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No borders for innovations: A ca. 2700-year-old Assyrian-style leather scale armour in Northwest China

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ABSTRACT

The first millennium BCE was pivotal for the environment and for human societies in Central and Eastern Eurasia because transformations accelerated and altered natural and cultural landscapes to hitherto unknown dimensions. Among the major driving forces was the increasing use of horse riding, which extended range of movement significantly and led to the development of cavalry units as a part of large armies. Empires with enormous outreach and gravitational pull formed and disintegrated in close dependence. The wide spread of military technologies demonstrates their bonds, though mostly in the form of metal objects due to the inherent survivability of their materials. Equipment and protective clothing of organic material, albeit produced in large numbers and thus an economic and environmental factor, are rarely preserved. In Yanghai cemetery site, Turfan, the remains of one leather scale armour were discovered. In this study, the results of the AMS radiocarbon dating as well as the construction details of the Yanghai find are presented and compared with a contemporary armour of unknown origin in the Metropolitan Museum of Art New York (MET) and with finds and depictions from the Near East, the adjacent northern steppe areas and the territory of China. The armour, datable to 786–543 cal BCE (95% probability), was originally made of about 5444 smaller scales and 140 larger scales, which, together with leather laces and lining, had a total weight of ca. 4–5 kg. Our reconstruction demonstrates that it can be donned quickly and without the help of another person by wrapping the left part around the back, tying it to the right part under the right arm and fastening with thongs crosswise over the back to laces at the opposite hip parts. Fitting different statures, it is a light and highly efficient defensive garment. In age, construction details and aesthetic appearance it resembles the MET armour. The stylistic similarities but constructional differences suggest that the two armours were intended as outfits for distinct units of the same army, i.e. light cavalry and heavy infantry, respectively. As such a high level of standardization of military equipment during the 7th century BCE is only known for the Neo-Assyrian military forces, we suggest that the place of manufacture of both armours was the Neo-Assyrian Empire. If this supposition is correct, then the Yanghai armour is one of the rare actual proofs of West-East technology transfer across the Eurasian continent during the first half of the first millennium BCE, when social and economic transformation enhanced.

1. Introduction

A recent global assessment of Holocene land use revealed that the environment of most inhabited regions was already largely transformed by 3000 years ago (Ruddiman, 2003; ArchaeoGLOBE Project, 2019). In Eurasia, among the major driving forces of altering the complex

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plant-animal-human relationship was the gradual drying of the eastern part of Central Asia, western and northern China due to climatic factors together with the expansion of agropastoralists with their herds and diverse crops (e.g. Wagner et al., 2011; Spengler et al., 2016; Tarasov et al., 2019). Above all, the increasing use of horse riding has entirely changed economic and political life and contributed to the new phase of globalisation during the first millennium BCE. The use of the horse accelerated movement, increased the radius of actions and made the development of chariotry and cavalry as parts of large armies possible.

All these factors resulted in greater mobility and faster changes in political conditions through temporary cooperation and competition. Between 3000 and 2000 years ago, empires and civilizations, such as Greek, Roman, Assyrian, Achaemenid, Parthian and Qin-Han-Chinese, exerted an enormous outreach and gravitational pull. The so-called empires of the steppe regions north of them, such as Scythians, Saka, or Xiongnu, had a comparably strong impact on environments, technologies and politics (e.g. Beckwith, 2009). In archaeological archives, their close bonds are visible, for example, in the spread of military technologies, though mostly in the form of metal objects. Equipment made of organic material, especially protective clothing is rarely preserved, although it was undoubtedly produced in large numbers and therefore an important economic and environmental factor. The exceptional case of the leather body armour we report in this paper highlights the closely interwoven knowledge network of Eurasia during the early first millennium BCE.

Body armour is special garment for physical combat, i.e. an extra body of a different materiality (Coccia, 2020) that a fighter adds to his anatomical body to reinforce it to safeguard vital organs, but as far as possible without limiting his mobility. It is a gear for protection, intimidation and parade. The material and design of body armour depend on available resources, engineering skills, fighting styles, the aesthetics of a particular time, region and society, and the social status or rank of a warrior. Because of the costly materials and manufacturing, armours were considered so precious, that it was the privilege of the elite to wear them (Dezsö, 2012a, 2012b). Such armours were stored in palaces (Ventzke, 1986) or in treasuries (Schmidt, 1957) and handed down from one generation to the other rather than buried with the owner (Mänchen-Helfen, 1973, 241). In China, suits of armour were occasionally even presented as tribute to the imperial court (Laufer, 1914, 185; Ikeuchi, 1930, 136). Laufer (1914, 262), for example, quotes a passage from the Records of the Three Kingdoms according to which the Sushen people from the area in Northeast China presented various types of armours made of leather, bone and iron to the Chinese imperial court in 262 CE.

However, the appearance of powerful states with big armies in the ancient world created also the necessity of less precious but nevertheless effective armours for ordinary soldiers. Scale armour is made of small shield-shaped pieces (of leather, bronze, or iron, depending on the period and culture) arranged in horizontal rows, the right edge of one scale overlapping the left edge of the following one (or vice versa), the rows from bottom to top sewn onto a backing, each upper row overlapping the lower one by about half so that all lacing thongs are covered. Ideally, the rows are offset laterally slightly, so that the edges of the scales of one row are partially overlapped by the row above, altogether resulting in a relatively smooth and contiguous protective surface of scales. Herodotus described the sight of Persian soldiers from the 5th century BCE, stating that "*they wore on the bodies sleeved tunics of divers colours, with scales of iron like in appearance to the scales of fish*" (Book VII: Godley, 1922, 378). Still today, bullet-proof waistcoats made of metal scales covered by fabric are included among high-priced personal protective equipment (Kim et al., 2019).

The invention of scale armour is linked to the use of light and fast horse-drawn chariots as mobile shooting platforms (Littauer and Crouwel, 1979) or, even more important, as multi-purpose special forces (Hulit, 2004) in battles in the Near East during the first half of the second millennium BCE (Dezsö, 2002). To keep the valuable and highly trained teams of horses and the chariots in action as long as possible, it was essential to protect the charioteers, who were in an exposed position above the infantrymen, with a shield-like cuirass, hard and yet light and flexible enough to allow fighting. Suits of armour made of bronze, iron and leather scales met those demands. Together with chariot warfare, scale amour spread west to Egypt and east to Iran by about the mid-second millennium BCE (Dezsö, 2003–2005). Dezsö (2002, 196) lists actual finds of scales from Egypt, Cyprus, Lebanon, Israel, Syria, Iraq, Turkey, Armenia and Iran dating from the 18th to 7th century BCE. However, no complete armour has been found as of yet. Hulit (2004, 110) even calculates that "all of the metal armour scales from the Near Eastern Late Bronze Age contexts put together do not add up to make a single complete coat of armour". The best-preserved cluster of bronze scales – about 180 pieces – were excavated in Kāmid el-Lōz (Fig. 1) and date to ca. 1400 BCE (Ventzke, 1983, 1986).

The practice of making different types of armour using leather scales or a combination of bronze and leather pieces is known from the cuneiform tablets of Nuzi (Fig. 1) from the late 15th/early 14th century BCE (e.g. Lachemann, 1955; Kendall, 1979; Dezsö, 2002), but only in Egypt, in the tomb of Tutankhamun in Thebes (Fig. 1) (first regnal year 1353–1331 cal BCE: Bronk Ramsey et al., 2010), one complete example of leather scale armour escaped decay. Due to its fragile state when found in 1922, and even more so 70 years later, Hulit (2004) could only study individual scales, short rows of scales, and fragments of the lacing and lining. The construction of the whole cuirass, however, could not be established. Considering the weight of pure bronze scale armour which ranges between 15 and 25 kg according to reconstructions by Kendall, Zaccagnini and Dezsö (all cited in Dezsö, 2002) and by Ventzke between 10 kg (waistcoat) and 27 kg (long coat) (Ventzke, 1986, 179), light-weight leather or rawhide scales most likely have been used more commonly than the archaeological record might otherwise lead us to believe, particularly if their protective effect is comparably good, as Hulit (2002) proved by experiments.

When Assyria, expanding in all directions during the first half of the 9th century BCE, became the dominating power in the Near East (Kessler, 1991), in addition to chariot troops all elite forces of the army, including spearmen, archers and slingers, were equipped with scale armour; as for example the palace reliefs in Nimrud (Fig. 1) show (Dezsö, 2012a, 99). Those 9th century BCE reliefs also present armoured cavalrymen. The Assyrians adopted the practice of mounted fighters from their north-eastern horse breading neighbours, but are credited with developing cavalry as independent unit of the army (Dezsö, 2012b, 13), which led to a growing demand for horses by the 8th century BCE and to the enlistment of foreign cavalrymen in the Assyrian army, who were likely equipped with Assyrian weapons and body armour (Dezsö, 2012a, 99). According to Ryabkova (2014), finds in Zhabotin (Fig. 1) prove that scale armour spread north across the Caucasus already in the 8th century BCE. After ties between Assyria and the Scythians became closer in the early 7th century BCE because they allied against Cimmerians, Egyptians and Medes (Kessler, 1991), the number of scale armour finds in the Kuban River area increased, as can be seen for example at Kelermes kurgan 3 (Fig. 1) ca. 650 BCE (Černenko et al., 2006, 58; Galanina, 2007). After the early Scythians in 616 BCE and Assyrians in 612 BCE were defeated by the Medes, the surviving Scythians retreated to the territories north and east of the Black Sea bringing with them scale armour and spreading it rapidly and widely from the 6th century BCE (Černenko et al., 2006, 135). The majority of excavated bronze and iron scales reported from the Danube to the Ural River, however, come from tombs of the 5th to 3rd century BCE, and no example of leather scale armour has been described in the literature so far (Černenko et al., 2006; Ryabkova, 2010). Tribes in Siberia did not seem to have used scale armour. For example, the famous rich and well-preserved burials of Pazyryk and Arzhan (Fig. 1, Čugunov et al., 2010), did not contain any scales, and in Central Asia the oldest finds date to the 4th to 3rd century BCE (Černenko et al., 2006, 129).

The Greeks adopted scale amour by contact with the Scythians and

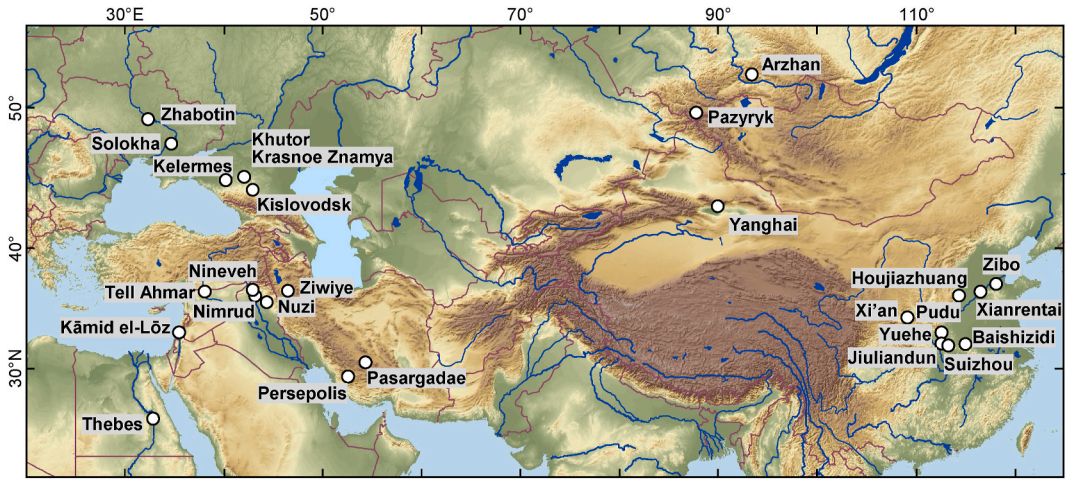

Fig. 1. Map showing the location of the Yanghai graveyard archaeological site in the north-eastern part of the Turfan depression and other sites referred to in this article. For better orientation, modern state borders are shown (red lines), as well as the main lakes, rivers and topographic features. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the Achaemenid Empire (550-330 BCE), although it remained foreign to them (Snodgrass, 1999, 91). In Greece no scale armour has been found to date, only single scales in temples regarded as consecration and in tombs as remains of booty (Karageorghis and Masson, 1975, 222). In two of the best depictions of Greek scale armour, as rendered on the famous gold comb from Solokha (Fig. 1), which dates to ca. 400 BCE (Alekseev, 2007), it is worn by Scythians: one bearing an all-scale corselet – the so-called "Oriental style" – and the other part-scale (i.e. scaled only on the chest area), which can be understood as the "new Greek type" (Snodgrass, 1999, 91).

War chariots comparable to Assyrian types were introduced to the capital region of the late Shang kingdom no later than 1200 BCE from outside China (Wang, 2002), but there is no evidence for bronze scale armour at that time. So far only one fragmentary find has been reported from the royal cemetery site at Houjiazhuang, Anyang, Henan province (Fig. 1, Liang and Gao, 1970). The excavators assumed that it was a lacquered leather armour, but since only the lacquer coating remained, the structure underneath could not be determined. Some 42 bronze plates from the Western Zhou period (1046-771 BCE) tomb 18 in the Pudu site (Fig. 1), reported as parts of armour, have holes in all four corners but were not found in overlapping position as would be the case for scale armour (CASS Institute of Archaeology Fengxi Team, 1988). Body armour made of plates of different material was widely used in central, south-central, and northern China from the mid-first millennium BCE. However, the predominant type of armour in central China was lamellar (Dien, 2000a, 18), i.e. the plates or lamellae were arranged side by side in rows, with the rows one above the other, not sewn to a backing, but rather joined through perforations in all corners and/or along all sides tied with strings or leather laces (Thordeman, 1939, 244–255). Because the plates neither horizontally nor vertically overlap substantially, the joining laces mostly stay visible at the surface. Scale armour is regarded as foreign in China (Dien, 2000b, 24).

