Eurasian Transfer of Knowledge vs. Eurasian Interchange of Knowledge —The Times Before Writing—

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Abstract / Summary

In light of the widely discussed issues on the modernization and industrialization of East Asia, it is sometimes overlooked that there has been a constant exchange of knowledge between East Asia and Europe. This "transfer of knowledge" during all known times was associated with the traffic of humans, animals and goods and had an input on skills and techniques, too. And it were not only goods, skills and knowledge, but religions, world views and cultures that were exchanged.

Thus is it productive to speak of an **"transfer of knowledge"**? Is it not rather productive to speak of a constant exchange and thus of an **"interchange of knowledge"** - and so of a steadily ongoing process of giving and taking? So is the real question what separates East Asia and Europe or what they have in common?

It is precisely this **general problem** that is to be pursued in a **special question** in time, for which there are no written sources. So it is about the **earliest history**, possibly even the origin of exchange processes between East and West, which can be achieved with most modern methods. Are the latest methods and results of archeology providing us with information on whether, as of when and in what areas, an exchange of knowledge between East and West existed before the time of writing? This question is being examined in a central region of the exchange, namely the "Oasis Silk Road" with the "bottle neck" of the Taklamakan.

The present study / presentation is only a small, highly incomplete "florilegium" − a selection of flowers. **Pilot studies with precise questions would be needed.** Such preliminary investigations and pilot studies could also

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be made for other regions **of knowledge exchange and cultural interaction in East Asia** in general.

On the **methodical side**, all methods of historiography and archeology have their specific advantages, but also their specific disadvantages. In the issue "Eurasian Interchange of Knowledge in Times before Writing", the combined results of historiography, modern archeology, and recent natural scientific and (molecular) biological archaeology are the basis for our current state of knowledge. On the long run the different methods and results from a variety of different scientific areas have to be evaluated in their meaningfulness, reach and validity for the historiography of human action.

On the basis of the **results from historiography and archeology** in the widest sense, can be assumed that there has been an exchange of materials, products, skills and creatures - animals and humans - since the beginning of the early agrarian culture in the Neolithic Age. Exchange processes in the widest sense in the later times of writing therefore seldom meet an almost untouched field. Rather, exchange processes usually build on existing cultural peculiarities, which are already an amalgam and thus an inseparable mixture of previous exchange processes.

In this sense, we do not have to speak of an "Eurasian Transfer of Knowledge", but rather an "Eurasian Interchange of Knowledge".

1. Transfer of Knowledge vs. Interchange of Knowledge: general problem

The Eurasian Transfer of Knowledge is an essential aspect of what separates Asia, especially China, and Europe - with a view to industrialization as well as with a view to modernization in general. The "Needham Question" (Tianlin, 2014), the thesis of "Great Divergence" (Pomeranz, 2000, Rosenthal and Wong, 2011) and similar questions reflect a time when Europe and East Asia continued to separate scientifically and technically.

The pre-modern forms of knowledge exchange between Asia and Europe are known in Europe through reports: since ancient times - beginning with the early Greek author Herodotus and others - into the High Middle Ages - here the famous Venetian Marco Polo must be mentioned - and the Early Modern Period - for example, through the extensive reports of the Jesuit Mission in China and Japan (Uhlig, 1986, Reichert, 1992, Frisch, 2016).

However, since the late 19th and early 20th century, we know from excavations that there must have been a lively exchange of knowledge even before we can rely on written sources.

For Europe, three examples of an exchange of knowledge in the period

before the written language can be mentioned:

- the **"man of the Tisenjoch" or "man of the Houselabjoch",** in short the world-famous **"Ötzi"**, who probably was murdered between 3.359 and 3.105 years BCE, thus more than 5,000 years ago. The genetic and technical analysis revealed his origin and the circumstances of his life. His dagger of flintstone came from Lake Garda, his copper ax probably originated from southern Tuscany (Fleckinger, 2011, Guilaine, 2011).

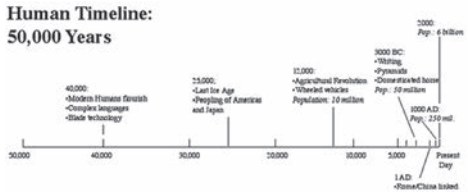
- the **"Archer of Amesbury"**, buried 2200 to 2400 BC. near world-famous Stonehenge, so about 4300 years before today. This man comes not from England, but from the northern Alpine region. His copper knives come from France and Spain (Clark, 2009, Fitzpatrick, 2011).

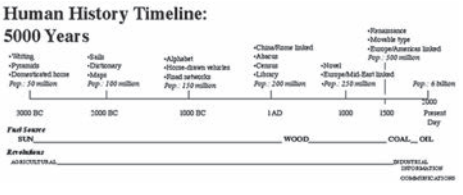
- the **"ship of Uluburun"**, which has sunk about 1,400 BC, so about 3,400 years before today, on the now Turkish Mediterranean coast. The ship transported among others red copper plates and bars (10 t), tin bars (1 t), glass bars (350 kg) and many other goods. The jewelry came from

Egypt, copper from Cyprus, cylinder seals from Assyria, weapons and ceramics from Mycenae, a sword from Sicily, amber from the Baltic Sea and glass bars from the Syrian-Palestinian area (Pulak, 1998). Various sets of scales found in this ship indicate rather civilized modes of interchange.

In all three examples, the archaeologists come to the conclusion that there has already been a widespread trade network from the early Bronze Age in Europe. In this network, not only goods, but also processing methods, for example for bronze or gold, have spread. The rare and therefore expensive tin, with which copper can be alloyed to bronze, probably originated from Central Asia at that time. Since the second millennium, tin has been dismantled along the route of the later Silk Road.

