

The Implications of Variation in Late Pleistocene Levantine Crania for
Understanding the Pattern of Human Evolution

by

Davorka Radovčić

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Anthropology)
in the University of Michigan
2011

Doctoral Committee:

Professor Milford H. Wolpoff, Chair
Professor John D. Speth
Associate Professor Paolo Squatriti
Professor Rachel Caspari, Central Michigan University

to my family and the Other

Acknowledgements

There is a long list of people who I am indebted to for the final realization of this dissertation. I was fortunate enough that throughout the whole process of being a graduate student, there were always a great number of people taking care of me on my way through academia, and to my adulthood.

First of all, I need to thank my advisor Dr. Milford H. Wolpoff. There are no words to describe how much I appreciate all the support that I received in various and unlimited ways from him. In the same way I extend my gratitude to Dr. Rachel Caspari, my mentor in various ways throughout my years at Michigan. She was, in same ways as Milford, my safety harbor. There are no words to thank you enough Milford and Rachel! All I can do is to follow your example and try to be as nice to people as you were to me! I would also like to thank Drs. John Speth and Paolo Squatriti for serving on my committee, and for putting in the time and effort and giving me great comments and support during the final stages of this work.

The research here would have not been possible without the permission to visit and study the original fossil and early medieval crania. The permissions were kindly granted to me, and I am very grateful to have such opportunity and extend my gratitude to Drs. Ildikó Pap, István Matskási and Erzsébet Fóthi from Természettudományi Múzeum, Budapest; Drs. Yoel Rak, Israel Hershkovitz and Baruch Arensburg from the Tel Aviv University and Dr. Ofer Bar-Yosef from Harvard University; Drs. Christopher

Stringer and Robert Kruszynski from the British Natural History Museum; Drs. Henry de Lumley and Amélie Viallet from Institut de Paléontologie Humaine; Drs. Steve LeBlanc and Michèle Morgan from the Peabody Museum of Harvard University. In addition, I extend my gratitude to everyone in the Department of Anthropology of Természettudományi Múzeum – Sándor, Szabolcs, Ági, Bela, Ildikó, Zsolt and Tamás.

For financial support throughout this dissertation research, I extend my gratitude to the CARE grant, Mrs. Matovinović, and the Department of Anthropology at the University of Michigan. The one who I specially thank is Laurie Marx who made sure I was supported through all these years of graduate school.

Many people provided great support, friendship, hospitality and company during my travels and stay in Israel and Hungary. I would like to specially thank the whole Rak family, Reuven Yeshurun, Guy Bar-Oz, Eszter, Ildikó, Péti, and Tamás and his family.

I am truly thankful to Zachary Cofran, for writing the statistical programs used in the analyses, and for being an immense support throughout the years. I thank Julie, Jerry, Marissa, Elizabeth, Mary, Brent, Lauren, Adam, Virginia, Caroline, Dana, Kristen, and Crystal for being great colleagues, but even more importantly friends throughout the years. The same gratitude I extend to Susanne, Jess, Paul, Eric, Kevin, Alex, and Raji. All said and done, it is a really great feeling to sit down, look seven years back, and remember the moments with you here – good and bad, ups and downs. I will continue to hold you very dear to me. You guys are my Ann Arbor Amarcord. I hope we continue

our friendship in the time to come, and remember that *mi casa es su casa* wherever I find myself at the moment.

I thank the whole Wolpoff family – Ben, Sarah, Barry, Donna, Michael, Tricia and Owen – for the immense and warm support I received over the years. For support and cheering that I always felt was of great help – thank you Janet Monge, Karen Rosenberg, Alan Mann, David Frayer, Bruno Maureille, Preston Miracle, Anne-marie Tillier and Fred Smith; and my cheerleaders at home – Dunja, Dora, Tamara, Sabolić, Marija, Leni and Jazzmin. Finally, I thank my family – mama, tata, Gigi and baka – without their support I would never have made it. I thank my dad for the stories about fisherman Palunko, and the great sea that once covered Pannonia. It made perfect sense back then, and now maybe even more so (or less so)!

Table of Contents

Dedication.....	ii
Acknowledgements.....	iii
List of Figures.....	x
List of Tables.....	xi
List of Appendices.....	xii
Abstract.....	xiii
Chapter	
1. Introduction.....	1
2. Historical and theoretical background.....	10
I. Introduction to the Mount Carmel sites and Qafzeh cave.....	12
II. What was known about human evolution in the 1930s.....	15
III. Is Neandertal our ancestor? Regional streams of thoughts – up to the discoveries at Mount Carmel.....	19
IV. How did the Levantine sample fit into the existing framework of human evolution?.....	32
V. Criticisms of McCown and Keith.....	39
1. By Ashley-Montagu – why not hybridization?.....	40
2. Weidenreich – why separate species?.....	43
3. Dobzhansky – population geneticist’s view.....	44
4. Thoma – testing the hybridization model.....	46

VI. The problem of holotype, type specimen, and species definition.....	48
VII. How do the Levantine fossils fit the present theoretical frameworks?.....	53
VIII. How the question is addressed here – back to the hybridization.....	55
IX. Conclusion.....	60
3. The Pannonian Plain in the Early Medieval Ages: how the mixed sample got mixed.....	63
I. Introduction to the Pannonian Plain.....	67
1. Geography of the Pannonian Plain.....	67
2. Origin and tradition of the name Pannonia.....	70
3. Pannonia as a part of the Pontic-Danubian realm.....	71
II. Roman Pannonia.....	74
1. Roman strategic interest in the Pannonian Plain and its conquest.....	75
2. The local population before and during the Roman rule.....	76
3. The internal struggle of the Roman Empire during the third and fourth centuries.....	78
III. The Great Migrations Period – fourth to eighth centuries in the Pannonian Plain.....	80
1. New populations entering Europe.....	83
IV. The Avars and the Avar period in the Pannonian Plain.....	89
1. The appearance of the Avars.....	90
2. Who were Avars?.....	92
3. The question of Avar ethnicity and various peoples under the Avars.....	95
4. Anthropological studies of pre-Avar and Avar age cemeteries.....	98
V. Conclusion.....	101
4. Material.....	104
I. Levantine sites.....	106
1. Excavations and findings of the Mount Carmel sites.....	108
a. Tabun.....	108
b. Skhul.....	119

2. Excavations and findings of the Qafzeh cave site.....	126
3. Excavations and findings at the Amud cave site.....	132
4. Summary of the cranial sample from the Levantine sites used in this dissertation.....	137
II. Comparative sample from the Pannonian Plain.....	140
1. Archaeological sites yielding the Pannonian comparative sample.....	141
III. Conclusion	143
5. Methods.....	147
I. Why non-metric cranial traits?.....	148
1. What are non-metric traits?.....	151
2. Factors influencing non-metric trait expression.....	154
3. Cranial non-metric traits.....	158
4. Non-metric traits in fossil human crania: Neandertal and modern human morphologies.....	160
II. Data collection.....	165
1. Assessment of sex.....	166
2. Assessment of age.....	167
3. Scoring.....	168
4. Scoring standards.....	173
III. Statistical analysis: summary statistics and resampling.....	174
1. Resampling.....	176
2. Resampling of the fossil data set.....	177
IV. Conclusion.....	179
6. Results and discussion.....	182
I. Results.....	184
1. Observed and resampled ratio distributions, means and variance.....	186
a. Assessing the significance of the fossil data set: the mean test statistics.....	187
b. Assessing the significance of the fossil data set: the variance test statistics.....	190
2. Conclusion of the results.....	192

II. Discussion.....	192
III. Conclusion.....	206
7. Conclusions.....	209
Epilogue.....	220
Appendices.....	226
Bibliography.....	279

List of Figures

3.1 Map of the Pannonian Plain.....	68
3.2 Map of the Roman provinces in 1st-3rd centuries.....	71
3.3 The Pontic-Danubian region in its Eurasian context.....	73
3.4 Map of the area of the Pannonian Plain under the Avar rule.....	92
4.1 Middle Paleolithic sites in the Levant area.....	105
4.2 Map of the Levantine area, with the locations of the four Late Pleistocene cave sites.....	107
4.3 Comparison of the stratigraphic section reported by Garrod with that revealed by Jelinek's excavations.....	115
4.4 Ground plan of the Skhul cave with locations of the burial sites.....	120
4.5 Ground plan of the vestibule area of the Qafzeh cave with the location of the Skeletal remains found.....	131
4.6 Schematic map of excavated areas of Amud cave.....	135
4.7 Map of the present day Hungary showing the locations of the pre-Avar and Avar age sites yielding crania used for the comparative sample.....	141
5.1 Flow-chart illustrating the procedure of calculating the ratios.....	175
6.1 Frequency distribution of observed ratios for 67 traits in the fossil data set.....	186
6.2 Frequency distribution of observed ratios for 67 traits in the Pannonian sample.....	187
6.3 Frequency of resampled mean statistics for the total Pannonian data set.....	189
6.4 Frequency of resampled variance statistics for the total Pannonian data set.....	191

List of Tables

3.1 Major elements of ethnic changes in Pannonia during the late fourth to middle of seventh centuries.....	87
4.1 The chronology of Mousterian industries in the Levant.....	125
4.2 Comparison and correlation of Qafzeh Mousterian layers recognized during Vandermeersch and Bar-Yosef campaigns to the ones recognized by Neuville and Stekelis.....	128
4.3 List of Late Pleistocene human fossil skeleton found at Qafzeh with the location of the discoveries within the cave, and archaeological layers.....	130
4.4 Summary of the specific Levantine crania used in this dissertation.....	139
4.5 List of the Pannonian crania used as comparative sample in this dissertation.....	142
5.1 Neandertal cranial autapomorphies, unique or most frequent in the group.....	161
5.2 List of morphological characteristics that McCown and Keith used in distinguishing Neandertal from modern human expression in Mount Carmel sample.....	164
5.3 List of 67 traits used in the analysis of the Levantine and Pannonian samples.....	171
6.1 Summary of results values for the 67 traits.....	192

List of Appendices

Appendix A: data collection sheets.....	226
Appendix B: scoring procedures.....	230
Appendix C: non-metric cranial scores for the Levantine and Pannonian samples.....	277

Abstract

The implications of variation in Late Pleistocene Levantine crania for understanding the pattern of human evolution

by

Davorka Radovčić

Chair: Milford H. Wolpoff

The inspiration for this dissertation comes from the variability in a sample of Late Pleistocene fossil human crania found in the Southern Levant, in present day Israel. This sample (n=13) is comprised of both Neandertals from Tabun and Amud, and the remains from Skhul and Qafzeh that are considered predecessors of modern humans. Many authors describe the heterogeneity of the Levantine sample as *unusual*, greater than what modern populations could be expected to exhibit, and many believe they represent groups of different human species.

The focus of this study is on whether the magnitude of Levantine variation is really *unusual* – because this has significance for understanding the pattern of human evolution and identifying past species. The issue is addressed in a statistical, comparative context: 113 crania at 6 museums and laboratories in 5 countries were examined. To demonstrate the Levantine sample variation is really caused by taxonomic differences, at the minimum the Levantines should exhibit a greater magnitude of variation than expected in a comparable modern population of mixed ancestry from a confined

geographic area and limited time span. This would indicate that the Levantine variation is not from *species* mixture; it involved a mixture of human *populations*.

This null hypothesis is tested by comparing the Levant sample's non-metric cranial variation with the cranial variation in 100 mixed-ancestry medieval crania from the Pannonian Plain (fourth to eighth century A.D.). Dichotomous, binomial responses were collected for 67 traits. The mean and variance of ratios of the scores describe the heterogeneity versus homogeneity. One thousand samples of $n=13$ were randomly drawn with replacement from the Pannonian data. The fossil Levantine sample was compared to the resampled Pannonian distribution to test whether the magnitude and variance of the Levant data are expected within it.

The results show that the magnitude of the variation in the Levantine sample is *not unusual* when compared to the Pannonian sample, and the null hypothesis of admixture of different populations *cannot be refuted*. These results are strongly supported by the recent ongoing advances in the study of ancient and modern nDNA, showing significant Neandertal mixture in the Levant.

Chapter 1

Introduction

“... *any term in science, including the term [...] ‘species’, means only what we make it mean*”
T.G. Dobzhansky, 1944, 254

The Late Pleistocene is a period when something that researchers recognize as ‘anatomically modern humans’ begins to appear in the fossil record from archaeological sites across the Old World. The inspiration for this dissertation comes from the discovery of a particular sample of Late Pleistocene fossils – those found within a relatively small, confined area of the Southern Levant, in present day Israel. The most unusual aspect of this sample is its variation. This hominid sample is comprised of both Neandertals (Neandertal-like humans) from Tabun and Amud, and the remains from Skhul and Qafzeh that are considered predecessors of more recent and modern humans.

There is a large literature describing and analyzing the variation expressed by these Late Pleistocene Levantine hominids. Today, some seventy years after the discovery of majority of the Levantine Late Pleistocene sample, the interpretation of the skeletal material found is still not agreed upon. During the course of this dissertation, the reader is introduced to the complexity of the interpretations in the pertinent literature. Particular focus is placed on the opposing ways of interpreting its *unusual magnitude*.

The first interpretation, presented shortly after the earliest Levantine discoveries of the 1930s, was that the Levantine sample represents a time when Neandertals and modern humans were ‘crystallizing’, each with their own particular morphologies, eventually leading to two divergent forms. Interpretations proposed afterwards range from two different populations hybridizing in this region, to two different species frequenting and inhabiting this area at different points of time, with no interaction.

What attracted the author to this research was the range of these interpretations, and their importance in the broader understanding of pattern of Late Pleistocene human evolution. In the significant literature that developed to offer solutions to the supposed problem of Levantine variation, one fact continued to appear in the works of many authors. The heterogeneity of the Levantine specimens is *unusual*, or *unexpected*, or in other words greater than what modern populations exhibited. Focus is on this key question, because from its resolution an understanding of the human population of the Late Pleistocene and its evolution follows. To ask if this sample is *unusual* in the magnitude of its variation requires knowledge of the *not unusual magnitudes* of variation in modern population. This is a statistical question that has to be answered in a comparative context.

The aim of this study is therefore to make a comparison of the variability in the Levant crania and dental remains and the variation in a human population. If the variation in the Levantine sample is really caused by taxonomic differences as some scholars posit, we would expect that the Levantines should exhibit a greater magnitude of variation than an appropriate and comparable recent modern comparative population sample. For a conservative study, the author concentrates on a population from one specific geographic

area (as the Levant is; further discussed in Chapter Three), over a limited time span. The population chosen for these comparisons is of mixed ancestry, because mixed ancestry is the key issue addressed by the variation in the Levantine remains. Interpretations of the Levantines that do suggest a mixture of populations, lie on a continuum in which a single biological population is less variable while a mixture of two different populations is more. The approach taken here is to test a null hypothesis comparing the Levantine cranial variation with the cranial variation in a specific human population from a limited geographic area with ancestry known to be mixed – the early medieval Pannonian sample. The Pannonian sample used consists of one hundred human crania from the area of Western and Central Hungary, spanning four centuries of the medieval period (fourth to eighth century A.D.). The null hypothesis tested in this dissertation is that the variation in the Levant samples is not unusual, or unexpected, when compared to human populations with an archaeological record that shows mixed ancestry between people found in the same geographic region.

To test the null hypothesis presented above, non-metric and anthroposcopic (visually discernable) cranial and dental traits were collected for the original Levantine crania. The same set of data was collected for the early medieval archaeological sample from the Pannonian Plain, which encompasses a large lowland area in the Central Europe. The magnitude of variability for this archaeological sample is appropriate in exploring the issue raised because during this time there were various significant population movements of many Eurasian steppe and Germanic tribes penetrating the eastern *limes* of the Roman Empire. These movements during the late antique and early medieval times resulted in substantial population mixture, which is documented both in

historical sources and further confirmed in the archaeological record, specifically in skeletal remains and material culture. The details on how the data were collected and how the null hypothesis was tested, as well as the issues involved in interpreting the Levantine variation, are presented in more detail in the chapters to follow.

This dissertation is divided into seven chapters. In the first chapter, an overview of the topics covered in this thesis is provided. As the author argues, the importance of the various opposing views for interpreting the variation present in the Late Pleistocene Levantine fossil sample invites further exploration of this issue. The main problem of the opposing interpretations revolves around establishing the magnitude of *unusual* versus *not unusual* magnitude of variation.

Chapter Two provides the background for the various interpretations of the Late Pleistocene Levantine fossils. The rationale for addressing this issue is presented, and the ways the questions surrounding the interpretations have been framed are discussed. The chapter begins with the 1930's, when human fossil remains from three caves sites in the Levant were brought to light. These caves – Mount Carmel caves of Tabun and Skhul, and the Qafzeh cave – contained skeletal materials that exhibited unprecedented combinations of features and an unmatched magnitude of overall variation. In order to explain how these newly found fossil specimens fit the theoretical framework of human evolution as it existed then, it is of importance to examine what was thought of, and known about, the course of human evolution by the 1930s and this is also presented. The chapter continues with the interpretations reached by Theodore McCown and Sir Arthur Keith who first studied the variation present in the Carmelite remains. They decided that

the Carmelites¹ represent a highly heterogeneous population that was in the “*throes of evolutionary change*”.

McCown and Keith’s interpretation of the great magnitude of variation that the Carmelite sample exhibited, and their conclusions about its significance, were met with various criticisms over the following decades, namely those of Ashley-Montagu, Weidenreich, Dobzhansky, Thoma and Howell. These critics concentrated on explaining the heterogeneity in the Levantine sample by various hybridization models.

Typology played an important role in these considerations. To understand the underlying issues, a discussion follows of the problems and implications of defining the holotype, or type specimen for a population known from a fragmentary fossil record. In addition, different species definitions and concepts that were, and are, used in paleoanthropology are presented since they are tied to the interconnected problems of how species are defined and how specimens are attributed to them.

Before accepting the validity of such taxonomic explanations for Levantine Late Pleistocene hominids, the approach taken here is to first try to establish the not unusual magnitude of variation exhibited in the skeletal morphology of a comparable modern human population. As noted above, this comparable population is like the Late Pleistocene Levantine sample because it is from one specific geographic area, and its presence is recorded over a limited time span. In addition, it comes from the archaeological record, and has demonstrably mixed ancestry. The conditions of the mixed ancestry are that the populations come from different but contiguous regions. Just as the Levant is at the crossroads of three different continents and is expected to have mixed

¹ I use Carmelites here and throughout the dissertation to refer to the Late Plistocene human crania found at Mount Carmel, meaning all Skhul crania and Tabun cranium. Not to be confused with a medieval monastic order, found in the 12th century.

populations from them in the Late Pleistocene world, as it does today, so Pannonia was a geographical intersection point.

Chapter Three describes the early medieval comparative sample from the Pannonian Plain. The Pannonian Plain is an area that is currently divided between many countries of Central Europe. The sample used here comes from the Western and Central parts of present day Hungary. The sites represented span the time period of fourth to eighth centuries A.D. These relate to the end of the Roman rule in this region (fourth and fifth century), and the span of Avar dominion over the Pannonian area (568-800 AD). The reason why this particular sample is used is because there are historical, archaeological and anthropological data that show the Pannonian Plain, in early medieval times, was a home to populations of demonstrably heterogeneous origins. In order to provide an adequate background for understanding the context of the comparative sample, general information about the history of the Pannonian Plain is presented, during and after Roman occupation.

The decline and fall of the Roman Empire and its rule over the Pannonian Plain marked the onset of the Great Migrations Period. During this period, influxes of new populations into the European territory occurred. The complexity of the population structure was increased by the presence of populations new to this area, which were of Central Asian and Northern European origins. Of particular importance is the arrival of the Avars and their presence on the Pannonian Plain, as they make up the most part of the comparative sample. The Avars remained a strong presence and power in this area for the following two centuries. Numerous anthropological studies of the abundant Avar-age graves from the western Pannonian Plain all attest to the significant biological

heterogeneity of the populations occupying this area from the sixth to the end of the eighth century. This is why the skeletal remains from the cemeteries of pre-Avar and Avar age make an ideal sample to compare what we know about how unusual or not unusual variation is in a heterogeneous population with mixed geographic origins.

Chapter Four presents detailed information on the Levantine Late Pleistocene fossil cranial sample and the comparative sample from the Pannonian Plain that were all analyzed by the author to test the null hypotheses of this dissertation. The Levantine sample consists of the human fossil remains from four Levantine cave sites – Tabun, Skhul, Qafzeh and Amud. Adult and near-adult specimens with preserved cranial remains are Skhul II, Skhul IV, Skhul V, Skhul VI, Skhul VII, Skhul IX; Tabun I; Amud I; Qafzeh III, Qafzeh V, Qafzeh VI, Qafzeh VII, and Qafzeh IX. In order to test the null hypothesis, one hundred crania from the ancestrally heterogeneous population of the late antique and Avar reign of the Pannonian Plain, dated to approximately fourth to eighth century A.D., were examined and the same data recorded.

Chapter Five describes the several methodological steps necessary to test the null hypothesis of no difference, using a resampling methodology developed specifically for this research. Non-metric and anthroposcopic cranial traits were chosen for the analysis. The choice of traits comes from the substantial literature that suggests their importance for identifying and distinguishing variation at various levels, the original publications on the Levantine fossil, typical Neandertal and modern human traits, and traits that the author devised. The Levantine fossil crania and the one hundred adult or near-adult crania from the Pannonian sample were scored for sixty seven non-metric cranial traits. Standardized scoring procedures for each of the traits developed for this study are set out

and described in Appendix B. One key criterion for the analysis is that the standards for scoring the specific expressions of the traits were defined in such a way that the scores could be collected as dichotomous, binomial responses for each trait. For meaningful analyses, only the traits that could be scored in at least one specimen from each of the Levantine sites are included in the analyses: sixty seven traits in all.

The data collected for the Levantine sample are then statistically analyzed in comparison with the Pannonian sample. Due to the small sample size of the Levantine fossils, resampling methods were developed. Resampling is an approach that gives statistical power to the analysis of small sample data sets. This method enables comparison of the Levantine results with the comparative Pannonian sample results.

The statistical analyses were performed as follows. First, the ratios between the binomial responses were calculated for each of the sixty seven traits in both samples. Second, to measure the average heterogeneity versus homogeneity in the samples, the mean of the ratios for the traits was calculated. Third, to see whether all traits show an equal magnitude of variability, the variance of the ratios was calculated. Then there were a thousand draws, with replacement, of random sets of thirteen individuals from the observed Pannonian data. The frequency of the resampled Pannonian distribution was compared to the observed variation in the fossil Levantine sample.

Chapter Six presents the results of this resampling analysis, and their discussion and interpretation. The results show that the magnitude of the variation in the Levantine Late Pleistocene cranial sample is *not unusual* when compared to the magnitude of the variation exhibited in the early medieval population of mixed ancestry. Therefore, the null hypothesis of no difference between the Levantine variation and the variation in the

comparative Pannonian sample cannot be refuted. This research provides no evidence that supports a species difference in the two supposed 'types' in the Late Pleistocene Levantine sample. These results are strongly supported by the recent ongoing advances in the study of ancient and modern nuclear DNA. The genetic studies show that different regional archaic populations, including Neandertals, did interbreed with the expanding African populations during the Late Pleistocene, and that some of the Neandertal mixture took place in the Levant.

Finally, Chapter Seven presents a synthesis, and the conclusions of the dissertation.

Chapter 2

Historical and theoretical background

In the summer of 1929, Dorothy Garrod was called to stop her ongoing excavation project near Jerusalem, and to redirect her team and dedicate their time to performing salvage excavation campaigns at the foothills of Mount Carmel, overlooking the Mediterranean shore. Six years after establishing the camp close to Wadi el-Mughara, the archaeological material unearthed from the group of four caves situated within the wadi presented an unprecedented amalgam of quite similar cultural material (Garrod and Bate 1937) but quite variable human skeletal finds (McCown and Keith 1939). The human fossil sample from the Mount Carmel cave sites (Tabun and Skhul), together with two other Late Pleistocene cave sites from the Southern Levant (Qafzeh and Amud), raised an ongoing debate regarding modern human origins and the magnitude of variation within human populations during this time period (Tillier 2007).

This chapter presents the information on historical and theoretical background for the multiple levels of problems created when trying to explain the magnitude of variation present in the Late Pleistocene Levantine fossil sample. Because this dissertation is inspired by the magnitude of variation present in the Mount Carmel sites, the introduction to the chapter is set around the original excavations of the Mount Carmel caves and the interpretations of the human remains yielded from these sites. In the sections to follow,

the intellectual milieu in which the Mount Carmel specimens have come to light is presented. This is relevant to understanding the different interpretations of the excavated material. Focus is put on the problem of modern human origins from the first recognized fossil finding in 1856 until the unearthing of Skhul, Tabun and Qafzeh specimens during the 1930s. Special focus is placed on the problem of the position and role of the Neandertals in human evolution.

After discussing the intellectual background, the author presents how the Levantine sample fit into the conceived ideas about the course of human evolution at the time, according to its first describers: Theodore McCown and Sir Arthur Keith. What follows are the first criticisms of the original interpretations by McCown and Keith, and the issues raised in the abundant literature written on the Levantine fossil sites since its original description. Since the Mount Carmel sample was one of the first sites to yield such an abundance of skeletal material, and since it exhibited an ‘unusual’ magnitude of variation, to explain the ‘unusualness’ of this variation, the author goes into explanations of the paleontological principles and problems of establishing ‘holotype’ specimens for the human fossil forms.

Another issue that is directly addressed by the finds of Levantine skeletons is the problem of determining the number of taxa at the sites, whether one or more species are represented. Background information is provided on how the Levantine sample is differently explained, and how different, indeed opposing explanations of the Levantine sample stem from differing views of the pattern of human evolution.

Finally, the author explains how she chose to address the issues presented in the magnitude of variation within the Levantine sample. There are sections that serve to

introduce the development of this research, wherein the rationale behind the hypothesis of this dissertation is presented, and how it recalibrates the problem of the ‘unusual’ magnitude of variation in the Late Pleistocene Levantine sites is discussed.

I. Introduction to the Mount Carmel sites and Qafzeh cave

It is important to start with the introduction of the sites from which the fossil sample comes. In addition, a brief history of the events surrounding the discovery of the specimens will be useful.

Mount Carmel refers to a mountain range that stretches from north-northwest to south-southeast along the Mediterranean coast, not far from Haifa, in present day Israel (Garrod and Bate 1937; McCown and Keith 1939). It is made of dolomite limestone, and is twenty kilometers long. Its hills are occasionally cut through by *wadis* – a local term for the steep and deep valleys characteristic of the Mediterranean basin that are dry most of the year, but during the more rainy months, serve as a bed for the fast streams that gather all the water from the surrounding hills. The particular wadi of interest, Wadi el-Mughara (‘the valley of the caves’), houses four cave sites that proved to be rich in prehistoric archaeological material. The mouths of three of these caves – et-Tabūn (‘oven’), ej-Jamal (‘camel’) and el-Wad (‘valley’) – are visible from far away, exposing themselves westward towards the Mediterranean Sea. If one walks away from these westward facing caves, inland and along the wadi, one may stumble across another rock shelter (*abri* in French), named es-Skhul (‘children’). This whole group of caves is located only 3.5 km from the Mediterranean coast line. E. T. Richmond, who served as the Director of the Antiquities in 1928 in then British Palestine, was the first to draw the

attention to these cave sites. Due to the construction of the new harbor in Haifa, Wadi el-Mughara was planned to be used as the main quarry source for the construction. On Richmond's call, Charles Lambert, on behalf of the Department of Antiquities, dug out sounding trenches at the cave sites to see whether the caves were of any archaeological importance. The first trenches proved Richmond's intuition that these sites were immensely rich in prehistoric material. Due to the urgent nature of the project, and the looming threat that these sites might be destroyed during the quarry work, a team composed of the British School of Archaeology in Jerusalem and the American School of Prehistoric Research was asked to call off its joint ongoing project of excavating the cave site Shukbah to come salvage the el-Mughara caves. It was in April of 1929 that a team of archaeologists, under the auspices of Dorothy Garrod, on behalf of the British School of Archaeology in Jerusalem, with the assistance of Theodore McCown, on behalf of the American School of Prehistoric Research, came to set up their first camp site and start working on the Wadi el-Mughara cave sites, remaining at work until August of 1934. Ej-Jamal did not produce much material due to erosion that stripped archaeological layers down to the bedrock, but it could be concluded that it once housed Mousterian and Early Bronze Age material. El-Wad contained cultural layers from Upper Levallois-Mousterian, Lower and Middle Aurignacian, Atlitian, to Lower and Upper Natufian and Bronze Age. In addition, it contained human burials from the Natufian layers. The main focus of the present work, however, is the human and archaeological remains from the remaining two cave sites – es-Skhūl and et-Tabūn² (Garrod and Bate 1937; McCown and Keith 1939).

² Es-Skhūl and et-Tabūn are the traditional transcriptions used in the original publications (Garrod and Bate 1937, McCown and Keith 1939). However today, the more common ways to simply refer to these sites and

Four years before Dorothy Garrod started her first season excavating the Wadi el-Mughara caves, interest in the prehistory of Palestine was stirred by the find of the ‘Galilee man’ in the Zuttiyeh cave, located in Wadi Amud, near the Sea of Galilee (Turville-Petre 1927). The remains of this Middle Pleistocene hominid, along with the stone tools once used, were discovered by British archaeologist Francis Turville-Petre, a school colleague of Dorothy Garrod from the time they both attended classes in prehistory at Oxford University (Bar-Yosef and Callander 2004). This discovery had significant media coverage and attracted and inspired more enthusiasts to search for prehistoric remains and proof of the antiquity of human presence in this area. René Neuville, a French diplomat who at the time served as a French ambassador in Jerusalem, inspired by Turville-Petre’s finding and hearing that some visitors of the Qafzeh cave near Nazareth had encountered similar flint tools to those found in association with the Galilee man from the Zuttiyeh cave, set off for an excavation campaign in Qafzeh. The excavation started in 1934 and in its first campaign the excavators, Neuville with his collaborator Moshe Stekelis, were fortunate to unearth the skeletal remains of five human skeletons (Neuville 1934, 1936, 1951; Köppel 1935). During the excavations, Neuville unearthed and established a sequence of strata spanning from Middle to Upper Paleolithic (Neuville 1951; Vandermeersch 1981; Bar-Yosef and Vandermeersch 1981, 1991).

The combination of the fossil finds from the Mount Carmel sites, together with the skeletal remains from Qafzeh, yielded much unprecedented and important material that contributed to many debates in the decades to follow. Among the central issues these 1930s discoveries furthered was the problem of succession of our ancestral forms, and the debate on the origin of the modern humans.

the specimens from the sites are Skhul and Tabun.

In summary, during the 1930s archaeologists brought to light human fossil remains from three cave sites in the Levant. These caves – the Mount Carmel caves Tabun and Skhul, and Qafzeh cave – contained skeletal remains that exhibited an unprecedented combination of features and overall variation.

II. What was known about human evolution in the 1930s

At the time the Mount Carmel and Qafzeh cave sites were initially being excavated, the study of prehistory and of human evolution were barely past their infancy. It is important to know what was thought about the course of human evolution then because it influenced how newly found Levantine human fossil remains were interpreted. Levantine sites are traditionally thought of as containing both Neandertals and modern human specimens. For this reason it is beneficial to introduce the history of Neandertal findings and the views on their position and role in the emergence of modern humans.

At the time of the publication of the first monographic treatment of the Mount Carmel human remains (Garrod and Bate 1937; McCown and Keith 1939), relatively few fossil human remains had been found. The first recognized discovery of an ancient human form was revealed in the Kleine Feldhofer Grotte, in the Neander valley of present-day Germany, in 1856 (Fuhlrott 1857; Schaaffhausen 1858). Fuhlrott and Schaaffhausen argued that the remains of a human (or human-like) skeleton found in Feldhofer were evidence of the existence of an ancient form of man, but many contemporary scholars disagreed. In contrast, they offered a variety of explanations for the provenance of these human remains – interpretations ranging from it being a pathological case, an old Cossack chased by the Napoleonic troops, an old Dutchman, or

an ancient Celt of 'low type' (Pruner-Bey 1863, 1864; Dawson 1863; Mayer 1864; Wagner 1864; Virchow 1872; Brace 1995).

However, as other ancient bones resembling this poor pathological case began to appear in other areas of Europe, these explanations had to be reevaluated. The first palpable evidence of evolutionary trajectories of humankind started to slowly amass and these tangibles could be put within the theoretical framework explaining the nature and origin of present day species, including man (Darwin 1859, 1871).

During the 1890s, the particularly fortunate Eugène Dubois, inspired by teachings and theoretical writings of Ernst Haeckel on the origin of man (Haeckel 1868), had uncovered remains of *Pithecanthropus* (Dubois 1894; Theunissen 1989; Howell 1994; Shipman 2001; Shipman and Storm 2002). Dubois' discovery of human fossil remains in Java broadened the catalogue of fossil findings, refreshing this palette of until then solely European and solely Neandertal-like finds with a far older Asian input to the catalogue. Then, pieces of the puzzle began to appear from different corners of the Old World. The legacy of eighteenth century enlightenment and the first scientific endeavors and ponderings about the natural world in the nineteenth century helped these finds fit into some previous theoretical frameworks, and some new interpretations were made (Dubois 1895; 1896; Keith 1895; Virchow 1895; Schwalbe 1906). The fossil remains shifted from being just peculiar curiosities gathered and placed in *Wunderkammer* collections of Renaissance Europe to being placed in museums, recognized as evidence of the process of evolution. Yet both the antiquity and the interpretation of these human-like skeletons remained an issue in many debates.

The discovery of two burials at Spy in 1886 (de Puydt and Lohest 1886; Fraipont and Lohest 1886) in Belgium, associated with extinct fauna, gave temporal depth to the European remains. Finding these Belgian Neandertals in association with extinct fauna finally fully liberated Neandertal man from being just a pathological oddity (Fraipont and Lohest 1887; Howell 1957). Although the Feldhofer remains were also found in association with extinct fauna, this fact was not given much attention (Schmitz *et al.* 2002), but was buried by the arguments about whether or not the specimen was pathological. The discovery of Spy burials in association with extinct fauna made the late 1800s scholars think about the probability of finding two pathological cases, and again in association with extinct fauna. Because of this statistical improbability, the Neandertal was now slowly coming to be viewed as an ancient form of man. King's (1864) position, giving Neandertal a phylogenetic context and specific appellation, *Homo neanderthalensis*, started to be more widely accepted at the beginning of the twentieth century. However, even then acknowledged as an ancient human form, Neandertal was not always accepted as being ancestral to modern human beings (Klaatsch 1910; Boule 1911-1913, 1921; Keith 1915).

Following the initial Neandertal discoveries, many more Neandertals were found across Western and Central Europe, and as far east as Teshik Tash in present day Uzbekistan (Okladnikov 1949). Apart from these Neandertal finds, more ancestral human forms from different parts of the world were also added to the catalogue of human-like fossil finds. By and during the 1930s, some of the African fossil remains, as well as more East Asian specimens were acknowledged (*Australopithecus africanus*, Dart 1925, 1934; Broom 1934; *Sinanthropus pekinensis*, Black 1927, 1933, 1934; Black *et al.* 1933; Pei

1930, 1931, 1933; Weidenreich 1937). However, researchers were focused on the origin of modern humans (which was at the time effectively equivalent to the origins of modern races) and the everlasting search for a ‘missing link’ before *Homo*. The relative dating of all specimens found was clear enough to suppose that Neandertal was the most recent group before the modern humans emerged. But there remained significant opposition by some authors to the view of Neandertals as a human ancestor (Keith 1915; Boule 1911-1913).

The reluctance to regard Neandertals as related to modern humans was actually aided by the discovery of another fossil human form in Europe. Only a little over a decade after the first recognition of Neandertal man from Kleine Feldhofer, skeletal remains considered to be a human of ‘modern type’ were discovered near a prominence called Cro-Magnon, in the Dordogne region of France (1868, Broca 1868; Lartet 1868). Additional ‘modern’ looking fossil specimens were found across Europe – a skeleton from Chancelade rock shelter (1888, Testut 1889a), skeletal remains from Grotte des Enfants (1901, Verneau 1902, 1906), Oberkassel (1914, Verworn *et al.* 1914), Předmostí (Matiegka 1934), and Mladeč (Bayer 1922; Szombathy 1925). All these fossil finds added to the debate over answering the question of “*where do we come from*” (and even more, *where do Europeans come from*) at the end of nineteenth century.

At the time, this question was being addressed and pondered within many disciplines, including disciplines in-the-making, such as archaeology and linguistics. Explorations of the origins and deep past of humankind were also pondered in other disciplines, based on their own lines of ‘evidence’. Naturally, putting emphasis on different lines of ‘evidence’ resulted in completely contradictory conclusions to the

enduring question of our possible origins. For example, philologists, basing their conclusions on the linguistic similarities across the Indo-European languages, proposed the Indian subcontinent as the *Urheimat*, the original homeland of the speakers of the Proto-Indo-European language (Schlegel 1808). This was well accepted as the birthplace of Europeans (or humanity?); during the nineteenth century studying classical languages was still the norm, so general familiarity with classical linguistics probably had an impact on the general acceptance of the classical philologists' and linguists' interpretations of human origins. According to Theunissen (1989) and Tattersall (1995), these theories were influential and prestigious in nineteenth century European culture, and did not help the case of Neandertal man for being acknowledged as the ancestor of a modern man: he had been found in the “wrong” places.

As we saw in this section, until the 1930s and the discovery of the Levantine cave sites, the majority of the human fossil findings were Neandertal, but other older human species (namely *Australopithecus* and *Pithecanthropus*) had been recovered and recognized as human ancestors. It was in this intellectual context of scientific research and debate over the course of evolution and the relationship between different human fossil species, that the Mount Carmel and Qafzeh finds were to be interpreted.

III. Is Neandertal our ancestor? Regional streams of thought in Europe – up to the discoveries at Mount Carmel

The amalgam of different fossil specimens found across the world, together with the advancements in the fields of geology, paleontology and archaeology, made it clear by the beginning of twentieth century that human existence had deep antiquity. One of the key elements in directly proving the antiquity of the fossil skeletal remains was the

use of fluorine dating techniques (Goodrum and Olson 2009). However, the new challenges were to establish how the different human fossil forms found by then were related to each other, their chronological succession, and how modern humans (and again, at that time modern races) are related to these fossils. Early twentieth century scholars developed their ideas and concepts of the course of human evolution largely through comparative anatomy, the examination of human fossil remains and comparisons with modern human skeletal remains and anatomical collections of great apes. However, there was very little appreciation of the importance of variation in understanding evolutionary questions.

Although archaeologists enthusiastically sought new Paleolithic sites, by the time the Mount Carmel sites and Qafzeh came to light only a few of their discoveries yielded fossil human remains, and of those most yielded the fragmentary remains of only one or two individuals. Although the record has increased since then, this continues to pose a problem when trying to estimate the variation present within past human populations (as discussed later in this chapter), or trying to establish what is characteristic about them. Fragmentary remains, distanced from each other by time, space, and varying for other idiosyncratic reasons, contribute to the issues and problems that make the process of discovery of our ancestors even murkier than the immense distance of time. The following section is therefore dedicated to studies of Neandertal remains and their variation, in light of interpreting the roles Neandertals played in the evolution of modern humans. All the discoveries to be mentioned below, as well as the proposed relationships between different fossil forms found, are important background because they describe the scientific atmosphere when the first fossil finds from the Palestine caves came to light.

Advancements in experimenting with new chemical dating methods fully made the case for the antiquity of the fossil remains. The first scholar who applied the fluorine relative dating technique to determine the age of Neandertal bones was Dragutin Gorjanović-Kramberger (1901:197), a Croatian paleontologist who excavated and described the Krapina site (Radovčić 1988). Krapina, a rock shelter situated in northwestern Croatia, was excavated from 1899 to 1905. The excavations yielded an unprecedented amount of the human material from a single site (Gorjanović-Kramberger 1901, 1902, 1904, 1905, 1906). Gorjanović's methods in both excavating and studying the Neandertal remains found in Krapina were groundbreaking (Radovčić 1988). Until then most sites had yielded remains of only one or two individuals, while at Krapina there were the remains of up to seventy individuals, as estimated from teeth (Gorjanović-Kramberger 1906; Wolpoff 1979; Radovčić 1988; Radovčić *et al.* 1988). It was the first site that provided a large enough sample, although fragmentary, to study the remains of fossil individuals as a biological population, with insight into its variability and the possibility of trying to explain it. Gorjanović, in order to examine the variability within the Krapina sample and how it relates to the variation of the present living human populations, traveled to Vienna and Budapest. The *Naturhistorisches Museum* in Vienna and *Magyar Természettudományi Múzeum* in Budapest were (and still are) institutions which house very extensive collections of modern human skeletal material. From Gorjanović's notes we can see that he was particularly interested in the details of morphological particularities of human skeletal material coming from Australia, New Guinea, Czech Republic, Slovakia, Malaya, Africa, Java, Greece and Croatia (Radovčić 1988). He noticed that some of the observations of the face, as well as the variation in the

details of the temporal bone (mastoid process) that he examined in recent European skeletal material, correspond to the same observations in the Krapina material (Radovčić 1988). That the plethora of various expressions seen in the Krapina material can be found in the recent modern populations led Gorjanović to conclude that Neandertals were a direct ancestor of modern humans.

Gorjanović was, in fact, the first to have sustainable intellectual reasons to describe Neandertals as the direct ancestors of modern humans (Gorjanović-Kramberger 1904). At one of his lectures given in 1904, Gorjanović presented “*razvojnu sliku čovjeka*”, or a developmental line of man. Based on the results of his osteological studies of Krapina Neandertals, he found clear evidence that *Homo primigenius* (a term Gorjanović used for Neandertals) was the direct ancestor of modern humans (Gorjanović-Kramberger 1904, 1906; Radovčić 1988). Gorjanović stressed the developmental continuity between the Neandertal and modern man, which can be seen in the morphological characteristics of modern man. He stated (1904:7-8):

*“And on this occasion today I would place yet more emphasis on the fact, as I hope the assembled gentlemen understand, that there have been no interruptions in the development of mankind from the time of the ancient Diluvium to the present, as testify the collective traits we find on ancient Diluvial humans, while we see them in generalized form today. I mention this because I find the introductory opinion of my highly esteemed colleague Dr. G. Schwalbe of the University of Strasbourg to be unfounded. He would exclude Homo primigenius altogether from humankind, just as was done, and rightly so, with Pithecanthropus. We do not possess a single non-adaptive organ, that would force the development course of that species to cease and the species to die out. Instead, all these most observable atavisms on later fossils and recent humans instruct us as to a developmental continuity between the old Diluvial and modern man”*³ (translated by Ellen Elias-Bursać from Radovčić 1988:81).

³ “Na tom bi samo mjestu još naglasio, a ufam se da je svoj gospodi jasno, da u razvoju čovjeka od starijeg diluvija do danas nije bilo prekidanja, što su nam osobito posvjedočili oni kolektivni biljezi, koje nalazimo na staro-diluvijalnim ljudima a danas ih vidimo generalizovane. To pako spominjem zato, jer mi se čini neosnovanim uvodno napomenuto mišljenje mog visokocijenjenog druga prof. D-ra G. Schwalbe-a u

In this excerpt, Gorjanović stated his disagreement with his colleague the German anatomist Gustav Schwalbe.

Schwalbe, at around same time as Gorjanović, attempted to establish the relationships between human fossil forms in a systematic way. In the tradition of Haeckel's *Stammbaum*, a representation of relatedness in a form of a tree with branches, Schwalbe proposed two possible schemes for how three human fossil forms known at the time, *Pithecanthropus*, Neandertal and modern, are related to each other (Schwalbe 1906). In one of the schemes, Schwalbe posited that *Pithecanthropus* was the direct ancestor of both Neandertal and modern man. But the Neandertal branch split away from the main evolutionary line from *Pithecanthropus* to modern humans. The second proposed scheme, which Schwalbe himself considered as more likely to be the true one, showed *Pithecanthropus* being the direct ancestor to Neandertal, and Neandertal being the direct ancestor to moderns (Schwalbe 1906; Radovčić 1988; Brace 1995).

The opinion that Neandertal was a direct ancestor to modern humans had strong support throughout Central Europe, in the German speaking part of Europe (Gorjanović-Kramberger 1904, 1906; Stołyhwo 1908, 1937; Weinert 1925; Hrdlička 1927; Weidenreich 1927), as well as by some French authors (Verneau 1924). On the other hand, opposition to viewing Neandertal as a direct ancestor of modern humans was strongly developed in the French speaking part of Europe. This view was most vigorously supported by the French paleontologist Marcellin Boule (1911-1913), who played a

Strassburgu, koji je sklon odlučiti vrst *Homo primigenius* iz roda onako, kako je – ali pravom – učinjeno za *Pithecanthropus*. Mi neimamo nijedan neadaptivan organ, a u koliko poznajemo skelet *Homo primigenius*, a da bi bio morao razvojni tok te vrsti sustati a ta species izumrti ne, što više, sve to većma motrivi atavizmi na mladjim fosilnim i recentnim ljudima poučavaju nas o razvojnem kontinuitetu između staro-diluvijalnog i modernog čovjeka.”

pivotal role in depicting the Neandertal man as a brutish, bestial form of hominid development.

