (Fig. 11.9). It demonstrates the same level of craftsmanship as the saddle itself, with many of the straps being folded and sewn carefully down the center. The construction of the bridle ensures that the smooth side of the leather sits against the horse elevating any discomfort.

The jointed iron bit (14 cm long) has round loops formed at either end through which wooden rods with a hole on each end (13 cm long) were placed. Attached to these holes with wooden pegs are two leather straps, which continued on to form the component parts of the bridle, i. e. headpiece and noseband.

The headpiece (99 cm long) is made up of two leather straps, the longer of which is running from the right side (offside) over the head to the left side (nearside) below the ear. The remaining length of the strap is formed by the second shorter strap, which is attached by a knot, presumably to allow for adjustment. Shorter leather straps were fixed to both straps approximately 35 cm from the bit. While on the offside strap, it was stitched to the headpiece and had slits cut into it, on the nearside it was twisted and stitched. A small wooden hook has been wedged onto the strip, which hooked into the slits on the opposite strap to form the throat lash.

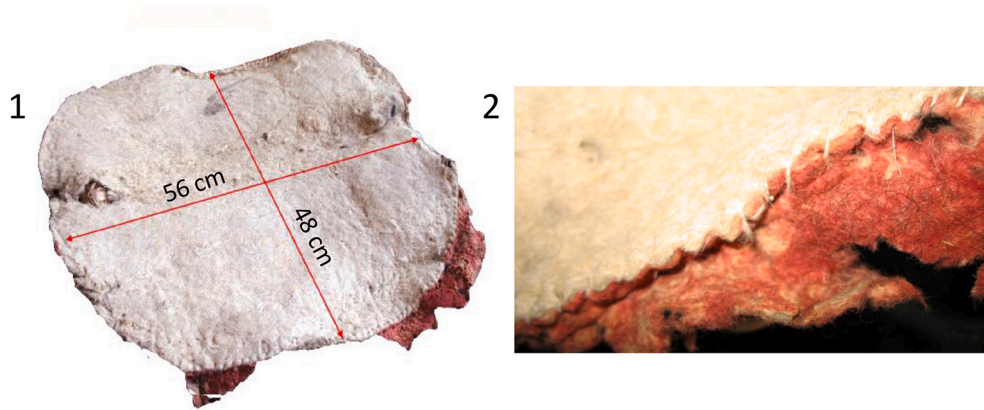
The noseband appears to have been formed from a single leather strap, although there is evidence of former pieces being stitched to it. It is unclear if these were repairs or part of the original strap. The noseband is looped around the headpiece, then runs alongside it being stitched to it at a distance of approximately 6 cm from the bit, and finally continues to the bit where it was attached. A decorative piece of cut leather has been slipped over the center.

A piece of leather was looped through the ring on the offside of the bit to which attached was the rein using a wooden peg. The rein was passed through a curved horn pendant, which was in turn linked to a leather strap supposed to be attached to the saddle. A knot in the end of the rein prevents it from slipping back through the pendant. A rope was attached through the nearside loop of the bit, which was knotted at approximately the same length as the leather rein and terminated with a wooden toggle. An opening inside the leather is visible between the knot and the bit. Assumingly, this rope formed the nearside rein fixed to the saddle in the same manner as the leather rein on the opposite side.

According to the excavation report, the bridle was directly attached to both sides of the saddle (Lü and Zheng, 2002). If this assumption was correct, it would make the process of placing and removing the saddle exceedingly complicated as either the saddle or the bridle would have to be lifted over the head of the horse. If the bridle was directly attached to the saddle, it was likely only on one side.

### 3.3.8. Leather type and saddle filling

The archaeologists assumed that the leather represents ox hide (Xinjiang Institute of Cultural Relics and Archaeology and Turfan Museum, 2003), however, examination by the authors revealed that the grain appears closer to that of goat or deer. For definite identification further analysis is needed. The leather forming the upper side panels was scraped clean, while that of the underside had traces of hair. The material used for the flocking of the panels has been described as deer hair (Lü and Zheng, 2002, 56).



**Fig. 14.** 1 - The white woolen felt pad with remains of a red felt border was attached to the underside of the saddle; 2 - A whip stitch was used to attach the red border to the white felt pad. Photo: Ch. Taylor. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