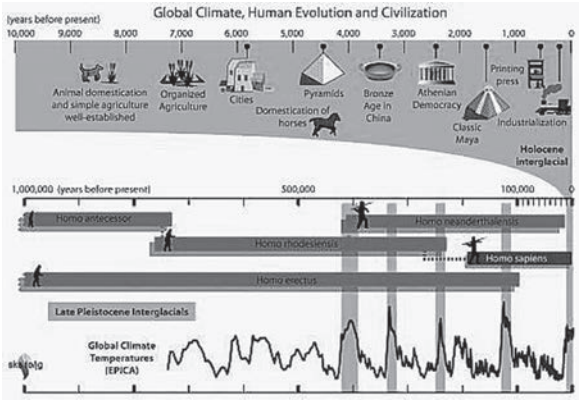
The conclusion is: in the face of the strongly discussed research questions on, for example, the modernization and industrialization of East Asia, **it is sometimes overlooked that there has been a constant exchange of knowledge between East Asia and Europe**. This "transfer of knowledge" during all known times was often associated with the circulation of goods, animals, and people, and was also affected by copying skills and techniques. And it was not only goods, skills and knowledge, but cultures, world views and religions that were exchanged.





Thus is it right to speak of a **"transfer of knowledge"**? For this means a process which goes from one side to the other – in premodern times, with such goods as silk, paper, porcelain, or tea. evidently from East to West, in modern times with weapons, then with industrial goods from West to East. Do we not have to speak of an exchange and thus of an **"interchange of knowledge"** - and thus, first of all, about a process of giving and taking, but also about a process in which, in this exchange, something new emerged that has not existed before on neither side?

It is therefore not a matter of what separates East Asia and Europe, but of what Asia and Europe have in common and what Asia and Europe have produced together for mankind.



2. "Eurasian Interchange of Knowledge in Times before Writing" - the special question

This general problem has to be subsequently addressed at least in a first attempt in a special question, in a special time, and thus also with special methods. Because of the three examples mentioned above, it must be assumed that there has been an exchange of people and goods also between East Asia and Europe, and thus also before the time of writing. So **"Eurasian Interchange of Knowledge in Times before Writing"** is the subject of the following considerations. The questions are:

- Has there been an exchange between East and West in the period before writing, which can be testified by valid methods and findings ?
- If yes, what does this exchange refer to and how long goes this exchange back in time?
- What kind of remnants and methods are used to determine the results and answers to these questions?

- What new findings have been achieved? What old findings had to be revised? What findings led to new questions?
- How can we, as historians, deal with these results and methods?
- What may be the aims of further work?

Methods of knowledge production over the past beyond the times of writing

The evidence of modern historical research is based on the remains of human activities of all kinds. In fact, historians mainly work with written sources, including (ancient) papyrus, inscriptions, coins as well as pictorial representations, objects, cloth and clothes, monuments, buildings, etc.

The methods and results of modern archeology differ considerably from these classical historiographical methods and sources. Thus, the sophisticated methods of classical excavation archeology, which are mainly concerned with the overall situation of an excavation site and its careful environmental analysis, are expanded and enhanced by recent methods as e.g.

- Underwater archeology (e.g., ships, cargoes)
- experimental archeology (e.g., weapons, machinery)
- Dendrochronology (determination of age)
- C dating for the analysis of biological materials (determination of age)
- Paleopathology - macro- and microscopic -
- radio-carbon method (determination of age)
- Microscopy, infrared and ultrasound recordings
- X-ray
- Chemical analyzes
- etc.

And as recent natural scientific and (micro-)biological methods are – among others - to mention

- aerial archeology and geophysical methods of soil analysis, e.g. by magnetic resonance, ground radar or ultra-sound (e.g., detection of hidden finds or discrete settlement traces such as foundations or posts)
- strontium isotope analysis (including exploration of origin and migration of humans and animals)
- different methods of genome analysis (origin and kinship of humans/animals/any biological remnants)
- Paleopathology - including genetic and molecular biology
- Archaeometallurgy (origin of metals, especially in alloys)
- spectroscopy/mass spectrometry (analysis of chemical, physical and biological findings)

- laser scans
- etc.

This list is not exhaustive. It is, however, easy to see that these are the most modern methods, often accompanied by a great scientific and technical apparatus, which in the widest sense can be attributed to natural sciences, (molecular) biology or medicine.

But historians are not archaeologists - and certainly not scientifically or biologically trained archaeologists. History is only an auxiliary science for archeology - and vice versa: archaeologists, technicians, molecular biologists are no historians; for historiography, archeology can be an auxiliary science. There is by no means always peace and harmony between archaeologists and historians. Lothar von Falkenhausen, a leading US-American China archaeologist, emphasizes that archeology must free itself from the leash of text-based research (von Falkenhausen, 2006, Shaughnessy, 2007): The written tradition does not cover all aspects of life - so von Falkenhausen; to this extent, archeology is more than complementary. But even with the most careful interpretation of the finds, archeology can only make conditional and limited statements - especially since the finds often come from burial grounds and therefore can represent a large part of human life only to a limited extent. Thus also the archaeological tradition does not cover all aspects of life.

