

Table of Contents

Acknowledgements	XI
I Introduction	I
2 Background	7
2.1 Archaeological background	7
2.1.1 Introduction	7
2.1.2 The (Middle and) Late Eneolithic period in the North Pontic steppe	7
2.1.2.1 History of Research	7
2.1.2.2 Characterisation of the (Middle and) Late Eneolithic steppe cultures	8
2.1.2.2.1 Chronology and regional subdivision	8
2.1.2.2.2 Economy and interaction of the Eneolithic steppe cultures	11
2.1.3 The Early Bronze Age Yamnaya period	12
2.1.3.1 Chronology	12
2.1.3.2 Distribution and regional subdivision	13
2.1.3.3 Burial tradition	15
2.1.3.4 Economy	16
2.1.3.5 Regional variants and distinct cultures of relevance	17
2.1.4 The Middle Bronze Age Catacomb culture period	19
2.1.4.1 Chronology	19
2.1.4.2 Distribution and regional subdivision	20
2.1.4.3 Burial tradition	21
2.1.4.4 Economy	24
2.1.5 (South)westward steppe impact	25
2.1.5.1 History of research	25
2.1.5.2 Late Eneolithic period	27
2.1.5.3 Early Bronze Age Yamnaya horizon	28
2.1.5.4 Middle Bronze Age Catacomb culture horizon	31
2.1.6 The Iron Age Scythian period	32
2.1.6.1 Introduction	32
2.1.6.2 Chronology and distribution of the Scythian cultural groups	33
2.1.6.3 Historical sources of the Scythians	34
2.1.6.4 Characterization of the Scythian culture in respect to this study	35
2.1.6.5 Cultural groups touched upon in this study	37
2.2 Methodological background	41
2.2.1 The application of isotope analysis	41
2.2.1.1 Mobility in archaeology and the application of strontium and oxygen isotope analyses	42

2.2.1.2	Palaeodiet and the application of carbon and nitrogen isotope analysis	44
2.2.2	Tooth and bone as sample materials and information archives . . .	46
2.2.3	Geology and ecology in the study region with regard to isotope analysis	50
3	Sample sites and Material	55
3.1	Introduction	55
3.2	Eneolithic and Bronze Age	56
3.2.1	Carpathian-Balkan region	56
3.2.1.1	Bulgaria	56
3.2.1.2	Hungary	59
3.2.2	North Pontic region	61
3.2.2.1	Central Ukraine	61
3.2.2.2	East Ukraine	64
3.2.3	Russia	65
3.2.3.1	Volga region	65
3.2.3.2	Kuban and Northwest Caspian Sea region	67
3.3	Iron Age	68
3.3.1	North Pontic region	68
3.3.2	Central Asia: Berel'	71
4	Mobility and Migration	73
4.1	Introduction	73
4.2	Theories on mobility and migration	73
4.2.1	History of research in mobility and migration theories in prehistoric archaeology	73
4.2.2	Mobility	74
4.2.2.1	Definition	74
4.2.2.2	Mobility models	75
4.2.2.3	Characteristic forms of mobility in the Eurasian steppe belt	77
4.2.3	Migration	79
4.2.3.1	Definition	79
4.2.3.2	Migration models	79
4.2.3.3	Migration in the West Eurasian steppes	81
4.2.4	Scientific contribution to mobility and migration research in archaeology	82
4.3	$^{87}\text{Sr}/^{86}\text{Sr}$ analysis	83
4.3.1	Basics	83
4.3.1.1	Introduction	83
4.3.1.2	Strontium in tooth and bone	84
4.3.1.3	Definition of the 'local' biologically available strontium	85
4.3.2	Material	87
4.3.3	Methods	88

