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Subsistence in the Late Bronze Age of the northern Black Sea region: a case study of Taraclia-Gaidabul (Republic of Moldova)

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Abstract: The site of Taraclia-Gaidabul belongs to a type known as ash mounds, although it is now known that they do not in fact contain ash at all. The ash mounds represent settlement remains of the Noua-Sabatinovka-Coslogeni cultural complex, which is found in the northern Black Sea region. There is an ongoing debate about the subsistence of this Late Bronze Age society: were they mobile pastoralists or settled farmers?
Unfortunately, there is a lack of pollen diagrams for this region and period, so landscape reconstructions are difficult. Nevertheless, it seems that the landscape was characterised by forest steppe in the north and dry grass steppe in the south. Arable farming would have been challenging without artificial irrigation. Because archaeobotanical remains are scarce, it is hoped that the faunal analysis of Taraclia-Gaidabul can contribute to the question of subsistence and lifestyle: mobile or settled.
During four excavation campaigns (2016–2019), more than 15000 animal bones were recorded and studied. Results from the zooarchaeological analysis show a dominance of cattle, followed by sheep and goat and horse. Pig is rare and wild animals also played only a minor role in nutrition, although the variety among the small number of wild animal remains is considerable. It seems that cattle were exploited for both milk and labour, while sheep and goat provided meat, wool and milk. Horses were used for transport, an additional source of meat and perhaps also for milk. Animal remains provide some indications that the settlement was occupied all year round. This paper will place the results of the faunal analysis for Taraclia-Gaidabul in a wider context through a regional comparison of subsistence strategies.

Keywords: Late Bronze Age, Republic of Moldova, ash mound, subsistence, pastoralism

Introduction

The region north of the Black Sea is characterised by two different types of steppes: grass steppe and forest steppe. The region is further characterised by a continental climate. According to Walter,[1] the climatic conditions in the Eastern European steppe zone change from north-west to south-east. The average temperatures rise and, as a consequence, evaporation increases. Precipitations, on the other hand, decreases. Another factor that affects vegetation is the soil. Walter describes the forest steppe as a transitional area between forest in the north and steppe in the south. It forms a mosaic of deciduous forest and grass steppe. The geomorphological relief and soil type determine which vegetation predominates in particular micro regions. In the south, stipa-grass-steppe dominates on *chernozem* (black soil). It is uncertain whether the modern division in climate and vegetation between these two types of steppes would have been similar in the Late Bronze Age due to a lack of pollen diagrams for this region

[1] Walter 1977.

and period. While arable farming is normally challenging in this environment, differences from today's climate might have made this more feasible in the past. Today, arable farming is only possible with artificial irrigation. It has been repeatedly stated in scientific literature that in the 2nd millennium BC the climatic conditions in steppe and forest steppe north of the Black Sea changed.[2] After a dry and warm phase, the climate would have become much more humid and probably colder. However, Bostonalieva[3] diachronically evaluated different paleoenvironmental archives for western Eurasia. One hundred proxy data for 66 sites from the steppe zone showed that after a warm and dry phase, which started around 3000 cal BC, the climatic conditions changed to "cold and humid" only after ca 1000 cal BC, so after the period this paper is concerned with.

There is an ongoing debate about the subsistence of Late Bronze Age societies in the western Eurasian steppe: was the life of Late Bronze Age people based exclusively on animal husbandry or did they also practise arable farming? A second, closely linked question about the subsistence economy is related to the degree of mobility: were Late Bronze Age people mobile pastoralists, settled farmers or something in between?

The reconstruction of the subsistence economy of inhabitants of the steppe zone in prehistory is a controversial theme. In Soviet times, the paradigm that animal husbandry was established early in these dry areas was developed. After all, it was believed that it was only through specialising in animal husbandry that an efficient economy was possible.[4] However, both in Soviet times and the following decades, there was a lack of settlement excavations with systematic sieving for macrobotanical remains. Archaeobotanical research was mostly based on analyses of impressions of cereal grains and seeds in ceramic and daub fragments.[5] Animal bones, on the other hand, were analysed systematically relatively often. Nevertheless, Morales Muñiz and Antipina[6] state that, for over 30 years, the same questions have been discussed again and again. They used the example of faunal material from settlements of the Srubnaya cultural complex, which is found in the Late Bronze Age Eurasian forest steppe and steppe east of the river Dnieper, to demonstrate the limits of the potential of currently available zooarchaeological datasets. In general, it is only possible to say that the zooarchaeological evidence shows a large variability and some indicators for either sedentary or nomadic lifestyles, but no firm evidence either way. Despite a thorough and systematic discussion of the potential indicators for sedentism or nomadism, Morales Muñiz and Antipina concluded that the data for most was not available. Future research should be interdisciplinary and include sieving or flotation to investigate the presence of commensal birds, rodents and invertebrates, investigation of size and sex ratios of livestock, butchery practices, seasonality and stable isotope analyses.[7]

Analyses for the northern Black Sea region are hindered by similar obstacles as those encountered by Morales Muñiz and Antipina. While zooarchaeological analyses have been carried out for a good number of Late Bronze Age sites, what is lacking is a publication of information on mortality profiles, sex ratios, size and morphology of livestock, as well as the raw data on which such interpretations are based. The new dataset from Taraclia-Gaidabul – which is presented in this paper – can be used as a test case to see what conclusions on subsistence and lifestyle are possible with access to a more complete zooarchaeological dataset and help to formulate specific aims for further research in the northern Black Sea region.

Subsistence in the Late Bronze Age northern Black Sea region

The research area that this paper will focus on is the northern Black Sea region, between the Carpathian Mountains and the river Dnieper (Fig. 1).[8] In the Late Bronze Age, this region coincided with the spreading of the Noua-Sabatinovka-Coslogeni cultural complex (NSCC).

[2] Gerasimenko 1997; Kremenetski 2003; Kotova / Makhortykh 2010.
[3] Bostonalieva 2014.
[4] Merpert 1974.
[5] Černych et al. 1998; Pashkevich 2003.
[6] Morales Muñiz / Antipina 2003.
[7] Ibid., 346–347.
[8] Although, geographically speaking, it would perhaps be more accurate to speak of the region north-west of the Black

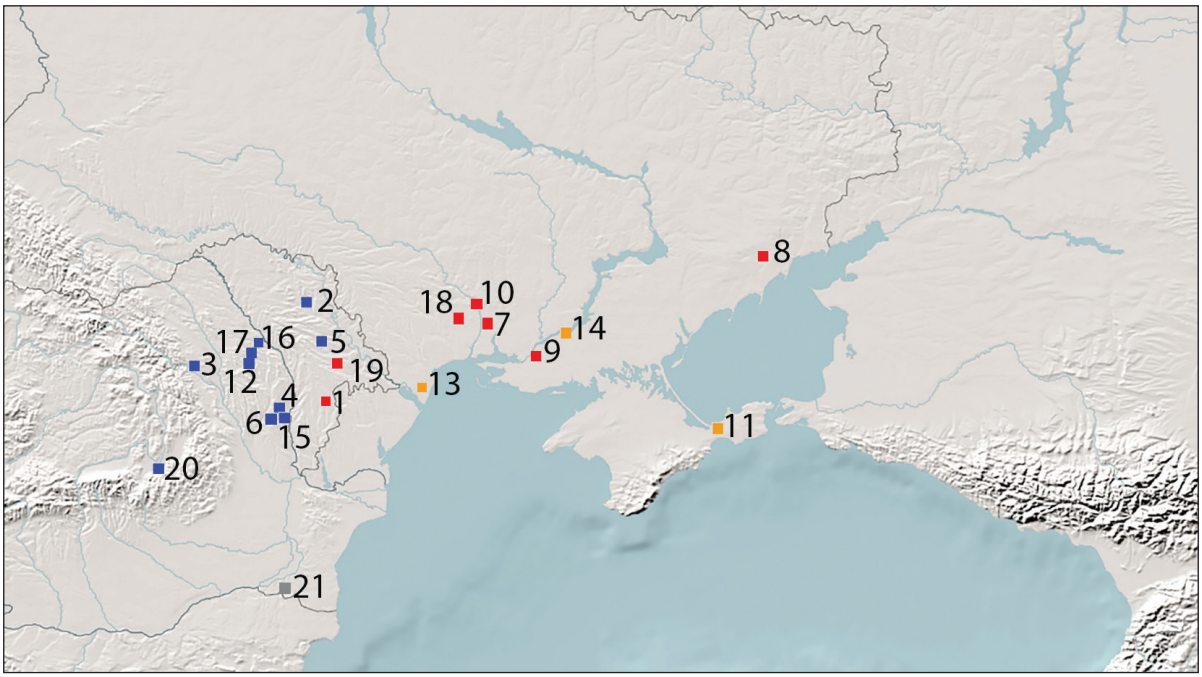

Figure 1. *Map with sites mentioned in the text and NSCC settlements with zooarchaeological data. 1 – Taraclia-Gaidabul, 2 – Odaia-Miciurin, 3 – Piatra Neamț, 4 – Bîrlad, 5 – Mereni, 6 – Gîrbovăț, 7 – Peresadivka (Peresadovka),[9] 8 – Mykolaivka (Nikolaevka),[10] 9 – Novokyivka (Novokievka), 10 – Vinogradnyi Sad, 11 – Kirovo, 12 – Drăgeşti, 13 – Voronivka II (Voronovka II), 14 – Dremailovka, 15 – Cavadineşti, 16 – Valea Lupului, 17 – Rateşu Cuzei, 18 – Shchut'ske (Shchutskoe), 19 – Tîrnăuca, 20 – Rotbav, 21 – Coslogeni. Red: Noua; Blue: Sabatinovka; Orange: Late Sabatinovka; Grey: Coslogeni*

