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## EARLY METALLURGY IN PARTS OF EURASIA

The history of Late Bronze Age copper-producing cultures in Eurasia – bordering on Scandinavia in the west and China in the east – and the occurrence and chemical composition of certain copper-base artefacts have been studied. The domestication of the horse and its use as a mounted animal brought the contacts of far-away situated cultures closer and contributed to the spread of artefacts. The close similarity, in manufacturing techniques and shape, of some Bronze Age artefacts such as horse-heads, bridles and knives often decorated with animal-motifs, has been observed. There are indications of an early transmittance of bronze artefacts over this vast region.

In this short study I wish to present some data concerning the chemical compositions of early copper-base artefacts, allowing for the fact that they are few and hardly representative either chronologically or chorologically. In addition, I will point to the emergence of certain copper and bronze artefacts in different parts of Bronze Age Eurasia, which could possibly indicate long distance communication. The significance of the equestrian as a disperser of artefacts is emphasized.

### Early use of copper and bronze

The question of whether knowledge was diffused from *one* area or the result of independant discoveries in *several* areas with regard to the shaping of native copper, the extraction of copper from the ore, and its alloying with tin, has long been the subject for unrelenting discussion. Among the diffusionists in metallurgy can be named Coles & Harding (1979), Tylecote (1987:14, 92), Muhly (1988:2–20) and Chernykh (1992). Upholders of the idea of sporadic local inventions are Craddock (1990:71), at least concerning the British Isles, and Renfrew (1993:181), who accepts a Balkan origin centre but rejects the concept of the diffusion of metallurgy through large-scale migrations.

Researchers agree that the finds of hammered objects of pure copper made in Cayönu Tepesi, Anatolia (Cambel & Braidwood 1983:157) dated to the eighth millennium BC, and in Catal Hüyük, Anatolia (Mellaart 1967) from the seventh millennium BC, comprise some of the oldest copper artefacts created. According to present knowledge from excavations and revised dating

methods, similar artefacts were not used or produced in Scandinavia or China before the fourth millennium BC (fig. 1).

Why then, allowing for the possible unbalance of excavated areas, did the first Old World copper-producing societies develop in Anatolia? The climate at that time seems to have been more humid (Moore 1979), rendering the river valleys fertile and inhabitable. The highland areas were rich in minerals, and access to fuel in the form of bush- and shrub- vegetation facilitated both the annealing of native copper and the extraction of copper from easily reduced oxides and carbonates. Once the vegetation supply was exhausted in one place, the miner was forced to move on to the next mineral deposit. Climate and geological conditions have thus contributed to the development of copper-using cultures.

It has long been anticipated that the Copper Age was succeeded by cultures which produced copper/arsenic alloys. It was earlier believed that arsenic was purposely added to transform the soft pliable copper into a hard tensile product, making it suitable for the production of tools and weapons. However, recent research (Rapp 1988:35; Chernykh 1992:17) shows that up to 5–7% arsenic can have accompanied native copper from the ore and thus cannot be regarded as purposely added. Larger amounts however, could well be intentional additions. The annealing of native copper containing arsenic will not cause the arsenic to evaporate at temperatures between 200° and 400°C (Tylecote 1987:93). Budd (1993:35–36) observes that a primitive technology where arsenic-bearing secondary copper ores could be smelted at a lower melting point because of the high con-



Fig. 1. Anatolian sites with early copper finds, pre-5000 BC. After Moore 1985.

tent of arsenic, could have resulted in the Early Bronze Age arsenic-rich cast axes found in the British Isles.

However, tin-bronze containing more than 2% tin must be regarded as intentionally alloyed. Tin occurs naturally in mixed copper-ores, seldom in native copper, and only c. 2% can remain in refined copper (Buchwald & Leisner 1990:95). Tin was mined in Anatolia probably in such amounts as met current demand during the Early Bronze Age (Yener 1989:244, 1990).

Copper and bronze artefacts are common in the archaeological material from the whole of Eurasia but from periods later than the early finds from Anatolia. In his recently published book *Ancient Metallurgy in the USSR*, Chernykh (1992) discusses how copper artefacts and the knowledge of copper extraction and of alloying with tin, have throughout millennia continuously spread from their area of origin in Anatolia.

Chernykh has endeavoured to find a method by which he could identify the origin of ore for groups of artefacts displaying similar trace-element composition. His research is based on 50,000 chemical analyses that allow him to combine the results from ore, slag and copper analyses from one and the same known locality, with results from the same in other areas. Several metallurgical areas have produced these prerequisites. Archaeological, chronological and geographical/geological data have been treated statistically and computerized. Thanks to this extensive material, a connection between the copper and the ore, seems often to have been revealed.

One multiplex question that occupies many researchers, concerns whether the knowledge of extraction and production of copper and copper artefacts spread via prospectors and metal-workers or via conflicts and migrations, or, as a third alternative, were local cultural innovations. Probably all dispersion traits worked simultaneously. Perhaps too, "local" cultural innovators received impulses from outside their own area. In the future, with the aid of newly published results from the whole of the former Soviet Union, it will, if not be easier because the material is complex, at least because of the broad range of material, be possible to discern from where, and when, similar groups of copper-base artefacts such as bridles and knives spread throughout Eurasia. In my study, the main emphasis is on potential continuous short- and long-distance communication over the vast

area of the former USSR into Scandinavia on the western, and China on the eastern, periphery. Thus Europe south of Scandinavia is not included in this study. The significance of the equestrian as a disperser of artefacts has been noted by Anthony et al. (1991:48). It has long been recognized that contacts with nomadic steppe tribes may have brought about the adoption of horseback riding in China, as well as the introduction of exotic animal-motifs in bronze casting (Bunker 1983:84).

### Artefacts selected for this study

I have chosen to study the available results of chemical analyses made on Bronze Age artefacts, and the occurrence and shape of mostly Late Bronze Age

- bronze horses and bridles
- bronze knives.

For Scandinavia, I have followed the traditional typological sequencing and dating system introduced by Montelius, despite some of its shortcomings as mentioned by Gräslund (1974:174–192) and Coles & Harding (1979:278–281). Additional systems have been followed for Eurasia (Chernykh 1992:54–56) and China (*The Great Bronze Age of China* 1980).

The application of artefact-shape comparison is based on the idea of diffusion. On the whole, it is difficult to theoretically pin-point cultural diffusion. Often it has been easier to accept indigenous developments. For example, Malmer (1975:106, 116–118) stresses that the Battle-Axe Culture is a "native Scandinavian handicraft tradition". He sees no influence from outside and observes that it would be very hard to prove such a development. He then puts forward criteria which in certain circumstances might provide evidence of an immigration of the Battle-Axe culture into Scandinavia. However, to follow these rigorous criteria would, according to Malmer, be both complicated and time-consuming.

In my study, I have observed the physical occurrence of similar, often almost-identical, artefacts, throughout a vast region. The similarity of these artefacts can indicate diffusion from one area to another. The spread of these artefacts may depend on several circumstances, everything from plundering, to the peaceful breaking of new ground. My present goal is to shed light upon the existence of contact and communication through the spread of artefacts of almost identical shape and manufacture throughout this area.

