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Chapman J., Gaydarska B.

THE PROVISION OF SALT TO TRIPOLYE MEGA-SITES

Introduction

The Tripolye mega-sites are widely recognised as extraordinary settlements - the largest in prehistoric Europe in the 4th millennium CAL BC (Šmaglij 1982; Kruts 1993; Videiko 1996). The concentration of people living in such huge communities makes their eating and drinking an important research problem. It is particularly striking that their local and regional palaeo-environments do not include any sources of salt, with the possible exception of the river Sinuka. It is highly probable that salt was required not only for humans but also for a dietary supplement for animals in this period, especially given the development of domestic-based dairy production, as well as for a range of other purposes. If we make the assumption that the inhabitants of the Tripolye mega-sites required a steady supply of salt each month and every year, there are major implications for trade and exchange. In this paper, we shall explore these implications for the later prehistory of Eastern Europe.

The demand for salt

There are two basic approaches to the demand for salt. One is that salt is a physiological necessity, a function of nature and biology; the other is that the consumption of salt is a cultural practice, a semiotic marker leading to the creation of social distance between those who possess it and those who do not.

There is a widespread acknowledgement that salt is a physiological necessity for humans (Gümpel 1989; Denton 1982; Multhauf 1978). According to the AD 17th century Chinese writer, Sung Ying-hsing, man without salt for a fortnight "would become too weak to tie up a chicken and feel utterly emaciated." The decrease in meat and fish protein and their partial replacement by plant-based products at the onset of the Neolithic meant a steep decline in the level of salt provided by a "normal" diet. It has been calculated that, if herbage for animals can provide between 1g and 2.3g of salt per kg dry matter, then grain provides even less than grass (Pickard 1986). Thus it is likely that the corollary of a cereal-rich diet is the need for salt supplements in some shape or form (e.g., extra meat or fish consumption). Tasić (2000) has argued that the beginning of the Neolithic inevitably stimulates an increased demand for salt (cf. Weller 2002). Both Adshead (1992) and Multhauf (1978) provide estimates for the physiological requirements of humans for daily salt intake (Table 1).

But the consideration of salt from a purely physiological standpoint is an overly narrow view, which ignores the recent insights from food research that food is a multi-dimensional social practice (Teuteberg 1992: 5; see here Table 2). Salt is the cause of edibility, enhancing other flavours. Multhauf (1978:4) terms salt the "primordial addiction." Although under certain dietary regimes, humans can live healthily without salt supplements, any experience of the taste for salt can lead to a longer-term demand which would have important social consequences.

A further dietary change is even more significant in stimulating additional demand for salt - the consumption of dairy products. Table 3 (source: Rosenthal 1991) lists those dairy products which require salt for their production. The increasing evidence for dairying from the beginning of the European Neolithic (Evershed 2002 et al.; Craig 2002; Craig et al., in press) confirms an additional reason for demand for salt. Additional social practices raising salt demand include the use of salt in the preservation of meat and fish its use in medicaments (Adshead 1992:25) and its use in production processes such as pottery-making and tanning (Erdogu et al., 2003).

Another social practice which would create a major increase in the demand for salt would be the provision of salt as a supplement for animals. According to the animal physiologist J. G. Morris (1992), most animals obtain their mineral requirements from their normal diet, without seeking specific foods rich in minerals or salt. However, the exception is the ruminants, which actively seek out salts of sodium and have a specific appetite for sodium (1992: 269). Pickard (1986:80) specifies a decline in milk yield through dehydration as a result of salt deficiency for ruminants, while Rebhun (1995:508) notes a loss of appetite, weight and production. Table 4 (source: Multhauf 1978:3) lists a range of estimated salt requirements for ruminants.