Material culture, which is associated with the Noua-Sabatinovka-Coslogeni cultural complex, is found over a large area, from the Lower Danube in the west to the Dnieper in the east. Although there are few radiocarbon dates, the culture is believed to be dated to the Late Bronze Age, i.e. between the 15th and the late 11th century BC.[11] Typical sites are the so-called "ash mounds". These sites are believed to be the remains of settlements,[12] although it has also been argued that they represent feasting sites and that the settlements were located adjacent to the ash mounds.[13] Cemeteries are also known, where individuals were buried in a crouched position on their side in burial mounds and flat graves.[14] Several bronze hoards found east of the Carpathian Mountains were dated to the Late Bronze Age and were attributed to the NSCC.[15] Together with some significant bronze objects, the pottery is quite characteristic. Vessels are mostly undecorated, but if ornaments are present, they consist of one or two horizontal rolls, sometimes with incisions or finger imprints, on the upper part of the pots. So-called *kantharoi* are another typical ceramic type and are often found in graves.

At the beginning of the 21st century, two synthetic papers on the subsistence of Late Bronze Age settlements in the northern Black Sea region appeared.[16] They presented somewhat different views that were partly based on the same body of evidence. Sava later revised his view after excavating an ash-mound settlement in Odaia-Micuirin.[17]

Sea, this area is commonly known among archaeologists working in this part of the world as the northern Black Sea region, and we will follow this convention to avoid confusion.

[9] Russian toponyms are given in brackets.

[10] 10 Mykolaiwka (Nikolaevka) is a settlement of the Late Bronze Age, located in eastern Ukraine, a region which is usually not considered to be a part of the NSCC. It is included here because the excavator assigned it to the Sabatinovka culture. Privalova / Privalov 1987.

[11] Sava 2002; 2014.

[12] Sava / Kaiser 2011.

[13] Dietrich 2011.

[14] Sava 2002.

[15] Dergačev 2002; Sava 2011.

[16] Gershkovich 2003; Sava 2005.

[17] Sava / Kaiser 2011.

Gershkovich[18] looked at archaeological, archaeozoological and archaeobotanical data and reconstructed subsistence for the NSCC. Archaeobotanical analysis was based on just a few settlements since very little archaeobotanical work has been done to date for this region and time period. For Coslogeni, carbonised plant remains are common (present in 16 out of 19 samples), but it is not clear what plants they represent (Fig. 1, 21).[19] For Novokievka, impressions of cereal grains in pottery indicate that cereals were present (Fig. 1, 9). Plant remains were also found in the organic temper of plaster, allowing the identification of four species of wheat, barley and millet. Additional species (two more species of wheat, including spelt wheat, another type of barley, pea and bitter vetch) were identified in Vinogradnyi Sad I (Fig. 1, 10). Pear-shaped household storage pits, metal sickles and sickle moulds provide further evidence for the harvesting and storage of cereals.

Archaeozoological data show a dominance of cattle. Most cattle reached ages older than one year, and the herds were dominated by females, suggesting exploitation aimed at meat and dairy. Oxen could have been used for traction.[20] Pigs are seen as an indicator of sedentism. Areas with more forest are more likely to have higher numbers of pigs. In the open steppe, pigs could have been fed refuse or food remains.[21] Small numbers of wild animals indicate that hunting was not an important activity, suggesting that animal husbandry was highly productive. No stables or enclosures are known from Sabatinovka sites. Near the river Bug, a ditched enclosure may have been used to hold livestock.

Gershkovich argues that the main settlements were inhabited permanently (i.e. throughout the year), but only for a few years. This conclusion was based on meat weight estimated for the Minimum Number of Individuals for each species for Novokievka and the fact that storage pits do not cut into each other.[22] With maximum use of storage pits of 5 years, this indicates of the length of time that a settlement was in use.

Gershkovich reconstructs subsistence as follows. Animal husbandry was transhumant, with animals brought to seasonal pasture in summer (with temporary camps) and kept close to permanent settlements in winter for supplementary feeding. Part of the human population engaged in agricultural activities near their permanent settlements. A slash-and-burn or swidden type of agriculture was practised. A high settlement density would not have been possible with a shifting field cultivation system, but with a short lifespan per settlement, high densities for some regions are put into perspective. Both storage pits and pigs are indicators of a sedentary lifestyle. The ratio between arable farming and animal husbandry may have fluctuated over time and may have varied for different regions.[23] Such a mixed economy of transhumant animal husbandry and swidden agriculture is only known in this region for the Late Bronze Age and was possible due to a damper climate during the 15th–12th centuries BC. Aridification after the 12th century BC was followed by the collapse of many Late Bronze Age cultures. The Early Iron Age is characterised by a subsistence economy based on nomadism, and this way of life persisted until the 18th century AD.

Sava[24] used a much larger archaeozoological dataset to explore the question of subsistence. The archaeobotanical data included in the study are all based on impressions in pottery and daub. Pastoralism is seen as the main economic factor regardless of the environment. This was characterised by seasonal movements of livestock to summer pastures. To maintain the herd through winter, animal feed had to be grown or collected in summer. The storage of animal feed meant a more settled way of life than in earlier periods when most younger animals were slaughtered before the winter. There are no indications that this occurred in the NSCC. The location of NSCC settlements in open landscapes confirms the pastoral nature of the economy. The forest steppe is better suited for settled pastoralism, which explains the higher proportions of cattle and pigs in this environment. In his analysis, Sava

[18] Gershkovich 2003.

[19] According to Černych et al. 1998, millet is dominant with 70% of cereal remains, followed by barley, emmer wheat and bread wheat, respectively.

[20] Gershkovich 2003, 311.

[21] Ibid., 311–312.

[22] To estimate how long the meat could feed eight families; a method which seems questionable.

[23] Gershkovich 2003, 309–310.

[24] Sava 2005.

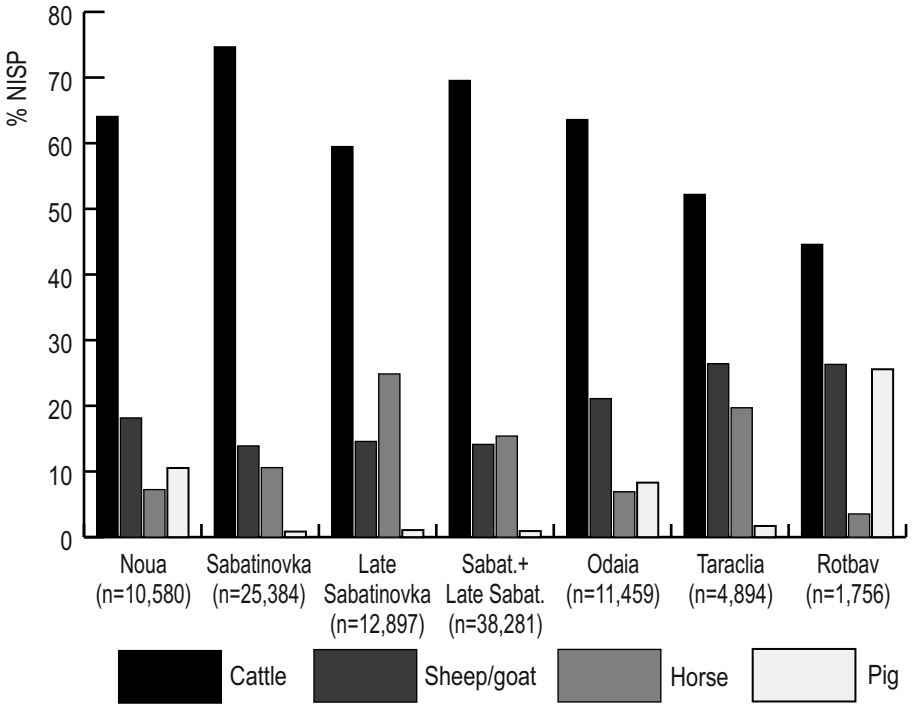

Figure 2. *Species proportions for the main domestic animals for the north-western Black Sea region, % NISP. Data for Noua and Sabatinovka settlements are average proportions for all settlements* (after Sava 2005)
(Odaia: Hochmuth 2011. Rotbav: Dietrich 2014; for location of sites, see Figure 1)

distinguishes between the Noua and Sabatinovka cultures, which are believed to roughly coincide with forest steppe and grass steppe, respectively. Very low percentages of wild animals (< 5%) are typical. Cattle are the dominant species in both cultures (Fig. 2). Sheep and goats are either the second or third species. Horses are much less common in Noua sites than in Sabatinovka sites, where they were sometimes the second species. Pigs are more common in the Noua sites than in the Sabatinovka sites.