To date, no complete scale armour of whatever material from the mid-second to late first millennium BCE had been excavated in the wide area from the Mediterranean to the Yellow Sea. The situation changed dramatically, however, with the excavation at the Yanghai cemetery site in Northwest China in 2013 of one nearly complete and fairly well preserved body armour made entirely of leather scales (Fig. 1). The armour was found in tomb IIM127 (Turfan Administration of Cultural Relics et al., 2019, 354–355) and first compared with defensive armour from the central plains of China by Chen (2019).

In this paper, we present the archaeological context of the Yanghai leather scale armour, its first absolute age determination, and the technical details including graphic reconstruction of the shape and manner of wearing. In the discussion, we compare it with one contemporary scale armour from the Metropolitan Museum of Art, New York (La Rocca, 2002, 42–43), and published finds from the Near East, Egypt and China in order to assess the significance of the Yanghai find in view of the early history of ancient body armour technology.

2. Material and methods

2.1. The Yanghai cemetery

The Yanghai cemetery archaeological site (Fig. 1) is located about 43 km southeast of the modern city Turfan in the north-eastern part of the Tarim basin and at the rim of the great Taklamakan desert. The cemetery was discovered by local villagers in the early 1970s. Since 2003, a team of the Cultural Relics Bureau of Turfan Prefecture and the Xinjiang Institute of Cultural Relics and Archaeology has excavated 521 tombs in an area of about 54,000 m^2 (Turfan Administration of Cultural Relics et al., 2019). In this published excavation report, the tombs are assigned to four chronological periods (I to IV) dated to the 13–11th, 10–8th, 7–4th centuries BCE and 3rd century BCE to 2nd century CE, respectively. Because of the extremely arid climate of the area (Domrös and Peng, 1988), a large quantity of organic materials including textiles, leather, wood as well as human, animal and plant remains is naturally preserved and triggered a number of specialised studies focused on individual plants (e.g. Jiang et al., 2006, 2007, 2009) or material objects (e.g. Beck et al., 2014; Kramell et al., 2014; Wertmann et al., 2020).

As more information continues to be gained by analyses of these archaeological findings, the richer and more multifaceted our picture of the former inhabitants of the Turfan Basin becomes. The people living there in the first millennium BCE did not leave their own written accounts, meaning that before archaeological fieldwork started they were only known through Chinese historical sources (Sinor, 1990; Zhang and Rong, 1998), which associated them with the Cheshi (Chü-shih) state. According to the *Book of Han* (Chapter 96: Mallory and Mair, 2000, 143–144), the Cheshi state occupied the wider Turfan area during the second half of the first millennium BCE and its population practiced an agropastoral lifestyle bringing forth proficient horse riders and archers (e.g. Ghosh et al., 2008; Li et al., 2013). Thanks to ongoing fieldwork, now the actual state of their technical knowledge can be deduced from the well-preserved remnants of their equipment.

2.2. Yanghai site grave IIM127

Grave IIM127 (Fig. 2), which contained the armour discussed in this

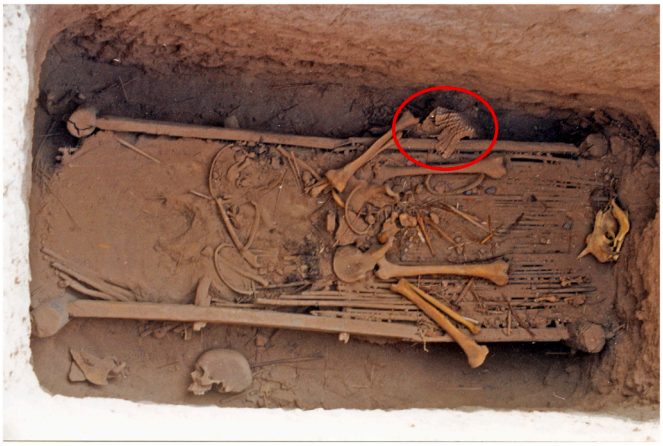

Fig. 2. Yanghai tomb IIM127 with the position of the leather scale armour indicated by the red circle. After: Turfan Administration of Cultural Relics et al., 2019, 354, fig. 606. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

study, is a simple vertical rectangular pit (depth 1.32 m, length 1.65 cm, width 0.84 m) opening 0.2 m below the topsoil (Turfan Administration of Cultural Relics et al., 2019, 354). The skeleton of one male deceased of about 30 years age was incomplete. At the time of discovery, only the skull, femur, and hip bone were found on a wooden framework (length 1.5 m, width 0.6 m, height 0.18 m), indicating either post-burial disturbance of the grave or a secondary burial. Scattered on and beside the wooden bedstead were two horse cheek pieces (from horn and wood), five wooden pegs, several pottery vessels (a single-handled jar, pot, cup, and bowl), a wooden comb, a wooden fire drill, and the skull of a sheep. Beneath the bed, only partly protruding on its western long side, lay the leather scale armour. In addition to two large fragments, various smaller, loose pieces of leather were found, which may have originally belonged to the body armour.

2.3. The Yanghai leather scale armour

The excavation report describes two large and generally well-preserved fragments of one body armour (IIM127:11–1 and IIM127:11–2) consisting of more than 5000 scales, presumably of cow rawhide, laced together and onto a thin leather lining (Turfan Administration of Cultural Relics et al., 2019, 355, 356, fig. 608, table 224.8). Partial deterioration and material loss especially of the lining led to the detachment of a considerable amount of scales so that the original design of the armour could not be recognized or easily reconstructed. In 2015, the armour was examined by a joint team of the Turfan Museum and German Archaeological Institute in a training course on the conservation and restauration of archaeological leather finds. The technical data in this paper is based on the observations and documentation made at that occasion and later supplements by the authors.

When choosing the material for determining the absolute age of the armour, we followed the regulations of the Turfan Museum. For the purpose of this study, we were able to obtain one direct AMS ^{14}C date from a plant thorn that dug deep into a leather scale. Careful visual inspection suggested that the thorn most likely represents the final stage of the armour's lifespan before burial. Earlier archaeological works in Yanghai (e.g. Jiang et al., 2006, 2007, 2009) clearly demonstrated that short-lived plant materials provide very reliable dates. On the contrary, the AMS dating of a leather stripe sample from a first millennium BCE grave from the Shengjindian archaeological cemetery in the Turfan oasis revealed a clearly older age than the associated plant remains (Li et al., 2013). This indicates that the hide processing may influence the age determination, and justifies our choice of plant material for dating the period of use of the armour.

In order to deduce the overall form of the armour, the technique by which it was constructed, and the way it might have been worn, we measured the pieces of the backing, the laces and the scales, counted the scales and rows, measured the horizontal overlap of the scales and the vertical overlap of the rows, and based on the obtained measurements calculated the original length of rows and the height of the different parts of the armour. In order to determine the place of the shoulder flaps, which were found detached, we tested several possibilities and present the currently most plausible solution.

3. Results

3.1. Dating of the scale armour from the Yanghai cemetery grave IIM127

Based on the examination of the tomb construction and artefact typology, grave IIM127 was assigned by the excavators to the 7th to 4th century BCE (Turfan Administration of Cultural Relics et al., 2019, 625; Chen, 2019, 33). The obtained ^{14}C date (Poz-74942: 2515 ± 30 ^{14}C BP) converted into calendar years using the IntCal20 calibration curve (Reimer et al., 2020) and the OxCal v4.4.2 software package (https://c14.arch.ox.ac.uk/oxcal.html; Bronk Ramsey, 1995) ranges between 786 and 543 cal BCE (95.4% probability). This date helps to verify the typologically defined age of the burial and establishes the excavated object as the oldest currently known leather scale armour in Eurasia.

3.2. Technical data of the Yanghai leather scale armour

3.2.1. Shape and size of the scales

We have found three different types of scales, which are all about 3 mm thick, basically rectangular in shape, but different in size (Table 1, Fig. 3). The first type, which comprises the majority of scales, measures 25 mm in length, 15 mm in width, and weighs ca. 0.5 g (Fig. 3A). Each scale has a rounded lower right corner and one row of three vertical slits pierced 3 mm below the top edge. We counted 4011 scales still attached to the big fragments of the armour and 1148 loose scales, i.e. altogether 5159 scales of this type.

The second type (length 80 mm, width 15 mm, weight 2.7 g) is substantially smaller in number (56 attached and 59 loose scales, 115 pieces in total) (Fig. 3B). It shows the same rounded lower right corner, but three rows of three slits, one 6 mm from the top edge, another 32 mm from top, and one 20 mm from the lower edge.

The third type (28 scales combined in one single, unattached row and 39 loose scales, 67 pieces in total) is 70 mm long and 20 mm wide, weighing 1.6 g, having two rows of slits, one 12 mm from the top and the other 12 mm from the bottom edge, but without a rounded corner (Fig. 3C). The slits in all three scale types are exactly 4 mm long and pierced neatly with the same distance to each other (4.5 mm) and to the sides of the scale (3 mm). Given that the third type of scales forms a band that was found loose and no scale of this type were detected on the big fragments, its original position and use remain unclear, leaving open the possibility that it was not part of this armour. However, remains of a leather string at the lower edge of this band indicate that it was attached to something at sometime in the past.

Given that all of the scales of each type are nearly identical in shape and size, we assume that they were cut from a piece of leather using hard-material stencils, templates, or shaped punches. The scales are coloured red along their cut edges. So far, no chemical analyses have been made to identify the type of pigment and the hide processing method. Traces of a dark and glossy substance observed on the surface of the armour scales indicate that the leather was possibly treated with fat or oil to make the scales more resistant to moisture. Similar ways of leather processing in areas with arid climatic conditions such as the Turfan basin are also attested for other regions, for example, Egypt (Van Driel-Murray, 2000, 303; Veldmeijer and Laidler, 2008, 1216).

Table 1
Size of scales/platelets from different sites, periods, and material with their number of lacing holes/slots and shape in chronological order. The location of the sites is shown on the map (Fig. 1).

Armour from	Age BCE, ca.	Material	Smallest scale type	Biggest scale type	Most frequent scale type	Number of lacing holes/ slits	Shape of lower edge	Publication
			L × W, cm	L × W, cm	L × W, cm			
Kāmid el-Lōz	1400	bronze	3.9 × 1.5	9.0 × 2.4/ 2.6	6.2 × 2.4	5, 7, 7	pointed	Ventzke, 1986
Tutankhamun, Thebes	1320	leather	2.5 × 0.9	5.8 × 2.4	unknown	5, 7, 9	pointed	Hulit, 2004
Pudu	1046–771	bronze	10.4 × 4.0	7.2 × 4.2	7.2 × 4.2	4	straight	CASS Institute of Archaeology Fengxi Team, 1988
Fort Shalmaneser, SW7, Nimrud	late 8th – late 7th c.	bronze, iron	2.4 × 1.5	6.3 × 1.4	unknown	varies	round, straight	Mallowan, 1966, 410; Muscarella, O., 1988, 317–321
Yanghai	786–543	leather	2.5 × 1.5	8.0 × 1.5	2.5 × 1.5	3	half round, notch	this publication
Khutor Krasnoe Znamya, mound 9	mid-7th c.	bronze			3.4 × 2.0	3	round	Černenko et al., 2006, 58, pl. 19.334
Ziwiye	late 7th c.	gold	5.0 × 1.9	8.5 × 1.8	unknown	3	round	Černenko et al., 2006, 129
Kislovodsk, "Industrija" grave 4	2nd half 7th c.	bronze			3.4 × 2.0	3	round	Černenko et al., 2006, 58, pl. 19.335
Kelermes, mounds 19, 24, 29	late 7th c.	bronze, iron	3.0 × 2.5	1.4 × 1.1	1.6 × 1.3	3	round	Ryabkova, 2010, 101
Zhabotin	late 7th/early 6th c.	bronze, iron	2.5 × 2.0	1.8 × 1.4	unknown	2	round	Černenko et al., 2006, 34, pl. 2.51
Persepolis	550–330	bronze, iron	1.6 × 1.2	4.7 × 4.4	unknown	2, 4, 5	straight, round	Schmidt, 1957, pl. 77
Pasargadae, Tall-i Takht, Room 94	4th c.	iron	1.2 × 2.8	unknown	unknown	?	round	Muscarella, 1988, 212.
Qin Shi Huangdi burial complex, pit K9801T2G2, Xi'an	died 210	stone	4.8 × 4.1	6.8 × 5.8	4.8 × 4.1	8, 12	straight	Shi Huang Ling kaogudui, 2001
King of Qi, Zibo	died 187	gilded iron	3.0 × 2.5	4.0 × 3.2	3.2–3.5 × 2.4–2.6	8, 6, 10	round	Shandong Linzi Museum et al., 1987

3.2.2. *Arrangement of the scales*

The scales of all three types are arranged in horizontal rows and connected by leather laces passing through the incisions. The right edge with the rounded corner consistently overlaps the left edge of the following scale, with no change of direction observed. Each scale overlaps about half of the following scale. The same lace serves to sew the scales onto the soft leather lining underneath. However, only at every second loop does the lace pass through the lining (indicated in yellow on Fig. 4).

The mass of small scales (type I) makes up the main part of the armour. The rows are fixed onto the backing from bottom to top laterally offset by one third of a scale's width, each upper row overlapping the lower one by about half of a scale's height so that slits and sewing laces are covered (Fig. 5). This arrangement results in two essential features: (A) in an overlapping of three and partly four scales, hence adding up to a total thickness of the armour of about 12 mm, plus the 1–2 mm thick lining, and (B) in a smooth surface geometrically structured by the many small arcs of the right rounded corners which dominate the view. Such an effect of producing a symmetrical lower edge pattern by overlapping asymmetrical scales was also observed at the Tutankhamun armour (Hulit, 2002, fig. 41). Both a technical and aesthetical reason for the rounding of the exposed lower right corner of the scales is that, compared to a rectangular edge, this shape is less prone to curl up over time.