To summarise, increased demand for salt was a consequence of changing dietary preferences away from meat and fish towards cereals and/or the towards dairy products. There is strong recent evidence from Cucuteni - Tripolye communities to support a wide range of secondary products (Monah D. & M. 1997:70

TABLE 1 PER CAPITA PER DIEM SALT REQUIREMENTS FOR HUMANS

M. Bloch 1970	1 - 2 g
Dauphinée 1960	5 - 10 g
Adshead 1992	6 - 12 g (physiological minimum = 4 g)
Kaufmann 1960	10 g
Milne-Edwards 1850	12 g (22% added)
Nenquin 1961	12 - 15 g
Multhauf 1978	12 g (individual alimentary)
Verhille 1968	20 g (50% added)

TABLE 2 SOCIAL AND PSYCHIC FUNCTIONS OF FOODSTUFFS AND LUXURIES (after Teuteberg 1992: Table 1.1)

1. Prestige products
   - o are regarded as personal attributes
   - o serve as a mark of exhibitionism
   - o underline a social elite position

2. Status products
   - o enable socio-cultural identification
   - o show social group conformity

3. Fetish and security products
   - o are consumed in situations of social stress to gain emotional safety
   - o serve as 'ego-boosters'
   - o food for children, the sick and the elderly

4. Hedonistic products
   - o are consumed to satisfy desire on basis of taste, fragrance and appearance

5. Functional products
   - o serve exclusively as physiological supply
   - o have no deeper significance

are symbolically neutral

- 73). Moreover, a wide range of cereals has been identified from Cucuteni and Tripolye settlements (Monah M. & F. 1997:67 - 70; Pashkevitch 1997). It is therefore highly probable that the diet of Tripolye-Cucuteni residents would have diversified to include a major cereal component and a dairy component of unknown importance. This provides the pre-conditions for the requirement of salt supplements for both physiological and social reasons.

The demand for salt in Tripolye-Cucuteni settlements

In this section, we develop estimates for the demand for salt in Tripolye-Cucuteni settlements of a range of different sizes. These estimates are based upon four values for salt intake:- low, medium, high and an élite preference model, in which 20% of the inhabitants have a high intake and the remaining 80% have a low intake. The standardisation of the estimation is assisted by the use of what we have termed the "basic village module" - a group of 100 people, keeping 30 cattle and 150 sheep. This is based on the overall village subsistence model developed by Robin Dennell for the Bulgarian tell of Chevdar (Dennell 1978). The results (Table 5) indicate that the selection of even a low salt intake implies an annual requirement of 450 kg, rising to over a 1,000 kg of salt per annum for a high-level intake. The élite preference model lowers overall demand to between the medium- and high-level intake, while increasing social distance. An interesting aspect of this model is that more salt is fed to animals than to humans. This may be an unrealistic practice in prehistory but we wish to emphasise that the figures provide nothing but global estimates - not an attempt at spurious accuracy.

The figures for the "basic village model" are used to estimate salt requirements for five Tripolye-Cucuteni

sites and two regions (Table 6). The range of *per annum* estimates for the small Cucuteni A settlement of Tîrpeşti (Marinescu-Bîlcu 1981), with a population estimated at 165 inhabitants, covers over 500 kg to over 2,000 kg. With the larger Cucuteni A settlement of Hăbăşeşti (Dumitrescu 1954), with an estimated population of 500, the figures for estimated salt requirements rise sharply to over 2,000 kg up to over 6,000 kg *per annum*. Broadly comparable figures pertain to the Tripolye B settlement of Pescanaja, with an estimated population of 600 people (Kruts 1989). The estimates rise even more steeply in the case of the 50-hectare Tripolye B settlement of Jatranovka (Kruts 1989), with requirements ranging from over 7,000 kg to over 20,000 kg *per annum*. The figures become vast for what is by no means the largest of the Tripolye mega-sites - the 180-hectare Majdanetskoe (Videiko 1996), with requirements ranging from over 36,000 kg to over 100,000 kg *per annum*. These are almost unbelievable figures, yet it has been estimated that Tallyanky required over 2 tons of flint per annum (p.c., M. Videiko), so the movement of huge quantitites of raw materials is not in doubt. At the regional level, Kruts' population estimates for the Uman region involve a mean population density of 5 persons/km^2, leading to a total estimated population of over 2,500 (Kruts 1993). Here, the *per annum* requirements for salt range from over 10,000 kg to over 35,000 kg. For the Bug-Dniestr micro-region, containing 1 mega-site and two small sites (Kruts 1993), the *per annum* estimates reach almost 125,000 kg.