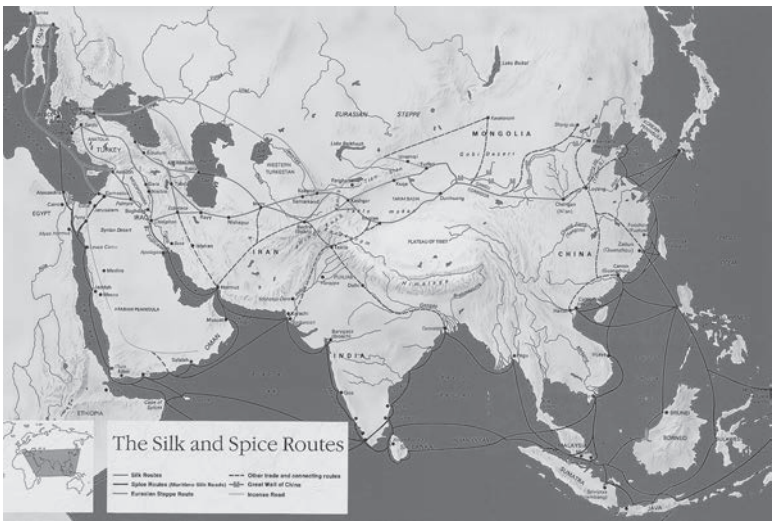
The key can therefore only be in a cooperation of both methods. And without doubt, archeology often goes deeper in the past as written sources. This is also true for the cultures which - like Egypt, Mesopotamia and also China - have developed writing very early.

And these questions are to be followed in the following steps:

What do we know from the latest results of archeology as to whether, when and in what areas, there has been an exchange of knowledge between East and West before the time of writing?

After setting out the general problem, the period and the specific questionnaire, the place where archaeological evidence are presented is to be defined. Between East and West, there are a number of famous routes, which were later labelled in a very shortening way as “Silk Road”. There should be discriminated at least four different routes:

- “Steppe Silk Road” north of Tianshan - Mountains
- “Oasis Silk Road” via Taklamakan
- “Buddhist Silk Road” via Pamir - Mountains
- Sea Silk Road



The "Oasis Silk Road" is chosen for the following considerations. In this once again widespread trading network, there is an area where all routes have to come through: this is the notorious Taklamakan. Coming from the west in Kashgar this road spreads into different routes through the Taklamakan and re-unites east of Dunhuang. In the southern arms of this "Oasis Silk Road" converge paths of the "Buddhist Silk Road". And east of Dunhuang converge also the branches of the "Steppe Silk Road", which extends north of the Tianshan and thus north of Taklamakan and flows then into the "Hexi-" or "Gansu corridor".

So also the reach of this study is defined: to search for archaeological evidence based on the methods of modern and recent archeology working with natural scientific and (molecular) biological methods gained on the "Oasis Silk Road" from the earliest known remnants to the time of the written reports on the Silk Road, that is to say until the 5th century BC.

3. Eurasian Transfer of Knowledge vs. Eurasian Interchange of Knowledge in Times before Writing – the "Oasis Silk Road"

3.1 Some preliminary methodological remarks

The literature on the Silk Road fills libraries. This mass shrinks considerably, if only those contributions are considered, which can be regarded as scientific. But also the scientific literature on the Silk Road is no longer to be overlooked and swells constantly.

From the classical - German-speaking - scientific Silk Road literature, a series of commodity trades are known or discussed (Haussig, 1983, Haussig, 1988, Klimkeit, 1988, Ptak, 2007, Wieczorek and Lind, 2007b, Höllmann, 2011, Selbitschka, 2014):

- jade from Khotan for approximately 7000 years (later also from Tai-shi: Southeast China, there are further deposits)
- ores (e.g., tin), metals, bronzes
- payments: shells, cast metals (silver, bronze), coins
- gemstones
- ivory
- silk since about 3600 BC; silk production and processing
- cotton, cotton fabrics
- ceramic products; methods of manufacture and finishing
- glass, mirrors
- (Bactrian) camels
- horses from Ferghana; horse sculptures (the famous "flying horse" of Wuwei, Gansu)
- chariots
- weapons and armor - and related tactics
- a.s.f.

But artefacts unearthed from tombs which are typical for Bronze Age archaeology in Asia are generally problematic in several respects:

- they represent a selection process, due to religious as well as economic frameworks. Moreover,
- dating is only as terminus ante quem possible, i.e. remnants found could have a considerable life-time before they were buried.
- Thus, a combination of dating methods including if possible C14 or dendrochronology should be applied, and
- many finds of silk road archaeology are probably not as old as indicated by classical archaeology
- but on the other hand some findings will be much older than assumed before.

Since the 1980/90s, the archeology of China is involved in many international archaeological projects. A special "UNESCO Silk Road Project" was already developed 1988 (http://en.unesco.org/silkroad/welcome-unesco-silk-road-online-platform). From this project numerous other cooperation projects are still continuing today, such as the Sino-German "Silk Road Fashion Project" running since 2013, which focuses on the question of communication through clothing from the first millennium BC (Wagner, 2014).

In the meantime an extremely rich literature on the classical excavations of the late 20th and early 21st century in China is on display, which has also produced impressive, beautifully illustrated catalogues and books (Chang et al., 2005, Wieczorek and Lind, 2007a, Liu and Chen, 2012, von

Falkenhausen, 2006). Valerie Hansen has summarized the recent results of this period in a book that is not only a wonderful reading, but is recommended internationally as a standard for the state-of-the-art introduction to the history of Silk Road (Hansen, 2012, Hansen, 2016).

In a first restriction only younger publications, published since about 2000, which deal with the question of knowledge exchange, will be taken into account. The most interesting and important questions of the exchange and the mixing of worldviews, especially of religions, are not pursued.

Recent research has given a new picture of the Silk Road. Thus the Silk Road, as Valerie Hansen elaborates on numerous treaties, invoices and legal disputes, was by no means a kind of long-distance road from the extreme west of Europe to the extreme east of Asia. Rather **the Silk Road was a widely intertwined network of various trade routes, where predominantly regional retail trade was operated**. The luxury goods were passed from trading partners to trading partners and passed through numerous stations before they finally arrived in the Far East or the Far West.

Wieczorek and Lind work up that the Silk Road was by no means a route for luxury goods. Rather, it was "a self-organizing network, which in its entirety could never be planned or even managed from a single point". **The Silk Road was a network of relations between the Mediterranean Sea and the Yellow Sea, and also between Siberia and the Indian subcontinent, that means also in the often overlooked North-South axis** (Wiezcorek and Lind, 2007b, 22).

