AGRICULTURE ON THE MONGOLIAN STEPPE

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The natural conditions on the Mongolian steppe are not favourable for agriculture: severe long winters with temperatures down to -40° C and hot summers with temperatures up to +40° C. Precipitation is less than 400 mm/y with snow (less than 10% of the total precipitation) in the winter and rain concentrated in July-August. The growing season is only about 100 to 110 days (in summer) (Jadambaa et al. 2003).

Water for the crops, however, may come from sources other than directly from rainfall. Snow melt in spring and continuing later in the year in the highlands feeds rivers that flow along the northern fringe of the steppe: large rivers like the Kerulen, the Onon and the Selenge, which are perennial and eventually flow into Lake Baikal and the Amur River. Smaller rivers in central and western Mongolia flow south and west from the highlands and end in shallow salty lakes. Melting snow also feeds groundwater, which along the banks of the Tuul River is sufficient to supply a large town like the capital Ulaanbaatar with the water it needs. This indicates that the availability of water for agriculture varies from area to area as well as with the techniques of extraction and distribution.

On the large flat or undulating steppe plains that are not crossed by rivers, water is scarce and only available during rainfall and at some sources fed by groundwater. Along its southern fringe the steppe grades into a semidesert or a desert with extremely low rainfall, but in many places groundwater is present at shallow depths and can be pumped up or obtained from wells. At its northern fringe the steppe grades into forest. Here the often broad valleys have a grassy steppe vegetation without trees, while the slopes, in particular the north-facing slopes, are forested. Often some surface water as well as groundwater is available during at least a large part of the year.

The nomad population on the Mongolian steppe during the past three millennia had essentially three options to obtain the cereals and some vegetables they needed to supplement their diet of meat, milk and milk products: growing them locally where possible, obtaining them through barter or trade from the farmers in present-day northern China or southern Siberia, or obtaining them by force through looting. It has been supposed that steppe nomads had a chronic shortage of agricultural products and therefore were forced either to trade with farmers or to rob them. Increased defence of China against raids by nomads forced the steppe nomads to organize themselves into larger units and eventually form a steppe state with political leadership and an "upper class." Barfield (2001) called such nomad states that extracted wealth from their sedentary neighbours in China "shadow empires." According to Khazanov (1984) and Golden (1987-91) agriculture, or rather the lack of sufficient agriculture on the steppe, played an essential role in the formation of such steppe states. Di Cosmo (2002), however, showed that it is unlikely — and rather hypothetical — that the steppe nomads in Mongolia had a shortage. The conditions of temperature and precipitation allow some agriculture, at least at the conditions that prevail at present.

However, the question remains to what extent the conditions of temperature and precipitation in Mongolia have stayed the same, or nearly constant, from ca.1000 BCE up to the recent increase of global temperature. This paper will consider to what extent climatic fluctuations may have influenced steppe nomad agriculture. Yet even if the conditions for agriculture have remained relatively favourable and agriculture could be practiced, it would be important to determine whether production was sufficient, whether trade or looting were necessary to obtain agricultural products or might have been preferred to farming. The role of agriculture in steppe nomad society is discussed in the last section of this paper.

Farming in Mongolia

The earliest known indications for farming in Mongolia have been found in Tamsagbulag in Dornod, and in the southern Gobi between Edsen Gol (Dong He) and Durbet (Dorbod) (Derevyanko and Dorj 1992; Berkey and Nelson 1926; Nelson 1926; Maringer 1950). They date from the 4th and 3rd millennium BCE, well before the population of the steppe by nomads, and are found on the banks of river valleys that are now mostly dry but at that time contained much more water than at present. In Tamsagbulag the people lived in fixed dwellings, in which and in their graves were found agricultural implements: hoes and hoe-like instruments, grinders,

millstones, pestles. In addition to farming, the people lived by food-gathering, hunting and some fishing. In the southern Gobi only grinding stones and pottery were found, no hoes, stone spades, digging sticks or other agricultural implements. Possibly the grinding stones were used only to grind locally gathered edible grains of wild species, but it is also possible that grain was grown locally or imported from the farming areas in nearby North China (Maringer 1950).

Such finds are comparable to what one might expect from the recent practice of farming by nomads in the Selenge valley (described by Róna-Tas, in Di Cosmo 1994). They open the soil of a strip of land near the river by wooden plows, break the clods by hand, and then sow seeds (wheat, barley or rye). After this, they leave for their summer pastures and return in autumn to harvest. Near Tarialan the ears are picked by hand, without any sickles, and threshing is done by animals (horses, oxen). Wooden shovels are used to separate grain from chaff. The leftover straw is used to line shallow pits (about 50 cm deep) where the grains are stored. Grinding is done with grinding stones in a mill operated by horses.

The Gobi area is steppe now a semi-desert, but more humid conditions prevailed during the time of the Neolithic settlements, as the dried-out streambeds, erosion tracks and ancient lake shores testify. After about 2500 BCE conditions in what is now the Eurasian steppe area changed to a cooler and more arid climate. Indications for this change have been found in the Altai and the Amur river area — i.e., directly west and east of Mongolia — but not (yet) in Mongolia itself (Anthony 2007, 2009). The forests retreated and open grassland expanded, which reduced the possibilities of farming. The steppe (probably also the Mongolian steppe) became populated by nomads around 1000 BCE. It is highly unlikely, however, that agriculture completely vanished during this transition (Volkov 1964). Di Cosmo (1994) cites indications for agriculture in central Mongolia from the late Bronze Age (about 800 BCE), in the Tuul River region and at Ulangom from 700–300 BCE.