These figures leave us in a dilemma. Either there is a massive over-estimation of salt requirements for these later prehistoric settlements or there is a salt trade on a scale which many specialists and salt historians could not possibly contemplate. Adshead is particularly scathing about the possibility of long-distance, bulk trade in prehistoric times:

"the argument ... that salt was a major item of early circulation whether by gift or exchange is dubious. Except in minimal quantities which most diets provided without deliberation, salt was an inessential, a relative luxury ..... in addition, a bulky luxury." (Adshead 1992: 23)

Adshead argues that, without sophisticated water transport, there could have been no bulk trade in salt. So, in the Classical world, according to Pliny, there was no long-distance trade in salt because no technique could carry the costs of sea-transport (Adshead 1992:31). But in a prehistoric world where the economics of supply and demand were not so constraining as in the Roman period, this possibility should not be

TABLE 3 DAIRY PRODUCTION AND SALT REQUIREMENTS

MILK	highly perishable
BUTTERMILK	salt required for production
BUTTER	salt required for production
CURD CHEESE	salt required for production
HARD CHEESE	salt very commonly added
YOGHURT	salt not required for production
SOUR CREAM	salt required in production
WHEY	pig fodder (90% of milk for cheese remains as whey)
FERMENTED PRODUCTS	salt not required for production

TABLE 4 PER CAPITA PER DIEM SALT REQUIREMENTS FOR ANIMALS

PIG		HORSE	
Multhauf 1978 (experimental data)	very little (normal diet)	Michigan State College	7 g
SHEEP			
		Nenquin 1961	50 g
Nandris 1987	10 g		
		Mollat 1966	50 g
CATTLE			
Babcock 1905	28 g (experiments)		
Nenquin 1961	100 g		
Mollat 1966	100 g		