In 1908, an intentionally buried skeleton of an old Neandertal was found in Bouffia Bonneval, a cave just outside the village of La Chapelle-aux-Saints in the Corrèze region of central France (Bouyssonie *et al.* 1908). This exceptionally complete skeleton was sent to be studied by Marcellin Boule in Paris. As a result of his study, Boule wrote a monumental monograph, published in different installments between 1911 and 1913, dedicated to the study of the anatomy of what turned out to be an old man of La Chapelle-aux-Saints. Boule's detailed study was very accurate in describing the anatomical details of the old individual, but unfortunately many of his interpretations of the accurately remarked morphologies and his conclusions were "*astonishingly wrong*" (Trinkaus and Shipman 1993:190). Boule concluded that the Neandertal could not have walked upright, but instead walked with bent knees, his head leaning forward almost resting on his chest (Boule 1911-1913). Boule's portrayal of the old Neandertal man, based on the La Chapelle specimen, as a hunched bestial man, lurking from the cave, ready to club someone, was completed by Boule's reconstruction of his fierce, crazy and blood-thirsty facial expression (Boule 1911-1913; originally published in *L'Illustration* and *Illustrated London News* in 1909; Stringer and Gamble 1993). Boule's view still flickers in the minds of many today when imagining the poor old Neandertal. It was not until later (1950s) that the skeletal details Boule considered proof of a bestial Neandertal were revealed to be caused by pathological changes in the old man's worn body (Arambourg 1955; Straus and Cave 1957).

Apart from Boule's conclusion regarding Neandertal as a bestial-like creature, his descriptions were thorough and scientific. Boule's detailed dedication to the morphology of a Neandertal man, although based on a single specimen, immediately was taken up in the scientific world, and remains classic (Trinkaus and Shipman 1993). Boule "*took the Old Man of La Chapelle-aux-Saints as the 'type' of Neandertals – not in a formal taxonomic sense, but psychologically – and painted a detailed picture of Neandertal anatomy that became the received truth*" (Trinkaus and Shipman 1993:190).

Boule, the father of French paleoanthropology, established a strong tradition among his students and successors of regarding Neandertal as a distinct, separate branch, an evolutionary dead end that in no way contributed to modern humans (Vallois 1954; Boule and Vallois 1957; Piveteau 1983). Why did Boule insist on this picture of the Neandertal man? It has to do somewhat with the fact that the remains from La Chapelle-aux-Saints belonged to an old individual, with many different pathological changes that he did not acknowledge as pathologies. However, knowing Boule's professional training, and the fact that he was very competent and knowledgeable in different scientific disciplines of the time ("*equipped as anatomist, palaeontologist, geologist, and culturist*" Keith 1943:43), it is odd that Boule did not recognize the pathologies of the old man of La Chapelle as such.

C. Loring Brace (1964) explains that Boule's standpoint on Neandertals stems from the French tradition of catastrophism⁴. Brace's interpretation of the influence of

⁴ In opposition to Darwin's evolutionism, Georges Cuvier, a French zoologist, established catastrophism as the proposed theoretical framework of how different species, known from the different geological strata, 'replace' each other (Brace 1964, 1995; Radovčić 1988; Tattersall 1995). Cuvier observed that each geological stratum is characterized by species which one cannot see in the other strata. Therefore, there are many episodes of catastrophes that occurred over geological time, during which old species were extinguished and replaced by the new species. After one such cataclysm, namely the last great flood, the human species emerged. At the time of Cuvier, this was strongly supported by the Christian milieu in

Cuvier's catastrophism on the French paleoanthropologists was overly harsh in his condemnation in viewing the whole school of French paleoanthropologists as anti-evolutionary (Genovés 1964; Bordes 1966; Vallois 1966). Indeed, one can read Boule carefully (1921) to reveal he held the idea that Neandertals were to be seen in between chimpanzees and modern humans, which makes Boule a Darwinian, not a catastrophist thinker. However, other circumstantial archaeological and paleontological records found up to that point (1910s), made Boule think that, although they represented genuine fossil population, Neandertals were no part of modern human ancestry. Boule had the idea (before looking at La Chapelle) that any intermediate form between chimpanzee and human had to look bestial. In that light, the pathologies of the old man of La Chapelle were not recognized as they might have been if Boule knew he had a modern man in front of him. This misstep might have also been accentuated by the debate that raged as long as Rudolph Virchow (1872) was alive and able to champion the denial of fossil-man finds, and interpret them as pathological oddities. Holtzman (1973), instead of looking back to the beginning of the nineteenth century for Cuvier's influence, interpreted Boule's standpoint on Neandertal as the influence of Boule's mentor and close friend, paleontologist Albert Gaudry. Gaudry interpreted evolution to take place in a multilinear fashion (Holtzman 1973) which would allow for "dead ends" like the Neandertal supposedly was. Moreover, Hammond (1982) and Van Reybrouck (2002) speculated on various factors that resulted in Boule's distinct position on Neandertals, based on a single

which he lived. However, the only direct remark Cuvier made in his published work concerning the existence of fossil man was that "*il n'y a point d'os humains fossiles*" (Cuvier 1826:65 in Brace 1995: "There are no fossil human bones"). Indeed, in 1826, when Cuvier's book was published, no fossil human remains had been found. However, the tradition of clear and drastic changes in the paleontological record, with new species replacing the older ones, in Brace's opinion can be seen in Boule's interpretation of Neandertal and modern human non-relatedness. Boule has seen the evidence of the extinction of Neandertal man and his replacement on European soil by modern man in the non-related morphologies of modern man and the Neandertal (Boule 1911-1913).

specimen of La Chapelle-aux-Saints. Both authors see the interpretation as a product of Boule's particular "*research traditions, pattern of training and academic micro-politics*" (Van Reybrouck 2002:161)⁵.

As Trinkaus and Shipman noted (1993:190), Boule established his ideas of Neandertal replacement before he set his eyes on the La Chapelle skeleton. The idea of replacement was in Boule's view upheld by the archaeological record of the different paleolithic stone tool industries. The paleolithic stone tool assemblages that had been amassed up to then from many excavated European sites, were interpreted as having an abrupt replacement when Mousterian stone tool assemblages (traditionally associated with the Neandertals) were replaced by the Aurignacian (and other) assemblages (traditionally associated with modern humans; Boule 1911-1913, 1923; Boule and Vallois 1957). In addition, the human fossil specimens of more 'modern' morphology but of old geological age being excavated from the sites across Europe were to Boule another proof that Neandertal could not have had the time to develop into the modern humans, and that other specimens from the Late Pleistocene were more plausible in the role of modern humans' ancestors.

One cannot deny the influence and impact that Boule's monograph (1911-1913) and later his textbook on human evolution (1921) have had on generations of students in paleoanthropology. Although somewhat critical of his French colleague's work, renowned British anatomist and anthropologist Arthur Keith (1921:322) started his review of Boule's textbook by the following laudations:

⁵ Hammond (1982:30) argued that: "*certain social and theoretical commitments tied to [Boule's] location in the Museum of Natural History and the French paleontological community were absolutely crucial in shaping the emergence of Boule's Neanderthal caricature, and in giving so much plausibility to the slouching posture and tragic Neanderthal fate*".

“On opening the covers of this magisterial work by Prof. Marcellin Boule, one has the feeling of having entered a court of justice where a severe judge has conveyed to counsel and to witnesses that his cases are to be tried according to the strict law of evidence, and that he will stand no nonsense. All the cases on which is based our conception of the antiquity and origin of man come up for review; judgments are duly given in such clear, unmistakable terms that they carry with them an air of finality.”

This illustrates the esteem that Boule enjoyed not only in the French circles of paleoanthropologists, but beyond France’s borders as well. Sustained by the high regard of his contemporaries, Boule’s work was very influential for generations to come as well.

In the same years that Boule, as a trustworthy authority, published three volumes of his monographic study of La Chapelle-aux-Saints, the remains of the Piltdown ‘specimen’ were brought to light (Dawson 1913; Smith Woodward 1913; Dawson and Smith Woodward 1913). This discovery, only much later to be revealed as a hoax, set back the study of human evolution in the decades to follow. The perpetrator of the hoax assembled selected fragments of a modern human cranium together with a female orangutan mandible and buried them in the gravel layer at Piltdown, in southeastern England. Together with the cranium and the mandible the excavators found artifacts and fossil animal bones from many places, presumably collected from many expeditions around the world conducted by the workers of the Natural History Museum (Gardiner and Carrant 1996). Although there were scholars who doubted these finds to be authentic from early on (Waterston 1913; Boule 1915; MacCurdy 1916; Miller 1918; Friederichs and Weidenreich 1932; Weidenreich 1943, 1946), many other prominent scholars of the time – Smith Woodward, Keith, and Boule⁶ whole-heartedly defended the case and saw the Piltdown specimen, named *Eoanthropus dawsoni*, as the proof that its modern

⁶ Boule immediately doubted the authenticity of the mandible from Piltdown, and described it correctly as a jaw of a great ape. However, he believed the Piltdown cranium was authentic, as it fit well into his framework of human evolution.

looking cranial size and shape were present in the first half of Pleistocene (Dawson and Smith Woodward 1913).

The unfortunate pseudo-discovery caused paleoanthropological interpretations to be foggy in the decades to follow. Scholars like Boule, although he had his doubts about the authenticity of the mandible finding (Boule 1915), accepted the cranium as authentic because it supported his claims that the Neandertals were a side branch that died off. In Piltdown he saw the direct ancestor of modern humans endowed with an ancient age, and it confirmed that modern morphology had its roots deep in the Lower Pleistocene (Boule 1921:160, 172). Therefore, the Piltdown man was not a surprise to Boule because he already thought that fully developed modern human specimens were earlier in time than Neandertal ones (Trinkaus and Shipman 1993). The culprit and the executor of this well thought-out and not easily detectable fraud was knowledgeable about which morphologies to skillfully include and which to alter (the Orang canine tooth was filed flat) in order for the specimen not to be too easy bait for the scholar, but at the same time to confirm some of their concepts, models, and explanations for reconstructing the course of human evolution (Trinkaus and Shipman 1993). It was only decades later, in 1953, that the Piltdown finding was finally confirmed as fraudulent by British and South African scholars (Weiner *et al.* 1953), ironically by using the fluorine technique for comparing the antiquity of Piltdown and the fauna it was “found” with, a half-century after Gorjanović used fluorine based relative dating at Krapina.

There have been many theories about the identity of the perpetrator(s) of the Piltdown hoax, and they involved most of the original researchers of the finds (e.g. Dawson, accused by Weiner 1955; Teilhard de Chardin by Gould 1979; Abbott by

Weiner 1979; Smith by Millar 1972; Keith by Tobias 1992). Only in the 1990s was the most probable culprit for implanting the hoax identified as Martin Hinton, who assumed the position of the Keeper of the Zoology department at the Natural History Museum in London in 1936 but had collaborated and worked with the Museum since 1910 (Gardiner and Carrant 1996; Gardiner 2003)

The Piltdown forgery had an immense impact on the study of human evolution in the decades to follow. The fossil form that specially suffered from the appearance of the Piltdown specimen was the Neandertal. As Trinkaus and Shipman have noted (1993:208):

“The effect of Piltdown on the scientific study of Neandertals was stifling. If Boule’s monograph had unceremoniously booted Neandertals out of the family tree, Piltdown had dug their graves anew and buried them. Neandertals were simply uninteresting, an irrelevant degenerate side-branch.”

Still, Piltdown was never regarded as a serious, authentic specimen by some authors (Waterston 1913; Boule 1915; MacCurdy 1916; Miller 1918; Friederichs and Weidenreich 1932; Weidenreich 1943, 1946), because of both the dubious mandible and its association with the cranium. Weidenreich actually proposed that *“‘Eoanthropus’ should be erased from the list of human fossils. It is an artificial combination of fragments of a modern-human braincase with orangutang-like mandible and teeth”* (Weidenreich 1943:273). However, the acceptance of the specimen as authentic by then-esteemed, very influential leading French and British scholars allowed the Piltdown “man” to make its mark on interpretations of the course of human evolution.

One of the scholars, who studied the Piltdown specimen and very much supported its authenticity and significance for the evolution of man, was Arthur Keith, a Scottish

anatomist, who rose to prominence in the British paleontological circles and was regarded as one of the leading scholars on questions of human evolution. In his book *The antiquity of man*, published in 1915, Keith presented his views on the course of human evolution and interpretations of the fossil remains found until then. He credited Otto Hauser, a Swiss antiquarian who excavated paleolithic sites in the Dordogne region of France, and Herman Klaatsch, professor of anatomy at Breslau, for first demonstrating that Neandertal man was not ancestral to modern man (Keith 1915:114). Therefore, Keith interpreted the Neandertal remains as belonging to a separate branch of human stock which was “*replaced, with the dawn of the Aurignacian period, by men of the same type as now occupy Europe*” (Keith 1915:136).

Arthur Keith’s view on the origins of modern humans and Neandertals’ role in the human stock is of great importance because Keith, some twenty years after publishing the above presented views, together with Theodore McCown, studied the Mount Carmel specimens.

In summary, the biggest debate that was brought on by the human fossil findings unearthed by the 1930s was how the Neandertals fit into the picture of human evolution and whether they were ancestral to modern humans. The scholars of the time were divided in their interpretations of the relationship of the Neandertals and modern humans. One of the prominent British scholars and anthropologists, Sir Arthur Keith, who would later together with Theodore McCown describe of the Mount Carmel population, was of opinion that Neandertals represented a side branch of fossil human form which did not contribute to the ancestry of modern humans.

IV. How did the Levantine sample fit into the existing framework of human evolution?

The first researchers to examine and scientifically describe the Mount Carmel hominid sample, and to fit it into a theoretical framework, were Theodore McCown, an American anthropologist and Sir Arthur Keith, quoted above. The following section is dedicated to their first description of the Mount Carmel fossil remains. Before continuing with the issue of how the Levantine sample fits the above mentioned frameworks of human evolution, it is of interest to discuss the scholarly background of McCown and Keith together with their ideas on the evolution of humans. After providing information on McCown and Keith's experiences and views on the course of human evolution, the specifics of the Mount Carmel sample will be introduced. After these details, their conclusions will be presented.

Arthur Keith (1866-1955) studied medicine at the University of Aberdeen, Scotland, and finished in 1888 with high marks performance in anatomy (Trinkaus and Shipman 1993). After finishing his studies in medicine, he was appointed as a doctor in what then was Siam (Thailand). When his doctoral duties would allow, Keith dedicated his free time in Siam to comparing the anatomical details, especially the morphology of ligaments, in humans and apes. Upon his return to Britain in 1893, he submitted his comparative study of ligaments in apes and humans, and with this completed his degree in 1894 (at that time the medical degree was obtained after completion of original research: Trinkaus and Shipman 1993).

During the last decade of the nineteenth century, Keith, as well as the other prominent British scholars, was of the opinion that both *Pithecanthropus* and Neandertal should be placed as the direct ancestors of modern humans (Trinkaus and Shipman 1993).

As Conservator of the Hunterian Museum at the Royal College of Surgeons in London, Keith extensively studied all of what he considered to be the significant British fossils, and put them in the context of other fossil discoveries coming from continental Europe. By this time, propelled by the discoveries of more modern looking crania from European paleolithic sites, Keith had changed his previously held position on Neandertals being in the direct line of ancestry of modern humans. He now believed that the morphology of modern humans had deeper roots, suggesting that modern humans were present at the same time as, if not before, the Neandertals. Therefore, Neandertals could not have been our ancestors. In his opinion, the presence of a modern human ancestor of great antiquity might be on British grounds – in the Galley Hill and Ipswich remains. However both of these turned out to be modern human burials of recent age that were interred into the Paleolithic layers (Trinkaus and Shipman 1993). By the time Keith wrote his first book on prehistory and human evolution in 1915, another two major events, already described – the publication of Boule’s monograph on Neandertals and the discovery of the Piltdown specimen – contributed to affirm Keith’s logic in thinking that Neandertals were not part of our ancestry.

Keith was knighted in 1921, in acknowledgement of his great achievements in the studies of the evolution of man (Trinkaus and Shipman 1993). His positions on and interpretations of human evolution were regarded with the highest esteem by British (and wider) audiences and colleagues. In 1925, after F. Turville-Petre discovered the Galilee Man from the Zuttiyeh cave in then Palestine, Sir Arthur Keith was entrusted with the study of the specimen (Keith 1927). The same happened a few years later, when Dorothy Garrod started revealing fossil skeletons from the Mount Carmel caves.

Keith changed his views on different species being ancestral to modern humans several times during his career (the position of *Australopithecus*, *Pithecanthropus*, and Neandertals in the human lineage, Trinkaus and Shipman 1993). The shift that is of interest here came when Keith, considered to be one of the most obstinate 'isolationists' interpreting Neandertal as a separate branch (Keith 1911, 1915; Weidenreich 1943), changed his view of the Neandertal Man after, as Weidenreich (1944) pointed out seventy years ago, analyzing the Mount Carmel discoveries (McCown and Keith 1939). However, the point of a divergence between modern humans and Neandertals was still firm in Keith's mind when he wrote the conclusion of the Mount Carmel monograph.

The young American who helped Sir Keith with the study and description of the Mount Carmel fossils was Theodore McCown (1908-1969), then a graduate student at the University of California at Berkeley. At the time Dorothy Garrod started excavating the Mount Carmel sites, McCown was already involved with the Yale-American School of Oriental Research in Jerusalem. With his bachelors degree in anthropology in hand and previous archaeological skills from participating in excavations of the Jerash site (northwestern Jordan), together with his father who was at the time Director of the Palestinian Archaeological Institute's School of Oriental Research, McCown was entrusted to serve as a field director of the joint expedition of the American School of Prehistoric Research and the British School of Archaeology. McCown was in charge of the excavations of human fossil remains at the Skhul cave. McCown's approach was to carefully quarry out the whole blocks of compact soil around the buried skeletons, which were shipped away to be more finely excavated in British laboratories. In order to monitor the lab work, as well as to work with Sir Arthur Keith, McCown moved to

Buckston Brown Farm, Down, Kent, in 1934 where he would remain, living with Keith until the monograph was written (Brooks 1969; Kennedy and Brooks 1984; Trinkaus and Shipman 1993). Having been trained at University of California, Berkeley as a student of Alfred Kroeber, Robert Lowie, and Edward Gifford, McCown had a strong background in cultural anthropology and had undergone the influences of Boasian teachings.

Although never formally trained in anatomy, McCown gained a sound education in anatomy and skeletal biology from Arthur Keith, while working with him on the Mount Carmel specimens (Kennedy and Brooks 1984).

What made Mount Carmel particularly interesting at the time, and still today, is the amalgamation of morphological features that was shown in a single population (a single population, Carmelites, as interpreted by McCown and Keith 1939). The population revealed, for the first time at a single location – Mount Carmel – a mix of both ‘modern’ and Neandertal characteristics. Moreover, the Mount Carmel group of sites (Skhul and Tabun) revealed continuous layers spanning the cultural period from the Acheulean to the Natufian, almost covering the entire duration of the Late Pleistocene period (Garrod and Bate 1937). There was also an observable continuity in tool production traditions throughout the whole span of the layers (Jelinek 1982).

Adding to the unusual nature of this sample, findings at the Qafzeh cave were just coming to light at the time (although not published until much later, beginning in the 1960’s). Not as rich as Mount Carmel in the thickness and continuity of cultural layers, Qafzeh revealed burials that immediately seemed penecontemporary to Tabun and Skhul (L. Picard’s personal early observations and personal communication in Bar-Yosef and

Vandermeersch 1981), containing a similar tradition of stone tool production (Jelinek 1982).

In the first monograph published on the Levantine fossil sample, McCown and Keith recognized marked variability in both the Tabun and Skhul human skeletal remains, characterized by a mixture of archaic (Palaeoanthropic, Neanderthal-like) and modern (Neanthropic, Cromagnon-like) features (1939). In their initial announcement of the Mount Carmel fossil material, Keith and McCown (1937) distinguished two morphologically distinct ‘types’ – “Skhul type” and “Tabun type”. The Skhul type was in their opinion characterized by features that can be found “in the modern races of man”, while Tabun exhibited more Neanderthaloid features. Nevertheless, they claimed that the Tabun type had an “*undoubted kinship with the Skhul type of humanity*” (1937:52). Furthermore, in the same publication Keith and McCown noted regarding the Skhul population that:

“[i]t is no exaggeration to say that if these individuals had been found in different sites at different times, and each one described by a different anthropologist or anatomist, we should have had a corresponding number of fossil races” (Keith and McCown 1937:51-52).

This shows that Keith and McCown were well aware of having to deal with a single population. As they noted, had the Skhul population been scattered among different sites, even in close proximity, anthropologists of that time might have most probably interpreted each individual as belonging to a different ‘type’, or in terms of the early twentieth century, belonging to a different ‘race’. However, two years after their original publication, and after studying the remains in closer detail while preparing the monograph on the Mount Carmel people, McCown and Keith wrote (1939:12):

“As our investigations proceeded we encountered so many characters which linked the Skhūl to the Tabūn type that we were ultimately obliged to presume that we had before us the remains of a single people, the Skhūl and the Tabūn types being but the extremes of the same series.”

Nevertheless, McCown and Keith conclude that the range in form of the Carmelites is unexpectedly great (1939:12). They showed it in their analysis of skeletal characteristics of the Carmelites and their comparison to both Neandertal man (following Boule 1911-1913) and Cro-Magnon man (following Verneau 1906). In their opinion, if one laid out all the human remains in gradual series from individuals with more Palaeoanthropic features to the ones exhibiting more Neanthropic features, Mount Carmel specimens would exhibit a range of variation with Neandertal at one end of the spectrum, and Cromagnon (modern) at the other. In an interpretation of a pattern of “structural instability” and a broad range of variability, McCown and Keith presented the Mount Carmel sample as being a window into a period when both Neandertal and modern human morphologies were in a process of divergence from a single ancestral form. They proposed that *“the Mount Carmel people were in the throes of evolutionary change”* (1939:14; *“plastic folk in the throes of evolutionary change”* in Keith 1938:341).

The following observations and interpretation follow from analysis in the monograph. First, McCown and Keith compared the twenty-five diagnostic characters, claimed by Boule to separate the Neandertal man from the modern human, in three different ‘types’ they identified – Neandertal man, Mount Carmel man and Cro-Magnon man. The conclusion was that only three of the twenty-five characteristics in the Mount Carmel man are the same as in Neandertal man – the morphologies of frontal torus and zygomatic bone, and the pattern of the molar teeth (McCown and Keith 1939:360). In eight characteristics, Mount Carmel is more similar to Cro-Magnon man. Twelve

characteristics are said to be intermediate in the Mount Carmel man, connecting Neandertal man and Cro-Magnon man. Three of the characteristics are shared by all three 'types' – dolichocephaly, wide ascending ramus of the mandible, and larger cranial capacity (McCown and Keith 1939:360).

McCown and Keith then examined Marcellin Boule's list of eighty-six characters used to compare the Neandertal man of La Chapelle aux Saints to both anthropoid apes and modern humans. The analysis of the eighty-six morphological characteristics in Neandertal man, Mount Carmel man and Cro-Magnon man showed that the Carmelites share thirteen of these with the Neandertal man, and twenty four with the Cro-Magnon man (McCown and Keith 1939:371). In thirty-five of the characters, the Carmelites reveal morphologies that are intermediate to Neandertal and Cro-Magnon man. Finally, ten of the characteristics are shared by all three types – Neandertal, Carmelite and Cro-Magnon (McCown and Keith 1939:371).

In sum, adding the two aforementioned lists together reveals that the Mount Carmel man has 14.4 % of the characters in common with the Neandertal, 28.8 % in common with the Cro-Magnon man, 41.4 % that are intermediate to both Neandertal and Cro-Magnon, 11.7 % that are indeterminate (or shared by all of them), and 3.6 % that are particular to their form (McCown and Keith 1939:371).

McCown and Keith pointed out that if they weigh each of the characters to be of equal importance, then Mount Carmel is more similar to the Cro-Magnon man. However, they concluded that due to the presence of many intermediate expressions of the characters, and to unequal weight of the characters, the Mount Carmel population should be placed into a 'Palaeoanthropic' genus (McCown and Keith 1939:372). They saw the

Mount Carmel people as bridging “*the structural hiatus lying between the Neanderthal and Neanthropic types*” (McCown and Keith 1939:372). In the later publication (1950), McCown once again supported his and Keith’s original conclusions in the monograph. McCown stressed the importance of regarding “*Skhul and Tabun series as representatives of polymorphic populations rather than members of distinct taxa*” (Kennedy and Brooks 1984:99).

This section presented the information on the monograph dedicated to the description and interpretation of the Mount Carmel human fossil remains, written by Theodore McCown and Sir Arthur Keith and published in 1939. The conclusions the authors came to about the variation present in the Carmelite remains is that they represent a highly heterogeneous population that was in the “*throes of evolutionary change*”. To McCown and Keith, the Carmelite skeletal remains exhibited both Palaeoanthropic (Neandertal-like) and Neanthropic morphological characteristics. This led McCown and Keith to conclude that in the Carmelite sample, one can see a population which gave rise to Neandertals on one side, and modern human on the other, which later in time, after Mount Carmel, would diverge from each other.

V. Criticisms of McCown and Keith

The scholars dealing with the evolution of man accepted McCown and Keith’s monograph with laudations. Many reviewers of the monograph have paid tribute to the great astuteness of the authors’ analysis and remarked on their fine observational skills. Reviewers, however, disagreed with McCown and Keith’s conclusions and interpretation of the variation present in the Mount Carmel population. Major reactions and objections

to McCown and Keith's interpretations in the decades following the publication of the monograph are presented below.

1. By Ashley-Montagu – why not hybridization?

In a review of McCown and Keith's monograph, Ashley-Montagu (1940) concurred with the authors' conclusion that the Mount Carmel people were in the throes of the evolutionary change. However, he objected to the authors' explanation of the causation/source of the 'exceptional' variability present in the Tabun and Skhul inhabitants. Going through the 'genetic' evidence available then, Montagu rejected the logic of McCown and Keith's description of two 'peoples' differentiating from one single population. Following genetic theory, the divergence of two species from one single population in the Mount Carmel is not probable (Ashley-Montagu 1940:96):

“Left to themselves, relatively small breeding groups, such as the Carmelites, rapidly become homozygous; there is a scattering of variability, and the process, which ‘race’ is, become temporarily genetically stable; the process, in human populations, becomes unstable by the introduction of new genes, by heterozygosis, resulting in a greater variability (although this is not always necessarily so), until there is again a ‘synthesizing’ of the new combinations, and the group is once more relatively homozygous according to a new genetic pattern. The evidence appears to indicate very strongly that the Carmelites represented a group which had recently received a new infusion of genes from some Neanthropic group. It is not impossible, but it is highly improbable, that the variability of the Carmelites was due to spontaneous germinal changes, or to spontaneous variations in gene frequencies.”

Therefore, in Ashley Montagu's opinion, the solution to the problem of explaining the variation within the Carmelite sample lies precisely in the scenario of recent crossing or hybridization that McCown and Keith mentioned but also discarded (McCown and Keith 1939:13):

“We have given the supposition of hybridity our serious consideration and have rejected it. To win support for such a theory we should have to produce the fossil remains of a Neanthropic form of man in Palestine from a level as old, or older, than the Levallois-Mousterian of Mount Carmel, as well as the remains of a fully evolved Neanderthal form. We have no such evidence.”

In order for this scenario to be accepted by McCown and Keith, they needed palpable evidence of proto-Neanthropic man in Palestine, one which would mix with European Neandertal-like man. But without the proto-Neanthropic man at their hands in 1939, they rejected the hybridization theory altogether. Montagu’s comment on this rejection is that regardless of whether one proto-Neanthropic individual was found, it does not rule out the possibility of it being found (*“if one will seek, one may find”*, Ashley-Montagu 1940:122). Moreover, McCown and Keith were of the opinion that modern man had risen from *“one of the genetic strains represented in the Mount Carmel peoples”* (1939: v).

In the decades following the McCown and Keith publication, researchers were split on the question of Neandertals as possible contributors to the modern human gene pool. Few anthropologists of the 1940s accepted Neandertal as (to some degree) ancestral to modern humans (Hrdlička 1927; Weidenreich 1943). Hrdlička wrote on the ‘Neanderthal phase’ of man (1927). Weidenreich stated that *“in no case, however, can the capability of [Neanderthal Man] advancing into Homo sapiens be denied”* (1943:48).

However, many others denied the contribution of Neandertals to human ancestry (Howells 1942, 1944; Hooton 1946; Sergi 1948; Vallois 1954; Le Gros Clark 1955; Boule and Vallois 1957; Piveteau 1957). W.W. Howells, aided by interpretations of Neandertal characteristics as published in Boule’s monograph (1911-1913), denied that Neandertals were on our evolutionary branch (Howells 1942). Howells wrote that *“Everyone is agreed that the Neanderthal was a species distinct from Homo sapiens,*

though of course without any implication that the two might have been mutually sterile”

(1942:186). In that light, being very explicit and categorical in his statement that everyone agrees Neandertals are different species, on the issue of interpretation and position of Carmelites on the human lineage, Howells wrote that

“no actual continuity between the species [Neandertal and modern man] can be shown, except in the extremely peculiar Mount Carmel situation. The most that has been urged is a tendency in a sapiens direction at one end of the Neanderthal variation” (1942:187).

Thus, Howells viewed Neandertals and modern humans as different species, but at the same time, and contradictorily, stated that viewing them as different species does not necessarily exclude the possibility of crosses with fertile offspring. Weidenreich (1943:40) pointed out however that Howells’s statement has different meanings entirely dependent upon the interpretation of the word ‘species’:

“If this word is applied in the usual sense of taxonomist, it would mean that Neanderthal Man is ‘specifically’ different from modern Man not only as to certain morphological features but also as to his special relationship. Or in other words, Neanderthal Man or a form equivalent to him is not an immediate ancestor of modern Man (Homo sapiens) but a hominid type whose anatomical properties are – it is true – similar to those of Man but in principle of such different kind that their bearer must have become extinguished in the course of time without leaving any descendants behind to merge into Homo sapiens. If, however, the word ‘species’ in Howells’ sentences stands merely for “type” and means no more than that this type differs from modern Man by certain features, there can be no objection against such a definition.”

2. Weidenreich – why separate species?

It is noticeable when reading through McCown and Keith's work that their interpretations are sometimes contradictory from page to page. This was noticed and criticized by Franz Weidenreich (1944) in his review of the Mount Carmel monograph.

Weidenreich wrote (1944:222-223):

“In one respect it is very difficult to follow the authors' ideas. They stress the fact that the Mount Carmel population consists of two types. One is represented by the female skull (I) of the Tabūn deposit, the other by the male skull (V) of the Skhūl deposit. The former represents a typical Neanderthalian with low cranium, receding forehead and chinless mandible. The second belongs to a peculiar type – so far unknown – with high cranium like the Galilee skull, vertical forehead and very pronounced supraorbitals but with a well-developed chin like that of modern man. Yet in their analysis of the Mount Carmel population and its comparison with other paleolithic types the authors treat this population as a unit although the Tabūn I type may have had other relations than the Skhūl V type. The authors' statement that the Krapina as well as the Ehringsdorf people find their closest resemblances with the Neanderthal peoples of western Europe and not with the Palestinians can only be maintained by neglect of the Tabūn-type. For the same reason they are not justified in stating that 'the Neanderthal is not found among the Mount Carmel people' but at the same time to claim that 'the Krapina type, the Steinheim Skull and the Ehringsdorf group approach very closely to the Tabūn woman'. The so-called 'Neanderthals' of Europe are no more a unit, morphologically speaking, than the Mount Carmel population.”

Weidenreich therefore pointed to a crucial contradiction that pervaded McCown and Keith's interpretations – the problem of distinguishing a 'type' of morphology, one that is supposed to stand as a 'norm' or point of idealized reference that other specimens found at the Mount Carmel sites do not quite reach. Although McCown and Keith did mention that the Carmelites should be seen as members of the same population, they continued to distinguish specific types within the same population, and therefore polarized the morphologies. The polarization allowed them to predict that there would be a divergence point, when the two types had crystallized to such an extent that they, sometime after the

Mount Carmel sample, would become two separate species. As Weidenreich pointed out, the prediction of divergence in the Mount Carmel sample (the fact that they are “*in the throes of an evolutionary change*”) was an expected solution because of Keith’s long standing view of modern morphologies originating deep in Pleistocene time, and Neandertal morphologies diverging as a separate branch. In this light, interpretations in the McCown and Keith’s monograph seem as though they were a necessary compromise between the two authors of different backgrounds and views. One was a young, previously fossil-unbiased Theodore McCown, coming from the Boasian school where he learned that it is important to encompass into the study the population and not the individuals. McCown stressed the importance that the Mount Carmel sample be seen “*as a remnant of a group of people [...] and that not all the fossils in a skeletal series had to be morphologically identical*” (Kennedy and Brooks 1984:99). The other was very much McCown’s senior, Sir Arthur Keith, who by the 1930s had very strong convictions about the course of human evolution.

3. Dobzhansky – population geneticist’s view

Further criticism of McCown and Keith’s conclusions came from Ukrainian geneticist and evolutionary biologist Theodosius Grigorievich Dobzhansky. At the same time when the original (first) excavations in Wadi el-Mughara and Qafzeh were taking place, Dobzhansky was one of the prominent members in forming the New Synthesis. During the 1930s and 1940s, scholars from different disciplines – including Dobzhansky’s blooming field of population genetics, paleontology, zoology, and biology – tried to fuse their conclusions and explorations of the evolutionary processes from

different standpoints into a synthesized theory of modern evolutionary thought (Dobzhansky 1937; Mayr 1944; Simpson 1944). Dobzhansky had an important impact on starting to apply the principles of population genetics to the studies of fossil humans. Dobzhansky addressed the issue of putting and interpreting the fossil finds within the evolutionary biology framework.

In his 1944 paper, *On species and races of living and fossil man*, Dobzhansky directly addressed some of the monographs published on the human fossil remains and whether the conclusions given by the authors are valid in terms of the genetic/biological perspective of the New Synthesis. In particular he addressed the work done by Hrdlička (1930), McGregor (1938), McCown and Keith (1939) and Weidenreich (1943).

Departing from McCown and Keith's description, Dobzhansky interpreted the magnitude of variation in the Mount Carmel sample not as two forms separating in their morphologies from the same populations, but rather as two forms previously crystallized elsewhere, coming and mixing together in the Mount Carmel sample.

In light of the New Synthesis, Dobzhansky posited that the scenario of having two different 'types' crystallizing and distancing themselves morphologically (and therefore biologically) out of a single population, without a known interbreeding barrier, is impossible. A more probable explanation of such variability in Dobzhansky's opinion would be that the Mount Carmel sample represents a population where Neanderthaloid and modern types, previously formed as subspecies from different geographical regions, hybridized (1944:258): "*The Mount Carmel population arose, therefore, as a result of hybridization of a Neanderthaloid and a modern type, these types having been formed earlier in different geographical regions.*"

With Dobzhansky's idea of hybridization we come to another issue – whether Neandertals and penecontemporary modern-like humans could have interbred. There are different, indeed opposing views on this but it is important to note that recent genetic data on the possibility and probability of Neandertals and penecontemporary modern humans interbreeding support Dobzhansky's position (Hawks and Cochran 2006; Hawks *et al.* 2007; Garrigan and Kingan 2007; Green *et al.* 2010).

4. Thoma – testing the hybridization model

A scholar who followed on Dobzhansky's hybridization model as the plausible explanation of the Carmelite heterogeneity was a Hungarian anthropologist Andor Thoma, who was particularly interested in the Levantine fossil specimens (Makra 2010). In his paper *Métissage ou transformation?: essai sur les hommes fossiles de Palestine*, published in two installments in 1957 and 1958, Thoma analyzed twenty seven morphological traits (nineteen cranial, two dental and six postcranial) across fourteen Palestinian specimens (two Tabun specimens, ten Skhul specimens which included infants, Zuttiyeh specimen, and Qafzeh V specimen) and scored them as typical classic Neandertal, progressive (advanced) Neandertal, intermediate, or sapient expressions (1958:31). From the results of this analysis, Thoma concluded that due to the mosaic appearance of all four types of expressions (typical classical Neandertal, progressive Neandertal, intermediate and sapient) in all of the specimens, the Palestine fossil humans were a case of hybridization between *H. neanderthalensis* and *H. sapiens* that demonstrated they actually were not different species. Thoma proposed that (1958:47):

“A distinct criterion for distinguishing species is the sterility of the crosses, the exceptions of which do not change the law. On the basis of

*'natural experiment' which took place in Palestine, we must remove the specific distinction between Homo sapiens Linné and Homo neanderthalensis King. We agree with the opinion of Dobzhansky (1944) who thinks that from the beginning, there existed only one human species. Between prehomins on one side and Neanderthals and presapiens on the other, the phyletic evolution was slow. Certain characteristics of Sinanthropus were within the limits of variation of the Neanderthals: it suffices to mention Trinil femur, which was an evidence of almost perfect uprightness. Mauer, Swanscombe and Steinheim specimens have characteristics that are simultaneously both primitive and progressive. Thus, a strict demarcation between the two 'phases' can not be traced. It is debatable whether Homo sapiens and Pithecanthropus belong to the same species, but the current classifications, which distinguish the species, genera or higher categories within the human fossil, seem unjustified.'*⁷

As presented throughout the section above, McCown and Keith's interpretations were met with various objections but also some agreements. Most of them objected to McCown and Keith's concluding statement that the Mount Carmel population is in the "throes of the evolutionary change". In contrast, reviewers contend that the Carmelites are to be seen as a population where groups of different origins admixed. Researchers who did not accept Neanderthals as playing part in the origins of modern humans however were wary of interpreting the Carmelite sample that way, considering it to be an exception difficult to explain until more specimens are revealed. The discussion on how to interpret the Mount Carmel sample continues until the present day. Some of the major issues are presented in the sections to follow.

⁷ "Un critère capital de la distinction de l'espèce est la stérilité des croisements, les exceptions ne changeant pas la loi. Sur la base de 'l'expérience naturelle' qui s'est déroulée en Palestine, nous devons donc supprimer la distinction spécifique entre Homo sapiens Linné et Homo neanderthalensis King. Nous nous rallions à l'opinion de Dobzhansky (1944) qui pense que, dès l'origine, il n'a existé qu'une seule espèce humaine. Entre les Préhominiens d'un côté, les types néandertaloïdes et présapiens d'autre côté, il ne s'est déroulé qu'une évolution phylétique lente. Certains caractères du Sinanthrope sont dans les limites de variation des Néandertaliens : il suffit d'évoquer le fémur de Trinil, de rectitude presque parfaite. Les spécimens de Mauer, de Swanscombe et de Steinheim ont simultanément des caractères primitifs et progressifs. Une délimitation stricte entre les deux 'phases' ne peut donc être tracée. On peut discuter si l'Homo sapiens et le Pithécantrope appartiennent à la même espèce, mais les classifications courantes, qui distinguent des espèces, des genres, voire des catégories supérieures à l'intérieur de l'humanité fossile, ne semblent fondées."

In summary, McCown and Keith's interpretations of the high magnitude of variation that the Carmelite sample exhibited, and their conclusions were met with various criticisms in the years after the original publication of their findings in 1939. Ashley-Montagu was the first to address the hybridization model as the most plausible explanation of the variation seen in the Carmelites. Weidenreich criticized McCown and Keith's need to distinguish two separate 'types', or 'norms' within the Carmelite sample, predicting therefore the later divergence point between the Palaeoanthropic type (crystallized into Neandertal) and Neanthropic type (crystallized into modern man). Dobzhansky agreed with Ashley-Montagu's criticism and confirmed that the hybridization model, in the light of the New Synthesis, indeed is the most plausible explanation of the Carmelite heterogeneity. Thoma followed upon the Ashley-Montagu's and Dobzhansky's hybridization model and tested it on then available Levantine fossil skeletal remains.

VI. The problem of holotype, type specimen, and species definition

After presenting the exchange of scholars in the years following the publication of McCown and Keith's monograph, this section discusses the more recent changes in interpretation of the Mount Carmel sample. The publications of American anthropologist Francis Clark Howell addressed the issue of Mount Carmel and Qafzeh sites' chronostratigraphy, and their relation in time (1957, 1959). In addition, in the course of his critical review of the Neandertal remains known then, Howell raised the issue of the definition of both Neandertal morphology and culture. Thus, we come to the important point of defining the 'norms' for both cultural and biological (morphological)

characteristics of the Neandertal. The following section is dedicated to the issues raised in Clark Howell's seminal papers.

Almost two decades after Montagu and Dobzhansky's criticisms of McCown and Keith's conclusions, the issue of the variability in the Levantine sample was addressed by Howell. By that time, many more fossil specimens had been unearthed worldwide, and significant advances in carefully retrieving their context had been made too. Howell (1957, 1959, 1998) argued that the issue of high variability in the Levantine sample can be simply resolved by differentiating between two different species from the Levant area in the Late Pleistocene – Tabun representing the Neandertal, and Skhul and Qafzeh representing the modern human form. Based on the context of the discovery of the human fossil remains from that area, the cultural strata and particularities of the tool industries, and their geological position, Howell argued that the specimens from these caves were not contemporary (Howell 1959). The details of contemporaneity indeed require attention. The specimens found in the Mount Carmel sample, as well as the Qafzeh, are broadly contemporary in a geological sense of time. However, this does not mean that the individuals preserved in this archaeological sample actually shared dinner or exchanged stories about their days on any given night. Specifically, Howell proposed arranging them in a temporal sequence, with Tabun first, though this does not explain the amalgam of both Palaeoanthropic and Neanthropic features appearing in all the Late Pleistocene Levantine fossil specimens.

Howell, in his 1957 paper, distinguished between different geographical groups of Neandertals, and between classic Neandertals and other non-classic Neandertal variants. In Howell's opinion, the morphological details exhibited in the Neanderthaloids within

the Levantine sample were clearly different than those found in skeletal morphology of European Neandertals. However, Howell does point out that the Neandertaloid specimens known at that time (1957; then only Tabun specimens) are not sufficient to establish a range of variation for the population they were once part of. Howell proposed the concept of different paleo-demes, distinguishable based on both morphological characteristics, and also on the dating of the specimens together with the cultural material (in particular, stone artifacts) found in association with the human skeletal remains (Howell 1957, 1959, 1998). A deme is any local interbreeding population or community (“*any assemblage of taxonomically closely related individuals*” say Gilmour and Gregor 1939:333 from Howell 1998:5), and paleo-demes are past hominine interbreeding populations or communities (Howell 1998). Howell therefore recognized several different and distinct Neandertal paleo-demes and for each of the demes, he proposed a kind of type specimen or holotype representative of such deme. Howell suggested the Feldhofer specimen as a holotype for the classic Neandertal (1957). The idea and practice of defining a type specimen is common in taxonomy.

By assigning the Feldhofer remains as a holotype, or ‘type specimen’, a representative form of a whole species, Howell touched on a significant problem present in the study of human evolution. The custom of establishing a holotype, a single specimen taken as an objective reference point for a whole species (Ohl 2007) draws upon the tradition of Linnaeus’ system of binomial nomenclature and nominal descriptions of all the biological species. The nomenclature procedure and rules are prescribed by the International Code of Zoological Nomenclature. “The Code” had seen many revisions over the years. However, it still contains conflicting principles.

The Code prescribes that a holotype is set for each recognized species. This is a procedure that dates back to the time of Carl Linnaeus, the father of modern taxonomy. However, when Linnaeus himself defined *H. sapiens* as a species in 1758, he did not set its holotype (Spamer 1999; Ohl 2007). This ‘omission’ is accepted and interpreted as irrelevant because “*the identity of the species is obvious*” (Ohl 2007). However, the delineation between two similar living species is complicated to draw, and for this reason many species concepts have been proposed (Groves 2007, according to Hey (2001) up to 24 concepts!; Tattersall 1992; Kimbel and Rak 1993; Szalay 1993; Holliday 2003). Defining the ‘boundaries’ of a living species is not an easy task, and to define a biological species solely through glimpses of preserved fossil specimens is considerably more troublesome. Dobzhansky touches upon the problem of assigning the species status based on morphology, and in particular, morphology of a single specimen, by stating (1944:254-255):

“The time is not far past when many systematists designated as species any two populations which they could (or thought that they could) distinguish by examining the morphology of a single specimen. To quote an example of this in a group of animals not very remote from man – Elliot (1912) recognized as many as ten species of chimpanzee instead of a single one!”