### Bronze Age chronology

As mentioned earlier, numbered among the first copper artefacts made, c. 7000 BC, are those found in Anatolia. Considerably later, by several thousand years, probably spreading originally from metalworking Anatolia, copper was worked in the Carpatho-Balkan, Caucasus, Ural, Lake Onega, Sayano-Altai and Transbaikalian areas (Chernykh 1992:7). The copper mine in Tonglushan in

the Hubei province in China (Baoquan et al. 1988:125–129) was worked at least from the end of the second millennium BC, well into the first century AD. Hardly anything is yet known about any early existence and use of copper in China. Early metalworking in the greater part of Asia Minor, in the Alpine region, Transylvania, in Spain and the British Isles, is also documented (Coles & Harding 1979; Tylecote 1987).

### *Asia Minor*

*The History of Iran* by Ghirshman was first published in 1951 but has since been updated. It gives a condensed overview of the more important events that have taken place in the densely settled parts of Asia Minor, from c. 4000 BC down to the conquest by Islam. Many events are only partly recorded, which is unavoidable in a work spanning such a long period of time and using a material which is partly difficult to decipher.

Asia Minor's rich sources of native copper, as well as different types of easily refined copper oxides and carbonates, were exploited at an early stage for the production of weapon, tools and jewellery (Ghirshman 1978: 34). Iran was situated in the middle of a network of important trade routes that connected the western part of the Old World with its eastern part. Akkadian writing was probably employed relatively early, and monumental reliefs depicting battles and conquests, carved high up in the rocks along the caravan routes (Ghirshman 1978:56) provide evidence of impressive deeds. The Akkadian empire, which was at its peak of prosperity around 2200 BC, could, according to new research (Weiss et al. 1993), have collapsed because of a climatic change, a dry spell, in the upper Euphrates-Tigris area resulting in massive immigration into the lowlands.

During the second millennium BC, small groups of presumably Indo-European peoples, the Hittites, probably from the south of Russia, seem to have invaded Asia Minor. The Hittites conquered northern Mesopotamia and Zagros and finally threatened Egypt. These peoples, famous for horse-taming, also left written information about the breeding and training of horses. One branch of these mounted warriors penetrated south of the main caravan route crossing Zagros, and settled among, and were assimilated by, the Kassites in an area which later became known for horse-breeding. A still more easterly branch of the Indo-Europeans forced their way over the Hindu-Kush mountains and penetrated into India (Ghirshman 1978:60–63). Renfrew (1993:134–136, 207–211, 265–266) discusses the movements of the Indo-Europeans from the linguistic point of view, and avoids the idea of language being transmitted through large-scale migrations, but envisages its spread by successive waves of new generations occupying new land.

The Kassites seem to have conquered Mesopotamia around 1700 BC and controlled the area for over 500 years. The horse had a sacred status (Ghirshman

1978:64–65). During the second millennium BC, the rich sources of precious metals in Iran, contributed to its dominant position; that which also made the influence of Iran along the trade routes to India possible (Ghirshman 1978:72).

Towards the end of the second millennium, another forceful expansion of Indo-Europeans from the south of Russia into Iran seems to have followed earlier patterns of migrations. Again Asia Minor was devastated. In the 12th century, the Indo-Europeans forced their way into the Greek archipelago and destroyed the dominance of the Hittites. They arrived in boats bringing cavalry and chariots, and again Egypt was threatened. They were, however, defeated and were driven away and settled in Palestine and Syria. These peoples, the Philistines, were probably shepherds and nomads and above all expert riders and skilful horse-breeders. For several centuries, groups of mounted warriors from the Eurasian steppes flooded Asia Minor and Europe (Ghirshman 1978:73–76).

The burial mounds, kurgans, of the mounted ruling class, contain weapons, harnesses and tools, some made of iron. But iron implements did not become widespread until the ninth to seventh centuries BC. The Assyrians tried in vain to control the iron-rich areas in Urartu and also to hold off the invading mounted peoples. They, the Assyrians, were forced to adapt their military organization to meet these mounted attacks. Before the reign of Assurnasirpal, 884–860 BC, cavalry had not been used in the army, only light chariots, which were however ineffective against mounted warriors or in mountainous areas (Ghirshman 1978:87–89).

Towards the end of the eighth century BC, hordes of mounted warriors, Cimmerians and Scythians living in the Crimea area, plundered land south of the Black Sea. The Scythians settled close to Lake Urmia. Again, around 650 BC, Cimmerian and Scythian warriors laid waste Asia Minor, but were halted at the borders of Egypt (Ghirshman 1978:96–99).

Novelties and adapted cultural traits spread constantly also northwards from Asia Minor into the Asian steppes and finally into Scandinavia and China, as indicated by artefact finds in the archaeological material.

### *Eurasia*

Scandinavia and China form the two peripheral extremes in that immense area called Eurasia. Little was known about early cultures and metallurgical centres inbetween these extremes, that is in the former Soviet Union, until Chernykh (1992) published his *Ancient Metallurgy in the USSR*. I have employed Chernykh's (1992:2) system for Bronze Age chronology pertaining to copper-base artefacts in the area of the former USSR (fig. 2). Chernykh points out that only the major successive stages of the chronological and territorial distribution of early coppers are shown and that the boundaries between some of these are often conditional especially because of discrep-