Although facing the astonishing results of modern classical archeology of the years 1990 to 2010, however, there are also numerous questions open to the general public, including archeology itself, which in particular refer to the fact that from the visible circumstances of excavation finds cannot be concluded to their real origins: This is by no means true only of materials, but above all also of creatures, and above all of human beings - who, at first glance, seem sometimes to have come directly from Europe. In fact, neither written sources nor modern archeology provide reliable information about the origin of primarily biological materials.

It is at this point that the latest scientific and (molecular) biological methods of archaeology are used which have been developed with the latest techniques since the end of the 20th century.

So our aim is devoted to a sceptical viewpoint asking for evidence from archaeologically excavated objects that must have been exported from the two most far reaching ends of Eurasia- namely from Europe and from China, sometimes even from early Korea or even Japan (see e.g. (Selbitschka, 2014) on (Wieczorek and Lind, 2007a)). To discuss the archaeological findings we either complete or contrast the referring literature with most recent findings

from modern natural scientific and/or (micro-)biological methods in archaeology. So as probably new sources of the history of the Eurasian Interchange of Knowledge, medical and scientific bibliographies, namely, PubMed and Web of Science, were systematically used as the basis for recent publications. The lemmas, among which was researched, were

- silk road
- silk road and history
- silk road and archeology
- silk road and genetic or genetics
- silk road and disease

There were so many - including, however, many false positive – bibliographical data that the research had to be limited to the last 10, possibly also to the last 5 years.

This makes another point clear: this paper/lecture can only be a small first look. For, apart from the many limitations already mentioned, the above-cited bibliographies cover exclusively English periodicals, and this mainly if not exclusively from the field of medicine, life sciences and natural sciences. Literature not published in English - for example articles from China or from Germany - is not reported in these bibliographies. It should therefore be said from the outset that the bibliographical research on this contribution probably does not cover more than 25 % of the relevant publications for the period in question – maybe even less. And also from these publications a strict choice must be made due to reasons of space and time. In the following lines evidence is often quoted directly from the summaries and conclusions of the literature mentioned.

3.2 Export goods from Far East (China) excavated in the Far West (Europe, Asia minor)

Silk and Textiles

Silk import from China (“serica”) has been documented by narrative sources from Roman imperial times. Thus, from Han-times onwards, there is also archaeological evidence of Chinese silk in Western oases like Palmyra in Syria (Pekridou-Gorecki, 2006).

FIGURE 1. *Incidence of silk or possible silk outside of China before the Former Han Period (207 BC–AD 220) and during initial attempts at formal trade with Bactria.*

1 *Altzier*	4 *Chiusi*	7 *Gordion*	10 *Niya*	13 *Loulan*	16 *Noin Ula*
2 *Hochdorf*	5 *Kerameikos*	8 *Toprak Kale*	11 *Pazyryk*	14 *Lop Nor*	17 *Deir al Medina*
3 *Hohmichele*	6 *Sardis*	9 *Sapalli Tepe*	12 *Ukok*	15 *Edsen Gol*	18 *Nevassa*

MAP (from: Good 1995: 960; Margariti 2011 falsified N° 5 not be silk, reported the same about N° 2–3, ibid. p.526).

However, for decades have European archaeologists tried to solve "the question of silk in pre-Han Eurasia" (Good, 1995). Problems with antique silk are manyfold:

- Fine textiles like silk are prone to decay over the centuries.
- Is ancient silk really Chinese silk (serica), or some other cocoon material?
- So: are these textiles imported from China via silk-roads or was it produced and distributed from India, Mesopotamia, or Greece (Kos)?

Textiles found by silk road archaeologists will become more and more thoroughly analysed by an already mentioned special Chinese-German programme for which the attractive term "silk road fashion" was coined.

Another subject in the area of silk and textiles is the − also complicated and just to be mentioned here - analysis of ancient dye stuff.

3.3 Export goods from the Far West (Europe, Asia minor) excavated in Far East (China)

Glassware

Glass beads from the Mediterranean or Persia were unearthed in tombs from the Spring and Autumn or Warring Times period in oasis tombs of Xinjiang (Bo and Lipeng, 2009): 327–28). In the Sampula oasis, also an ear pendant of typical Chinese design was found. So artefacts from China as well as Persia or even Asia minor were found in the same graveyard on the Southern silk road, however dated only to late Han period 1st c. BC (Bo & Lipeng 2009, 323–24).

Fig. 2.3. Northwestern Silk Road and ancient Chinese glass distribution. ● PbO–$BaO–SiO_2$ glass × $Na_2O–CaO–SiO_2$ glass ▼ Alkali faience ■ $K_2O–SiO_2$ glass.

(Map Fig. 2.3 in Fuxi 2009: 54)

Ancient typical Chinese glass spread westward along the oasis silk road no further than Xinjiang only since the Han Dynasty ((Fuxi, 2009a, Fuxi, 2009b, Fuxi et al., 2009a, Fuxi et al., 2009b). Only few Chinese glass or fayence artifacts have been unearthed from pre-Han periods in Mongolia and Siberia (N=2, Fuxi 2009: 46–51).

Central China produced different glass material than central Asia or western Eurasia. The Chinese products e.g. of the Zhou period resembled in their chemical components rather fayence material; techniques were developed from pottery and glazing ("proto-porcelain") (Fuxi 2009: 9–12; (Wei, 2009): 244–45).

It was not before ca. 500 BC that also in China not only fayence but glass in modern terms was produced by increasing the oven temperature and changing compounds. But these alkali-lime-silicate as well as the later lead-barium-silicate or potash-silicate glass were still of clearly different composition than glass made in other parts of the world (Fuxi 2009: 8). Glass was made for precious objects to imitate precious stones esp. Jade.