As Dobzhansky postulated, the problem of the traditional systematists is defining a biological species strictly by the morphology of few known specimens, and thus possibly ignoring different sources of variation known to exist within the species. Dobzhansky stressed the importance of applying the genetic (biological) species concept to morphologies. Moreover, certain issues are important to keep in mind when applied to humans, because we are such a wide spread biological species (Dobzhansky 1944:254):

“Wherever and whenever human races come in contact in the same territory, they mix and exchange genes more or less freely. There is no indication of either lessened variability or of sterility of hybrids. Caste and class barriers sometimes impede the free gene flow from race to race, but it is doubtful if these barriers can justifiably be compared with sexual isolation as the latter exist on the biological level. Be that as it may, it is certain that none of the existing caste and class barriers are strong enough to reduce the gene exchange between the human races to a point where the racial differences might remain constant or even increase in the course of time.”

This statement can be extrapolated to the past human populations, at least to the human populations of the Levantine area (Dobzhansky 1944). In addition, with the recent breakthroughs in retrieving and analyzing ancient nuclear DNA (addressed in the discussion in Chapter Six), there is a possibility of a ‘revival’ in using the biological species concept as the operational model even for the certain human fossil specimens (Hawks 2011).

To come back to the paleo-demes, Howell concluded that the different Late Pleistocene demes he recognized *“must have represented distinctive sympatric species which led dissimilar ways of life and were characterized by habit and behavioural differences, so much so that interbreeding did not customarily occur”* (1957:342).

However, based on the recent advancements in the genetic studies of ancient DNA, it has been confirmed that the Late Pleistocene populations did exchange genes. It has been shown that Neandertals significantly contributed to the modern human gene pool (Green *et al.* 2010; Yotova *et al.* 2011). This means that the exchange of genes between the Neandertals and modern humans was not an exceptional and rare event. In order to contribute significantly to the modern human gene pool, this would mean that instead of hybridization, it was reticulation that occurred when Neandertal and other more ‘modern’

populations met (Wolpoff 2003). Thus, the appropriate species concept to be applied to the fossil record would be the biological species concept.

In summary, in this section the issue of chronological (a)synchrony of the Late Pleistocene Levantine specimens was raised, as pointed out by Clark Howell during the 1950s. However, the amalgam of both Palaeoanthropic and Neanthropic morphological characteristics appearing in all the specimens of the Levantine sample cannot be simply resolved chronologically. In addition the problem of defining holotype, or type specimen for a population known from a fragmentary fossil record was presented, as well as different species definition and concepts that are used by paleoanthropologists. These issues need to be addressed because they pertain to the explanation of the variation present in the Levantine fossil sample.

VII. How do the Levantine fossils fit the present theoretical frameworks?

With the large, significant Late Pleistocene fossil record from the Levant, precisely the area where the three continents of the Old World come together, this region is the ideal place to study the intermingling characteristics of various populations and look for evidence addressing the differing predictions of the models of human evolution. This is in fact the goal of this dissertation. In the following section, the author presents how the Levantine fossils are interpreted by researchers today. The author continues with the specifics of her approach in addressing this important issue.

Dobzhansky used the Mount Carmel example as evidence that “*a morphological gap as great as that between the Neanderthal and the modern types may occur between races rather than between species*” (1944:259). There are several researchers today who

continue to argue that the Levantine sample as a whole is one species. These include Ahern (2006; Ahern *et al.* 2005), Arensburg and Belfer-Cohen (1998), Corruccini (1992), Kramer and colleagues (Kramer *et al.* 2001), Minugh-Purvis (1988), Quam and Smith (1998), Wolpoff (1999), Wolpoff and Lee (2001).

A number of researchers have proposed a taxonomic solution as an explanation of considerable variability in the Late Pleistocene Levantine sample. A taxonomic solution is required by the Out of Africa theory. The authors who clearly stated there are two different species present in the Levant include Harvati (2003), Lieberman and colleagues (2002), Rak (1993, 1998) and colleagues (Rak *et al.* 1994, 1996, 2002), Stringer (1992), Stringer and Andrews (1988), Tattersall and Schwartz (1999; Schwartz and Tattersall 1996a, 1996b), White and colleagues (White *et al.* 2003). These researchers state that the amount of the variability in the Levantine specimens is too large to be present in a single species (Vallois and Vandermeersch 1976; Vandermeersch 1981; Rak 1993, 1998; Rak *et al.* 1994, 1996, 2002). They interpret the variation present as evidence of two different species cohabitating, *sensu lato*, in this area during the Late Pleistocene. For instance, Vandermeersch (1981) noted that although the traditionally viewed 'modern' group (Skhul-Qafzeh) shares cultural affinities with the traditionally viewed Neandertal group (Tabun-Amud), these two groups are anatomically independent and phylogenetically different (Vandermeersch 1992).

Thus, the main problem revolves around the quite opposite interpretations of the variation present in the Levant. To draw conclusions on one versus two species present in this area, one has to determine whether the variation exhibited in the Levantine material is unusual or unexpected.

In summary, the above section presented how the variation within the Late Pleistocene Levantine fossils is interpreted today. In that light, there are researchers who view the Levantine sample as a whole as representing one species. On the contrary, a number of researchers differentiate the Late Pleistocene Levantine sample into two distinct and separate species, therefore finding the source of the great magnitude of variation in different taxonomy.

VIII. How the question is addressed here – back to the hybridization

There are many faces of the problem when looking at, and moreover interpreting, the magnitude of variation in the Late Pleistocene Levantine fossil sample. One has to bear in mind the complexity of the issues raised over ‘not unusual’ magnitude of variation: opposing views of modern human origins; interpreting the Levant remains as one heterogeneous population or seeing the same remains as reflections of two species present in the area; and the issue of anatomical modernity. In the sections to follow, the choice of addressing and solving some parts of the problem raised are explained. Due to the complexity of the issue, one has to act using small steps. First step, and the scope of this dissertation, is to establish what not unusual magnitude of variation *is* in populations known from the archaeological record of mixed ancestry.

McCown and Keith’s original interpretation of Mount Carmel being a single but quite heterogeneous population has to be addressed. The authors concluded that although they had a different opinion in the earlier stages of their investigation, their final conclusions had to be as follows (McCown and Keith 1939:12):

“... we encountered so many characters which linked the Skhul to the Tabun type that we were ultimately obliged to presume that we had before

us the remains of a single people, the Skhul and the Tabun types being but the extremes of the same series.”

The way McCown and Keith saw it, when looking at the morphologies of these specimens, one can see that different expressions appear in all of them. There is no set of clear ‘modern’ versus ‘Neandertal’ morphological traits that appear in one skull or the other. Rather, the amalgamation of both archaic- (Neandertal-) and modern-like features can be seen in each of them. It is important to note that these authors were the last to see the whole Mount Carmel collection together, before its dispersal among the institutions sponsoring the excavations, and therefore their insight is unique⁸.

McCown and Keith were aware that Skhul and Tabun, based on the archaeological and paleontological evidence (Garrod and Bate 1937), are not perfectly contemporary with each other. Following the archaeological and paleontological data, it was suggested that Skhul people are geologically older than human remains coming from the layer B of Tabun cave (McCown and Keith 1939:11). The problem has always revolved around the provenance of the female Tabun I skeleton (details presented in Chapter Four). Although McCown and Keith knew that the specimens found at Skhul and Tabun were not absolutely contemporaneous to each other, they still concluded that they were nonetheless “*members of the same species or race*” (McCown and Keith 1939:12). They made these conclusions based on 1) the dental morphologies showing uniform expressions across all the specimens found, 2) almost identical cultural material coming

⁸ Due to the collaboration of the American School of Prehistoric Research (affiliated with Harvard University) and British School of Archaeology in Jerusalem on the project of excavating the Mount Carmel sites, part of the material was sent to be housed at the Peabody Museum of Harvard University, part to the British Natural History Museum, and a part stayed at the Rockefeller Museum in Jerusalem, Israel. A similar story is true for the Qafzeh sample – where the sample is divided between the Institut de paléontologie humaine in Paris, and Tel Aviv University, Israel. The sample of thirteen Levantine specimens is now dispersed between Jerusalem, Tel Aviv, Paris, London and Boston.

from the both sites, and 3) both Tabun and Skhul people living in the same locality, at relatively similar period of time (McCown and Keith 1939:12). They asserted there was no clear way, or criterion, to divide the Mount Carmel sample in two distinct, different populations because “*all the members of the group posses certain characters in common*” (McCown and Keith 1939:12).

There are many different sources of variation present in any population, such as variation based on sex, age, and idiosyncratic disparity (Lee 1999; White 2003; Van Arsdale 2006). Moreover, there are preservational and retrieval biases in finding any of the fossil specimens. In the Levantine sample one can assume that the magnitude of variation is aided by the particular geographic location. When groups of ‘anatomically modern’ populations left Africa, on their way to Asia and Europe (though they did not know this), they must have reached and passed first through the Levantine corridor. Therefore, different ancestry is another item to be added to the list of sources of variation, whether or not a single species is represented. All of these sources of variation should be considered when assessing the overall magnitude of variation present in a population.

The intermingling of European and African and/or Asian morphologies can be seen throughout the sample. If we consider the Levantine sample to represent two species, Neandertal Amud and Tabun in opposition to ‘anatomically modern’ Qafzeh and Skhul, the possibilities of these two species interchanging their genes cannot be ruled out. However, if they should instead be considered as two different species, mixture is possible but minimal or negligible, and would differ from the pattern of mixture in a population of the same species (such as the Pannonian sample central to this dissertation). The issues are explored further in the discussion chapter (Chapter Six). The bottom line is

that if the Carmelite population is formed out of two different species, the variation present in their morphologies should be greater than what is present in any modern human population, even if the modern population examined is very heterogeneous and of different admixed ancestry.

Everything that McCown and Keith noticed regarding the morphological characteristics and the variation present in the Mount Carmel sample still stands today. As already mentioned, it was criticized early on by Ashley-Montagu (1940) and Dobzhansky (1944). Dobzhansky's model for explaining the variation, that the two 'types' previously formed in different geographic regions and came together in the Levant sample, is still pertinent today. The aim of this dissertation is to test Dobzhansky's model of hybridization (admixture) in the Levantine sample by comparing its variation to that of a recent admixed archaeological sample. The question of whether the Levantines exhibit an unusual magnitude of variation could be addressed by exploring what is a normal magnitude of variation in the Late Pleistocene populations overall. However, due to the paleoanthropological problem of small sample sizes and taphonomic biases in preservation and randomness of discoveries of the remains in certain areas of the world, this is not an easy task.

The approach proposed here is to try to establish the not unusual magnitude of variation that can be exhibited in the skeletal morphology of a modern human population, known only from the archaeological record. But what kind of population? Late Pleistocene skeletal remains from the Levant come from an area that lies on a geographic crossroads – the meeting point of the three continents of the Old World (Garrod 1937; Bar-Yosef and Vandermeersch 1993). The Levant region is situated not in some forgotten

and isolated corner of the Late Pleistocene world, but precisely in the heart of the then inhabited world. One can assume that therefore this region was a sort of melting pot of the Late Pleistocene world, if populations could interbreed. The Late Pleistocene populations of all three continents exhibit clear regional affinities and variation in their morphologies, as a normal response to differing histories, local adaptation and higher frequency and probability of more localized gene flow. Nonetheless, broader gene exchanges could have been present (and observable in the fossil record), therefore keeping the ties with other continents' populations by normal, usual, movements of people, and the exchange of genes (Thorne *et al.* 1993; Eckhardt *et al.* 1993; Wolpoff 1996). Therefore, it is most reasonable to make comparisons of variation with a recent modern population of mixed ancestry. For this reason, the choice is to compare the Levant sample's non-metric cranial variation with the cranial variation in one hundred mixed-ancestry medieval crania from the Pannonian Plain, dated between fourth to eighth century A.D. As discussed in the next chapter, these medieval individuals represent diverse populations and comprise a particularly appropriate sample for comparison with the Levantine sample.

The contribution of the author to the issues raised is twofold. First, the author concentrates on a non-metric approach to examine the variability within the Levantine fossil sample. Many authors are very critical of accepting species designation based on anything that is not solely morphological characteristic (Tattersall 1992; Wiesemüller *et al.* 2000; Tattersall and Mowbray 2005). Thus, only cranial, non-metric morphological features, across the Levantine sample are considered here. Furthermore, by collecting all the data personally on each subset samples (Levantine and Pannonian subsets), the

observations were done in a consistent and standardized fashion for all subsets, and therefore not biased by different researchers using different standards for different subsets. A second important contribution is incorporating resampling methods into analyses of the collected data.

To summarize, this section has introduced the blueprint for this dissertation's research. By briefly restating the problems of the interpretation of the variation seen in the Late Pleistocene Levantine fossil record, the presentation on how the author is going to address the issue of variation in the Levantine sample by testing the hybridization model was laid out.

IX. Conclusion

In this chapter, the background and rationale behind the development of this dissertation's research was presented. It started with 1930s, when human fossil remains from three caves sites in the Levant were brought to light. These caves – Mount Carmel caves Tabun and Skhul, and Qafzeh cave – contained skeletal remains that exhibited previously unprecedented combinations of features and overall variation. In order to explain how these newly found fossil specimens fit into the theoretical framework of human evolution of the excavators and interpreters, it was of importance to present what was thought of and known about the course of human evolution until the 1930s. Few human-like fossil forms had been recognized by that time (*Australopithecus*, *Pithecanthropus*, Neandertal), and the relationship between different human fossil species remained to be interpreted. The biggest debate, however, that was brought on by the human fossil findings unearthed by 1930s was how the Neandertals fit into the picture

of human evolution and whether they were ancestral or not to modern humans. The scholars of the early 1900s were divided on the interpretation of the relationship of the Neandertals and modern humans.

Because the description and interpretation of the Mount Carmel human fossil remains written by Theodore McCown and Sir Arthur Keith and published in 1939 was a major inspiration behind this project, it was presented in detail. The conclusions the authors came to about the variation present in the Carmelite remains is that it derived from a highly heterogeneous population that was in the “*throes of evolutionary change*”. However, as we learned in this chapter, McCown and Keith’s interpretations of the high magnitude of variation that the Carmelite sample exhibited, and their conclusions, were met with various criticisms, namely by Ashley-Montagu, Weidenreich, and Dobzhansky. In contrast to McCown and Keith’s interpretation, these critics concentrated on explaining the heterogeneity in the Levantine sample by the hybridization model. Thoma followed upon the Ashley-Motagu’s and Dobzhansky’s hybridization model and tested it on until then available Levantine fossil skeletal remains.

Later criticism, namely from Clark Howell, posited that the issue of chronological (a)synchrony of the Late Pleistocene Levantine specimens resolves the question of heterogeneity in the Levantine sample. Howell saw the Levantine sample as specimens of two separate species, defining type specimens as representatives of each of those two species. Therefore, the problem of defining holotype, or type specimen for a population known from a fragmentary fossil record was raised, as well as difficulties surrounding both different species definition and concepts that are used by paleoanthropologists.

The variation within the Late Pleistocene Levantine fossils is differently interpreted today, based on the two major opposing theories of the origins of modern humans. In that light, there are researchers who view the Levantine sample as a whole as representing one species, but there are also a number of researchers who differentiate the Late Pleistocene Levantine sample into two distinct and separate species, and therefore find the source of so great a magnitude of variation in different taxonomy.

Many recent assessments of variation in the Levant have focused on inter-specific explanations of diversity. Prior to accepting taxonomic explanations for Levantine Late Pleistocene, it is important to take into account the signature and the amount of variation in admixing populations. This chapter introduced the reader to the choice of addressing the problem of interpreting the magnitude and pattern of variation in the Levantine Late Pleistocene fossil sample. The research presented here will rigorously test Dobzhansky's model by comparing Levantine non-metric cranial variation to an archaeological sample of a known admixed population from the Pannonian Plain.

Chapter 3

The Pannonian Plain in the Early Medieval Ages:

how the mixed sample got mixed

Upon entering the attic of the Hungarian Natural History Museum, where the Department of Anthropology found its home, one's walk to the main office along the long and narrow hallways is accompanied by display cases. Some of these cases exhibit different human skulls, mostly from the early medieval period (circa 400-1000 A.D.), that were found on Hungarian territory. They span from the age of the onset of the Great Migrations Period and the first Hunnic penetration into the Pannonian Plain in late fourth century A.D., to the Conquest Period which encompasses the arrival of Magyars (Hungarians) and their Árpádi royal line in this area at the beginning of the tenth century.

Each of the human skulls in the display cases serves to inform the observer of the great variety of humans from different geographic origins present during early medieval times in the Pannonian Plain. The display cases also serve as a testimony to the work of middle twentieth century anthropologists who strove to categorize these skulls into certain types, based on their morphological characteristics. Thus, the museum vitrines point out the existence and appearances of these types. The onlooker is presented with skulls chosen as representative specimen of its 'type' – 'Baikal type' (i.e. "Paleo-siberian", "Protomongoloid"), 'Sinid type' ("North Chinese"), 'Sayanic type', etc. Most

of these specimens actually come from different Avar-age cemeteries within the Pannonian Plain, part of which encompasses the Hungarian territory nowadays. (The Avars were a heterogeneous elite who managed a vast Central European empire between sixth and ninth centuries.) The names of the ‘types’ stem from the morphological characteristics of the skulls that are thought to originate from certain geographic areas of the Asian continent, where the Avars were one thought to have come from due to the fact that they exhibit morphological similarities with the populations inhabiting these areas in much more recent times.

There are many interesting issues that one is inspired to explore when faced with these minimalistic but very effective displays. What is most striking, and of great interest for this dissertation, is the amount and richness of human morphological variation, exhibited just within the few skulls that are represented. This high magnitude of variation is certainly helped by the fact that these skulls are picked out of a much larger collection, and are material documents of the time when we know there was a great influx of peoples from Central Asia and the North of Europe into the present Hungary’s territory. This is attested by the influx of morphologies characteristic of Asian populations, and confirmed by both the written sources that we are fortunate to have from this time period and the findings and conclusions of archaeological exploration of the fourth to eighth centuries in the Pannonian Plain. However, the number of migrants was not very significant, especially in proportion to the Romanized Pannonians. That the people who got called “Avars” were more numerous reflects the willingness of many people, including those with nothing to do with Central Asia to *become Avars* after the end of Roman hegemony.

The main goal of this chapter is to understand the origins of the anatomical variability in the human sample of peoples of various and mixed origins from the Pannonian region during the fourth to eighth centuries. This is the period that yielded the modern sample used for comparative purpose in this study. The details below support the choice of this particular area of the world, at this particular window in time, as the source of an appropriate comparative sample of a population of mixed ancestry.

This chapter is dedicated to introducing the reader to the provenance and context of the comparative sample used in this dissertation. In this chapter the reader is first presented with a basic overview of the geography of the Pannonian Plain. The chapter continues with the explanation of toponymy and tradition of the word Pannonia which signifies a specific geographic location, but also indirectly explains the political situation of the period of interest. What follows is a description of the broader area of the Pontic-Danubian realm that the Pannonian Plain is a part of.

Following this is a discussion of the history of the region. Information is presented on the strategic interests that led the Roman Empire to subjugate part of the Pannonian Plain. Briefly outlining Roman rule over the plain and the process of its Romanization sets the beginning of the time period the majority of the comparative sample comes from. Roman written sources present valuable documentation for the populations of different European origins that inhabited the Pannonian Plain prior to and during Roman rule.

Romans initially encouraged the influx and settlement of new incoming groups as a part of a defensive strategy that worked for certain amount of time, and it was a sign of Roman power (see e.g. Heather 1997; Pohl 1997; Wirth 1997; and Wolfram 1997).

However, the decline of Roman power enabled the influx of steppe warrior groups in the Pannonian Plain area, who entered the region and established their kingdoms within the Plain. The time period when this happened is roughly defined as from the fifth to the eighth centuries, and is known as the Great Migrations Period in the historical literature, or as the Barbarian Invasions: it depends on one's perspective. The complex situation during the transformation of Late Roman rule over the area to the onset and formation of new non-Roman, or in Roman terms "barbarian", kingdoms is overviewed. Although only a small portion (twenty percent) of the crania used in this dissertation comes from the fourth (Roman rule) and fifth (presence of various Germanic groups) centuries, it is crucial to explain the late Roman and Great Migrations Period for a better grasp of the complexity of population structure within the Pannonian Plain during the Avar age (second half of the sixth to the end of the eighth century).

Due to the fact that the majority of the comparative sample comes from the numerous Avar-age cemeteries found within the territory of present day Hungary, the second part of the chapter more closely focuses on the Avar presence in the Pannonian Plain. The Avars are a steppe group whose origins are traced to the Central Asian area⁹. In the second half of the sixth century they entered the Pannonian Plain and set up a powerful kingship – *khaganate*. They ruled over the western part of the Pannonian Plain until Frankish army forces under Charlemagne raided over the area at the end of the eighth century. What is known of Avar origins from the written historical record, along with what is known from archaeological studies are presented. The chapter explores who

⁹ Although the term 'tribe' is used to describe the Avars in the Roman historiographies, 'tribes' were in early medieval times very porous and elastic groups, receptive to people 'joining'. This will be shown in the section on the Avar group formation. Therefore, the term 'group' is preferred over the term 'tribe', although in many historiographies the term 'tribe' is ascribed to these early medieval groups.

the Avars of the Pannonian Plain are, their history from the second half of the sixth century to the eighth century, and the written sources on the Avars. The complicated population structure of various groups under the Avar rule and the issue of defining what is 'Avar' is discussed. In addition, anthropological studies conducted on the skeletal material from the numerous and abundant Avar age cemeteries are set forth.

The conclusion is a summary confirming the historically complex and mixed population structure of the early medieval Pannonian sample. The issues that are raised in exploring the history of research on early medieval Europe and Avar age Pannonia are not only fascinating, but serve as a great example that is in many ways comparable to the study of our deeper past, something that both early medievalists and prehistorians can benefit from. These issues are touched upon in the concluding section of this chapter.

I. Introduction to the Pannonian Plain

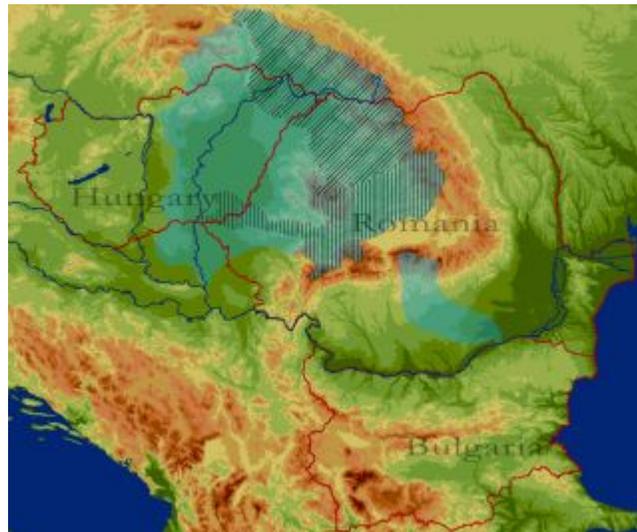
In order to adequately introduce the reader to the Pannonian Plain – the area where the comparative sample for this study comes from – the first section is dedicated to an introduction and general description of the geography of the Plain, including information on the origin and tradition of the name Pannonia. The Pannonian Plain is presented as a part of the larger geo-cultural area of the Pontic-Danubian realm.

1. Geography of the Pannonian Plain

In order to provide an adequate background on the comparative sample used in this work, the starting point is to describe the geographical provenance of the sample. The

Pannonian Plain (fig. 3.1) encompasses a large lowland area in Central Europe, which was formed after the drying out of the Pliocene Pannonian Sea (Getis *et al.* 2000).

Figure 3.1 Map of the Pannonian Plain (taken from http://www.clavier-eu.org/?q=system/files/images/wp3c_01a.jpg)



The area is also known as the Carpathian Basin or Pannonian Basin. The mountain ranges surrounding the plain demarcate its boundaries: the Alps to the west, the Dinarides to the southwest, the Balkan Mountains to the southeast, and the Carpathian mountains to the north. Today it encompasses the territory of all of Slovakia and Hungary, including parts of the Czech Republic, Austria, Slovenia, Croatia, Serbia, Romania and Ukraine.

The plain consists mostly of clayey loess soil, which in certain climatic conditions can develop into very agriculturally productive land (Getis *et al.* 2000).

The human cranial material used as the comparative sample comes from the area encompassing central and western part of Hungary. The sites that yielded the crania are situated east of the Austrian-Hungarian border, south of the Danube Bend, west of the

Tisza river, and north of the Drava river and Hungarian-Croatian border. The focus is put on central and western part of Hungary due to the preservation of the crania found at numerous Avar-age cemeteries present in this area, and due to the fact that there are more sites in this area from pre-Avar periods.

It is important to explain here why the area of the Pannonian Plain is taken as an appropriate source for the comparative sample in this study. As mentioned earlier in Chapter Two, the Levantine area where the fossil sample comes from was, during the Late Pleistocene, time located in the heart of major crossroad and communication routes of the Old World continents. This area is referred to as the Levantine corridor which fauna (and human populations) used for migratory routes and biotic exchanges (Tchernov 1988, 1992; Goren-Inbar and Speth 2004). The Mediterranean Sea on the west, and the desert stretching on the east constricted the biotic exchanges to the Levantine corridor. A parallel to the Late Pleistocene Levantine corridor is seen in the early medieval Pannonian Plain. As Batty (2007) pointed out, the Pannonian Plain is a western continuation of the vast steppe region that connects the Pontic-Danubian region. The specific geographic location of the Carpathian Mountains directed the populations coming from the eastern steppes into the European continent to either the northern or southern route; northern route towards and into the Pannonian Plain was the easier to handle. To advance south from the Danube delta leaving the steppe belt is possible, but much more restricted (Batty 2007). Therefore, the northern route was the one preferred. In addition, the Alps located at the western edge of the Pannonian Plain directed routes into the Pannonian Plain as well, making the Plain the easiest passage from the northern parts of Europe into the south. This is another reason why the Pannonian Plain, being on

the crossroads of the early medieval migratory routes, makes it an appropriate choice for the source of the comparative sample: it parallels the conditions of the migratory route confluence of the Late Pleistocene Levantine corridor.

2. Origin and tradition of the name Pannonia

Although the area of interest is known in the scholarly literature as the Carpathian Basin, here it will be referred to as Pannonia and the Pannonian Plain because this appellation indirectly reflects the power and population structure for the period of interest. The name Pannonia is given to the plain after the tribe that inhabited this area in the first millennium B.C. The tribe *Pannonii* (*Παννόνιοι*) was first mentioned by Polybius (frg. 64, 122, ed. Büttner-Wobst IV p. 523 from Mócsy 1962:519), a Greek historian writing in the second century B.C. (Mócsy 1962; Domic Kunić 2006). Pannonians were an Illyrian tribe that ancient sources started using as *pars pro toto*, a collective name for all the Illyrian tribes inhabiting the river Sava valley (Barkóczy 1980). The Romans, after occupying and incorporating this geographic area into their provincial system, used the term Pannonia to denote the province bearing the same name. The borders of the province, which underwent few territorial reorganizations and divisions at the beginning of the second and the end of the third centuries, encompassed the area from river Sava to the south, the Danube to the north and east, and the Alps to the west (Soproni 1980; fig. 3.2). This territory today corresponds to Transdanubia of present-day Hungary, Burgenland in Austria, and Panonska nizina in Croatia. The Roman tradition of calling this area Pannonia was kept by the Magyars (who appear in the Pannonian Plain in 896 A.D.; Salamon and Sós 1980; Róna-Tas 1999), whose kings bear the official regal

name “*Rex Pannoniae*”. Thus, the Roman toponymic was preserved and kept throughout the Middle Ages, and all the way until the present day.

Figure 3.2 Map of the Roman provinces in 1st – 3rd centuries (figure taken from <http://2guysreadinggibbon.files.wordpress.com/2010/04/map740px-roman-provinces-of-illyricum-macedonia-moesia-pannonia-and-thracia.jpg>)



3. Pannonia as a part of the Pontic-Danubian realm

To understand the population movements and influx of people of Central Asian origin during the Great Migration Period, it is important to explain that the Pannonian Plain is the most western part of a larger Pontic-Danubian area, and therefore an area that connects Europe with the West and Central parts of Asia. The Pontic-Danubian region

(fig. 3.3) is an extended geographical area of Eurasia with no particularly clear territorial boundaries or barriers; thus the area has always been a zone of interaction of the West (Europe/Mediterranean) and East (Black Sea, Central Asia; Batty 2007). It encompasses regions around the middle and lower Danube, the Carpathian basin, the area north to the Black Sea, and ending in the area north and a bit east of the Caspian Sea. Throughout prehistory and early history, arrival and interchange of various cultures and ethnicities have been a constant theme in this area. Batty's (2007) work parallels Horden and Purcell's (2000) description of the Mediterranean cultural milieu as "*interaction between the plethora of diverse micro-regions which fundamentally characterizes the area*". Batty describes the Pontic-Danubian realm having the same working principles as the Mediterranean realm. These realms are characterized by interactions between at times quite diverse smaller areas, that nonetheless together form a larger cultural sphere, sharing and exchanging many cultural characteristics. The only difference between the two large cultural areas – the Mediterranean World and the Pontic-Danubian realm – are the bonding catalysts that unite the smaller areas within them. This was the Mediterranean Sea in one case, and the great plains of the Pontic-Danubian area in the other (Batty 2007). The Pannonian Plain, on the western end of Batty's Pontic-Danubian zone, due to its location in the center of Europe, is of crucial importance in connecting various parts of Europe and Asia. It is more than other places an area where the West and East¹⁰ clash and mix together, but also a site for encounter between northern and southern

¹⁰ Term "West" is used here to identify the Greco-Roman world and its cultural milieu, and "East" as the term to describe the other, non-Greco-Roman cultures and peoples.

Figure 3.3 The Pontic-Danubian region in its Eurasian context. Taken from Batty 2007:2.

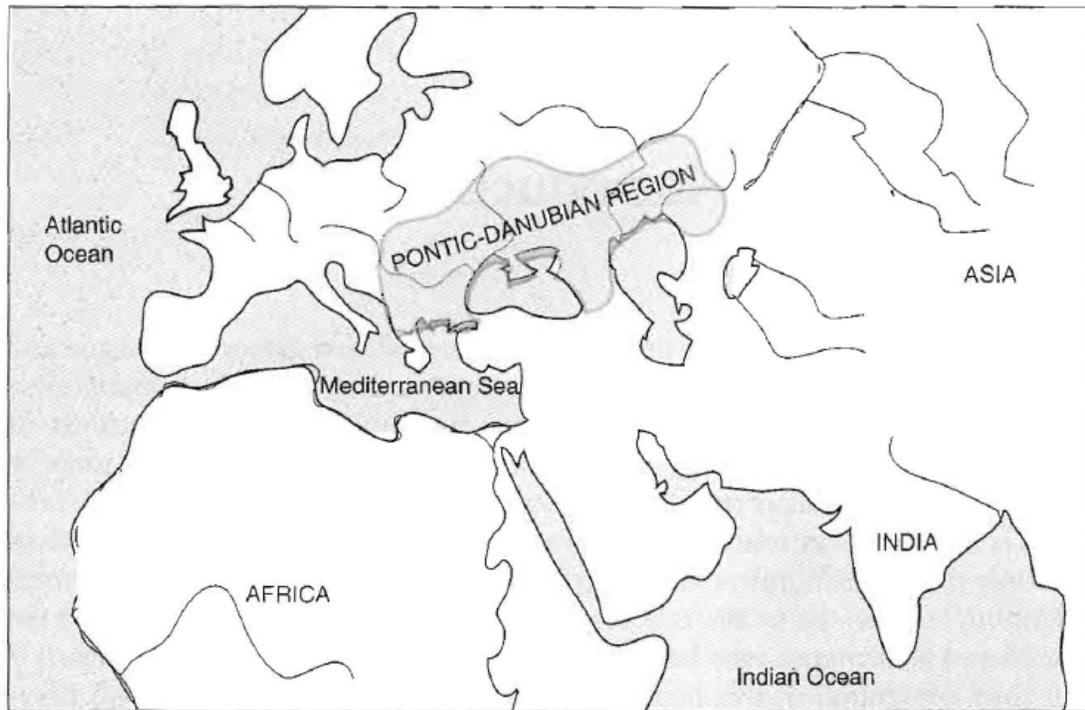


Figure 0.1. The Pontic-Danubian region in its Eurasian context

parts of Europe. Due to its geographical position as the terminus of the central Asian steppes, the area of the Pannonian Plain played an important and unique role throughout prehistory, the Roman era, as well as the medieval period. It was an area through which material and ideas were traded, but on the other hand, was also an area which had to withstand many invasions and witness many wars. As a place of passage for people, goods and culture, it was an area that people of different origins inhabited for various periods of time. Therefore, the Pannonian Plain saw a unique amalgamation of populations by the early medieval period.

In summary, the Plain encompasses a large flat lowland area in Central Europe. This area was referred to by the Romans as Pannonia, named after the Illyrian tribe that inhabited the area during the first millennium B.C. The name was kept throughout the

Middle Ages when no Pannonian-Illyrian tribe existed. On a larger scale, the Pannonian Plain is a part of a greater Pontic-Danubian region, an area of interchange of various cultures throughout prehistory, antiquity and medieval times because of its unique position between Europe and Asia, and north and south Europe. The populations are therefore a unique mish-mash reflecting geography and history. Although all of human populations have their own unique demographic histories, characterized with mixture and fluidity of populations, the Pannonian mixture is taken as an appropriate parallel here because it is known from the archaeological record, and documented in historic sources as a mixture of localized people and new incoming eastern and northern groups. As discussed below, this is further confirmed by the anthropological studies done on the skeletal material from this time period, in the Pannonian Plain.

II. Roman Pannonia

To better understand the power and population structure of the Avar age, it is useful to start with the overview of Roman rule over the western and central parts of the Pannonian area. Some of the aspects of the process of Romanization – the Roman strategy of incorporating the newly conquered territories into the Roman political and cultural sphere – relevant to the population structure in the Pannonian Plain in Avar times, when the crania studied here were deposited, are described. The following sections briefly overview the period of the Roman rule in Pannonia.

1. Roman strategic interest in the Pannonian Plain and its conquest

Rome found its interest in expanding to the territories east of the Apennine peninsula and southeast of the Alps quite early during the Republic's time (Mócsy 1962; Domić Kunić 2006). The Romans recognized the importance of the Pannonian area in terms of its geo-strategic position – communication with and access to Macedonia and Greece, areas under Roman rule from the second century B.C. onward (Cary and Scullard 1979; Domić Kunić 2006). The routes following the Danube, Sava and Drava, three major navigable rivers that cross the Pannonian Plain, were the main communication passages and trading routes for the Roman provinces in the Southern Balkans (Barkóczy 1980). Due to this, it was of crucial importance to enable safe passage through Pannonia. The river network crossing through Pannonia communicated with other navigable rivers of the wider European area, so controlling the Pannonian portion and trading along these river networks was valuable to the Romans. In addition, ancient Greek and Roman sources mention Pannonia as an area rich in natural precious metal and mineral resources (Domić Kunić 2006).

The western part of the Pannonian Plain was subdued and incorporated into the Roman provincial system during the early imperial period (12-9 BC: Mócsy 1962; Barkóczy 1980; around 9 B.C. - Domić Kunić 2006; fig. 3.3). After conquering the area, Rome used the river network of Sava, Drava and Danube as a natural frontier. The Roman *limes*, or frontier zone, enabled Rome to create a buffer zone between the *barbaricum* – territory occupied by the non-subject tribes to the east of Danube – and the Roman Empire itself. Although there were some attempts by the Romans to expand the territory to the plain beyond the Danube, these attempts always proved to be of temporary

duration (Barkóczy 1980). The Danube remained as the border for centuries more, the defense line to the East. Thus, the creation of *limes*, the Roman system of defense outposts and watch towers with legion camps, was established along the Danube – to explore and venture into the barbaricum, and to defend the core of the Roman Empire as well (Lengyel and Radan 1980)¹¹.

2. The local population before and during the Roman rule

Before the Romans came to the scene, the local population was rather mixed, due to many migratory movements sweeping through the Pannonian Plain. As we saw in previous sections to this chapter, the particular location of the plain made it the easiest pathway for communication between western, eastern, and southern Europe. The populations that inhabited this region during the Late Iron Age and pre-Roman times were characterized as Celtic peoples (cca. fifth to first c. B.C.; Wells 1998; Diepeveen-Jansen 2001; Bonfante 2011). Thus, in this area it seems that just prior to the Roman conquest a mix of local Illyrian-Pannonian tribes was intermingled with an older “Celtic” substratum. The last significant Celtic migratory wave occurred more than fifty years before the Roman penetration into this area (Fitz 1980b). Thus, at the beginning of Roman rule over Pannonia, Greek and Roman authors of the first and second centuries A.D. – Strabo (7.5.2), Pliny the Elder (*Historia naturalis* 3.148) and Appian (III 22-24 from Mócsy 1962; Fritz 1980b; Domic Kunić 2006), give an impressive list of tribes present within the borders of the province. Pliny the Elder, for example, mentions many Illyro-Pannonian tribal communities (*Historia naturalis* 3: 146-147 from Barkóczy

¹¹ *Limes* means pathway in Latin. It was not a defensive line in any strategic sense, but a mechanism for cultural penetration of borderlands, and for their control through patronage. See Mattingly (1987) on the Roman frontier.

1980:85) with four larger Celtic tribes – Boians, Taurisci, Eravisci and Scordisci (Fitz 1980b; Domić Kunić 2006). One has to keep in mind that the delineations of these tribes were not at all clear and that lumping together of groups of ‘Illyrian’ and ‘Celtic’ peoples were more a reflection of Roman sources, and not of modern scholars. What we know about these smaller communities is what exists in the reports on the situation during the Roman rule which was colored by Roman ethnographic traditions about barbarity, and by Roman political ambitions. However, archaeologically, it is very difficult to differentiate between these different “ethnic” groups present in the area since the material culture does not support the written record’s emphasis on ethnic distinction. In addition, what is known of the situation in the Roman times is that Romans already divided the territory and therefore any major groups that might have existed into different administrative-geographic regions – to break whatever unity and therefore strength the tribal communities may have had, and prevent any possible revolts in the area (Fitz 1980b). After the Roman take-over, the process of Romanization, or acculturation, of the area began, in order to accelerate the process of cultural and therefore true incorporation of the area into the Roman system (Cary and Scullard 1979; Fitz 1980b). The settlement of Roman administrators and troops in the area was crucial to Romanization, and added to the heterogeneity of the Pannonian province.

The Romanization model for explaining the processes of intercultural changes in the Roman provinces has been criticized and reconsidered in the last few decades (Webster 2001). It is considered too “top-down”, assigning too little agency to ordinary provincial people “on the ground”. However, here it is used to denote the growing presence of a large number of Roman citizens (of various ethnicities and origins) within

the Pannonian territory. Defining this new population is difficult because by the time Pannonia was incorporated into the Roman Empire, the territory of the Empire had already spread considerably over the wide Mediterranean area and “being Roman” was already a heterogeneous identity linked to the fluidity of the peoples within imperial territory. For that reason, defining what is the population structure of the new Pannonian-Roman population is not an easy task, but for the purposes of this work, the important fact is that there was a considerable influx of outsiders into the region, and considerable movement within the region of the “insiders”, already a mixed bunch. In this picture the resettlement of the Roman veterans was an important component, for retired Roman veterans received money and/or pieces of fertile land from the Empire (Fitz 1980a; Pollard 2006), usually close to their last place of service. This added to the mixed population structure present within the Pannonian territory.

3. The internal struggle of the Roman Empire during the third and fourth centuries

Important as the realization of how Roman imperial administration mixed up the demography of the Pannonian Plain is to this dissertation, still more important is the penetration of the Central Asian steppe tribes into the European regions and their accumulation along the frontiers of the Roman Empire, particularly Pannonia. This demands a brief explanation of internal and external Roman politics during the third and fourth centuries (Potter 2006) that led to the streams of tribes coming into the area closer to the Roman sphere of influence from the north and east. As Cary and Scullard note, the migrations would have never seriously jeopardized Rome’s frontiers had not different garrisons during the third and fourth centuries concentrated on and engaged in the game

of making and breaking the emperors (Cary and Scullard 1979; Pollard 2006). Another important thing to point out is the decline in the discipline of the army of the third and fourth centuries (Cameron 1993). Since the beginning of the third century, the frontier military troops incorporated a sizable number of non-Roman citizens into their corps (Ando 2009 from Gibbon 1788). Many of the recruits were Germanic mercenaries who served under their own leadership and in the long run the Germanic leaders grew independent of the Mediterranean centers of command (Pollard 2006). In addition, the owners of the big provincial estates during the third and fourth centuries were obliged to meet military quotas by sending a certain number of people from their estates to obligatory military service. Usually, the owners deployed the least competent of their workforce to meet the obligatory military quota (Cary and Scullard 1979). This practice resulted in parts of Rome's forces reluctant to comply with discipline and rules, which in turn resulted in many recorded military revolts during the course of the third and fourth centuries (Cary and Scullard 1979). In sum, Roman preoccupation with the internal political struggle, and revolts within the army that was part of that struggle, created excellent opportunities for the people Rome called barbarians. The so-called Great Migrations Period saw different steppe and northern tribes pour into the Pannonian Plain, taking advantage of the situation on the limes.

Thus, the western part of the Plain, incorporated into the Roman provincial system during the first century B.C. to serve as a buffer zone between the 'barbarian' territory and Roman imperial territory, gradually lost direct Roman control on this area after the third century. However, Rome, and later Byzantium did control the Plain indirectly, by forming treaties as part of their foreign relations with non-Roman groups

penetrating beyond the Roman frontiers (and under the Rome's auspices). Greek and Roman authors had reported on the different tribes occupying the area during the Roman domination, when Roman citizens (of various ethnicities and origins) settled in the Pannonian area. Towards the end of the Roman rule over this area, many 'barbarian' populations found their way to the heart of the Empire by penetrating the Roman limes along the Pannonian Plain. This changed the population structure of the Plain, and served to introduce more eastern populations of North Europe and Central Asian origins (discussed below in the section on anthropological studies of pre-Avar and Avar age cemeteries) into the area during the early medieval times.

III. The Great Migrations Period – fourth to eighth centuries in the Pannonian Plain

The Great Migrations Period is roughly defined as the period from the fourth to the eighth century (Pohl 1997; Goetz 2003). This time is characterized by the transition or transformation of late antique into early medieval societies. It is witness to the “*decline and fall of the Roman Empire*”, and the formation of new kingdoms that in a sense launched a new Europe. In addition, during this period there were influxes of new populations into the Roman-European territory, several of which entered the European stage by passing through, or even remaining in the Pannonian Plain. All of these conditions justify the choice of early medieval Pannonia as a proper comparative sample, a population from a limited geographic area with demonstrably mixed ancestry, to be juxtaposed to Levantine prehistory.

This section serves to present the information on the Great Migrations Period. First the general information on the onset of the population movements is presented. The

second part details the new populations entering European territory, new populations that contributed to the changing in the Pannonian Plain.

The beginning of this time period is roughly the onset of the already described internal political struggles of the Roman Empire exacerbated by the pressures at the borders created by endless conflicts with the barbarian groups along the Roman frontiers and their penetration into Roman territories. Early classicist scholars were especially interested in this period – attempting to find reasons for, in E. Gibbon’s words, “*the decline and fall of the Roman Empire*” (1788). The eponymous book written by Gibbon and published in six volumes from 1776 to 1788 set the paradigm for the explorations of this period for the following few centuries for researchers who concentrated on explaining how the ‘glorious’ and ‘civilized’ Roman Empire fell victim to the ‘barbarian’, ‘uncivilized’ tribes (Ando 2009).

Only during the middle of the last century were other models proposed for examining the period that witnessed the decline of the Roman Empire and the rise and organization of new kingdoms on the previously Roman territory. The paradigm shifted from Gibbon’s decline and fall to “*the transformation of the Roman World*” (White 1966 in Pohl 1997). The new paradigm of the integration of the Roman legacies with the new non-Roman cultural, ethnic and political components is much more encompassing. At the same time, the previous studies of the non-Roman, ‘barbarian’ ethnicities and organizations gained a more objective outlook, more free from explanations of those communities derived from the ‘Roman’ biased point of view (Pohl 1997).

Despite this shift of paradigms and the new outlook encapsulated by the label “transformation of the Roman World”, which includes important components of both

Roman legacies and the new input of the different non-Roman ethnic groups, the late-Roman period remains a great example of biases in the studies of the ‘others’ (Curta 2008a). Actually, it was the amalgam of different cultural and biological entities that formed the new, medieval Europe. The study of this period serves to show that the picture ‘on the ground’ (or for archaeologists, ‘in the ground’) tends to be much more complex than general explanations of what happens when ‘new’ people and ‘new’ cultures flow into ‘old’ territories (Vida 2007).