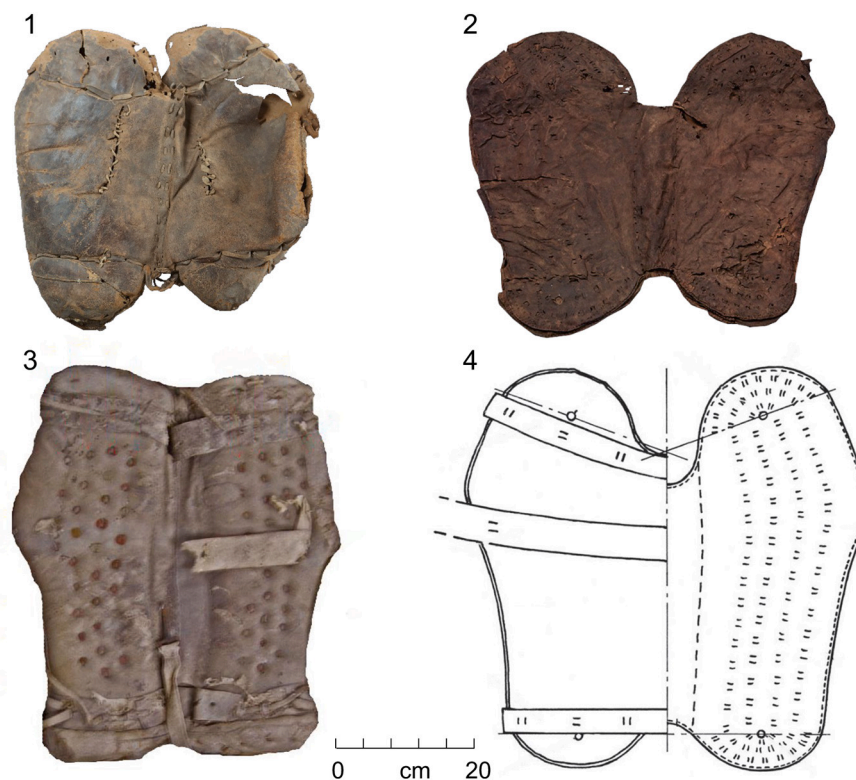
#### 4. Discussion

##### 4.1. Comparison of the Yanghai and Subeixi saddles

Both specimens from Yanghai and Subeixi are soft leather saddles. Considering their practical and well-thought-out design, the fine execution of crafting techniques, in particular the leather- and needlework, both items were made by skillful craftsmen familiar with leatherwork, horse husbandry, and riding. Obvious traces of repair, of which some are executed in a simpler and cruder way, imply that they were intensively used and maintained by less trained hands. Both saddles are composed of two symmetrical leather hides stitched to each other around the outer edges using a fine running stitch, and along a central

axis forming a gullet. They feature front and back supports, which are essential for the comfort of the horse and help the rider to stay in a balanced seat. The constructions of the supports, however, differ. While in the case of the Yanghai saddle, they are shaped out of the hides that make up the upper and underside of the saddle, those of the Subeixi item are additional gussets at the front and rear with bone attachments.

Further differences are apparent. The Subeixi saddle is larger than the Yanghai saddle and has a more elaborate appearance. It features connecting straps for added strength and to prevent the front and rear of the saddle from spreading, a girth for fastening, as well as a felt pad fixed to the underside of the saddle. Considering the fine crafting of this saddle, it was likely an item of prestige meant for a warrior as indicated by the weaponry found together with the saddle in Subeixi grave M10.



**Fig. 15.** Top view of the saddles from: 1 - Yanghai tomb IIM205; 2 - Tuekta barrow no. 1; 3 - Subeixi tomb M10; 4 - Pazyryk barrow no. 3 (reconstruction based on median measurements from 9 saddles). Photos/drawing: 1 - P. Wertmann; 2 - after fig. 1.2 in [Stepanova, 2016](#); 3 - Ch. Taylor; 4 - after fig. 8 in [Stepanova, 2016](#).



The Yanghai saddle is simpler in design and probably represents a more common saddle that its female owner used in her daily life. Alternatively, the technical differences might mirror a chronological distance between the two saddles, i.e. the “younger” Subeixi type being an advancement of the “older” Yanghai type.

#### 4.2. Turfan in the evolution of saddlery in central and eastern Asia

The analyzed Turfan saddles share basic construction features such as symmetrical wing-shaped saddle cushions, a gullet, and lens-shaped support elements at the front and the rear with saddles of the Pazyryk culture in the Altai and western Kazakhstan. Regarding size and layout of the cushions the Yanghai saddle (Fig. 15.1) is closest to the saddle from Tuekta barrow no. 1 (Fig. 15.2) (Stepanova, 2016) dated to 430–420 BCE (Stepanova, 2006, 104). But different from the Yanghai item, the one in Tuekta is quilted and has the supports at the front and rear constructed with separate gussets. The Subeixi saddle's size and design (Fig. 15.3) corresponds to the saddles from Pazyryk barrow no. 3 (Fig. 15.4) (constructed ca. 299–260 BCE; Stepanova, 2006, 2016). With an original length of ca. 55–60 cm, a maximal width of 19–23 cm and a minimal width of 16–19 cm, they are larger than the Yanghai saddle. The cushions are made of large cattle hides, sewn together along the edges with fine stitches using sinew thread, and leather thongs for the internal seams confining the stuffed parts. Four lens-shaped support elements (gussets) (Stepanova, 2016, 2–3; Stepanova, 2021, 562) were cut out and sewn on at front and rear as in Tuekta and Subeixi. In addition, the saddles from Pazyryk are quilted with cords made of horse hair to prevent the filling from moving (Stepanova, 2016, 2–3). The soft leather saddles of the 5th–3rd centuries BCE barrow no. 11 at Berel are said to be constructed the same way (Francfort, 1999, 49–57; Samashev, 2006, 35–44).

With an age range of 727–396 BCE (95.4% probability), however, the Yanghai IIM205 saddle may predate all Scythian saddles so far published. Although another soft saddle composed of two pads filled with sheep fleece, thus similar in style to the Yanghai saddle, reported from grave 85QZM2 at the Zaghunluq site (Fig. 1) in the southern part of the Tarim basin (Xinjiang Museum et al., 1998; Wang, 1999b, 80) might be even older. A poplar wood sample taken from the same grave chamber has a calibrated age of 1125–895 BCE (Xinjiang Museum et al., 2003, 132; Wang, 1999b, 83), though an influence by the ‘old wood effect’ must be considered (Dong et al., 2014). That horse breeding and riding communities were present at the southern rim of the Tarim basin during this time period was confirmed by horse skulls with bits and cheekpieces from the contemporaneous Liushui site in the Kunlun Shan (Wagner et al., 2011). There, however, the leather and other organic parts of possible saddles have not been preserved as in most other equestrian burials in the Tian Shan and Altai mountains, e.g. Chawuhugou (Wang and Lü, 1999, 345–410), Qunbake (CAS Xinjiang Team et al., 1991), and Sa'ensayi (Xinjiang Institute of Cultural Relics and Archaeology, 2013, 180–194) (Fig. 1).