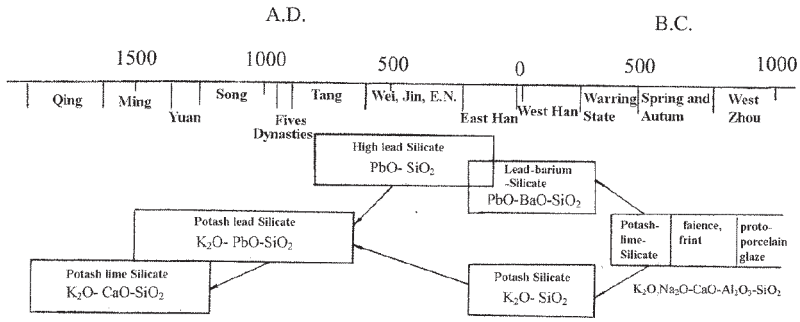


Fig. 1.1. Development of the chemical compositions of ancient Chinese glasses.

(Fig. 1.1 in Fuxi 2009: 8)

Clustering 2000 artifacts, Chinese glass contained specific lead percentages and can thus be distinguished from others.

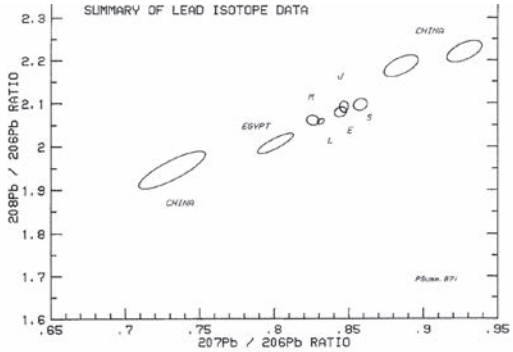


Fig. 3.2. Lead-isotope data for approximately 2000 ancient artifacts made of various materials from all over the ancient world. Many ores are also included. Note that leads in Chinese glasses are among the highest and lowest ratios found.

(Fig. 3.2 in Brill 2009: 115)

In general, however, ancient glass finds along the oasis silk road rather show a border: Chinese glass remained east of Urumqi or Turfan.

3.4 Migration or spatial diffusion of organisms due to archaeological finds

3.4.1 People (anthropometrically or culturally reconstructed ethnical categories)

For Western archaeologists it seems impressive to see that mummified corpses from regions like Tarim or Altai look quite similar to modern Europeans, so far from Europe.

However, they have to bear in mind that most probably these persons did not migrate from the Atlantic coast, but that common Indo-European ancestors came probably from Lake Aral. Even when Skythian or Sogdian individuals might have been especially involved in far distance trade along northern routes, the distance covered by the individuals unearthed in Xinjiang, Siberia or Kasakhstan remains unclear. Change of burial rites is difficult evidence for migration or even transfer in general, especially if there is not a specific burial model from another region copied completely.

So defining "alien"-humans being buried among indigenous graveyards by artefacts only seems difficult. So − the question is: **what can recent biological data contribute to this question?**

"Northwest China is closely adjacent to Central Asia, an intermediate region of the Eurasian continent. Moreover, the Silk Road through the northwest of China once had a vital role in the east-west intercommunications. Nevertheless, little has been known about the genetic makeup of populations in this region." Shou et al. collected 503 male samples from 14 ethnic groups in the northwest of China. Their "results illustrated obvious genetic difference among these ethnic groups, and in general their genetic background is more similar with Central Asians than with East Asians. The ancestors of present northwestern populations were the admixture of early East Asians peopling northwestward and later Central Asians immigrating eastward. This population mixture was dated to occur within the past 10 000 years. **The (…) lineages (sc. in question) likely entered China during the eastward migration of Central Asians. The influence from West Eurasia through gene flows on the extant ethnic groups in Northwest China was relatively weak**"(Shou et al., 2010).

"Archeological researches have proposed arguments for human mobility and long-distance trading over the Eurasia before the Silk Roads. (Sc. In the study was utilized) biologically available strontium isotope analysis to assess the extent of pre-Silk Road population movements and cultural communications across the Asian interior. From an early Iron Age cemetery (ca. 2500 yr B.P.) on the eastern Pamir Plateau (…) from 34 individuals display considerable variability, and 10 individuals are distinguished as migrants (…). **Comparison of the proportion (10/34) with the regional census data completed in 1909 A.D. (3% non-locals) suggests a highly migratory behavior on the Pamir plateau 2500 years ago. Furthermore, exotic mortuary objects, such as silk fabrics from eastern China and angular harp originated from the Near East, clearly demonstrate an interaction between different cultures on the plateau before the establishment of the Silk Road"** (Wang et al., 2016).

"There are several indigenous ethnic populations along the silk road in

the Northwest of China that display clear differences in culture and social customs, perhaps as a result of geographic isolation and different linguistic traditions. However, extensive trade and other interactions probably facilitated the admixture of different gene pools between these populations over the last two millennia. (…) Phylogenetic tree and principal component analysis revealed clear pattern of population differentiation between 4 populations living in Sinkiang Uighur Autonomous Region and other 9 populations dwelled in the upper regions of Silk Road. (Sc. **Further analysis) showed high-level gene flow and population admixture dose among these ethnic populations in the Northwest region of China.** (…) a larger percent of genetic variance (21.58% versus 2.3%) can be explained by geographic isolation than linguistic barriers, which matched with the contribution of geographic factors to other world populations" (Zhang et al., 2014).