Sava concludes that the NSCC had a complex agrarian economy consisting of animal husbandry and, to a lesser extent, of arable farming. That arable farming was practised is suggested by the presence of different kinds of wheat, barley and millet, but how arable farming was practised still needs to be explained. Late Bronze Age settlements of the steppe, with a mixed agrarian economy, were made possible because of a damper climate. When the climate became drier at the end of the Late Bronze Age, mixed farming was no longer possible and new economic systems developed. This is reflected by a decrease in cattle and an increase in sheep/goats and horses. The summer movement of livestock was replaced by total nomadism.

On the basis of new data obtained within a research project in which the settlement with ash mounds Odaia-Miciurin was excavated in the north of the Republic Moldova, Sava and Kaiser proposed a new model for the subsistence economy and mobility, at least for the group of NSCC inhabiting the forest steppe.[25] They consider ash mounds as places that were seasonally occupied by pastoralists and to which they returned regularly during cyclic movements. The radiocarbon dates suggest that the ash mound settlements were inhabited repeatedly by several generations. It was mainly sedimentological processes which caused the formation of the so-called ash mounds.[26] Thus, Sava and Kaiser assume a mobile form of pastoralism for the forest

[25] Sava / Kaiser 2011.

[26] Ibid., 430–433; Kaiser / Sava 2016.
The term "ash mound" is misleading since the light soil colour is not caused by ash, as was originally assumed. Unfortunately, pedological investigations did not give any clear answer about the formation of the light grey sediment. It seems that such sediments typical for the ash mound are enriched in carbonate. Sava / Kaiser 2011, 414, Tab. 28; Kaiser / Sava 2016, 440.

steppe in the Late Bronze Age in the region to the north-west from the Black Sea. Only a few charred macrobotanical remains were found in Odaia-Miciurin, even though sediments of the cultural layer were wet-sieved systematically. As millet was predominant, the authors concluded that this settlement was inhabited during early summer.[27]

This short review shows that three aspects of subsistence are and will always be discussed in close relation to the NSCC: the ratio between animal husbandry and arable farming, type of animal husbandry (herd composition in terms of species, age and sex) and degree of mobility of people and livestock.[28]

Gershkovich and Sava/Kaiser presented different basic models for subsistence in the Late Bronze Age of the northern Black Sea region. While Gershkovich assumes that main settlements were permanently inhabited but only for a short time, the latter proposed that ash mounds were the remains of seasonally settled camps. Both agree that NSCC groups relied heavily on animal husbandry but with some arable farming. Gershkovich hypothesises – for settlements excavated in the grass steppe – that livestock was moved away from the main settlement to pasture in summer and fed close to the settlement in winter, while Sava and Kaiser think the pastoralists of the NSCC in the forest steppe moved in cyclic migration routes from one camp to another (today's ash mounds). Since each model applies to a different environment (but within the same culture and time frame), it is possible that both models existed side by side. One problem is that both models rely on the assumption of a damper climatic phase in the Late Bronze Age, an assumption that is no longer tenable.[29]

Information on the exploitation of livestock (in the form of slaughter ages and sex distribution of herds) is limited. As a result, it is difficult to assess the importance of secondary products such as milk. Furthermore, archaeozoological data on seasonality have not yet been utilised to investigate the question of seasonal or permanent occupation. The zooarchaeological dataset for the region has been expanded by research in two further settlements: Odaia-Miciurin and Taraclia-Gaidabul. The Odaia data have been published,[30] but this paper will be the first publication on the faunal remains from Taraclia-Gaidabul. This paper will investigate how these two new datasets fit into the existing pattern and whether they allow us to say more about the nature of subsistence. It is hoped that these new data will allow for a more detailed view of animal husbandry and better insight into mobility and seasonal patterns.

Excavations in Taraclia-Gaidabul

The archaeological site of Gaidabul is located close to the town of Taraclia, in the southern part of the Republic of Moldova (Fig 1, 1). Excavations took place in 2016–2019 by E. Sava and E. Kaiser.[31] The site is situated on a flat plateau 18 m above the valley of the small river Gaidabul and represents an open settlement (Fig. 3). Ash mounds are usually discovered after ploughing, since they are characterised by light soil. Since the area where the site of Gaidabul is located is covered with grass steppe vegetation, ash mounds are not visible on the surface here. In the erosion gullies on the edge of the site, ceramic fragments belonging to the NSCC and animal bones were uncovered. A test trench along one erosion gully revealed a sediment with a very light colour, similar to the soil of an ash mound, and the first radiocarbon dating of a bone taken from this location confirmed an age of cal 14th/13th century BC. Since 2017, three excavation campaigns have taken place, during which a large area covered by an ash mound and its immediate surroundings were excavated. The grey sediment of the ash mound represents the cultural layer. In some areas, probably its periphery, it was 20 cm thick, and in its central part, up to 80 cm. This sediment was more or less homogenous; no layers

[27] Sava / Kaiser 2011, 365–367.

[28] This holds true for the entire Bronze Age. Reconstructions for particular archaeological cultural complexes are usually based on the number of settlements, their relation to the number of synchronous burial mounds in the steppe and forest steppe and the zooarchaeological and archaeobotanical evidence (i.e. Bunyatyan 2003).

[29] Bostonalieva 2014.

[30] Hochmuth 2011.

[31] Sava et al. 2018; Kaiser et al. 2020. We would like to thank Mariana Sîrbu, Livia Ermurachi, Eugen Mistreanu and Valeriu Bubulici for their hard work during the excavations and post-excavation analysis.

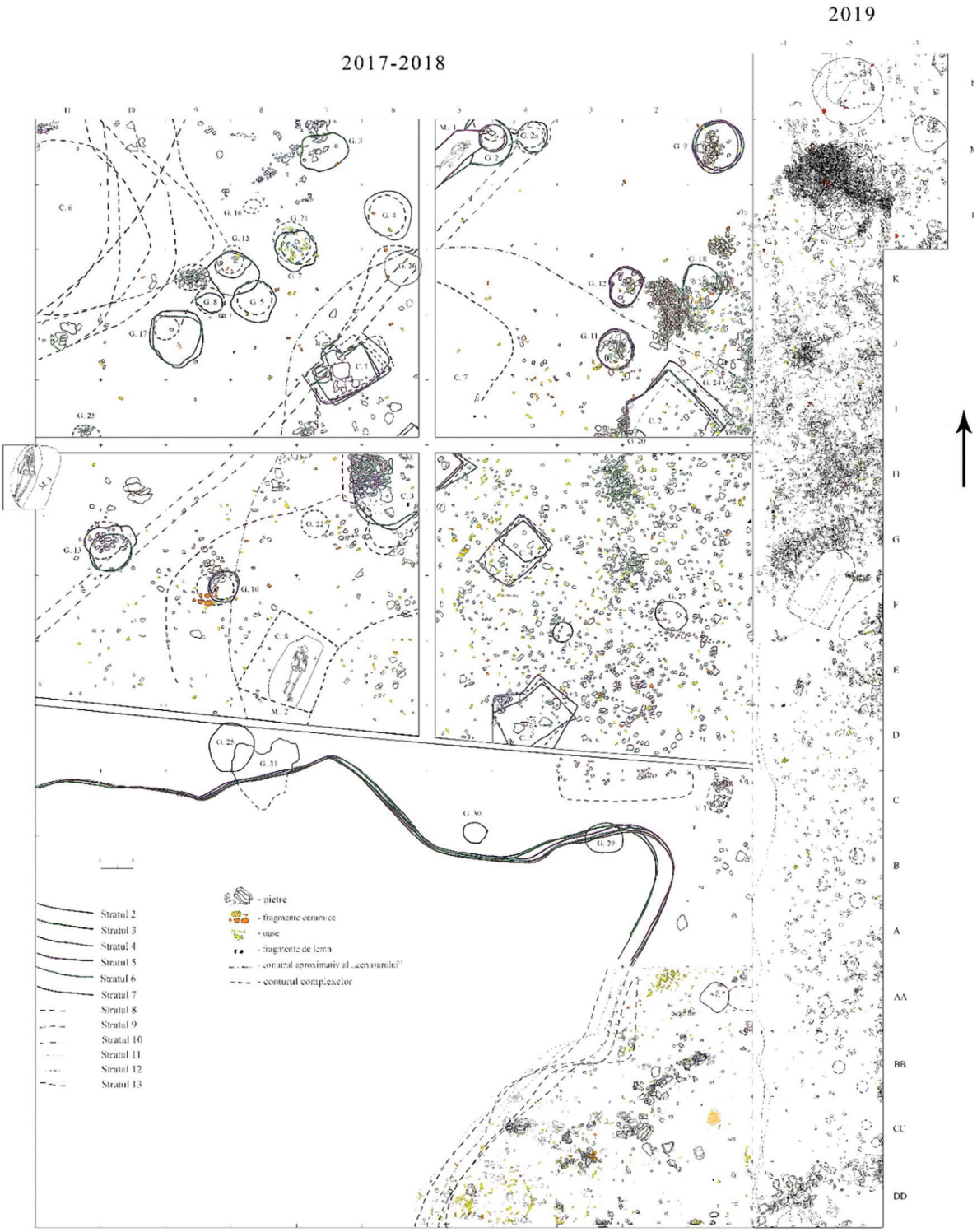

Figure 3. *Excavation plan for Taraclia-Gaidabul*

could be detected. In the northern part, the bottom of a rectangular dwelling with a hearth was found below the ash mound. Thirty-nine pits of various sizes and depths were found within and under the ash mound. A total of 15835 ceramic fragments were found during the excavations and represent, together with a large number of animal bones, the bulk of the material that was

collected. Together with the much smaller numbers of bone, stone and bronze artefacts, they are typical settlement refuse. While there are a few burials from a later period and several shepherd huts from the 19th century, most finds are dated to the Late Bronze Age. Fourteen radiocarbon dates place the settlement in the Late Bronze Age (ca 1400–1100 BC; sample material: bones and charcoal). The archaeobotanical samples await analysis but, at first glance, they contain few cereals, although they are present (possibly millet and barley or wheat). Pits (possibly storage pits) and fragmented storage vessels (*pithoi*) further suggest the use of cereals. In the nearby Late Bronze Age site of Cazaclia, cereals (barley and millet) were found inside storage vessels in 2016, suggesting that such vessels were used to store cereals.