The use of soft saddles continued in the area of Xinjiang during the Han dynasty as shown by finds from Shengjindian in Turfan (Yibulayinmu and Lin, 2020, 240; Jiang et al., 2015) and Sampula near Khotan (Keller, 2001, fig. 38) (Fig. 1).

To date, no saddles from the 1st millennium BCE or earlier have been found in central China. However, the depiction on a bronze mirror from the Jincun cemetery, Eastern Zhou dynasty (770–256 BCE; Chinese Bronzes Committee, 1998, 33) (Fig. 1), shows a mounted warrior seated on a saddled horse. The saddle appears to be a quilted soft saddle with front gusset and several straps including chest, crupper and breeching straps, and a girth, thus resembling saddles from Scythian sites and Subeixi. A 3rd century BCE grave in Xianyang revealed two pottery figurines of cavalymen dressed in non-Han Chinese tunics, trousers, and boots common among the nomadic people in the north and northwest with now decayed reins in their hands (Fig. 1; Xianyang Institute of Cultural Relics and Archaeology, 1996). Evidence for the use of soft

quilted saddles with front and rear gussets, girth and crupper strap, and saddle cloth is also provided by some of the cavalry horses guarding the Mausoleum of the First Emperor of China, who died in 210 BCE (Archaeological Excavation Team of the Terracotta Warriors Pit, 1978). During the Han dynasty, soft saddles were already common in China as evidenced by pottery horses from tombs and burial pits at Xiangshan (SACH, 2007, 117–122), Yangjiawan (Ji, 2006, 117–122), and Shijiaxingcheng (Xi'an Institute of Cultural Heritage Protection and Archaeology, 2009, 720) (Fig. 1).

#### 4.3. Turfan in the early history of horse-riding in central and eastern Asia

The Yanghai saddle does not mark the onset of horse-riding in Turfan. Reviewing all horse-related artefacts (bones/teeth/tail, whip, bridle, cheekpiece, bit, saddle) in the Yanghai cemetery, some remarkable traits can be discerned (periodisation and statistics based on Turfan Administration of Cultural Relics et al., 2019):

During the earliest burial period I (ca. 1300–1000 BCE) 5 of 30 tombs (16.6%), during period II (ca. 1000–700 BCE) 36 of 153 tombs (23.5%), and during period III (ca. 700–300 BCE) 28 of 256 tombs (10.9%) contain objects related to the utilization of horses. During period I, three of the five tombs contained only a whip but no other artefacts indicating control of horse. Whips in form of a wooden rod (ca. 30–60 cm long) with a leather lash (up to ca. 67 cm long) fastened to it (in some cases an additional metal band wrapped around the rod) are a distinct object in all periods, found in 20 tombs during period II and in 13 tombs of period III. However, if we assume that a whip cannot be unambiguously associated with urging horses, then only two graves assigned to period I remain relevant, including IM157, which additionally contained a decorated horse tail (Turfan Administration of Cultural Relics et al., 2019, plate 256.3), and IM21, which revealed the earliest leather bridle from Yanghai with two wooden rod-shaped cheekpieces, no bit, but slid-on bronze buttons (Turfan Administration of Cultural Relics et al., 2019, plate 223.1).

Bridles are also found in 10 tombs of period II and in 9 tombs of period III. The most complete example from grave IM204 typologically dated to ca. 1000–700 BCE has two longitudinal side-straps (headstall) starting from the cheekpieces and joining behind the ears, a noseband and throat lash joining the side-straps, the reins attached to the bit, and a pair of cheekpieces (Turfan Administration of Cultural Relics et al., 2019, plate 223.7).

The Yanghai cheekpieces are all rod-shaped in different variants such as antler tip-shaped and straight (uncarved or carved). They range in length between 10 and 19.1 cm (ca. 12–16 cm in average) and are made of organic material, including poplar wood, bone, and antler. Each cheekpiece features three holes or, in a few cases, three grooves to attach the bit (through the inner hole/groove) with a short leather strap and side-straps (through the outer holes/grooves). The small number of bits found at Yanghai (none in period I, 4 in period II, 6 in period III) in comparison to the larger number of bridles and cheekpieces (i.e. 2, 33, and 23, respectively in the periods I, II, and III) suggests that mostly soft bits made of perishable material were used, e.g. of hemp cord, as indicated by remains in the inner hole of bit IM91:2, or leather strips, as known from other areas of Eurasia (e.g. Bokovenko, 1995, 286; Chechushkov et al., 2018).

The Yanghai bits range in length between 12.5 and 19.7 cm and include jointed bronze bits with stirrup-shaped ends and organic one-piece bits with round ends made of antler, bone, or wood. Chechushkov et al. (2018) regard rod-shaped cheekpieces as indicative for riding, perhaps “luxuries for mounted warriors”. Their age in Yanghai corresponds to that of the earliest specimens in Siberia (ca. 1200–1000 BCE) and the emergence of mounted warriors. Three-holed cheekpieces relate Yanghai with Karasuk culture sites in the Minusinsk Basin where they are dated to the 11th–9th centuries BCE (Taylor et al., 2016). Only from the 10th century BCE, rod-shaped cheekpieces of antler or bronze were used on the Chinese Central Plains (Takahama, 2020; Rawson et al., 2021).