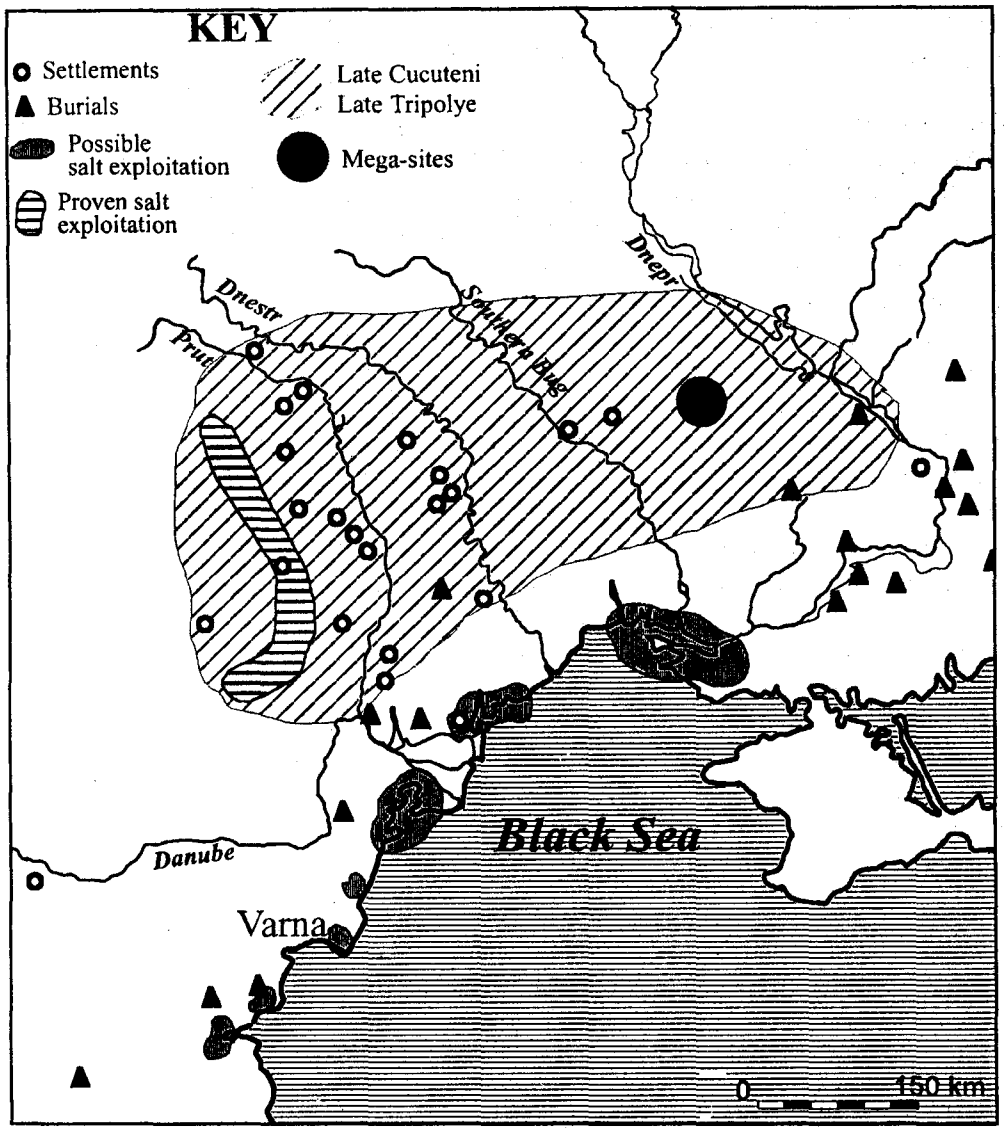

Fig. 1. Potential salt sources for Tripolye mega-sites

immediately dismissed. We now turn to the potential sources of salt for the Tripolye mega-sites.

Sources of salt for Tripolye mega-sites

There are three conditions of pasturage in which the addition of salt is not necessary for ruminants:- (1) proximity to the sea, leading to the growth of salt-rich pastures; (2) presence of coeval salt-rich soils, such as szik, solonchak and solonetz; and (3) insufficient precipitation for the leaching of surface salts through the soil profile. However, none of these conditions applies to the inland Tripolye mega-sites.

There are three potential zones from which salt sources are known or suspected:- (1) the Black Sea coast, including the Crimea; (2) areas to the East (the Volga Basin, Western Georgia); and the Eastern Carpathian piedmont zone (Fig. 1).

In the Black Sea zone in later (Classical) periods, coastal limans concentrated the salt water from the low-salinity Black Sea to provide a saline-rich brine concentrate used for local consumption and for export. Herodotus mentions these lagoons in connection with the pickling of sturgeon at the mouth of the Dniepr (quoted in Adshead 1992:28). Dio Chrysostom (Orations, 36th Discourse) mentions the large number of salt-works at Olbia, where Greeks, Scythians and barbarians buy their salt. Byzantine salt production in the Black Sea was also concentrated on the natural limans between the mouths of the Bug and the Dniestr, on the South coast of the Crimea and as far East as the Kerch straights (Adshead 1992: 64). The German traveller J. G. Kohl provides an account of limans at the mouth of the Dniepr, in which he records the spontaneous evaporation and deposition of salt by the end of July; he records a total production of over 1 million kg of salt in the year 1826 (Kohl 1842). According to Multhauf (1978:35), the most important of the Crimean limans was Perikop, which produced more than half of all the salt from the Crimea in 1832 and a third of the total Russian salt production for that year.

It is conceivable that the North Black Sea and Crimean saline limans were already in existence in the Late Neolithic - Chalcolithic and that these were exploited for trade North into the forest-steppe. However, there have, as yet, been no discoveries of prehis-

toric pottery near these limans, possibly because no-one has looked in detail for briquetage or other tell-tale artefacts.

One of the authors (BG) has identified a number of Neolithic and Chalcolithic sites near potential salt sources on the Western (Bulgarian) Black Sea coast. Palaeo-environmental work in this region indicates the existence of four super-salty limans but their age is not yet understood. There are no known sites close to two of these super-salty lakes (Taukliman and Balchiska tuzla) but this is because the limestone caves in the vicinity of each liman have not yet been explored. There is a Copper Age tell within 2 km of the shore-line of the third lake, Atanasovskoto Ezero, while a flat site with Late Neolithic and Copper Age ceramics is known near the fourth lake - Shablanska tuzla. The Bulgarian research into coastal limans may well shed light on the situation on the Northern shores of the Black Sea (Gaydarska, in press). But it is important to note that there have been significant changes to the coastline since the Bronze Age near the most important liman in Ottoman times - Anchialos (modern Pomorye). There are also three currently-known salt springs in inland North East Bulgaria site; one spring is located at the modern salt-works of Provadia, with a Copper Age tell next to the salt spring.