Zooarchaeological results for Taraclia-Gaidabul

Material and methods

A total of 22063 animal bone fragments were collected during the 2017–2019 excavations and then analysed. Nearly all material was hand-collected. During the excavations, extensive sieving and flotation for botanical remains was carried out, but this yielded only a few animal bones. The animal bones are generally very well preserved but highly fragmented: for 82%, less than 10% of the original element is present, and only 5% is complete (Fig. 4). Among the identified fragments, 36% is present with less than 10% of the element, and 20% is complete. Many of the complete fragments are teeth, carpals, tarsals and phalanges, all small compact bones.

Identifications were carried out on location in Moldova, with about half of the material being transported to Berlin and identified there using the reference collections of the Institute for Prehistoric Archaeology, Freie Universität and the German Archaeological Institute.[32] Where possible, fragments have been identified down to the species and skeletal elements. When the species could not be identified, fragments were assigned to different size categories: large mammal, medium mammal and small mammal. In some cases, even this was not possible and fragments were recorded as mammals, birds or fishes. The distinction between sheep and goat was only made for a small number of fragments.[33]

Quantification is based on the number of identified specimens (corrected for associated fragments), Minimum Number of Individuals and total bone weight. The Minimum Number of Individuals is based on the highest number of zones for either the left or right side of any element. Serjeantson's and Dobney and Rielly's zones were used to record the part of an element that was present.[34] Fragmentation was recorded through six categories (Fig. 4).

Slaughter ages were established by the eruption and wear of the teeth and by epiphyseal fusion. Tooth eruption and wear for cattle, sheep and goats, and pigs was recorded by using Grant's eruption and tooth wear stages.[35] For complete mandibles, these lead to mandible wear stages. The mandible wear stages were linked to absolute ages according to Hambleton's tables.[36] For incomplete mandibles, only a range of possible mandible wear stages can be given. For horses, the ratio between milk teeth and permanent teeth was established to provide a rough figure for the proportion of horses killed before adulthood. The crown height of complete horse premolars and molars was measured and translated into an absolute age according to Levine's method.[37] The state of closure of the epiphyses (unfused, fusing or fused) was recorded and linked to an absolute age using the tables by Silver and Habermehl.[38] This information was used to construct mortality profiles, showing the proportions of animals killed per age category.[39]

The sex of the animals could only be established infrequently. This was done on the basis of the shape of the pubic bone for cattle, sheep

[32] We would like to thank Dr Norbert Benecke and Michael Hochmuth for their help.

[33] Using the criteria described by Zeder / Lapham 2010 and the reference collections.

[34] Serjeantson 1996, 195–200; Dobney / Rielly 1988.

[35] Grant 1982.

[36] Hambleton 1999, 64–65. Age categories according to Bull / Payne 1982; Halstead 1985; Higham 1967; Payne 1973.

[37] Levine 1982, 250, Tables 3b. 3c.

[38] Silver 1969, 285–286; Habermehl 1975, 48, 104–5, 121–2, 150, 166–7.

[39] According to Chaplin 1971, 128–131. Fusing epiphyses were added to the unfused epiphyses.

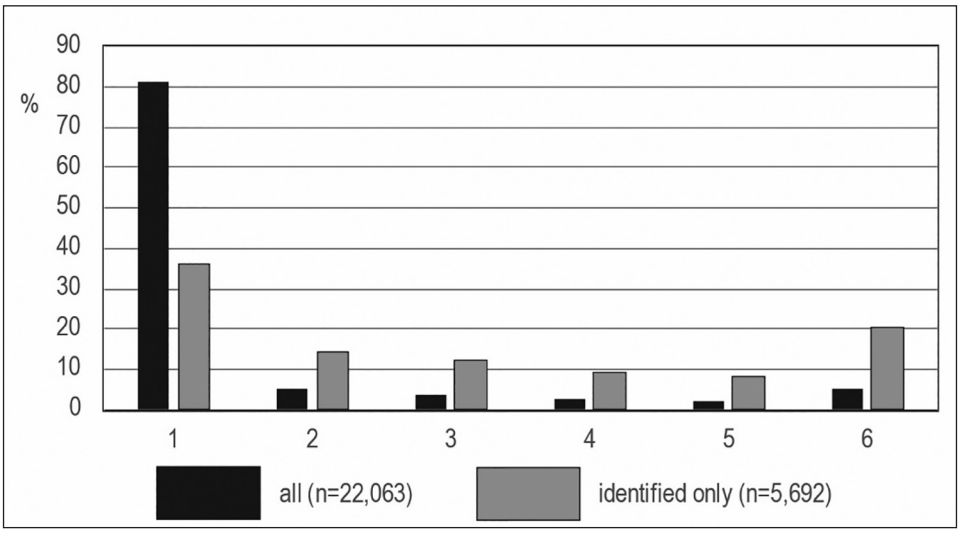

Figure 4. *Fragmentation for all fragments and for identified fragments: 1 = less than 10% of the original element present, 2 = 10–25%, 3 = 25–50%, 4 = 50–75%, 5 = 75–95% and 6 = complete*

or goats and horses, the shape of the canine teeth for pigs and the presence or absence of canine teeth for horses.

The presence of gnawing marks, butchery marks and burning was recorded. Gnawing was recorded as present or absent; all gnawing marks seem to be caused by dogs. Burning was recorded as partially charred, charred, partially calcined and calcined. Butchery marks were recorded as cut marks or chop marks. A note was made of bones showing signs of being worked or having use-wear traces. Measurements were recorded according to Von den Driesch.[40] Withers height was calculated by using different methods.[41]

To analyse the distribution of skeletal elements, a division of seven categories of the body was used: head and neck, rump, upper front leg, upper hind leg, lower limbs, phalanges and other elements. Most ribs and vertebrae were not identified down to the species but only to the size. Since these elements are common, they need to be considered in order to reach a representative idea about skeletal element distribution. Therefore, all fragments from large and medium-sized mammals for which the skeletal elements were recorded have been added to the body parts of the main meat-providing domestic mammals by ratio.

Species and NISP

Out of the total of 22063 animal bones, 5692 fragments or 26% have been identified down to the species level. Out of the unidentified fragments, 7 are from birds, 4 from molluscs and 1 from fish; all remaining fragments are from mammals.

The identified bones can be divided into different groups. First, domestic animals: cattle, sheep and goats, horses, pigs and dogs. Domestic mammals dominate the material, making up 98% of all identified fragments (Table 1). Among the domestic species that were consumed, cattle are the main species in terms of the number of fragments at 52%, followed by sheep and goats at 26% and horses at 20%; the pig is a minor species in terms of the number of fragments with only 2% (Fig. 2).[42]

Among the sheep or goat remains, 14 fragments were identified as goat and 18 as sheep. In a biometrical analysis of astragalus measurements, most of the Taraclia values fall within the values for modern sheep (n = 5) or in the overlapping area for modern sheep or goats (n = 5); only one value falls within the area for modern goats (Fig. 5).[43] When the Minimum Number of Individuals is taken, sheep and goats are the most numerous with 41 individuals, followed by cattle

[40] Driesch 1976.

[41] For cattle, according to Driesch / Boessneck 1974 and Matolcsi 1970; for sheep, according to Teichert 1975; for goats, according to Schramm 1967; for dogs, according to Harcourt 1974; for horses, according to May 1985.

[42] Corrected for associated bones.

[43] Salvagno / Albarella 2017, fig. 33.

Table 1. *Taraclia-Gaidabul. Number of fragments and weight per species*

species	n	n asso*	n – n asso	weight (g)	MNI
cattle	2647	92	2555	121180	41
sheep/goat	1299	7	1292	12984	37
horse	998	35	963	57895	14
pig	84		84	1870	3
dog	554	481	73	1576	5
red deer	12		11	240	
wild boar	15		11	503	
hare	42	32	8	51	
fox	7		7	20	
wolf?	4	1	3	54	
badger	1		1	7	
polecat	1			17	
Otis tarda	1			1	
Cyprinus carpio	1			2	
Tortoise/terrapin	3	2	1	2	
Unio spec.	8			31	
Cardium spec.	1			1	
hedgehog	5	4	1	7	
hamster	6		6	6	
snake	3	2	1	1	
bird	7		7	15	
fish	1		1	1	
mollusc	4		4	4	
small mammal	15		15	14	
medium mammal	3037		3037	7110	
large mammal	11883	1	11882	112943	
mammal	1424		1424	1642	
total	22063	657	21406	318177	

*n asso is the number of bones that the total figure should be corrected for, i.e. each association is counted as one, the other fragments of the associated bones are counted as n asso.

with 37, horses with 14 individuals and pigs with 3 individuals (Table 1).[44]

Next, there are the wild mammals with 82 fragments. Seven species are present: three game species (red deer, wild boar and hare) and four species of carnivores (badger, wolf, fox and

[44] MNI based on the most common zone (left or right) as defined by Serjeantson 1996 and Dobney / Rielly 1988 for the mandible. For sheep/goats and cattle, zone 1 of the left or right mandibula is actually more common, with 56 and 42 fragments, respectively, than the zones used for the MNI (right humerus zone 6 for sheep/goats and left mandibula zone 2 for cattle), but this zone is quite large and may therefore not be as diagnostic as other zones.