There is never a complete replacement of populations, or of thoughts, of traditions, and this is especially true at the level of ‘regular’ people, the commoners. The biggest shifts are seen in the ruling social layer – the ‘nobility’, the ‘warriors’ – the symbols of identity, traditions and origin (Sinor 2005). This is as true for the Romanization process for the newly encompassed territories, where research had been previously focused on the Romanization of the elite within the provinces, and only recently more attention dedicated to the “bottom-up” explorations of the Romanization process (Webster 2001), as it is for the period of the barbarian migrations. In that sense the idea of ethnicity and identity of the people is very interesting to explore.

What is important for this work is that the Great Migrations Period is a time which witnessed significant population fluidity, and considerable influxes of new populations into the territory that would come to be thought of as European. This is one reason why this particular time period is suited to a project about populations of various, different biological ancestries. Moreover, the area of the Pannonian Plain – the area which connects the Asian steppe with European territory – is taken as a great source for

the comparative sample precisely because during the Great Migrations Period it was a melting pot, an area where various populations came together and intermixed.

In this section, it was shown that even before the Roman rule in this area, there were already various groups of different origins present. Most of these groups were of broader “European” origins. During the Great Migrations Period, this area witnessed an accelerated influx in various waves, of different groups, some with deeper (central and possible eastern) Asian origins (discussed below in the section on anthropological studies of pre-Avar and Avar age cemeteries). The following subsection provides the reader with information on these eastern tribes entering Europe, starting at the end of the fourth century. After the general overview of the situation in the fourth and fifth centuries in the Pannonian Plain, the focus is completely turned to the Avars, the tribe of central Asian origin that occupied the Pannonian Plain from the end of the sixth to the end of the eighth century. The comparative sample in this work is mostly from the Avar age cemeteries in the western Pannonian Plain.

1. New populations entering Europe

*“Therefore the Huns, after having traversed the territories of the Alani, and especially of that tribe of them who border on the Gruthungi, and who are called Tanaitae, and having slain many of them and acquired much plunder, they made a treaty of friendship and alliance with those who remained. And when they had **united them to themselves**¹², with increased boldness they made a sudden incursion into the extensive and fertile districts of Ermenrichus, a very warlike prince, and one whom his numerous gallant actions of every kind had rendered formidable to all the neighbouring nations.”¹³ (bold by the author)*

¹² N.B., this is the pattern – people *sign up* to become Huns because there are perceived advantages to being a Hun. Fear of the Huns came from Central Asia.

¹³ “Igitur Huni pervasis Halanorum regionibus quos Greuthungis confines Tanaitas consuetudo nominavit, interfectisque multis et spoliatis, reliquos sibi concordandi fide pacta iunxerunt, eisque adiuti confidentius

Ammianus Marcellinus, *Rerum gestarum libri*, Liber XXXI, Caput III, 1. (*The Roman history of Ammianus Marcellinus*, translated by C.D. Yonge, p. 583)

Ammianus Marcellinus (330-395 A.D., Barnes 1998), one of the last major Roman historians, mentions this event in his portrayal of the history of the Roman Empire. It marks one of the trigger points of the Great Migrations Period. Ammianus, a contemporary but not an eyewitness himself, describes the Huns, a group of steppe people who trace their origin back to Central and East Asian areas (Heather 1995, 2006; Thompson 1996; Golden 2003) at the time of their entrance on the European stage. At the time that Ammianus was writing about them (late fourth century), they had already arrived at the doors of Roman Europe. After crossing the river Volga, they subjugated the tribe of Alans¹⁴, which until then occupied and controlled the area between the lower mouth of the river Don (Tanais) and river Volga. Around 375 A.D., the Huns continued their westward movement by traversing the Don and attacking the Ostrogoths (East Goths), a Germanic tribe drawing their origins from the Scandinavian area from which they descended to the northern shores of the Black Sea in the middle of third century (Golden 2003; Heather 2006).

After the Huns plundered their lands, the Ostrogoths searched for the protection moving westward, towards the Visigoths (West Goths). The Visigoths also fell victim to the attacks of the Huns. To seek protection from the Roman Empire, large groups of Gothic refugees moved toward the Empire's Danube frontier (Cameron 1993). After

Ermenrichi late patentes et uberes pagos repentino impetu perruperunt, bellicosissimi regis et per multa variaque fortiter facta vicinis nationibus formidati.”

¹⁴ Alans refers to a “collective name for groups of Iranian-speaking nomads occupying land north of the Black Sea and east of the river Don in the fourth century” (Heather 2006:461). This is the kind of “weak” ethnic/tribal group that acted in the early Middle Ages. Huns were just like this – groups of people speaking vaguely similar languages held together by polities.

negotiating with the Empire and gaining the status of *foederati*¹⁵, the Goths entered and inhabited the Roman territory. In the summer of 376, it is estimated that two groups with separate leadership crossed the Danube frontier, each comprising some 10,000 warriors (Heather 2006:145). The Goths' entrance into the territory of the Roman Empire was the first event to announce the subsequent arrival of the Huns and the rise of their power in the central Europe, as well as the eventual final fall of the West Roman Empire exactly one hundred years later. Although these two events are separated by one hundred years, Heather (1995, 2006) argues that the first (Goths and Huns on the Danube) is consequential to the second (fall of the West Roman Empire). However, these two events very easily could have nothing to do with each other (Goffart 1989).

The Hun migration demarcated the onset of a series of great movements and commotion typical in the early medieval histories of all the European territories (Batty 2007). Huns crossing the river Don caused a series of westward movements of many tribes who were occupying the region west of the river Don, all the way to the Danube. The appearance of the Huns and the movements that they caused resulted in severe short and long term consequences affecting the Roman Empire and accelerating the pouring of the barbarian populations into the Empire (Pohl 2003). Pohl estimated that between years c. 375 and 410, some 100,000 barbarian warriors entered the area, jeopardizing the Empire (Pohl 2003:572)¹⁶. During the movement of the Goths, some of them were settled in Pannonia in 380 as *foederati* (Vida 2007).

¹⁵ *Foedus* was a treaty that the Roman Empire established as part of their foreign relations with non-Roman groups beyond the Roman frontier. Groups bound by such treatise was known as *foederati* (Heather 1997).

¹⁶ N.B., this is a "maximum" view, and "minimum" ones are just as respectable. The maximum view is supported by Heather (1995, 2006) and Pohl (2003), although there are skeptical arguments by Goffart (1989) and Kulikowski (2002) that support views that "*the barbarian invasions after 370 were neither numerous nor long-lasting*" (Goffart 1989:130 from Pohl 2003).

From the northern shore of the Black Sea, the Huns continued their movement deeper into Europe, and eventually settled within the Pannonian Plain. The Romans lost control over Pannonia in the first decades of the fourth century (Vida 2007), a few decades after the settlement of the Gothic-Hun-Alan groups as *foederati* in this area (Vida 2007). One hundred years later, by 426, the Huns assumed rule over the Pannonian Plain, which they made the heart and center of their power. At the height of their power, the Hunnic Empire controlled a vast territory of Central and Western Europe and controlled the lands north of the Black Sea (Thompson 1996). However, the Hunnic polity quickly dissolved after the death of their most powerful leader Attila in 453 (Bury 1958; Thompson 1996).

After the dismemberment of the Hunnic Empire, other groups assumed rule over the Pannonian Plain. The major groups that took over Roman Pannonia were Germanic tribes of different Scandinavian origins (Bóna 1976). In addition, the Gepids, another Germanic group that controlled the eastern part of the Plain, now with the Huns gone, strived for more power over the Plain (Bóna 1976). Table 3.1 presents the general overview and chronology of major ethnic presences and changes in the western Pannonian Plain during the end of fourth century through the middle of sixth century and the arrival of the Avars.

Table 3.1 Major elements of ethnic changes in Pannonia during the late fourth to middle of seventh centuries. Taken from Vida 2007:320

380 - 426 A.D.	Various peoples fleeing the Huns arrive at the Carpathian Basin; in Pannonia, they live side-by-side with the remnants of late Roman population
426 - 454	Hun rule, the fading of Roman traditions
454 - 473	Gothic rule in southern Pannonia
473 - 510	Suevian and Herul ¹⁷ rule in Pannonia
510/526 - 568	Arrival and settlement of the Langobards ¹⁸ in Pannonia
568 - 650/670	Arrival and settlement of the Avars in the Carpathian Basin

Along with the Huns, different groups of Germanic origins (or Germanic-speakers; presented in the table above) were major elements in the Pannonian Plain during the fifth and sixth centuries. After the fall of the Western Roman Empire, Byzantium continued to use strategies of forming treaties with these people, protection of Byzantium with the land under indirect control of Byzantium (such as the Pannonian Plain) in exchange. Procopius mentioned Langobards and Gepids as having lived within the Roman territory since the Gothic wars and controlled it to some extent (Pohl 1997b). Pohl mentioned that in practice, although having a treaty with the Byzantium, different groups in the Pannonian Plain evaluated their own power balance amongst themselves until 565 A.D. when Byzantine emperor Justin II stopped all the payments to Avars, Gepids and Langobards (Pohl 1997b:132).

To summarize, the Great Migrations Period is roughly defined as a period from the fourth to the eighth century. This period has been witness to the decline and fall of the Roman Empire and the Great Migrations Period during which influxes of new populations into the European territory occurred. Before the emergence of the Avars, the

¹⁷ Suevi is a term used for a 'tribe' of Germanic origin that was present in the Pannonian Plain during the fifth century (Heather 2006:195). Heruls are another Germanic 'tribe' present in the Plain during the fifth century (Heather 2006:330).

¹⁸ Langobards are a 'tribe' of Germanic origins (Christie 1995, Jarnut 2003).

Pannonian Plain was inhabited by a mix of populations present in the area since the beginning of and during Roman rule. During the course of the fifth and the sixth centuries the complexity of the Pannonian population structure was enriched by incoming Hunnic and Germanic ethnic groups.

Important point to make here is that the antique groups, or “tribes”, are not to be considered like water-tight reservoirs of population that move in concert. These groups were short-lived federations of clans, based on the prestige of a leader and his credibility in promising benefits for members of the group. It was easy to join these tribes, regardless of where they come from. None of the groups mentioned above, such as Huns and different groups of Germans, were homogenous populations. Many of the groups that inhabited the Pannonian Plain during the fourth to sixth centuries are labeled as Germanic peoples. However, as Goetz (2003:7) pointed out

“we are not even sure any more what “Germanic” really means. The Germani of the Roman sources seem to be a Roman construction (and, moreover, the term was not used very frequently), and there are no signs of a “Germanic” self-conception among the “barbarian” peoples which the Romans considered (or we think) to have been “Germanic”. In other words, the “Germanic” peoples did not conceive themselves as being “Germanic”, or at least did not attach any importance to this feature. The term can be defined, of course, in terms of language, but with regard to the early period we have little knowledge of the language spoken by those peoples which, according to Reinhard Wenskus, were conglomerations of different communities anyways.”

The most important point is that these formations were, as quoted above, *conglomerations of different communities*, and in that light it is plausible that these groups were very heterogeneous groups of different geographic provenance.

IV. The Avars and the Avar period in the Pannonian Plain

Most of the kingdoms that emerged in different parts of Europe after the fall of the Roman Empire, although “barbarian” (at least in terms of the ruling elite), followed to some extent the centuries-old Roman political models. In order to successfully maintain power, the ruling elite chose to incorporate Christianity, an important tool of their power system that conciliated Christian populations already present in the areas. The barbarian kingdoms also maintained the pre-existing Roman infrastructure, and retained the same means of communications that the Empire used (Pohl 2003). However, the Pannonian Plain was one stage where these rules of post-Roman polities were not followed. One reason for this “exceptionalism” was that the powerful kingdom formed by a ruling elite in Pannonia was the Avar khaganate (568-c.800; Pohl 2003).

The following section is focused on explaining the population structure in the Pannonian Plain during the Avar age (568-c. 796 A.D.) because the majority of the crania in the comparative sample come from this time period. In order to properly explain the complex population structure in this particular area during that time, it is necessary to briefly describe Avar origins, the question of Avar ethnicity, and the groups under Avar rule. In addition, a brief historical overview, together with the material culture retrieved from the archaeological excavations, is presented to better understand the provenance and context of the comparative sample.

The Avars were a group of horse-riding warriors originating in the Central Asian steppe lands (Pohl 1988). Their westward movement, toward the Pannonian Plain, was apparently propelled by the conflict with a more powerful steppe tribe of Turkic origin. It is reported in the writing of Byzantine historiographers that in the middle of the sixth

century Avars crossed the Volga and therefore entered Europe as it is understood in classical geographical terms. In their advances toward Byzantium and the Balkans, many groups that they subjugated on their way joined them in their movements, as was typical of all barbarian movements. Finally, in 568 they started to settle in the territory of ex-Roman Pannonia¹⁹. They organized a powerful khaganate and controlled the Pannonian Plain and much territory south and east of it until the end of the eighth century, when the Frankish army defeated the khagan and eradicated Avar power. The following section is dedicated to describing the appearance, origins, history, archaeology and anthropology of the Avars in more detail.

1. The appearance of the Avars

“One Kandikh by name was chosen to be the first envoy from the Avars, and when he came to the palace he told the Emperor of the arrival of the greatest and most powerful of the tribes. The Avars were invincible and could easily crush and destroy all who stood in their path. The Emperor should make an alliance with them and enjoy their efficient protection. But they would only be well-disposed to the Roman state in exchange for the most valuable gifts, yearly payments and very fertile land to inhabit. Thus spoke Kandikh to the Emperor.”

Menander Protector, *History*, Fr. 5,1,
Translation from Blockley 1985:49

This excerpt, written by Byzantine historian Menander Protector, describes the arrival of the Avars in vicinity of Byzantium, and their first diplomatic envoy to the emperor Justinian at his palace in Constantinople, in January of 558 A.D. (Pohl 1988). The emperor, old and abandoned by his previous warlike spirit (Menander Fr. 5,1 from Blockley 1985), accepted the Avar proposal and their protection. Justinian decided to

¹⁹ This tidy date (568) is based on the supposition that Pannonia had recently been evacuated by the Lombards, who settled in Italy in 567-568.

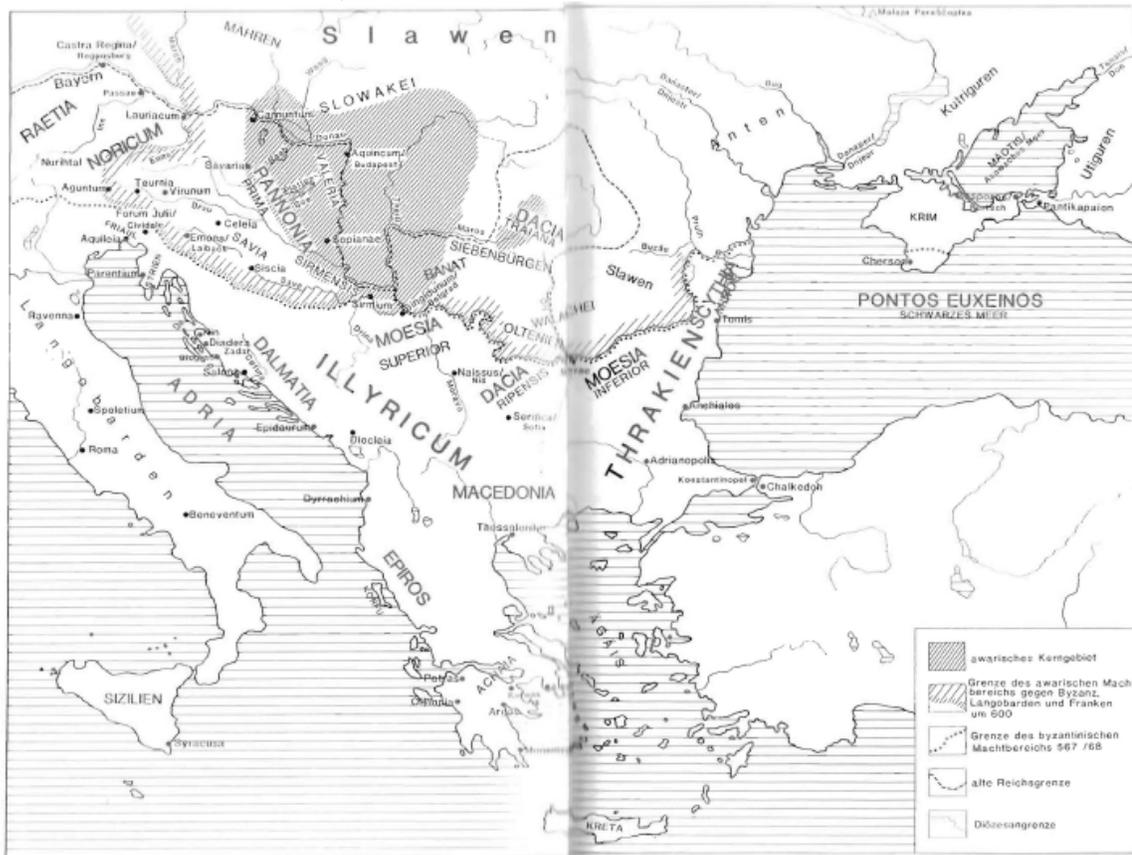
‘fight’ the arrival of yet another barbarian tribe by using them to fight off the other steppe tribes endangering the borders of the Byzantium (Louth 2008a). He immediately

“... sent the gifts: cords worked with gold, silken garments and a great many other objects which would mollify the arrogant spirits of the Avars. In addition, he sent an ambassador Valentinus, one of the imperial bodyguards, and he urged the tribe to make an alliance with the Romans and take up arms against their enemies. This [...] was a very wise move, since whether the Avars prevailed or were defeated, both eventualities would be to the Romans’ advantage. When Valentinus arrived at his destination, presented his gifts and delivered the Emperor’s message, the Avars first crushed the Unigurs, then the Zali, a Hunnic tribe, and they also destroyed the Sabirs.”

Menander Protector, History, Fr. 5,2
Translation from Blockley 1985:49-50

Thus the Avars entered the European stage and remained a strong presence for over the next two centuries. The alliance that Justinian established upon the first diplomatic contact with the Avars had later led to the Byzantine’s loss of most of its provinces on the Balkan peninsula (Pohl 2003). The rise of Avar power came along with the establishment of a khaganate, powerful centralized, personal leadership of the khagan. The center of the khaganate was located within the Pannonian Plain (fig. 3.4). The following sections of this chapter serve to describe the settlement of the Avars in the Pannonian Plain. The information on the Avar origins and their history, known from the Byzantine historians and other medieval chronicles, are presented. Following that is the explanation of who the Avars were once they are settled in the Pannonian Plain. Some of the issues of Avar ethnicity are examined with Avar archaeology to which a few paragraphs are dedicated. Finally, anthropological studies of the Avar age skeletal remains during the twentieth century are presented.

Figure 3.4 Map of the area of the Pannonian Plain under the Avar rule (in stripes; taken from Pohl 1988).



2. Who were Avars?

Originally, the Avars seem to have been a nomadic group from the central Asian steppes (Pohl 1988, 2003; Batty 2007). But like all ethnic groups, they evolved over time. The Pannonian Avars of 568 to c. 800 A.D. were not the same as their central Asian ancestors.

What is known of the Avar origins is what is recorded in the chronicles of their enemies. The most informative excerpts concerning the Avar origins were written by the Byzantine historiographers Menander Protector and Theophylact Simocatta (Pohl 1988). Byzantine sources consistently refer to this group as *Avari* or *'Αβαροι*. However, both

Menander Protector and Theophylact Simocatta report that to the other central Asian populations, Avars were known as *Varchonitai*. This can be interpreted as a contraction of two other tribal names – *Var* and *Chunni* – which could be an indicator of the heterogeneity of the Avar group from the start (Pohl 1988, 2003). One of the most informative passages on the Avar origins was in the writings of Theophylact Simocatta (written around 640 A.D., Whitby and Whitby 1986). The passage, however, created significant disputes about their origins because of its openness to different interpretations. This passage is quoted below, to help better understand how groups of the early medieval period were formed.

“[The Turks, after victory over the Hephtalites,] enslaved the Avar nation. But let no one think that we are distorting the history of these times because he supposes that the Avars are those barbarians neighbouring on Europe and Pannonia, and that their arrival was prior to the times of the emperor Maurice. For it is by a misnomer that the barbarians on the Ister [Danube] have assumed the appellation of Avars; the origin of their race will shortly be revealed. So, when the Avars had been defeated, some of them made their escape [to different places. Next, the Turkish khagan subdued the Ogurs,] one of the strongest tribes on account of its large population and its armed training for war [...] The earliest leaders of this nation were named Var and Chunni; from them some parts of those nations were also accorded their nomenclature, being called Var and Chunni. Then, while emperor Justinian was in possession of the royal power, a small section of these Var and Chunni fled from the ancestral tribe and glorified their leader with the appellation of khagan. Let us declare, without departing in the least from the truth, how the means of changing their name came to them. When the Barselt, Onogurs, Sabir, and other Hun nations in addition to these, saw that a section of those who were still Var and Chunni had fled to their regions, they plunged into extreme panic, since they suspected that the settlers were Avars. For this reason they honoured the fugitives with splendid gifts and supposed that they received from them security in exchange. Then, after the Var and Chunni saw the well-omened beginning to their flight, they appropriated the ambassadors’ error and named themselves Avars; for among the Scythian nations that of the Avars is said to be the most adept tribe. In point of fact even up to our present times Pseudo-Avars (for it is more correct to refer to them thus) are divided in their ancestry, some bearing the time-honoured name of Var while others are called Chunni.”

Pohl interprets Theophylact's account as having valuable credentials and a good description of how Central Asian steppe power groups were formed (2003). The account is in accordance with a few principles that are characteristic of the steppe groups as recorded in later accounts. First of them was that westward movement of steppe groups that later became powerful in Eastern and Central Europe had been prompted by the conflict and loss of power in struggles with other neighboring and conquering groups in Central Asia. Second, a powerful leader, or khagan, and compliance with his expansionist strategy and authority, was crucial for directing the newly-formed groups into new areas. Third, whoever complied with the power and the leadership of the khagan therefore became part of the group, and complied with its 'ethnic' identity. This means that groups of different cultural and/or biological origins were united under the power of the khagan. The name *Avars sensu stricto* was reserved for the warrior elite tightly formed around the khagan (Pohl 2003:578). However, more broadly it encompassed the people who acted together politically with the Avars or the descendants of the Avar elite. Finally, giving a name that will stand for this amalgam of people united under the power of the khagan is of great importance. The name was usually chosen (or imposed by others on the designated group) from one of the previously known, prestigious and honorable names. However, this did not mean that the new bearers of the name share a common descent from the original name bearers. The new name served as a signifier of the chosen self-identification and also signifier to the others what the new group stands for (Pohl 1988, 2003:577-588).

3. The question of Avar ethnicity and various peoples under the Avars

The Avars who started their westward movement, after a defeat by a powerful Central Asian tribe of Turkic origin, were composed of various Central Asian groups who complied with the power of the khagan and his circle of loyal warriors. No matter what the ethnic origins of all the components of the newly formed group were, once they followed the khagan, they were seen as Avars and presumably saw themselves this way too. It seems impossible to pin-point the exact origins of the Avar formation (if such a thing exists), because, as it was described above, the groups were not based on the issue of common descent but on their common interests and actions. Thus Avars were a process, never a fixed entity. Therefore, the notion of ethnicity in the early medieval time is as complex as the modern understandings and definitions of ethnicity (Pohl 1991, 1998, 2003; Gillett 2006; Curta 2007). No generalizations can be applied to the early medieval notions of ethnicity, although a considerable number of earlier publications (and historiographies written in the late antique and early medieval times) tends to oversimplify those notions. Pohl's position on the notion of ethnic belonging in the early medieval times is that (2003:586):

“Even in early-medieval western Europe, ethnic groups were not peoples in the modern sense, well-delineated units that integrated societies from top to bottom; for steppe peoples, such a notion would be totally inappropriate. Still, ethnic identity formed a fundamental part of the political language, and was also used to define power and those who held it on every level.”

By explaining the westward advancement of the Avars, it will be clearer how the Avars were joined by other different groups on their march from a Central Asian location, along the northern Pontic shores and into the Pannonian Plain.

At the end of 550s A.D., the Avars crossed the river Volga, penetrating into the area stretching from Volga to river Don. This area was then under the control of Bulgars, Sabirs and Ogurs²⁰, but the Avars defeated them and occupied this zone (Bell-Fialkoff 2000). The westward movement of the Avars continued, now encompassing some of the defeated peoples under the Avar aegis. By this time, significant numbers of subdued people - the Cutrigurs, Utigurs, Zaloi, Sabirs, Antae and others (Pohl 2003:578) – joined the Avars at their westward advances (Pohl 1988; Bell-Fialkoff 2000). In addition, Theophylact Simocatta reports that more Central Asian tribes – Tamiach, Zabender and Kotzagir – decided to join the khagan, each tribe contributing 10,000 men to the Avar warrior mass (Theophylact Simocatta 7,8 from Pohl 2003:578). Not all of the groups that joined the Central Asian Avars on their way west simply became the Avars. The delineation and recognition of some of the groups (recognized by sharing different language or closer ‘provenance’) under the Avars were kept, but many of the names of the groups that joined the Avars disappeared by the end of the sixth century (Pohl 2003:579). Two important groups that were somehow distinct under the Avars were the Bulgars, and the Slavs. However, who exactly these ‘distinct’ groups like Slavs and Bulgars were and how they were distinguished from the other peoples within the Avar organization is still a much debated issue (Curta 2001)²¹. What is certain is that the movements and dispersals from the northern Pontic areas of people who spoke Slavic

²⁰ All the groups mentioned are of supposedly Turkic origins, with major of their population components originally coming somewhere from Central Asia. The same goes for the groups which name ends in *-gur* (Pohl 2003, Bell-Fialkoff 2000).

²¹ There is no evidence of any “ethnic” differentiation as a conscious identity among these groups at this time. Slavic-speakers did not exist in ‘tribes’ (as far as we can tell now) until the 700s (Curta 2001). However, Pohl (2003) distinguishes people like Slavs and Bulgars as distinct “ethnic” groups under Avars, although it is not apparent how these are distinguishable (and based on which criterion) from the other peoples under the Avar political leadership.

languages were propelled by the Avars' movement westwards (Pohl 2003; Curta 2001; Zimonyi 2005).

As already mentioned, as soon as the Avars came to a closer proximity with the Byzantine Empire, they negotiated with Byzantium and gained the status of their protectors against pressures of other barbarian tribes on the Byzantine borders (Louth 2008a). In effect, Byzantium revived the old Roman *limes* policy of controlling barbarians across the frontier by diplomacy. Therefore the Avars, in exchange for yearly high payments from Constantinople, controlled the area along the left banks of Danube, serving as the buffer zone for Byzantium. With the rise of the powerful khagan Baian, one of the few khagans known under his actual name and not solely referred to in the writings of the historiographers as khagan, the Avar ambitions and expansionist strategy grew bigger. The khagan demanded that the Byzantium allow the Avars to settle south from the Danube, therefore penetrating into Byzantine territory (Bell-Fialkoff 2000). Byzantium refused the khagan's request, turning the Avars over to seek other areas to occupy. At that time, the tribe that was in control of Pannonia were the Longobards, a tribe of Germanic origins (Christie 1995; Jarnut 2003) who helped Byzantium fight off another Germanic tribe in Pannonia, the Gepids (Bóna 1976). Longobards controlled the western part of the Pannonian Plain, and Gepids ruled over north-eastern parts. In 567, the Avars and Longobards united their forces to fight against the Gepids (Bell-Fialkoff 2000; Louth 2008a; Moorhead 2008). After they defeated the Gepids, the Pannonian Plain was under joint Longobard and Avar control. However, in 568 A.D., the Longobards left the Pannonian Plain to migrate southwest, settling in the northeast region of the Apennine peninsula, and forming a powerful kingdom there (Pohl 1988). Once the

Longobards left, together with a minority of the defeated Gepids, the Avars were left in possession and control of the western Pannonian Plain.

As already mentioned, the amalgam of people who dominated the Pannonian Plain from 568 A.D. under the leadership of the Avar warrior elite was comprised mostly of Bulgars and Slavs (Salamon and Sós 1980; Pohl 1988, 2003). However, after the Avars entered the Plain, the people who were previously settled there continued with their lives under the new masters. Therefore, the population of the Avar khaganate included the warrior and ruling Avar elite from the Central Asia, groups of Bulgars, Slavs, Germanic-speakers (most specifically the Gepids and some remnants of the Longobards), and the Romanized population (Salamon and Sós 1980; Pohl 1988, 2003; Daim 2003; Vida 2008). This is the population from which the comparative sample in this study was mostly taken.

This complex picture derived from more or less contemporary written sources is affirmed in the legacy of different archaeological material dating from the Avar age of the Pannonian Plain. Moreover, the anthropological studies of numerous excavated skeletal materials retrieved from a number of Avar age large cemeteries (over 60,000 retrieved graves! of Avar age – Pohl 2003; Daim 2003) confirm the complex population origins and structure in the western Pannonian Plain. In the next section, a brief overview of the anthropological studies done on the pre-Avar and Avar age cemeteries is presented.

4. Anthropological studies of pre-Avar and Avar age cemeteries

The great heterogeneity of the population in the Pannonian Plain during the Avar age is confirmed by many anthropological studies (Bartucz 1950; Lipták 1951, 1955,

1956, 1957b, 1959, 1963, 1970, 1983; Bártai 1952; Wenger 1952, 1957, 1972, 1977; László 1956; Finnegan and Marcsik 1979; Ferencz 1981, 1986, 1991; Farkas and Hunya 1984; Éry 1992; Fóthi 2000; Bernert 2003, 2005; Varga *et al.* 2003a, 2005; Évinger and Bernert 2005). These studies confirm that during the Avar age period there was an influx of peoples of eastern origins (Farkas and Hunya 1984; Ferencz 1981, 1986, 1991; Fóthi 2000; Lipták 1959, 1983; Wenger 1972). Lipták (1983:13) reported that among the skeletal remains of the Pannonian Plain one can find representatives of nearly the whole of Northern Eurasia. These authors, based on the frequency of the occurrence of certain cranial morphological features emphasize the Central Asian provenance of considerable number of individuals in the Pannonian Plain during the pre-Avar and Avar age.

The Hungarian anthropologists since early twentieth century dedicated much time to the explorations of the ancestral provenance of the people occupying the Pannonian Plain. This was aided by the fact that the Avar age left us with particularly large cemeteries that were excavated by Hungarian archaeologists in great detail (Daim 2003; Pohl 2003). The reason for such interest in this age is because of the explorations of where the Hungarians are from – Magyars who are traditionally thought to appear in the Pannonian Plain in 896 A.D. (Róna-Tas 1999). Based on the historical resources and linguistic particularities of the Hungarian language, it was known that the Magyars came from Central Asian area (Róna-Tas 1999). Thus the Avars were considered by modern Hungarians a kind of proto-Magyar, who could fit into modern narratives of nation-formation.

The majority of the work of Hungarian anthropologists typologized the crania found in the Pannonian Plain (Fóthi 2000). Although typologization is an

oversimplification of human variation due to the fact that it focuses on averages and ignores the range of variation (Saunders and Rainey 2008), the abundance of typological studies of the skeletal material is of great help in this dissertation. Those studies have implications for the general ancestral provenance of some of the characteristic morphological features that appear in the Pannonian Plain crania. There is a substantial magnitude of variation among individuals within any given population (Edgar and Hunley 2009). Nonetheless, the frequency of occurrence of some morphological characteristics is greater among people that more frequently exchange their genes, i.e. people who live in proximity to each other, even if the same morphological characteristics can occur in any other population, due to gene flow. It follows that based on the frequency of the occurrence of certain morphologies patterns of geographic provenance can be explored.

Of course, categorizing the cranial material based on the specifics of their morphologies naturally cannot reflect the culture, beliefs, or thoughts of the individuals in question, or tell us anything about how they would personally identify themselves, or their cultural life history. Having said this, the author maintains that the immense body of research done in Hungary on the typologization and the exploration of provenance of these types is helpful in this dissertation about Levantine skeletons because it furnishes evidence of the morphological heterogeneity of the population present in Pannonia during the early medieval period.

To summarize, the Avars were a group of horse-riding warriors coming from the Central Asian steppe lands. The Avars were composed of various Central Asian groups who complied with the power of khagan and his circle of warriors. As they moved

westward, various other groups, of various ethnic and geographic origins joined the Avars. In the middle of the sixth century, the amalgam of various groups under the Avars started to settle the western part of the Pannonian Plain, therefore occupying the ex-territory of Roman *Pannonia*. Once settled in the Plain, the Avars ruled over and incorporated the groups previously present in this area. The population of the Avar khaganate included the warrior and ruling Avar elite from the Central Asia, the Bulgars, the Slavs, Germanic groups (most specifically the Gepids and some remnants of the Longobards), and the Romanized population. The Avars remained a strong presence and power in this area for the following two centuries. Numerous anthropological studies done on the abundant number of Avar-age graves from the western Pannonian Plain attest the biological heterogeneity of the populations occupying this area from the sixth to end of eighth century.

V. Conclusion

This chapter served to present the general background for the source and context from for the comparative sample for this dissertation. This comparative sample consists of pre-Avar and Avar age skeletal remains. This particular sample was used because there are historical, archaeological and anthropological data that to show the Pannonian Plain, in the early medieval times (roughly fourth to eighth century A.D.) was home to populations of demonstrably heterogeneous origins.

In order to provide an adequate background for understanding the context of the comparative sample, a general history of the Pannonian Plain was sketched. The Plain encompasses a large lowland area in Central Europe, referred to by the Romans as

Pannonia, named after the Illyrian tribe that inhabited the area during the first millennium B.C. The name was kept throughout the Middle Ages. On a larger scale, the Pannonian Plain is a part of a greater Pontic-Danubian region which was witness to the arrival and interchange of various cultures throughout the prehistory, antiquity and medieval times. Since the Roman rule changed the population structure of the area, a considerable part was dedicated to explaining how this took place. The western part of the Plain was incorporated into the Roman provincial system during the first century B.C. to serve as a buffer zone between the 'barbarian' territory and the Roman Apennine peninsula. Greek and Roman authors offer valuable reports on the population structure of different tribes occupying the area shortly after and during the Roman conquest.

Roman conquest, however, changed the population structure by bringing Roman citizens (of various ethnicities and origins) into the Pannonian area. Towards the end of the Roman rule over this area, due to the internal and external struggle of the Roman Empire, many 'barbarian' populations were finding their way towards the heart of the Empire by penetrating the Roman borders through the Pannonian Plain. This changed the population structure of the Plain again, and served as the first wave of more eastern populations of Central Asian origins coming into the area during the early medieval times.

The "decline and fall" of the Roman Empire and its rule over the Pannonian Plain coincided with the onset of the Great Migrations Period. During this period, influxes of new populations into the European territory occurred even if they are hard to quantify. The complexity of the population structure was increased by presence of populations new to this area, many of which were of Central Asian and northern European origins. Of the

particular importance is the arrival of the Avars and their presence in the Pannonian Plain, as they make the most part of the comparative sample used in this dissertation.

The Avars were composed of various Central Asian groups who complied with the power of khagan and his circle of warriors. As they move westward, various other groups, of different ethnic and geographic origins, joined the Avars. In the middle of the sixth century, the amalgam of various groups under the Avars started to settle the western part of the Pannonian Plain, therefore occupying the ex-territory of Roman *Pannonia*. Once settled in the Plain, the Avars ruled over and incorporated the groups previously present in this area. Therefore, the population of the Avar khaganate included the warrior and ruling Avar elite from the Central Asia, the Bulgars, the Slavs, Germanic groups (most specifically the Gepids and some remnants of the Longobards), and the Romanized population.

The Avars remained a strong presence and power in this area for the following two centuries. Numerous anthropological studies done on the abundant number of Avar-age graves coming from the western Pannonian Plain all attest to the significant biological heterogeneity of the populations occupying this area from the sixth to end of eighth century. This is why the skeletal remains from the cemeteries of pre-Avar and Avar age make an ideal comparative sample to explore what we know about variation (how unusual or not unusual it is) when faced with a heterogeneous population of mixed geographic origins.

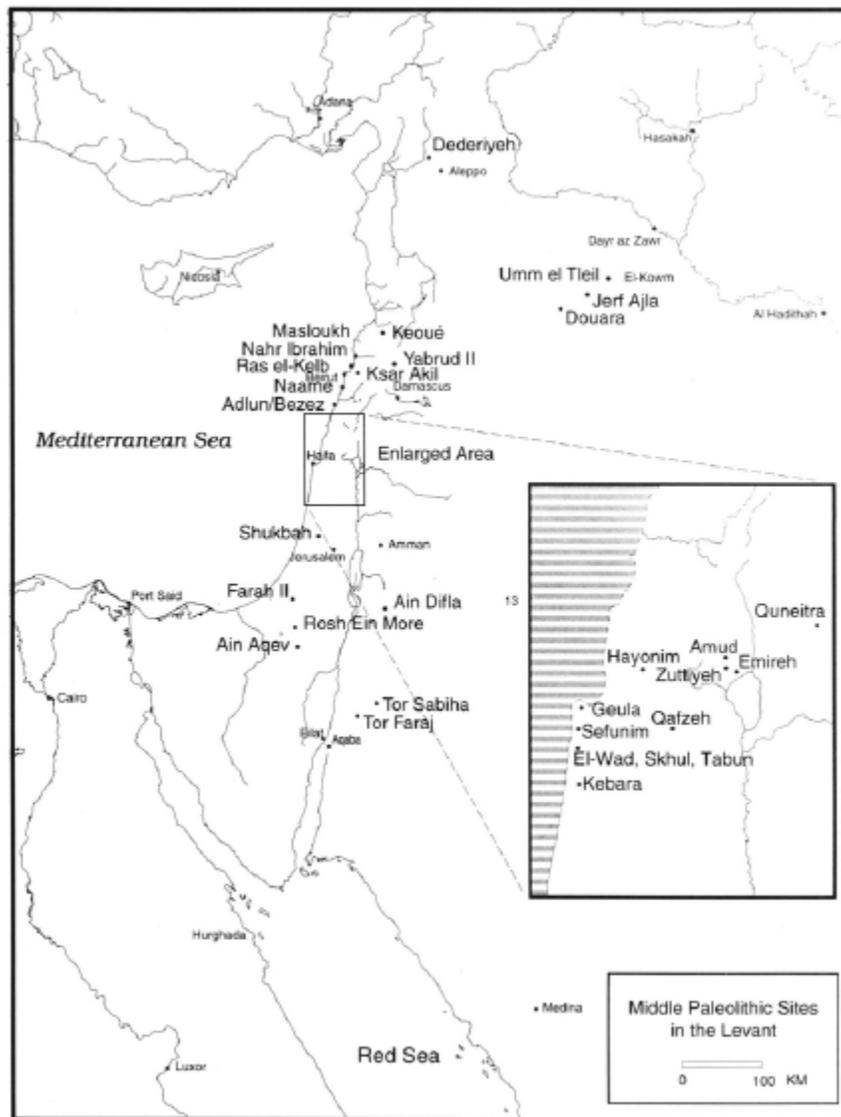
Chapter 4

Material

The Levant presents us with Late Pleistocene sites either yielding crania of Neandertal-like hominids, alternatively referred to as archaic humans, or with sites yielding ‘modern human’ remains (fig. 4.1). The sites that are traditionally said to contain the Neandertal-like specimens are Tabun, Israel (McCown and Keith 1939), Kebara, Israel (Bar-Yosef and Vandermeersch 1991a), Amud, Israel (Suzuki and Takai 1970; Rak *et al.* 1994), Dederiyeh, Syria (Akazawa *et al.* 1993, 1995), and Me’arat Shovakh, Israel (Trinkaus 1987). The sample traditionally considered to be modern human from this area is composed of the remains from Qafzeh, Israel (Neuville 1934; Vandermeersch 1981) and Skhul, Israel (McCown and Keith 1939). Human remains from three other sites in the Levant – Hayonim, Israel (Arensburg *et al.* 1990), Shukbah, Israel (Keith 1931), and Ksâr ‘Akil, Lebanon (Ewing 1956, 1963) – are too incomplete to attribute the remains to either of these two traditional appellations (Trinkaus 1995).

Crania from four cave sites are appropriate for the research in this dissertation (fig. 4.2). The choice was dependant on the completeness, number of cranial remains, and the state of preservation of hominid cranial material. The four sites are Skhul, Tabun, Qafzeh and Amud. They are all located in close proximity to each other, and are all confined to the geographic area of the Southern Levant.

Figure 4.1 Middle Paleolithic sites in the Levant area (taken from Bar-Yosef 1998:40).



The purpose of this chapter is to present the description of the nature and context of the Levantine Late Pleistocene and Pannonian Early Medieval sites where the crania used in this dissertation come from. The first part presents the reader with the particularities and context of the human fossil finds from the four Levantine cave sites that are the focus of this dissertation. All the material found in association with the human remains, together with information such as the locations of the cave sites and their

local environments during the Late Pleistocene, are crucial in reconstructing the behavior and culture of Late Pleistocene populations. However, because the scope of this dissertation is to focus on the morphological variation that these human remains exhibit, the purpose here is to provide sufficient background for understanding the time of occupation and the context of human skeletal remains found, and basic information on the material culture found in association with the human remains. The second section of this chapter is where the hominid cranial material appropriate for testing the hypothesis is listed.

The third section of this chapter is dedicated to the archaeological context and provenance of the cranial material from the Early Medieval Pannonian sites. In the previous chapter, the reader was informed of the general historical context of the Pannonian Plain in Early Medieval times. Here, the information on the general overview of Avar-age archaeology is presented, as well as its chronology. Finally, the list of the sites, where the one hundred crania in the comparative sample come from, is provided.

I. Levantine sites

Four of the Late Pleistocene Levant sites yielded human fossil remains appropriate for testing the null hypothesis in this dissertation. The four sites are Skhul, Tabun, Qafzeh and Amud (fig. 4.2). Tabun and Skhul are located within the same wadi, Wadi el-Mughara (Nahal Mearot), overlooking the Mediterranean coast line from the slopes of the Mount Carmel, located in northern Israel, some 20 km south of Haifa. The Qafzeh cave is located within the Wadi el Haj, in the vicinity of the modern city of Nazareth, some 25 km southwest from the Sea of Galilee. The cave site Amud, located

within the eponymous wadi, is located northwest from the Sea of Galilee, in the Upper Galilee region of present day Israel. These four cave sites are therefore confined to a small area of the Southern Levant.

In this section, each of the four sites yielding fossil crania used in this research is presented. First, the Mount Carmel sites, Tabun and Skhul, are presented because they were first to be excavated and the ones that raised the question addressed in this research. Second, Qafzeh cave is presented, and last, the Amud cave details. The general template for presenting the sites is as follows – general description of the location, stratigraphy of the site, archaeological (cultural) material, and context of the human fossil remains location within the strata. At the end, the absolute dating age results for the layers containing the human fossil remains are presented.

Figure 4.2 Map of the Levantine area, with the locations of the four Late Pleistocene cave sites yielding human fossil remains. Taken from Gibbons 2010:681. Represented in squares are ‘Neandertal’ sites, and in circles ‘anatomically modern human’ sites.



1. Excavations and finds of the Mount Carmel sites

The following section presents the information on the excavations and findings of the Mount Carmel cave sites – Tabun and Skhul. These sites are located within the Wadi el-Mughara, some 150 m apart. They were the first of the Late Pleistocene Levantine sites yielding human fossil remains to be excavated. First, the excavations and discoveries made at Tabun is presented, after which the same is done for Skhul. At the end of this section, general remarks pertaining to both of these sites are set forth.

a. Tabun

Tabun (originally Et-Tabūn) is one of the caves located within Wadi el-Mughara, on the slopes of the Mount Carmel in the northwestern part of Israel. Et-Tabūn (‘the oven’) was excavated for five seasons by Dorothy Garrod and her coworkers (1929, 1931-1934; Garrod and Bate 1937). The maximum thickness of the strata present at the cave was 24.5 m, but due to the steep slope of the deposits within the cave and the ones coming out beyond the mouth of the cave, this thickness was never present at a single vertical section (Garrod and Bate 1937:57). During the campaigns, sequence of seven general layers was established by the excavators, spanning from Tayacian as the oldest to Bronze Age and Modern period as the most recent layer.