Somewhat later, during the period of the Xiongnu, who formed a steppe state from 209 BCE to the end of the first century CE, there is ample evidence of agriculture (Di Cosmo 1994). Although Sima Qian in his history only mentions about the Xiongnu that they were cattle-raising nomads (Sima Qian 1961/1993), agriculture was practiced at many, usually fortified settlements scattered throughout Mongolia (Hayashi 1984, Di Cosmo 1994). The largest, and best studied one is the partly non-Xiongnu settlement at Ivolga on the Selenge river south of Ulan Ude. At Ivolga Xiongnu graves contain cast iron ploughs (probably models of the wooden ploughs that were used in the field), and graves near Ivolga as well as at Noyon uul, north of Ulaanbaatar, contain kernels of millet (Davydova 1968; Rudenko 1969; Bunker 1997). In Ivolga the style of the dwellings, their heating system, and their spades and ploughs point to a Chinese influence. It is therefore probable that the farming was done by Chinese or by original (Chinese–influenced) inhabitants who had been conquered by the Xiongnu. At two other, much smaller Xiongnu dwelling sites north of Kiakhta there are no indications for agriculture (Erdélyi 1994).

The Chinese records of the Han dynasty, the *Han Shu*, contain several references to Xiongnu farming: a Chinese military expedition into Xiongnu territory (in 141–87 BCE) appropriated Xiongnu grain and cereals to feed the troops (Di Cosmo 1994); in 88 BCE a harvest of grain and other agricultural products was lost because of continuing rains and frost; Chinese captive soldiers were employed in farming at the Ling wu river (Rudenko 1969; T'ang 1981). Also, the Xiongnu sent four thousand cavalry men to Jushi to work the land, whence they were later expelled by the Chinese (Di Cosmo 1994). Much of the farming was probably done by imported Chinese farmers and prisoners, and possibly by impoverished Xiongnu (Di Cosmo 1994). The Xiongnu had military agricultural colonies with Chinese prisoners, who probably worked the land while the Xiongnu military guarded them. Collecting Chinese prisoners was one of the main reasons for looting neighbouring China; some were probably bought from other nomadic tribes. Chinese farmers came to the Xiongnu on their own initiative because living conditions were better among the Xiongnu than in imperial North China (Hayashi 1984). Probably also some farmers came from the (sedentary) Western regions. In addition to housing farmers, the fortified villages were mainly for storage of provisions.

After the Xiongnu state ended, there is a gap of about 450 years with few indications for agriculture on the Mongolian steppe. The Xianbi took over from the Xiongnu in the first century CE. They grew grain in favourable places, but whether this was on the steppe or in an area with a sedentary population is not clear. After a large number of Xianbi had gone to northern China, the Juanjuan (or Rouran) took over from the Xianbi. Their empire reached from the Ili river to Manchuria. They ruled Mongolia from ca.400–552 (Sinor 1990) and also practiced agriculture, but the locations are not known. A fortress/village with agriculture is mentioned in northern Mongolia, but on the whole such villages were not so developed among the Juanjuan as among the Xiongnu. Hayashi (1983) states that also among the Xianbi and the Juanjuan farming was mainly done by Chinese.

The Juanjuan were conquered in 552 by the Türk, who had a steppe state up to 744 CE covering an area

ranging from the Aral Sea to Manchuria. At that time there probably was some agriculture of importance. Agriculture was mentioned in inscriptions of the 8th century (the Orkhon inscriptions) with Türk words for "field" and "grain" (Lopatin 1939, 1940), which were interpreted by Thomsen (1896, p.67) as "seed grain." It was requisitioned from China by the Türk Khan together with 3000 farming tools. The Tang imperial records indicate that in 627 the grain harvest of the Türk (probably not all of it) was bought by China for the army (which is surprising considering the large agricultural production in China itself). Both in 520 and 698 seed grain and farming tools were imported from China, which may have been needed to replace seed grain that had been lost or consumed. Farming (beans and cereals) was done north of the Yellow River between Li He and Hequ and around present-day Hohhot. In 694 (?) Qap Khan invaded northern China carrying farming tools and seeds, with the intention to occupy the area (Liu Mau-tsai 1958, pp. 456-7, 751; Hayashi 1990).

The Turkic Uighur, who replaced the Eastern Türk in 744, had their state in Mongolia up to 840 CE. They built towns, including the capital Karabalgasun on the Orkhon River and Baybalik on the Selenge. The population in the towns (traders, officials, clerics) needed food; this stimulated agriculture to produce grain and vegetables. Tamim ibn Bahr, an Arab traveller in 821 CE, described farming using irrigation near the Uighur capital (Minorsky 1947–8). In addition, Manichaean beliefs adhered to by the Uighur required the clergy to eat onions and "other strong vegetables." This led to an edict (in 763) that the population as a whole was to eat vegetables, not meat. Remains of irrigation works are still extant near Karabalgasun, and grain as well as pestles and millstones have been found during excavations in the town. Also millet was found in graves, but Mackerras (1990, p. 336) states that nomad cattle breeding remained dominant and that the Uighur continued to be nomads to a large extent.