3.2.3. *Construction of the scale armour*

Examining the leather finds of grave IIM127 in 2015, we noted not only two large fragments of the body armour and loose scales, but further pieces, detached scale row segments, thin leather sheets with traces of sewing and leather bands of different thicknesses. It was impossible to ascertain whether all these leather fragments originally belonged to the body armour or to other items, for example, boots or a leather helmet, or to equipment like horse harness and trappings, as the cheek pieces suggest. We therefore concentrated on assembling the fragments which most plausibly belonged to the scale armour: the front cover with remains of attached side panels (A-1 in Figs. 6 and 7), the end of the proper left side panel (A-2 in Figs. 6 and 7), and the shoulder flaps (A-3 and A-4 in Figs. 6 and 7).

In order to deduce the overall form of the armour, its construction technique and the way it might have been worn, we first took a closer look at the inside (Fig. 6A). The lining of the Yanghai body armour consists of several parts (Fig. 6B): (L1 – L5) the front cover with two triangular additions at the top and two trapezoid additions at the bottom, (L6) the proper left panel, (L7) and the proper right-side panel. The outside of the armour shows a seamless scaly surface (Fig. 7), except for the two fragments which were identified by the excavators as shoulder flaps (Fig. 6: A-3, A-4, B L8 and L9, Fig. 7: A-3 and A-4). The garment did not have sleeves.

Due to decay at some edges and deformation of the leather, the size of the pieces could only be approximated by measuring the remaining fragments, counting the scales and rows and, based on the observed overlap, calculating the original length of rows and height of the parts.

3.2.4. *Front part*

The rectangular front piece of the backing reaching from the neck to the lower edge of the bottom fringe is 67.5 cm long at the right side, at the left side about 3 cm shorter, at top and bottom ca. 45 cm wide. Two triangles extend the neckline by ca. 6 cm at each side towards the shoulders and two trapeze-shaped pieces widen the bottom fringe by ca. 10 cm to the right and the left (Fig. 6B), giving the front cover an hourglass shape. Stitching holes along the edges, where the five lining pieces meet, indicate that these pieces were originally sewn together. However, no threads are preserved. Now they are held together by the rows of scales connected to them.

Vertically the front cover in its central part is composed of 23 rows of type I scales from the neckline to the point where the side panels attach and 22 rows from there to the one row of the long type II scales. Beneath are another 13 rows of type I scales on the proper right side and 10 rows

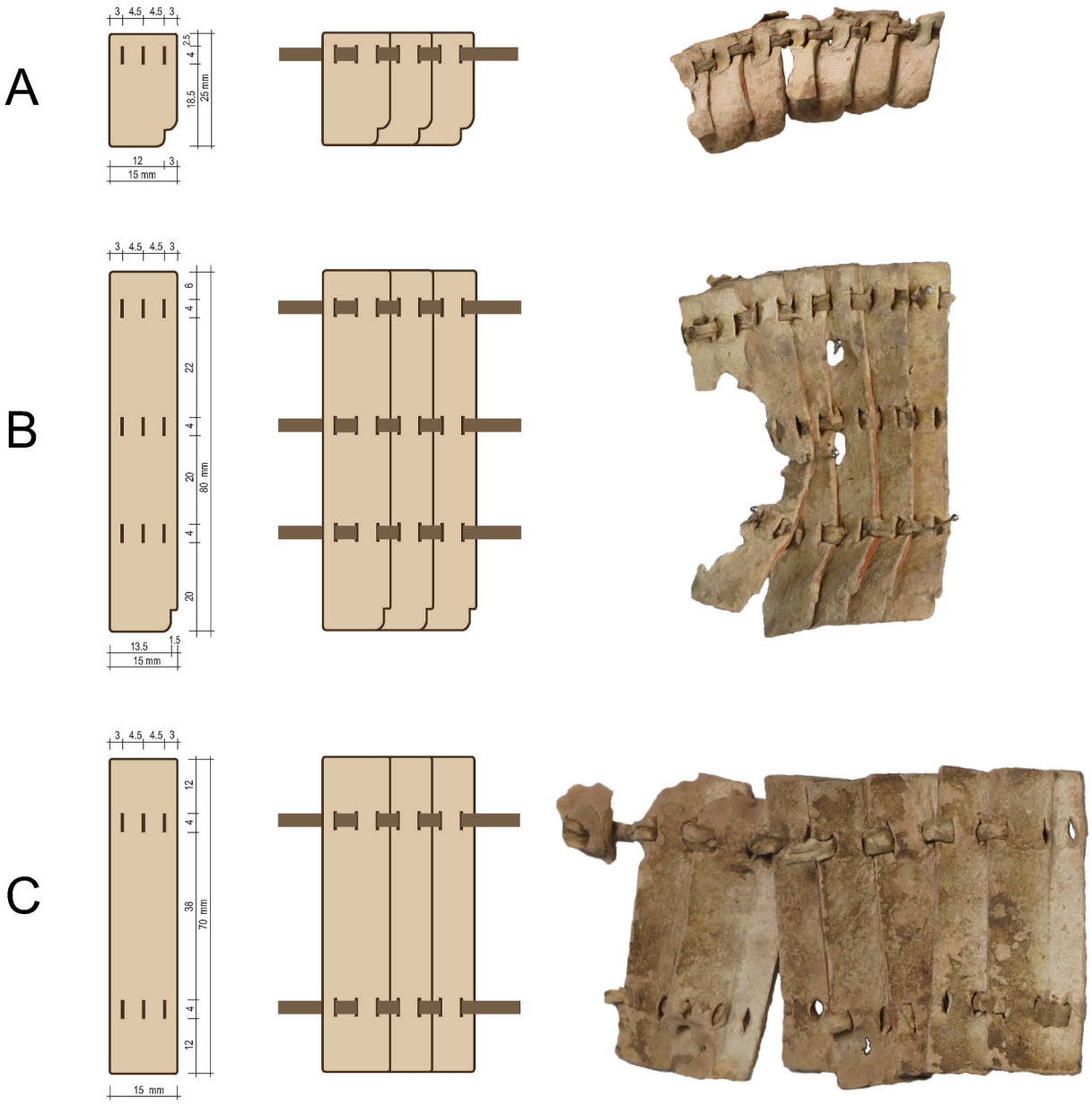

Fig. 3. Yanghai leather scale armour: types of scales. A – scale type I (ca. 5159 pieces preserved), B – scale type II (ca. 115 pieces preserved), C – scale type III (ca. 67 pieces preserved). Photos: P. Wertmann, drawings: I. Elkina.

on the proper left side. The neckline has 57 scales, the shortest row just above the side panels is 45 scales wide and the first line beneath the type II scales row has 56 scales.

The lower section of the scale armour from hip to thighs (Figs. 6 and 7) appears intentionally made asymmetrical. With only 10 rows of scales, the proper left side is shorter than the proper right side with 13 rows. Starting below the fourth row of scales, a triangular-shaped piece of the backing is incised but not completely cut out and left free of scales (Fig. 8). This separation of the loin-thigh part into a longer cover for the right thigh and a shorter cover for the left thigh leaves an opening at the crotch which makes the mounting of a horse or horse riding more convenient.

3.2.5. *Right and left side parts*

Between the triangles and trapeze-shaped pieces at the height of the waist, two rectangular pieces of lining (Fig. 6) covered with scales (height: 22 rows type I scales plus 1 row type II scales, i.e. ca. 28 cm) are attached to the central rectangle stretching to both sides (Fig. 7). The right one (length: ca. 35 scales) covers the right side. But the left one is longer (length ca. 60 scales) and could be wrapped around the lower back, ending underneath the right arm of the wearer. The upper three rows of the longer left panel protrude by 3 scales and form a rounded tab (Fig. 9). Using this tab, the wearer could grab the panel and pull it behind his back to the right side, place it over the shorter right panel and fasten it with laces to the right hip (Fig. 7B). Our first experiments with a reconstruction made of leather according to the original measurements showed that the side parts naturally slant downwards over the back when put on and only fit tightly in this way. Notably, the protruding tab of the left side panel meets the lace on the right-side hip for fastening. Seen from the outside, this middle section looks like a compact waistband with a total length of 140 scales (Fig. 7), which is finished off at the bottom, at the height of the hip, by a continuous row of type II scales.

3.2.6. *Shoulder flaps*

Two smaller pieces of trapezoidal shape (A-3 and A-4 in Figs. 6 and 7) were found detached, their original place at the armour could not be

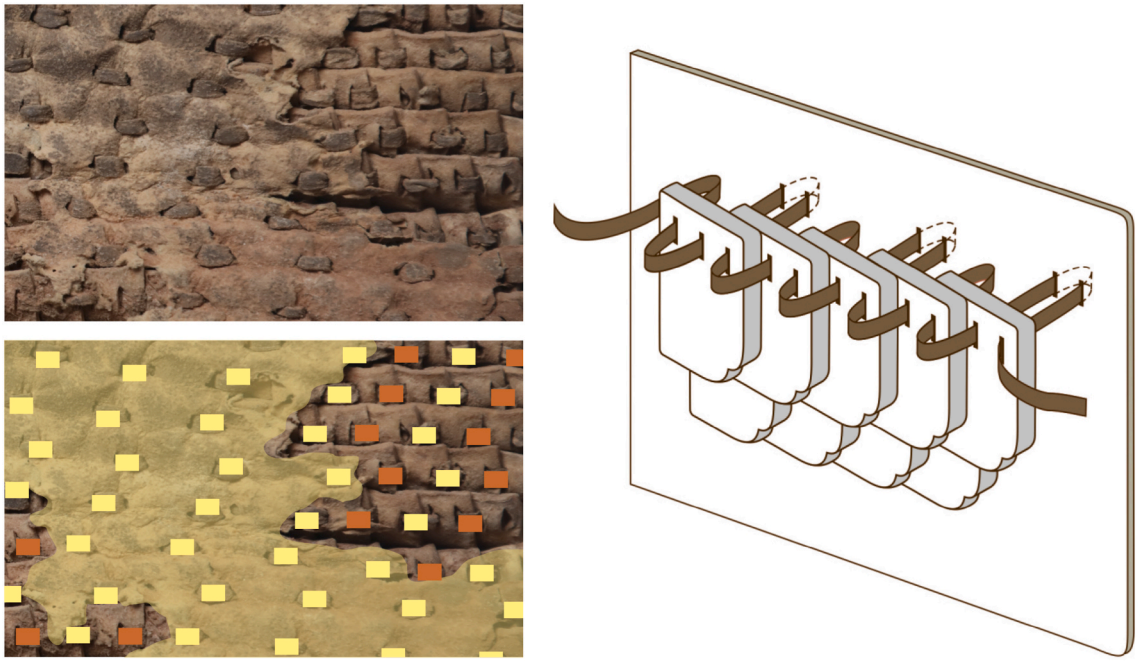

Fig. 4. Yanghai leather scale armour: interlacing of the scales type I and sewing on the lining (yellow area). Each scale overlaps about half of the following scale. The same lace serves to sew the scales onto the soft leather lining underneath. At every second loop does the lace (yellow rectangles) pass through the lining. Orange rectangles indicate the loops that became visible in places where the lining has not been preserved. Photo: P. Wertmann, drawing: I. Elkina. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

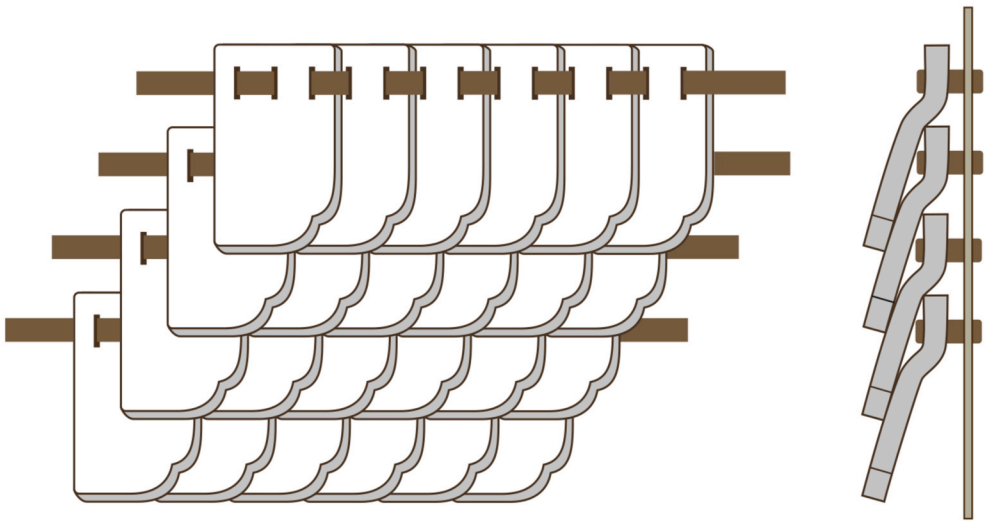

Fig. 5. Yanghai leather scale armour: arrangement of the scales type I showing the overlapping and view of the surface. Drawing: I. Elkina.