Before going into the description of the archaeological layers, there is an issue of slumping, which has affected assessment of the provenance of the Tabun remains and the chronology of the excavated layers at the Tabun cave. Slumping, caused by sinkhole activity, and chemical dissolution and stratigraphic layer collapse, is a general concern at the Tabun cave (Garrod and Bate 1937; Goldberg 1973; Jelinek *et al.* 1973; Ronen and

Tsatskin 1995; Albert *et al.* 1999; Rink *et al.* 2004). The slumping due to sinkhole activity was dramatically affecting the layers, which made them a challenge to dig. If the changes in the layers and the effect of the sinkhole activity were not recognized immediately during the excavations, a mixture of archaeological material coming from different layers makes it a challenge to interpret later. The mixture of stone tool assemblages can potentially be separated by their typological differences (however, this can also in some cases be problematic), but it would be more difficult to assess the provenance of human skeletal material from deposits affected by slumping (Garrod and Bate 1937; Bar-Yosef and Callander 1999). Moreover, slumping due to chemical dissolution (various depositional components and post-depositional chemical changes; e.g. Weiner *et al.* 2002), has more subtle stratigraphic effects, but it directly affects the apatite in the bone remains. The mobilization of bone apatite due to chemical dissolution therefore subtly skews the results of electron spin resonance and thermoluminescence absolute dating.

The slumping issue most dramatically affected lower layers of the Tabun cave. The lower units F and G (Acheulean) show slumping into the sinkhole at the base of the Tabun chamber (Garrod and Bate 1937; Ronen and Tsatskin 1995). This would have occurred with sea-level drop or tectonic uplift back in the early Middle Pleistocene. The most dramatic changes due to slumping can be seen in Garrod's Acheulean layers F and G, and parts of layer G that are nearly vertical. However, slumping does not represent a great issue for the human fossil remains, which come from younger layers of Tabun cave, although it does subtly influence absolute dates of the human fossil remains (A. Stutz, pers. comm.). Nonetheless, although the tilt of the beds is less severe in layer C, they are

far from horizontal, thus establishing the provenance of the skeletal remains remains somewhat problematic.

After clarifying the slumping issue pertaining to the archaeological layers of the Tabun cave, following section presents the archaeological material yielding from the Tabun layers.

Excavated archaeological layers

Layer G²² (maximum observed thickness 3.80 m, maximum thickness unknown²³), the deepest, contained the stone tools that were described as Tayacian, flints were very sparse and no bone was found. There were some traces of black and grey hearths. Layer F (maximum observed thickness 3.60 m, maximum thickness unknown), based on the stone tools, was of Upper Acheulean period, containing a relatively large number of hand axes, with a reduced number of flints and other flake tools. Finds of large faunal bones were sparse in this layer, and no human fragments were found (Garrod and Bate 1937:68-69).

Layer E (maximum observed thickness 7.10 m, maximum thickness unknown), subdivided in four substrata (E a-d), was characterized as Upper Acheulean of Micoquian type. The subdivision of the stratum was based on the change in the craftiness of stone tool production. The substratum Ef yielded stone tools smaller in size and not so refined in their make, while Ec contained a mass of Micoquian hand axes. Sublayer Eb had the same types of tools as seen in Ef. Substratum Ea held hand axes and side scrapers that

²² The layers here are presented in chronological order, from the oldest and deepest (layer G) to the youngest and most superficial (layer A).

²³ Maximum thickness for layers G, F and E are unknown because the excavation could not be in parts carried to the bedrock (Garrod & Bate 1937).

were bigger and more nicely made than in sublayer Eb. At the base of sublayer Ea, Châtelperronian points were found, together with forms resembling the European Lower Aurignacian stone tools. These Upper Paleolithic assemblages, Châtelperronian and Lower Aurignacian, found below the Mousterian (Middle Paleolithic) assemblages were later recognized as a real stone tool industry often referred to as Amudian (Jelinek 1990; Gopher *et al.* 2005). Moreover, a cache of 29 hand axes was found in Ea. Within the E layer, numerous animal bones were present in the parts of the layer that consisted of breccia and within the red soil. Thin streaky hearths were present in some places within the layer. Moreover, this layer contained two human fragments – the shaft of right femur and a molar – both found at the base of sublayer Ea (Garrod & Bate 1937:65-67).

Layer D (maximum thickness 2.70 m) was labeled as Lower Levalloiso-Mousterian. The tools of this industry were found in large number, but sparsely distributed throughout the layer. Two large hearths were found within the layer. In parts of the layer characterized by greenish soil, bones were rare, while in the parts that consisted of red breccia, bones were well preserved and found in an abundant number (Garrod and Bate 1937:65).

Layer C (maximum thickness 2.20 m) contained stone tools of Levalloiso-Mousterian industry, animal bones, an almost complete burial of a woman, together with other fragments of human bones (Garrod and Bate 1937:64; the discussion of provenance of the woman's skeleton is presented below, after the presentation of the remaining layers of the Tabun cave). A black hearth was visible in a part of the layer, and within it numerous flint flakes and large fragments of animal bones were found. Flints were very common in the most upper part of the layer, but even more so in the lower parts.

Layer B (maximum thickness 3.40 m) was characterized by the deposits of red earth, packed with limestone blocks. It contained flints and animal bones, but they were quite sparse. Based on the stone tools found, the layer was characterized as belonging to the Upper Levalloiso-Mousterian period (Garrod and Bate 1937:62). There were also two chimneys within the cave filled with layers defined as Upper Levalloiso-Mousterian (Garrod and Bate 1937:59). Within the layer B, twenty nine skull fragments, nine deciduous teeth together with fragments of a maxilla, and seven isolated teeth at various depths were found (Garrod and Bate 1937:63).

Provenance of the human fossil remains

The fossil human remains were found in layer E (shaft of right femur and a molar tooth), layer C (nearly complete skeleton of Tabun I; six fragments of lower jaw known as Tabun II; shaft of a right femur, right hamate, left pisiform, and distal phalanx of left pollex, distal fourth of a right radius), layer B (twenty nine skull fragments, nine deciduous teeth, together with fragments of maxilla and seven isolated teeth at various depth) and Chimney II (few pieces of skull and nine human teeth; Garrod and Bate 1937). The remains of the mandible (Tabun II) were found in the East sector of the terrace area in front of the cave. The buried female skeleton of Tabun I was revealed in the West sector of the terrace area (Garrod and Bate 1937; Bar-Yosef and Callander 1999). Additional human remains were found in layer A, but those are of a recent date (Garrod and Bate 1937).

Although Garrod listed Tabun I burial as coming from layer C (Garrod and Bate 1937:64), she did point out that there is a suspicion the skeleton might have been from layer B (Garrod and Bate 1937:64):

“The skeleton lay so near the surface of C that the question must arise whether it does not represent a burial from Layer B. There was no obvious sign of disturbance, but since the earth of B in this area was also red, and the industry so far in the same tradition that the presence of a few intrusive flints in C could not possibly be detected, I feel that this must remain an open question”.

The issue of Tabun I provenance was further complicated by the possibility that it might be coming from layer D (Jelinek *et al.* 1973). Layer D, as the layer containing Tabun I, was proposed based on the comparison of stone tools assemblages found in layers C and D of the Tabun cave, to the stone tool assemblages from the Skhul cave, in combination with the supposition that Skhul fossil remains are said to be ‘modern’, and Tabun I said to be Neandertal (Jelinek *et al.* 1973; Kaufman 2001). It is not clear whether slumping might have caused the confusion on the exact position and provenance of Tabun I. Most if not all of the layers in Tabun are tilted, all the result of subsidence into the underlying sinkhole. Garrod excavated horizontally and used very thick levels thereby creating the possibility of mixing beds during the excavation. However, although it has to be kept in mind, slumping is probably not a major issue when dealing with the Tabun human fossil remains, except the subtle effect on the absolute dating (Albert *et al.* 1999; Bar-Yosef and Callander 1999). However, examination of Garrod’s cautious hesitation regarding the provenance of the Tabun I burial through a historical perspective by Bar-Yosef and Callander (1999) seems to support Garrod’s original remark that Tabun I was, although still debatable, indeed found within the layer C.

Garrod reported that the Tabun I skeleton was interred on its back, with head pointing towards west, legs loosely flexed and the left arm rested on the thorax (Garrod and Bate 1937:64). If the Tabun I skeleton was indeed found within the layer C, it would make it the oldest known burial, accepting the Mercier and Valladas's (2003) date of $165,000 \pm 16,000$ for this layer (Vandermeersch 2006).

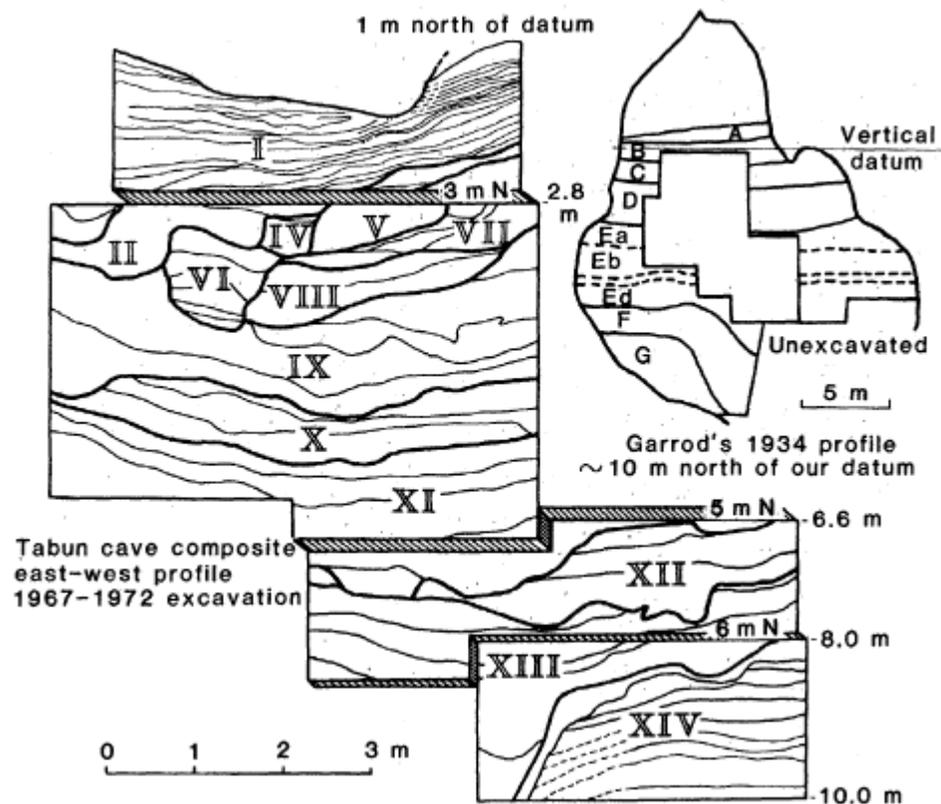
Newer excavation campaigns

In order to better understand the long chronological sequence of the cultural layers in Tabun, Arthur Jelinek and colleagues “re-opened” the cave and set upon a new series of excavation at the site from 1967 to 1972 (fig. 4.3; Jelinek *et al.* 1973; Jelinek 1981, 1982). These excavations dealt with the succession of layers in more geological detail (a more refined sequence was possible by this time with the advancements in sedimentology and palynology). The excavations addressed the reconstruction of environmental circumstances at the time the cave was frequented and inhabited, along with the particularities of stone tool industries and their succession. During the renewed excavations, “sub-beds” (contextual loci) were defined in much greater detail than during the previous (Garrod's) excavations. The reevaluation and the new campaigns made it possible to shed light on the finer picture of the environmental circumstances during the time the cave was inhabited and frequented, and it enabled greater insight into the trends of artifact production and human behavior at and around the site.

In addition, during the late 1990s, the deepest layers of the Tabun cave were excavated by Avraham Ronen and colleagues (Ronen and Tsatskin 1995; Albert *et al.* 1999). These studies modified the geological history of Tabun, in terms of better

reconstruction of the basal layers of the cave prior to the collapse of the roof of the cave (Ronen and Tsatskin 1995). Albert and colleagues', based on the phytoliths retrieved during the renewed excavations, confirmed that the layer C of the cave represented the time of domestic occupational mode of the cave (Albert *et al.* 1999). The phytoliths yielding from layer B indicate much burning and fire activity, together with possibility that the cave during this period may have been used as a game trap (Albert *et al.* 1999:1249).

Figure 4.3 Comparison of the stratigraphic section reported by Garrod with that revealed by Jelinek's excavations. Taken from Jelinek 1982:1370.



Sedimentological analysis of Garrod's profile led to the conclusion that the cave was first inhabited during the last interglacial, when the coast line was further away from the location of the cave (Jelinek 1982). However, this has been challenged and rejected by Bar-Yosef and almost everyone else given the date of 165,000 for layer C and much earlier dates for the underlying layers. Jelinek's dating and conclusions in the 1970s and 1980s were based on geological work in the 1970s which is mostly now rejected (Jelinek *et al.* 1973; Jelinek 1982). The major environmental changes within the Mousterian layers of Tabun occurred when the chimney of the cave opened, and this resulted in a great and rapid accumulation of *terra rossa* from the hillside above the cave (Jelinek 1982). These structural transformations changed the functional usage of the cave itself. It may have been, and faunal evidence does suggest it, that after the chimney roof collapsed, the cave was no longer used primarily as the habitat site. The abundant remains of *Dama mesopotamica* (Persian fallow deer) suggested to Jelinek that the opening in the roof of the cave was used as a trap where *Dama* were enticed as a successful hunting strategy. The shift from *Gazella* to *Dama* is largely a result of different hunting strategies and differences in hunting preferences (Jelinek 1982). Although these ideas about cultural choices are good, and may be correct (or at least partially correct), this interpretation still remains a minority position. Many still follow Dorothy Bate's original interpretation that the frequency of *Dama* and *Gazella* reflect climatic/environmental shifts.

Absolute dating of the human fossil remains

Different methods for direct and indirect absolute dating have been applied to date the Tabun human fossil remains (Grün 2006). The Tabun remains have been dated using thermoluminescence (Mercier *et al.* 1995), electron spin resonance (Grün *et al.* 1991; Grün and Stringer 2000; Rink *et al.* 2004; Coppa *et al.* 2005), Uranium series (Schwarcz *et al.* 1998; Grün and Stringer 2000). The oldest thick sequence of the Tabun cave (Unit III according to Jelinek *et al.* 1973) has been dated using the TL method to at least 350,000 years (Mercier *et al.* 1995). The layer where the Tabun I skeleton most probably came from (layer C – Garrod and Bate 1937; Unit II – Jelinek *et al.* 1973) is on average about 170,000 years old, based on the thermoluminescence (TL) dates (Mercier *et al.* 1995). However, the electron spin resonance (ESR) and Uranium series (U-series dating) for this layer give a much younger age. The age estimate given by both ESR (Grün *et al.* 1991) and U-series dating (McDermott *et al.* 1993) is about 125,000-100,000 years old. Layer B (Garrod and Bate 1937; Unit I according to Jelinek *et al.* 1973), deposited during the late Mousterian, is dated from around 80,000 years (ESR dating; Grün *et al.* 1991) to around 50,000 years (U-series dating; Grün *et al.* 1991). The direct dating of the skeletal elements of the Tabun I skeleton yielded the age range from about 63,000 to 14,000 years (Schwarcz *et al.* 1998). Relatively young age results for the direct dating of Tabun I skeleton have been criticized in terms of methodological problems (Millard and Pike 1999) and archaeological problems (Alperson *et al.* 2000; from Grün and Stringer 2000). Direct dating of the Tabun I skeleton based on ESR and U-series analyses by Grün and Stringer (2000) yielded much older results than those yielded by analyses conducted by Schwarcz and colleagues (1998). The Grün and Stringer age estimates for Tabun I are a

little over 100,000. In addition, the revised TL dating of the burnt flint coming from layer C (Mercier and Valladas 2003), put the Tabun I skeleton to $165,000 \pm 16,000$, naturally, if one accepts that Tabun I came from layer C (Vandermeersch 2006).

Age estimates based on different direct and indirect dating of remains found at the Tabun cave are shaded by considerable discrepancies. There are problems ranging from the doubtful provenance of the remains, such as the case of Tabun I skeleton, to the problems in the various direct dating methodologies and the correlation of archaeological remains (flint) with the human remains. And again, as discussed above, the problem of slumping due to chemical dissolution in the Tabun cave might have had an effect on the human remains. Due to the chemical dissolution involved in the slumping (Albert *et al.* 1999; Rink *et al.* 2004), conditions in which bone apatite in the human remains is mobilized and dissolved might have occurred (Weiner *et al.* 2001). This would result in having subtle effects on electron spin resonance and thermoluminescence dating. This makes Mercier and Valladas' (2003), and Rink and colleagues' (2004) absolute dating results for the Tabun remains more trustworthy (A. Stutz, pers. comm.). Therefore, following Mercier and Valladas' (2003), the age of the Tabun I is estimated to $165,000 \pm 16,000$.

In sum, the Tabun cave yielded an archaeological sequence of almost 25 m of thickness, rich in Lower and Middle Paleolithic remains (Garrod and Bate 1937; Jelinek *et al.* 1973; Jelinek 1982; Bar-Yosef 1998). In addition to rich cultural material and faunal remains, the cave yielded fossil human remains. Of particular interest for the research presented here is the cranium of Tabun I female individual found at the cave.

The best assessment of its age would be $165,000 \pm 16,000$ for this layer (Mercier and Valladas 2003; Vandermeersch 2006).

b. Skhul

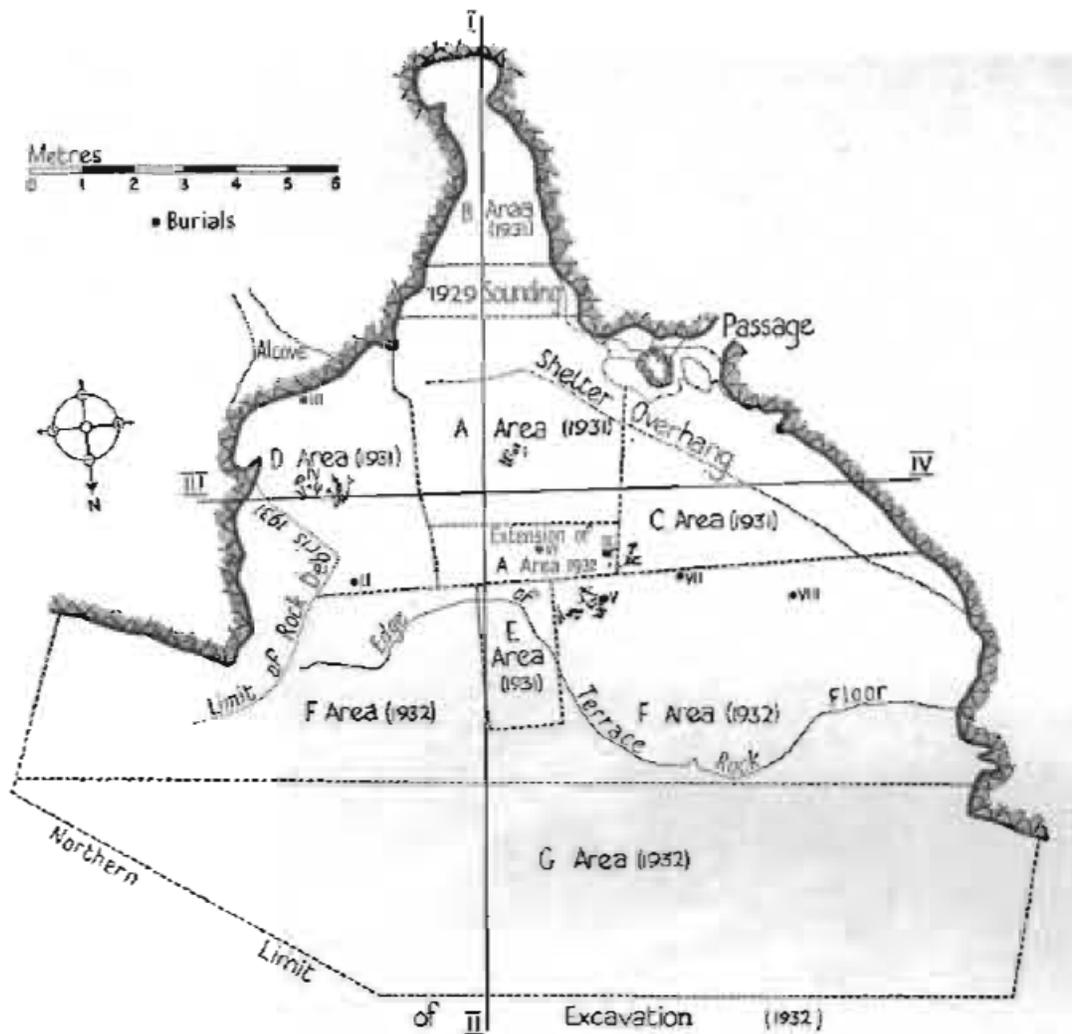
Leaving Tabun cave and the view of the Mediterranean coastline and taking a pleasant stroll inland toward the main drain of the Wadi el-Mughara, one encounters the Skhul rock shelter. Skhul yielded Late Pleistocene human fossil remains in abundance, being called by the original excavator and descriptor a Late Pleistocene necropolis (McCown 1937; parallel to the discovery (Maška 1895) and description (Matiegka 1934, 1938) of the ‘mass-grave’ at Předmostí, Moravia which was published right at the time the Mount Carmel monograph was in preparation). The following provides the description of the location of the site, the archeological material the site yielded, the context of the human fossil remains found and information on the dating of the site.

Excavated archaeological layers

Skhul (originally Mugharet Es-Skhūl – ‘cave of the kids’), situated some 150 m from Tabun cave, was first sounded by Mary K. Clark in 1929, yielding promising enough results to further investigate the cave, actually an abri – rock shelter. From 1931, Theodore McCown was in charge of the subsequent excavations there. Part of the rock shelter was damaged by quarrying explorations that the Public Works Department had done for the construction of the port of Haifa, the reason which initiated the whole salvage campaigns of Wadi-el-Mughara cave sites. During the 1931 and 1932 campaigns, three general strata were defined: layer C (Lower Levalloiso-Mousterian), layer B (Lower

Levalloiso-Mousterian; subdivided into sublayers B1 and B2 based on the slight differences in the stone tools found), and layer A (a superficial layer where a mix of Mousterian, Natufian, and Aurignacian tools were found together with recent Arab pottery sherds (Garrod and Bate 1937; McCown 1937)).

Figure 4.4 Ground plan of the Skhul cave with locations of the burial sites. Taken from Garrod and Bate 1937: Plate L.



Provenance of the human fossil remains

There were remains of ten individuals in total found at the site (Skhul I to X) and they were all found within the Mousterian layers (fig. 4.4). There is unambiguous evidence that Skhul I, IV, V and VII were buried intentionally (McCown 1937:104). Moreover, Skhul V was buried holding a wild boar mandible within his embrace (McCown 1937:104). Those burials found in an undisturbed state, all had in common the general rite of interment – legs tightly flexed and with arms usually flexed (McCown 1937:104). The burials differed in their relative depth so, although relative depth of the burial is not directly indicative of chronology, McCown speculated (based on disturbances of some burials with newer ones, and the color, state and mineralization of bones) that Skhul VI, VII, VIII, IX, and X (with possibly Skhul III) may have been older than Skhul I, IV and V (McCown 1937:105). Although there were many carnivore bones found at the site, there were no signs of gnawing seen on the human bones. Thus, in the case where the burial was disturbed, it is supposed that it was disturbed by the people who inhabited this cave site after being interred. Indeed, this cave and rock shelter site was not solely used as a prehistoric sort of necropolis, but also as a habitation site. McCown stated that, based on the continuous interchange of layers and the rich cultural material found, the cave was continuously occupied (1937:106).

Absolute dating of the human fossil remains

As is the case with Tabun, several different absolute dating methods have been applied to date the human fossil remains from Skhul. Indirect dating methods have been performed on faunal remains – as well as ESR (Stringer *et al.* 1989; McDermott *et al.*

1993) and U-series (McDermott *et al.* 1993). In addition, thermoluminescence dating has been applied on burnt flint (Mercier *et al.* 1993). Direct dating has been done on the remains of Skhul II (ESR; Grün *et al.* 2005) and Skhul IX (γ spectrometric and thermal ionization mass spectrometric (TIMS) U-series analyses; Grün *et al.* 2005). The ESR indirect dates give an estimate of 100,000 to 55,000 years (Stringer *et al.* 1989) and 88,000 to 46,000 (U-series; McDermott *et al.* 1993). TL indirect dates estimate the age to 134,000 to 99,000 years (Mercier *et al.* 1993). The direct dating of Skhul II yielded an estimate of $32,100 \pm 800$ and is assumed to be associated with very large error (Grün *et al.* 2005), and $131,000 \pm 2,000$ estimate on Skhul IX (Grün *et al.* 2005). Dating based on faunal teeth in clear association with the remains of Skhul V and Skhul IX are in accord with the direct dating on the Skhul IX (Grün *et al.* 2005). McCown noted that Skhul IX was possibly buried earlier than Skhul V, but nonetheless, Grün and colleagues, based on the absolute dates of the three burials (Skhul II, V and IX), posit that the burials took place in a relatively short time period (2005:330), giving a general age range for the Skhul burials of 130,000 to 100,000. This range is in accordance with the Mercier and colleagues' date range based on TL dating method (1993).

In sum, Skhul cave was used as both an occupational site, as well as the burial place for the Late Pleistocene population living in the Levantine area. The site yielded Middle Paleolithic stone artifacts, as well as the human skeletal remains that show a mixture of both archaic and modern features. The best estimates age the human remains between 130,000 and 100,000 years (Mercier *et al.* 1993; Grün *et al.* 2005).

Conclusions of the Mount Carmel excavation campaigns

The campaigns at the Mount Carmel sites (both Tabun and Skhul) enabled Ms. Garrod to establish a chronological sequence for the whole Palestine region – starting from Tayacian, with each subsequent layer represented, all the way to Natufian. Garrod's chronostratigraphy included other important Late Pleistocene sites that yielded human fossil remains – Qafzeh and Kebara, although the Qafzeh stratigraphy had not been published yet (Garrod and Bate 1937:113). Garrod corroborated her chronostratigraphy based on the type and industries of stone tools found, with the chronostratigraphy developed by Dorothea Bate, her collaborator at the Mount Carmel excavations and person in charge of faunal remains. Bate analyzed the faunal remains from the strata of Mount Carmel caves, including the finds of some extinct species, and compared them with other Palestine sites (Bate 1937). In addition, the establishment of the stratigraphy was fitted into Pleistocene geological formations in the wider area of Palestine, done by L. Picard (1929). These three lines of evidence gave Garrod a good sense and certainty of the relative stratigraphy of the Wadi el-Mughara cave sites, and also how they fit into the general Late Pleistocene of Palestine and adjacent areas. The chronology of the Middle Paleolithic sites has been defined in more detail since Garrod's time, especially with advances in radiometric dating (Bar-Yosef 1998). The current generally accepted chronology is presented in the table 4.1 (modified according to Bar-Yosef 1998:45; Shea 2003, 2006:192).

It is interesting to notice that when Garrod compared the peculiarities of stone tool industries found within the Wadi el-Mughara sites with other stone tool industries from adjacent areas, there were some interesting trends (Garrod and Bate 1937). In types

of tools, during the Tayacian and Acheulean periods, the el-Mughara tools are much more similar to the ones from Western European sites, while they differ from the closer, Northern African finds. Anthony Marks confirmed that there were no cultural connections between North Africa and the Levant (1975, 1992; Marks *et al.* 2001). However, during the Mousterian period, this trend switched and during this time, the industries were much closer in their execution to the ones found in Egypt. After the Mousterian period, the ties were again more apparent and closer to Europe and the Northern Black Sea Plain (Crimea). This perhaps has something to say about the direction and preference of cultural relations and movement during these different periods.

Based on his excavations and study of the Tabun artifacts, Jelinek was of opinion that the artifactual remains point to an existence of a single cultural tradition – the Mugharan Tradition (Jelinek 1980, 1982:1371). Within this tradition, three industries can be recognized – Yabrudian, Acheulian and Amudian facies, but nonetheless there was, in Jelinek’s view, evidence of continuity between these different facies (1982:1371). In Jelinek’s opinion, the evidence of the continuity in a long cultural sequence at the Tabun cave can be extrapolated to have implication for the *in situ* development of modern behavior, and is not indicative of modern humans replacing the archaic humans present in this area before. The “modernization” in the production of the artifacts, seen at the end of the sequence in the Tabun cave, is compatible to the cultural material from Skhul and Qafzeh (Jelinek 1977, 1982:1375).

Table 4.1 The chronology of Mousterian industries in the Levant. Modified according to Bar-Yosef 1998:45; and Shea 2003, 2006:192.

geol. period	arch. period	dates (kyr)	marine OIS	Levantine climate	fossil human remains	lithic industries	representative archaeological context
Late Pleistocene	Initial Upper Paleolithic	47-32 kyr	Mid-late OIS 3	cold and dry		Initial Upper Paleolithic, Ahmarian industry	
	Late Middle Paleolithic	71-<47 kyr	OIS 4-early 3	cold and dry	Amud I	Tabun B-type/Phase 3 Levantine Mousterian	Amud levels B1-B4
	Middle Middle Paleolithic	128-71 kyr	OIS 5	initially warm and humid but growing colder, more arid	Tabun I; Skhul; Qafzeh	Tabun C-type/Phase 2 Levantine Mousterian	Tabun unit I Skhul level B Qafzeh units XVII-XXIV
Middle Pleistocene	Early Middle Paleolithic	250-128 kyr	OIS 7-6	warm, then colder		Tabun D-type/Phase 1 Levantine Mousterian	Tabun units II-IX (and lower unit I?)
	Late Lower Paleolithic	350-250 kyr	OIS 8-7	cold, then warmer	Zuttiyeh	Late Acheulean and Acheulo-Yabrudian	Zuttiyeh Tabun units X-XII

In sum, the Mount Carmel cave sites, Tabun and Skhul, yielded human fossil remains that are broadly contemporaneous. They are confined to the Late Pleistocene geological period, and the Middle Paleolithic cultural period. Recent absolute dating reassessment of the burials at Tabun and Skhul estimate that these burials fell within the 165,000 (Tabun I; Mercier and Valladas 2003) and 130,000 to 100,000 time range (Grün *et al.* 2005).

2. Excavations and findings of the Qafzeh cave site

Another southern Levantine site that yielded human fossil remains used in this research is the Qafzeh cave. The human remains from this cave have a significant bearing on the understanding not only of the nature of the Late Pleistocene human fossil variation, but for understanding the emergence of modern humans. The following paragraphs present general information on the location of the cave site, its general stratigraphy, the archaeological remains found at the site, and the context of the human fossil remains. Finally, the absolute dating age for the archaeological sequence is presented.

Qafzeh ('precipice') cave is located in the Wadi el Hadj (Pilgrim's Wadi), near Nazareth (Vandermeersch 1981, 2002). The valley and the cave were continuously frequented during the Byzantine period and ever since then. There are structures within the cave itself that attest to the religious attention paid to this site during the Byzantine period, in particular the paved floor and a Byzantine cross worked into one of the stone blocks present (Vandermeersch 1981, 2002). The pilgrims continuously visited the cave all the way into twentieth century. In the 1930s, the pilgrims' reports of finding stone tools resembling the ones that were found with the historically famous discovery of the Galilee man brought the attention of René Neuville to this site. Neuville had a strong interest in the prehistory of Palestine, and had previously excavated some of the prehistoric sites in the region and established chronostratigraphies that helped Garrod in her work (Garrod and Bate 1937). After promising sounding excavations, together with Moshe Stekelis, an Israeli later to become the Professor of Prehistory at the Hebrew University in Jerusalem, Neuville excavated Qafzeh cave during 1934 and 1935 (Neuville

1934, 1935; Vandermeersch 1981). During the first campaign, they were fortunate enough to find remains of five individuals within the Levalloiso-Mousterian layers (Vandermeersch 1981, 2002). Due to Neuville's diplomatic duties, the excavations, although planned, could not be continued and the official all-inclusive report of the excavations was never published, although some information was included in Neuville's publication on Paleolithic and Mesolithic of Judean desert (Neuville 1951; Vandermeersch 1981, 2002).

Excavated archaeological layers

Neuville recognized thirteen layers altogether (layers M to A) in the inner cave area, vestibule and terrace area (Neuville 1951 from Vandermeersch 1981:26). Layer M was present only in the terrace area and it was sterile. Layer L was attributed to Lower Levalloisian. It contained many faunal finds, and amongst those, remains of five human individuals (Qafzeh 3, 4, 5, 6 and 7). Layers K and J contained remains of Lower Levalloisian and abundant remains of fauna. The distinction in these two layers was made because of the changes in presence of types of gravel and a mass of fallen rocks. Layer I was characterized by the presence of Middle Levalloisian tools, found in abundance within this layer together with numerous faunal finds. Layer H and G contained Upper Levalloisian with abundant faunal finds. Layer F contained few faunal finds and Neuville defined tools yielding from this layer as Mousterian. Within layer E, Upper Paleolithic tools were found in abundance (phase I according to Neuville), together with faunal remains. Layer D contained Upper Paleolithic artifacts of phase II. Layer C had few Upper Paleolithic tools, and within this layer Qafzeh 2 was found. Layer B, based on the

finds, was attributed to Bronze age. Within this layer, remains of Qafzeh 1 were found. The most superficial layer, layer A, contained ruins of a Byzantine structure of religious character and more recent finds (Neuville 1951; Vandermeersch 1981:26).

Newer excavation campaigns

Due to the promising finds from the site, excavations were continued from 1965 to 1979, under the supervision of Bernard Vandermeersch and Ofer Bar-Yosef (Vandermeersch 1981, 2002). Vandermeersch and Bar-Yosef managed to correlate some of the layers found during their investigation of the site to those of Neuville and Stekelis (Vandermeersch 1981:29; table 4.2). Based on the studies of the faunal remains, Jean Bouchud (1974) concluded that there was a marked climatic switch from the Mousterian layers, characterized as humid period within this cave, to those of the Upper Paleolithic formed during very dry periods. The greatest humidity was during the deposition of layers XVI to XI.

Table 4.2 Comparison and correlation of Qafzeh Mousterian layers recognized during Vandermeersch and Bar-Yosef campaigns to the ones recognized by Neuville and Stekelis. Taken from Vandermeersch 198:29.

Vandermeersch and Bar-Yosef campaigns		Neuville and Stekelis campaigns	
vestibule	cave	vestibule	cave
VIII	12		G, H, I
?	13		J (sup.)
XVII to XIX ?	?	L	

Microfaunal remains allowed for the relative comparison of the stratigraphy of Qafzeh with Tabun cave (Jelinek *et al.* 1973; Vandermeersch 1981). These comparisons suggest that the Qafzeh Mousterian strata are older than the Tabun D layer (Vandermeersch 1981). Thus, even before the absolute dating was done on the remains from these caves in the late 1980s and early 1990s (Valladas *et al.* 1988; Schwarcz *et al.* 1988; McDermott *et al.* 1993), Haas, based on microfaunal finds, and L. Picard, based on the particularities of the soil composition, suggested that the Qafzeh cave was the oldest in its deposited Mousterian strata (Jelinek *et al.* 1973; Vandermeersch 1981; Bar-Yosef and Vandermeersch 1981, 1991; Vandermeersch 2002).

Both Mousterian and Upper Paleolithic tools were found at the site. However, there was a hiatus between the Mousterian layers and the Upper Paleolithic one, based on the absence of early Upper Paleolithic forms. Neuville (1951) differentiated between Lower, Middle and Upper Mousterian based on the frequency of points and scrapers found within the layers. Lower Mousterian is characterized by presence of more points than scrapers. During the Middle Mousterian the ratio of points to scrapers is the same. In the Upper Mousterian, scrapers are more abundant than the points (Neuville 1951; Vandermeersch 1981).

Provenance of the human fossil remains

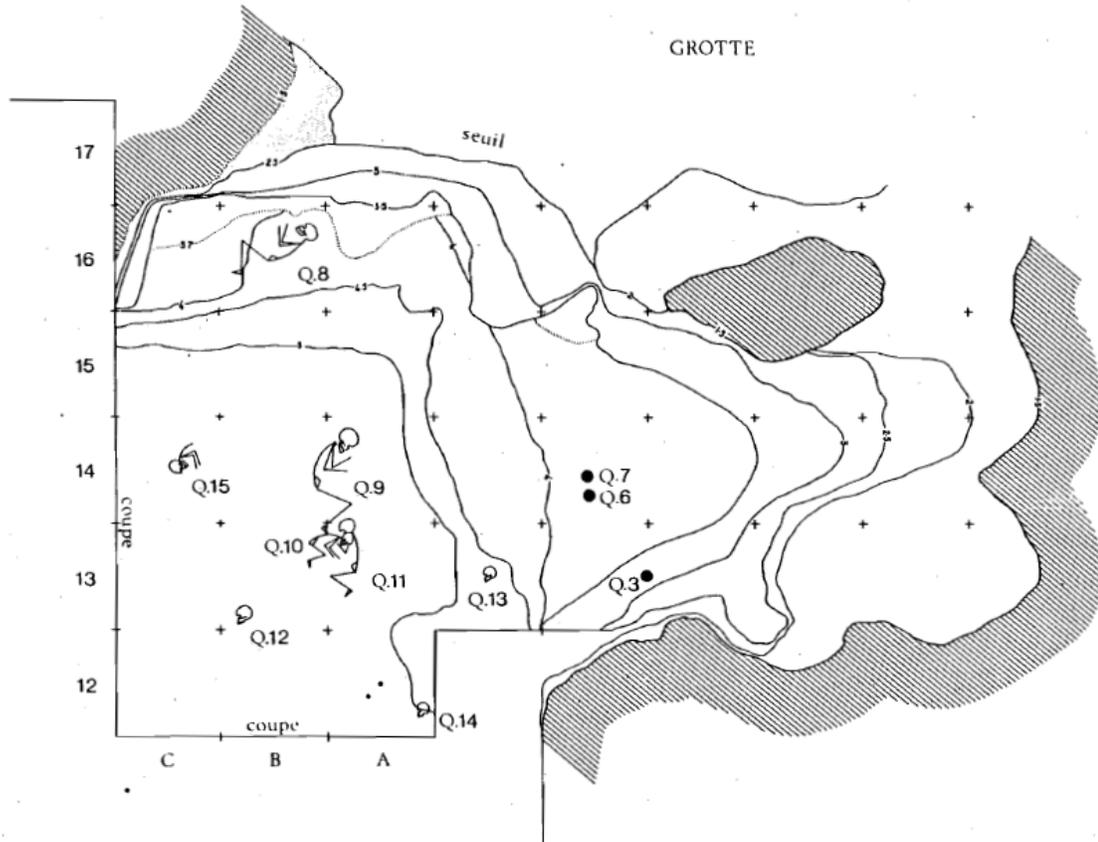
The first skeletal remains were excavated by Neuville and Stekelis, during the 1934 and 1935 campaigns (fig. 4.5; Neuville 1934, 1936, 1951). These were the specimens Qafzeh 1 to Qafzeh 7. Qafzeh 1 and 2 were of recent age. Skeletons from the Mousterian layer (layer L) were dug up in 1934 – Qafzeh 3, 4, 5, and 6. In 1935, Qafzeh

7 was found. During the later campaigns led by Vandermeersch and Bar-Yosef, remains of eight more individuals were found – Qafzeh 8, 9, 10, 11, 12, 13, 14 and 15, all of them found buried in the vestibule area of the site (Vandermeersch 1981:32). These individuals came from layers XVII (Qafzeh 8, 9, 10, 12, 14 and 15; Vandermeersch 1981:32), XXII (Qafzeh 11; Vandermeersch 1981:32), and XVa (Qafzeh 13; Vandermeersch 1981:32). Three isolated teeth were labeled as Qafzeh 16 (molar from layer XVII), 17 (incisor from layer XVII) and 18 (incisor from layer XV; Vandermeersch 1981:32). The location within the cave, and the provenance of the skeletons is listed below in table 4.3.

Table 4.3 List of Late Pleistocene human fossil skeleton found at Qafzeh with the location of the discoveries within the cave, and archaeological layers. Taken from Vandermeersch 1981.

skeleton	layer	area
Qafzeh 3	layer L	vestibule
Qafzeh 4	layer L	terrace
Qafzeh 5	layer L	terrace
Qafzeh 6	layer L	vestibule
Qafzeh 7	layer L	vestibule
Qafzeh 8	layer XVII	vestibule
Qafzeh 9	layer XVII	vestibule
Qafzeh 10	layer XVII	vestibule
Qafzeh 11	layer XXII	vestibule
Qafzeh 12	layer XVII	vestibule
Qafzeh 13	layer XVa	vestibule
Qafzeh 14	layer XVII	vestibule
Qafzeh 15	layer XVII	vestibule

Figure 4.5 Ground plan of the vestibule area of the Qafzeh cave with the location of the skeletal remains found. Taken from Vandermeersch 1981:33.



Absolute dating of the human fossil remains

Different indirect absolute dating methods have been applied to the human fossil remains from Qafzeh (Grün 2006) – thermoluminescence dating of burnt flint (Valladas *et al.* 1988), electron spin resonance dating of the faunal remains (Schwarcz *et al.* 1988) and Uranium series dating (McDermott *et al.* 1993). Direct dating of the human fossil remains has been performed on the Qafzeh 6 specimen (γ spectrometry of U-series; Yokoyama *et al.* 1997). It gave an age range of 104,000 to 62,000 and 104,000 to 86,000 (Yokoyama *et al.* 1997). This is in accordance with date estimates based on the analyses

of burnt flint done by Valladas and colleagues (1988), which give a range of $92,000 \pm 5,000$ years. The author believes the best age estimate for the skeletons is $92,000 \pm 5,000$.

In sum, Qafzeh cave yielded human fossil remains that are generally penecontemporaneous with the human remains from the Mount Carmel sites of Skhul and Tabun. They are confined to the Late Pleistocene geological period, and the Middle Paleolithic cultural period. Absolute dating results of the burials at Qafzeh estimate that these burials fell within the 97,000 to 87,000 time range (Valladas *et al.* 1988).

3. Excavations and findings at the Amud cave site

The other Levantine site with human fossil cranial remains that date to the Late Pleistocene period is Amud. In 1960, Hitoshi Watanabe, from the Tokyo University Scientific Expedition to Western Asia, brought the Amud cave to attention (Suzuki 1970). Wadi el-Amud, the eponymous wadi where the cave is located (named after a tall tower-shaped rock in proximity of Amud cave), is situated about 10 km northwest of the Sea of Galilee. Wadi el-Amud is rich in Paleolithic sites, including Emireh/Amira (Garrod 1955) and Me'arat Shovakh (Mugharet esh-Shubbabiq; Binford 1966; Trinkaus 1987). Moreover, only some 500 m downstream the wadi from Amud is where the Zuttiyeh cave is situated, the place where the remains of Galilee man, the first Pleistocene hominid discovered from Israel, were found (Turville-Petre 1927; Suzuki 1970). The whole wadi is located within the Great Jordan Rift Valley, and therefore lies within the depression. The Amud cave itself is located 110.2 m below sea level (Chinzei 1970). The cave that one sees today was a part of a bigger cave, but the roof above the outermost part of the pre-existing cave had collapsed. The terrace that is now located in front of the

mouth of the cave is thus considered the floor of the once larger cave (Chinzei 1970:21). The cave, carved into limestone, was filled with deposited layers of soil that do not exceed 3 meters in maximum thickness. The following presents the location of the site, archeological material the site yielded, the context of the human fossil remains found and information on the dating of the site.

Excavated archaeological layers

The Amud cave was originally excavated during two seasons, in 1961 and 1964 (Suzuki and Takai 1970). There were two major stratigraphic units within the cave, layers A and B, that are further subdivided based on the sedimentary analysis and finds within the layers. Layer A (subdivided into A1 and A2) consisted of mostly prehistoric and more recent soil deposits, ranging from Bronze Age, Byzantine period and recent depositions. Layer B was entirely a Paleolithic layer. Although the stone artifacts throughout the whole stratum were uniform, this layer was subdivided into four sublayers based on differential sedimentary processes. Layer B was not equally distributed throughout the cave, and its maximum thickness did not cumulatively exceed 3.5 meters (Chinzei 1970). Just below the top of sublayer B1 is where the skeleton of the Amud man (Amud I) was found (Chinzei 1970). This sublayer, poorly stratified, with its maximum thickness of 1.1 meters, was distributed in only part of the cave and on the terrace. Sublayer B2 was present mainly in the central terrace area. Sublayer B3 was present exclusively in the middle terrace area. This sublayer did not contain any remains of stone artifacts or faunal remains. The deepest and final deposit of the cave was sublayer B4, distributed in the middle and the lower terrace areas. The difference between the environments during the

deposition of layer B versus layer A was observable through fine sedimentary analysis, as well as the faunal analysis (Chinzei 1970; Takai 1970).

Layer B of the Amud cave contained Paleolithic deposits and represented the occupied layer within the cave. This was confirmed by the stone tool industry represented throughout the sublayers of layer B. Sublayer B3 did not contain any remains (stone artifact nor faunal remains) that would be indicative of the occupation time of the cave (Chinzei 1970). The stone tools found within layer B represented a single industrial cycle, characterized by a mixture of Levalloiso-Mousterian elements with Upper Paleolithic tools forms (Watanabe 1970:94).