The Khitan, nomads from what is now Manchuria, formed an empire (the Liao) in northern China in 916 but before this they had occupied eastern and central Mongolia in ca. 860, several decades after the Uighur had been defeated by the (nomadic) Kirghiz. To feed the occupation army they started agricultural projects along the Kerulen and Orkhon rivers around 1000 CE, probably irrigating the fields with river water (Wittfogel and Feng 1949). Harvests (of millet and wheat) were very good but presumably ended when the Khitan were defeated by the Jin in 1125 and left Mongolia. The Jin, who succeeded the Khitan (or Liao) in northern China, did not occupy Mongolia. It was left in the hands of various tribes and tribal confederations until the 13th century when the Mongol empire emerged from among them. There are no indications that agriculture was practiced during that time. In the "Secret History of the Mongols," written in the early 13th century, grain and granaries are mentioned in the area of the Merkit who lived south of Lake Baikal on both sides of the lower Selenge river between present-day Kiakhta and Ulan Ude (de Rachewiltz 2004).

During the Mongol conquests in ca.1220 agriculture (millet) and granaries were observed on the flanks of the Khanggai range and on the plains south of Uliassutai (preset-day Uliastay) by Chinese travelling to Chinggis Khan in Afghanistan. There were irrigation canals and the farmers were at least partly Moslem (Hui He), probably Uighur; the autumn harvest was already ripening when the travellers passed through. It is most likely that these farmers were the captives that Chinqai had brought (probably in ca. 1212) from Central Asia and had settled between the Khangai and the Altai mountains. This was called the *Chinqai Balgasun*, the town, or granary, of Chinqai. The settlement was only partly successful, as a number of captives could not endure the harsh climate and had to be resettled in Hebei in northern China, but the settlement in Mongolia persisted until the 14th century (Buell 1993; Waley 1931). The original purpose of the settlement probably was the production of grain for the army.

A few decades later, the Mongol Khan Ögedei initiated farming (with irrigation) near the Mongol capital Karakorum along the Orkhon River to feed the town's population and visitors. Mainly barley and two kinds of millet, vegetables and spices were produced, but the production was not sufficient and imports were needed together with imports of vegetables and spices that could not be produced locally because of the climate (Dardess 1972–3, Rösch et al. 2005). Also grain was produced in southern Siberia in imperial colonies. Several decades later, the Khan and future emperor of China Qubilai could successfully blockade his rival Ariq Böke in Karakorum by cutting off the supplies of grain from China, which indicates that production in Mongolia was insufficient Later he stimulated farming to feed both the impoverished local population and the army in Mongolia, in areas that apparently had been already under cultivation before: along the Kerulen river, near Karakorum and around Chinqai Balghasun as well as in the upper Yenisei basin. In 1272 an army unit was ordered to open canals and plough fields; in 1279 oxen and tools were issued to an army unit (the same one?); in 1288 water from a river was used to irrigate the fields of the local population; in 1289 troops were sent to dig more canals; and in 1297 plow oxen were issued to farming households. In spite of these efforts, agricultural

production, as under Ögedei, again was insufficient to meet the needs (Dardess 1972-3). After the Ming succeeded the Mongol (Yüan) empire in 1368, Mongolia was occupied by different independent tribes, and there are no indications of farming during that period. Barfield (1989) states that around 1632 grain was always in short supply, but the reason why is not clear. Grain (as well as livestock and metal) was imported for the common people and to feed prisoners; luxury goods were imported for the elite.

From about 1725 to 1911 during the Manchu (Qing) occupation, farming was largely done by local labour around the monasteries (especially in the 19th century) and, into the 20th century, by Chinese settlers on local plots. The Manchu at first did not support the development of agriculture in Mongolia, but in 1715 the Kangxi emperor ordered the military to prepare suitable regions in central Mongolia for agriculture. Until 1911 military camps were maintained by the Manchu where millet, barley and wheat were cultivated (Bold 2001). Already in the 18th century Chinese farmers had come to Mongolia, with certificates or without, and settled there. Many took Mongol wives and at least a number of them supplied the local people with grain (Bawden 1982). Large scale industrial farming including sprinkler installations was initiated after ca.1960 by the state, while the local farming at favourable localities by nomads continued. Fodder was produced when industrial farming and husbandry were introduced in state farms. At present ca. 1 % of Mongolia is arable land (Petrov 1970, Forni 1995). Between ca.1960 and 1992 less than half this area was cultivated and less than 10% irrigated. Present large-scale farming is limited by the costs of labour and irrigation, which are high in relation to the price that can be realized for the products. Large scale vegetable production is entirely dependent on irrigation; in 1992, 20% of the potatoes was produced with irrigation and 10% of the fodder (Forni 1995). Farming occurs, or has occurred in the late 19th and in the 20th century mainly around Hovd and Ubsa Nuur, near the Khan Khuchei mountains, in Hovsgol, Bulgan, Selenge, eastern Khentey, Dornod and in the Gobi, producing grains, fodder, potatoes and vegetables (Petrov 1970; Friters 1949, pp. 27-8). Small plots are locally farmed for vegetables by the nomadic steppe population (Germeraad and Enebisch 1996, p. 91).