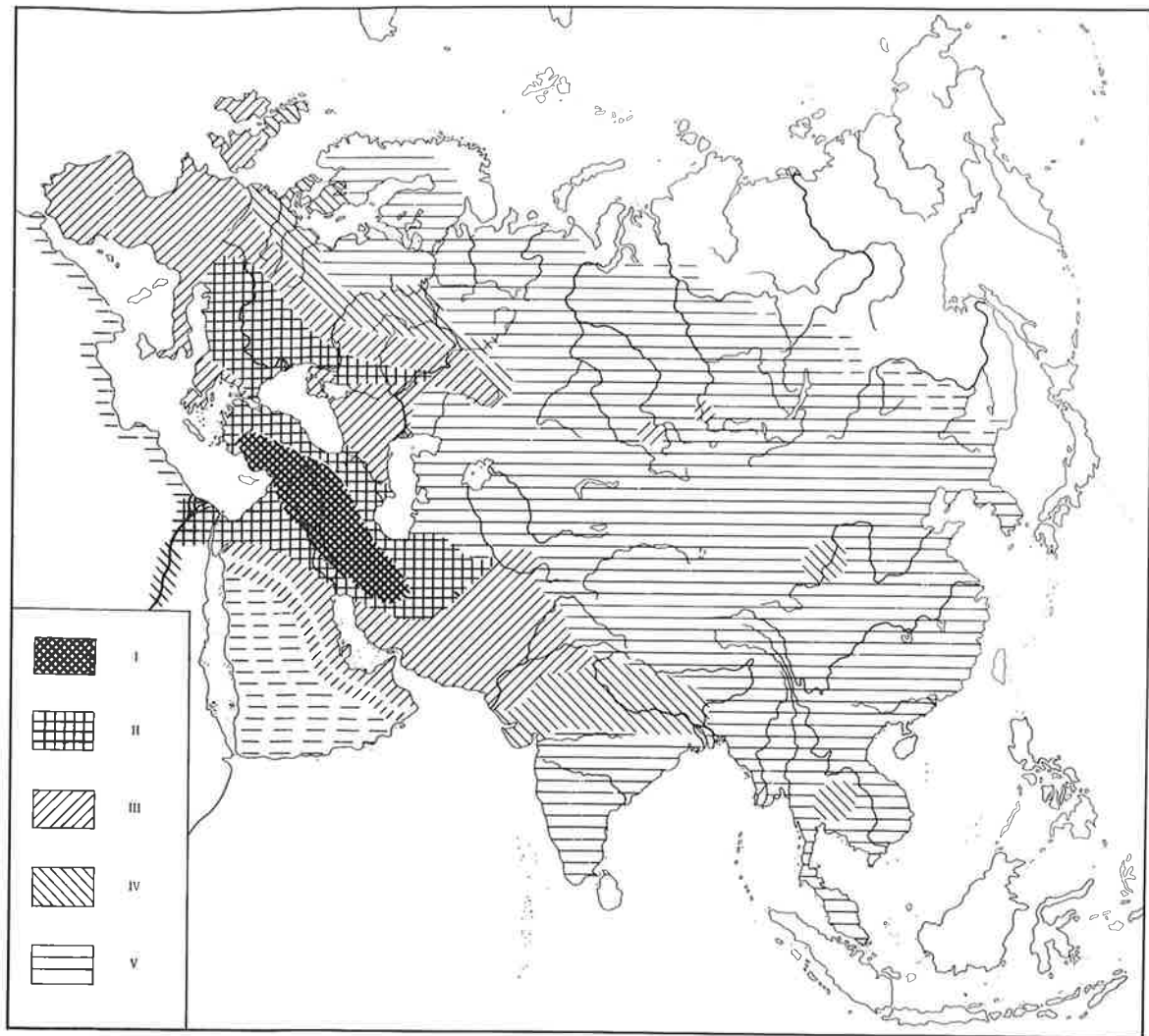


Fig. 2. Successive stages in the distribution of copper and bronze artifacts in the Old World. After Chernykh 1992, p. 2. Conventions: I = seventh to sixth millennium BC; II = fifth to first half of the fourth millennium BC; III = mid-fourth to first half of the fourth millennium BC; IV = mid-third millennium BC to the eighteenth, seventeenth centuries BC; V = sixteenth, fifteenth centuries BC to the ninth, eighth centuries BC

ancies in different dating systems.

For the Copper Age period, where Anatolia is the oldest copper producing culture, and the Early Bronze Age from c. 4500 BC, Chernykh (1992:54–56) defines a large copper-working area, which he calls the Circumpontian Metallurgical Center. This consists of many small copper-working localities reaching from the Balkans and Carpathians in the west, to the Caucasus in the east, from Anatolia in the south, to Ukraine, middle Dnjepr and the southern Urals in the north (fig. 3).

Chemical analyses show that it was probably during the Late Bronze Age that the rich sulphide copper ores in the Caucasian region were first worked (Chernykh 1992:60), indicating that the refining technique had not been mastered previously.

In northern Caucasus, Kuban and western Transcaucasus there are several large mounds, kurgans, from the Early Bronze Age, the largest being in Maikop from which that culture got its name. These contain ex-

trremely rich treasures of gold, precious stones, polished flint-axes, flat copper axes and thin-walled cauldrons, swords and knives and also objects of lead and zinc. All copper objects are arsenic bronzes. The inhabitants of this area are understood to have been horse-breeders, not metallurgists (Chernykh 1992:67–83).

The East-European steppes, spreading from Moldavia to southern Ural, contain settlements where 80% of the excavated dry-bone material comprises horse. The majority of the Bronze Age tools in that area are made of annealed extremely pure copper. Flat copper axes occur here (Chernykh 1992:86–90). The nomads and agriculturalists who during the Bronze Age buried their dead in kurgans can also have employed specialists in bronze-working to judge by the occurrence of many “smiths’ graves”.

Further north, close to the Ural area, the Fatyanovo-Balanovo culture has produced many finds of polished battle-axes of stone and corded-ware ceramics (Mongait

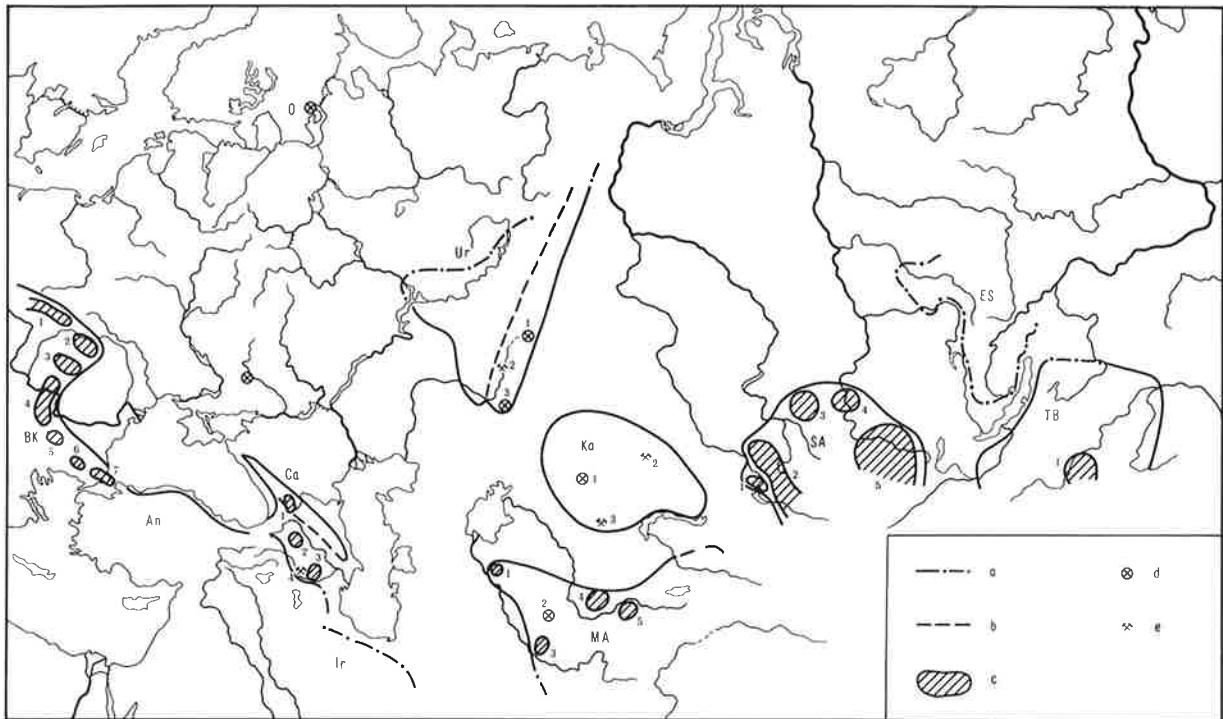


Fig. 3. The most important metallurgical regions (MMR), mining and metallurgical centres (MMC), and isolated mining districts. After Chernykh 1992, p.5.

Conventions: a = boundaries between MMRs; b = boundaries between the principal zones of activity of ancient mines; c = MMCs; d = local groups of ancient mines; e = isolated ancient mines; An = Anatolian MMR; BK = Carpatho-Balkan MMR; Ca = Caucasian MMR; Dn = Donet copper bearing sandstones; ES = Eastern Siberian MMR; Ir = Iranian Plateau MMR; Ka = Kazakhstan MMR; MA = Soviet central MMR; On = Mines near Lake Onega; SA = Sayano-Altai MMR; TB = Transbaikalian MMR; UR = Ural MMR.