"The Tarim Basin, located on the ancient Silk Road, played a very important role in the history of human migration and cultural communications between the West and the East. However, both the exact period at which the relevant events occurred and the origins of the people in the area remain very obscure. (Sc. Li et al.) present data from the analyses from human remains excavated from the Xiaohe cemetery, the oldest archeological site with human remains discovered in the Tarim Basin so far. (Sc. **The results demonstrated) that the Xiaohe people were an admixture from populations originating from both the West and the East, implying that the Tarim Basin had been occupied by an admixed population since the early Bronze Age.** To our knowledge, this is the earliest genetic evidence of an admixed population settled in the Tarim Basin" (Li et al., 2010).

Some supplementary remarks:

While most populations on the Silk road have been characterized, little is known about past migration patterns." The scientific expedition "Marco Polo"

has recently collected genetic and phenotypic data in six regions (Georgia, Armenia, Azerbaijan, Uzbekistan, Kazakhstan, Tajikistan) along the Silk Road to study the genetics of a number of phenotypes. The genetic structure of these populations was characterized within a worldwide context. **Observed was a West-East subdivision albeit the existence of a genetic component shared within Central Asia and nearby populations from Europe and Near East. Mezzavilla et al. observed a contribution of up to 50% from Europe and Asia to most of the populations that have been analyzed. The contribution from Asia dates back to ~25 generations and is limited to the Eastern Silk Road.** Time and direction of this contribution are consistent with the Mongolian expansion era" (Mezzavilla et al., 2014).

"Uyghurs are one of the many populations of Central Eurasia that is considered to be genetically related to Eastern and Western Eurasian populations. However, there are some different opinions on the relative importance of the degree of Eastern and Western Eurasian genetic influence. In addition, the genetic diversity of the Uyghur in different geographic locations has not been clearly studied. (…) **Xinjiang Uyghurs are more genetically related to Chinese population in genetics than to Caucasians.** Moreover, there was genetic diversity between Uyghurs from the southern and northern regions. There was significance in genetic distance between the southern Xinjiang Uyghurs and Chinese population, but not between the northern Xinjiang Uyghurs and Chinese. (…) The study confirms that there are significant genetic differences among the Uyghurs in different geographical locations" (Ablimit et al., 2013).

"Contemporary Jews retain a genetic imprint from their Near Eastern ancestry, but obtained substantial genetic components from their neighboring populations during their history. **Whether they received any genetic contribution from the Far East remains unknown, but frequent communication with the Chinese has been observed since the Silk Road period.** To address this issue, 55,595 Eurasians are analyzed. The existence of some eastern Eurasian haplotypes in **eastern Ashkenazi Jews supports an East Asian genetic contribution, likely from Chinese**. Further evidence indicates that this connection can be attributed to a gene flow event that occurred less than 1.4 kilo-years ago (kya), which falls within the time frame of the Silk Road scenario and fits well with historical records and archaeological discoveries. This observed genetic contribution from Chinese to Ashkenazi Jews demonstrates that the historical exchange between Ashkenazim and the Far East was not confined to the cultural sphere but also extended to an exchange of genes" (Tian et al., 2015).

3.4.2 Domesticated animals

As we know, donkeys have been among the first pack animals − probably before cattle and certainly before camels. In recent research "**the process of domestication and the dispersal routes of the Chinese donkey**" was questioned. "In this study, the phylogenetic analysis reveals that ancient Chinese donkeys have high mitochondrial DNA diversity and two distinct mitochondrial maternal lineages, known as the Somali and Nubian lineages. These

results indicate that the maternal origin of Chinese domestic donkeys was probably related to the African wild ass, which includes the Nubian wild ass (Equus africanus africanus) and the Somali wild ass (Equus africanus somaliensis). **Combined with historical records, the results of this study implied that domestic donkeys spread into west and north China before the emergence of the Han dynasty. The number of Chinese domestic donkeys had increased primarily to meet demand for the expansion of trade,** and they were likely used as commodities or for shipping goods along the Silk Road during the Tang Dynasty, when the Silk Road reached its golden age" (Han et al., 2014).

"The **Kazakh horse** is an important old horse breed in Xinjiang. They have contributed greatly to the breeding and improvement of other local horse breeds, yet their genetic diversity and population structure are not well understood." In their recent genetical research Gemingguli and others have found a high level of genetic diversity in the Kazakh horses in China and in Kazakhstan. "However, no clear correspondence between haplogroups and geographic origin and no significant differentiation between populations in the two countries were observed. **This might have resulted from the frequent contact between the two countries through the Silk Road in the past, or due to long-term outcrossing and hybridization with the introduced horses**"(Gemingguli et al., 2016).

A comparable study by Warmuth and others on **horses** has the same results on a general level. "The overall level of genetic differentiation was low, consistent with historically high levels of gene flow across the study region. The spatial genetic structure was characterized by a significant, albeit weak, pattern of isolation by distance across the continent with no evidence for the presence of distinct genetic clusters. Incorporating landscape features considerably improved the fit of the data; however, when we controlled for geographical distance, **only the correlation between genetic differentiation and the Silk Roads remained significant, supporting the effectiveness of this ancient trade network in facilitating gene flow across large geographical distances in a topographically complex landscape**" (Warmuth et al., 2013).

A study on **Mongolian cattle** as one of the most widespread breeds with strictly Bos taurus morphological features in northern China comes to the results, that **this typical Chinese cattle is a mixture with cattle from India.** "Historical and archeological records indicate that B. taurus was introduced to Xinjiang during the second millennium BC and B. indicus appeared in this region by the second century AD. The two types of cattle coexisted for many centuries in Xinjiang, as depicted in clay and wooden figurines unearthed in the Astana cemetery in Turfan (3rd-8th century AD). Multiple lines of

evidence suggest that the earliest B. indicus introgression in the Mongolian cattle may have occurred during the 2nd-7th centuries AD through the Silk Road around the Xinjiang region. This conclusion differs from the previous hypothesis that zebu introgression to Mongolian cattle happened during the Mongol Empire era in the 13th century" (Yue et al., 2014).