The oldest (Neolithic) sites with agriculture were located near water (a river, a lake), but there is no indication that this water was used for irrigation. Also the Xiongnu sites are located near water (the Ling wu and Ivolga rivers and probably other streams), but there is no indication that irrigation was used. How the Türk farmed is unknown, but from the Uighur period to the present irrigation is mentioned. The sources indicate only irrigated farming under the Uighurs, Khitans and Mongols in Mongolia, but it is likely that there was also farming on small plots without irrigation. Only in modern times is there a clear distinction between large scale farming without irrigation and irrigated farming. For the latter, success of the harvest depends on the availability of river water or ground water during the growing season (spring to summer) rather than on local precipitation. Apart from the availability of water, on the steppe the success of any farming depends on the absence of heavy frost or excessive rainfall during the growing and harvesting seasons.

Steppe farming in Mongolia: palaeotemperatures and palaeohumidity/precipitation

Although we know about agriculture on the steppe in the past only through scattered archaeological and historical records, we can attempt to investigate to what extent farming on the steppe was influenced by climate fluctuations by comparing those records with the estimates of temperature and humidity/ precipitation during the past few thousand years. After the last glacial period in the Pleistocene, that ended around 12.000 BP, a worldwide pattern of climatic improvement led to a thermal optimum that ended ca. 3500 BCE. Then there was a step-wise change to somewhat cooler conditions, that resulted in cooler and more arid conditions on the Eurasian steppe after 2500 BCE. Although Chen et al. (2003) estimated from sediment cores of Lake Yanhaizi (Inner Mongolia) that 2300–1200 BCE was still a relatively wet period, data from Uvs Nuur in northwestern Mongolia indicate that in that area the climate became dryer already after 3000 BCE, and dune sands were deposited over soil profiles formed during the previous more humid period (Grunert et al. 2000). On the southern Loess plateau in North China a more arid climate began around 1100 BCE (Huang et al. 2003).

For agriculture on the steppe after about 1000 BCE it is important to know to what extent water was available in the rivers during the growing season as well as the amount of precipitation during the growing season and the air temperature in summer and spring. Lack of water or prolonged winter frosts would prevent the grain from growing and ripening. A warmer climate with more snow melting in the mountains is favourable for growing grain, as more water is available in the rivers and spring temperatures would generally be higher. Former air temperatures can be estimated from the oxygen isotope ratio (δO^{18}) in organic material and in carbonate and from tree growth conditions that are indicated by tree rings, which are wider apart when conditions are better.

Pollen spectra in peat and sediments give general indications of climate conditions, as do palaeosols and ice cores. Tree rings and oxygen isotopes in organic material indicate temperatures during the growing season, ice cores indicate winter temperatures, and palaeosols indicate the general conditions of temperature and humidity. In addition to this there are historical records that indicate climate conditions, and recently climate modelling became a tool for understanding past climatic variations. As the records show, large volcanic eruptions with an enormous output of ash and aerosols can lower the temperature over a large part of the world for one or several years (Briffa et al. 1998). This occurred in 1453 (eruption in the South Pacific in 1452), 1601 (eruption in 1600 in Peru) and 1815-18 (eruption of the Tambora in Indonesia in 1815), but such short-term temperature drops are often not visible in local data.

Relevant for the climatic history of Mongolia during the last 3000 years are the palaeotemperature and paleohumidity/precipitation data, that were collected in Mongolia as well as in areas adjacent to Mongolia (Inner Mongolia, southern Siberia).[1] The palaeotemperature data are summarized in Fig. 1, those for palaeohumidity/precipitation in Fig. 3; data for both palaeotemperatures and palaeohumidity/ precipitation in the Baikal region, Mongolia and the Uiuk and Minusinsk depression (from Koulkova 2004) are given in Fig. 2. There is no agreement or synchronicity between the warmer and colder, or dryer and wetter periods at different localities. Warmer conditions occur at one locality at the same time as colder conditions at another. For example, in the Khitan period, when harvests were described as large, the climate may have been warmer (Hulun Buir, Fig.1.V) and more humid (Fig. 3.7), or colder (Tumo plain, Fig.1.VII) and more humid (Fig. 3. 3) or dryer (Telmen Lake Fig.3.1; Daihai Lake, Fig. 3.6). The warmer or colder, dryer and wetter conditions that are observed/estimated therefore reflect primarily local conditions and are not representative of a larger area.The transition to warmer or colder (and wetter or dryer) conditions in fact is more gradual than indicated in Figs.1 and 3, where sharp lines are drawn, but even if a gradual transition takes a century (from – 50 yrs. to + 50 yrs. from the line), there will be no more agreement or synchronicity between the various locations. An analogous comparison (by Rosen et al. 2000) of warmer and cooler/dryer and moister periods between 2000 BCE and 1500 CE in southern Kazakhstan, the Tien Shan mountains, and Lake Balkash, and pollen data in Kazakhstan and Siberia shows a similar lack of correlation, the data representing local/regional conditions. This local/ regional variation obscures the large worldwide changes in climate (as observed by Jones et al. 2009, and Chapman and Davis 2010). There is also no indication that low temperatures, or a rapid decline of temperature, north of China at the end of the Han (206 CE), Tang (906), Song (1279) and Ming (1644) led to the collapse of these dynasties and replacement by pastoral invaders from the north (cf. the contrary opinion by Zhang et al. 2010). It is more likely that the collapses were caused by internal conditions in China rather than by a temperature drop north of China.