4.3.3.1	Methodology for tooth enamel samples	88
4.3.3.2	Methodology for comparative samples	90
4.3.3.3	Strontium concentration measurements	91
4.3.4	Results	91
4.3.4.1	Correction of the $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratios	92
4.3.4.2	Results of the $^{87}\text{Sr}/^{86}\text{Sr}$ analysis	93
4.3.4.2.1	Eneolithic and Bronze Age	93
4.3.4.2.2	Iron Age	98
4.3.4.3	Intra-site and inter-site comparison	99
4.3.4.4	Inter-regional comparison	101
4.3.4.5	Differences related to gender and age	101
4.3.4.5.1	Eneolithic and Bronze Age	101
4.3.4.5.2	Iron Age	104
4.3.4.5.3	Comparison on a regional scale	104
4.3.4.6	Chronological differences	105
4.3.4.7	Strontium concentrations	107
4.3.5	Biological measurements of $^{87}\text{Sr}/^{86}\text{Sr}$	110
4.3.5.1	Published $^{87}\text{Sr}/^{86}\text{Sr}$ data	110
4.3.5.2	Estimation of the 'local' $^{87}\text{Sr}/^{86}\text{Sr}$ range and identification of 'locals' and 'non-locals'	112
4.3.5.2.1	Eneolithic and Bronze Age	112
4.3.5.2.2	Iron Age	120
4.3.5.3	Evaluation of the 'local' $^{87}\text{Sr}/^{86}\text{Sr}$ values	122
4.4	$\delta^{18}\text{O}$ analysis	124
4.4.1	Basics	124
4.4.1.1	Introduction	124
4.4.1.2	Variations in $\delta^{18}\text{O}$	125
4.4.1.2.1	General causes of variation	125
4.4.1.2.2	Seasonal variation	126
4.4.1.2.3	Intra-tooth and intra-species variation	127
4.4.1.2.4	Intra-site variation	127
4.4.1.3	$\delta^{18}\text{O}$ analysis of $\delta^{18}\text{O}$ in tooth enamel carbonate	129
4.4.1.4	Data conversion	129
4.4.1.4.1	Conversion of $\delta^{18}\text{O}_\text{c}$ measured against V-PDB into V-SMOW data.	129
4.4.1.4.2	Conversion into data comparable to meteoric water	130
4.4.1.5	Data comparison	133
4.4.1.5.1	Comparison to $\delta^{18}\text{O}$ results of studies in the same region	133
4.4.1.5.2	Comparison to $\delta^{18}\text{O}$ in modern precipitation	134
4.4.2	Material	135
4.4.3	Method	135
4.4.4	Results $\delta^{18}\text{O}_\text{c}$ (V-PDB)	136
4.4.4.1	Eneolithic and Bronze Age	137

4.4.4.2	Iron Age	142
4.4.4.3	Intra-site and inter-site comparison	143
4.4.4.4	Inter-regional comparison	145
4.4.4.5	Gender and age related differences	145
4.4.4.5.1	Eneolithic and Bronze Age	145
4.4.4.5.2	Iron Age	149
4.4.4.5.3	Comparison on a regional scale	149
4.4.4.6	Chronological differences	150
4.4.5	Biological measurements of $\delta^{18}\text{O}$	152
4.4.5.1	Estimation of the 'local' $\delta^{18}\text{O}$ range	152
4.4.5.2	Published data of $\delta^{18}\text{O}$ in humans and animals	152
4.4.5.3	Published modern water values	155
4.4.5.4	$\delta^{18}\text{O}$ in precipitation	155
4.4.5.5	Conversion of $\delta^{18}\text{O}$ in tooth enamel carbonate into $\delta^{18}\text{O}$ in water	158
4.4.6	'Locals' and 'non-locals'	159
4.4.6.1	Results of the data conversion into $\delta^{18}\text{O}$ in water and 'local' $\delta^{18}\text{O}$ ranges	159
4.4.6.1.1	Eneolithic and Bronze Age	159
4.4.6.1.2	Iron Age	164
4.4.6.2	Potential correlation between $\delta^{18}\text{O}$ results and longitude and latitude	165
4.4.6.3	Evaluation of the 'local' $\delta^{18}\text{O}$ values	166
4.5	Combined results and discussion of $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{18}\text{O}$ analyses	167
4.5.1	Eneolithic and Bronze Age	167
4.5.2	Iron Age	191
4.6	Discussion of this chapter's results	199
4.6.1	Sampling	199
4.6.1.1	Sample selection and sample size	199
4.6.1.2	Reference sample material and the definition of the 'local' signatures	200
4.6.1.3	Intra-individual sampling in humans	205
4.6.2	Identification of outliers	205
4.6.2.1	'Local' or 'non-local'?	205
4.6.2.2	Identification of outliers on an intra-site level	207
4.6.2.3	Identification of outliers on an intra-regional level	209
4.6.2.4	Identification of outliers on an inter-regional level	209
4.6.3	Reconstruction of economic systems	210
4.6.3.1	Mobility variants	210
4.6.3.2	Elements of uncertainty	212
4.6.4	Detection of a possible increase of mobility due to the emergence of draught animals, wagons and climatic changes using $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{18}\text{O}$ analyses	214
4.6.4.1	Site variability	214