Different from Scythian sites, such as Arzhan, Pazyryk, or Berel, where fully equipped horses were sacrificed in large numbers, this custom was uncommon at Yanghai during the first three periods. The only horse remains are: one tail tassel (grave IM157, period I), a single horse tooth (grave IM1, period II), and one-horse sacrifice (period III) in a separate pit associated with grave IIM212 (Turfan Administration of Cultural Relics et al., 2019). This also distinguishes Yanghai from contemporary burial sites at higher elevations in the Tian Shan and Kunlun Shan, where horse skulls were often deposited together with the deceased. Only during the latest period IV (ca. 300 BCE–200 CE) at Yanghai, horse sacrifices became more common as indicated by 10 horse pits.

To sum up, the archaeological assemblages from Yanghai suggest that already among the first generations in Yanghai were horse-riders. At least two men were recognized as mounted warriors by weaponry and dress (Wagner et al., 2022). In general, however, horse remains and equestrian paraphernalia do not appear in greater numbers in the grave assemblages and the entire cemetery until ca. 300 BCE. Grave goods and funerary customs speak more for an agrarian economy, which included some husbandry. Despite very good preservation conditions for leather, only two saddles have been discovered in altogether 531 excavated and studied burials, making them exceptional rather than common. The better-preserved saddle presented in this article is dated directly to 726–395 BCE. It is of the same age or perhaps a century younger than the unique and not locally produced hide-scale armour found in Yanghai and dated to 786–543 BCE (Wertmann et al., 2021). Discussing the armour's place of origin, Wertmann et al. (2021) considered that this time period was marked by a substantial increase in mobility and interaction in the eastern part of Eurasia (Høisæter, 2017), which is reflected in the range of grave goods from the Yanghai cemetery. The woman in tomb IIM205, who was bestowed the saddle for her afterlife, might have come from a community of mounted pastoralists living in the steppes or mountains in the near or distant western or northern neighborhood or her saddle was among the items acquired through contact with them.

## 5. Conclusions

The arid climate conditions of the past millennia in the Turfan area of Northwest China led to an exceptional preservation of organic materials and objects (produced locally or obtained through exchange and distant contacts), allowing identification, analysis, and reconstruction of early manufacturing technologies not recognizable elsewhere. The leather saddle found in grave IIM205 next to an adult woman was <sup>14</sup>C-dated to 727–396 BCE (95.4% probability range), which makes it contemporaneous or possibly older than the earliest Scythian saddles from the Altai region and eastern Kazakhstan investigated and published so far. Thus, together with the non-directly dated saddle from Zaghunluq, the one from Yanghai currently stands at the beginning of the history of saddle making. Unlike the younger finds from the elite Scythian burials, this early saddle was made from inexpensive materials and used by a common woman. Yet it is testimony to the same mastery of craftsmanship. Both the functional design considering the anatomy and well-being of horse and rider, and the fine execution of the crafting techniques, i.e. leather- and needlework, demonstrate that the Yanghai saddle was manufactured by a specialist familiar with leatherwork, horse husbandry, and riding. The lack of elaborate decorative applications together with traces of wear and repair spots, some of which were executed in a simpler and cruder way, imply that the saddle was an every-day item maintained by the user.

It exhibits the basic elements of soft saddle construction that are still in use today, including two wing-shaped hides sewn together along the outer edges and separated by a central gullet-like spacer, and lens-shaped support elements in each corner resembling knee and thigh rolls of modern saddles. Notably, a special stitching technique, the so-called saddle stitch, was already applied, which is crucial for objects whose seams must hold under heavy load or pressure stress, even if parts

of the thread tear in some places.

The fact that only two saddles dated to ca. 700–300 BCE were found in a total of 531 graves studied at Yanghai suggests that the placement of saddles in graves was an exception rather than a tradition. In contrast, a choice of other devices associated with horse-riding – whips, cheekpieces, bridles, and bits – was given to a limited number of the deceased starting from the earliest burial period (ca. 1300–1000 BCE). In most cases, these items were found in male or joint male/female burials, but not exclusively. For example, during the period 700–300 BCE, four female burials were given bridle, whip, and/or cheekpieces. This makes the female owner of the saddle from grave IIM205 less unique and suggests that horseback-riding was not the exclusive right of men.

The saddle from nearby Subeixi is constructed in a more complex manner and is similar to the earliest known Scythian saddles. In proportions and construction features it closely resembles the saddles from Tuetka (430–420 BCE) and Pazyryk (late 4th – mid-3rd centuries BCE), as well as the saddles of the terracotta cavalry horses guarding the deceased First Emperor of China in Xi'an.

The saddle and other equestrian paraphernalia in the Yanghai grave assemblages further illuminate the role of horsemanship in sedentary communities in eastern Central Asia during the first half of the first millennium BCE.

## CRedit authorship contribution statement

**Patrick Wertmann:** Conceptualization, Data curation, Methodology, Formal analysis, Writing – original draft, Visualization, Supervision. **Maria Yibulayinmu:** Conceptualization, Data curation, Visualization. **Mayke Wagner:** Methodology, Formal analysis, Writing – original draft. **Chris Taylor:** Data curation, Methodology, Formal analysis, Writing – review & editing, Visualization. **Samira Müller:** Data curation, Writing – review & editing. **Dongliang Xu:** Data curation. **Irina Elkina:** Visualization. **Christian Leipe:** Writing – review & editing. **Yonghong Deng:** Data curation. **Pavel E. Tarasov:** Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

All data needed to evaluate the drawn conclusions are included in the article.