unambiguously ascertained. In the excavation report they were presented as the two shoulder flaps which seems very likely (Turfan Administration of Cultural Relics et al., 2019, table 224.8). The question, however, is how they were attached to the front part. Both flaps are nearly equal in height, i.e. 11 overlapping rows of scales equalizing to ca. 12.5 cm, but they differ in width because one is damaged at one side. Flap 1 has a fully intact leather backing made up of one bigger and one smaller patch (Fig. 6A-3). Therefore, we assume that a length of 29 scales (ca. 29.5 cm) on one side and 20 scales (ca. 20.5 cm) on the other was its original size and the form with one almost straight and one diagonal side intended. The leather laces attached at both sides for fastening the flap to other pieces are well visible (Fig. 6A-3). At flap 2 the nearly straight side is intact, but from the other side scales have fallen off and the ends of the ribbons hang loose. Only 20 scales (ca. 20.5 cm) in the first (lowest) row and 13 scales (ca. 13.5 cm) in the last (upper) row (A-4 in Figs. 6 and 7) are preserved. Although it is not possible to be certain, we assume for the time being that this shoulder flap was the same size as the other one. The main difference between the flaps is that the straight edges are at opposite sides of the pieces regarding the overlap of the scales and rows. If we assume that the straight sides were tied to the front part where deformations caused by strong pull are still well visible (Fig. 10), the uppermost row would in both cases be next to the neck and the overlap of the scales would point away from the neck, then flap 1 would have been placed on the proper left side and flap 2 on the proper right side of the armour (Fig. 7). This position seems most plausible to us because it allows the scales to slide up smoothly when the arms and shoulders were raised. In which way the diagonal ends of the flaps were pulled tight, however, remains an open question because the

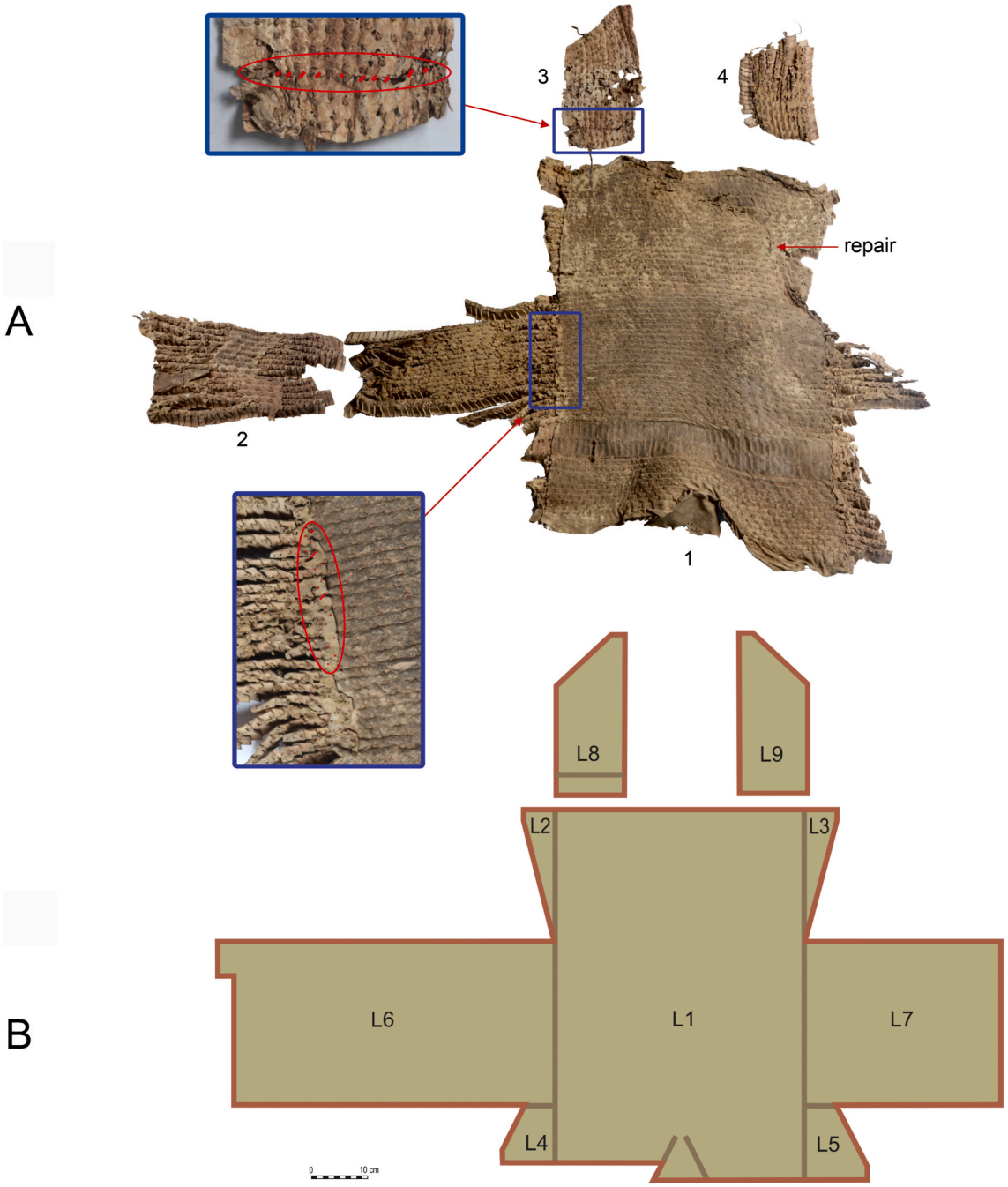

Fig. 6. Yanghai leather scale armour (IIM127:11): main fragments inside, view of lining. A-1 front cover with remains of attached side panels, A-2 end of proper left side panel, A-3, A-4 shoulder flaps; B – scheme of the several parts of lining (L): L1-main front piece, L2, L3-two triangular additions at the chest part, L4, L5-two trapezoid additions at the hip-thigh part, L6-proper left side panel (including the end piece), L7-proper right side panel, L8, L9-shoulder flaps. Photos: D.L. Xu, P. Wertmann, M. Yibulayinmu, drawing: I. Elkina.

armour does not have an upper back part. It is conceivable that a strap ran from each flap crosswise over the back and was tied to the laces which are still attached at the height of both hips (Fig. 7). This construction type is known from the apron-like armour of some terracotta warriors of the first Chinese emperor Qin Shi Huang, who died in 210 BCE (Liu, 2003, Fig. 11).

3.2.7. Weight

To estimate the weight of the complete Yanghai armour according to our reconstruction, we made the following calculation: 5444 type I scales × 0.5 g = 2722 g plus 140 type II scales × 2.7 g = 378 g, which results in a total weight of 3100 g. Adding the lining and laces, the whole armour might have had a total weight of approximately 4–5 kg.

3.2.8. Brief summary

To sum up, the Yanghai armour has the form of an apron-like waistcoat protecting mainly the front of the torso, hips, the left side and the lower back of the body. It can be put on quickly and without the help of another person by wrapping the left waist part around the back, placing the end above the right waist part and securing the ties under the right arm. Then, the shoulder flaps with straps are thrown from the front to the back and possibly tied crosswise to laces at the opposite hip areas. This design fits people of different statures, because width and height can be adjusted by the thongs. It is a light, highly efficient one-size-fits-

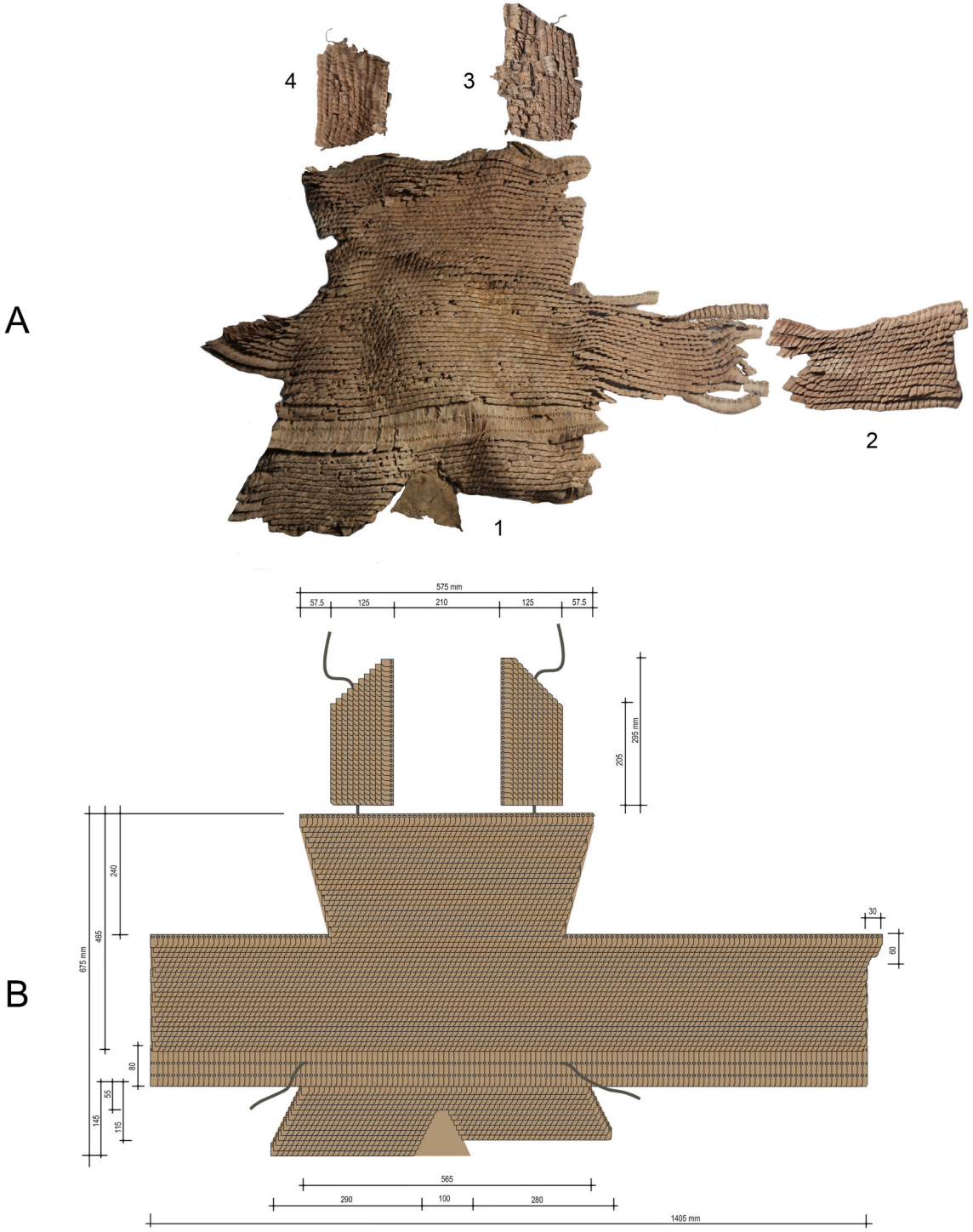

Fig. 7. Yanghai leather scale armour (IIM127:11): main fragments outside, view of scales. A-1 front cover with remains of attached side panels, A-2 end of proper left side panel, A-3, A-4 shoulder flaps; B – reconstruction. First wear test with a simple reconstruction made of leather showed that the side panels only lay smoothly against the back when inclined downwards. This way, the rounded tab protruding at the top of the longer left side panel meets the point where the lace on the proper right-side hip was attached and likely served to fasten the tab. Photos: D.L. Xu, P. Wertmann, M. Yibulayinmu, drawing: I. Elkina.

all, defensive garment for soldiers of a well-organized army. Short overall length, smoothly covering the proper left side and leaving freedom of movement for the right arm, it seems the perfect outfit for both mounted fighters and foot soldiers, who have to move rapidly and rely on their own strength. The cheek pieces of a horse harness which were found in tomb IIM127 may indicate that the tomb owner was indeed a horseman.

4. Discussion

Noticeably, no scale armour, not even a single armour scale of leather or other material, were found in any of the other 520 excavated tombs of the Yanghai cemetery. Nor are any finds of scale armour known from other archaeological sites of the second and early first millennium BCE in Northwest China. In terms of overall shape, construction and size/shape of the scales and their arrangement all together, there is

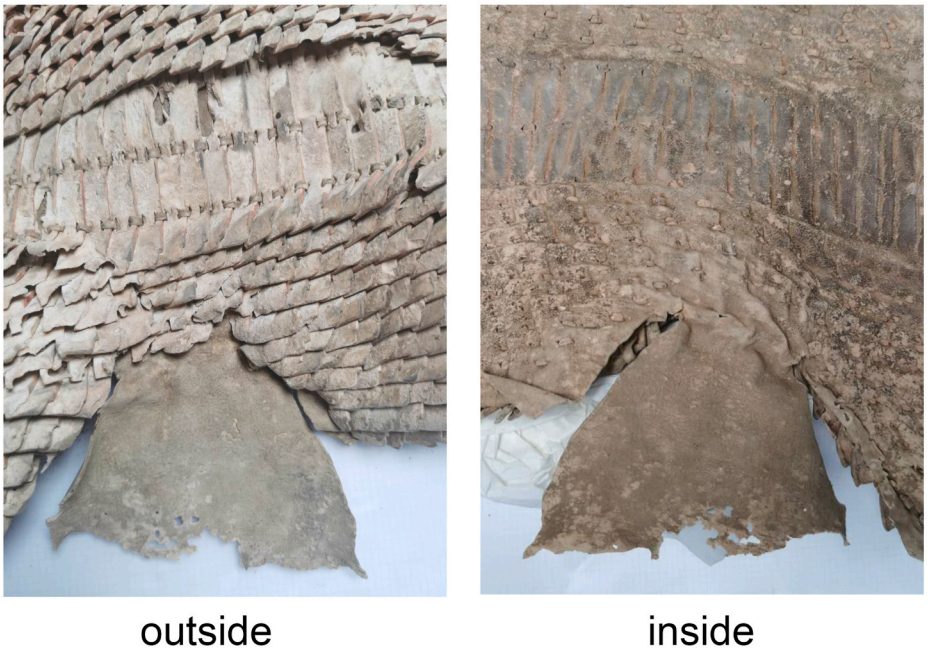

Fig. 8. Yanghai leather scale armour (IIM127:11): crotch piece. Photos: P. Wertmann.