The estimates of warmer, colder, dryer or wetter periods do not allow any conclusions whether during a certain period in Mongolian history, conditions for agriculture were more favourable or less. Also there is no agreement with the worldwide changes in climate (see Fig. 1.XI, after Jones et al. 2009). The large harvests under the Khitan and the disappointing harvests in Mongol times occurred in the same worldwide warmer period. This does not mean that the conditions may, or may not have been favourable, but that the available estimates of temperature and humidity/ precipitation do not show it. It seems more likely, therefore, that differences in farming techniques, or skills, were responsible for the differences in harvests, and not differences in temperature and humidity/ precipitation, or maybe the Khitan were just lucky with the weather. Or the size of the population that had to be fed may have led to disappointments, because harvests, although relatively large, were not sufficient.

Nomads and agriculture

Some interpretations have suggested that agriculture, or rather insufficient agricultural production, was at the base of the formation of the steppe states which existed in Mongolia (summary in Di Cosmo 2002). Prior to the population of the steppe by nomads in ca.1000 BCE, in its border regions there was nomadism on a smaller scale in combination with some form of sedentary life and animal husbandry. Khazanov (1984) distinguished a first phase of sedentary animal husbandry (presumably early in the second millenium BCE), that was induced by a change to a more arid climate which made farming less rewarding. This was followed by a second phase of semi-sedentary pastoralism, a third phase of husbandry in herds, using more distant pastures, and a fourth phase of semi-nomadic pastoralism and pastoral nomadism, which spread over the entire Eurasian steppe. Because of the need for protection on the steppe, an upper class of nomads emerged whose main occupation seems to have been warfare (Di Cosmo 2002). They appropriated the wealth obtained by trading with or looting the sedentary communities outside the steppe.

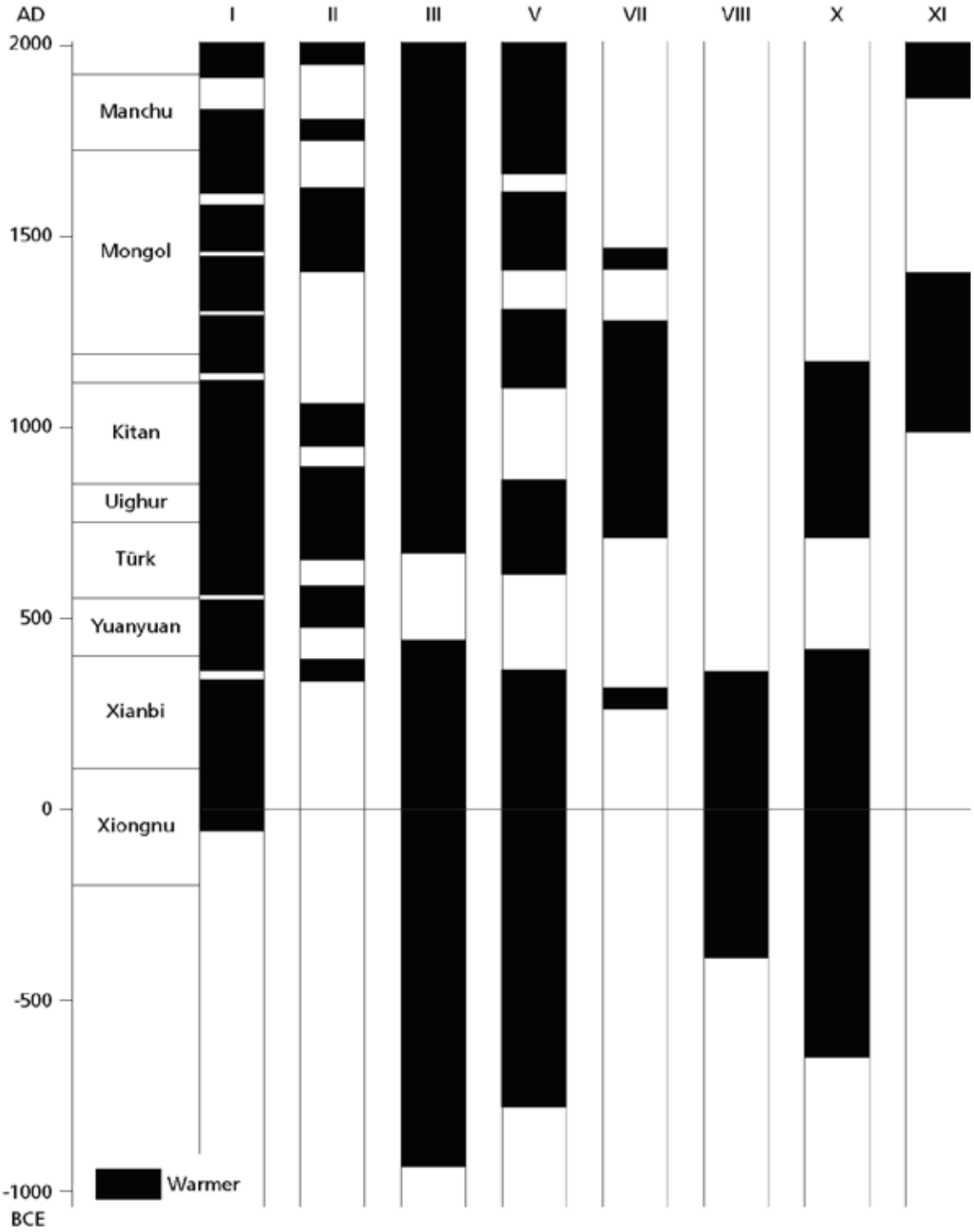

Fig.1. Estimated periods with higher temperatures in Mongolia and adjacent regions. Shaded areas: periods with higher temperatures than before or after.