1970:142), which indicate contacts with the Baltic area as well as with the Carpathians. Chemical analyses link the ores in the Urals with finds of copper artefacts that seldom contain arsenic, either during the Early or Middle Bronze Age (Chernykh 1992:135, 157).

During most of the Bronze Age, copper was annealed, melted, or cast, at a multitude of localities, but most was produced in Asia Minor, the Carpathians, Caucasus, and Balkans, according to Chernykh (1992:145–162).

During the Middle Bronze Age, an increase in bronze artefacts is observed together with their occurrence in “new” areas, while some “older” areas become void of finds. Tools and weapons receive new shapes and functions. New deposits worth mining are discovered in Ural, Kazakhstan, east Ukraine and around the northern valley of the Donets. Tin is extracted in Central Asia in Zirabulak-Ziyayetdin. Copper is now mostly alloyed with tin except in the European region, where artefacts made of pure copper prevail (Chernykh 1992:190–200).

During the Late Bronze Age, copper-producing and metallurgical centers occur in a wide belt all over the Eurasian steppes, as far as Mongolian Altai close to China (Chernykh 1992:192).

The Seima-Turbino culture, c. 1400–1200 BC, belonged to a nomadic people who, during a comparatively short period of time, migrated over a wide area from the west of Siberia via the Urals to eastern Europe. Probably groups belonging to this culture also moved in the re-

verse direction. These rather small groups of people brought about metallurgical innovations such as a new type of fixture for axe shafts, the “shaft-hole axe” (Chernykh 1992:215–233), and single-edged, curved knives often furnished with a handle crowned by an animal. They seem to have used mass-produced weapons. Four groups of alloys have been defined: arsenic/copper, tin/copper, copper/silver and silver/copper, the last two probably emanating from the Urals. Simultaneously, a rapid metallurgical development took place in the northern Balkans and the Carpathians, probably owing to influences from Mycenae. The period is characterized by East-European copies of Carpatho-Balkan weapons, as well as imports from that area (Chernykh 1992:215–233).

Burials were still taking place in kurgans. Chieftain-mounds in the Seima-Turbino culture, which earlier contained large four-wheeled wagons have now light-weight two-wheeled chariots with wheels measuring approximately 1 m in diameter. The interred person is often surrounded by several horses.

During the Late Bronze Age, from c. 1000–900 BC, burials in kurgans cease. The production of metal artefacts (now mostly found in hoards) are concentrated to the areas north of the Black Sea and extraction of copper takes place around the northern valleys of the Donets, Ural, Kazakhstan, etc. (Chernykh 1992: map p. 238). Tin-bronzes are found mostly to the west of the Urals

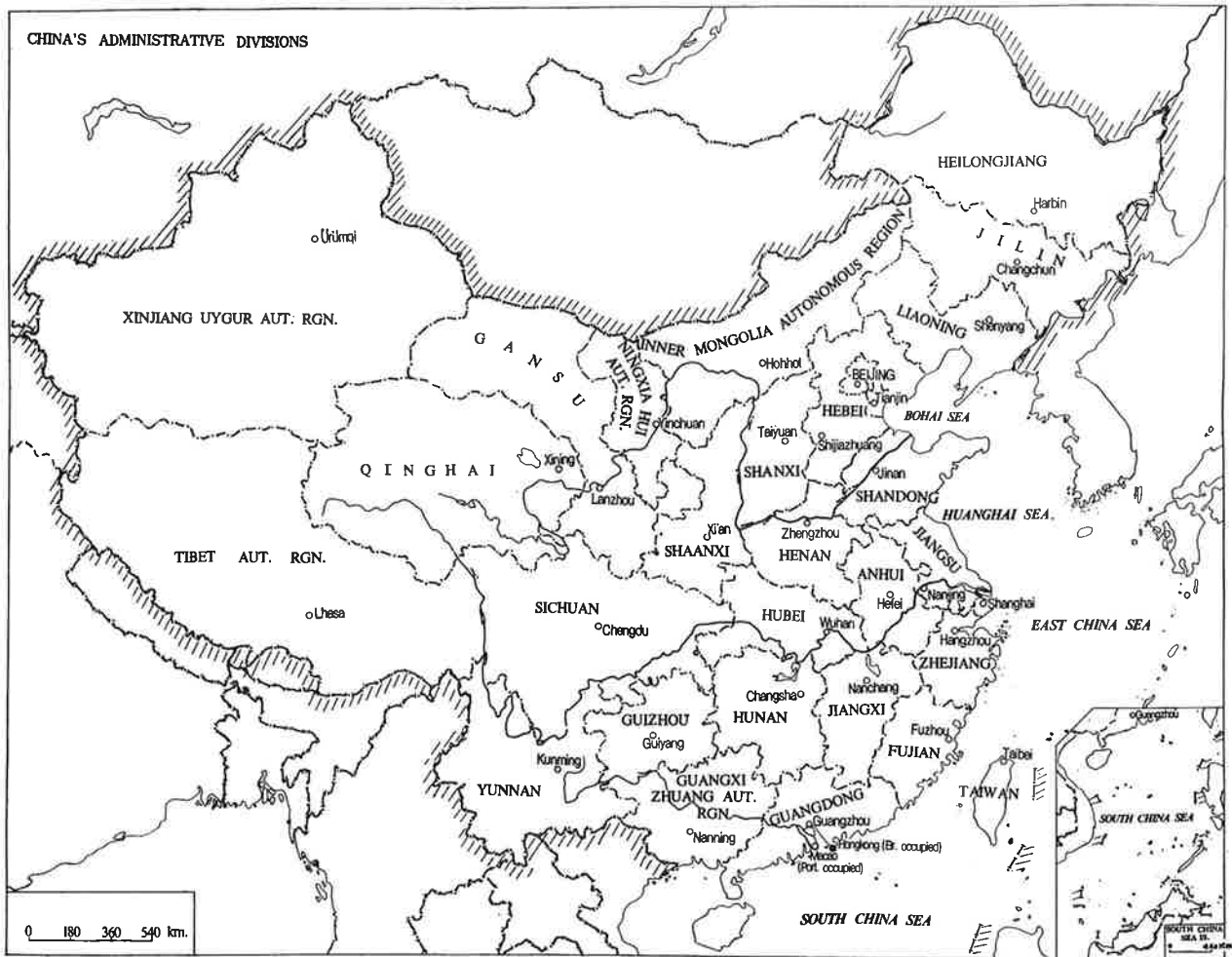


Fig. 4. Map of Chinese Provinces (after Appendix to *The Great Bronze Age of China*, 1980).

while pure copper and arsenic/copper bronzes are more common east of the Urals, thus indicating two main zones. The production of weapons and tools is concentrated to the European zone. These are characterized by a clear uniformity of shape but a wide variety of functions. All are tin-bronzes and chemical analyses indicate that these metals were extracted in the rich multi-metal area of Transylvania (Chernykh 1992:252–255).

The chorology and chronology of the extraction of copper and the production of copper-base artefacts during the Late Bronze Age is still not sufficiently studied in this area. Yet wide-spread cultures have been identified. In the west, lie the Irano-Afghan and Caucasian provinces, and in the Far East, the Central Asian province bordering Mongolia. In the latter province we find the Karasuk culture known for its monoliths with carved representations of weapon-bearing warriors. This tradition of erecting carved stones reached the Balkans during the Early Iron Age. The Karasuk culture is also known for its curved knives and folding-knives with handles made from bone, and also special bronzes, possibly yokes for horse or oxen. Similar knives and yokes are also found in Chinese cultures and reflect encounters between the sedentary Chinese population and Asian nomads. Chernykh

stresses that many of the traits in the Shang culture, such as bronze-metallurgy, horse-breeding and war-chariots, probably came about through contacts with western cultures during the second millennium BC. The bronzes found in the Karasuk culture are mostly of arsenic/copper. Only 15% are tin-bronzes (Chernykh 1992:265–271).