4.6.4.2	Exceptional burials	217
4.6.5	Mobility in the Iron Age Scythian period	219
4.6.5.1	Human mobility	219
4.6.5.2	Evidence for faunal mobility in the Iron Age Scythian period	220
4.6.6	Isotopic indicators for possible migrations from the steppe area to the west	221
4.7	Conclusions Chapter 4	223
5	Case study: Faunal mobility in the context of the Globular Amphora culture	227
5.1	Introduction	227
5.2	Theories of faunal mobility	227
5.3	Stable isotope analysis of faunal mobility	228
5.4	Archaeological framework	229
5.4.1	Globular Amphora culture and cattle depositions	229
5.4.2	Archaeology of Zauschwitz	231
5.5	Expected isotopic values of Zauschwitz	232
5.6	Material	233
5.7	Results and discussion	234
5.7.1	Strontium isotope analysis	234
5.7.2	Oxygen isotope analysis	235
5.7.3	Combination of strontium and oxygen isotope analyses	237
5.8	Conclusions Chapter 5	240
6	Palaeodiet	243
6.1	Introduction	243
6.1.1	Objectives of this study	243
6.1.2	Diet of the West Eurasian steppe people in the Eneolithic, the Early and Middle Bronze Age	243
6.2	Methodological basics	244
6.2.1	Potential information derived from stable isotope analysis	244
6.2.2	$\delta^{13}\text{C}$ analysis	245
6.2.2.1	Basic principles	245
6.2.2.2	$\delta^{13}\text{C}$ in C_3 and C_4 plants and their consumers	246
6.2.2.3	$\delta^{13}\text{C}$ in marine, freshwater and terrestrial diet	246
6.2.2.4	Trophic level shifts	247
6.2.3	$\delta^{15}\text{N}$ analysis	248
6.2.3.1	Basic principles	248
6.2.3.2	Trophic level effect	249
6.2.3.3	Terrestrial, freshwater and marine food	249
6.2.3.4	Climatic effect and water dependency	250
6.3	Material	250
6.4	Method	251
6.5	Results of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analysis	252
6.5.1	Sample preservation	252

6.5.2	Results faunal material	252
6.5.3	Results human material	253
6.5.3.1	Human bones	253
6.5.3.2	Results and discussion of combined $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analysis of the human bones	254
6.5.3.3	Human teeth	258
6.6	Discussion	258
6.6.1	Discussion of the results of the faunal references compared to further studies	258
6.6.2	Discussion of the results of the human bones	261
6.6.2.1	Internal site variation	261
6.6.2.2	Correlation between $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ ratios	263
6.6.2.3	Chronological comparison	266
6.6.2.4	Variations based on gender and age	267
6.6.3	Discussion of the results of human teeth	269
6.6.4	Discussion of possible dietary components	270
6.6.5	Comparison of the results for human bones to analogous studies	274
6.6.5.1	North Pontic region	274
6.6.5.2	Kuban region	276
6.6.5.3	West Pontic region	277
6.7	Conclusions Chapter 6	280
7	Summaries in English, German and Russian	283
8	Bibliography	295
Appendices		
	Introduction to the Appendices	327
	Appendix A	
	I Sites	328
	II Samples	349
	Appendix B	
	Data $^{87}\text{Sr}/^{86}\text{Sr}$ analysis	384
	Appendix C	
	Data $\delta^{18}\text{O}$ analysis	388
	Appendix D	
	Data $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analysis	399