I. West Mongolia (tree rings), data from Jacoby et al. 1996, d'Arrigo et al. 2001.
II. West Mongolia (lake sediments), data from Shinneman et al. 2010.
III. Inner Mongolia, Lake Zhuyeze, data from Fa Hu Chen et al. 2006.
V. Inner Mongolia, Hulun Buir (lake levels), data from Jule Xiao et al. 2009.
VII. Inner Mongolia, Tumo plain (historical records), data from Chen Guangming 1988.
VIII. Minusinsk, Kutuzhekovo Lake, data from Zaitseva et al. 2004.
IX. Jinchuan (Jilin) (peat bog), data from Hong et al. 2000.
X. North China, data from Jenkins 1974.
XI. Worldwide, data from Jones et al. 2009, Chapman and Davis 2010.

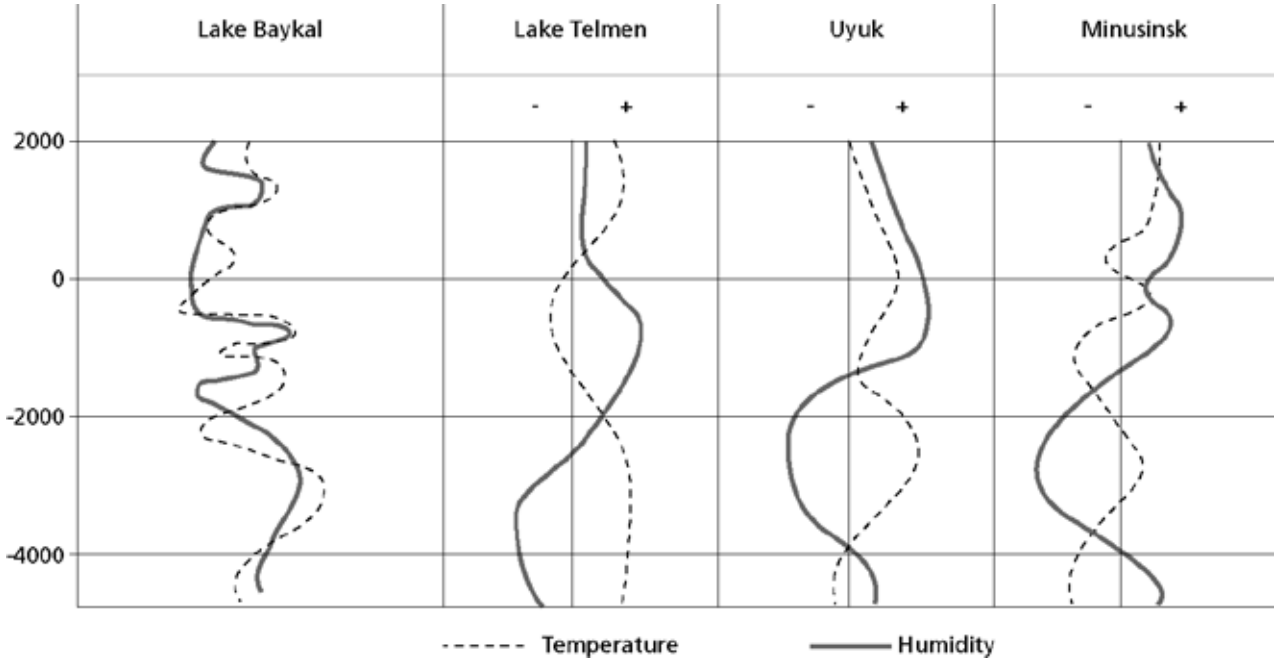

Fig 2. Estimated records of high and low temperature and humidity in the Baikal region, Mongolia and the Uyuk and Minusinsk depressions. After: Koulkova 2004.

North China protected itself against the looting and the raids with walls, fortresses and soldiers. While some have assumed that the nomads' response was to unite and form a steppe state, in at least certain cases this was not so. The Xiongnu state formed intially as a reaction to an invasion from China (by the Qin). The Türk and the Uighur states were the result of successful rebellions. In creating the Mongol state Chinggis Khan was motivated to expand into border states initially by a desire for tribute, spoils and prisoners (artisans) and to gain free passage for trade caravans, but not specifically to acquire agricultural products. Indeed it is impossible to determine whether there was a shortage of agricultural products among the nomads impelling them to trade with the farmers or to rob them. Di Cosmo (2002) argued against this hypothesis, citing the absence of any evidence in the archeological and historical records. Imports of grain from China — annual "gifts" — were only in small amounts; some degree of farming was present among the nomads themselves. Nomad raiding parties into the sedentary communities took away animals and people, not agricultural products; trading was done mainly to exchange silk for horses and other livestock. This could only be done in periods of relative prosperity on the steppe, when there was a surplus of horses and sheep. Farming was done near the steppe from Manchuria to the Tarim Basin but the commercial and economic relations of the steppe states were with the city states and non-Chinese agro-pastoral communities that lived alongside or within the steppe, and not with farming communities of interior China. Although there were many raids and wars between steppe states and the bordering sedentary states, both sides tended to incorporate territories with people (farmers) and livestock, so that the border regions became a combination of both nomadic and sedentary communities.