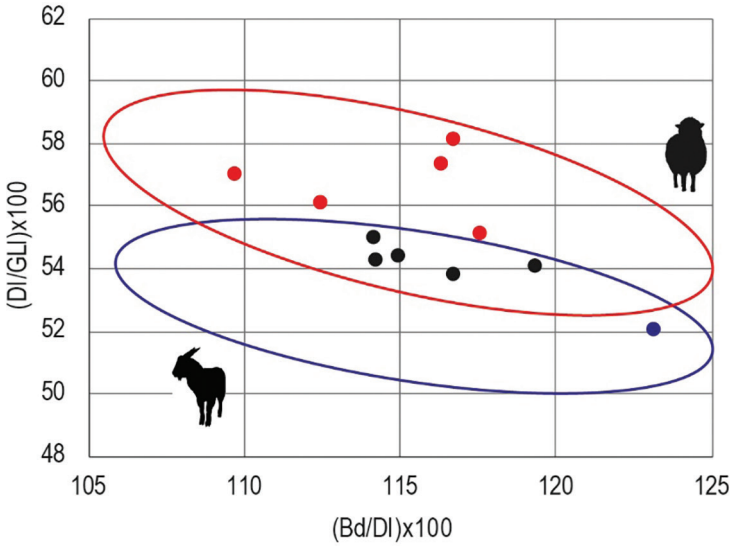

Figure 5. *Shape indices for sheep/goat astragali. Red oval: range of values attributed to sheep, blue oval: range of values attributed to goats* (according to Salvagno and Albarella 2017) (Bd: breadth of the distal end; Dl: greatest depth of the lateral half; GLl: greatest length of the lateral half)

polecat). Red deer is represented by both antlers and bones, so it is certain that this species was hunted. Carnivores may have been hunted for their fur or seen as a danger to the livestock.

Only one bone from a wild bird was found, a scapula from a great bustard (*Otis tarda*). Fish is also represented by just one identified fragment, a vertebra from a European carp (*Cyprinus carpio*). Considering their large size, these animals are likely to have been hunted and caught for food. The near absence of birds and fish in this site is not due to a lack of sieving. Molluscs are represented by eight fragments from *Unio spec.* and one fragment from *Cardium spec.* Reptiles are also represented by just one species of tortoise or terrapin (3 fragments); this animal can be regarded either as food or as an intrusive species. Finally, there are intrusive species, which have become part of the archaeological site as a result of their behaviour rather than of human activity. Intrusive species include burrowing animals such as rodents (only hamster identified, but other species are present), hedgehogs and snakes.

Associated bones were encountered regularly. The larger associations come from pits or bone concentrations in layers. Smaller associations, in most cases, are those of two fragments; they indicate that the material was incorporated into the occupation layers in a relatively fresh state.

Skeletal elements

The distribution of skeletal elements for cattle, horses, sheep/goats and pigs shows that all parts of the body are present. All species show low proportions of fragments from the rump, but when the fragments identified as large-sized or medium-sized mammals are added by ratio to the main livestock species, the rump is the most common body part for all species except for pigs. For sheep or goats and pigs the proportion of phalanges is much smaller than that of cattle and horses; this is perhaps explained by their small size.

Butchery

Overall, 3.7% of the animal bones show traces of butchery or bone working; 65 fragments (0.3%) were worked or used as an artefact, leading to modifications of the bone surface. In selecting bones for bone working or use, horses and, to a lesser degree, sheep and goats are overrepresented compared to cattle.[45] Four fragments of red deer antlers show signs of being processed.

[45] This does not include 37 worked bone fragments, which were kept separate during the 2019 campaign, that were not seen by the first author and were not added to the database. Identifications from photographs are: cattle 2x, sheep/goats 6x, horses 2x, antler 1x, not identified down to the species 26x. Including the 2019 worked bone fragments, the percentage of worked bones is 0.5%.

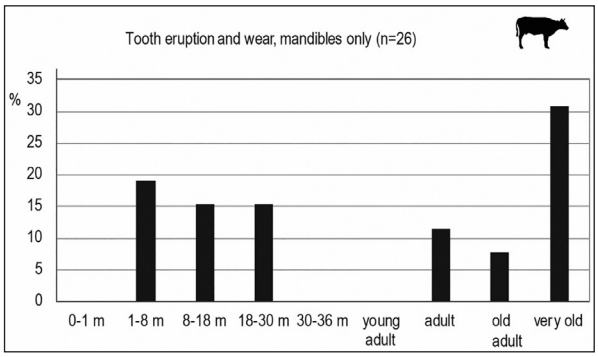

Figure 6. *Slaughter ages for cattle, based on the eruption and tooth wear (excluding isolated teeth and incomplete mandibles)*

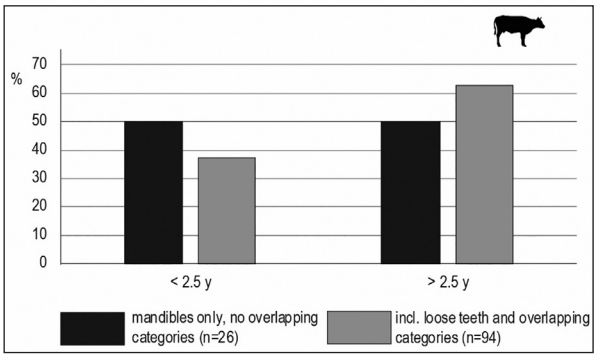

Figure 7. *Slaughter ages for cattle, based on the eruption and tooth wear*

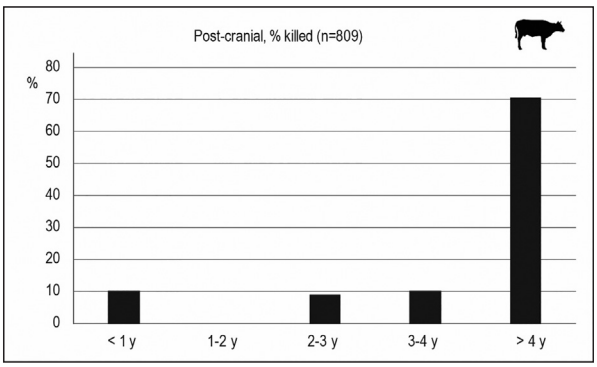

Figure 8. *Slaughter ages for cattle, based on epiphyseal fusion*

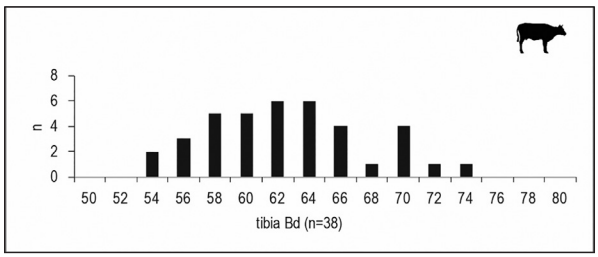

Figure 9. *Distal breadth of the tibia for cattle*

Bones of larger mammals (cattle and horses) show higher proportions of butchery than the smaller species (17% and 13% compared to 6% for both sheep/goats and pigs). This is explained by the greater degree of butchery required for larger mammals to obtain pieces of meat of a size suitable for cooking or roasting. Butchery marks are also found on fragments of red deer, dogs, wild boars and badgers. In the case of badgers, it is proof that this species did not become part of the archaeological site due to dying a natural death in its burrow. In the case of dogs, it suggests that the possibility that this species was consumed should be considered.

Age and sex

For cattle, mandible wear stages and corresponding ages were established for 26 mandibles (Fig. 6). Isolated teeth and incomplete mandibles led to a further 68 age estimates. These have been included to provide a broad picture of the ratio of young to adult animals (Fig. 7). While including isolated teeth and incomplete mandibles increases the sample size, there are two issues to consider. Firstly, many can only be assigned to a range of mandible wear stages rather than a single one. In cases when this leads to more than one age category, it adds a degree of uncertainty to the age profiles. Secondly, including isolated teeth introduces a potential bias to the dataset, both because all molars but only one deciduous tooth were included and because deciduous fourth premolars are smaller than molars and, therefore, less likely to be recovered. Indeed, slaughter profiles, including isolated teeth and incomplete mandibles, show a larger proportion of adult animals. This is observed for cattle and sheep/goats.

The more detailed analysis (based on complete mandibles only) shows some slaughter of cattle in the three categories, between 1 and 30 months (Fig. 6). The main slaughter peak is reached with elderly animals. Half of all cattle lived to adulthood (Fig. 7); when isolated teeth and incomplete mandibles are included, this proportion increases to 63%.