In the areas to the East of the Tripolye mega-sites, the Volga Basin is the first zone where industrial-scale salt sources are known (Lydolph 1970). As far as is known to this author, there are no known prehistoric sites which lie adjacent to the salt lakes of Baskunchak and Elton (Lydolph 1970:105) or the rock salt sources of Artemovsk and Solikamsk (Lydolph 1970:526) but it is clear that further research is badly needed within the settlements of the Khvalynsk group. Clearer evidence has been found at the West Georgian salt-pans, where pottery dating to the Iron Age (1st half of the 1st millennium BC) is associated with rectangular fired clay basins and briquetage (Solovyev 1950). However, no earlier material has been reported (Nenquin 1961:98-9).

Finally, research by scholars such as Dan Monah, Gheorghe Dumitroaia and Marcius Alexianu in the third zone - the East Carpathian piedmont zone of Moldavia - indicates the frequency of salt springs and rock salt sources in areas demonstrably settled by Cucuteni communities (Monah, D. 2002) as well as in the Early Neolithic (Dumitroaia 1994; Chapman et al., in press). Dan Monah and the main author have hypothesised that the reason for the long-term existence of the Poduri tell - the only tell known in the Cucuteni - Tripolye groups - is connected to local exploitation for export to the East of salt from salt springs lying close to the tell (Chapman et al. 2001; Monah, D. 2002).

There are potential salt sources in the North West Ukraine, near Lvov and Uzhgorod (Lydolph 1970:Fig. 5-9), but no details of these sources are known to us.

To summarise, there is unequivocal evidence of Cucuteni settlement near salt springs in the Moldavian piedmont and of Chalcolithic settlement near two super-salty lakes and one salt spring on the Bulgarian Black Sea zone. Further fieldwork is necessary to investigate later prehistoric exploitation of the remaining two super-salty lakes in Bulgaria, all of the limans in

TABLE 5 SALT REQUIREMENTS OF BASIC VILLAGE MODULE OF 100 PEOPLE, 30 CATTLE AND 150 SHEEP

PER DIEM	LOW	MEDIUM	HIGH	ÉLITE
100 PEOPLE	0.5 kg	1 kg	1.5 kg	0.7 kg
30 CATTLE	0.3 kg	0.45 kg	0.75 kg	0.75 kg
150 SHEEP	0.45 kg	0.9 kg	1.5 kg	1.5 kg
TOTAL	1.25 kg	2.35 kg	3.75 kg	2.45 kg
MONTHLY				
100 PEOPLE	15 kg	30 kg	45 kg	21 kg
30 CATTLE	9 kg	13.5 kg	22.5 kg	22.5 kg
150 SHEEP	13.5 kg	27 kg	45 kg	45 kg
TOTAL	37.5 kg	70.5 kg	112.5 kg	88.5 kg
ANNUAL				
100 PEOPLE	180 kg	360 kg	540 kg	252 kg
30 CATTLE	108 kg	162 kg	270 kg	270 kg
150 SHEEP	162 kg	324 kg	540 kg	540 kg
TOTAL	450 kg	846 kg	1,350 kg	1,062 kg

TABLE 6 ESTIMATED TOTAL SALT DEMAND FOR PEOPLE AND Ş ANIMALS IN TRIPOLYE-CUCUTENI SITES AND AREAS

SITE / AREA	LOW	MEDIUM	HIGH	ELITE
TÂRPEŞTI (CUCUTENI A) POPULATION OF 165		569 kg	1,404 kg	2,240 kg 1,758 kg
HĂBĂŞEŞTI (CUCUTENI A) 500	2,262	4,255	6,787	5,327 POPULATION OF
PESCANAJA (TRIPOLYE B) 20 ha: >600 PEOPLE	2,715	5,160	8,145	6,393
JATRANOVKA (TRIP B) 50 ha: 1,500 PEOPLE	7,335	13,860	22,005	16,750
MAJDANETSKOE (TRIP B) 180 ha: 8,000 PEOPLE	36,200	68,080	108,600	85,240
UMAN REGION (530 km^2 @ 5 persons/km^2)	11,991	22,551	35,973	28,235
BUG-DNIESTR MICRO-REGION (1 LARGE + 2 SMALL SITES)	41,630	78,292	124,890	98,026

the Northern Black Sea and Crimean zones and in the Volga Basin and Western Georgia.