All these arguments make it plausible that agriculture was not an important factor in the formation of steppe states. Most archaeological and historical evidence for agriculture in Mongolia pertains to those steppe states where at least part of the population was concentrated in settlements: fortified villages among the Xiongnu (Ivolga was exceptionally large); towns and smaller settlements under the Uighurs, the Mongols, the Manchus and in the 20th century; military camps under the Khitan, the Mongols, the Manchus; monasteries in the Manchu period; and, in the 20th century settlements stimulated by Communist economic policy. To feed these concentrations of people agricultural products were needed, and local production had to increase. For the steppe states that did not build settlements (the Xianbi, the Juanjuan and the Türk) the evidence of agriculture is sparser or absent, and the same applies to "stateless" periods when Mongolia was inhabited only by tribes and tribal confederations. This does not mean that there was no agriculture, but rather that plots were scattered and few traces have been left. Also few graves from these periods have been found or excavated.

It seems then that, when needed, agriculture to a large extent was organized by the rulers of the steppe

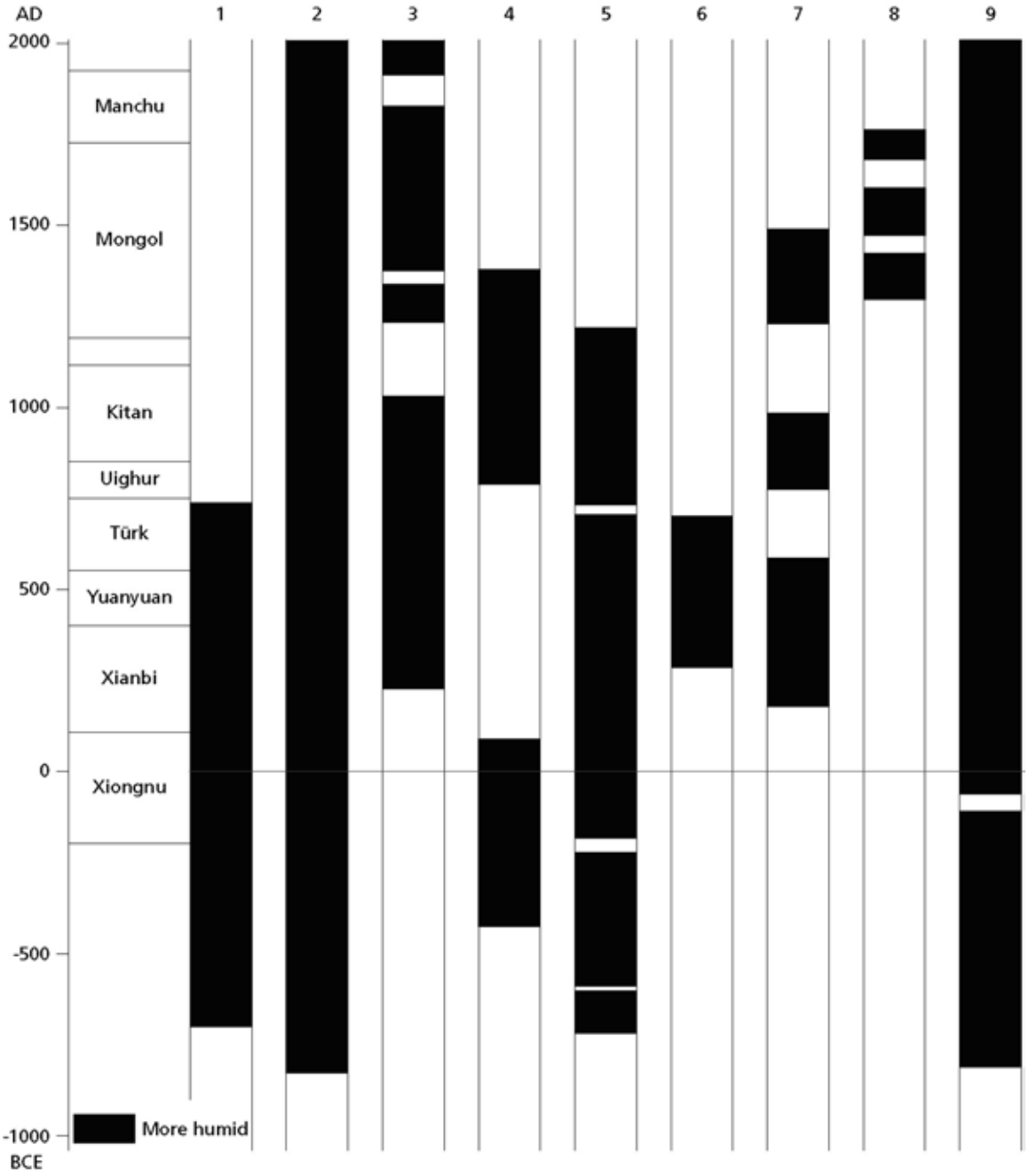

Fig.3. Estimated periods with higher humidity/precipitation in Mongolia and adjacent regions. Shaded areas: periods with higher humidity/precipitation than before or after.