Epiphyseal fusion shows that a small proportion of cattle were killed in the first year of life (Fig. 8). Similarly, small proportions were killed in the third and fourth year. More than two-thirds of cattle were killed at ages beyond

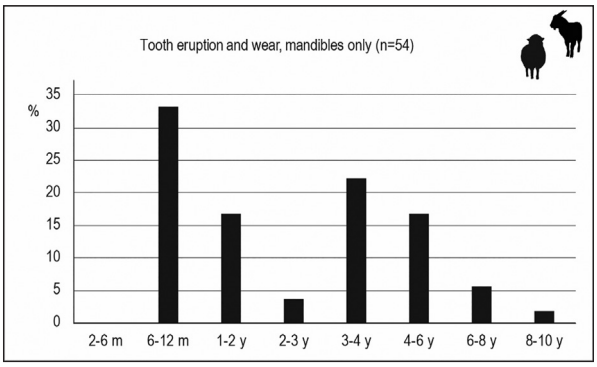

Figure 10. *Slaughter ages for sheep and goats, based on the eruption and tooth wear (excluding isolated teeth and incomplete mandibles)*

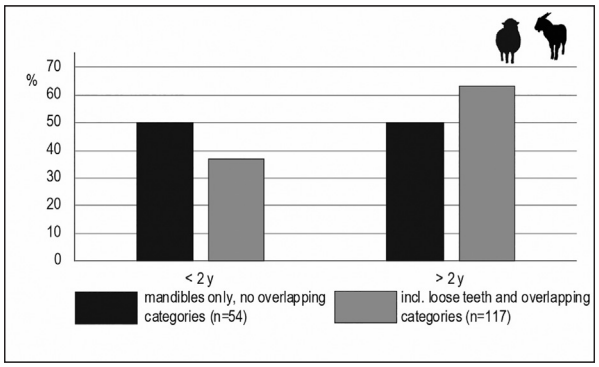

Figure 11. *Slaughter ages for sheep and goats, based on the eruption and tooth wear*

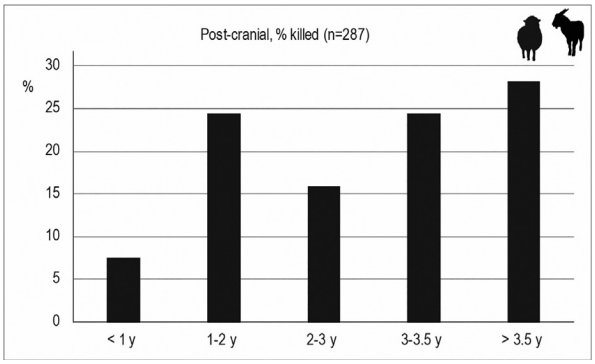

Figure 12. *Slaughter ages for sheep or goats, based on epiphyseal fusion*

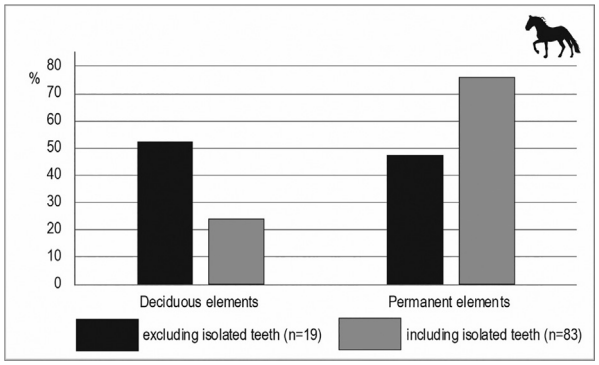

Figure 13. *Horse mandibles and maxillae with deciduous or permanent elements, with or without isolated teeth*

four years. A discrepancy in slaughter data for mandibles and epiphyseal fusion is not unusual and can be caused by a taphonomic bias against unfused bones from young animals, which are more fragile than fused bones. No bones from foetal or neonatal cattle were registered, but bones from juvenile animals (probably less than six months old) are present. In 15 cases, the sex of cattle could be established on the basis of the shape of the pubic bone: 3 male and 12 female animals. The distal breadth of the tibia shows a distribution that supports a population dominated by smaller female animals with a few larger males (Fig. 9).

As for cattle, sheep and goats, tooth eruption and wear were analysed both for complete mandibles only and then also including isolated teeth and incomplete mandibles with overlapping age categories. The complete mandibles show a slaughter peak of 33% between 6 and 12 months old (Fig. 10); 50% lived to adulthood (Fig. 11). When isolated teeth and incomplete mandibles are included, 63% lived to adulthood (Fig. 11). As for cattle, including isolated teeth introduces a bias towards adult animals.

Epiphyseal fusion shows a low level of slaughter in the first year of life (Fig. 12). Around a quarter were killed in their second year. About 15% were slaughtered in their third year and a quarter between 3 and 3.5 years old; 28% survived beyond 3.5 years. This means that 68% survived the first two years of life, which fits in well with the picture provided by both complete and incomplete mandibles and isolated teeth, which shows 63% survival past the age of 2 years. The presence of foetal and neonatal sheep/goat remains indicates that animals were bred at the site and that they were present in late winter and early spring. Some bones could only be designated as juvenile, which means that they are clearly from very young animals (less than six months old). This age category is not represented among the mandibles. Out of 16 sheep or goat pelvic fragments for which the sex could be established, only two are from males; the other 14 are all from females.

Figure 14. *Slaughter ages for horses, based on the crown height of cheek teeth*

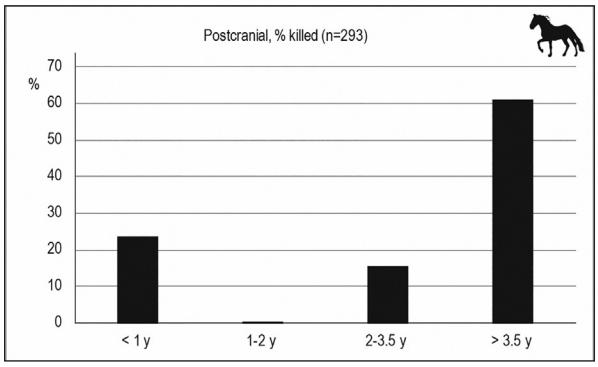

Figure 15. *Slaughter ages for horses, based on the epiphyseal fusion*

For horses, the ratio of milk and permanent teeth was established by counting all loose teeth and mandibles and maxillae. The proportion of milk teeth is 24%. As for cattle and sheep/goats, including loose teeth may cause bias against younger animals. Indeed, when isolated teeth are excluded, the proportion of mandibles and maxillae with milk elements is 53% (Fig. 13). Age based on the crown height (adult animals only) shows that about a third of adult horses reached ages over 12.5 years (Fig. 14).

Epiphyseal fusion shows quite a high slaughter level of 23.5% in the first year of life, followed by a low slaughter level in the next years (Fig. 15); 61% survived to adulthood. No foetal, neonatal or juvenile horse bones were registered. One male and two female horses are present (based on the shape of the pubic bone and the presence/absence of canine teeth).

One juvenile pig bone was found. The numbers of epiphyses and mandibles are small but suggest the slaughter of pigs aged between 2 months and 3.5 years. Two males and four females are present (based on the shape of the canine teeth).

Animal size and morphology

The mean withers height for 13 cattle bones is 120 cm, with a range of 108 to 134 cm. For seven horse bones, the mean withers height is 140 cm, with a range of 132 to 147 cm. Three sheep metapodials are from animals with withers heights between 66 and 72 cm, with an average of 69 cm. Two sheep or goat humeri are either from sheep with withers heights of 63 cm or goats with withers heights of 56–57 cm.

Only one horncore was observed for cattle. For sheep and goats, twelve horncores were identified as goat, one as sheep or goat, and three sheep skulls were horned (out of which two only had very small horncores).

Pathology

Pathological changes were noted on a total of 85 fragments. The prevalence of pathology is similar for most species, but lower for sheep and goats (Fig. 16). It is interesting to note that dogs do not really display a higher prevalence of pathology than other species, something that is found for other regions.[46] Among cattle, joint pathologies are by far the most common (Fig. 17). They consist of osteoarthritis in the hip joint and so-called 'lipping' of proximal first and second phalanges. Sheep and goats have mostly oral pathology, consisting of calculus and 'coral root'. Two cattle and one sheep/goat incisor show grooves below the crown, which are caused when long strands of grass are pulled through the teeth or when the gingiva has retracted, exposing the neck of the tooth to enzymes.[47] Oral pathology also affects horses the most. In this case, teeth show erosion lines, which can be caused by certain kinds of grazing or fodder. In general, livestock seems to have been healthy and treated well (as evidenced by a low number of fractures).

Zooarchaeological results for Odaia-Miciurin: A summary

Odaia-Miciurin is a settlement with more than 25 ash mounds in the north of the Republic of Moldova (Fig. 1, 2). In 2003–2008, Sava and

[46] Murphy 2005; Grimm 2008; Groot 2016, table 1.
[47] Miles / Grigson 1990, 494; Müller 1997.