## Acknowledgements

We would like to thank our colleagues from the Turfan Museum and the Academia Turfanica for providing us the opportunity to study the leather saddle from Yanghai grave IIM205 and permitting us to take samples for <sup>14</sup>C dating; Prof. T. Goslar for processing the radiocarbon dates and V. Scholz for drafting the base map. The investigation of the Subeixi saddle by Chris Taylor in 2008 was made possible thanks to a research project led by Dr. Marsha Levine at the McDonald Institute for Archaeological Research, Cambridge. Furthermore, we would like to express our thanks to master saddler Urban Truniger and Dr. Sue Dyson for valuable comments and insights into the construction and functionality of saddles. The work of PW contributes to the research project “Sino-Indo-Iranica rediviva” of the Institute of Asian and Oriental Studies at the University of Zurich, funded by the Swiss National Science Foundation (SNSF). Not least, we would like to express our thanks to the Editor in Chief Prof. R.L. Bettinger and two anonymous reviewers for the careful reading of the manuscript and helpful comments and suggestions.

## References

- Anthony, D.W., 2007. *The Horse, the Wheel, and Language: How Bronze Age Riders from the Eurasian Steppes Shaped the Modern World*. Princeton University Press, Princeton.
- Archaeological Excavation Team of the Terracotta Warriors Pit at the Tomb of the First Emperor, 1978. Qin Shihuang ling dong ce di er hao bingmayong keng zuantan shijue jianbao [Preliminary excavation report on the prospection and trial excavation of the second terracotta pit on the east side of the mausoleum of the First Emperor of Qin]. *Wenwu* 5, 1–19 (in Chinese).
- Beck, U., Wagner, M., Li, X., Durkin-Meisterernst, D., Tarasov, P., 2014. The invention of trousers and its likely affiliation with horseback-riding and mobility: a case study of late 2nd millennium BC finds from Turfan in eastern Central Asia. *Quat. Int.* 348, 224–235.
- Bokovenko, N., 1995. Scythian culture in the Altai Mountains. In: Davis-Kimball, J., Bashilov, V., Yablonsky, L. (Eds.), 1995. Berkeley, Zinat Press, Nomads of the Eurasian Steppes in the Early Iron Age, pp. 285–295.
- Bondi, A., Norton, S., Pearman, L., Dyson, S., 2020. Evaluating the suitability of an English saddle for a horse and rider combination. *Equ. Veterin. Educ.* 32, 162–172.
- Cai, D.W., 2021. Gu DNA yu Zhongguo jiamu qiyuan yanjiu [Ancient DNA and the Origins of Chinese Domestic Horses]. Science Press, Beijing (in Chinese).
- CAS Xinjiang Archaeological Team, Xinjiang Bayingolin Autonomous Prefecture Bureau of Cultural Relics, 1991. Xinjiang Luntai xian Qunbake muzang di er, san ci fajue jianbao [A preliminary report of the second and third excavations of ancient tombs at Qunbake, Luntai, Xinjiang]. *Kaogu* 8, 684–703 (in Chinese).
- Chechushkov, I.V., Epimakhov, A.V., Bersenev, A., 2018. Early horse bridle with cheekpieces as a marker of social change: an experimental and statistical study. *J. Archaeol. Sci.* 97, 125–136.
- Chen, G., 2002. Subeixi wenhua de yuanliu ji yu qita wenhua de guanxi [The origin of the Subeixi culture and its relation to other cultures]. *Xiyu Yanjiu* 2, 11–18 (in Chinese).
- Chugunov, K.V., Parzinger, H., Nagler, A., 2010. Der skythenzeitliche Fürstengraben Aržan 2 in Tuva. Philipp von Zabern, Mainz.
- Committee of the Complete Collection of Chinese Bronzes, 1998. *Zhongguo qingtongqi quanji – tongjing* [The Complete Collection of Chinese Bronzes – Bronze Mirrors]. Wenwu Press, Beijing.
- Cunliffe, B., 2019. *The Scythians: Nomad Warriors of the Steppe*. Oxford University Press, Oxford.
- Curtis, J., Tallis, N., 2012. The horse in the ancient Near East. In: Curtis, J., Tallis, N. (Eds.), *The Horse: From Arabia to Royal Ascot*. The British Museum Press, London, pp. 16–27.
- Darke, C., 2006. The tools and techniques of leatherworking: correct tools + skills = quality. In: Kite, M., Thomson, R. (Eds.), *Conservation of leather and related materials*. Boston, Butterworth-Heinemann, London, pp. 103–112.
- Delpout, L., 2021. What makes a horse a horse? Configurational aspects of ancient Egyptian equines. *Cheiron: Intern. J. Equ. Equest. Hist.* 1 (1), 17–45.