1. *NW Mongolia, Telmen Lake, data from Peck et al. 2002.*
2. *NW Mongolia, Uvs Nuur, data from Grünert et al. 2000.*
3. *Inner Mongolia, Tumo plain (historical records), data from Chen Guangming 1988.*
4. *Inner Mongolia, Lake Zhuyeze, data from Fa Hu Chen et al. 2006.*
5. *Duowa, Qinghai (caves), data from Maher and Hu 2006, Maher 2008.*
6. *Inner Mongolia, Daihai Lake, data from Jule Xiao et al. 2006.*
7. *Inner Mongolia, Hulun Buir (soils), data from Li and Sun 2006.*
8. *NE China (groundwater), data from Gates et al. 2008.*
9. *Minusinsk, data from van Geel et al. 2004a, 2004b.*

states who also built settlements. It is likely that they did this because they feared a shortage would develop if they did not. An increase in settlements presumably coincides with an increase in populations needing to be fed. The Uighurs imported merchants and probably also artisans and officials, who lived in the towns around which also agriculture was concentrated. The Mongols imported both farmers from Central Asia and merchants and artisans, who came to live in Karakorum. Large amounts of grain imports from northern China were required, as local production was insufficient. Shortages might result when an army was stationed in Mongolia, as under the Khitan, the Mongols and the Manchus (who founded military farms), or when an increasing number of steppe nomads was not engaged in agriculture any more (e.g. because they were engaged in war). In the latter circumstance, agriculture was probably maintained by conscripting farmers. This involvement of the Khans with agriculture points to a possible motive for the formation of a nomad state: it was expected of a Khan to take care of the grain supply. If agricultural products are part of the daily meal, an assured constant supply is needed. This cannot be assured by raiding the settled communities or by trading with them, but only by a safe and constant production, by local farming, by importing farmers or by occupying productive areas.

For other steppe states the evidence is less clear. The Xiongnu imported Chinese farmers but probably not in very large numbers. Perhaps there was little need for them if, as seems likely, the population decreased when the Xiongnu expanded into the "Western Regions." One might also posit a decrease in population to occur when large numbers of them were scattered over northern China after the Southern Xiongnu had separated themselves from the Northern Xiongnu, and, defeated, the remaining Xiongnu moved westward (Yü 1990). If there were shortages of agricultural products in the Xiongnu period, they would have occurred in times of armed conflict. The Xianbi, the Juanjuan and the Türk may also have used Chinese farmers for agriculture in Mongolia (Hayashi 1990). The Türk used the Chinese in the border region north and east of the large bend in the Yellow River and in the region of present-day Hohhot, and invaded northern China to obtain the grain they needed (Hayashi 1990). Even if they did not build settlements, the Türk rulers showed they recognized a need to develop agriculture: Qap Khan invaded North China with the intention to settle farmers there. These were the areas with more favourable conditions for agriculture than might be expected on the steppe. There are no data to establish to what extent and in what numbers Chinese may have been employed in Mongolia but not in neighbouring regions. Both the Xiongnu and the Türk could have obtained agricultural products from the sedentary regions they occupied.

After a steppe state with settlements ended, the settlements and towns were deserted and the population was dispersed. At the end of the 1st century CE, when the Xiongnu suffered heavy losses against the Chinese Han armies and the Xianbi, many fled to China or elsewhere, the settlements were abandoned and finally the Xianbi took over the territory vacated by the Xiongnu (Yü 1990). After their defeat by the Kirghiz the Uighurs moved west in large numbers to present-day Xinjiang. Defeated by the Jurchen, the Khitan likewise left Mongolia, some ending up in Manchuria, others in Central Asia. Driven out by the Ming, the Mongols in China returned to Mongolia, where they took up nomadic steppe life again. With the end of Qing rule in Mongolia in 1911, we see a similar pattern. In all these cases nomadic life became dominant again on the steppe. After the fall of the Manchu, when the Manchu army and the Chinese left but many Mongol continued to live in monasteries and in some settlements (mainly regional administrative centres), nomad life dominated (even today about 40 % of the population lives as nomads on the steppe).

As there is no indication of large imports of grain, or robbery, local agricultural production, at least partly carried out by Chinese farmers, probably was sufficient. Yet it seems likely that agricultural production was low and risky and with failures when it was too cold or too wet; so rulers of steppe states with settlements or towns without exception found it necessary to organize a good production of cereals and vegetables (and the Türk found it necessary to invade North China). In the absence of clear evidence to the contrary, there remains a possibility that during the predominantly nomadic periods shortages of agricultural products may have occurred. This may have led to some trading with, or looting of the farmers along the steppe borders, events not important enough to be mentioned in historical records.

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Note

1. In western Mongolia data were collected at the Tarvagatay Pass and Solongotyn Davaa (tree rings, Jacoby et al. 1996; d'Arrigo et al. 2001) and at several lakes (sediment cores, Shinneman et al. 2010). In Inner Mongolia data were collected at Lake Zhuyeze (Gansu) (pollen records, Chen et al. 2006), at Daihai Lake (sediment cores, Xiao et al. 2006), at Hulun Buir (Hulun Nur, Hulun Lake) (lake levels, Xiao et al. 2009), at the Tumo plain (historical data, Chen 1988). Estimates for the summer monsoon were given by Sheng–Hua Li and Jimin Sun (2006) and Feng et al. (2006). Northwest of Mongolia in the Minusinsk valley data were collected at Kutuzhekovo Lake (sediment cores, Zaitseva et al. 2004) and in the the Jinchuan peat bog in Jilin, northeastern China (oxygen isotopes, Hong et al. 2000). For northern China data had been collected by Jenkins (1974); more recent estimates of worldwide temperature changes during the last millenium are taken from Jones et al. 2009 and Chapman and Davis 2010.