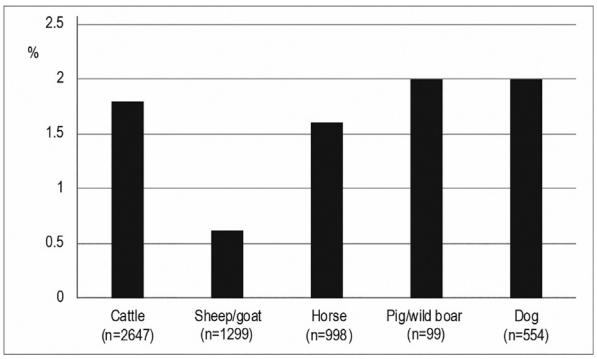

Figure 16. *Prevalence of pathology. Percentage of the number of bones with pathological changes out of the total number of fragments per species (uncorrected for associated fragments)*

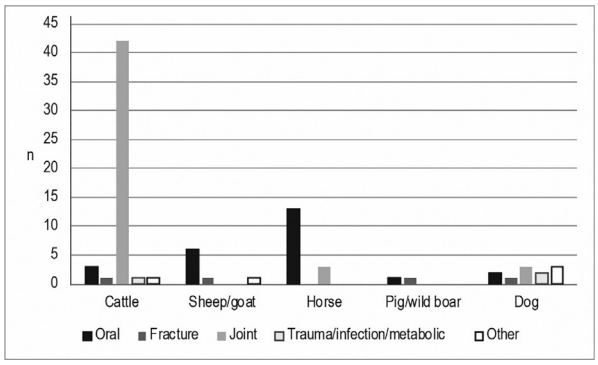

Figure 17. *Number of fragments with pathological changes per category per species*

Kaiser excavated three ash mounds completely and a fourth one partially. A series of radiocarbon dates shows that the site was in use from the 14th to the 11th century BC. The excavations have yielded 11623 identified animal bones, which were very well preserved but highly fragmented.[48] Wild mammals are represented by less than 1% and only three species are present: wild boar, red deer and aurochs. Cattle is the dominant species with 64% of the main domestic animals (Fig. 2), followed by sheep/goats with 21%. Horses and pigs are roughly equal, with 7 and 8% respectively.

Most cattle were slaughtered when they were between 3 and 3.5 years old, with a small proportion (13%) reaching older ages and 22% killed before being 3 years old. All 37 sex determinations (based on pelvis and horncore) were female. Sheep and goats also show a slaughter peak of young adults, with 68% killed between 2 and 3 years old. Twelve females and one male were identified. Five partial skeletons of very young animals were found. For pigs, the majority was killed at ages younger than two years (67%), with equal proportions of males and females. Most horses seem to have reached adult ages. No cut marks were found on dog bones, and most dog remains are from adult dogs, which suggests that this species was not important for meat.

The animal bones were interpreted as settlement refuse. The large quantity of bones and the presence of pigs were seen as archaeozoological indicators of a permanent settlement.[49] The dominance of cattle, sheep and goats, the small proportion of wild animals and the small proportion of pigs suggest an open landscape. Seasonal movement of herds was possible but not necessary. Cattle, sheep and goats were exploited, first and foremost, for meat, with milk and wool playing a secondary role. Some cattle were used for labour and kept to older ages.

Archaeobotanical analysis revealed carbonised and uncarbonised remains.[50] Some of the uncarbonised remains have been radiocarbon-dated to younger periods and will not be discussed further. Among the carbonised remains, millet stands out with 45 grains. The other cereals (emmer, einkorn, barley) and bitter vetch were represented by 1 or 2 grains only. The total of 207 samples of 5 litres only yielded 58 grains or seeds. The low number of remains and the dominance of millet are typical for this region. Millet provides an indication of the type of arable farming, which is likely to have been seasonal. Millet is perfectly suited for hot, dry summers. It grows very quickly and can be harvested 50–70 days after sowing. When sown in May, harvest can take place in July. No evidence was found for winter crops or accompanying weeds.

[48] Hochmuth 2011.

[49] The excavators of the site came to a different conclusion based on different sources of information. Repeated use of a seasonal camp over many years could also lead to a large quantity of refuse, including animal bones.

[50] Sava / Kaiser 2011, 355–367.

Discussion

Subsistence in the site of Taraclia-Gaidabul was highly reliant on domestic mammals, with very little hunting and fishing. What little hunting there was may have been done for food, to get rid of competition for crops or predators threatening livestock, or for fur. The dominant livestock species was cattle, followed by sheep/goats and horses, with very few pigs. All body parts of the domestic species were present, suggesting that animals were butchered on site. The proportion of butchery marks is low, but fragmentation is high and probably results from processing body parts for food.

Out of the calves slaughtered when aged between 1 and 30 months, the younger ones could be related to milk use, whereas the older calves were slaughtered for meat. Cattle that survived to adulthood mostly reached old ages. The cattle population consisted mostly of females. Cattle were exploited for milk, meat, herd survival, and possibly traction or the value of living animals (as exchange objects). For sheep or goats, neonatal/foetal and juvenile animals are present. Slaughter occurred in all age categories, but mortality profiles show few older animals. The herd mostly consisted of female animals. Sheep and goats were mainly exploited for meat and perhaps also for milk. Wool or hair is likely to have been used, but exploitation was not specifically geared towards this. It is possible that different strategies were used for sheep and goat, but unfortunately, it is not possible to separate slaughter ages for the two species. Nearly a quarter of horses was slaughtered in their first year, which suggests that milk and meat were important products. Apart from this, exploitation was aimed at herd survival, and horses were likely to have been used for transport. There is little information on sex ratios. Due to the small number of pig bones, there is little information for this species, but what there is does not contradict pigs being kept locally.

Indications for seasonality in the settlement are scarce. Firstly, late foetal or neonatal remains of sheep or goat are present, suggesting occupation in early spring. The presence of possible juvenile wolf remains supports this. Remains of young, but almost grown hares could indicate presence in autumn.

Sheep and goat mandibles show a slaughter peak between 6 and 12 months, suggesting occupation in autumn and winter. There are only two mandibles aged 2 to 6 months, which would point to presence in summer. However, bones from juvenile sheep or goats are present. Furthermore, cattle aged 1 to 8 months are present (based on tooth eruption and wear). These calves appear to be at the low end of the age range, suggesting presence in late spring/summer. Bones that clearly belonged to juvenile cattle and one pig are likely to be younger than six months. Overall, it seems that the site was occupied in all seasons, although, of course, this may not have been the case every year.

We can compare the results of the archaeozoological analysis of Taraclia-Gaidabul with the parameters useful for detecting nomadism or sedentism discussed by Morales Muñiz and Antipina (2003).[51] Morales Muñiz and Antipina warn against relying on a single parameter and emphasise that different lifestyles may still result in convergent data. In Taraclia-Gaidabul, ten parameters seem to suggest sedentism:

- the faunal assemblage has a relatively high taxonomic diversity; although cattle are dominant, sheep/goats and horses make up a large proportion as well (1–2);
- the ages of cattle and sheep/goats fit mostly with the expectations for sedentary sites, and so does the dominance of females for both cattle and sheep/goats (3–4);
- the near absence of cattle horncores suggests that at least female animals were hornless, especially when contrasted with the frequent occurrence of sheep and goat horncores or horned skulls. Goats were horned, and sheep were horned, but in some cases with small horns (5);
- pathological changes are present, and, although the frequency cannot be compared with other sites in the research area, it does not seem particularly low (6);
- bone density is high, and all skeletal elements are present (7–8);
- butchery seems intensive, although again, this is difficult to assess without comparison (9);

[51] Morales Muñiz / Antipina 2003.

– bone tools are present and not uncommon, but there is no evidence for bone working on an industrial scale (10).

Five parameters suggest a nomadic lifestyle:

– the low proportion of pigs;
– the high proportion of horses;
– the horned goats;
– the absence of a bone working industry;
– the absence of commensals such as house sparrows, house mice and black rats may not be very significant, as not all rodent remains have been identified down to the species.

Overall, the data are more suggestive of permanent settlement.

Cattle size could only be compared with Odaia-Miciurin: cattle in Taraclia are similar in size to cattle in Odaia (Fig. 18 and Fig. 19); the few larger individuals observed according to their astragalus could be bulls. Horses are also similar in size, although some individuals from Odaia are smaller than the horses in Taraclia (Fig. 20).