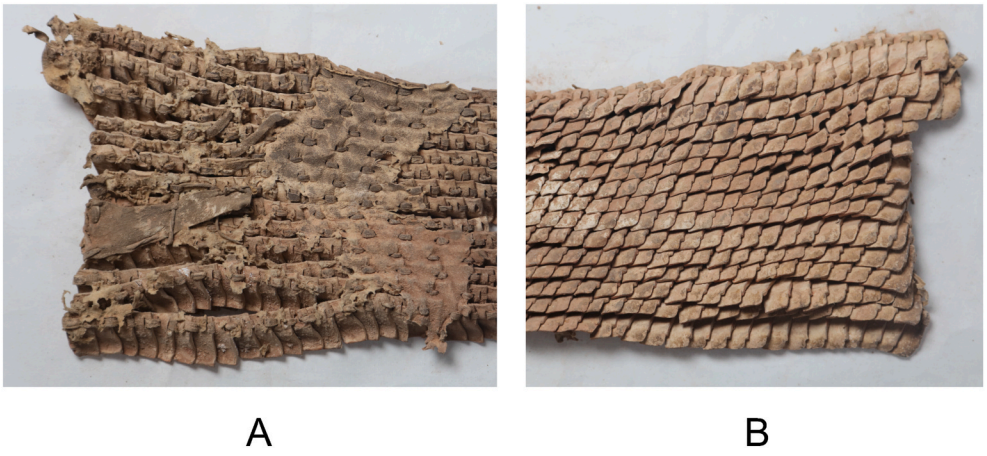

Fig. 9. Yanghai leather scale armour (IIM127:11): end piece of proper left side panel, A – inside, B – outside. Photos: P. Wertmann.

currently no direct parallel to the Yanghai armour anywhere in the world, other than the example in the Metropolitan Museum of Art. However, meaningful matches of some aspects can be found and will be discussed in this chapter.

4.1. Comparison with the scale armour from the Metropolitan Museum of Art, New York

The closest analogue to the Yanghai armour concerning material, scale shape and arrangement, age and basic features of construction is a leather scale armour in the Department of Arms and Armor in the Metropolitan Museum of Art (MET) in New York (accession number: 2000.66a-c) (Fig. 12). Based on measurements provided by the curatorial and conservation team of the MET and the joint evaluation of photographs and online discussions of the most plausible interpretation, we calculated the lengths of scale rows and heights of the armour's parts based on the observed horizontal and vertical overlaps of scales and rows. Future analyses will provide more precise knowledge about this object, help to verify the assumptions made in this paper, and hopefully clarify some of the remaining open questions.

The place of origin of the MET armour is unknown. However, the age of the armour could be established based on two samples taken from loose leather scales, which were sent to the AMS radiocarbon dating laboratories at Beta Analytic Inc. Miami (sample 1) and ETH Zurich (sample 2) and dated to 2480 ± 40 ^{14}C BP (Beta-126351) and 2285 ± 85 ^{14}C BP (ETH-19983), respectively. With a probability of 95.4%, sample 1 dates to the interval 773–421 cal BCE, and sample 2 to 746–58 cal BCE (object files, Department of Arms and Armor, MET, New York). These results indicate that the MET armour may well have been made at about the same time as the Yanghai armour (dated to 786–543 cal BCE).

Apart from local instability and deterioration, the MET armour is almost complete. The conservation report states that cow hide was used to fabricate the scales and lining, which may have been tanned with brain, oil, and/or smoke. The scaled torso of the MET armour is stiffer than that from Yanghai because its lining is about double in thickness. It has an overall height of up to ca. 80 cm at the front and is ca. 35 cm wide at the chest (Fig. 12A), and thus appears taller but slimmer. Additionally, attached to the bottom edge of the front-proper-left-side part it had a multi-layered skirt of relatively thin sheets of pliable leather, measuring ca. 50–60 cm in length (Fig. 12B and C), which was folded

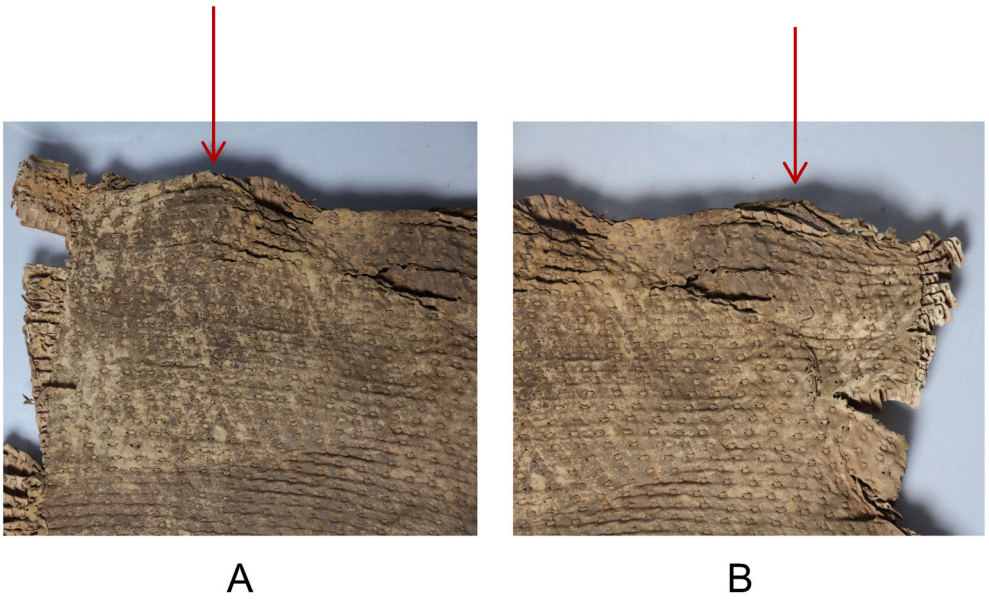

Fig. 10. Inside view of attachment points of the shoulder flaps where the neckline is deformed by the pull. A – proper left side, B – proper right side. Photos: P. Wertmann.

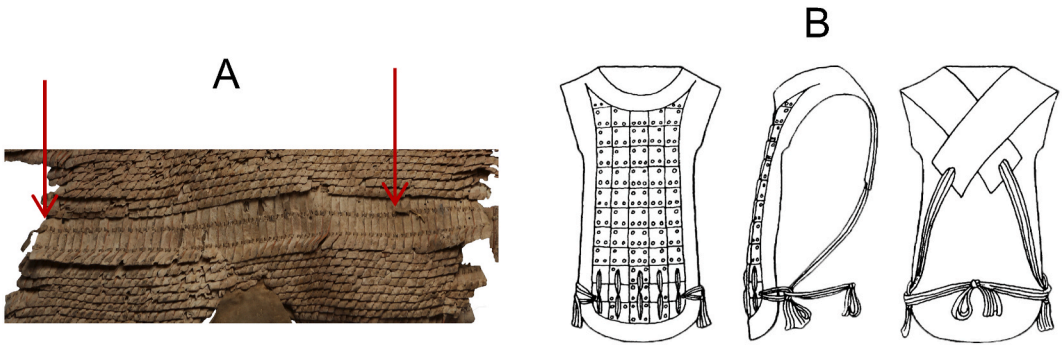

Fig. 11. A – Remains of leather straps at both sides' hip position of the Yanghai armour. B – Fastening of the apron-shaped armour of Qin Shi Huang's terracotta soldiers at the hips with straps running crosswise over the back. Photo: P. Wertmann, Drawing after: Liu, 2003, 24.

into the torso.

4.1.1. Shape, size and arrangement of the MET armour scales

Similar to the Yanghai armour, the MET armour has one dominant type of small scales that make up the main body, and one type of taller scales that form a single belt-like row all around the waist. Both type I and type II scales have three vertical slits for lacing cut in regular distance below the straight top edge, and the bigger scales have another line of three slits above the lower edge, but no slits in the middle. The lower rim of the MET scales is fully rounded (not only one corner as in the case of Yanghai), but has a notch at one corner similar to the Yanghai scales. The reason for the scales being rounded must be the same for both armours. Moreover, despite the different ways of rounding, the outer surface pattern of the MET armour looks the same as the Yanghai armour, because in both cases, only the notched and rounded corner remains visible when the scales overlap.

Proportional to the overall bigger suit, both main types of the MET scales are somewhat bigger than the Yanghai scales (Table 1) but the arrangement is the same: the scales in one row overlap about half of the next, the rows are sewn onto a lining, thicker than the Yanghai lining but still flexible, the rows overlap by about half of a scale's height and offset laterally by about one third of a scale's width.

Different from the Yanghai scale arrangement is the change of overlapping direction at the MET armour. Starting from the two vertical outer edges of the armour, the scales of each row overlap with the notched corner always pointing towards a spine that runs vertically up the centre of the back of the armour, where the rows meet. The spine is formed by a third type of ridged leather scale of butterfly shape, the side edges of which are overlapped by the outermost scales of each abutting row and closes the gap between them. The backs of the spine-scales form a vertical ridge that runs down the entire back of the armour. The height of the spine-scales corresponds to the height of scales type I and II, but their wings make them two times as wide. Because for each row only one spine-scale is needed there are 39 pieces for the rows of small type I scales and 1 piece for the one row of big type II scales.

This scheme of reversing the overlap direction at the spine was observed in the scale armour fragments from Tell Ahmar site (Fig. 1) dated to the 9th century BCE. Based on the changing position of lacing holes on the scales, De Backer (2013a, 26, fig. 160) proposed they meet at the front and the rear of the wearer. Different from the MET armour, however, one scale is placed on top and not beneath the spot where the two rows meet. The same scheme as in Tell Ahmar also occurs in later armours from China, e.g. the stone scale armour of the terracotta warriors in the burial complex of the first Chinese emperor (Fig. 13) (Shi Huang Ling kaogudui, 2001, 16, 26) and the iron scale armour of the King of Qi (died 179 BCE) (Fig. 14) (Shandong Linzi Museum et al., 1987, 1041). Additionally, in these Chinese armours the overlap direction changes once more at the centre of the front. This technique of

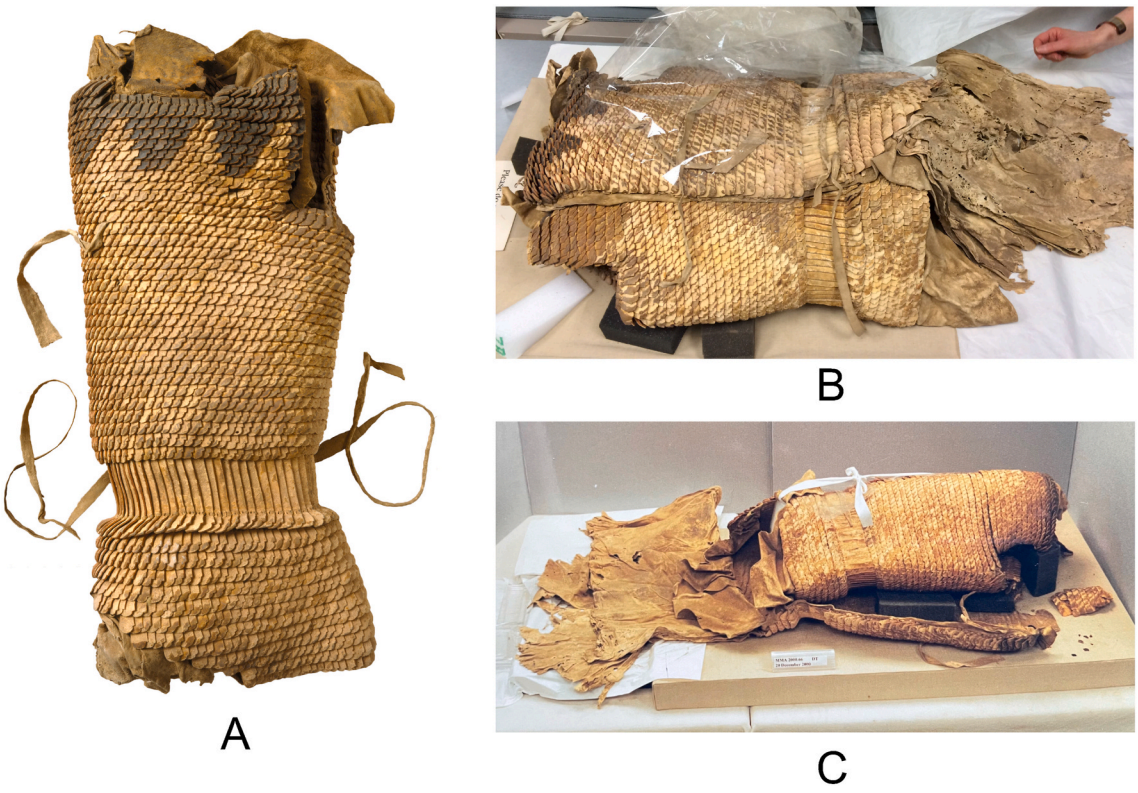

Fig. 12. Leather scale armour from the Arms and Armor Collection of the Metropolitan Museum of Art, New York (accession number: 2000.66a-c). A – front view with skirt folded inside, B – face up, view from proper right side, C – face down, view from proper right side, with one detached scaled piece which might have been a shoulder flap. The Metropolitan Museum of Art, New York, Purchase, Arthur Ochs Sulzberger Gift, 2000. Photo: Department of Arms and Armor, The Metropolitan Museum of Art.