- Desvergnès, A.C., 2020. *Between the Gourd and the Harp: Historical Repairs in African Manuscripts*. Available online at: <https://amelieconservation.com/2020/04/23/between-the-gourd-and-the-harp-historical-repairs-in-african-manuscripts/>. accessed 28 September 2022.
- Dezso, T., 2012. *The Assyrian Army. I. The Structure of the Neo-Assyrian Army as Reconstructed from the Assyrian Palace Reliefs and Cuneiform Sources. 2. Cavalry and Chariotry*. Eötvös University Press, Budapest.
- Domros, M., Peng, G., 1988. *The Climate of China*. Springer, Berlin.
- Dong, G.-H., Wang, Z.-L., Ren, L.-L., Matuzeviciute, G.M., Hui Wang, H., Ren, X., Chen, F., 2014. A comparative study of <sup>14</sup>C dating on charcoal and charred seeds from late Neolithic and Bronze Age sites in Gansu and Qinghai provinces, NW China. *Radiocarbon* 56, 157–163.
- Drews, R., 2004. *Early Riders: The Beginning of Mounted Warfare in Asia and Europe*. Routledge Taylor & Francis Group, New York, London.
- Edwards, E.H. (Ed.), 1977. *Encyclopedia of the Horse*. Crescent Books, New York.
- Francfort, H.P., 1999. The frozen mausoleum of the Scythian prince. *Ligabue Magaz.* 35, 42–63.
- Ghosh, R., Gupta, S., Bera, S., Jiang, H.E., Li, X., Li, C.S., 2008. Ovi-caprid dung as an indicator of paleovegetation and paleoclimate in northwestern China. *Quat. Res.* 70, 149–157.
- Goodrich, C.S., 1984. Riding astride and the saddle in ancient China. *Harv. J. Asiat. Stud.* 44 (2), 279–306.
- Greve, L., Dyson, S., 2013. The horse-saddle-rider interaction. *Vet. J.* 195, 275–281.
- Grupe, G., Marx, M., Schellerer, P.M., Bemmman, J., Brosseder, U., Yeruul-Erdene, C., Gantulga, J.O., 2019. Bioarchaeology of Bronze and Iron Age skeletal finds from a microregion in Central Mongolia. *Anthropol. Anz.* 76 (3), 233–243.
- Gryaznov, M.P., 1984. *Der Großkurgan von Aržan in Tuva, Südsibirien. Mater. Allgem. Vergleichen. Archäol.* 23. München.
- Han, J.Y., 2007. Xinjiang de qingtong shidai he zaoqi tieqi shidai wenhua [The Bronze Age and Early Iron Age Cultures of Xinjiang]. Wenwu Press, Beijing (in Chinese).
- Høisæter, T.L., 2017. Politics and nomads: the emergence of the Silk Road exchange in the Tarim Basin region during late prehistory (2000–400 BCE). *Bull. SOAS* 80, 339–363.
- Hornung, E., Krauss, R., Warburton, D., 2006. *Ancient Egyptian Chronology. Handbook of Oriental Studies*, Brill, Leiden.
- Ji, D.Sh., 2006. Shenyun yu huihuang – Shaanxi Lishi Bowuguan guobao jianshang (taoyong juan) [An appraisal of the National Treasures in the Shaanxi History Museum (pottery figurines)]. Sanqin Press, Beijing, pp. 117–122.
- Jiang, H.E., Zhang, Y.B., Lü, E.G., Wang, Ch.S., 2015. Archaeobotanical evidence of plant utilization in the ancient Turpan of Xinjiang, China: a case study at the Shengjindian cemetery. *Veg. Hist. Archaeobotany* 24, 165–177.
- Keller, D., 2001. Fabulous Creatures from the Desert Sands. In: Keller, D., Schorta, R. (Eds.), *Central Asian woolen textiles from the second century BC to the second century AD*. Riggisberger Berichte 10. Abegg-Stiftung, Riggisberg.
- Kramell, A., Li, X., Csuk, R., Wagner, M., Goslar, T., Tarasov, P., Kreuzel, N., Kluge, R., Wunderlich, C.H., 2014. Dyes of late Bronze Age textile clothes and accessories from the Yanghai archaeological site, Turfan, China: determination of the fibers, color analysis and dating. *Quat. Int.* 348, 214–223.
- Kuznetsov, P.F., 2006. The emergence of Bronze Age chariots in Eastern Europe. *Antiquity* 80, 638–645.
- Levine, M.A., Whitwell, K.E., Jeffcott, L.B., 2005. Abnormal thoracic vertebrae and the evolution of horse husbandry. *Archaeofauna* 14, 93–109.
- Li, X., Wagner, M., Wu, X., Tarasov, P., Zhang, Y., Schmidt, A., Goslar, T., Gresky, J., 2013. Archaeological and palaeopathological study on the third/second century BC grave from Turfan, China: individual health history and regional implications. *Quat. Int.* 290–291, 335–343.
- Li, X.Z., 2022. *Prehistoric Research in Xinjiang, Northwest China*. PhD Dissertation. <https://refubium.fu-berlin.de/handle/fub188/34922> (accessed 11 February 2023).
- Li, Y., Zhang, C., Taylor, W.T.T., Chen, L., Flad, R.K., Boivin, N., Liu, H., You, Y., Wang, J., Ren, M., Xi, T., Han, Y., Wen, R., Ma, J., 2020. Early evidence for mounted horseback-riding in Northwest China. *PNAS* 117 (47), 29569–29576.
- Li, Y.H., 2019. Zhongguo gudai “ruan ma’an” ji xiangguan wenti [Soft saddles in ancient China and related issues]. *J. Nat. Museum China* 193, 68–79 (in Chinese).