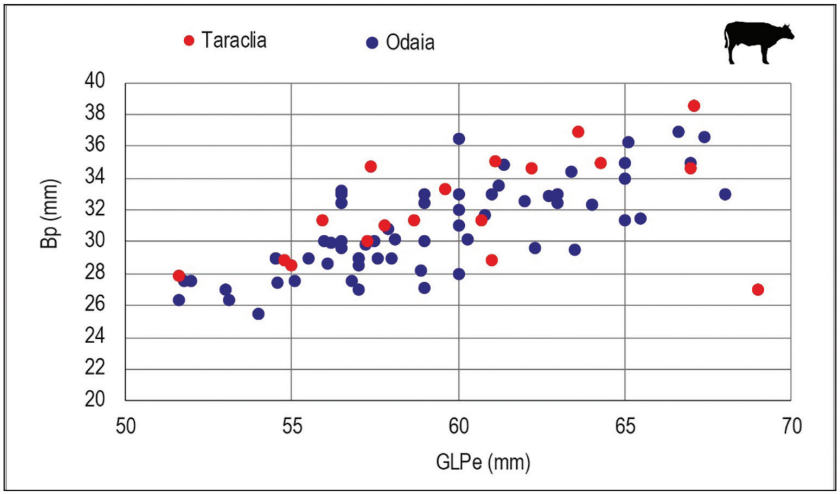

Figure 18. *Scatterplot for the proximal breadth and greatest length of the anterior first phalanx for cattle from Odaia-Micuirin (n = 63) and Taraclia-Gaidabul (n = 18)*

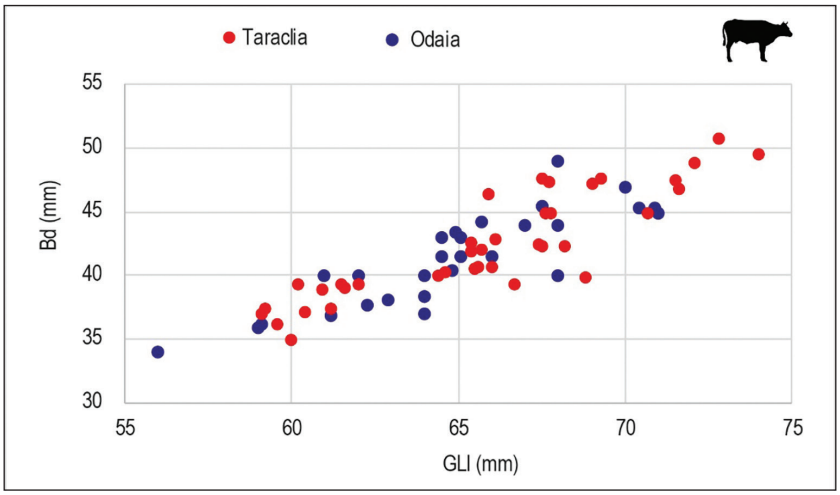

Figure 19. *Scatterplot for the distal breadth and greatest lateral length of the astragalus for cattle from Odaia-Micuirin (n = 28) and Taraclia-Gaidabul (n = 39)*

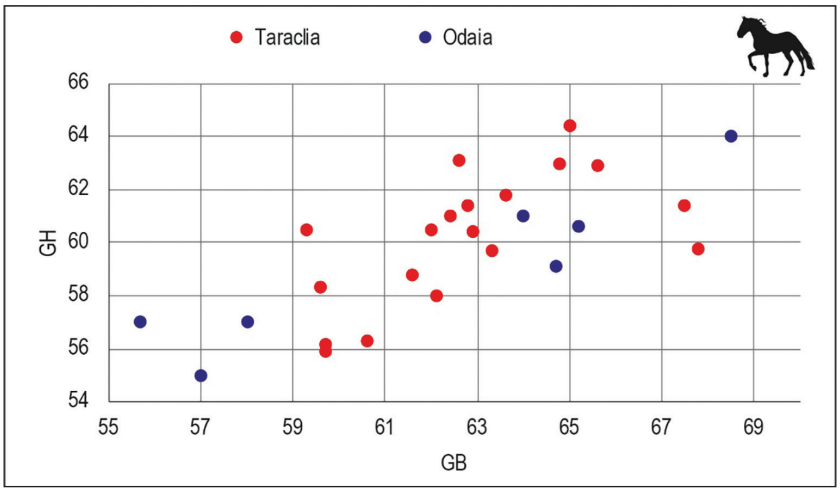

Figure 20. *Scatterplot for the greatest breadth and greatest height of the astragalus for horses from Odaia-Micuirin (n = 7) and Taraclia-Gaidabul (n = 19)*

When we compare the species proportions for Taraclia and Odaia with those Sava published for Noua and Sabatinovka settlements, we see that the Odaia species proportions are very similar to those from Noua sites, while those from Taraclia are more similar to Sabatinovka sites (the low proportion of pigs) and have the high proportion of horses that is found in Late Sabatinovka sites (Fig. 2). What is different is that Taraclia shows a much higher proportion of sheep/goats than the average for Sabatinovka and Late Sabatinovka sites and a relatively low proportion of cattle. Most Sabatinovka and Late Sabatinovka sites have sheep/goat proportions between 11 and 17%, with one lower and one higher (Mereni with 31%). The relatively low proportion of cattle, like the high proportion of horses, seems typical for/is more common in Late Sabatinovka sites.

Figure 2 also shows species proportions for Rotbav, a site belonging to the NSCC but located in a very different environment, to the west of the Carpathian Mountains (so not steppe). This site shows a very high proportion of pigs compared to all other sites. It also has a high proportion of sheep/goats and the lowest proportion of cattle of all sites (although cattle is still the dominant species).

Bendrey's study[52] shows a strong correlation between species proportions and climate in the steppe zone. Today, the southern part of Moldova is much drier than the northern part. This can perhaps explain the higher proportion of sheep/goats in Taraclia since it is considered the southernmost of all sites. Mereni shows an even higher proportion but has a relatively small assemblage, so it may be less reliable. The low proportion of pigs in Taraclia seems to have been determined more by the landscape/vegetation than by the lifestyle.

A systematic investigation of the parameters discussed by Morales Muñiz and Antipina may help determine the lifestyle – nomadic or sedentary – for individual sites. Two parameters for Novokievka, another Sabatinovka settlement, also suggest a sedentary lifestyle: hornless cattle and a dominance of female cattle. However, it would be dangerous to rely on just two parameters. When we consider the two basic models for NSCC subsistence from the perspective of Taraclia-Gaidabul, it seems that both models may have existed side by side. The tentative conclusion based on the archaeozoological remains from Taraclia-Gaidabul is that this was a permanently inhabited settlement. This stands in contrast to Odaia-Miciurin, which is believed to have been seasonally occupied. In this sense, each site fits the model that applies to the region and environment in which they are located: the north/forest steppe and the south/grass steppe. Clearly, high-quality data for more settlements are needed to test this.

[52] Bendrey 2011.

Conclusion

The archaeozoological data from Taraclia-Gaidabul have provided further insight into the subsistence in the Late Bronze Age northern Black Sea region. It seems that the two models proposed by Gershkovich[53] and Sava[54] can exist side by side, with the first one suitable for the southern part of the region (grass steppe) and the second one suitable for the northern part of the region (forest steppe). Vegetation and climate in this region seem to be the main influence on species proportions for the main domestic livestock species. A systematic discussion of the parameters described by Morales Muñiz and Antipina can be useful in assessing the lifestyle for an individual settlement, but even for Taraclia, not all data were available.

Future research in this region could include analysis of those parameters that are currently unexploited, such as data on mites and beetles. This, of course, will only be possible when appropriate samples are collected during future excavations. A detailed analysis of measurements of existing faunal assemblages may be more feasible. A biometric analysis could also indicate whether and to what extent cattle were used for traction, providing further insight into subsistence and potentially highlighting differences between sedentary and mobile people. Analysis of strontium and stable isotopes could also provide information on mobility and management of livestock, while an organic residue analysis could confirm whether horse milk was used in this region, something that is suggested for Taraclia-Gaidabul.

Multidisciplinary research is clearly the way forward. Furthermore, each settlement should be analysed and interpreted in its own right. Modern systematic settlement archaeology in the northern Black Sea region has only just begun and new excavations can perhaps answer some of the many questions that currently remain unanswered.

[53] Gershkovich 2003.

[54] Sava 2005; Sava / Kaiser 2011.

Rezime

Način života u kasnom bronzanom dobu sjevernog crnomorskog regiona: studija slučaja Taraklija-Gajdabul (Republika Moldavija)

Arheozoološki podaci s lokaliteta Taraklija-Gajdabul pružili su dodatne uvide u način života u sjevernom crnomorskom regionu tokom kasnog bronzanog doba. Čini se da dva modela koja su predložili Geršković i Sava mogu postojati paralelno – prvi je primjeren južnom dijelu regije (travnata stepa), dok je drugi primjeren sjevernom dijelu regije (šumska stepa). Vegetacija i klima u ovom regionu izgleda da imaju ključan utjecaj na proporcije glavnih vrsta domaćih životinja. Sistematska rasprava o parametrima koje su opisali Morales Muniz i Antipina mogla bi biti korisna za procjenu načina života pojedinačnih naselja, ali čak i za Tarakliju nisu svi podaci bili dostupni.

Buduća istraživanja u ovom regionu mogla bi uključivati analizu trenutno neiskorištenih parametara, poput podataka o grinjama i bubama. Ovo će, naravno, biti moguće samo ako se prikupe odgovarajući uzorci tokom budućih iskopavanja. Detaljna analiza mjerenja postojećih životinjskih ostataka mogla bi biti ostvarivija. Biometrijska analiza također bi mogla pokazati u kojoj su mjeri goveda korištena za vuču, pružajući daljnje uvide u način života i potencijalno ukazujući na razlike između sedentarnog i mobilnog stanovništva. Analiza stroncijuma i stabilnih izotopa mogla bi dati informacije o mobilnosti i upravljanju stokom, dok bi analiza organskih ostataka mogla potvrditi da li je konjsko mlijeko korišteno u ovoj regiji, što se sugerira za Tarakliju-Gajdabul.

Multidisciplinarna istraživanja jasno predstavljaju pravac budućnosti. Pored toga, svako naselje treba analizirati i interpretirati kao jedinstven slučaj. Moderna sistematska arheologija naselja u sjevernom crnomorskom regionu tek je započela, i nova iskopavanja možda će moći odgovoriti na neka od mnogih pitanja koja trenutno ostaju neriješena.

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