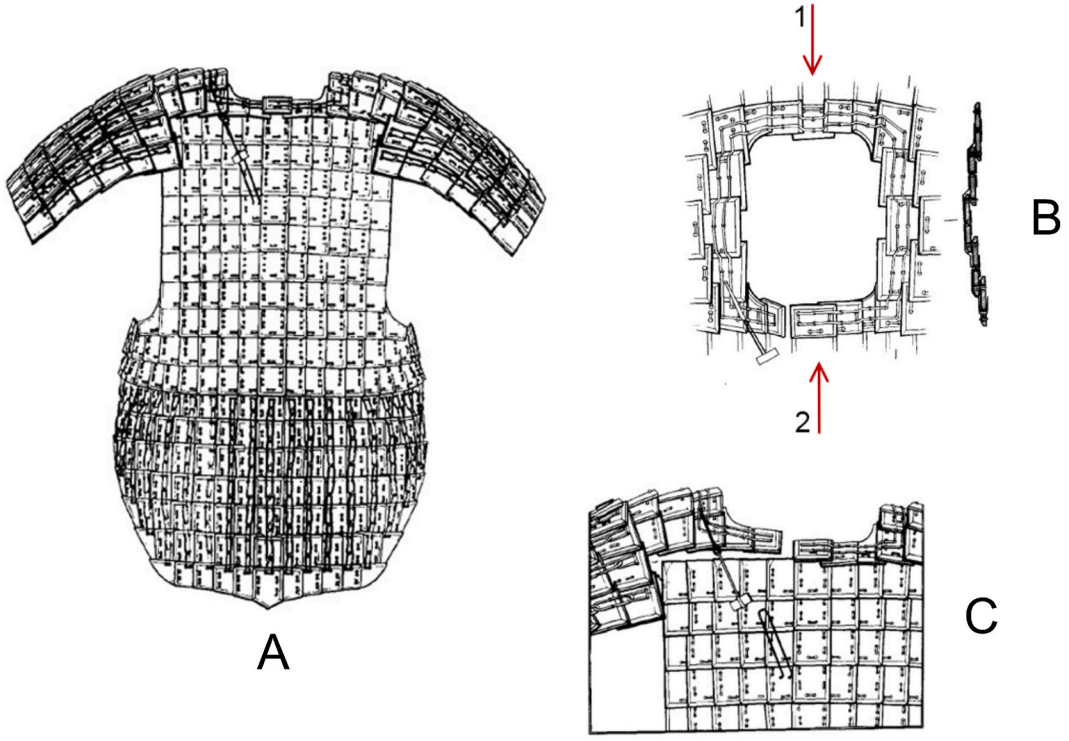

Fig. 13. Stone platelet armour from pit K9801 of the burial complex of the first Chinese emperor Qin Shi Huang, Xi'an, Shaanxi province (Fig. 1). A – front view, B – top view of the neck opening, platelet on centre back (spine) is under the platelets coming from the sides (arrow 1), platelet on centre front (chest) is on top the platelets coming from the sides (arrow 2), C – front view of neck, proper left shoulder closed, proper right shoulder open and to be fastened with two thongs and a toggle. After: Shi Huang Ling kaogudui, 2001, 16, fig. 16, 26, fig. 30, 31.

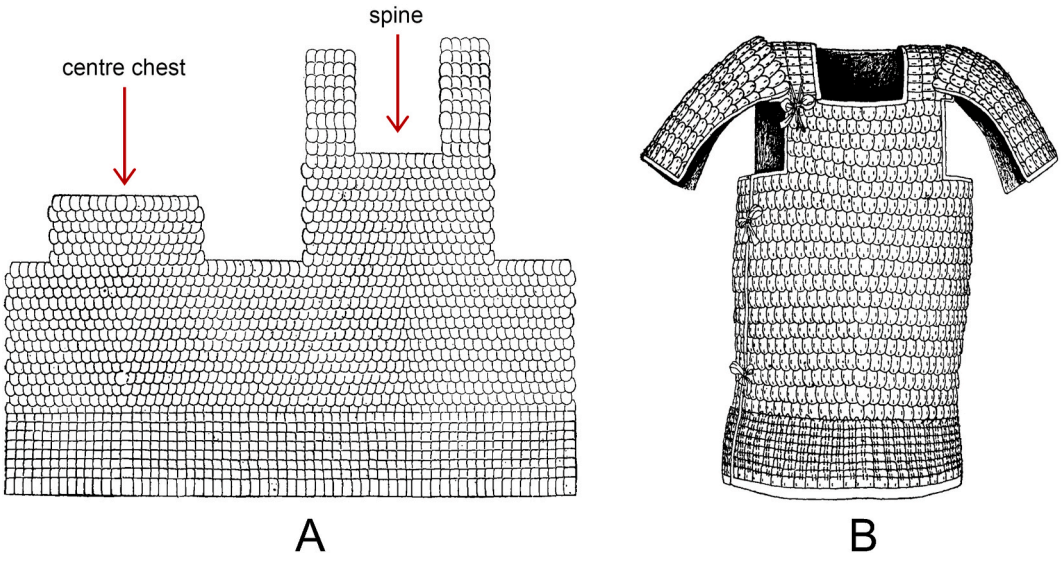

Fig. 14. Han dynasty scale armour from the tomb of King of Qi, Zibo, Shandong province (Fig. 1). A – Reconstruction of armour laid out flat, B – Reconstruction of armour worn. After: Shandong Linzi Museum et al., 1987, 1093, fig. 9, 13.

changing the overlap direction of armour scales was still common for Tibetan lamellar armours until around the 15th to 17th century CE (La Rocca, 2006, cat. nos. 1, 2, and 3).

It is striking that, like the Yanghai scales, the MET scales are also coloured red along the edges. Differently, however, the scales along the neckline have a dark brown surface forming a stepped triangle pattern at the chest and a linear border along the upper edge of the centre back (Fig. 12). Rows of interlocking light and dark stepped triangles resembling merlons are a recurring motif in Yanghai on wood and ceramic vessels as well as textiles, for example, on woollen trousers (Beck et al., 2014, 228). Whether the colour of the lighter scales represents the natural patina of the leather or the remains of a certain dye is unclear yet, because the surface of the lighter scales was pretty much completely eliminated by insects, whereas the dark-brown scales were not affected.

4.1.2. Construction of the MET scale armour

The form and some constructive details, particularly at the shoulders and the bottom edge, could not be established with certainty because the armour, despite some conservation treatment, remains in a rolled form and cannot be laid out flat for full examination of the inside and outside. Overall, the MET armour is designed in such a way as to wrap around the whole torso. It is sleeveless and closes at the proper right side like the Yanghai armour, but covering also the upper back where the shoulder flaps are attached. To put on, the high panel at the proper right side is first placed over the right chest, then the front is folded over it and fastened with thongs under the armpit. A pair of corresponding thongs preserved at the type II scale waist band starts from near the spine and is long enough to tie the armour close at the front (Fig. 12A). The front shows rudiments of shoulder covers, which are two scale rows high. How the shoulder flaps from the back were attached there, however, has not yet been clarified. They are of a different width and only made of plain leather, which is an extension of the interior lining (Fig. 12A). Remains of straps are visible by which flap 2 might have been fastened to the inner right-side panel. Perhaps, the detached scaled piece, in shape and size comparable to the Yanghai shoulder flaps, belonged on one of the shoulders (Fig. 12C, lower right corner of the picture) indicating different forms of shoulder covers on the right and left side. The body armour of the terracotta soldiers of the first Chinese emperor Qin Shi Huang (Fig. 13) and the King of Qi (Fig. 14) had a shoulder part on the left side that was firmly attached to the front and back, while only the right side was open and had to be tied close. Perhaps the MET armour was constructed in that way, too.

Similar to Yanghai, the scales of the MET armour continue over the area of the lower abdomen and loins, and is likewise asymmetrical, with one side having more rows of scales (12) and the other less (7), but offset laterally around the body so that the triangle cut into the lining is not at the front, but at the back beneath the tailbone. The thick lining continues about 20 cm to form a short tight skirt. A second longer skirt of about 50 cm is made of several layers of very fine leather sewn onto the interior lining at the base of the main skirt, but on the proper right side only and reaches from the right side to the centre back (Fig. 12B and C). The base seam is covered by the lowest row of scales. Because of the fragility of this subsidiary skirt, it cannot be fully opened yet, and therefore we can only estimate its length and width. It appears that the long skirt was intended to cover the front and left thigh to the wearer's knees, leaving the rear of his right thigh open. This type of asymmetrical wraparound skirt was characteristic for slingers, spearmen, and archers of the Neo-Assyrian heavy infantry as depicted on the reliefs of the palace in Nineveh (Fig. 15A) and described by Dezsö (2012a).

To sum up, the MET armour matches the Yanghai armour in many essential constructional and aesthetic details: scales, backing, laces and thongs are made exclusively of leather (rawhide); the shape of the scales is not identical but similar enough (one notch and rounded corner) to form the same surface pattern when scales and rows overlap; all scales have red edges; two sizes of scales – the small type is used for the main part, the big type only for one row at the waist; it is wrapped around the body so that the proper left side of the wearer is seamlessly covered and the armour tied close with thongs at the proper right side; asymmetrical loin cover with a cut-out triangle. However, the MET armour differs in the placement of this lowest part and its extension by a multi-layered skirt of soft leather, a stiffer and stronger, less flexible torso. The stylistic correspondence but slightly differing functional specifics suggests that the two armours were designed as outfits for different units of the same army: the Yanghai armour possibly for light cavalry (Fig. 15B), the MET armour perhaps for heavy infantry (Fig. 15A). Such a degree of standardization of military equipment about the 8th to 5th century BCE was only reached by the Neo-Assyrian army after the reforms of Sennacherib (704-681 BCE), but particularly under his successor Assurbanipal (668-631 BCE) when the importance of heavy infantry and cavalry (and possibly, the production of scale armour) reached its peak (Dezsö, 2012b, 160ff; De Backer, 2013b, 186ff).

Fig. 15. A – Assyrian infantry archer in scale armour depicted in a relief from the south west palace of Sennacherib (reigned 704-681 BCE) in Nineveh (Fig. 1); B – Assyrian cavalry archer in scale armour depicted in a relief from the palace of Assurbanipal (reigned 669-631 BCE) in Nineveh. Photos: The Trustees of the British Museum.

4.2. The place of the Yanghai armour in the evolution of scale armour in Eurasia

Neither in the Near East, the core area of scale armour invention at the end of the second millennium BCE and flourishing during the 7th century BCE, nor in Central or East Asia do earlier or contemporary complete objects exist that can be compared with the Yanghai armour. What is available for comparison are individual or groups of scales, depictions of persons wearing armour, and textual references from the period. Even though the cuneiform tablets of Nuzi (Lachemann, 1955; Kendall, 1979; Dezsö, 2002) mention leather scales, the only ones that could be verified previously were those found in the tomb of Tutankhamun. Hulit (2004, 104, fig. 6) identified in that group a variety of large and small pointed scales with differing numbers of lacing holes along the top and both long edges (Table 1). In outline, number and placement of the lacing holes, i.e. the technique of assembling the scales, they correspond to the bronze scales excavated in Kāmid el-Lōz (Ventzke, 1986, 168, fig. 28), but they are smaller. The same can be observed when comparing the majority of the Yanghai type I leather scales with contemporary metal scales: for example, from Khutor Krasnoe Znamya mound 9 (bronze) (Černenko et al., 2006, 58, pl. 19.334), Kislovodsk "Industrija" grave 4 (bronze) (Černenko et al., 2006, 58, pl. 19.335), Kelermes mounds 19, 24, 29 (bronze, iron) (Ryabkova, 2010, 101), Zhabotin (bronze, iron) (Černenko et al., 2006, 34, pl. 2.51, Ryabkova, 2014) and Ziwiye (gold) (Černenko et al., 2006, 129) (see Fig. 1 for the site locations). They match in outline, number and placement of the lacing holes, but the leather scales are smaller than the metal scales (Table 1). The MET scales are larger than the metal ones, indicating that also during the 8th to 6th century BCE the scale size differed.

There are two important features that distinguish the Yanghai and MET scale armours from the older specimen in Kāmid el-Lōz dated to ca. 1400 BCE. First, the variety of scale size has been reduced. In one suit of armour only one size of scales is used for the main part and a second bigger type of scales only for the waistline. Second, the method of construction has been simplified. The scales are only connected to each other and to the backing by three holes or slits at the upper edge. Černenko et al. (2006, 126) recognized the appearance of this new assembling technique at the beginning of the first millennium BCE, with the armour of Pharao Sheschonk I (946-925 BCE) as the oldest example. However, the old technique was not fully replaced until the 7th century BCE. These improvements in simplification and standardization were preconditions for serial production to meet the needs of the growing Assyrian army, particularly when large numbers of foreign troops were employed under Sennacherib and Assurbanipal and had to be outfitted with Assyrian gear (Dezsö, 2012b, 34; De Backer, 2013b). Although scale armour became more common defensive equipment, the rank of its wearer could still be expressed through the choice of materials and design. Leather was likely the most practical and economical material for the large numbers of heavy infantry and cavalry soldiers, while metal (bronze, iron, gold) – more expensive and time consuming to work – was reserved for the elites. Evidence is provided by hundreds of mostly single armour scales made of bronze and iron, for example, from the late 8th-late 7th century BCE site of Fort Shalmaneser at Nimrud (Oates, 1959; Mallowan, 1966, 410; Dezsö, 2003–2005) (Table 1, Fig. 1), as well as depictions on contemporary stone reliefs of soldiers predominantly dressed in waist-long scale armours composed of rectangular-shaped scales with rounded edges (De Backer, 2013a, 2013b).