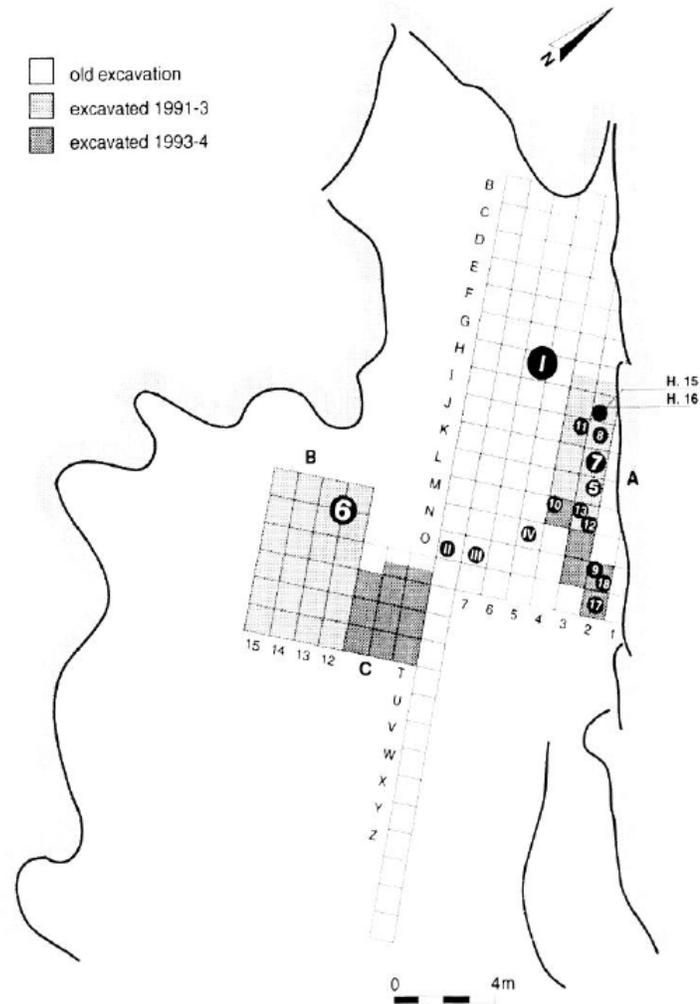
Newer excavation campaigns

The second set of excavations was conducted from 1991 to 1994 (Rak *et al.* 1994; Hovers *et al.* 1995). The renewed excavations confirmed and refined the stratigraphic picture of the Amud layers set forth by the previous excavations (Chinzei 1970). The new studies and reassessment of the stone tools from layer B concluded that the assemblage is firmly placed within the Levantine Mousterian industries (Hovers *et al.* 1995:48), and not as previously viewed to be representative of a transitional Middle to Upper Paleolithic assemblage (Watanabe 1970).

Provenance of the human fossil remains

The human fossil remains were retrieved both during the 1960s and 1990s. In the campaigns led by Suzuki and Takai, remains of four individuals were recovered. These consisted of the almost complete skeleton of Amud I, right adult maxilla of Amud II,

Figure 4.6 Schematic map of excavated areas of the Amud cave. Hominid remains recovered in the 1960s are marked by Roman numerals, those recovered in the 1990s are marked by Arabic numerals. Size of the circles is relative to the completeness of the skeletons. Taken from Hovers *et al.* 1995:49.



cranial fragments of an infant Amud III and an infant temporal bone representing Amud IV (Suzuki 1970). During the 1990s excavations led by Hovers and colleagues, fragmentary human fossil skeletal elements have been found representing fourteen other individuals (maximum estimate; Fig. 4.6; Rak *et al.* 1994; Hovers *et al.* 1995). These fossil remains belong to the neonates and infants from the Middle Paleolithic layer (Amud 5, 6, 7, 10, 12, 15, 16, and 18), children (Amud 8 and 11), and adults (Amud 9

and 17; Hovers *et al.* 1995:50). Three intentional burials were recognized at the site, due to the completeness of the skeletons retrieved and the articulation of the skeletal elements (Amud I, 7, 9 and 10; Hovers *et al.* 1995; Vandermeersch 2006).

Absolute dating of the human fossil remains

The absolute dating for the Amud cave remains has been done indirectly using several different methods (Chinzei 1970; Schwarcz and Rink 1998). The original absolute dates done in the 1960s (Chinzei 1970) have been revised in last few decades using more advanced methods (Schwarcz and Rink 1998; Valladas *et al.* 1999). The thermoluminescence method has been applied to date burnt flint found within the cave (Valladas *et al.* 1999). Electron spin resonance has been applied to date the faunal tooth from the layer that the skeleton of Amud I is thought to yield from (layer B1/6 – Hovers *et al.* 1995; Schwarcz and Rink 1998; Rink *et al.* 2001). The layer containing the skeletal remains of Amud I has yielded dates between $43,000 \pm 5,000$ and $48,000 \pm 6,000$, based on electron spin resonance dating (Schwarcz and Rink 1998:63), and the author accepts this as the most probable range of estimates. The dating of the remains from different layers suggests that the site was occupied from about 70,000 years ago (Valladas *et al.* 1999) to as recently as $43,000 \pm 5,000$ years ago (Schwarcz and Rink 1998).

In sum, Amud cave is another southern Levantine cave site that yielded human fossil remains dated to the Late Pleistocene. Most of the remains are of fragmentary and incomplete nature, with the exception of the burial of the male skeleton, Amud I. The cranium of Amud I, approximately 48,000 to 38,000 years old, completes the Late Pleistocene Levantine cranial sample used in this research.

4. Summary of the cranial sample from the Levantine sites used in this dissertation

The Southern Levant yielded abundant human cranial remains dated to the Late Pleistocene period. The variation seen in the Late Pleistocene Levantine fossil sample inspired the research presented in this dissertation. There is a long literature describing and analyzing the variation expressed by the Late Pleistocene Levantine hominids. Long-standing evolutionary issues are raised by this variation, including the recognition of intra vs. inter-specific variation, questions of changing variation over time, and recognition of the extent of admixture in both modern and fossil samples. This hominid sample is comprised of both Neandertals (Neandertal-like humans) from Tabun and Amud, and the remains from Skhul and Qafzeh that are considered predecessors of more recent and modern humans. The variation in the Levant has been interpreted a number of ways: taxonomically (as two separate species), as a population undergoing the transition from archaic to modern humans, and as an admixed sample representing the mixing of two populations. The goal of this dissertation is to test the hypothesis that this sample is not significantly different in its magnitude of variation than the recent human comparative sample of mixed ancestry. Due to the fact that non-metric cranial data are indicative of underlying genetic variation, the focus of the study is on the cranial non-metric variation.

It is appropriate to treat the remains of these four cave sites together as a sample. This is due to the fact that the human fossil remains found at these cave sites are the only representatives of the Late Pleistocene population which inhabited the area of Southern Levant. Only adult or near-adult cranial remains from the mentioned southern Levantine sites are chosen for the research, due to their fully developed expressions of the non-metric traits. Therefore, the list of the Levantine cranial sample that the author studied

consists of the following specimens – Skhul II, Skhul IV, Skhul V, Skhul VI, Skhul VII, Skhul IX; Tabun I; Amud I; Qafzeh III, Qafzeh V, Qafzeh VI, Qafzeh VII, and Qafzeh IX. The following table (tab. 4.4) presents the information on the sex and estimated age of each specimen, their original description reference, and the author's assessment of the most probable absolute dates for the layers they were found in. The fossil cranial remains studied are presently housed at Tel Aviv University, Tel Aviv (Amud I, Qafzeh IX), Rockefeller Museum, Jerusalem (Skhul IV), Peabody Museum of Archaeology and Ethnology at Harvard University, Boston (Skhul II, V, VI, VII), Natural History Museum, London (Skhul IX, Tabun I), and Institut de Paléontologie Humaine, Paris (Qafzeh III, V, VI, VII). All the original fossil crania were studied by the author, except the Skhul IV specimen. The whole burial of Skhul IV is exhibited in a permanent exhibition at the Rockefeller Museum, Jerusalem, under a large museum vitrine. Due to the difficulties of removing the specimen from its exhibition place, the fossil cranium was observed by the author in its glass case. The details that needed closer look in order to score them properly were observed on a cast of the Skhul IV specimen.

Table 4.4 Summary of the specific Levantine crania used for this dissertation

specimen	sex	age	date	description
Skhul II	female	30-40 years	119,000 ± 18,000 ¹ 130,000 and 100,000 years ^{1a}	McCown and Keith 1939:287-289
Skhul IV	male	40-50 years	119,000 ± 18,000 ¹ 130,000 and 100,000 years ^{1a}	McCown and Keith 1939:267-276
Skhul V	male	30-40 years	119,000 ± 18,000 ¹ 130,000 and 100,000 years ^{1a}	McCown and Keith 1939:231-252
Skhul VI	male	30-35 years	119,000 ± 18,000 ¹ 130,000 and 100,000 years ^{1a}	McCown and Keith 1939:293-295
Skhul VII	female	35-40 years	119,000 ± 18,000 ¹ 130,000 and 100,000 years ^{1a}	McCown and Keith 1939:289-293
Skhul IX	male	~ 50 years	119,000 ± 18,000 ¹ 130,000 and 100,000 years ^{1a}	McCown and Keith 1939:277-286
Tabun I	female	~ 30 years	125,000 to 100,000 ² 165,000 ± 16,000 ^{2a}	McCown and Keith 1939:253-265
Qafzeh III	female	old adult	92,000 ± 5,000 ³	Vandermeersch 1981:119-128
Qafzeh V	?	young adult	92,000 ± 5,000 ³	Vandermeersch 1981:128-131
Qafzeh VI	male	adult	92,000 ± 5,000 ³	Vallois and Vandermeersch 1975; Vandermeersch 1981:95-118
Qafzeh VII	?	adult	92,000 ± 5,000 ³	Vandermeersch 1981:132-138
Qafzeh IX	female	subadult	92,000 ± 5,000 ³	Vandermeersch 1981:51-94
Amud I	male	~ 25 years	43,000 ± 5,000 ⁴	Suzuki 1970:123-206

¹Stringer *et al.* 1989 (ESR dating); Mercier *et al.* 1993 (TL dating) ; ^{1a} Grün *et al.* 2005

² Grün *et al.* 1991 (ESR dating); McDermott *et al.* 1993 (U-series dating);

^{2a} Mercier and Valladas 2003

³ Valladas *et al.* 1988 (TL dating)

⁴ Schwarcz and Rink 1998 (ESR dating)

In sum, thirteen Levantine crania were found to be appropriate for this study. The list of the specimens was presented above. In order to see whether the magnitude of variation that these thirteen specimens exhibit is unusual, they are compared to a recent modern human sample from the Pannonian Plain that the author studied for this purpose. The choice of this particular recent modern population as an adequate comparative sample is presented in the sections to follow.

The Levantine sample, consisting of the human fossil remains coming from the four Levantine cave sites – Tabun, Skhul, Qafzeh and Amud, are appropriate to test the Late Pleistocene Levantine human fossil variation because these are the only remains yielding from that time period, in this particular region of the world. Comparison with the single Pannonian sample is conservative in the sense that by using a sample circumscribed in time (the comparative sample spans only four centuries), disproof of the null hypothesis is easier. It would therefore strengthen results that fail to reject the null hypothesis.

II. Comparative sample from the Pannonian Plain

The comparative sample comes from the early medieval period of the Pannonian Plain, as described in Chapter Three. The Pannonian Plain encompasses a large lowland area in Central Europe, presently within the boundaries of many Central European countries. The sample used consists of recent modern human crania coming from pre-Avar and Avar age cemeteries of Western Hungary. These cemeteries date from the fourth to eighth century A.D. Both ancient written sources and the archaeological record confirm that this region, by the fourth century, had complex ethnic structure. This was

even more emphasized from the middle of fourth century and onward, when many of the so-called Eastern steppe tribes were populating the area, during the period that is known in the literature as the Great Migrations Period (Cary and Scullard 1979; Fóthi 2000; Curta 2007, 2008b).

In the following section, the comparative cranial sample is briefly presented, and the sites yielding the comparative cranial sample are listed.

1. Archaeological sites yielding the Pannonian comparative sample

The comparative recent modern sample consists of one hundred crania coming from the western part of present day Hungary, and dating to the pre-Avar and Avar

Figure 4.7 Map of the present day Hungary showing the locations of the Avar age sites (taken from Lipták 1983).

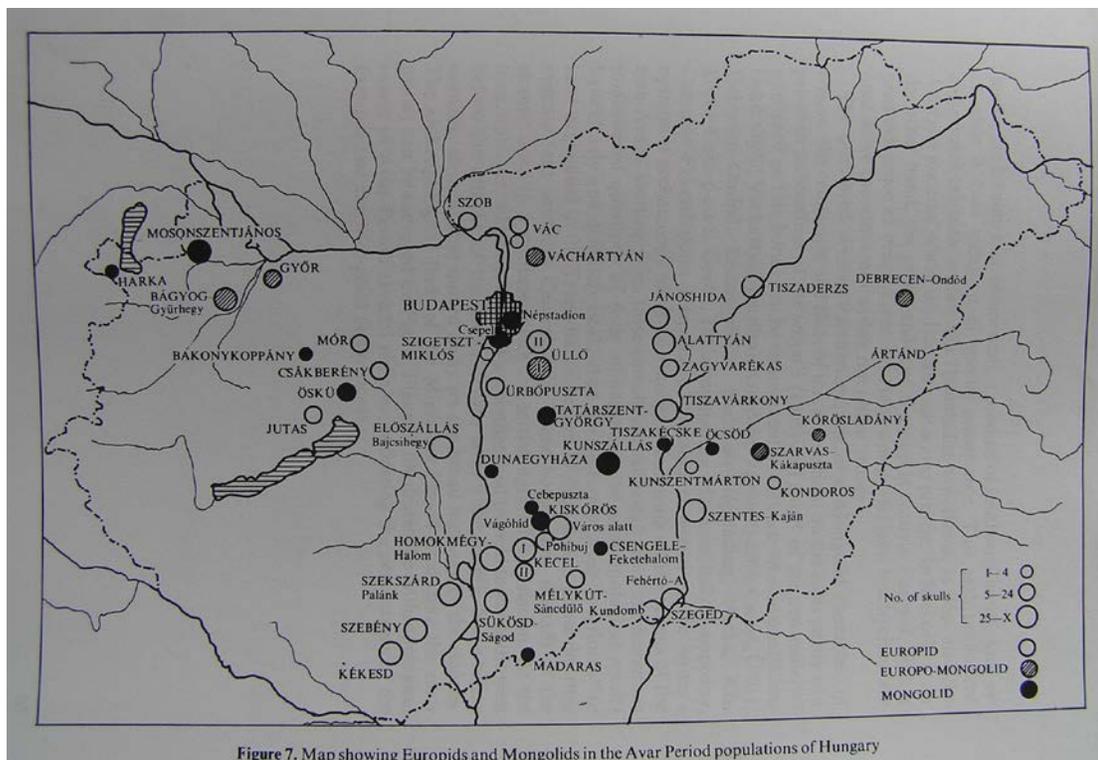


Figure 7. Map showing Europids and Mongolids in the Avar Period populations of Hungary

period. The crania used in this thesis come from the following sites: Mosonszentjános, Üllő, Homokmégy-Halom, Bugyi-Ürbőpuszta, Váchartyán, Tiszavárkony-Hugyinpart, Tatárszentgyörgy, Budapest Népstadion, Alattyán-Tulát, Keszthely-Dobogó, Budakalász, Hegykő and Szőny, representing an age range of approximately fourth to eighth century A.D. The location of the sites yielding crania for the study is presented in the figure above (fig. 4.7). Table 4.5 presents the list of sites together with the original publications with the anthropological studies of the sites in question. Also, the number of crania retrieved for the study is presented (adapted from Lipták 1983).

Table 4.5 List of the Pannonian early medieval sites and the number of crania used

no.	excavation	no. excavated		period	no. of crania used	anthropological publication
		graves	skeletons			
1	Mosonszentjános	276	105	Avar age	4	Bartucz 1929, Lipták 1959b
2	Üllő II	153	115	Avar age	11	Lipták 1955b
3	Homokmégy-Halom	167	84	Avar age	12	Lipták 1957a
4	Bugyi-Ürbőpuszta	56	39	Avar age	5	Lipták 1951b
5	Váchartyán	64	35	Avar age	10	Bátai 1952
6	Tiszavárkony-Hugyinpart -	92	58	Avar age	4	Lipták 1958
7	Tatárszentgyörgy	54	14	Avar age	2	Lipták 1959b
8	Budapest-Népstadion	35	17	Avar age	3	Lipták 1963c
9	Alattyán-Tulát	708	244	Avar age	20	Wenger 1952, 1957; Lipták 1963
10	Keszthely-Dobogó			4 th century	10	Varga <i>et al.</i> 2003b
11	Budakalász			Avar age	3	
12	Hegykő			5 th century	10	Tóth 1964
13	Szőny			4 th	6	
Total					100	

In sum, during the late antiquity and Avar reign over the Pannonian Plain, a unique development of the Avar culture, encompassing both local tradition but clear eastern influences as well, has taken place (Daim 2003). It is characterized by a great magnitude of heterogeneity in the archaeological record, as well as in the population structure. For this reason, the comparative sample studied by the author has been taken from this particular area of the world, during this particular window in time – fourth to eighth century A.D.

III. Conclusion

The chapter describes the Levantine Late Pleistocene fossil cranial sample and the comparative sample from the Pannonian basin in Europe that were analyzed by the author to test the main hypotheses of this dissertation. Six museums in five countries were visited in this research. The Southern Levant yielded abundant human fossil remains dated to the Late Pleistocene period, between roughly 130,000 and 43,000. There is a significant literature describing and analyzing the variation expressed by the Late Pleistocene Levantine hominids, reviewed in the background chapter (Chapter Two). Long-standing evolutionary issues are raised by this variation, including the recognition of intra vs. inter-specific variation, questions of changing variation over time, and recognition of the extent of admixture in both modern and fossil samples.

The goal of this dissertation is to test the hypothesis that this sample has no more variation than the recent human comparative sample of mixed ancestry. The Levantine sample, consisting of the human fossil remains coming from the four Levantine cave sites – Tabun, Skhul, Qafzeh and Amud, is appropriate to test the Late Pleistocene Levantine

human fossil variation because these are the only remains yielding from that time period, in this particular region of the world. Comparison with the single Pannonian sample is conservative in the sense that by using a sample circumscribed in time (the Pannonian sample spans only four centuries), disproof of the null hypothesis is easier. It would therefore strengthen results that fail to reject the null hypothesis. Due to the fact that non-metric cranial data reflect genetic variation, the focus of the study is put on the cranial non-metric variation. This chapter served to present both the Levantine cranial sample, and the comparative Pannonian sample.

Tabun cave yielded an archaeological sequence – almost 25 m thick, rich in Lower and Middle Paleolithic remains (Garrod and Bate 1937; Jelinek *et al.* 1973; Jelinek 1982; Bar-Yosef 1998). In addition to rich cultural material and faunal remains, the cave yielded fossil human remains. Of particular interest for the research presented here is the cranium of the Tabun I female individual found at the cave. The best assessment of its age would be $165,000 \pm 16,000$ for this layer (Mercier and Valladas 2003; Vandermeersch 2006). Skhul cave was used as both an occupational site, as well as the burial place for the Late Pleistocene population living in the Levantine area. The site yielded Middle Paleolithic stone artifacts, as well as the human skeletal remains that show a mixture of both archaic and modern features. The best estimates age the human remains between 130,000 and 100,000 years (Mercier *et al.* 1993; Grün *et al.* 2005). In sum, Mount Carmel cave sites, Tabun and Skhul, yielded human fossil remains that are broadly contemporaneous. They are confined to Late Pleistocene geological period, and Middle Paleolithic cultural period. Recent absolute dating reassessment of the burials

at Tabun and Skhul estimate that these burials fell within the 165,000 (Tabun I; Mercier and Valladas 2003) and 130,000 to 100,000 time range (Grün *et al.* 2005).

Qafzeh cave yielded human fossil remains that are generally penecontemporaneous with the human remains from the Mount Carmel sites of Skhul and Tabun. They are confined to Late Pleistocene geological period, and Middle Paleolithic cultural period. Absolute dating results of the burials at Qafzeh estimate that these burials fell within the 97,000 to 87,000 time range (Valladas *et al.* 1988).

Amud cave is another southern Levantine cave site that yielded human fossil remains dated to the Late Pleistocene remains. Most of the remains are of fragmentary and incomplete nature, with the exception of the burial of male skeleton of Amud I. The cranium of Amud I, approximately 48,000 to 38,000 years old, completes the Late Pleistocene Levantine cranial sample used in this research.

In sum, only adult and near-adult specimens with preserved cranial remains were used in the research. The specific Levantine specimens are – Skhul II, Skhul IV, Skhul V, Skhul VI, Skhul VII, Skhul IX; Tabun I; Amud I; Qafzeh III, Qafzeh V, Qafzeh VI, Qafzeh VII, and Qafzeh IX.

In order to test the unusualness of the magnitude of variation exhibited in these thirteen specimens, a comparative sample of known mixed ancestry was chosen as appropriate for this study. Heterogeneous sample from the late antiquity and Avar reign of the Pannonian Plain was chosen, dated to approximately fourth to eighth century A.D., a unique development of the Avar culture, encompassing both local tradition with clear eastern influences (Daim 2003). It is characterized by a great magnitude of heterogeneity in the archaeological record, as well as in the population structure. For this reason, the

comparative sample studied by the author has been taken from this particular area of the world, during this particular window in time – fourth to eighth century A.D. The methods used in testing the null hypothesis are presented in the chapter to follow.

Chapter 5

Methods

The research problem of this dissertation is to determine whether the magnitude of variation exhibited in the Late Pleistocene Levantine fossil is unusual. The null hypothesis tested is that there is no difference between the magnitude of variation seen in the cranial sample of the Late Pleistocene Levantine human fossil remains and the recent modern sample coming from the western Pannonian Plain, and dated to the early medieval period. This chapter serves to present the methodological procedures used in testing the null hypothesis. There were three major steps included in testing the hypothesis: 1) choice of non-metric cranial traits, 2) setting clear, objective and repeatable data collection procedures, and 3) analysis of the data collected and application of resampling method. The chapter systematically presents a detailed description of each of these major three steps, and the rationale behind them.

The first section of the chapter sets forth the choice of non-metric cranial traits for exploring the variation within the Late Pleistocene Levantine sample and testing the null-hypothesis in this research. The extensive literature on non-metric traits suggests that these traits are appropriate for exploring skeletal variation at various levels. These claims are presented in the first section. The complete list of the non-metric cranial traits used to test the null hypothesis, together with the rationale behind how this list was compiled follows.

In the second section the rationale for the cranial non-metric traits is discussed. This part describes the details of data collection procedures. First, the general, basic data collection steps are set forth – determining sex and age of the specimen. Then, the scoring procedures for the list of non-metric cranial traits are presented. In the non-metric trait scoring, it is important to set firm standardized and repeatable procedures. In the Appendix B, each non-metric trait is defined, and the scoring procedures are established.

In the third and final part of the chapter, the statistical methodology and analysis for data collection is presented. First, the summary statistics, developed specifically for this analysis, are described. Second, the resampling methodology applied in the data analysis is explained. Explanation of the data analysis completes the description of the methodological steps and procedures applied in this research.

I. Why non-metric cranial traits?

An inexperienced student in an osteology class facing human skeletal morphology for the first time may recognize many bony peculiarities in the human skeleton. This is emphasized when looking at the examples of human bones illustrated in the osteology textbooks, and comparing those examples with the bones that one has in front of oneself. One realizes quickly that human bones exhibit a large magnitude of variation in different morphological details, far more than any textbook shows. All the examples of each bone have same general bone ‘architecture’, the same template, but different details of the template vary considerably from person to person. Differences exhibited from individual to individual within a species set the magnitude of variation that is not unusual within that species. Living human populations exhibit a great richness in skeletal variation.

These variations are caused by various factors influencing the final outlook of our skeletal morphologies, some systematic such as sexual dimorphism and others individualistic. The genetic template that we start with is influenced during development by the maternal environment, hormones, nutrition, and expressions vary between sexes and with age, activity levels and patterns, trauma, pathologies, etc.

The same sources of variation influenced past human populations. However, when trying to determine what constitutes a “normal” or “not unusual” amount of variation in past populations, one encounters additional problems interpreting past human variation from fragmentary and incompletely preserved paleoanthropological and archaeological materials. The issues paleoanthropologists are faced with come from studying randomly preserved representations of past human populations. What remains is only a glimpse of past diversity in the human fossil remains. To complicate things even more, the randomness of the sample preserved is not really systematically random, but influenced by a plethora of preservation biases – from geological biases to cultural preferences.

To be specific, in order to explore where the magnitude of variation in the Levantine Late Pleistocene sample falls – within or outside the ‘not unusual’ magnitude of variation exhibited in modern human populations – one has to start with establishing what the ‘not unusual’ magnitude of variation in the modern human populations is. And then the issue is which modern populations, since there are many differences in normal populational variability. As discussed in Chapter Four, for the comparisons in this dissertation, populations constrained in time and space, known to reflect mixed ancestries have been chosen. In particular, an archaeological sample representing populations that

inhabited the Pannonian basin during the relatively short temporal span from fourth to eighth century A.D. creates the basis for a conservative study. Here the choice of the methodology to explore the variation is presented. This is followed by the methodology of analysis.

There are different ways and approaches to explore the details of the variation of the human bones that are the sole direct evidence of past skeletal populations. For this research I will focus on morphological characteristics with character states that are either expressed or not expressed. These variants of particular morphologies are usually referred to as non-metric traits – bony skeletal variants that differ from individual to individual, and are a sign of normal, non-pathological, variation. This kind of variation is what the author finds most appropriate to explore when looking at the problem of the variation of the Late Pleistocene Levantine population. The reason for this is that non-metric traits that are said to be hereditary have been useful tools in the analysis of population relationships. Studies have shown that certain non-metric traits show population relationships, i.e. groups with similar frequencies of the occurrence of non-metric traits are more closely related (Hanihara and Ishida 2001a-d; Hanihara *et al.* 2003). The success of this approach relies on the premise that more closely related people share more similar morphological shapes and more similar non-metric trait expressions. In addition, by studying non-metric traits, one does not encounter the issues of size differences, but concentrates on the shape similarities and differences. Therefore, it enables comparison of qualitative data beyond the influences of size, which is usually problematic when concentrating on metric, quantitative data.

The following section presents the basic background information on what non-metric traits are and what sort of questions non-metric traits can address.

1. What are non-metric traits?

“Non-metric traits are morphological variants of anatomy, typically of a feature or of an anatomical landmark. They can be found in any tissue, but the hard tissue, tooth and bone, are of main interest to the biological anthropologist” (Saunders and Rainey 2008:533). There has been a wide variety of names referring to such skeletal variants – non-metric (Berry 1968, 1969; Cheverud *et al.* 1979; Sjøvold 1984; Prowse and Lovell 1996), discrete (Rightmire 1972, 1976; Corruccini 1974; *“discreta”* – Rösing 1982), discontinuous (Ossenberg 1969), minor skeletal variants (Berry and Searle 1963), quasi-continuous (Grüneberg 1952; Thoma 1978, 1979, 1981), epigenetic (Berry 1963; Berry and Berry 1967; Hauser and De Stefano 1989), etc. (Saunders and Rainey 2008:538). Discrete and discontinuous nomenclature is usually used to indicate the traits that can be scored dichotomously – as either absent or present (Saunders and Rainey 2008), or any other alternative of two expressions only (Hauser and De Stefano 1989). However, there are many non-metric traits that are expressed as seemingly gradual differences in the extent of their appearance. Therefore, the term quasi-continuous is used in those cases. Different non-metric traits have different etiological provenance and therefore appear in either discontinuous or quasi-continuous expressions. Hauser and De Stefano (1989) advocated for the use of epigenetic traits to refer to the different minor skeletal variants. Epigenetic refers to *“gradual emergence of complexity seen in embryonic development”* (Hauser and De Stefano 1989:1). Therefore, *“epigenetic variants are an expression of the*

genes affecting development” (Berry and Berry 1967:362). The reason for advocating the epigenetic nomenclature is that none of the skeletal variants, in Hauser and De Stefano’s view, can be distilled to absolute binomial response. As they emphasize, even in cases where the trait can be scored as absent and present, ‘present’ expressions vary from individual to individual in the details of that expression (Hauser and De Stefano 1989:1-2).

Furthermore, there has been an emphasized distinction by some authors (Saunders and Rainey 2008) between non-metric and anthroposcopic traits. Anthroposcopic traits are “*visually discernible differences*” in various morphological expressions (Byers 2008:153). Anthroposcopic traits are not usually scored as present or absent, but are more shape-characterized (Saunders and Rainey 2008). These include different morphological expressions of the shape of the nasal aperture, eye orbits, etc. (Byers 2008).

What is true for both non-metric and anthroposcopic traits is that they are qualitative morphological expressions in the bony tissue. These variants have no pathological results in the functioning of the body, but are rather just variants of different possible expression. Therefore, in this study the author uses non-metric traits to refer to both ‘traditional’ ones (in a sense of discerning absent from present expression) and anthroposcopic traits that are for the purposes of this study standardized into binomial dichotomous responses.

The variation in expressions of various non-metric traits has been of interest to naturalists studying them from early on (as early as 1670 by the Dutch anatomist Theodor Kerckring, and onwards – Blumenbach 1776; Gruber 1852, 1870; Hyrtl 1859; Virchow 1875; Anoutchine 1878; Krause 1880; Testut 1889b; Bertelli 1892; Duckworth 1904;

Quain 1908; Le Double 1903, 1906, 1912; Schultz 1919; etc. compiled from Hauser and De Stefano 1989:1). After the initial descriptive nature of the reports on various non-metric traits, the explorations whether such non-metric expressions are indicators of heritability were initiated (Shepherd 1893; Symmers 1895; from Hauser and De Stefano 1989:1). These early explorations of familial occurrences of minor skeletal variants indicated that they would be useful for population studies (Russell 1900; Wood Jones 1931-1934; from Hauser and De Stefano 1989:1). Grüneberg (1952, 1954), Searle (1954a, 1954b) and others (Deol *et al.* 1957) conducted studies of skeletal variants in mice and confirmed that there was a potential for using skeletal variants in addressing genetic relations between different individuals (Hauser and De Stefano 1989:1). The studies on mice initiated attempts to determine whether these skeletal phenotypic expressions can reveal underlying genetic influences causing differences in morphological expression in humans (Berry and Berry 1967). The issues of whether non-metric traits are inherited in the Mendelian fashion, and are therefore discontinuous in their expression (e.g. present or absent; discrete), or whether they appear in continuous or quasi-continuous, as Grüneberg pointed out (1952) were addressed in studies during the 1950s and 1960s (Moorrees *et al.* 1952; Suzuki and Sakai 1960; Alvesalo and Kari 1972). Grüneberg's 'quasi-continuous' nomenclature of the skeletal variants indicated the interaction of two processes that affect the final expression:

“the underlying continuous variable which is influenced by the action of a number of genes, and the discontinuity imposed by the existence of alternative possible end-results of development which is the epigenetic consequence of interaction or competition between different developmental processes” (Berry and Berry 1967:362).

As Hauser and De Stefano point out (1989:1), it has been shown since then that none of the traits are inherited in a purely Mendelian fashion. Instead, it has been shown that many factors influence the variant expressions (e.g. Berry 1975; Mouri 1976; Perizonius 1979; Česnys and Konduktorova 1982; etc.). Nonetheless, the occurrences of similar morphological traits expressions do say something about closer relatedness of populations (Ishida and Dodo 1993). Therefore, non-cranial metric traits were chosen as means to explore the variation in the Levantine Late Pleistocene specimens.

2. Factors influencing non-metric trait expression

Although initially promoted as better indicators of genetic relatedness than metric traits (Berry and Berry 1967), studies have since then showed that many factors influence the expression of non-metric traits (Berry 1975; Berry 1978). Variant expressions are naturally not solely genetically instrumented, but are influenced by many environmental factors during the development and life of an individual. Factors that influence the final adult morphological expressions of the non-metric traits include diet, maternal environment, sex, age, etc. (Berry 1978; Bocquet-Appel 1984; Bocquet-Appel and de Morais 1987; Ansorge 2001). These factors therefore, in addition to the genetic basis, manipulate the final expression of bone's morphological characteristics. In addition, not all of the non-metric traits are inherited in the same manner, and therefore are not ultimately expressed in the same manner under the similar environmental influences (e.g. Czarnetski 1975; Berry 1975; Cheverud and Buikstra 1981; from Tyrrell and Chamberlain 1998).

Many studies have focused on establishing which traits are under environmental influences. The idea behind these studies is that by weighing the environmental influences, one can establish the underlying genetics of certain trait expressions. A number of these are presented in a synthetic publication dedicated to epigenetic traits by Hauser and De Stefano (1989). For each cranial trait encompassed in the synthesis by Hauser and De Stefano, a number of studies done on the environmental influence and expression preference have been compiled. However, different environmental influences are population specific. What one finds in many cases is that different studies may find quite opposing results on the environmental influences and expression of certain traits. For example, the studies on the occurrence of foramen of Huschke (tympanic dehiscence) have different population specific results (Hauser and De Stefano 1989:144):

“No consistent sex dimorphism is reported with tympanic dehiscence; differences in incidence between the two sexes are mostly not significant, for example the predominance in males observed by Krogman (1932), Laughlin and Jorgenson (1956), Perizonius (1979a), and in females by Corruccini (1974), Berry (1975), Cosseddu et al. (1979), Scarsini et al. (1980), Dodo (1982), Molto (significant difference, 1983). Similarly the majority of studies report that asymmetric expression predominates (Perizonius 1979b, Scarsini et al. 1980) with no side preference (Cosseddu et al. 1979). Yet Anderson (1969) and Molto (1983) reported that the defect occurs predominantly symmetrically, but if unilaterally expressed is more common on the left side than on the right; a tendency for the latter is indicated also in Perizonius’ (1979b) data. According to Česnys (1985) the incidence of tympanic dehiscence increases slightly between late childhood (from 10 years onwards) and adolescence, but remains stable thereafter (20-40 years 14.8%, 40 years and more 14.98%). Molto (1983) observed a significant decreased in adulthood while Berry (1975) and Perizonius (1979a) reported an increase in frequency in late adulthood.”

Although a single example is presented above, this can be extrapolated to studies of other different traits. The final expression of many traits is influenced by complicated intertwining factors that are very difficult to isolate, and are population specific.

The examples above illustrate that the expression of non-metric variants is influenced by environmental and developmental factors and is clearly more complicated than was once supposed. Nevertheless, they remain valuable aspects of the phenotype that have a genetic component, whose frequencies reflect population differences. Non-metric traits can be treated as aspects of the phenotype which have certain advantages over metric analysis, including their independence of size related issues and ease of comparison. Moreover, new analytical approaches and techniques such as those developed in this dissertation enable us to analyze non-metrics in a more straight-forward statistical manner than had been possible in the past. Some non-metric traits are clearly population specific and there are examples of these in the Late Pleistocene human fossil record. One example is a particular deflected shape of the internasal suture that is characteristic to the Krapina Neandertal sample (Smith and Smith 1986). The occurrence of a particular detail that is common within a sample can therefore address closer relatedness of the individuals within the sample. Thus, even without knowing what kinds of genetic and environmental influences are involved in particular phenotypic expressions, there is something to be said about the relatedness of the individuals within the sample if they exhibit same particular morphologies. Even Tyrrell and Chamberlain, who are wary of usage of non-metric traits in explorations of population relatedness (Saunders and Rainey 2008), concede that as phenotypic markers they have value:

“However, as a peculiar consequence of the nature of the variance of phenotypic and genotypic traits, a paradox emerges whereby to estimate

genetic relatedness it is sometimes more accurate to use a measurement based on phenotype than genotype, especially when sample sizes are small (Cheverud 1988; Roff 1995)” (Tyrrell and Chamberlain 1998:549).

In the opinion of this author, there is something to conclude from noticing similarities of phenotypic expressions in the human fossil samples.

In their introductory note to the book on cranial epigenetic traits, Hauser and De Stefano point out that:

“The present evidence suggests that, on the whole, epigenetic traits show little or no sexual dimorphism, little or no dependence upon age during adulthood, significant side to side associations in their expressions, no consistent tendency to occur on one side more often than on the other, and are largely independent in their expression from one another. All these generalizations however must at present be regarded more as working hypotheses than as firmly established rules without any exceptions. The reason for this is not the scarcity of published data on variation in epigenetic traits (in fact such data are quite abundant) but rather the fact that meaningful comparison between the results of different studies are hampered, and sometimes made virtually impossible, by differences in methods of analysis” (Hauser and De Stefano 1989:16).

In sum, the study of variation of non-metric traits can profitably be explored and encouraged, especially on a worldwide scale that has been attempted in some recent studies (e.g. Hanihara and Ishida 2001a-d; Hanihara *et al.* 2003). There is significance in the occurrences of similar patterns of overall set of traits. Although we might not yet know exactly which genetic and environmental influences interact to result in a certain expression of traits, patterns of certain expressions and their occurrences do address regional variation. Observing the similarities in both traditional non-metric traits and anthroposcopic observations can reflect the relatedness of the populations, and regional affinities. It is appropriate to apply non-metric traits when dealing with human fossil

samples because of the exigencies and nature of such samples (Cheverud 1988; Roff 1995; Tyrrell and Chamberlain 1998). Therefore, the non-metric and anthroposcopic traits are chosen to explore the variation within the Late Pleistocene Levantine fossil sample, with comparable data recorded for the comparative sample.

3. Cranial non-metric traits

After the blooming of the studies of non-metric traits during the 1950s and 1960s, the research suffered from a draw-back during decades to follow. More and more studies were showing that interaction of many complicated factors influence the final expressions and it seemed almost futile to study the traits in the explorations of genetic relatedness and heritability (historical overview in Saunders 1978; Saunders and Rainey 2008). However, after period of stagnation and skepticism, there has been reassurance that the non-metric traits have positive implications in estimating biological distance, and admixture based on different ancestry. Moreover, it was shown that some traits do exhibit strong heritability (e.g. Hilborn 1974; Berry 1978; Cheverud and Buikstra 1981a, 1981b, 1982; Tyrrell 2000).

During the 1970s, the potential use of non-metric studies for establishing the familial relationships and biodistance in archaeological samples was realized. The premises of such studies were that “*related individuals are more likely to possess similar patterns of variants than individuals who are not related*” (Sjøvold 1976-1977 from Saunders and Rainey 2008:544). Biodistance studies could explore the relatedness of the individuals buried together within the same cemetery or other burial places. The premise of such studies is that individuals who are buried in proximity to each other are

theoretically more likely to be closer related than those who are not (Lane and Sublett 1972; Saunders and Rainey 2008:544). Therefore, in determining biodistance, non-metric traits were used in reconstruction of past kinship systems (Allen and Richardson 1971; Lane and Sublett 1972; Piontek 1979; Carson 2006; Česnys and Tutkuvienė 2007) and biological relatedness (Buikstra *et al.* 1990; Rogers and Harpending 1983; Piontek and Śmiszkiewicz-Skwarska 1994; Stojanowski and Schillaci 2006).

However, Cadien and colleagues (1974) suggested that archaeological skeletal samples reveal lineages rather than biological populations. Therefore, since they span a wider temporal range, non-metric traits of retrieved archaeological populations can be more influenced by environmental factors over time, and can result in different populations appearing to be more similar. In the Levantine sample, with its broader temporal span, this is indeed an issue to address. However, not all the expressed morphologies are solely under the influence of the environment, but include genetic underlying as well. And this is precisely when one sees in the Levantine sample. There is a mix of both archaic and modern morphologies across all the specimens studied.

Some studies have found that cranial non-metric traits have implications for exploring regional differences (Laughlin and Jørgensen 1956; Brothwell 1959; Ossenbergh 1976; Pardoe 1991; Johnson and Lovell 1995; Prowse and Lovell 1995; Blom *et al.* 1998; Christensen 1998; Gemmerich Pfister 1999; Cybulski 2001). Hanihara and colleagues (2003), based on a large worldwide population sample, have shown that there is discrete regional distinctiveness in the expression and occurrence of cranial non-metric traits. However, although there are regional tendencies, there is a continuous change in the frequencies of the occurrence of certain combinations of non-metric traits from region to

region (Hanihara *et al.* 2003; Saunders and Rainey 2008). Studies of the occurrence of the non-metric traits were shown to be useful in the studies of the populations' admixture and population history (Hallgrímsson *et al.* 2004).

Influence of the environmental stress, in specific cranial modification, does have a moderate proximal effect on the expression of the non-metric traits (Konigsberg *et al.* 1993; Del Papa and Perez 2007; Saunders and Rainey 2008). However, Konigsberg and colleagues' study has also shown that nonetheless, the non-metric traits are partially heritable (Saunders and Rainey 2008). Therefore, the cranial non-metric traits were appropriate to employ in the exploration of the variation in the Levantine Late Pleistocene fossils.

4. Non-metric traits in fossil human crania: Neandertal and modern human morphologies

Particular morphological details in terms of anthroposcopic and non-metric traits have been described for the crania of many human fossil groups. This was done in trying to define what is characteristic or particular for each group. Because many authors explain the variation in the Levantine Late Pleistocene human fossil sample taxonomically, what is of interest for this study is to examine particular characteristics that are said to be typical cranial non metric traits for Neandertals and those said to be typical cranial non-metric traits for 'anatomically modern human' in these remains.

The traits that are said to be autapomorphic to Neandertals are listed in table 5.1 (list compiled from Hublin 1998:297, Wolpoff 1999:756, Ahern 2006:256, Tattersall and Schwarcz 2006:256, and Trinkaus 2006:600, 601, 603 after Hublin 1978, 1998; Santa Luca 1978; Vandermeersch 1981; Stringer *et al.* 1984; Schwarz and Tattersall 1996a,

1996b, 2005; Rak and Hylander 2003). What is said to be characteristic for ‘anatomically modern humans’ is that they do not exhibit those features, and in contrast have developed others that Neandertals do not express. Some of the characteristic modern human cranial morphological features are relative parietal expansion, supraorbital torus absence, sagittal keel absence, nuchal torus absence (or minimal development), reduced or absent angular torus, prominent parietal bosses, laterally bulbous mastoid processes, reduced juxtamastoid eminence, external occipital protuberances, high and rounded temporal squamous portion, reduced facial length, posterior position of the anterior zygomatic root, distinct canine fossa, narrow nasal aperture, and narrow nasal bridge (Trinkaus 2006:600-601).

Table 5.1 Neandertal cranial autapomorphies, unique or most frequent in the group. Arranged by cranial area. Modified after Hublin 1998:297 (Table 1), Wolpoff 1999:756, Ahern 2006 and Trinkaus 2006.

Cranial vault	secondarily increased relative platycephaly
	“en bombe” cranial shape
	low symmetrically arched temporal squama
	external auditory meatus at the level of the posterior zygomatic arch with a strong inclination of the basal groove of this process
	fully developed suprainiac fossa associated with a bilaterally protruding occipital torus
	highly convex upper scale of the occipital
	laterally flattened mastoid process, medially oriented inferiorly
	anterior mastoid tubercle
Face	rounded supraorbital torus without distinct elements
	high orbits
	mid-facial prognathism resulting in low subspinal angle, low nasiofrontal angle, large difference between M1 alveolus and zygomaxillare radii
	infraorbital area horizontally flat or convex, obliquely receding in alignment with the antero-lateral surface of the zygomatic
	posterior rooting of the facial crest
Basicranium	flat articular eminence
	mediolaterally developed postglenoid process
	elongated foramen magnum
	root of the stylomastoid process medial to the anterior end of the digastric groove and stylomastoid foramen
	small and inferiorly situated posterior semicircular canal

However, as Wolpoff points out “*it is difficult to find true autapomorphies in the Neandertals*” (Wolpoff 1999:756). Not all the Neandertal specimens exhibit all of the features listed above nor their morphologies are exactly equivalent. Nor is it true that those features appear exclusively in the Neandertals. Studies by Frayer (1986, 1992, 1993), Szilvássy and colleagues (1987), Smith (1992), Mann and colleagues (2003) and Wolpoff (1999) have shown that Upper Paleolithic Europeans, and other Late Pleistocene populations, almost always exhibit some of those Neandertal ‘unique’ features (from Wolpoff 1999:756). However, the frequency of occurrences of such ‘unique’ features and the extent of their morphological expression do differ. The difficulty that remains is where to draw the line between those features having true ‘Neandertal’ extent and patterns of expression versus some of those who do not possess that kind of the accentuated expression but nonetheless appear in non-Neandertal specimens of the Late Pleistocene, and Holocene period. The same can be said about characteristic modern human morphological characteristics. There are modern humans who do not exhibit some of the features that are said to be typical and ubiquitous among modern human populations. Therefore, the features said to be typical for Neandertals and modern humans were examined across the Levantine samples to see whether there is a clear differentiation and clustering of Neandertal features on certain specimens and modern human features on other specimens.