### China

There is a rich literature on the shape, decoration and inscriptions of Chinese ritual vessels, but comparatively little research has been carried out on metal objects preceding the periods of these ritual vessels. This may be the result of lack of interest by researchers and collectors, earlier often foreigners, leading to the existence of only a few collected assemblages of early copper artefacts. The lack of early coppers, such as tools, could also be due to a real absence of these artefacts in China.

However, modern researchers now question the absence of an early formative metallurgical period in the Chinese Bronze Age. Metal production seems to originate during the Shang Dynasty (table 1) with already fully developed, complicated cast vessels, where shape and

<i>Xia Dynasty ca 2100–1600 BC</i>	
Erlitou Culture	1900–1600 BC
<i>Shang Dynasty 1600–1100 BC</i>	
Erligang Culture (Zhengzhou phase)	1600–1400 BC
Yinxu Culture (Anyang phase)	1300–1100 BC
<i>Zhou Dynasty 1100–256 BC</i>	
Western Zhou	1100–771 BC
Eastern Zhou	770–256 BC
Spring and Autumn Period	770–475 BC
Warring State Period	476–221 BC

Table 1. *The Bronze Age chronology of China. After The Great Bronze Age of China 1980, p. xv*

decoration find no parallels in any other archaeological artefacts outside China (Muhly 1988:4; Franklin 1983:98). Late finds of an awl and two pendants (Chase 1983:106) and two bronze knives from the Gansu Province are of interest. The two knives, one containing 6–10% tin, have been radiocarbon dated to the end of the fourth millennium BC and the end of the third millennium BC. Chase (1983:106–107) discusses whether these knives were made locally or were introduced. Regarding the proximity of the Gansu Province to the metal-producing nomads in Mongolia, he points to possible influences from Siberia (fig. 4).

#### Available chemical analyses of Bronze Age artefacts

Chemical analyses made by Barnard (1961:169–198) on 110 axes, swords, arrow-heads and 30 vessels from different periods, show that these objects consist of a material which is heavily alloyed with tin and lead. Only four arrow-heads are alloyed with tin alone, while two contain c. 25% and 5% lead. Two dagger-halberds are of pure copper.

Gettens (1969:48–56) presents element-analyses on 87 vessels from the Shang to the Zhou Dynasties housed in the Freer Gallery. A chronological comparison of these vessels is related to the highest, average and lowest values of copper, tin and lead. Variations of tin and lead are almost constant during most of the period, with tin ranging from 1.7–21.5%, and lead from 0.4–26%. Similar types of vessels do not show similar proportions of alloying elements, which indicates a reliance on available metals. Trace-element composition does not deviate much from the average. In a technical study made by Meyers and Holmes (1983:124) it is concluded that “no differences in casting techniques between various centers of bronze production can yet be recognized”.

Hayashi (1972:502–507) has analysed seven bronzes from the Erlitou Culture. Only one object is of pure copper, while the others are tin-bronzes, five containing less than 10% tin and 1–27% lead. Ritual vessels from the eastern Zhou contain c. 12% tin and lead. Dagger-

halberds from the Anyang Period show c. 7% tin and lead, ritual vessels of the same period contain c. 15% tin and c. 5% lead. The only conclusion which is possible to draw from all this is that tin and lead were amply available from the Erlitou Culture onwards.

Almost 100 metal objects from the Qija Culture (2200–1760 BC) of the Xia Dynasty have been analysed. More than half of the objects consisted of pure copper, while the rest were tin and lead alloys. The transition between this period of development and that of the ritual vessels is not clear. Chase (1983:119) suggests that the sudden appearance of ritual vessels and their presence for more than a thousand years indicate a ceremonial state requirement. Muhly (1988:16) has studied possible influences from South-East Asia and emphasizes that during all his archaeological/metallurgical studies of early metallurgy he has never been able to identify any missing link in technical development.

Until recently prehistoric copper extraction in China that could have been associated with the great number of excavated heavy bronze vessels was unknown. However, in 1965 a copper-mine was discovered in Tonglushan in the Hubei province. Radiocarbon datings show that copper was extracted there during the whole of the first millennium BC. The mine was excavated from 1974 to 1985. The area around the mine is covered with more than 400,000 tons of slag, containing less than 0.7% copper (Baoquan et al. 1988:125).

#### *Scandinavia*

Copper spirals and pendants from the Early or Middle Neolithic have been found in several places in Jutland, Denmark (Randsborg 1979:181–190). In Sweden, from the third millennium BC within the Battle-Axe Culture, a few sites have been excavated in Östergötland and Scania, which contained spirals and pendants (Malmer 1975:58–59). From Suovaara, Finland and Zvejnieki, Latvia, there are finds of copper rings dated to the first half of the second millennium BC (Taavitsainen 1982:41–49).

The Bronze Age in Scandinavia is usually sub-divided as follows (following Montelius 1987):

<i>Early Bronze Age</i>	<i>1800–1200 BC</i>
period I	1800–1650 BC
period II	1650–1400 BC
period III	1400–1200 BC
<i>Late Bronze Age</i>	<i>1200–700 BC</i>
period IV	1200–1050 BC
period V	1050–850 BC
period VI	850–700 BC

It is believed that possible original surface deposits of copper oxides and carbonates in Scandinavia have disappeared due to the scraping action and movement of the ice during periods of glaciation. Thus, during the Bronze Age, access to pure copper or easily smelted copper oxides extracted in Scandinavia, should have been almost



non-existent. However, on-going research in upper Norrland has shown that deep oxidation-layers of copper sulphides do exist there (Brask 1993).

Mainland Denmark lacks copper-ore minerals, but however, copper-ore deposits embedded in sandstone layers are present in the nearby German island of Helgoland in the Atlantic Ocean (Lorenzen 1965).

In different parts of Finland, stray finds of crystals of native copper, transported by glacial action, have been found (Mäkinen 1938). In 1910, a large copper sulphide ore-body was discovered in Outokumpu, central Finland, by means of systematically tracing the paths of ore-blocks moved by glacial action (Mäkinen 1938:25–33). In Karelia close to Lake Ladoga in Russia, finds of native copper have been made (Zhuravlev et al. 1981:247–250). The production of several hundred copper rings, pendants, tubes and sheets, found in that area, is supposed to have appeared spontaneously (Coghlan 1951). Chernykh (1992:189) is of the same opinion.

In Norway there are rich copper-sulphide ore deposits along the Caledonian mountain range, in Trøndelag and in Telemark. Workings of the richest ones began late: Kongsberg probably before the 14th century AD and Røros in 1644 AD (Thuesen 1979:7, 16). Native copper found in Telemark and along the Oslo Basin (Neumann 1985:2–3) could have been used at an early period (Forshell 1992:97).

The main deposits of copper sulphide ores in Sweden are found in the Skellefte fields, Norrland; in the Bergslagen area, southern central Sweden; and in Småland (Tegengren 1924). Copper may have been extracted in Falun, Dalarna, already during the Vendel Period (Eriksson & Quarfort 1992), but the first historic date is from 1288 AD (Wessén 1947:29, 95).