The Ziwiye scales in Mesopotamia and all scales north of the Caucasus where suits of bronze and iron scale armour and the knowledge of their manufacturing technology were brought during the 7th century BCE (or even already by the mid-8th century as Ryabkova (2014) assumes) show the new fastening technique (Černenko et al., 2006). After the end of the Near Eastern campaigns of the early Scythians and the fall of the Neo-Assyrian Empire, the Scythians further developed and spread scale armour production (Černenko et al., 2006, 128–129). South of them, the Persians continued to dress heavy infantry and cavalry in scale armour as known from texts, but comparatively few actual scales of the Achaemenid period (6th-4th century BCE) remain (Dezsö, 2012b, 26, footnote 101), for example, from the sites of Persepolis and Pasargadae (Schmidt, 1957, pl. 77; Muscarella, 1988, 212; De Backer, 2012, 11ff) (Table 1). In comparison with the Yanghai scales, these scales appear less standardized, as indicated by a larger variety of sizes, lacing holes

and shapes. It should be noted, however, that no comprehensive study has so far been published on Achaemenid scale armour based on actual finds. In the case of the armour scales from Persepolis, a small selection has been measured and digitized by the Oriental Institute of the University of Chicago. In addition, armoured personnel are not depicted in detail in palace reliefs. Thus, there is little knowledge about the Achaemenid forms of scale armour and their manufacturing, which makes it difficult to compare them with the Yanghai scale armour.

In eastern China, one armour find of the Western Zhou dynasty period (1046-771 BCE) in Pudu (Fig. 1) is always referred to as marking the onset of metal body armour production in China (Liu, 2003) where the rectangular shape and size of the bronze plates (Table 1) could be recognized (CASS Institute of Archaeology Fengxi Team, 1988). They are substantially bigger than the Near Eastern bronze scales and have holes at all four corners indicating a different fastening technique without imbrication. No other metal plate finds are reported from the following centuries. Instead, several armours made of lacquered leather have been excavated that mark the height of early leather armour production in China during the Eastern Zhou period (770-256 BCE) (Yang, 1992, 91). They come from south-central and northern China, for example: Xianrentai site (Shandong University Department of Archaeology, 1998), Baishizidi site (Xinyang Cultural Relics Management Committee and Gushi County Cultural Bureau, 1981), and Yuehe site (Nanyang Institute of Cultural Relics and Tongbai County Administration for Cultural Relics, 1997), but mostly from the ancient state of Chu, i.e. the modern provinces of Hubei and Hunan and date to the 5th-4th centuries BCE (Fig. 1). Even though in most cases the leather was decayed leaving only the lacquer coat behind, 12 suits of armour from the tombs of Marquis Yi of Zeng in Sui county, modern Suizhou city (CASS Institute of Archaeology, 1989, 332–352), and 28 suits from the Jiuliandun tomb 1 in Zaoyang county (Wang, 2016) could be reconstructed (Fig. 1). The material used for the armour from the tombs of Marquis Yi of Zeng was identified as cow rawhide (CASS Institute of Archaeology, 1989, 333). In the case of the armours from Jiuliandun, the leather was decayed, leaving only the lacquer coating preserved. In total, 7 different types of armours were identified. Most of them consisted of larger plates differing in shape and size, some of them more than 17 cm long and more than 13 cm wide. One type of armour, for example armour M1:242, consists of smaller plates. Here, the plates forming the front and back piece were 6–6.2 cm long, 4.8–6.2 cm wide, and they had up to 16 holes for connecting laces of either silk or leather. The shape and size of the smaller scale type armour resembles the Pudu plates; their assembling technique, however, differs (for reconstructions of these armours see CASS Institute of Archaeology, 1989, 335; Wang, 2016). Early textual evidence such as the *Zuo zhuan*, i.e. the *Commentery of Zuo* completed around 300 BCE, frequently refers to the use of rhinoceros, buffalo and wild ox hide as well as the use of red lacquer as protective and ornamental coating (for an English translation see Legge, 1872) in the late Spring and Autumn period (see also Laufer, 1914, 181–182, 190; Robinson, 2002, 126–128). Actual finds of this type of armour, however, have so far not been uncovered. Thus, at the time when the Yanghai armour was made and used, leather armour was also manufactured in the kingdoms of eastern China, but in a fundamentally different technical and aesthetic tradition.

In the extended tomb complex of the first Chinese emperor Qin Shi Huang, who died in 210 BCE, the masses of life-size terracotta soldiers and finds in sacrificial pits present a very different picture. Altogether four types of body armour with variants for heavy infantry, cavalry and chariotry have been documented (Dien, 2000b, 27–30 and citations therein) and interpreted as imitations of lacquered leather armours (Yang, 1978, 116; Dien, 1981, 11). Particularly the cavalry armour, i.e. waistcoats without shoulder guards, closely resemble the Yanghai armour (Fig. 11). It is therefore conceivable that the construction of the Yanghai body armour was the forerunner of the apron-like armour worn by some of the terracotta warriors (Liu, 2003).

The actual finds of 87 suits of armour in pit K9801T2G2 (Shi Huang Ling kaogudui, 2001) are most interesting because, comparable to Near Eastern scale armour, the plates are small and imbricate horizontally, the rows vertically (Fig. 13). However, in the Chinese fashion, they have a straight lower edge and a high number of holes (Table 1) through which they are tied with bronze wires. The armours of pit K9801T2G2 look like wearable waistcoats, were they not made of stone platelets with a weight of 35–40 g (big plates), 25–30 g (small plates) each. Therefore, they are regarded as imitations of metal scale armour, of which none from the time of the first emperor, i.e. 3rd century BCE has been found to date. Both textual (Laufer, 1914, 189) and archaeological evidence (see for example Yang, 1976, 32–43; Dien, 1981, 11; Yang, 1992, 214–220) indicate that iron scale armours became increasingly popular from the 2nd century BCE, perhaps influenced by the nomadic, possibly Scythian type of scale armours (Laufer, 1914, 200; Dien, 1981, 13). Two very representative suits of armour made of 2244 and 2142 iron scales and interlaced with hemp threads from the tomb of the King of Qi could be reconstructed (Shandong Linzi Museum, 1985, 253–254; Shandong Linzi Museum et al., 1987; Liu, 2003, 36–37). Still, the hole-at-all-sides lacing technique is retained, but new is the use of proper rounded scales for chest, abdomen, back and arm cover (Fig. 14). The suit originally had a leather lining covered with silk, and a border of brocade.

To sum up, the Yanghai scale armour, while unique as a documented find from the Turfan oasis and all of Northwest China, almost certainly represents a type that was professionally produced in large numbers to outfit the troops of a big army. It bears all the technical signs of the Near Eastern scale armour tradition and mostly closely resembles the scale waistcoats for armoured cavalrymen invented in Assyria in the 9th/8th century BCE and most widely used to equip Neo-Assyrian forces during the 7th century BCE. Since the absolute age of the Yanghai armour ranges from 786 to 543 cal BCE, it might have been manufactured either under Assyrian reign or their Persian successors or by people who brought the technology to the steppes. In any case, it is currently the only actual find of a Near Eastern style leather scale armour with clear archaeological context. It does not signal the start of a production tradition in western China of its own, but rather the fact that the knowledge was there earlier then assumed so far. Likely it is related to the increasing mobility in eastern Central Asia (Wagner et al., 2011), as indicated by a noticeable genetic influx from Caucasus/Iranian-Plateau/Transoxiana identified in ancient DNA of individuals from Mongolia and the Baikal region and dated to ca. 750 BCE, i.e. ca. 200 years before the formation of the Achaemenid empire (Jeong et al., 2020).

The use of scale armour in Central Asia by the end of the first millennium BCE has been corroborated by a number of depictions (discussed for example by Dien, 2000a). When China had need of military equipment, mass production for large armies under the reign of the first emperor Qin Shi Huang (221–210 BCE) and the succeeding Han dynasty (206 BCE–220 CE) intensified outreach towards the West, the knowhow was available for being merged with their own eastern lamellar technology and garment fashion.

5. Conclusions

In grave IIM127 of the Yanghai cemetery site, Turfan, Northwest China, the extensive remains of one leather scale armour consisting of more than 5000 scales was discovered and AMS radiocarbon dated to the time interval from 786 to 543 cal BCE (95% probability). The shape and size of the scales, their technique of fastening and the construction of the armour could be studied and the overall form and functionality of the armour reconstructed. By comparison with a contemporary armour of unknown origin in the Metropolitan Museum of Art New York (MET) and finds and depictions from the Near East, the adjacent northern steppe areas and China, we reached the following conclusions.

(1) According to our reconstruction, a total of 5444 small and 140 big scales were originally used for the armour; together with leather laces and lining adding up to a total weight of ca. 4–5 kg. The scales overlap horizontally, the rows vertically, by which a regular surface pattern is created.
(2) The Yanghai armour is an apron-shaped waistcoat covering front, groin, sides and lower back. It can be put on quickly and without the help of another person by wrapping the left part around the back, tying it at the right hip and fastening the shoulder flaps, with thongs crosswise over the back to laces at the opposite hip parts. Fitting different statures, it is a light and most economic one-size-fits-all, highly professional defensive garment. The cheek pieces of a horse harness, which also were found in tomb IIM127, indicate that the tomb owner was a horseman.
(3) In age, construction details and aesthetic appearance its closest parallel is the MET armour. The stylistic correspondence but functional specifics make the two armours appear as outfits for different units of the same army: the Yanghai armour possibly for light cavalry, the MET armour perhaps for heavy infantry. This degree of standardization of military equipment at the time under discussion was a characteristic feature of the Neo-Assyrian forces in the 7th century BCE. With all of the above in mind, we suggest that both leather scale armours were manufactured in the Neo-Assyrian Empire.

Whether the wearer of the Yanghai armour himself was one of the foreign soldiers in Assyrian service who was outfitted with Assyrian equipment and brought it home, or he captured the armour from someone else who was there, is a matter of speculation. Without the survival of even one actual complete scale armour from an Assyrian context, the available evidence (i.e. in particular representations on stone reliefs) is not enough to make a definitive judgment on the precise origin of the scale armour from Yanghai. What it does establish, however, is that the Yanghai armour is one of the rare actual proofs of West-East technology transfer across the Eurasian continent during the early first millennium BCE when social and economic transformation accelerated.

Author contributions

Conceptualisation, P.W., P.E.T., M.W.; Material and data collection, P.W., M.W., D.X., M.Y., I.E., R.V., D.J.L.R.; Methodology, P.W., M.W., D. X., M.Y., I.E., R.V., D.J.L.R., P.E.T.; Analysis, P.E.T.; Writing (original draft), P.W., P.E.T., M.W.; Writing (review and editing), D.J.L.R., P.W., P.E.T., M.W.; Visualization, I.E., P.W., M.W., D.J.L.R., P.E.T.

Data availability

All data generated during this study are included in this published article.

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.

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References

Alekseev, A., 2007. Skythische Könige und Fürstenkurgane. In: Menghin, W., Parzinger, H., Nagler, A., Nawroth, M. (Eds.), Im Zeichen des Goldenen Greifen: Königsgräber der Skythen. Prestel Verlag, München.
ArchaeoGLOBE Project, 2019. Archaeological assessment reveals Earth's early transformation through land use. Science 365, 897–902.
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.
Beckwith, C.I., 2009. Empires of the Silk Road: A History of Central Eurasia from the Bronze Age to the Present. Princeton University Press, Princeton.
Bronk Ramsey, C., 1995. Radiocarbon calibration and analysis of stratigraphy: the OxCal program. Radiocarbon 37, 425–430.
Bronk Ramsey, C., Dee, M.W., Rowland, J.M., Higham, T.F.G., Harris, S.A., Brock, F., Quiles, A., Wild, E.M., Marcus, E.S., Shortland, A.J., 2010. Radiocarbon-based chronology for dynastic Egypt. Science 328, 1554–1557.
CASS Institute of Archaeology Fengxi Team, 1988. 1984 nian Chang'an Pudu cun Xi Zhou muzang fajue jianbao [Preliminary excavation report of the Western Zhou dynasty tomb in Pudu village, Chang'an, 1984]. Kaogu 9, 769–777 (in Chinese).
CASS Institute of Archaeology, Hubei Province Museum, 1989. Zeng Hou Yi Mu [The Tomb of Marquis Yi of Zeng]. Archaeological Monograph Series. No. 37. Wenwu Press, Beijing (in Chinese).
Chen, X.Y., 2019. Tulufan Shanshan Yanghai mudi chutu pi kaijia [Excavation of a leather armour from Yanghai cemetery, Shanshan, Turfan]. Tulufan Xue Yanjiu [Journal of Turfan Studies 1, 24–33 (in Chinese).
Černenko, E.V., Rolle, R., Kenk, R., Seemann, H., 2006. Die Schutzwaffen der Skythen. Steiner Verlag, Stuttgart.
Coccia, E., 2020. Sinnenleben: Eine Philosophie. Übersetzt von Caroline Gutberlet. Carl Hanser Verlag, München.
Čugunov, K.V., Parzinger, H., Nagler, A., 2010. Der Skythenzeitliche Fürstenkurgan Aržan 2 in Tuva. Archäologie in Eurasien, Band 26. Philipp von Zabern, Mainz.
De Backer, F., 2012. Scale-armour in the Mediterranean area during the early iron age: A) from the IXth to the IIIrd century BC. Revue Des Études Militaires Anciennes 5, 1–38.
De Backer, F., 2013a. Scale-Armour in the Neo-Assyrian Period: Manufacture and Maintenance. Lap Lambert Academic Publishing, Saarbrücken.
De Backer, F., 2013b. Scale-Armours in the Neo-Assyrian Period: A Survey. State Arch. Assyria Bull. XIX (2011-2012), 175–202.
Dezsö, T., 2002. Scale Armour of the 2nd millennium BC. In: Bács, T.A. (Ed.), A Tribute to Excellence. Studies Offered in Honor of Ernő Gaál, Ulrich Luft, László Török. Studia Egyptiaca XVII, Budapest, pp. 195–216.
Dezsö, T., 2003-2005. Panzer. In: Ebeling, E., Meissner, B. (Eds.), Reallexikon der Assyriologie und Vorderasiatischen Archäologie. Walter de Gruyter, Berlin, New York, pp. 319–323.
Dezsö, T., 2012a. The Assyrian Army. I. The Structure of the Neo-Assyrian Army as Reconstructed from the Assyrian Palace Reliefs and Cuneiform Sources. 1. Infantry. Eötvös University Press, Budapest.
Dezsö, T., 2012b. 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.
Dien, A.E., 1981. A study of early Chinese armor. Artibus Asiae 43 (1/2), 5–66.
Dien, A.E., 2000a. A brief Survey of defensive armor across Asia. J. East Asian Archaeol. 2 (3–4), 1–22.
Dien, A.E., 2000b. Armour in China before the Tang dynasty. J. East Asian Archaeol. 2 (3–4), 23–59.
Domrös, M., Peng, G., 1988. The Climate of China. Springer, Berlin.
Galanina, L.K., 2007. Die Fürstengräber von Kostromskaja und Kelermes. Im Zeichen des Goldenen Greifen: Königsgräber der Skythen. Prestel Verlag, München, pp. 198–203.