This is a correction in time for nearly more than 1.500 or even 2.000 years earlier as previously had been assumed.

An even more astonishing result is on **chicken** – as we assume one of the main and one of the oldest dishes in Chinese kitchen. "The chicken (Gallus gallus domesticus) is the most widespread domestic animal in the world. However, the timings and locations of their domestication have remained debatable for over a century. China, and particularly northern China, has been claimed as one of the early centers for the domestication of chickens, because many chicken remains have been discovered at a number of archaeological sites. However, the identification of archaeological domestic chicken bones from early Holocene sites in China remains contentious. In this study, we analyzed 1831 bird bones, which included 429 bones previously recorded as "domestic chicken" from 18 Neolithic and early Bronze Age sites in central and northern China. Although morphological species identification criteria for the bones of 55 modern Chinese Phasianidae species, including the domestic chicken and wild red junglefowls, have not yet been fully established, **upon reanalysis none of the "domestic chicken" bones were derived from chickens. In addition, bones determined to be candidate chicken bones were found at only 2 of the 18 sites, suggesting that chickens were neither widely kept nor distributed in central and northern China during the early and middle Holocene period**"(Eda, 2016).

3.4.3 Grains etc

Jones and others present 2016: "A number of **crops** that are of global importance today, including **wheat (Triticum spp) and barley (Hordeum vulgare)**, were domesticated in Southwest Asia between 10,000 and 11,000 years ago and subsequently spread through the Old World, into Europe, North Africa and eastwards across Eurasia. Their routes of expansion have been a focus of debate and are increasingly being revealed by widespread dating of archaeobotanical remains from across Eurasia. **Of particular interest is work by Zhao (2009) who proposed three routes for the spread of wheat into China: firstly, across the Eurasian Steppe, second by sea from India to the east coast of Eurasia and third, along the Hexi Corridor, which forms part of the Silk Road in western China"** (Jones et al., 2016).

Wheat is the sort of grain, which is widely agreed upon to have been

transferred from western Asia, where it has been improved since ca. 8000 BC, all over Eurasia by human beings. In China, it seems to have appeared before 2000 BC in densely populated eastern regions (Yellow River valley) even some hundred years earlier than in western China (Xinjiang, 2000–1500 BC), so that probably there were diverse distribution channels, sometimes rather from northern than western neighbours (Liu & Chen 2012, 92–94). During the 2nd millenium BC it were those western regions, where wheat replaced more and more indigenious sorts of millet, which were domesticated originally before 7000 BC in late palaeolithic Yellow River valley (Liu & Chen 2012, 82–85). Pasta made from millet was found in a silk road oasis 5th-3rd cent. BC (Wieczorek 2007: 178).

However, the velocity over 5–6 millennia seems hardly to exceed 1–2 km per year and just the scale of distribution seems more efficient than propagation of prolific seeds in a prevailing west wind zone.

The article of Spengler and others emphasizes **the role of part-time nomadic, part-time sedentary living in the developing of grains (= transhumance; pastoralism)**. They "present a new archaeobotanical analysis from pastoralist campsites in the mountain and desert regions of Central Eurasia that documents the oldest known evidence for domesticated grains and farming among seasonally mobile herders. Carbonized grains from the sites of Tasbas and Begash illustrate the first transmission of southwest Asian and East Asian domesticated grains into the mountains of Inner Asia in the early third millennium BC. By the middle second millennium BC, seasonal camps in the mountains and deserts illustrate that Eurasian herders incorporated **the cultivation of millet, wheat, barley and legumes into their subsistence strategy. These findings push back the chronology for domesticated plant use among Central Eurasian pastoralists by approximately 2000 years"** (Spengler et al., 2014).

3.4.4 Fermenting, Brewing, Liquor, and Beer

In connection with grains we think more or less automatically on fermenting and brewing processes. "Chemical analyses of ancient organics absorbed into pottery jars from the early Neolithic village of Jiahu in Henan province in China have revealed that **a mixed fermented beverage of rice, honey, and fruit (hawthorn fruit and/or grape) was being produced as early as the seventh millennium before Christ (B.C.)**. This prehistoric drink paved the way for unique cereal beverages of the proto-historic second millennium B.C., remarkably preserved as liquids inside sealed bronze vessels of the Shang and Western Zhou Dynasties. These findings provide direct evidence for fermented beverages in ancient Chinese culture, which were of considerable social, religious, and medical significance, and help

elucidate their earliest descriptions in the Shang Dynasty oracle inscriptions" (McGovern et al., 2004).

The first known recipe for making beer was also found nearly as early as the production of barley: "The pottery vessels from the Mijiaya site reveal, to our knowledge, the first direct evidence of in situ beer making in China, based on the analyses of starch, phytolith, and chemical residues. **Our data reveal a surprising beer recipe in which broomcorn millet (Panicum miliaceum), barley (Hordeum vulgare), Job's tears (Coix lacrymajobi), and tubers were fermented together.** The results indicate that people in China established advanced beer-brewing technology by using specialized tools and creating favorable fermentation conditions around 5,000 y ago. Our findings imply that early beer making may have motivated the initial translocation of barley from the Western Eurasia into the Central Plain of China before the crop became a part of agricultural subsistence in the region 3,000 y later" (Wang, 2016).