Coles & Harding (1979:281) assume that there would have been little if any production of copper objects consisting of copper extracted in Scandinavia at least during the Early Bronze Age. However, in addition to the already mentioned research project in upper Norrland, another project regarding possible prehistoric mining and smelting of copper ores is presently being carried out in Tjust, Småland (Gunborg O. Janzon forthcoming).

#### Available chemical analyses of Bronze Age copper artefacts

One hundred and twenty-two copper axes excavated in the south of Sweden have been chemically analysed by AB Analytica, Stockholm. Eleven flat axes from the Early Bronze Age contain more than 98% copper, five of them have c. 1% silver and an arsenic content of c. 1%. The axes possibly consist of arsenic-rich copper ores smelted in a primitive way at low temperatures (Oldeberg 1976, II:120–123). Depending on the component part of arsenic, which lowers the melting-point, arsenic-rich coppers could probably be produced (Pollard et al. 1990:72–74). The remaining flat axes, flanged axes

and palstaves are tin-bronzes usually with a tin content above 3% and lead content below 1%. Two axes (replicas?) have 29% and 9.6% zinc and 2–4% lead.

Twenty-one flat axes found in the south of Sweden were analysed by Junghans and others (Cullberg 1969). They proved to be of copper with high amounts of arsenic, yet only one axe contains arsenic above 5%. The remaining 14 axes contain arsenic, silver, nickel and antimon in amounts of c. 1% of each element. Only two flanged axes contain more than 1% tin (2.4% and 7.3% tin).

Flat axes are common in all areas of the USSR, while flanged axes seem to not occur (Chernykh 1992). Thus it is possible to note that flat axes can have entered Scandinavia from many different areas including the USSR, while flanged axes and palstaves could not have come from the USSR. The only palstave depicted by Coles & Harding (1979:235) comes from the Atlantic region of France. The majority of palstaves were found in northern Europe, France and Italy, according to Montelius (1987:35).

Chemical analyses on Danish (hammered?) copper ornaments from the Early Bronze Age, show an average content of below 0.1% silver and c. 1% arsenic, which could possibly indicate the use of native copper (Ottaway 1973). However, this pattern does not fall into any of Ottaway's two arbitrarily defined groups: (a) native copper where the only impurities are medium high values of silver, below 1% , and (b) pure copper with a high amount of different impurities but with low concentrations except for silver and arsenic, which are c. 1%.

Randsborg (1979:303–318) has discussed the axes made of pure copper found in Denmark, in relation to their distribution and function around 3000 BC and the scanty occurrence of axes during the third millennium. At that time these axes were high in arsenic and low in silver. He assumes that copper axes functioned less effectively in practice than flint axes and proposes that the copper axe had only a symbolic function which required their withdrawal from circulation by burial. He concludes: "We believe that they all [the axes] served the same purpose in the social exchange and that they were not needed later. It is difficult to explain that copper mining should otherwise have declined so drastically." However, according to Chernykh (1992:5), technical experiments have repeatedly shown the effectiveness of copper as superior to stone. Still, the effectiveness of copper over stone does not exclude a possible symbolic role for the copper axes. The most likely explanation for the scarcity of copper axes during the third millennium in Denmark is probably that the production and distribution of axes made of pure copper during Neolithic times ceased because the copper-ore body from a certain area, copper characterized by high purity (as in the Bygholm find), was exhausted, or the axe and copper trade was interrupted by conflicts, or other causes. Findings from later periods, where the copper contains several impuri-



ies, indicate that the later copper came from a different ore-body. Interruption of the extraction and transportation of the possible main exchange commodity, flint, may have been another hinder to access of material.

Ten axes and two lurs from the Bronze Age in Denmark have been chemically analysed (Buchwald & Leisner 1990:64–102). The results are summarized as follows: “The analytical data and the structural observations let us vaguely distinguish five groups, more or less overlapping in time; a/ Cu–As–O, b/ Cu–As–S, c/ Cu–As–low Sn–S, d/ Cu–As–high Sn–S and e/ Cu–high Sn–S–Pb. This development occurs over about 2800 years in our area, from about 3500 to 700 BC.” None of these objects are believed to consist of native copper. Apart from the changes in metal structure and composition caused by casting, cold-working and corrosion attack, the element composition of the artefacts indicated that the raw-material was derived from several ore-bodies.

Thus the chemical compositions of the early coppers and bronzes found in Scandinavia point to an extraction of ores from several different areas.

## Bronze bridles

### *Asia Minor*

Luristan, situated between the Caspian Sea and the northern part of the Persian Gulf, is known for its very rich burial finds of high quality bronze and iron artefacts of unusual shapes, characterized by animal ornamentation. Probably these artefacts were produced during a period of several hundred years, possibly between 1200 and 600 BC. They are believed to have belonged to an elite of mounted nomads, since no settlements have been found in the area (Ghirshman 1978:99–105, Porada 1965:71–75). Famous are the bronze bridles made of two cheek-pieces shaped like stags, lions or horses, etc., attached to a movable but rigid mouth-piece. The cheek-pieces were cast in moulds, with relief figures on only one side (Muscarella 1988:155–157). There seem to be no such finds from the USSR. However, animal-style decoration is common all over Eurasia. Representations of Luristan cheek-pieces can be found in Porada (1965:82), Burney (1977:188), Arne (1962:12–13) (fig. 5) and Oldeberg (1976, II:129–130).

A large number of such cheek-pieces, sold to private collectors and museums all over the world, come from clandestine diggings. Thus it is difficult to establish if any of them were found outside Luristan (Muscarella 1988:155–157). Rostovtzeff (1931:49) maintains that the bridles were made with the sole intention of being used as burial gifts. Muscarella (1988:157) on the other hand, points out that some of the mouth-pieces show signs of wear which indicates a practical use.

Simple functional bridles of bronze, where the mouth-piece or bit has a central joint and terminates in a ring on each side, have been found in many places. The straight

cheek-pieces are either cast in one with the mouth-piece or cast separately. Representations of such bridles from Late Mycenae can be seen in e.g. Przeworski (1939:pl.XII:3). One probably employed for breaking-in wild horses, from Persepolis c. 500 BC, is published by Ghirshman (1978:178, 180) (fig. 6).

### *The area of the former USSR*

The “runners for the reins” animal style from c. 800 to 700 BC was found in Bixe, Central Asia (*On the Silk Road* 1986:23) (fig. 5). Also in animal style are the wooden cheek-pieces from c. 500 BC from Pazyryk, High Altai (*Frozen Tombs* 1978:71), a motif style with traditions in many parts of Asia (Bunker 1983:90). From burials in Koban, Caucasia, of the Late Bronze Age (*Avant les Scythes* 1979:166, 185) bits occur with simple slightly bent cheek-pieces and cast holes or loops for reins, similar to those from Troy (displayed in the Archaeological Museum in Istanbul). A Late Bronze Age bit from Artik in Transcaucasia (Chernykh 1992:287) has a somewhat different construction.

### *China*

In the material available from China, no single cheek-piece or bit has been published. However, in 1969, bronze statues of horses with bridles, chariots and equestrians, were unearthed in the famous burial from c. 200 BC in Wu Wei, in the province of Gansu (*The Chinese Exhibition* 1975:no. 228). These cheek-pieces are S-shaped.