- Librado, P., Khan, N., Fages, A., Orlando, L., 2021. The origins and spread of domestic horses from the Western Eurasian steppes. *Nature* 598, 634–640.
- Lindner, S., 2020. Chariots in the Eurasian steppe: a Bayesian approach to the emergence of horse-drawn transport in the early second millennium BC. *Antiquity* 94, 361–380.
- Lü, E.G., 2001. Ancient corpses of Subeshi. In: Wang, B.H. (Ed.), *The Ancient Corpses of Xinjiang*. Xinjiang Renmin, Urumqi, pp. 94–112.
- Lü, E.G., 2002. Subeixi fajue de zhuyao shouhuo [The main results from the excavation of Subeixi]. In: Yin, Q. (Ed.), *Tulufan xue xin lun* [New Discussions on Turfan]. Xinjiang Renmin Press, Urumqi, pp. 239–252.
- Lü, E.G., Zheng, B.Q., 2002. Xinjiang Shanshan Xian Subeixi yizhi ji mudi [The Subeixi site and cemetery in Shanshan county, Xinjiang]. *Kaogu* 6, 42–57.
- Mallory, J.P., Mair, V.H., 2000. *The Tarim Mummies: Ancient China and the Mystery of the Earliest Peoples from the West*. Thames and Hudson, London.
- Molodin, V.I., Polos'mak, N.V., 2007. Die Denkmäler auf dem Ukok-Plateau. In: Parzinger, H. (Ed.), *Im Zeichen des Goldenen Greifen: Königsgräber der Skythen*. Prestel, München, pp. 140–147 (in German).
- Polos'mak, N.V., 1994. Steregyshchie Zoloto Grify, Ak-Alakhinskii Kurgany [Griffins Watching over Gold, the Ak-Alakha Kurgans]. Nauka, Novosibirsk.
- Rawson, J., Chugunov, K.V., Grebnev, Y., Huan, L.M., 2020. Chariotry and prone burials: reassessing late Shang China's relationship with its northern neighbours. *J. World Prehist.* 33 (2), 135–168.
- Rawson, J.R., Huan, L.M., Taylor, W.T.T., 2021. Seeking horses: allies, clients and exchanges in the Zhou period (1045–221 BCE). *J. Prehist.* 34, 489–530.
- Rudenko, S.I., 1953. Kul'tura Naseleeniia Gornogo Altaia v Skifskoe Vremia [The Culture of the Population of the Altai Mountains in Scythian Times]. Izd-vo AN SSSR, Moskva/Leningrad.
- Rudenko, S.I., 1970. *Frozen Tombs of Siberia: The Pazyryk Burials of Iron Age Horsemen*. University of California Press, Berkeley/Los Angeles.
- SACH, 2007. 2006 Zhongguo zhongyao kaogu faxian 2006 [Major Archaeological Discoveries in China in 2006]. Wenwu Press, Beijing.
- Sadykov, T., Caspari, G., Blochin, J., 2020. Kurgan Tunug 1: new data on the earliest horizon of Scythian material culture. *J. Field Archaeol.* 45 (8), 1–15.
- Samashev, Z.S., 2006. Culture of the nomadic elite of Kazakhstan's Altai region (based on materials from the Berel necropolis). In: Chang, C., Guroff, K.S. (Eds.), *Of Gold and Grass: Nomads of Kazakhstan*. Foundation for International Arts and Education, pp. 35–44.
- Schröder, O., Wagner, M., Wutke, S., Zhang, Y., Ma, Y.X., Xu, D.L., Goslar, T., Need, R., Tarasov, P., Ludwig, A., 2016. Ancient DNA identification of domestic animals used for leather objects in Central Asia during the Bronze Age. *The Holocene* 26 (10), 1722–1729.
- Schultz, M., Schmidt-Schultz, T.H., Wu, X.H., 2008. Ergebnisse der paläopathologisch-anthropologischen Untersuchung der menschlichen Skelettfunde aus dem Grab 26 von Liushui, Xinjiang (China). Philipp von Zabern, Mainz, pp. 181–197.
- Shelach-Lavi, G., Jaffe, Y., Bar-Oz, G., 2021. Cavalry and the Great Walls of China and Mongolia. *PNAS* 118 (16), e2024835118.
- Sinor, D., 1990. *The Cambridge History of Early Inner Asia*. Cambridge University Press, Cambridge.
- Stepanova, E.V., 2006. Evoliutsiia konskogo snariazheniia i otnositel'naia khronologiia pamiatnikov Pazyrykskoi kul'tury [The evolution of horse gear and the relative chronology of sites of the Pazyryk culture]. *Arkheol. Vesti* 13, 102–150.
- Stepanova, E.V., 2016. Reconstruction of a Scythian Saddle from Pazyryk Barrow No. 3. *The Silk Road* 14, 1–18.
- Stepanova, E.V., 2021. Saddles of the Hun-Sarmatian period. In: Pankova, S.V., Simpson, St. J. (Eds.), *Masters of the Steppe: The Impact of the Scythians and Later Nomad Societies of Eurasia*. Archaeopress, Oxford, pp. 561–587.
- Takahama, Sh., 2020. Two technical traditions of casting horse bits in China and their relationships with the steppe area. *Asian Archaeol.* 3, 47–57.
- Taylor, W.T.T., Bayarsaikhan, J., Tuvshinjargal, T., 2015. Equine cranial morphology and the identification of riding and chariotry in late Bronze Age Mongolia. *Antiquity* 89, 854–871.