To what extent does existing knowledge about exchange between the Tripolye zone and the three potential salt sources provide confirmation of salt trade routes ? The general point is that the entire North Pontic zone, from the Volga to Varna, is connected through prestige goods and possibly other forms of exchange. The dense distribution of exotic materials and objects in both Cucuteni and Tripolye zones indicates a strong, pre-existing social network stimulating the movement of raw materials and things between Ukraine, Moldova and Moldavia (Rassamakin 1999; Chapman 2002). But Rassamakin (1999) also discusses prestige goods and lithic exchange between the Skela and later groups and the Khvalynsk group; it should not be forgotten that the Khvalynsk cemetery contains imported copper objects of Varna - Gumelniţa type (Rassamakin 1999: 104).

However, although links between the Tripolye core area and the Eastern Carpathians are demonstrably the strongest, the objection to bulk salt trade between these two areas can be made on the basis that riverine bulk transport is much more effective (p.c., D. Monah). Thus, Monah's understanding is that South East - North West exchange routes, following the main North Pontic valleys, is more probable than West - East trade routes across the interfluves. However, there is a substantial series of nine rapids at Zaporozhye on the Dniepr - the river providing the most direct approach to the Tripolye mega-sites, which would have made upstream bulk salt transport rather hazardous. Nevertheless, Monah's point is well taken and it is possible that, without some form of wheeled transport, bulk transport of salt across the interfluves would have been difficult, even over an undulating and relatively open landscape, with grass-herb steppic conditions and broad-leaved tree species (Kremenetski 1997:280-281).

However, the development of wheeled transport would have been an important breakthrough. Although several specialists have followed Stuart Piggott (1983) in dating the invention of wheeled transport to the late 4th millennium CAL BC, several hubbed wheel models from secure Eneolithic stratigraphic contexts have been published (Dinu 1981). These include models from several Cucuteni phases, including phase A2, the Gumelniţa A2 phase, the Turdaş -Petreşti group and the Ariuşd group. None of these models can be dismissed as "large spindle-whorls" and their stratigraphic context is more secure than, e.g., the large fired clay wheel model from an undetermined context on tell Bikovo, Bulgaria. These finds imply the potential significance of the movement of bulk goods, of which two possibilities are proposed. The first is local arable produce, with the diversification of land use and the location of some fields far from large settlements. The second is the bulk transport of salt across open interfluves or indeed up and down open river valleys. Pollen analysis from the forest steppe zone indicates that even the main valleys of the North Pontic zone were only lightly wooded until the late 2nd millennium CAL BC.

Conclusions

It can be concluded that the Ukrainian forest-steppe in which the Tripolye mega-sites were located was lacking in one of the most important resources for eating, food storage, possibly animal breeding and probably small-scale local production processes. In this paper, we have discussed the potential scale of the

bulk salt trade required for a range of estimates for Cucuteni and Tripolye settlements. These estimates range from as little as 500 kg per annum for small sites such as Tîrpeşti and over 100,000 kg per annum for Tripolye mega-sites such as Majdanetskoe. The consumption of even a small fraction of the estimated demand for salt would have required a major logistical achievement - the organisation of the world's first bulk trading network. Arguments for three different source areas for salt were rehearsed, with the evidence for coeval (i.e., Eneolithic) sites in close proximity to known salt sources currently known only from the Bulgarian Black Sea coast and the Eastern Carpathian piedmont. The intensity of non-salt exchange networks is currently greatest between the Carpathian zone and Eastern Ukraine. However, riverine movement of salt may have been easier than bulk land transport across the forest-steppe interfluves, even given the introduction of wheeled transport in the Eneolithic period. The most important conclusion is that further fieldwork and small-scale excavation is urgently required in the limans of the North Pontic coastline and that of the Crimea, to determine the likelihood of Eneolithic exploitation of the limans of the Northern Black Sea coast.

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