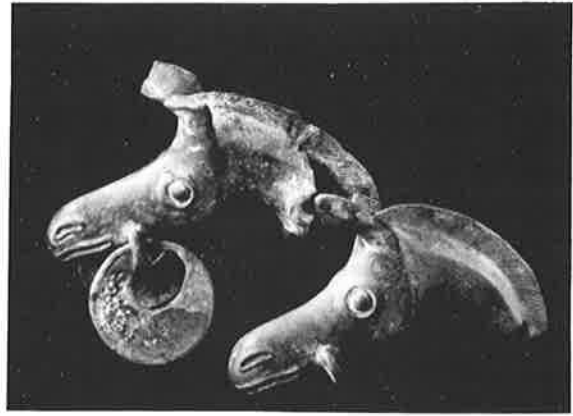
### *Scandinavia*

Examples of Bronze Age copper or bronze draught-animals found in the Nordic countries are very sparse. The often depicted “horse” in front of the Trundholm sun-wagon, from Denmark, is dated to c. 1200 BC by Brøndsted (1977:225), to c. 1400 BC by Levy (1982:6), and Period III–IV according to Montelius. Brøndsted describes the horse as small, roundish and sleek, a thoughtful little character, a horse in budding (“... spinkel, trind og glat, et alvorsfuldt lille væsen, en hest i knop”). This is a tender description and suits the animal well. Yet, is this really a horse? To my mind it resembles more an ass or an onager, the common draught-animal in the Mediterranean Middle Bronze Age area. Two other animals (Montelius 1987:65, 42) found together with parts of a wagon, similar to the one from Trundholm, have been excavated at Tågaborghöjden, Scania. These animals too, have sleek bodies and do not resemble horses. The three animals seem to originate from similar prototypes and to represent draught-animals.

Two bronze horse-heads occurred in a hoard from Åsle, Västergötland, (Stenberger 1979:301–302). These animals resemble horses. They have loops, ends of bits,



a



b



c

Fig. 5. a) Cheek-pieces crowned by stag-heads from Bixe, High Altai. After *On the Silk Road* 1986, p. 23. b) horse-heads from Åsle, Västergötland (SHM Vgl 22470). Photo: Sören Hallgren; copyright ATA. c) horse-heads crowning a Luristan bridle (mmLur. 128) Photo: Museum of Mediterranean Art.

protruding from behind the corners of their mouths, cast jointly with the head. Round bronze plates still hang from one of the loops. Such plates are also known from Ekes and Eskelhem on Gotland (Montelius 1987:80, 97), dated to c. 500 BC. The two horse-heads seem to have been cast in the same mould. The heads are broken off from the body. The Åsle horses have Scythian-like rounded eyes. The mouth and nostrils are shaped as slightly curved lines. These compare well with the heads on the cheek-pieces from Bixe, Altai from c. 800-700 BC (*On the Silk Road* 1986:23) and those on the Luristan bridle (Arne 1962:12-13)(fig. 5).

A bridle with a rigid mouth-piece, which probably can be dated well before c. 500 BC was found at Hove, Zealand, in Denmark (*Jeg ser på oldsager* 1979:191) and two bridles, where the mouth-piece has a central joint occurred at Eskelhem (belonging to Montelius' Period II:6) (Montelius 1987:97, no. 1450). One of these has a bronze bit and pendant bronze plates, the other has an iron bit which could be a repair (Hjärthner-Holdar 1993:138-139). These compare with a bridle from Persepolis dated to c. 500 BC (Ghirshman 1978:180) and one of the same date from Pazyryk in

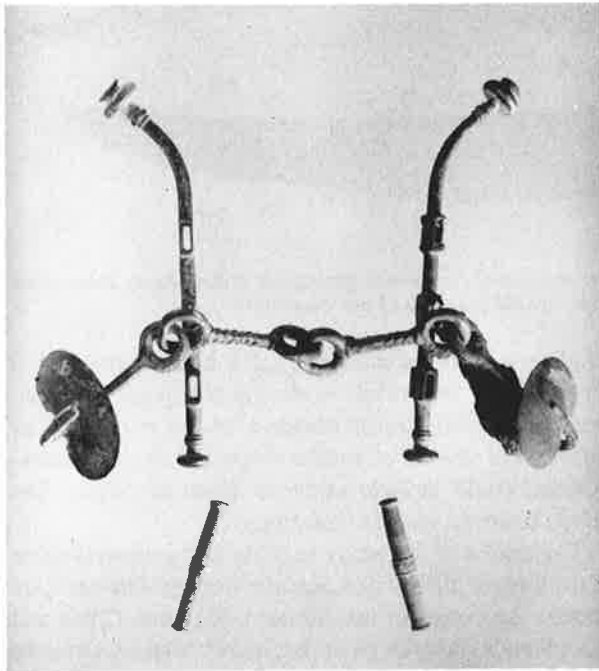
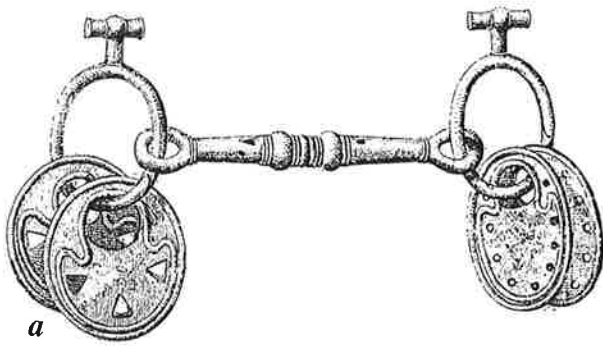
High Altai (*Frozen Tombs* 1978:70). All display a more functional stage in the development of bridles (cf. fig. 6).

### Knives

Since my aim is to identify early communication throughout Eurasia through the spread of artefacts which in all likelihood were connected with mounted nomads, the study of that easy-to-carry weapon, the knife, is another obvious choice. However, it is difficult to point to any unambiguous cultural links in the Eurasian/Swedish/Chinese artefact material dated before c. 1500 BC. Therefore, I have concentrated my investigation to Bronze Age knives of corresponding types produced after 1500 BC. I have tried to avoid the overwhelming number of knives displaying a shape typical of Greek Mycenaean influence. It has also sometimes been difficult to discern if some knives functioned rather as razors.

### Asia Minor

Knives and short daggers with wide triangular or narrow blades are frequent in the archaeological material from



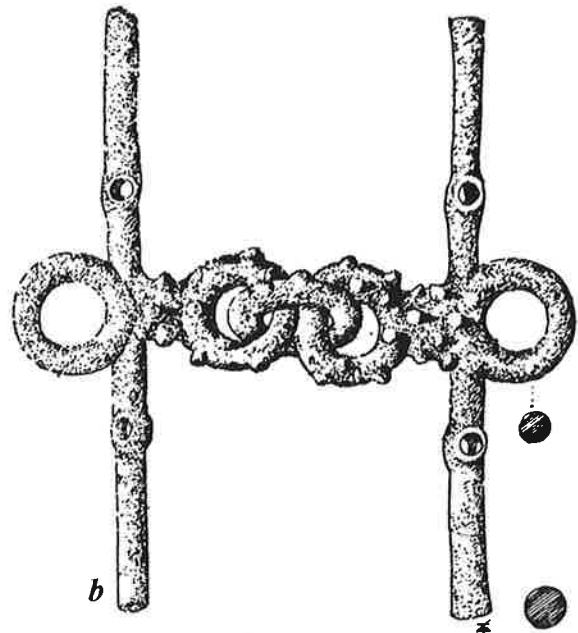
c

the Late Bronze Age onwards. Many have been found in Troy (exhibited in the Archaeological Museum in Istanbul). Other daggers with triangular blades dated to the early second millennium BC have been found in Byblos, Anatolia (Burney 1977:108).