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.
Godley, A.D., 1922. Herodotus. The Persian Wars, Vol. III: Books 5-7. Harvard University Press, Cambridge.
Hulit, Th., 2002. Late Bronze Age Scale Armour in the Near East. An Experimental Investigation of Materials, Construction, and Effectiveness, with a Consideration of Socio-Economic Implications. Doctoral Thesis,. University of Durham.
Hulit, Th., 2004. Tut'Ankhamun's body armour: materials, construction, and the implications for the military industry. In: Dann, R.J. (Ed.), Current Research in Egyptology 2004: Proceedings of the Fifth Annual Symposium. Oxbow Books, Oxford, pp. 100–111.
Ikeuchi, H., 1930. A Study of the Su-Shen. Memoires of the Research Department of the Toyo Bunko. The Toyo Bunko, Tokyo, pp. 97–164.
Jeong, C., Wang, K., Wilkin, S., Taylor, W.T.T., Miller, B.K., Bemmann, J.H., Stahl, R., Chiovelli, C., Knolle, F., Ulziibayar, S., Khatanbaatar, D., Erdenebaatar, D., Erdenebat, U., Ochir, A., Ankhsanaa, G., Vanchigdash, C., Ochir, B., Munkhbayar, C., Tumen, D., Kovalev, A., Kradin, N., Bazarov, B.A., Miyagashev, D.A., Konovalov, P. B., Zhambaltarova, E., Ventresca Miller, A., Haak, W., Schiffels, S., Krause, J., Boivin, N., Erdene, M., Hendy, J., Warinner, C., 2020. A dynamic 6,000-year genetic history of Eurasia's Eastern Steppe. Cell 183, 890–904.e29.
Jiang, H.E., Li, X., Zhao, Y.X., Ferguson, D.K., Hueber, F., Bera, S., Wang, Y.F., Zhao, L.C., Liu, C.J., Li, C.S., 2006. A new insight into Cannabis sativa (Cannabaceae) utilization from 2500-year-old Yanghai tombs, Xinjiang, China. J. Ethnopharmacol. 108, 414–422.
Jiang, H.E., Li, X., Ferguson, D.K., Wang, Y.F., Liu, C.J., Li, C.S., 2007. The discovery of Capparis spinosa L. (Capparidaceae) in the Yanghai Tombs (2800 years b.p.), NW China, and its medicinal implications. J. Ethnopharmacol. 113, 409–420.
Jiang, H.E., Zhang, Y.B., Li, X., Yao, Y.F., Ferguson, D.K., Lü, E.G., Li, C.S., 2009. Evidence for early viticulture in China: proof of a grapevine (Vitis vinifera L., Vitaceae) in the Yanghai tombs, Xinjiang. J. Archaeol. Sci. 36, 1458–1465.
Karageorghis, V., Masson, E., 1975. A Propos De La Découverte DÉcailles DArmure En Bronze à Gastria-Alaas (Chyphre). Archäologischer Anz. 90, 209–222.
Kendall, T., 1979. Warfare and Military Matters in the Nuzi Tablets. Brandeis University, Massachusetts.
Kessler, K., 1991. Die Assyrer. In: Hrouda, B. (Ed.), Der Alte Orient. Geschichte und Kultur des alten Vorderasien. Bertelsmann, Gütersloh, pp. 112–150.
Kim, Y.H., Choi, C.H., Kumar, S.K.S., Kim, Ch.G., 2019. Behavior of dragon skin flexible metal bumper under hypervelocity impact. Int. J. Impact Eng. 125, 13–26.
Kramell, A., Li, X., Csuk, R., Wagner, M., Goslar, T., Tarasov, P., Kreusel, 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.
Lachemann, E.R., 1955. Excavations at Nuzi. Vol. VI: the Administrative Archives. Harvard Semitic Series, vol. XV. Harvard University Press, Massachusetts.
Laufer, B., 1914. Chinese Clay Figures. Part I. Prolegomena on the History of Defensive Armor. Field Museum of Natural History, Chicago.
Legge, J., 1872. The Ch'un Ts'eu, with Tso Chuen. The Chinese Classics, vol. V. Trubner, London.
La Rocca, D.J., 2002. Arms and Armor: Notable Acquisitions, 1991–2002. The Metropolitan Museum of Art, New York.
La Rocca, D.J., 2006. Warriors of the Himalayas: Rediscovering the Arms and Armor of Tibet. The Metropolitan Museum of Art, Yale University Press, New Haven and London.
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.
Liang, S.Y., Gao, Q.Sh., 1970. Houjiazhuang (Anyang Houjiazhuang Yin dai mudi) (1004 hao da mu) [Anyang Houjiazhuang Yin period cemetery) (Large tomb 1004)]. Academia Sinica, Taibei (in Chinese).
Littauer, M.A., Crouwel, J.H., 1979. Wheeled vehicles and ridden animals in the ancient Near East. Antiquity 54 (212), 247–258.
Liu, Y.H., 2003. Zhongguo Gudai Junrong Fushi [Ancient Chinese Armour]. Shanghai Chinese Classics Publishing House, Shanghai (in Chinese).
Mallory, J.P., Mair, V.H., 2000. The Tarim Mummies: Ancient China and the Mystery of the Earliest Peoples from the West. Thames & Hudson, London.
Mallowan, M.E.L., 1966. Nimrud and its Remains, vol. II. Collins, London.
Mänchen-Helfen, J.O., 1973. The World of the Huns: Studies in Their History and Culture. University of California Press, Berkeley, Los Angeles, London.
Muscarella, O., 1988. Bronze and Iron. Ancient Near Eastern Artifacts in the Metropolitan Museum. The Metropolitan Museum of Art, New York.
Nanyang Institute of Cultural Relics, Tongbai County Administration for Cultural Relics, 1997. Tongbai Yuehe yi hao Chun Qiu mu fajue jianbao [Short excavation report of the Spring and Autumn Yuehe tomb no 1 in Tongbai]. Zhongyuan Wenwu 4, 8–23 (in Chinese).
Oates, D., 1959. Fort Shalmaneser: an interim report. Iraq 21 (2), 98–129.
Reimer, P.J., Austin, W.E.N., Bard, E., Bayliss, A., Blackwell, P.G., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kromer, B., Manning, S.W., Muscheler, R., Palmer, J.G., Pearson, C., van der Plicht, J., Reimer, R.W., Richards, D.A., Scott, E.M., Southon, J.R., Turney, C.S.M., Wacker, L., Adolphi, F., Büntgen, U., Capano, M., Fahrni, S.M., Fogtmann-Schulz, A., Friedrich, R., Köhler, P., Kudsk, S., Miyake, F., Olsen, J., Reinig, F., Sakamoto, M., Sookdeo, A., Talamo, S., 2020. The IntCal20 northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). Radiocarbon 62 (4), 725–757.
Robinson, H.R., 2002. Oriental Armour. Dover Publications, Mineola, New York.
Ruddiman, W., 2003. The anthropogenic greenhouse era began thousands of Years ago. Climatic Change 61, 261–293.
Ryabkova, N.V., 2010. Cheshuychatyye pantsiri ranneskifskogo vremeni [Scale Armor of the Early Scythian period]. In: Alekseev, A.J. (Ed.), Archaeological Papers, 38. The State Hermitage Museum, St. Petersburg, pp. 87–106 (in Russian).
Ryabkova, N.V., 2014. Kurgan 524 u s. Zhabotin v sisteme pamyatnikov perioda skifskoy arkhaiki [Kurgan 524 near the village of Zhabotin in the system of Scythian archaic monuments]. In: Rossiysky Arkheologichesky Ezhegodnik, vol. 4, pp. 236–277 (in Russian).
Schmidt, E.F., 1957. Persepolis. Volume II. Contents of the Treasury and Other Discoveries. The University of Chicago Press, Chicago.
Shandong Linzi Museum, 1985. Xi Han Qi Wang mu suizang qiwu keng [The funerary pits of the Western Han dynasty tomb of the King of Qi]. Kaogu Xuebao 2, 223–266 (in Chinese).
Shandong Linzi Museum, Linzi Administration of Cultural Relics, CASS Institute of Archaeology, 1987. Xi Han Qi Wang tie jiazhou de fuyuan [Reconstruction of an iron armour from the Western Han tomb of the King of Qi]. Kaogu 11, 1032–1046 (in Chinese).
Shandong University Department of Archaeology, 1998. Shandong Changqing xian Xianrentai Zhou dai mudi [Zhou dynasty Xianrentai cemetery in Changqing county, Shandong]. Kaogu 9, 11–25 (in Chinese).
Shi Huang Ling kaogudui, 2001. Qin Shi Huang lingyuan K9801 peizang keng di yi ci shijue jianbao [Trial excavation of the accompanying pit K9801 of the Qin Shi Huang Mausoleum]. Kaogu yu Wenwu 1, 3–34 (in Chinese).
Sinor, D., 1990. The Cambridge History of Early Inner Asia. Cambridge University Press, Cambridge.
Snodgrass, A.M., 1999. Arms and Armor of the Greeks. John Hopkins University Press, Baltimore.
Spengler III, R.N., Ryabogina, N., Tarasov, P.E., Wagner, M., 2016. The spread of agriculture into northern Central Asia: timing, pathways, and environmental feedbacks. Holocene 26 (10), 1527–1540.
Tarasov, P.E., Demske, D., Leipe, C., Long, T., Müller, S., Hoelzmann, P., Wagner, M., 2019. An 8500-year palynological record of vegetation, climate change and human activity in the Bosten Lake region of Northwest China. Palaeogeogr. Palaeoclimatol. Palaeoecol. 516, 166–178.
Thordeman, B., 1939–40. Armour from the Battle of Wisby, 1361. Chivalry Bookshelf, Stockholm.
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).
Van Driel-Murray, C., 2000. Leatherwork and skin products. In: Nicholson, P.T., Shaw, I. (Eds.), Ancient Egyptian Materials and Technology. Cambridge University Press, Cambridge, pp. 299–319.
Veldmeijer, A.J., Laidler, J., 2008. Leather work in ancient Egypt. In: Selin, H. (Ed.), Encyclopaedia of the History of Science, Technology, and Medicine in Non-western Cultures, 2 Volumes. Springer, Berlin, Heidelberg, New York, pp. 215–1220.
Ventzke, W., 1983. Zur Rekonstruktion eines bronzenen Schuppenpanzers. In: Hachmann, R. (Ed.), Frühe Phöniker im Libanon. 20 Jahre deutsche Ausgrabungen in Kāmid el-Lōz, Philipp von Zabern. Mainz am Rhein, pp. 94–100.
Ventzke, W., 1986. Der Schuppenpanzer von Kamid el-Loz. In: Hachmann, R. (Ed.), Kamid el-Loz 1977-81, Saarbrücker Beitrage zur Altertumskunde 36. Rudolf Habelt, Bonn, pp. 161–182.
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. Proc. Natl. Acad. Sci. Unit. States Am. 108 (38), 15733–15738.
Wang, H.Ch., 2002. Writing and the Ancient State: Early China in Comparative Perspective. Cambridge University Press, Cambridge.
Wang, X.F., 2016. Hubei Zaoyang Jiuliandun yi hao mu pijia de fuyuan [Reconstruction of the leather armours from Jiuliandun tomb no 1 in Zaoyang, Hubei]. Kaogu Xuebao 3, 417–444 (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., 102576.
Xinyang Cultural Relics Management Committee, Gushi County Cultural Bureau, 1981. Gushi Baishizidi yi hao he er hao mu qingli jianbao [Short investigation report on tombs 1 and 2 from Baishizidi, Gushi]. Zhongyuan Wenwu 4, 21–28 (in Chinese).
Yang, H., 1976. Zhongguo gudai de jia zhou – Yin Shang-San Guo [Ancient Chinese armours and helmets, Part I (Yin-Shang – Three Kingdoms)]. Kaogu Xuebao 1, 19–46 (in Chinese).
Yang, H., 1978. Jia he Kai – Zhongguo gudai junshi zhuangbei zhaji zhi san [Armour and harness – Notes on ancient Chinese military equipment]. Wenwu 5, 77–83 (in Chinese).
Yang, H., 1992. Weapons in Ancient China. Science Press, New York, Beijing.
Zhang, G.D., Rong, X.J., 1998. A concise history of the Turfan oasis and its exploration. Asia Major, Third Series 11.2, 13–36.