3.4.5 Fruits and vegetables

The period from the late third millennium BC to the start of the first millennium AD witnesses the first steps towards **food globalization in which a significant number of important crops and animals, independently domesticated within China, India, Africa and West Asia, traversed Central Asia greatly increasing Eurasian agricultural diversity.**" Stevens's et al. "paper utilizes an archaeobotanical database (AsCAD), to explore evidence for these crop translocations along southern and northern routes of interaction between east and west. To begin, crop translocations from the Near East across India and Central Asia are examined for wheat (Triticum aestivum) and barley (Hordeum vulgare) from the eighth to the second millennia BC when they reach China. The case of pulses and flax (Linum usitatissimum) that only complete this journey in Han times (206 BC–AD 220), often never fully adopted, is also addressed. The discussion then turns to the Chinese millets, Panicum miliaceum and Setaria italica, peaches (Amygdalus persica) and apricots (Armeniaca vulgaris), tracing their movement from the fifth millennium to the second millennium BC when the Panicum miliaceum reaches Europe and Setaria italica Northern India, with peaches and apricots present in Kashmir and Swat. Finally, the translocation of japonica rice from China to India that gave rise to indica rice is considered, possibly dating to the second millennium BC. The routes these crops travelled include those to the north via the Inner Asia Mountain Corridor, across Middle Asia, where there is good evidence for wheat, barley and the Chinese millets. The case for japonica rice, apricots and peaches is less clear, and the northern route is contrasted with that through northeast India, Tibet

and west China. Not all these journeys were synchronous, and this paper highlights the selective long-distance transport of crops as an alternative to demic-diffusion of farmers with a defined crop package" (Stevens et al., 2016).

Vitis vinifera in contrast to other undomesticated sorts would be a tracer, and some archaeological finds of **wine seeds** have been found in even early Bronze age Chinese sites (5000, 3000–2000 BC cf. table 2 in Jiang 2009: 1463). However most of these plants were some kind of wild types and not the Mediterranean sort. **A piece of wood from domesticated wine was unearthed from a tomb in Xinjiang, dated ca. 300 BC which might serve as evidence for viniculture in the Turpan district, probably imported by Hellenistic migration, which was also illustrated by specific ornaments found from this period** (Jiang 2009, cf. also Wieczorek 2007: 74sq).

"Common **walnut** (Juglans regia L) is an economically important species cultivated worldwide for its wood and nuts. It is generally accepted that J. regia survived and grew spontaneously in almost completely isolated stands in its Asian native range after the Last Glacial Maximum. Despite its natural geographic isolation, J. regia evolved over many centuries under the influence of human management and exploitation. We evaluated the hypothesis that the current distribution of natural genetic resources of common walnut in Asia is, at least in part, the product of ancient anthropogenic dispersal, human cultural interactions, and afforestation. **Genetic analysis combined with ethno-linguistic and historical data indicated that ancient trade routes such as the Persian Royal Road and Silk Road enabled long-distance dispersal of J. regia from Iran and Trans-Caucasus to Central Asia, and from Western to Eastern China. Ancient commerce also disrupted the local spatial genetic structure of autochthonous walnut populations between Tashkent and Samarkand (Central-Eastern Uzbekistan), where the northern and central routes of the Northern Silk Road converged.** Beyond the economic importance of common walnut, our study delineates an alternative approach for understanding how the genetic resources of long-lived perennial tree species may be affected by the interaction of geography and human history" (Pollegioni et al., 2015).

3.4.6 Tea

China is the father-/or motherland of tea. But the beginning of tea − production and its use in everyday life is still uncertain. So we are all glad to hear, that the early beginning of tea-culture in China is now proven by biomolecular evidence:

"Phytoliths and biomolecular components extracted from ancient plant remains from Chang'an (Xi'an, the city where the Silk Road begins) and

Ngari (Ali) in **western Tibet, China, show that the tea was grown 2100 years ago** to cater for the drinking habits of the Western Han Dynasty (207BCE-9CE), and then carried toward central Asia by ca. 200CE, several hundred years earlier than previously recorded. The earliest physical evidence of tea from both the Chang'an and Ngari regions suggests that a branch of the Silk Road across the Tibetan Plateau, was established by the second to third century CE" (Lu et al., 2016).

Summary - Conclusions

On the basis of the results and valuable hints from historiography and archeology, we can assume that there has been an exchange of knowledge at the latest since the beginning of the Neolithic period, and probably earlier, and therefore well before the time of writing.

This exchange includes goods, products, skills, animals − and also humans. The transfer of knowledge should have been similar to that of goods: by means of traded goods and products and of migrating skilled people, new knowledge was transferred, new skills were assimilated.

Certain populations - obviously on transit areas such as the Oasis Silkroad - developed their own cultures, in which something new developed through steady exchange processes with other cultures.

That means: Exchange processes in the widest sense rarely encounter a completely independent, untouched field. Rather, exchange processes are usually based on cultural peculiarities, which in turn represent an amalgam, an inseparable mixture of previous exchange processes.

In this sense, we are talking about an "Eurasian Interchange of Knowledge" rather than "Eurasian Transfer of Knowledge".

The present study is only a small, highly incomplete selection − a "florilegium". So precise pilot studies are necessary. These studies, if successfull and promising, can be systematically expanded to research projects, e.g. on specific products, specific skills or specific procedures. In this context the different methods and results from a variety of different scientific areas have to be strictly evaluated in their meaningfulness, reach and validity for the historiography of human action.

Above all, such preliminary surveys and concise pilot studies could also be made for other regions of knowledge exchange and cultural interaction: our opening examples speak for Europe; in East Asia others are, just for example, the North-South axis from Siberia to Indonesia, or the continuing routes to Korea and Japan.

"The Silk Roads have normally been treated as a system of exchanges linking the major regions of agrarian civilization in Afro-Eurasia, and as originating in the classical era. A revised understanding of the role and history of the Silk Roads shows the extent to which **the entire Afro-Eurasian landmass has been linked by complex networks of exchange since at least the Bronze Age**. It reminds us that Afro-Eurasia has a common history despite the ecological and cultural variety of its many different regions" (Christian, 2000).

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