#### The former USSR

Knives of different shapes and sizes are numerous in this area. From the Late Bronze Age, in Omsk, a dagger belonging to the Seima-Turbino culture from c. 1400–1200 BC is known (Chernykh 1992:226–228). The dagger is crowned with a skier drawn by a horse, holding a rein visible only on one side of this small 3 x 5 cm equipage. Another dagger from the same culture is crowned by two horses. These horses are related to the species which lived in Altai and in Mongolia. Late Bronze Age knives are also known from Chust, Central Asia (Chernykh 1992:245)

Late Bronze Age single-edged knives (“elbow knives”) preceded those with a slightly curved back. About 700 specimens have been found from e.g. Bidzhaulus, Kugunek, Fedorova Ulus, Krivaya and Minusinsk,



b



d

Fig. 6. Bridles from a) Hove, Zealand. After Jeg ser på oldsager 1979, p. 191; b) Persepolis, Persia. After Ghirshman 1978, p. 180; c) Eskelhem, Gotland (SHM Go7994). Length 19 cm. Photo: ATA. d) bits from Pazyryk, High Altai. After Frozen Tombs 1978, p. 70.

all in Karasuk (Chernykh 1992:266–267), and in Russian Talysh, Caucasia (Chernykh 1992:289).

Double-edged knives with handles ending in rings have been found in Karasuk and Tuva in Mongolia (Chernykh 1992:264–271). These handles have often engraved geometrical patterns, and can also be crowned by an animal head. Composite knives cast with shaft-holes or a framework intended for a cast-on handle or for bone or wood-hafting have been found in the material from the eastern Caucasian province (Chernykh 1992:286–288).

#### China

On triangular daggers from the c. 16th to 11th century BC found at Chengchow in the Honan Province, China (*The Chinese Exhibition* 1975:nos. 59, 64), the attachment for the hilt or handle is squared.

Knives with blades pointing upwards or curved, and with handles ending in rings or animal heads are numerous in China. One knife with a concave curved back is depicted in *The Chinese Exhibition* (1975:no. 63). Many knives of such types, mostly coming from the Gansu

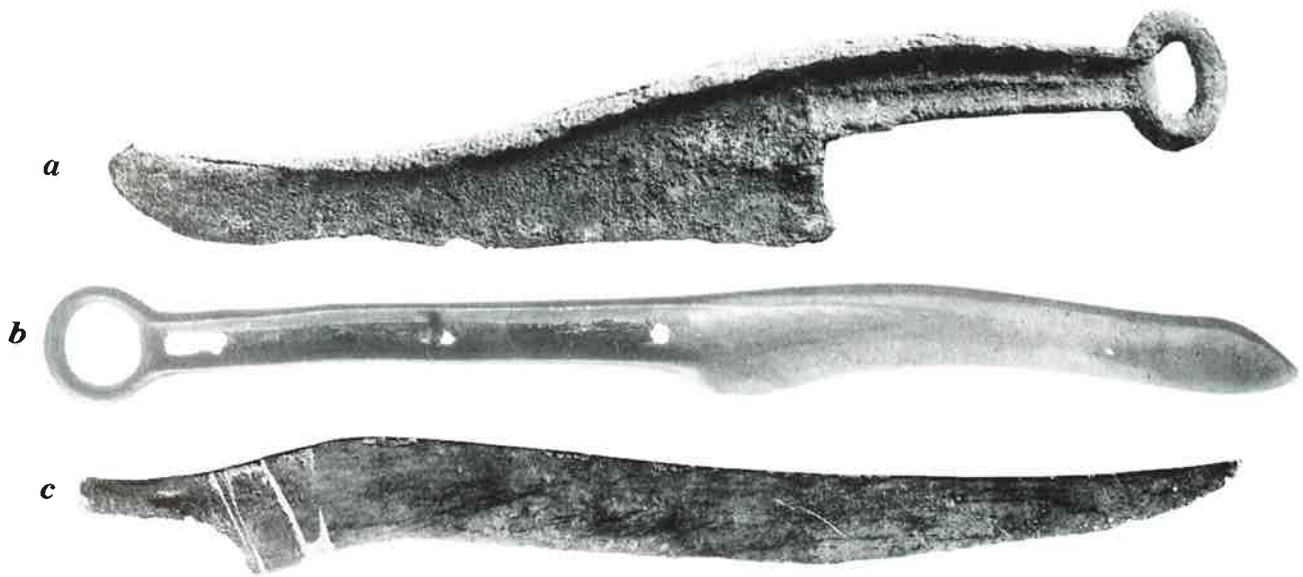


Fig. 7. Knives. a) from the Gansu Province (K 12022). Length 25.5. Photo: Museum of Far Eastern Antiquities; b) from Äspö, Skåne (SHM SK3040). Length 21.7 cm. Photo: ATA; c) from Kvarsebo, Östergötland (SHM Ög12805). Length 23 cm. Photo: ATA.

Province and dated to the Yin Dynasty, c. 1300–1028 BC, but of unknown find-place, are now housed in the Museum of East Asian Antiquities in Stockholm (Karlgrén 1945:pl. 29–32) (fig. 7).

### Scandinavia

Curved knives similar to those found in Central Asia with handles ending in a round pommel, as well as knives cast with a framework intended for bone or wood-hafting, are found in southern Sweden belonging to Montelius Periods II and III (Montelius 1987:61, 67) and in Hvidegaard, Zealand (Glob 1974 in Coles & Harding 1979:310). Such knives are also known from Hammarlöf, Scania; from Tunhem, Västergötland; and from Båstad, Halland (Montelius 1987:nos. 924, 1018 and 1019).

Antenna knives, often razors, where the handle terminates in two spirals, have been found in the Nordic material (Montelius 1987:83), and in central Europe (Beck 1980, Gedl 1981, Prüssing 1982), but seemingly not in the former USSR. A knife with handle terminating in a single ring was found in Äspö, Scania, and a similar blade was found at Kvarsebo, Östergötland belonging to Montelius Period II:5 (Montelius 1987:82, nos. 1252 and 1253). The similarity of shape and size between the Chinese knives from Gansu (Karlgrén 1945:29–32, nos. 158, 159 and 160) and the ones from Espö and Kvarsebo, may be coincidental but is indeed interesting (fig. 7).

### Discussion

The partial lack of published information on chemical analyses for some of the areas studied is an obstacle, but with the publication of further results translated into

English, a more detailed study will become possible. I have found it worthwhile to already now point to indications of the early transmittance of metal artefacts. The diffusion of objects of similar shape and chemical composition could indicate common areas of origin. The areas, however, change with time.

The results of this study indicate that communication in the form of diffusion of artefacts from Middle and Late Bronze Age areas of the former USSR into China and Scandinavia did take place but hardly directly between the periphery areas. The artefacts which are most significant, bridles and knives often decorated with animal motifs, seem to have belonged to different Asiatic nomadic, probably mounted, peoples and are mostly dated to the first millennium BC.

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