The variation in the sample of the Late Pleistocene Levantine specimens studied in this research (thirteen specimens, Chapter Four on material) has been explained by some authors as evidence of the penecontemporary coexistence of two different taxa in the Levant area (Neandertals and modern humans). However, all the specimens show a

mix of both archaic and modern features. There are certain non-metric characteristics that are said to be autapomorphic to Neandertals, and some that are characteristics for the anatomically modern humans. McCown and Keith, in their monograph on the Mount Carmel Late Pleistocene population (1939), recognized these differing expressions of morphologies in terms of what they described as Palaeoanthropic versus Neanthropic characteristics (represented in tab. 5.2), following the literature until then published on characteristics of ‘typical’ Neandertal morphology (Boule 1911-1913) and ‘typical’ modern human morphology (Verneau 1906).

Table 5.2 List of morphological characteristics that McCown and Keith used in distinguishing Neandertal from modern human expressions in Mount Carmel sample. Taken from McCown and Keith 1939:359-360 (only cranial and dental characteristics presented, under McCown and Keith numeration) – “*Analysis of the diagnostic characters of the type or species represented by:*”

	Neandertal Man	Mount Carmel Man	Cromagnon man
2	Head massive with the facial parts large relatively to the brain-containing part.	Head massive, but face not excessively developed.	Head massive, but face not excessively developed.
3	Skull dolichocephalic or mesaticephalic.	Most are strongly dolichocephalic but one – Tabun woman – has an index of 77.	Most are strongly dolichocephalic.
4	The vault is very low (platycephalic).	Vault of medium, or even above medium height.	Vault high.
5	Eyebrow ridges assume form of continuous torus.	Torus, but with a tendency to separate into medial and lateral parts.	Separation into medial and lateral parts is complete.
6	Forehead very receding.	Forehead moderately full.	Moderately full or developed.
7	Occiput ‘en bourrelet’, compressed vertically; does not project behind attachment of neck.	Not compressed vertically. Projects slightly beyond attachment of neck.	Compressed laterally. Projects well behind attachment of neck.
8	Face – particularly the upper face – very long.	Face of moderate – or above moderate – length.	Face of moderate length.
9	Face prognathous.	Face usually orthognathous.	Face orthognathous.
10	Malar bone has the flat form seen in anthropoid apes.	Malar is flat and anthropoid-like, but with a decided tendency in some individuals towards a Neanthropic form.	Malar is Neanthropic.
11	Superior maxillae are devoid of canine fossae and are snout-like in form.	Superior maxillae, although devoid of fossae, are flattened in front but are usually not snouted.	Neanthropic.
12	Orbits are large and rounded in form.	Orbits wide but not high.	Orbits wide but not high.
13	Nose very large, projecting and wide, its lateral margins not demarcated from face.	Nose variable in projection and width. Laterally it is partially demarcated.	Nose variable in projection, usually narrow; laterally sharply demarcated.
14	Subnasal part of face is deep and wide.	Subnasal area wide, but not deep.	Subnasal area moderate in width and depth.
19	Teeth are big.	Teeth are moderate in size or large.	Teeth moderate in size.
20	Molars retain certain primitive characters.	Molars retain certain primitive characters.	Molars are Neanthropic in characterization.

The observations made by McCown and Keith on the ‘Palaeoanthropic’ versus ‘Neanthropic’ expression of certain morphological characters are the starting point in creating the list of non-metric cranial traits used for this research. Therefore, it is

appropriate to compare the occurrences of ‘typical’ archaic and modern cranial non-metric traits in this sample, and compare whether the magnitude of variation shown by such heterogeneity is unusual when compared to the modern Pannonian sample.

In sum, focus is put on non-metric and anthroposcopic variation for this analysis because there is a substantial amount of literature that suggests their importance for identifying and distinguishing variation at various levels (e.g. Berry and Berry 1967; Corruccini 1974, 1976; Cheverud *et al.* 1979; Buikstra 1980; Hauser and De Stefano 1989; Saunders 1989; Buikstra *et al.* 1990; Gill and Rhine 1990; Buikstra and Ubelaker 1994; Hillson 1996; Brasili *et al.* 1999; Gualdi-Russo *et al.* 1999). Subsets of different non-metric and anthroposcopic variation were described in detail in each of the descriptive monographs for the Levantine sites, but they have never been considered together in a comparative context based on the same set of observations made by a single researcher. In addition, focus is put on morphological features that are differentiated between the archaic and modern populations.

II. Data collection

To test the null hypothesis, the data on the occurrences of cranial and maxillary dental non-metric traits in the Levantine fossil sample and recent modern human archaeological sample from the Pannonian Plain were collected (Appendix C). The cranial observations were determined by considering all observations found in monographs published on the Late Pleistocene Levantine fossils (McCown and Keith 1939; Suzuki and Takai 1970; Vallois and Vandermeersch 1975; Vandermeersch 1981; Bar-Yosef and Vandermeersch 1991b) and additional repeatable observations the author

made. The rationale behind the traits compiled is to consider all the traits that researchers described as very variable in the original Levantine fossil sample. In addition, other commonly scored non-metric traits that could be observed in the fossils were included. The traits are therefore based on the observations in the original fossil sample that was presented in the previous chapter (Chapter Four). Everything that can be observed in the adult or nearly adult fossil specimens was included in the study. The only criterion for including a fossil was near- or full adulthood. Among the Pannonian cranial sample there was another additional criterion followed in choosing the specific skulls to work on – the most complete at each site. This does not mean that they were in impeccable state of preservation due to the fact that they all also come from the archaeological excavations.

In the following section, the steps involved in data collection procedures are described. First, the general sex and age assessment for each specimen is performed and details on the assessment procedures are set forth. What follows is a detailed list of all the non-metric cranial traits used in the statistical analysis.

1. Assessment of sex

First, the general personal assessments of the sex based on standard sexual dimorphic cranial traits (skull size, glabellar region, nuchal region, mastoid processes, orbital margins following Acsádi and Nemeskéri 1970) were made. The sexing of the Levantine crania is based on what is accepted in the first descriptions of the specimens (McCown and Keith 1939; Suzuki and Takai 1970; Vallois and Vandermeersch 1975; Vandermeersch 1981) and in others since then in the literature. However, for some of the specimens, specifically Qafzeh IX, the issue of determining sex has been debated among

different scholars. Vandermeersch is of opinion that Qafzeh IX is probably female for various reasons (1981:44), while Frayer and colleagues determine it to be male (see discussion in Frayer *et al.* 2006:199). For this study, sex of Qafzeh IX can remain an open question, because both samples, Levantine and Pannonian, contained both sexes and were not in analyses in any way differentiated between the sexes.

2. Assessment of age

Thirteen original Levantine fossil crania were examined (tab. 4.3, presented in Chapter Four on material) and one hundred adult crania from the recent Pannonian modern sample (tab. 4.4, presented in Chapter Four on material). Juvenile specimens were excluded from this study. However, a number of near-adult individuals were scored to enable the comparison with the near-adult fossil specimen (Qafzeh IX).

The determination whether the individuals examined were adult was assessed primarily based on the presence of their third molars. The presence of a fully erupted third molar in occlusion was necessary to meet the criterion of being adult. In cases where third molars were not present (either because they were not congenially present or damaged) in certain specimens, but the individual displayed adult characteristics based on tooth wear and sutures, the specimens were included in the research.

The adults were divided into two major groups – a younger adult group and an older adult group. The younger adults have erupted third molars, but dentition that is only slightly worn, and sutures that are still open or clearly visible. The older adults have erupted third molars, but dentition that is quite or heavily worn (all the way to dentine), or absent (attrition of the bone). In addition, those individuals were checked for closed or

obliterated sutures. The Standards (Buikstra and Ubelaker 1994) were followed in assessing both the phases of suture closure (Walker *et al.* 1991) and dental wear (Lovejoy 1985; Richards and Miller 1991).

The near-adult specimens were included in the study due to the assessment of the Qafzeh IX fossil specimen to be of late adolescent age (Vandermeersch 1981:48-49). The subadults were determined as having indication of third molars erupting, but not in the full occlusion.

3. Scoring

The list of the variables (tab. 5.2) was composed of some of the commonly scored non-metric traits extensively used in the literature that already have standardized methodology (e.g. presence of different sutural ossicles, etc.; Hauser and De Stefano 1989). Those commonly used traits that were possible to score on fossil specimens were included. In addition to these commonly scored variants, other variants were chosen based on their different expression described and noticed in the original descriptive publications of the Levantine fossil specimens (McCown and Keith 1939; Suzuki and Takai 1970; Vallois and Vandermeersch 1975; Vandermeersch 1981). If there was already developed methodology for scoring such traits, the recommendations for scoring procedures were followed. However, in some cases the scoring procedures were modified, and some additional methodological procedures were developed.

The reason for the modification of some of already established scoring procedures was the need to reduce the scoring of all the traits to binomial responses for each variable. Therefore, the scoring questions were designed to be answered as either one

way or the other, as opposed to scoring gradual (quasi continuous) responses (e.g. very small, small, medium, large, very large). All data were collected as binomial responses for each variable as yes or no, large or small, angled or straight, absent or present, etc. The reason for the abandonment of the quasi-continuous gradation of certain morphologies, and preference of discrete, binomial scoring is to reduce the problem of error within the collection of qualitative data by opposing two different morphological expressions, and ignoring the nuances in size differences. The resolution of the data may be lower, but their accuracy and repeatability are far higher. All the scoring questions and procedures are detailed in Appendix B.

The cranial traits that are already described and commonly used by many researchers were collected according to the procedures recommended by Hauser and De Stefano (1989). For the maxillary dental traits, scoring standards developed by C. Turner and colleagues (Turner *et al.* 1991) and T. Crummett (Crummett 1994) were used, as well as the recommendations by S. Hillson (1996).

The initial list of non-metric traits to score was comprised of 132 traits, presented in Appendix A. All the original fossil specimens (with the exception of Skhul IV, explained in Chapter Four on material) were scored for these 132 traits by the author. The same set of observations was repeated on each cranium from the Pannonian comparative sample. Inevitably, due to the nature of the preservation of the fossil specimens, a number of traits were not possible to observe or score. This was because of the fragmentary nature of fossil specimens – in many cases some key cranial elements were missing. Due to the fact that the Pannonian sample is from archaeological excavations, the problem of preservation bias was present in the comparative sample as well. Therefore, there were

some comparative cranial specimens where certain traits were unobservable (missing). This, however, influenced data collection to a lesser extent. Differences between the preservation of two different samples are due to the fact that these samples are retrieved from different geological and archaeological contexts, using different techniques. Specimens from the Pannonian sample have biases in preservation such as missing anterior dentition (excavation bias). Fossil specimens have more problems with the preservation biases due to the fact that they were buried under heavy sediment, in a cave environment. Both samples are not only influenced by these geological/ archaeological/ excavation biases, but the biased burial customs of the Late Pleistocene (Vandermeersch 2006) and the Pannonian sample (Daim 2003). The burial customs in different cultures differ in terms of who gets to be buried – age, sex, social status and cause of death can all play an important role. Moreover, the choice of burial grounds and robustness of skeletal remains buried will also influence which specimens are more likely to withstand the millennia while buried under the heavy sediments. However, these are exigencies characteristic of the fossil skeletal material that one cannot control except in the choice of an appropriate comparative sample.

For the purpose of comparable analyses, differences in preservation and the ability to accurately repeat observations required that 12 of the traits from the original list of 132 traits had to be omitted. The omitted traits are the following: #67, 77, 78 (due to the problem of setting a standardized cut off value for the modern and fossil measures with confidence); #107 (too difficult to set the repeatable scoring standard); # 115 (due to the fact that in none of the thirteen fossil specimens this trait could be observed with confidence); #124-130 (these traits were problematic to observe in the Pannonian sample

where anterior dentition was lacking due to the archaeological provenance and post-mortem loss of the loose anterior dentition – modern anterior teeth were missing most of the time). Therefore, the working list of traits employed in the analyses was reduced to total of 120 traits.

This list was further reduced to almost half its original size. This was because for the meaningful analyses of variation, only the traits that were possible to score in at least one specimen of all the Levantine sites were included. The number of traits included in the analyses in this research was reduced to sixty seven. The following table presents the full and final list of non-metric traits that it was possible to statistically analyze (tab. 5.3).

Table 5.3 List of 67 traits used in the analysis of the Levantine and Pannonian samples. Observations, as well as scoring procedures, are presented and explained in Appendix B.

final trait #	original trait #	trait name
1	11	Position of the greatest breadth as seen from above
2	12	Brows above orbits
3	13	Passage from the torus to the frontal on the sides
4	14	Outline from the postorbital constriction to the tuber parietal
5	15	Frontal keeling
6	16	Sagittal keeling
7	17	Forehead
8	18	Prebregmatic eminence
9	19	The sagittal line continues to rise behind the bregma
10	20	Prelambdoidal flattening
11	25	Subnasal region surface
12	26	Alveolar prognathism
13	30	Suprameatal spine
14	31	Hyperostosis of tympanic (tympanic thickening)
15	32	Foramen of Huschke (tympanic dehiscence)
16	33	Prominent temporal crest on parietal
17	34	Angular torus
18	35	Supramastoid crest
19	36	Mastoid crest
20	38	Massive mastoid process
21	39	Mastoid shape
22	40	Mastoid's summit
23	41	Mastoid suture

24	42	Exposure of the digastric fossa on the lateral side of the skull
25	43	External auditory meatus' angle
26	44	External auditory meatus' shape
27	48	Metopic suture
28	49	Frontal groove
29	50	Supraorbital notch
30	51	Deep supraorbital notch
31	58	Supraorbital structure
32	59	Supraorbital region
33	60	Shallow groove that passes obliquely outwards and upwards between the medial and lateral element of supraorbitals
34	61	Glabella dips downward
35	62	Projecting glabella
36	63	Lateral extension of supraglabellar sulcus/supratoral sulcus
37	64	Downward dislocation of lateral superior orbital margin
38	65	Superior margin of the orbit
39	66	Orbit shape
40	70	Nasal spine
41	71	Subnasal margin
42	72	Double lower nasal margin (internal and external)
43	83	Position of the greatest breadth as seen from the rear
44	84	Cranial rear rounded
45	85	Mastoid process projects minimally
46	86	Mastoid well detached from the petrosal bone
47	87	Laterally convex surface of mastoid
48	88	Mastoid tip
49	90	<i>Torus occipitalis</i> (between supreme and superior line)
50	91	Torus breadth equals semispinalis breadth
51	92	Supreme nuchal lines away from midline
52	93	Supreme nuchal lines come together to form external occipital protuberance
53	94	Superior nuchal lines come together to form tuberculum linearum
54	95	Location of the EOP and tuberculum linearum coincides
55	96	Occipital bun
56	97	Elliptical suprainiac fossa
57	98	<i>Semispinalis capitis</i> attachment
58	103	<i>Sutura mendosa</i>
59	104	Maxillary torus
60	109	Digastric sulcus is fairly wide
61	110	Digastric sulcus is fairly shallow
62	111	Juxtamastoid crest
63	120	Glenoid cavity has significant anterior vertical surface
64	121	Medial glenoid (temporal) spine
65	122	Post-glenoid process (spine)
66	131	Peg like M3
67	132	Accessory cusp on molar (any molar)

4. Scoring standards

The standards for scoring the specific expressions of the traits were set in such a manner that the scores could be collected as dichotomous, binomial responses for each trait. This is clear and easy to do in cases of presence and absence of traits. For every other qualitative expression, e.g. morphology of eye brows, flatness of the base, etc., the standards were set so that expressions could also be scored as binomial responses.

In the cases where the trait is expressed bilaterally, and where both responses can be scored, left side was preferably scored. However, when the left side expression was missing or not possible to score (preservation issues), the right side was observed and, if present, data were collected. Ignoring the difference between unilateral and bilateral presence of traits and only scoring the occurrence (or absence) of the traits is a common approach used in numerous studies (Korey 1970; Buikstra 1972; Birkby 1973; McWilliams 1974; Suchey 1975; Jeyasingh *et al.* 1980 from Hauser and De Stefano 1989:17). The definition and description of each of the traits is presented in Appendix B, which also contains the information on the standardized scoring procedures used in the data collection.

In sum, several consistent steps were followed in data collection for both samples. The personal assessments of the sex of the Pannonian specimens based on standard sexual dimorphic cranial traits were made. The sexing of the Levantine crania was based on what is accepted in the first descriptions of the specimens and in others since then in the literature.

Thirteen original Levantine fossil crania were examined and one hundred adult crania from the recent Pannonian modern sample. Juvenile specimens were excluded

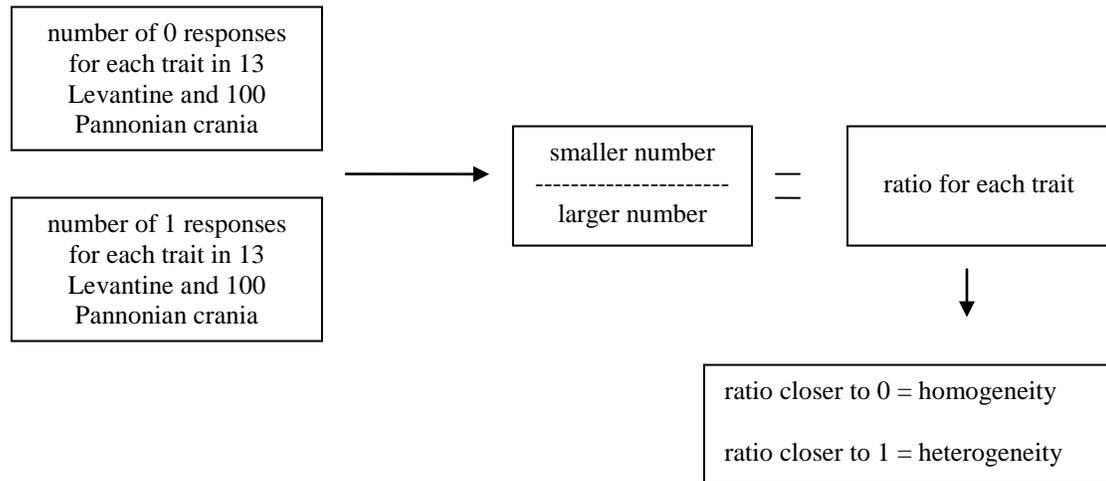
from this study. However, a number of near-adult individuals were scored to enable the comparison with the near-adult fossil specimen (Qafzeh IX).

The list of the non-metric traits used in this study was composed of some of the commonly scored non-metric traits extensively used in the literature, that already have standardized methodology. Those commonly used traits that were possible to score on fossil specimens were included. In addition, cranial non-metric traits that are characteristic of archaic and modern fossil specimens were included. The standards for scoring the specific expressions of the traits were set in such an order that the scores could be collected as dichotomous, binomial responses for each trait. The standardized scoring procedures for each of the traits included in this study are presented in Appendix B. For the meaningful analyses, only the traits that were possible to score in at least one specimen of all the Levantine sites were included in the final analyses. Therefore, sixty seven traits were included in the analyses of this research.

III. Statistical analysis: summary statistics and resampling

When data collection was completed for both samples – original fossil and comparative sample, the test statistic was constructed in the following way. For each variable, the total number of each binomial response in the sample was counted. This resulted in two summary numbers of which the smaller of the two was divided by the larger. Each variable then resulted in a summary ratio reflective of the variation, always one or smaller than one. The larger the ratio, the more variable the trait was, and inversely, the smaller the ratio meant more homogeneous results (fig. 5.1).

Fig. 5.1 Flow-chart illustrating the procedure of calculating the ratios.



After calculating the ratios for all the 67 traits studied, the following two summary statistics were computed:

1. the average of the ratios for the different traits (variables), measuring the average heterogeneity versus homogeneity; and
2. the variance of these ratios, measuring the variation of the traits, whether all traits show an equal magnitude of variability.

For the purposes of the analysis, the Levantine sample is comprised of all the specimens coming from the four Levantine site – Qafzeh, Skhul, Tabun and Amud – further referred to as ‘all fossil data set’. For the data set, summary ratios were calculated as mentioned above. Each ratio has a specific sample size – dependent on the number of fossil specimens and the presence of preserved traits that can be accurately measured.

1. Resampling

Paleoanthropologists face several problems when dealing with fossil human remains. Primarily, the few discovered sites often yield only one or few fossil specimens. With sample sizes that consist of only few individuals, it is very difficult to draw any valid statistically weighted conclusions. In addition, fossil materials are often fragmentary, where only some elements are preserved, leading to preservation biases. The unpredictable process of fossil preservation in addition to the randomness associated with sampling only some individuals or some fossilized elements can produce misleading results in studies that analyze variation. Therefore, several authors have proposed resampling methods for dealing with small fossil sample sizes (Lee 1999; Gordon *et al.* 2008). Since the Levantine sample is small, it is appropriate to use resampling techniques to examine the question of whether the heterogeneity and variation of the non-metric traits among the Levantines are unexpected when compared to human populations of mixed ancestry. In order to see whether the fossil sample is unusual, it is compared to the recent Pannonian sample which comes from the archaeological record. Assessing the preserved variation in the Levantine sample and then resampling those results from the comparative Pannonian sample many times should address whether the magnitude of variation in the Levantine sample is unusual when compared to the modern comparative sample.

Resampling is an approach that makes minimal assumptions about the distribution of the underlying statistical population, other than that the sample is considered a good representation of the true population (Estabrook and Estabrook 1989; Crowley 1992; Estabrook 2002, 2005). In resampling, the focus of study is the sample itself, and no

assumptions are made about the population from which it derives. This approach enables comparisons with the recent, much larger, Pannonian sample. Furthermore, it enables the estimation of the probabilities that the Levantine sample can be regarded as unusually variable relative to the population of mixed ancestry.

2. Resampling of the fossil data set

To address the question of whether the whole Levantine fossil sample is unexpected in its variation, a sample size equal to that of the Levantine sample is randomly drawn from the Pannonian sample multiple times with replacement. Since the total fossil data set consists of thirteen specimens in total, the random drawing of a set of thirteen individuals from the Pannonian sample was repeated 1,000 times with replacement. The two summary statistics described above – the average of the ratios for the different variables and the variance of these ratios – were then calculated for each instance of random drawing from the Pannonian sample, generating a distribution of 1,000 randomly sampled statistics that reflects the mean and variance of thirteen individuals in the human sample. This procedure provides statistically weighted results that determine whether the mean and variance (two summary statistics) of the total fossil data set of thirteen individuals are unusual. The question is about where the mean and variance for the fossil sample falls within the distribution resampled from the Pannonian data. The results can then be interpreted in the context of the chances of finding the fossil set in the resampled human distribution. If the observed fossil summary statistics fall within the 95% confidence interval of the resampled distributions, the null hypothesis cannot be rejected. This addresses how unusual the fossil variability is.

The major issue encountered during the performance of the resampling analysis was the necessity of omitting certain traits from the analysis. The issue was whether and how to omit problematic traits. Traits were omitted because the resampling program would encounter problem with continuing pooling sets of individuals after certain number of permutations that were the result of the missing/uncollectible (x) fossil expressions. Therefore, in cases where not enough expressions in the fossil record could be observed – not enough for running the resampling program and have a meaningful analysis with statistical power – the trait was omitted from the analyses. Omitting traits was avoided when possible.

The traits used in the analysis of the total fossil data set were also limited to ones that were present in each of the Levantine sites. Therefore, the list of the traits used in the analysis of the total fossil data set was reduced from the original list. It was not possible to observe forty three of the original traits in the Tabun I specimen. An additional ten traits could not be observed on the Amud I specimen (missing elements). Skhul and Qafzeh specimens were not missing any additional traits. In all, the analysis included sixty seven traits from the original list (original list presented in Appendix A).

To reiterate, the data collected for the Levantine sample was statistically analyzed in comparison with the resampled distribution of the same sample size from the Pannonian sample. The analysis was performed in few steps. First, for each variable, the total number of each binomial response was counted. Second, the ratio indicating homogeneity versus heterogeneity for each trait was computed. Third, the average of all the ratios was calculated. Fourth, the variance of the ratios was computed.

In order to see whether the variability of the Levantine sample is unusual, its position within the resampled Pannonian sample was examined. A sample size equal of 13 to that of the Levantine sample was randomly drawn from the Pannonian sample multiple times. A random drawing of a set of thirteen individuals from the Pannonian sample was repeated 1,000 times with replacement. The average of the ratios for the different variables and the variance of these ratios were calculated for each instance of random drawing from the Pannonian sample, generating a distribution of 1,000 randomly sampled statistics that reflects the mean and variance of thirteen individuals in the human sample. This procedure provides statistically weighted results that determine whether the mean and variance (two summary statistics) of the total fossil data set of thirteen individuals are unusual. If the observed fossil summary statistics fall within the 95% confidence interval of the resampled distributions, the null hypothesis cannot be rejected.

The results are described in the next chapter.

IV. Conclusion

To test the null hypothesis of no difference between the magnitude of variation seen in the cranial sample of the Late Pleistocene Levantine human fossils and the human population of mixed ancestry from the early medieval Pannonian basin, several methodological steps had to be followed. This chapter presented the rationale behind the methodological procedures employed. There were three major steps included in the testing the hypothesis: 1) choice of non-metric cranial traits, 2) setting clear and repeatable data collection procedures, and 3) the analysis of the data collected using a resampling approach.

To test the hypothesis, non-metric and anthroposcopic cranial traits were chosen for the analysis. This choice came from the substantial literature that suggests their importance for identifying and distinguishing variation at various levels, and distinguishing humans and Neandertals, the two species thought (by some) to coexist in the Levant. Subsets of different non-metric and anthroposcopic traits were described in detail in each of the descriptive monographs for the Levantine sites, but they have never been considered together in a comparative context based on the same set of observations made by a single researcher.

Several steps were followed in data collection for both samples. First, the general personal assessments of the sex based on standard sexual dimorphic cranial traits were made for the Pannonian sample. The sexing of the Levantine crania was based on what was accepted in the first descriptions of the specimens and in others since then in the literature.

Thirteen original Levantine fossil crania were examined and one hundred adult or near-adult crania from the recent Pannonian modern sample. Standardized scoring procedures for each of the sixty-seven traits included in this study were set. The traits were chosen from the original publications on the Levantine fossils, typical Neandertal and modern human traits, and traits that the author devised. The standards for scoring the specific expressions of the traits were defined in such an order that the scores could be collected as dichotomous, binomial responses for each trait. For meaningful analyses, only the traits that could be scored in at least one specimen from each of the Levantine sites were included in the analyses: sixty seven traits in all.

The data collected for the Levantine sample was then statistically analyzed in comparison with the Pannonian sample. Two summary statistics were computed for both samples: 1) the average of the ratios for the different traits (variables), measuring the average heterogeneity versus homogeneity; and 2) the variance of these ratios, measuring the variation in the variability of the traits, whether all traits show an equal magnitude of variability. After calculating the average of trait ratios, and the variance of the trait ratios for the Levantine sample, resampling methods were employed. This method enabled the comparison of the Levantine results with the comparative Pannonian sample results. The results are presented in the following chapter.

Chapter 6

Results and discussion

Thus far, the reader has been introduced to the complexity of the interpretations of the Late Pleistocene Levantine human fossil variation. Today, some seventy years after the discovery of the majority of the Levantine Late Pleistocene sample, the interpretation of the skeletal material found is still not agreed upon. As presented in previous chapters, the source of the ‘unusual’ variation seen in the Levantine fossil record has been interpreted in various ways. The first interpretation presented was that the Levantine sample represents a point in time when Neandertal and modern humans were ‘crystallizing’ each in their own particular morphologies, a point that would later inevitably lead to the divergence of the two forms. Interpretations proposed afterwards range from two different populations hybridizing in this region, to two different species frequenting and inhabiting this area at different points of time with no interaction. Previous chapters discussed causes for varied, opposing ways of interpreting the same thirteen specimens of the Late Pleistocene Levantine sample.

What attracted the author to this research was the breadth of these interpretations, and their importance in the broader understanding of human evolution. The focus was on the first premise of the whole problem of the Levantine Late Pleistocene populations – the magnitude of their variation: was it really unusual? Following the significant literature offering solutions to the problem of Levantine variation, one fact continued to

appear in the works of many authors. The heterogeneity of the Levantine specimens is *unusual*, or in other words greater than what modern populations could be expected to exhibit. But do we know what the *not unusual* variation in the modern population is? It seemed to the author that this was a statistical question that had to be answered in a comparative context.

The aim of this study was therefore to make a comparison of the variability in the Levant crania and the variation in a human population (variation in other parts of the body could follow). If the variation in the Levantine sample is really caused by taxonomic differences as some scholars posit, we would expect that the Levantines should exhibit a greater magnitude of variation than an appropriate, admixed comparative population from one specific geographic area (as the Levant is). The population chosen was one of mixed ancestry, because interpretations of the Levantines that are opposed to a mixture of species interpretation involved a mixture of human populations (this was first suggested by Dobzhansky in 1944). The approach was to test a null hypothesis comparing the Levantine cranial variation with the cranial variation in a human population from a limited geographic area with ancestry known to be mixed. The Pannonian sample I used consisted of 100 human crania from the area, spanning four centuries of the medieval period, of known mixed ancestry.

The methodology of how the magnitudes of variation in Levantine and Pannonian samples were identified and compared was set forth in the previous chapter. This chapter presents the results of the statistical analyses. First the raw results are presented. What follows in the second section is the discussion of how these results fit in the current human evolutionary framework. The immensely important advances in research on

ancient human DNA sequences yielded seminal papers published in the last few years. These new findings help reconcile the various interpretations of the magnitude of variation seen in the Levant during the Late Pleistocene, and fully support the findings of this research. Following are conclusions and implications of this research and their consolidation with the advances in the studies of nuclear genetics of archaic human populations.

I. Results

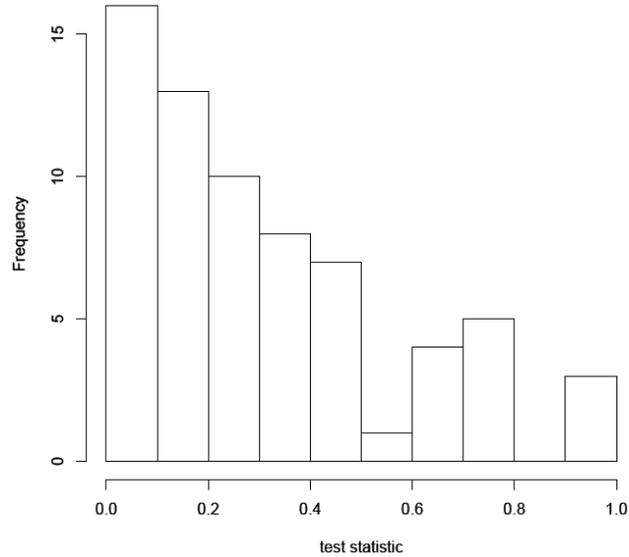
The following section presents the results of the statistical analyses of the data that was collected for this research. Information was collected on two samples – the Late Pleistocene Levantine sample (maximum age range estimates date the sample between 130,000 and 38,000 before present) and the early medieval Pannonian sample (fourth to eighth century A.D.). The Levantine sample consisted of thirteen specimens coming from the Skhul (n=6), Qafzeh (n=5), Amud (n=1) and Tabun (n=1) cave sites. The Pannonian sample consisted of one hundred crania coming from the following sites: Mosonszentjános (n=4), Üllő (n=11), Homokmégy-Halom (n=12), Bugyi-Ürbőpuszta (n=5), Váchartyán (n=10), Tiszavárkony-Hugyinpart (n=4), Tatárszentgyörgy (n=2), Budapest Népstadion (n=3), Alattyán-Tulát (n=20), Keszthely-Dobogó (n=10), Budakalász (n=3), Hegykő (n=10) and Szőny (n=6). The specimens in both samples were observed and scored by the author for the sixty seven morphological traits (tab. 5.3 in previous chapter). All the morphological features were scored as binomial responses (scoring procedures are detailed in Appendix B). After the data collection was completed for both samples, the author proceeded with the statistical analyses of the data.

The statistical analyses were performed in the following steps. First, the ratios of the binomial responses were calculated for each of the sixty seven traits across both samples. Each of these ratios was calculated by dividing the smaller number of responses (whether these are positive or negative) by the larger number of responses. Therefore a low ratio means there is a great deal of homogeneity and a large ratio means a great deal of heterogeneity for each trait. Second, to measure the average heterogeneity versus homogeneity for all the traits in each sample, the mean of the ratios for all the traits was calculated. Third, to see whether all traits show an equal magnitude of variability, the variance of all the ratios was calculated. Then the thousand draws of random sets of thirteen individuals from the observed Pannonian data set were calculated, and the frequency of the distribution was compared to the observed variation that the fossil Levantine specimens exhibit. The results are presented as follows. First, the distribution of the ratios in each of the samples is shown. The mean and variance of the ratios for each of the two samples are discussed (Figures 6.1 and 6.2). Next, the results of the resampling analyses are presented; the first (Figure 6.3) shows how likely it is to find the Levantine mean ratio in a sample of 1,000 ratios, each ratio derived from 13 randomly drawn modern crania. The second resampling analysis shows the likelihood of finding the Levantine variance in a sample of 1,000 variances, each variance derived from 13 randomly drawn modern crania.

1. Observed and resampled ratio distributions, means and variance

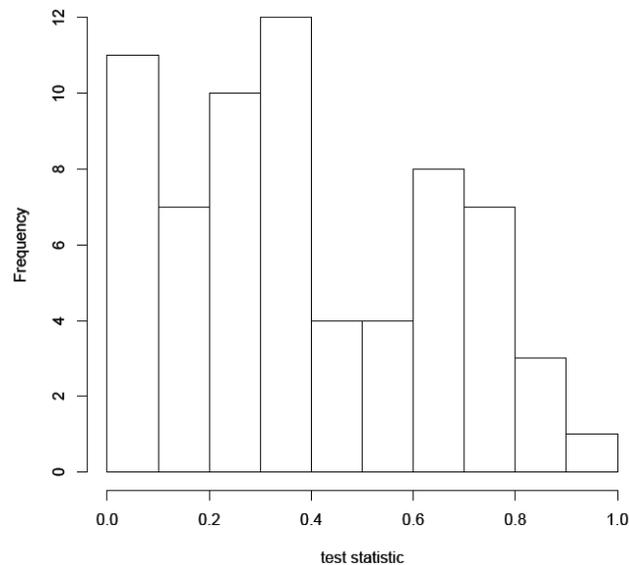
The distribution of the 67 ratios observed in the fossils is presented in figure 6.1. The figure shows that most of ratios are quite homogenous, having 0 or close to 0 as a summary ratio of the responses of many traits. A ratio of zero means that the non-metric trait scored is present in all the individuals. The mean of the 67 ratios in the fossil data set is 0.32, with a variance of 0.075.

Figure 6.1 Frequency distribution of observed ratios for 67 traits in the fossil data set (n=13). See text for further details. A ratio of zero means that the non-metric trait scored is present in all the individuals.



The following figure (fig. 6.2) presents the distribution of ratios for the 67 traits of in the medieval Pannonian sample. The mean ratio is 0.40 with a variance of 0.067.

Figure 6.2 Frequency distribution of observed ratios for 67 traits in the Pannonian sample (n=100). See text for further details. A ratio of zero means that the non-metric trait scored is present in all the individuals.

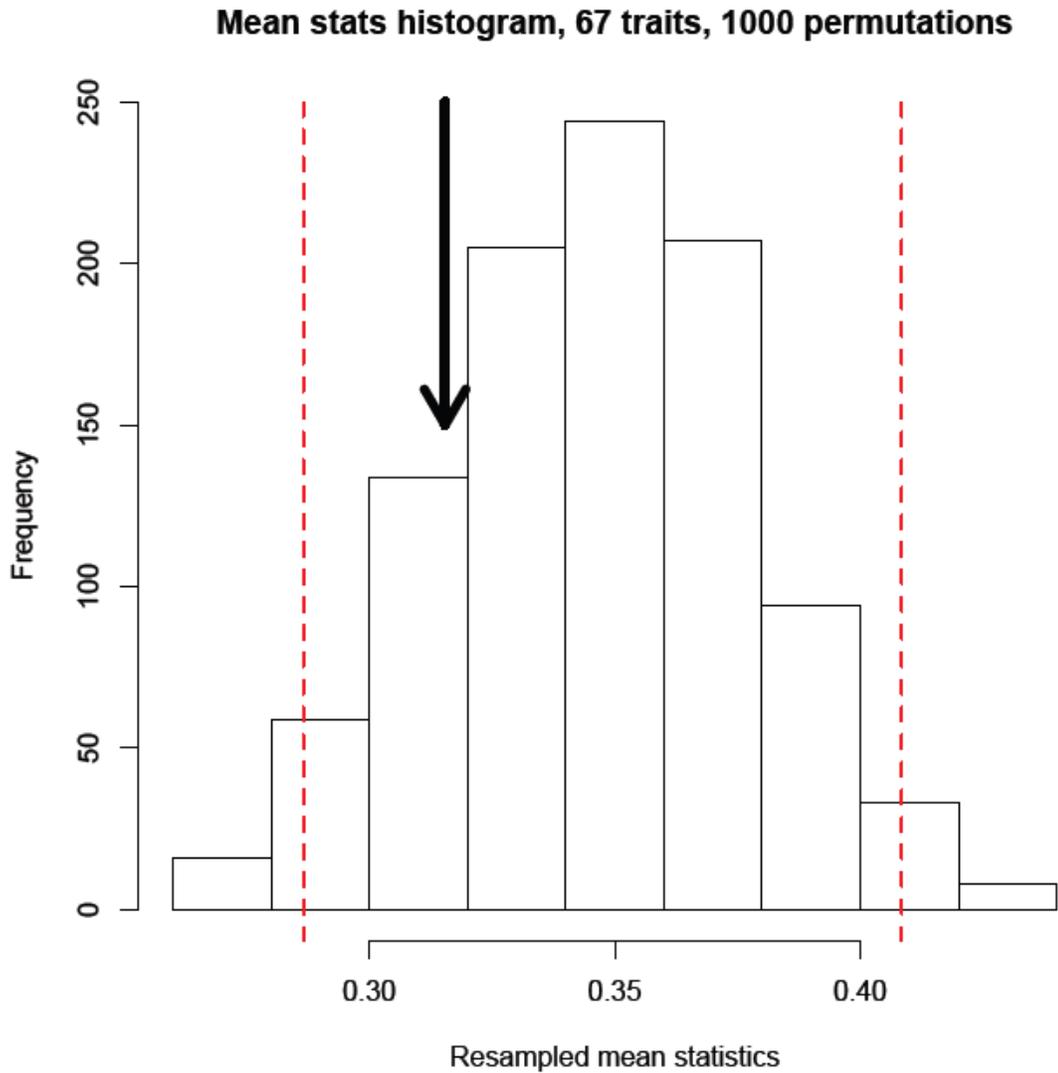


a. Assessing the significance of the fossil data set: the mean test statistics

As discussed in Chapter Five, the first test statistic calculated was the average of the ratios for the variables, measuring the average heterogeneity versus homogeneity. For the set of 67 traits, the observed total fossil (n=13) mean statistic for the ratios is 0.32. To determine whether the average heterogeneity of the Levantine sample was unusual, a resampling method was employed where 1,000 random samples of 13 crania were drawn from the Pannonian data set, and the average ratio and variance derived for each of the 1,000 samples. The observed summary statistics (mean and variance) for the fossil sample were thus compared to two distributions: first, the distribution of the 1,000 resampled means, and second, the distribution of 1,000 resampled variances. If the observed statistic fits within the 95% confidence interval of the resampled distribution, the null hypothesis is not refuted and the Levantine sample cannot be considered

unusually heterogeneous. Figure 6.3 represents the distribution of the 1,000 means that comprise the resampled distribution. As shown in figure 6.3 the observed Levantine mean fits well within the 95% confidence interval, indicating that the Levantine sample is not unusually heterogeneous.

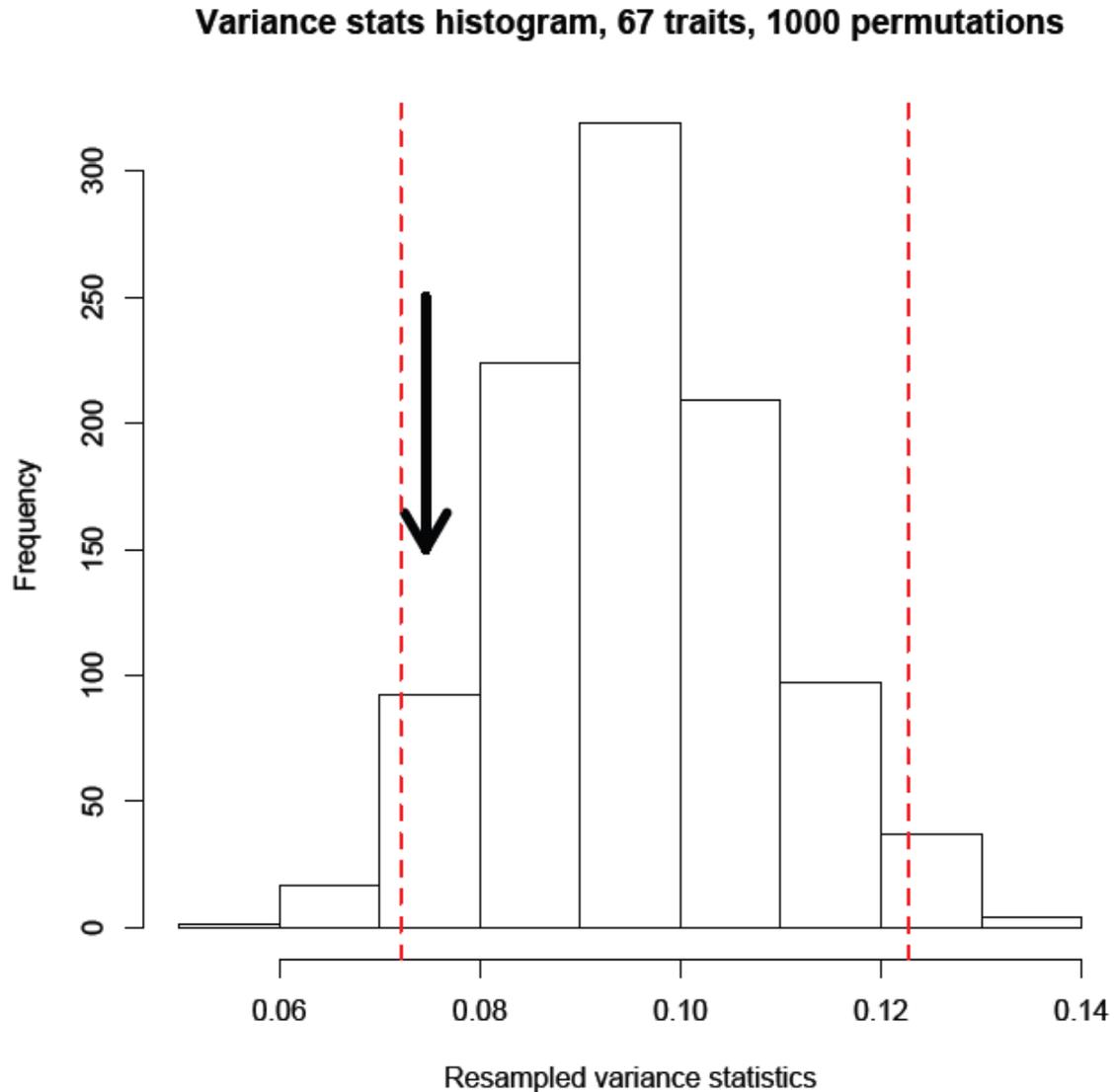
Figure 6.3 Frequency of resampled mean statistics for the total Pannonian data set. These are the means of the 67 ratios of 1,000 randomly drawn samples of 13 individuals each from the Pannonian data set. The black arrow indicates the observed fossil data mean of 0.32 and falls within the resampled frequency distribution. The red dashed lines are at the 95% confidence interval. The key point is that the fossil data fall within this interval.



b. Assessing the significance of the fossil data set: the variance test statistics

As discussed in Chapter Five, the second test statistic calculated was the variance of the calculated ratios, measuring the variation of the traits; that is, whether all traits show an equal magnitude of variability. The observed fossil variance statistic was 0.075. Again, the observed fossil sample's variance was compared to a distribution of 1,000 resampled variances. As with the mean test statistic, such variation as seen in the fossil sample is not unexpected in the medieval sample. The observed variance falls within the 95% confidence interval and the null hypothesis cannot be rejected.