- Taylor, W.T.T., Tuvshinjargal, T., Bayarsaikhan, J., 2016. Reconstructing equine bridles in the Mongolian Bronze Age. *J. Ethnobiol.* 36 (3), 554–570.
- Taylor, W.T.T., Cao, J., Fan, W., Ma, X., Hou, Y., Wang, J., et al., 2021. Understanding early horse transport in eastern Eurasia through analysis of equine dentition. *Antiquity* 95 (384), 1478–1495.
- Trautmann, M., Frînculeasa, A., Preda-Bălănică, B., Petrușneac, M., Focșăneanu, M., Alexandrov, S., Atanassova, N., et al., 2023. First bioanthropological evidence for Yamnaya horsemanship. *Sci. Adv.* 9 (9 (o. J.)), eade2451.
- Turfan Administration of Cultural Relics, Xinjiang Institute of Cultural Relics and Archaeology, Academia Turfanica, Turfan Museum, 2019. *Xinjiang Yanghai mudi* [Xinjiang Yanghai Cemetery]. Wenwu Press, Beijing (in Chinese).
- Ulloa, L., 2008. Tunics from the Azapa Valley, Late Formative Period. A new weaving tradition in the lower valleys. In: *Textile Society of America Symposium Proceedings*, p. 139.
- Ventresca Miller, A.R., Wilkin, S., Hendy, J., Turbat, T., Batsukh, D., Bayarkhuu, N., et al., 2022. The spread of herds and horses into the Altai: how livestock and dairying drove social complexity in Mongolia. *PLoS One* 17 (5), e0265775.
- Wagner, M., Wu, X., Tarasov, P., Aisha, A., Bronk Ramsey, C., Schultz, M., Schmidt-Schultz, T., Gresky, J., 2011. Radiocarbon-dated archaeological record of early first millennium B.C. mounted pastoralists in the Kunlun Mountains, China. *PNAS* 108 (38), 15733–15738.
- Wagner, M., Hallgren-Brekenkamp Xu, D.L., Kang, X.J., Wertmann, P., James, C., Elkina, I., Hosner, D., Leipe, Ch., Tarasov, P.E., 2022. The invention of twill tapestry points to Central Asia: Archaeological record of multiple textile techniques used to make the woollen outfit of a ca. 3000-year-old horse rider from Turfan, China. *Archaeol. Res. Asia* 29, 100344.
- Wang, B.H., 1999a. New finds in Turfan archaeology. *Orientalia* 30 (4), 58–64.
- Wang, B.H., 1999b. *The Ancient Corpses of Xinjiang: The Peoples of Ancient Xinjiang and their Culture*. Xinjiang Renmin Press, Urumqi.
- Wang, M.Zh., Lü, E.G., 1999. *Xinjiang Chawuhu: daxing shizu mudi fajue baogao* [Chawuhu, Xinjiang: Excavation report of a large cemetery of clan burials]. Dongfang Press, Beijing (in Chinese).
- Wang, Y.G., Cui, F.G., Li, Y.L., 2007. Shaanxi Ganquan xian chutu wan Shang qingtongqi [Late Shang dynasty bronze wares unearthed in Ganquan county, Shaanxi]. *Kaogu Wen.* 3, 11–22 (in Chinese).
- Wertmann, P., Chen, X.Y., Li, X., Xu, D.L., Tarasov, P.E., Wagner, M., 2020. New evidence for ball games in Eurasia from ca. 3000-year-old Yanghai tombs in the Turfan depression of Northwest China. *J. Archaeol. Sci. Rep.* 2020, 102576.
- Wertmann, P., Xu, D.L., Elkina, I., Vogel, R., Yibulayinmu, M., Tarasov, P.E., La Rocca, D. J., Wagner, M., 2021. No borders for innovations: a ca. 2700-year-old Assyrian-style leather scale armour in Northwest China. *Quat. Int.* 623, 110–126.
- Whitfield, S., 2020. Alfalfa, pasture and the horse in China: a review article. *Quad. Stud. Indo-Mediterr.* XII, 227–245.
- Wu, H.Y., 2013. *Chariots in early China: Origins, cultural interaction, and identity*. BAR International Series, Oxford.
- Wu, X.H., Wagner, M., Görsdorf, J., Tarasov, P., Aisha, A., Jianjun, M., 2006. Das Gräberfeld Liushui des 9. bis 7. Jahrhunderts v. Chr. im Kunlun-Gebirge, NW-China. In: *Eurasia Antiqua*, Band 12, 2006, pp. 173–191.
- Xi'an Institute of Cultural Heritage Protection and Archaeology, 2009. *Xi'an Dong Han mu* [Eastern Han dynasty tomb in Xi'an]. Wenwu Press, Beijing, pp. 117–122.
- Xianyang Institute of Cultural Relics and Archaeology, 1996. *Xianyang shiyou gangguan gangsheng chang Qin mu qingli jianbao* [Brief report on the investigation of Qin tombs at Xianyang petroleum steel and wire plant]. *Kaogu Wen.* 5, 1–18 (in Chinese).
- Xinjiang Institute of Cultural Relics and Archaeology, 2013. *Xinjiang Sa'ensayi mudi* [Sa'ensayi cemetery Xinjiang]. Wenwu Press, Beijing (in Chinese).
- Xinjiang Institute of Cultural Relics and Archaeology, Turfan Museum, 2003. *The Subeixi site and cemeteries in Shanshan County, Xinjiang*. *Chin. Archaeol.* 3, 135–142.
- Xinjiang Museum, Administration of Cultural Relics of Bayingol Mongolian Autonomous Prefecture, Administration of Cultural Relics of Qiemo County, 2003. *Xinjiang Qiemo Zhagunluke yi hao mudi fajue baogao* [Excavation report of Zaghunluq cemetery no 1 in Qiemo, Xinjiang]. *Kaogu Xuebao* 1, 89–136.
- Xinjiang Museum, Bazhou Cultural Heritage Administration, Qiemo Cultural Heritage Administration, 1998. *Xinjiang Qiemo Zhagunluke yi hao mudi* [Zaghunluq cemetery no 1 in Qiemo, Xinjiang]. *Xinji. Wen.* 4, 1–109 (in Chinese).
- Yibulayinmu, M., Lin, L.M., 2020. *Xinjiang Tulufan Shengjindian mudi M15 hao muzang fushi yanjiu* [Study on clothes unearthed from Shengjindian burial 15, Turfan, Xinjiang]. *Nanf. Wen.* 4, 240–250.
- Yuan, J., 2021. A Zooarchaeological study on the origins of animal domestication in ancient China. *Chin. Ann. Hist. Sci. Technol.* 5 (1), 1–26.
- Yuan, J., Flad, R., 2005. New zooarchaeological evidence for changes in Shang dynasty animal sacrifice. *J. Anthropol. Archaeol.* 24, 252–270.
- Zhang, G.D., Rong, X.J., 1998. A concise history of the Turfan oasis and its exploration. *Asia Major, Third Ser.* 11 (2), 13–36.