Figure 6.4 Frequency of resampled variance statistics for the total Pannonian data set. Depicted is the distribution of variances of the 67 ratios for 1,000 randomly drawn samples of thirteen crania from the Pannonian data set. The black arrow indicates the variance of ratios observed in the fossil data and falls within the resampled frequency distribution. The red dashed lines are at the 95% confidence interval. The key point is that the fossil data fall within this interval.



The following table (6.1) presents the summary statistics for all the observed values based on 67 traits.

Table 6.1 Summary of results values for the 67 traits.

sample	mean statistic	variance statistic
total fossil data set (n=13)	0.3154304	0.07460882
Pannonian data set (observed, n=100)	0.3939505	0.06734495
resampled data set (n=13)	0.3461262	0.09555113

2. Conclusion of the results

What the results have shown is that the observed mean and variance statistic for sixty seven scored morphological traits in the Levantine sample are not unexpected when compared to the equivalent mean and variance in the medieval Pannonian sample of equivalent size (random sets of thirteen individuals resampled one thousand times). The interpretation and implications of these findings are presented below.

II. Discussion

The null hypothesis tested in this research is that the magnitude of variation seen in the cranial sample of the Late Pleistocene Levantine human fossil remains is not unusual when compared to a recent modern sample of mixed ancestry. The results of the analyses above show that the null hypothesis cannot be refuted. The magnitude of the variation in the Late Pleistocene Levantine human fossil sample is not unexpected within the variation seen in samples of n=13 drawn randomly from the early medieval Pannonian population of mixed ancestry.

The Levantine specimens span possibly as much as 100 millennia (130,000 to 38,000 years ago) in their temporal range, while the crania from Pannonian sample have a much smaller temporal range of four centuries. With the differences in the temporal range of the two samples, one might expect more variation in the sample with a broader temporal span. However, results have shown that the Levantine sample does not exhibit unusual variation.

What are the implications of these findings and how do they fit the current explanations of the Late Pleistocene Levantine sample? As presented in the previous chapters, much of the debate about the Levantine variation polarized into a taxonomic interpretation of variation and the interpretation that there was no unusual magnitude of variation. As Dobzhansky postulated, the Levantine area was a probable place and a probable case of possible hybridization of two different populations. Hybridization here is taken as mixture between two populations, following Harrison (1990), not necessarily mixture between two populations of two different species. The results of this study support Dobzhansky's model. The magnitude of variation seen in the Levant is shown to be within the magnitude of variation seen in a recent modern population of mixed ancestry.

The results show that the magnitude of the observed variation in the Late Pleistocene Levantine specimens is *not unusual*. The results however can not resolve the issue whether the populations that hybridized were belonging to one or two different species, it only shows that the variation is not unusual for populations within a single species. Fortunately, since this research began and during its conduct in the last several years, a number of papers (discussed below) were published that directly strongly support

the contention that there was significant and persistent gene flow between different Late Pleistocene populations in this very region that some scholars thought to be populations of different species. In this light, Dobzhansky's model of hybridization of two different populations in the Levant is absolutely plausible. These studies support what this research has shown based on the cranial morphologies of the Late Pleistocene Levantines. The new research is based on a quite different source of evidence – the nuclear genetic makeup of ancient populations and its reflection in the genetics of modern populations.

Since the time of the discovery and recognition of Neandertals as fossil humans there has been continued controversy about whether the Neandertals contributed to the genetic legacy of living humans. Were the Neandertals one of our direct ancestors, or had they no part in the genetic formation of the sapient, modern man? The only direct palpable line of evidence paleoanthropologists could work with for over a century were morphological features of the discovered fossil skeletal remains, and archaeological indications of their behavioral capacities. However, morphological evidence has been interpreted in two opposing ways, some saying that certain morphologies confirm the Neandertal legacy in the Upper Paleolithic European morphologies (Jelínek 1969, 1976, 1978, 1985; Smith 1982, 1984, 1985, 1991, 1992; Simmons and Smith 1991; Frayer 1992, 1993; Zilhão and Trinkaus 2002; Trinkaus *et al.* 2003; Wolpoff *et al.* 2001; Frayer and Wolpoff 2003; Wolpoff *et al.* 2004; Smith *et al.* 2005), and some argue against it (Stringer 1985, 2003; Bräuer 2001; Conard and Bolus 2003; Klein 2003; Bräuer *et al.* 2006; Bailey *et al.* 2009). Since the advances in the retrieval and analyses of ancient DNA, there were studies that argued both against the Neandertal genetic contribution to the living human gene pool (Currat and Excoffier 2004; Serre *et al.* 2004), and those

which supported the Neandertal legacy in populations living today (Evans *et al.* 2006; Wall and Hammer 2006, Green *et al.* 2010:710; Reich *et al.* 2010; Abi-Rached *et al.* 2011; Yotova *et al.* 2011). All of the studies arguing against Neandertal contribution to the modern human gene pool examined the mitochondrial DNA (Currat and Excoffier 2004; Serre *et al.* 2004), since the mitochondrial part of the ancient human genome was the first one to be successfully retrieved and analyzed (Comas *et al.* 1997; Krings *et al.* 1997). However, mitochondrial DNA forms only a very small part of the human genome. In addition, it is inherited only through the maternal line, and therefore the inherited information does not reveal both parts of the genetic make of individuals, but only limited maternal information across many generations, completely omitting the contributions from the paternal side. And mtDNA is under selection, so that its history does not conform to the history of the population. Therefore, the lack of confirmed contribution of Neandertal mitochondrial DNA to the present human mtDNA does not exclude possibilities of Neandertal genetic contribution to modern humans.

In the last several years, with the advances in retrieval of ancient nuclear DNA, studies have confirmed that Neandertals did contribute genetic information to the living day nuclear genome in many areas of the world (Green *et al.* 2010).

In May of 2010, Green and colleagues published “*a draft sequence of the Neandertal genome*”. This is a culmination of the immense advances in ancient DNA research (Pääbo 1989, 1993, 2004; Krings *et al.* 1999; Relethford 2001; Gutierrez *et al.* 2002; Pääbo *et al.* 2004; Green *et al.* 2006, 2010; Lambert and Millar 2006; Noonan *et al.* 2006; Coop *et al.* 2008; Krause *et al.* 2010). What geneticists are now able to do is to retrieve the nuclear DNA of the individuals that lived up to some 70,000 years ago

(Lalueza-Fox *et al.* 2007, 2008, 2009; Krause *et al.* 2007; Green *et al.* 2010). These findings, together with the immense and growing data banks on nuclear DNA composition and variation in human populations today, can help us establish some evolutionary trajectories of humankind in last hundred millennia.

The exploration of the human genome and comparison with the Neandertal one was inspired to see how and when we became modern humans – what in our DNA made us so special and different from our closest living and fossil relatives? As Green and colleagues point out:

“comparison of the human genome to the genomes of Neandertals and apes allow features that set fully anatomically modern humans apart from other hominin forms to be identified. In particular, a Neandertal genome sequence provides a catalog of changes that have become fixed or have risen to high frequency in modern humans during the last few hundred thousand years and should be informative for identifying genes affected by positive selection since humans diverged from Neandertals” (Green et al. 2010:710).

However, this research also served to identify Neandertal genes in human populations, a result of key interest to paleoanthropologists.

Green and colleagues extracted parts of nuclear DNA from three late Neandertals from Vindija cave level G (specimen Vi33.26; unknown sublayer; directly dated to $44,450 \pm 550$ years; Green *et al.* 2010), level G3 (specimen Vi33.16; directly dated to $38,310 \pm 2,130$ years; Green *et al.* 2010) and level I (specimen Vi33.25; older than layer G; direct dating not possible to obtain; Green *et al.* 2010), Croatia. They compared the nuclear DNA parts of those three Vindija individuals to the nuclear DNA of three other Neandertal individuals from other sites across Europe and Western Asia – Mezmaiskaya, Russia (70,000-60,000: Skinner *et al.* 2005), Feldhofer cave, Germany (42,000: Schmitz

et al. 2002) and El Sidrón, Spain (49,000: de Torres *et al.* 2009). These comparisons were made in order to put the Vindija individuals' genetic material in context and comparison with other Neandertal material across Europe and Western Asia, across time span of about 40,000 years (Green *et al.* 2010).

In order to explore the divergence of the Neandertals in relation to living human populations, Neandertal nuclear DNA material was also compared with the DNA of living human individuals from different parts of the world. The premise was that the derived genetic material in all living human individuals tested is of the same divergent distance to the Neandertals. As a control group, Neandertal and living modern human alleles were compared to chimpanzee and orangutan alleles to identify the ancestral alleles (Green *et al.* 2010:718). The modern human sample included five individuals from different areas of the world – San from Southern Africa, Yoruba from West Africa, Han Chinese from East Asia, French from Western Europe, and Papua New Guinean from Australasia. The proportion of derived alleles resulted in 30.6% in the Yoruba, 29.8% in the Han Chinese, 29.7% in the French, 29.3% in the Papuan, 26.3% in the San, and 18.0% in Neandertals (Green *et al.* 2010:718). In other words, the biggest proportion of the derived alleles from the ancestral control group was found in the Yoruba, and the smallest proportion in the Neandertals, which is not surprising considering the age of the Neandertals tested for the alleles, and the modern human sample of five individuals.

More importantly and more indicative, Green and colleagues (2010) tested whether the Neandertals are on average closer to living humans from some parts of the world than from others. If the Neandertals diverged from modern human populations before the diversification of modern human populations, the authors expected to find

relatively equal amount of differences in the derived alleles of all the living populations (no matter from which part of the world) in relation to the Neandertal alleles. As previously thought, some authors posited that even if there were no gene flow between the Neandertals and modern humans, some segments of the genome could still possibly show similarities of Neandertal and living modern human segments. Those scholars saw the explanation of these similarities in the fact that Neandertals and living human populations do share a common ancestor, and some similarities that we observe in both Neandertals and modern humans could be attributed to the fact that they were inherited on both sides from the common ancestor (Pääbo 1999). Even if a certain living human population shares more commonalities with the Neandertals, this would not necessarily demonstrate direct gene flow between ancestral modern populations and Neandertals, but instead, could be due to the preservation of some of the characteristics inherited from common ancestor.

The scenario of interpreting the similarities in some of the living human populations and Neandertals and its conservative interpretations of no direct gene flow, but inheritance and preservation of certain genes from common ancestors, is the result of the fact that many geneticists relied on the scenarios of drift as the largest driving force of evolution. Unless it is certain (from some other line of evidence) that selection worked on certain traits, the possibility of the action of selection in genetic scenarios was often, even usually, dismissed. Instead, genetic drift served as the driving force and fundamental point of geneticists' working hypotheses.

It followed that when studies before 2010 indirectly demonstrated that there are similarities between living humans and Neandertals in certain segments of the genome

(Green *et al.* 2006), these were still not absolutely convincing that there was clear and direct evidence of gene flow between the Neandertals and the ancestral modern human populations.

The new analyses of the nuclear genome have shown that the genes were indeed exchanged in direct gene flow between Neandertals and ancestral modern human populations (Green *et al.* 2010). As Green and colleagues stated, under the scenario of direct gene flow between the Neandertals and other ancestral modern humans, matches in Neandertal alleles with the individuals from some parts of the world more often than with the individuals from other parts of the world are expected. If it can be shown that Neandertals are, on average *across many independent regions* of the genome, more closely related to certain groups of living humans today, it would indicate that this closer relatedness is due to Neandertals exchanging parts of their genome with the living modern human ancestors. Green and colleagues tested this by looking at the alleles that are derived in both Neandertals and living modern humans (derived from a common ancestor, in this case the chimpanzee). The analysis was further restricted to those alleles that show variation in modern humans, where two different living modern humans carry different alleles (Green *et al.* 2010:718). For this study, the Neandertal alleles were matched with alleles of eight living human individuals from various parts of the world – two European Americans, two East Asians, and four West Africans. The results of the allele matching showed that no matter how you subdivide the data, the Neandertals consistently show greater genetic proximity to European and Asian individuals (Green *et al.* 2010:718).

To further examine these results, the authors compared the Neandertals to a larger and more diverse set of living humans – French, Han Chinese, Papuan, Yoruba and San individuals. This analysis confirmed the previous results of Neandertals sharing more derived alleles with the living Europeans and Asians than sharing the derived alleles with the living Africans. The results are consistent with the previous finds and indicate that the Neandertals *did* indeed exchange genes with the ancestors of the non-African, Eurasian living populations (Green *et al.* 2010:718). Moreover, the results indicated that the direction of the gene flow was from the Neandertals into the other modern human ancestors (Green *et al.* 2010:718).

Some of the old haplotypes found in the living Eurasian populations were inherited by gene flow from the Neandertals (Green *et al.* 2010:721). The estimated magnitude of haplotypes inherited from the Neandertals in existing Eurasian populations is between 1 and 4%. This is consistent with the previous models that most of the genetic material comes from the African populations, but with a significant amount of Neandertal genetic material in Eurasian populations. This is compatible with the multiregional model of human evolution which predicted that most of the genetic material came from African populations because they were the largest and most centrally located but with significant input from archaic populations, and not their complete replacement (Wolpoff *et al.* 1984; Wolpoff 1989; Wolpoff and Thorne 1991; Thorne and Wolpoff 1992; Frayer *et al.* 1993; Wolpoff *et al.* 2001; Smith *et al.* 2005). While African populations contributed most of the genetic material in living human populations (Harpending *et al.* 1998; Relethford 1998), other archaic populations also made important contributions to the emergence of modern humans (Relethford 2001; Green *et al.* 2010). Therefore, we can view the Late

Pleistocene as characterized by more dynamic changes and intermixing population movements than ever before, dispersing over the all three continents of the Old World. This is not a surprise when we consider the ever growing world's overall population size.

Green and colleagues make a striking observation. They note the fact that their results have shown Neandertals to be as closely related to a Chinese and Papuan individual as to a French individual, although it would be perhaps more predictable for Neandertals to exhibit more similarities with European and Western Asian populations.

The explanation for this is proposed by the authors as following (Green *et al.* 2010:721):

*“... the gene flow between Neandertals and modern humans that we detect most likely occurred before the divergence of Europeans, East Asians, and Papuans. This may be explained by mixing of early modern humans ancestral to present-day non-Africans with Neandertals **in the Middle East** before their expansion into Eurasia. Such a scenario is compatible with the archaeological record, which shows that modern humans appeared in the Middle East before 100,000 years ago whereas the Neandertals existed in the same region after this time, probably until 50,000 years ago (Bar-Yosef 1998).”* (bold by the author)

This study has confirmed that the magnitude of the variation seen in the Levantine Late Pleistocene fossil remains is of the equivalent magnitude of variation in a modern population of mixed ancestry. The cranial morphology examined in this study confirms the scenario of population mixture in the Middle East during the Late Pleistocene. Green and colleagues' observation that all the tested living Eurasian populations are equidistant from the Neandertals will be more definite with more observations, but at the moment it appears that their interpretation is the strongest possible independent direct evidence of mixing in the Levant that confirms and strengthens the research presented here.

Since the Neandertals, populations that inhabited European and Western Asian territory, probably exchanged more genes with the other new-coming African populations

in those areas for a longer time, and it is peculiar that more genetic similarities are not seen in Neandertals and living Europeans. In contrast, we see the same amount of the similarities between Neandertals and all other living Eurasian populations. One scenario, presented above, is that the mixing occurred at one point of time, during the Late Pleistocene in Middle East, and since then there was no additional mixing, and an equal amount of the Neandertal genetic material spread across Eurasia. But this interpretation is contradicted by the fact that while the percentage of genes inherited from Neandertals is close to the same in Europe and Asia, for the most part there are different genes in these regions, and generally each of us has different Neandertal genes. This implies that there were many mixing events and not a single one.

An alternative scenario to the single mixture one that seems plausible in explaining why Neandertals do not share more similarities in genetic material with the living Europeans than with the living Asian populations, is that later Neolithic-related migrations and gene exchanges obscured more accentuated similarities most probably present in European populations during the Upper Paleolithic time (Green *et al.* 2010). The probability that there were more shared similarities in the Upper Paleolithic times is supported by comparative morphologies of Neandertal Late Pleistocene populations and Upper Paleolithic/Holocene European populations (e.g. Thorne *et al.* 1993; Eckhardt *et al.* 1993; Wolpoff 1996; Wolpoff *et al.* 2001; Trinkaus *et al.* 2003). More similarities in the morphologies Neandertals share with the Upper Paleolithic Europeans than with the East Asian Upper Paleolithic populations might be expected to mean there were more similarities in the nuclear genomes of Neandertals and living Europeans. However, based on what is known of the known demographic histories and population movements that

continuously occurred *since* the Upper Paleolithic period, it can be concluded that these movements kept changing the genetic makeup of Europeans since the Upper Paleolithic times. The gene exchanges between Eurasian populations did not cease from the Late Pleistocene to the present-day, and naturally the populations that lived in Europe since the Upper Paleolithic period were not identical to their predecessors. The gene exchange occurred constantly, and moreover was emphasized during waves of archaeologically and historically known population movements across the vast Eurasian area.

One example is the movement of the first agricultural populations during the Neolithic period from the Levant to Europe (and other areas; Bar-Yosef 1998; Bocquet-Appel and Bar-Yosef 2008). Differences in the biological structures of these populations were explored by Ron Pinhasi and Mark Pluciennik (2004), and based on the craniometric data have shown clear differences between the Upper Paleolithic Europeans and early Neolithic populations. This does not entail population replacements. Instead, there is integration of the genetic material of both old regional and new-coming populations. Naturally, there is a greater genetic mark in the descendent populations of one of the admixing ancestral population that was greater in size (Green *et al.* 2010; Krause *et al.* 2010). Another example supporting this scenario is the case presented here in this study, of the influx of populations of Central Asian origin during early medieval times. Many examples such as these two mentioned above are known historically – multidirectional population movements that occurred regularly (constantly or in greater waves) that would account for the equal amount of the shared derived genes between Neandertals and both European and Asian living populations.

Additional genetic research provides more data showing the existence of other various Late Pleistocene groups that have contributed parts of their nuclear genome to certain living populations. Such is the case for newly found skeletal remains from Denisova cave, Siberia (Reich *et al.* 2010). The genetic analyses of the remains have shown that Denisovans that putatively occupied eastern Asia during the Late Pleistocene had a shared common ancestor with the Neandertals but had distinct population history (Reich *et al.* 2010:1059). Part of the Denisovans nuclear genome has been found in living Melanesians, and other far eastern populations.

What Neandertal and living human nuclear DNA analyses tell us is that the admixture between Neandertal and other Late Pleistocene populations certainly occurred, as well as with Denisovans and other Late Pleistocene populations. This can be seen in presence of derived alleles in living humans from Neandertals in Eurasian populations and from Denisovans in Melanesian population.

Starting in the Late Pleistocene, more African-like features appear in fossil remains on non-African soil, although this is debatable (Frayser and Wolpoff 2004). However, the fossils still also exhibit the features of the archaic populations that were present in Europe and Asia (Wolpoff 1999). Therefore, the fossils are the direct evidence and proof of these different populations intermixing, sharing their gene pool over time (Templeton 1994, 1996, 2002). The reason why larger presence of the African features is seen in the Late Pleistocene is due to the fact that Africa has the biggest overall population in the then-inhabited world. While African populations contributed many genes to humans today (Harpending *et al.* 1998; Relethford 1998), the other archaic populations also made important contributions to the emergence of modern humans

(Relethford 2001; Green *et al.* 2010; Reich *et al.* 2010). The Late Pleistocene can be viewed as characterized by more dynamic changes and intermixing population movements dispersing over the all three continents of the Old World. This is not a surprise when the dramatic climate changes that occur during the Late Pleistocene are considered, in combination with the world's ever growing overall population size.

Accepting the present evidence that some living human populations contain part of their nuclear genome inherited from the Neandertals (Green *et al.* 2010) and Denisovans (Reich *et al.* 2010) leads to the acceptance of Neandertal (and other archaic populations such as Denisovans) as part of a single Late Pleistocene human species. Since the present direct genetic evidence directs us to conclude that interbreeding between different Late Pleistocene populations was successful (in a sense that the genetic exchange that occurred in the Late Pleistocene is still visible in the nuclear genome of the living populations), this inevitably leads to the acceptance of the interbreeders as belonging to one species. Therefore, the fortunate fact that geneticists are able to retrieve and analyze parts of nuclear genome of Late Pleistocene populations gives rise to the possibility of testing the relatedness of populations under the biological species concept – those which can interbreed and produce fertile offspring (Hawks 2011). This interpretation was first proposed by Dobzhansky in 1944 by looking at the Levantine sample and the magnitude of their morphological variation. Only now with the genetic data can the hypothesis of interbreeding between different ancestral populations can actually be tested.

Ever since Montagu (1940) and Dobzhansky (1944) proposed the interpretation that the Late Pleistocene Levantine human fossil sample was evidence for admixture of

different populations, and not different species, there were scholars who agreed with this kind of interpretation (Chapter Two). The scholars who saw the similarities in shared morphological characteristics of the human remains from Tabun, Skhul, Qafzeh and Amud, now have direct support of their morphological analyses from explorations of the nuclear genome. The research presented here, along with new advances in nuclear genome explorations confirm the claims of Baruch Arensburg and Anna Belfer-Cohen (1998:320):

“In sum, analyses of the Israeli Middle Paleolithic human fossils reveal numerous incongruences, such as assumed ‘Neandertals’ lacking specific Neandertal traits and [anatomically modern human species] manifesting Neandertaloid features. Large morphological variability is observable within both early sapiens and “Neandertal” groups and the evidence suggests that “Neandertals” and sapiens were living in the same territory, sometimes in the very same caves. All these, alongside the generally accepted fact of Upper Pleistocene gene flow in an African-Eurasian direction and the logistical problems implicit in an assumption of a Neandertal migration, at whichever date, from Europe to the Near East make the hypothesis of a strong African influence on the south Levantine Middle Paleolithic human group highly probable. Accordingly, a gene-flow from the northern provinces seems to play a minor role in shaping the particular morphology of that population.”

III. Conclusion

To conclude, the author explored whether the magnitude of the heterogeneity within the Levantine sample is unusual when compared to a recent modern population of admixed ancestry. The goal of this dissertation was to test Dobzhansky’s model of admixture for the Levantine sample, looking at the interbreeding as defined by Harrison (1990) – between different populations, not between different species. The null hypothesis was that the Levant variability was not unexpected in a human population of mixed ancestry. The results have shown that the null hypothesis could not be disproved

and the magnitude of the variation in the Levantine Late Pleistocene species is *not unusual* when compared to the magnitude of the variation exhibited in the early medieval Pannonian population of mixed ancestry.

These results are supported by the independently derived recent advances in the study of the nuclear parts of archaic and present day genomes. The genetic studies have shown that different regional archaic populations did interbreed with the expanding African populations during the Late Pleistocene, and that a significant part of this interbreeding took place in the Levant. Although the majority of the modern nuclear genome has been inherited from the Late Pleistocene African populations, the presence of significant parts of the nuclear genome inherited from the archaic non-African Late Pleistocene populations confirms the interbreeding of different Late Pleistocene populations. These findings do not support the previous views of complete population replacements of old regional Late Pleistocene Eurasian populations by the expanding African populations. In addition, these findings do support the application of the biological species concept to the Late Pleistocene populations, and thus far confirm the presence of single human species during and ever since Late Pleistocene times.

In sum, the new genetic findings support the numerous similar conclusions that were based on the morphological analyses of the fossil record. The research presented here has shown that the shared cranial non-metric morphologies indicate that the magnitude of the variation in the Late Pleistocene Levantine fossils does not have to be explained taxonomically. To the contrary, the magnitude of variation is not at all unusual, and is equivalent to the magnitudes of variation that recent population of mixed ancestry exhibit. Therefore, the magnitude of the Late Pleistocene Levantine population can be

explained by Dobzhansky's model of different populations of different ancestry (and not species) admixing in the Levantine region. These findings are in complete accordance and are supported by the explorations of the parts of nuclear genome of archaic and living populations.

Chapter 7

Conclusions

This dissertation research was dedicated to the exploration of what constitutes the ‘unusual’ magnitude of variation seen samples of fossil hominids, and how it is determined. The particular sample of the Late Pleistocene fossils – those found in the foothills of Mount Carmel, in present day Israel – is a “test case” for this question. There is a long literature describing and analyzing the variation expressed by the Late Pleistocene Levantine hominids. Long-standing evolutionary issues are raised in this literature because of the variation that is preserved, including the recognition of intra vs. inter-specific variation, questions of changing variation over time, and recognition of the extent of admixture in both modern and fossil samples. This hominid sample is comprised of both Neandertals (Neandertal-like humans) from Tabun and Amud, and the remains from Skhul and Qafzeh that are considered predecessors of more recent and modern humans. The variation in the Levant has been interpreted a number of ways: taxonomically (as two separate species), as a population undergoing the transition from archaic to modern humans, and as an admixed sample representing the mixing of two populations. While the admixing model (hybridization) was suggested by Dobzhansky as early as 1944, it has yet to be systematically tested.

The goal of the dissertation was therefore to test Dobzhansky’s model of admixture in the Late Pleistocene Levantine sample using comparative analysis. The

focus was to examine, first and foremost, whether the Levantine variation lies outside the expectations of human population variability when the population is of mixed ancestry. The null hypothesis was that the variation in the Levant sample is not unusual, or unexpected, when compared to human populations with an archaeological record that shows mixed ancestry between people found in the same geographic region. How the author chose to explore the focus of this dissertation and test the null hypothesis is presented throughout several chapters.

In Chapter Two, the background and rationale behind the development of this dissertation's research was discussed. The chapter started with research in the 1930s, when human fossil remains from three cave sites in the Levant were brought to light. These caves – Mount Carmel caves of Tabun and Skhul, and the Qafzeh cave – contained skeletal remains that exhibited an until then unprecedented combination of features and overall variation. In order to explain how these newly found fossil specimens fit the theoretical framework of human evolution, the discussion began with what was known about the course of human evolution until the 1930s, and how it was interpreted. Few human-like fossil forms had been recognized by that time (*Australopithecus*, *Pithecanthropus*, Neandertal or *Homo primigenus*), and the relationship between different human fossil species were difficult to interpret. The biggest debate developing out of the human fossil findings unearthed by 1930s was how the Neandertals fit into the picture of human evolution and whether they were ancestral to, or among the ancestors of, modern humans. The scholars of the time were divided on the interpretation of the relationship of the Neandertals and modern humans.

The conclusions made by Theodore McCown and Sir Arthur Keith who first studied the variation present in the Carmelite remains from Tabun and Skhul, situated along a single wadi, were that the Carmelites represent a highly heterogeneous population that was in the “*throes of evolutionary change*”. However, McCown and Keith’s interpretations of the high magnitude of variation that the Carmelite sample exhibited, and their conclusions were met with various criticisms then and in the following decades, namely by Ashley-Montagu, Weidenreich, Dobzhansky and Thoma. These critics concentrated on explaining the heterogeneity in the Levantine sample by a hybridization model, in contrast to McCown and Keith’s interpretations.

Later criticism, namely from F. Clark Howell, posited that the issue of chronological (a)synchrony of the Late Pleistocene Levantine specimens resolved the question of heterogeneity in the Levantine sample. Howell saw the Levantine sample as consisting of specimens of two separate species, defining type specimens as representatives of each of those two species. To understand the underlying problems, issues and implications of defining the holotype, or type specimen for a population known from a fragmentary fossil record were explored. In addition, different species definition and concepts that are used by paleoanthropologists were discussed, since they are tied with the issues of defining specimens and attributing them to different species.

The variation within the Late Pleistocene Levantine fossils is differently interpreted today, based on the two major opposing theories of the origins of modern humans. In that light, there are researchers who view the Levantine sample as a whole as representing one species. In contrast, a number of researchers differentiate the Late

Pleistocene Levantine sample into two distinct and separate species, therefore finding the source of great magnitude of variation in different taxonomy.

Many recent assessments of variation in the Levant have focused on inter-specific explanations of diversity. Prior to accepting taxonomic explanations for Levantine Late Pleistocene diversity, the signature and the amount of variation in admixing populations must be taken into account. The question of whether the Levantines exhibit an unusual magnitude of variation could potentially be addressed by exploring what is a normal magnitude of variation in the Late Pleistocene populations overall. However, due to the paleoanthropological problem of small sample sizes and taphonomic biases in preservation and randomness of discoveries of the remains in certain areas of the world, this is not an easy task.

The approach taken in this study is to establish the not unusual magnitude of variation exhibited in the skeletal morphology of the crania in a modern human population, known from the archaeological record (providing a time depth). Due to the particular geographic location of the Levantine region, precisely on the crossroads of the most active zones in the Late Pleistocene world, one can assume that this region could have been a sort of melting pot, where population of various ancestry, potentially from Europe, Asia, and Africa met and intermixed. Therefore, it is most reasonable to make comparisons of variation with recent modern population of mixed ancestry.

Chapter Three served to present the general background for the source of the comparative sample used in this research, and context for its findings. This comparative sample consists of pre-Avar and Avar age skeletal remains from early medieval times (roughly fourth to eighth century A.D.), found within the Western Pannonian Plain region

of present-day Hungary. This particular sample was used because there are historical, archaeological and anthropological data to show the Pannonian Plain, in early medieval times, was home to populations of demonstrably heterogeneous origins.

In order to provide an adequate background for understanding the context of the comparative sample, general information about the history of the Pannonian Plain was presented. Since Roman rule changed the population structure of the area, a considerable part of this dissertation was dedicated to explaining how this took place. In effect, the western part of the Plain was incorporated into the Roman provincial system during the first century B.C. to serve as a buffer zone between the ‘barbarian’ territory and the Roman Apennine peninsula. Greek and Roman authors offer valuable reports on the population structure of different tribes occupying the area shortly after and during the Roman conquest.

The “decline and fall” of the Roman Empire and therefore of Roman rule over the Pannonian Plain occurred with the onset of the Great Migrations Period. During this period, influxes of new populations into and within the European continent occurred. The complexity of the population structure in Pannonia, already quite heterogeneous, was increased by the presence of populations new to this area, many of which were of Central Asian and Northern European origins. Of particular importance was the arrival of the Avars in the 500s and their presence on the Pannonian Plain as a political and social force until the 800s, since they make up the largest part of the comparative sample used in this dissertation.

In origin, the Avars were probably composed of various Central Asian groups who complied with the power of a khagan and his circle of warriors. As this community

moved westward, various other groups, of different ethnic and geographic origins joined the Avars. In the middle of the sixth century, the amalgam of various groups others called “the Avars” started to settle the western part of the Pannonian Plain, therefore occupying the former territory of Roman *Pannonia*. Once settled there, the Avars ruled over and incorporated the groups previously present in this area. Therefore, the population of the Avar khaganate at its height in the seventh and eighth centuries included the warrior and ruling Avar elite from the Central Asia, Bulgars, Slavs, Germanic groups (most specifically the Gepids and some remnants of the Longobards), and the Romanized population.

The Avars remained a strong presence and power in this area for the two centuries following their immigration. Numerous anthropological studies done on the abundant Avar-age graves in the western Pannonian Plain all attest to the significant biological heterogeneity of the populations occupying this area from the sixth to the end of the eighth century. This heterogeneity is why the skeletal remains from the cemeteries of pre-Avar and Avar age make an ideal comparative sample to explore what we know about variation (how unusual or not unusual it is) when faced with a past heterogeneous sample of mixed geographic origins.

Chapter Four described the Levantine Late Pleistocene fossil cranial sample and similar sample from the Pannonian Plain. Both were analyzed to test the null hypothesis, namely that the Levantine sample has no more variation than the recent human comparative sample of mixed ancestry. The Levantine sample, consisting of the human fossil remains coming from the four Levantine cave sites – Tabun, Skhul, Qafzeh and Amud are appropriate to test the Late Pleistocene Levantine human fossil variation

because these are the only remains yielded from that time period in this particular region of the world. Comparison with the single Pannonian sample is conservative in the sense that by using a sample circumscribed in time (the comparative sample spans only four centuries), disproof of the null hypothesis is easier. It would therefore strengthen results that fail to reject the null hypothesis. Due to the fact that non-metric cranial data are for the most part an unambiguous and scale-free reflection of genetic variation, the focus of the study is put on the cranial non-metric variation of the Levantine cranial sample, and on the Pannonian sample to which it is compared.

Adult and near-adult Late Pleistocene Levantine specimens with preserved cranial remains were used. The specific Levantine specimens are – Skhul II, Skhul IV, Skhul V, Skhul VI, Skhul VII, Skhul IX; Tabun I; Amud I; Qafzeh III, Qafzeh V, Qafzeh VI, Qafzeh VII, and Qafzeh IX. In order to test the unusualness of the variation exhibited in these thirteen specimens. One hundred crania from the ancestrally heterogeneous population from late antique and Avar periods of the Pannonian Plain, dated to approximately fourth to eighth century A.D., constituted the comparative sample.

Chapter Five presented the several methodological steps that had to be taken in order to test the null hypothesis of no difference between the magnitudes of cranial non-metric variation. The rationale behind the methodological procedures employed was discussed. There were three major steps included in the testing the hypothesis: 1) choice of non-metric cranial traits, 2) setting clear and repeatable data collection procedures, and 3) the analysis of the data collected using a resampling approach.

To test the hypothesis, non-metric and anthroposcopic cranial traits were chosen for the analysis. This choice came from the substantial literature that suggests their

importance for identifying and distinguishing variation at various levels, and distinguishing humans and Neandertals, the two species thought (by some) to coexist in the Levant. Thirteen original Levantine fossil crania were examined and one hundred adult or near-adult crania from the recent Pannonian modern sample, as described above. Standardized scoring procedures for each of the traits included in this study were set. The traits were chosen from the original publications on the Levantine fossils, typical Neandertal and modern human traits, and traits that the author devised to record observable variations. The standards for scoring the specific expressions of the traits were defined in such a manner that the scores can be collected as dichotomous, binomial responses for each trait. For meaningful analyses, only the traits that could be scored in at least one specimen from each of the Levantine sites were included in the analyses: sixty seven traits in all.

The data collected for the Levantine sample were then statistically analyzed in comparison with the Pannonian sample. Two summary statistics were computed for the both samples: 1) the average of the ratios for the different traits (variables), measuring the average heterogeneity versus homogeneity; and 2) the variance of these ratios, measuring the variation of the traits, whether all traits show an equal magnitude of variability. After calculating the average of trait ratios, and the variance of the trait ratios for the Levantine sample, resampling methods were employed for the comparisons. Resampling is an approach that makes minimal assumptions about the distribution of the underlying statistical population, other than that the sample is considered a good representation of the true population. This method enabled the comparison of the Levantine non-metric cranial variation with the Pannonian variation. The comparison was done by first

assessing the observed variation of the Levantine sample, which consisted of thirteen specimens, and then repeatedly drawing random sets of thirteen individuals from the observed one hundred Pannonian crania. Random set of draws was repeated one thousand times. After establishing the frequency distribution of thousand random draws from the Pannonian sample, one can see whether the observed Levantine fossil sample falls within the range of variation seen in the resampled frequency distribution of the Pannonian sample. In this way, the null hypothesis can be refuted if the observed Levantine variation falls outside the 95% confidence interval of the resampled distribution. However, this was not the case.

Chapter Six included the results and their interpretation and discussion. The author explored whether the magnitude of the heterogeneity within the Levantine sample is indeed unusual when compared to recent modern population of admixed ancestry. The goal was to test Dobzhansky's model of admixture for the Levantine sample, in that the inability to reject the null hypothesis would support it. "Admixture", or interbreeding, is meant as defined by Harrison (1990) – between different populations, not between different species. The null hypothesis was therefore that interbreeding (admixture) of different populations – and not the mixture of different species – explained the Levantine cranial sample's variation. This would imply there was no evidence for species difference between the two supposed 'types' of the Late Pleistocene Levant sample. The research findings showed that the magnitude of variation in the Levantine Late Pleistocene sample was *not unusual* when compared to the magnitude of the variation exhibited in the early medieval Pannonian population of mixed ancestry.

The results of this study are supported by the recent advances in the study of nuclear parts of archaic and present day genomes. The genetic studies have shown that different regional archaic populations did interbreed with the expanding African populations during the Late Pleistocene. Although the majority of the nuclear genome was inherited from the Late Pleistocene African populations, parts of the nuclear genome inherited in living populations come from other archaic non-African Late Pleistocene populations such as Neandertals and what are called Denisovans for lack of a clear anatomical identification of the remains yielding the mtDNA and nDNA studied. This directly confirms the interbreeding of different Late Pleistocene populations, and in the Neandertal case a significant amount of the interbreeding was in the Levant region, between Europe and Asia, because different Neandertal genes are found in Europe and Asia. These findings do not support the previous views of complete population replacements of old regional Late Pleistocene Eurasian populations by the new-coming expanding African populations. They further show the application of the biological species concept to the Late Pleistocene populations, and thus far confirm the presence of single human species during and ever since Late Pleistocene time.

In conclusion, this dissertation served to demonstrate that shared cranial non-metric morphologies can indicate that the magnitude of the variation in the Late Pleistocene Levantine fossils does not have to be explained taxonomically. Quite the contrary, the magnitude of variation is not unusual, and is equivalent to the magnitudes of variation that a recent population of mixed ancestry exhibits. Therefore, the magnitude of cranial variation in the Late Pleistocene Levantine population can be explained by Dobzhansky's model of different populations of different ancestry (not species) admixing

in the Levantine region. This conclusion is supported by recent genetic studies of Neandertal nuclear DNA.

Epilogue

Encountering the Other

*“the self is only possible through the
recognition of the Other”*

E. Lévinas

During the journey of researching and writing this dissertation, important issues and parallels became apparent, and therefore a need to write this epilogue as a personal note and conclusion was felt by the author. A central theme throughout this work has been the notion of encountering and describing (or even defining) ‘the Other’. It is critical to how we define ourselves as modern humans and to explorations of the fundamental question – where do we come from? This question has various facets, but central to it are the very complex issues of how we differ from others, and how we define others and therefore ourselves. The theme of the Other is crucial and evident in the undertones of this research – from the views of Neandertals as the Other held by the first describers of the Neandertal remains, to the view of Avars and other early medieval groups as the Other in the late antique chronicles and the work of later researchers who were interested in early medieval times. As Curta pointed out (2008a:ix), *“constructing the image of the Other was no doubt based more on preconceived ideas than on actual experience with the ways of life and custom of the Other(s)”*. From these early descriptions, which were more based on preconceived ideas than on actually knowing

and meeting the Other (because they were long gone), stem certain legacies that are still very much present even today²⁴.

One of the figures who defined the Neandertals as the Other, opposed to us, glorious modern humans, was Marcellin Boule. The language that Boule used in describing the sapient man in contrast to the words reserved for Neandertal was at that point not the product of the science, that nonetheless Boule did well, but of his personal outlook on it. Boule's *interpretation* of the Neandertal man was (1913:227):

“Je dois encore faire remarque, sans y insister, combine les caractères physiques du type de Néanderthal, tels que je viens de les résumer, sont en harmonie avec ce que l’archéologie nous apprend sur ses aptitudes corporelles, son psychisme et ses mœurs. Il n’est guère d’industrie plus rudimentaire et plus misérable que celle de notre Homme moustiérien. L’utilisation d’une seule matière première, la pierre (en dehors du bois et peut-être de l’os), l’uniformité, la simplicité et la grossièreté de son outillage lithique, l’absence probable de toutes traces de préoccupations d’ordre esthétique ou d’ordre moral s’accordent bien avec l’aspect brutal de ce corps vigoureux et lourd, de cette tête osseuse aux mâchoires robustes et ou s’affirme encore la prédominance des fonctions purement végétatives ou bestiales sur les fonctions cérébrales.”²⁵

In contrast to the Neandertal that he studied and described, Boule (1913:227) could set the picture of Cro-Magnon man, our true and only ancestor, and therefore the picture of *ourselves*:

“Quel contraste avec les Hommes de la période géologique et archéologique suivante, avec ces Hommes du type de Cro-Magnon, qui avaient un corps plus élégant, une tête plus fine, un front droit et vaste, et

²⁴ Just a simple example of the use of pejoratives, such as calling someone ‘barbarian’, or ‘Neandertal’.

²⁵ I still have to remark, without insisting, combination of the physical characteristics of the Neandertal type, as I have just summarized, are consistent with what archaeology tells us about his bodily abilities, his psyche and his customs. There is barely an industry more rudimentary and more miserable than that of our Mousterian man. The use of a single commodity, stone (no wood and possibly bone), consistency, simplicity and coarseness of his stone tools, the likely absence of all traces of aesthetic or moral preoccupations in combination with the brutal aspect of his sturdy and heavy body and his bony head with the robust jaws confirms the predominance of purely vegetative or bestial functions of his brain.

qui ont laissé, dans les grottes qu'ils habitaient, tant de témoignages de leur habileté manuelle, des ressources de leur esprit inventif, de leurs préoccupations artistiques et religieuses, de leurs facultés d'abstraction et qui furent des premiers à mériter le glorieux titre d'Homo sapiens!"²⁶

A parallel to this can be recognized by studying the history of the research on the early medieval comparative sample used in this study. As in the Neandertal case, all that is left from the early medieval groups that once lived in the Pannonian Plain is their material culture and skeletal remains. But in addition, we have something we lack in the Neandertal case: contemporary, late ancient sources about the 'barbarian' groups pouring into the territory that once belonged to the Roman Empire. Naturally, these sources had their own personal and social perspective, and what we read in them is the picture of the Other tinted by Greek, Roman and Byzantine points of views. In other words written sources were politically and socially biased in representing the 'barbarian' groups. To them, the Other was a *barbaros*, a speaker of incomprehensible gibberish, and an opportunity to show their own superiority vis à vis him.

Jordanes in the mid-sixth century described the Huns as "*a stunted, foul and puny tribe, scarcely human and having no language save one which bore but slight resemblance to human speech*", while John of Ephesus characterized the Avars as "*the filthy race of long-haired barbarians*" (Curta 2008a:1). As Curta pointed out, neither Jordanes nor John of Ephesus (like many other medieval chroniclers) had actually seen and met the subjects of their descriptions. But they made an impressible image of the

²⁶ What a contrast to the men of the following geological and archaeological period, the men of the type of Cro-Magnon, who had more elegant body, finer head, a broad and upright forehead, who in the caves they lived left such evidence of their manual skills, resources and inventiveness, their artistic and religious preoccupations, their powers of abstraction, and who were the first to merit the glorious title *Homo sapiens*!

Other and defined the proper social feeling towards the Other for their communities, influencing their contemporaries and everyone else who read their chronicles ever since.

Similar bias and cultural agendas can be recognized in the research focuses of the Hungarian archaeologists in the twentieth century. I do not wish to single out Hungarian archaeology here: the same things can be said for the archaeological research of many European countries during and after the two world wars because these discoveries were inevitably tied to ideological notions, and to proving the long or short presence of particular ethnicities in certain territories, with obvious consequences for the issue of who has the “historical” right to the land. The fact that there are an astonishing number of Avar-age graves (60,000!), as estimated by Pohl, excavated in the Pannonian Plain is not a pure coincidence. Certainly, the reason for retrieval of this large number of graves is tied to the Avars’ burial customs, and the importance the Avars themselves put on formation of certain types of large graveyards in parts of the landscape later people have not used intensively. But, it is also connected with the research interests of the early twentieth century archaeologists. They focused on retrieving these bones because it spoke for and emphasized “eastern” components of modern Hungarian history. The shift of research interests from the early twentieth century, and from the oriental-focused views of Hungarian early medieval research is now apparent. As Curta wrote (2008a:2-3):

“... archaeologists, especially in Hungary, have already begun to question the obsessive preoccupation with the “Orient” and the “steppe” that was so typical for traditional approaches to the history of Avars, Bulgars, of Khazars. As Hungary and Bulgaria have now joined the European Union, Avar and Bulgar archaeology has moved away from the Steppenfixierung of the old school, whose research agenda was often driven by questions formulated by Turkologists. Instead of yurts and horse gear, archaeologists have now turned to “Germanic” assemblages from western Hungary, especially from around the southwestern end of the Balaton Lake, which could be dated to the Avar age and thus testify to the

continuing relations with Western Europe at a time for which most historians assume that such relations did not exist. Elsewhere, while interest in the “Other” and the steppe has remained relatively strong among historians, archaeologists have begun to develop new models of interpretation primarily based on comparison with contemporary phenomena in Western Europe.”

In other words, the vicissitudes of Hungarian history during the eventful 1900s shaped the agendas and outlooks of researchers. As was discussed in the course of this work, the new paradigm, an integration of the Roman legacies with the new non-Roman cultural, ethnic and political components, is much more encompassing. It now looks like it was the amalgam of different cultural and biological entities that formed the new medieval Hungary, solidly part of Western Europe. The study of this period serves to show that the picture ‘on the ground’ (or for archaeologists, ‘in the ground’) tends to be much more complex than general explanations of what happens when ‘new’ people and ‘new’ cultures flow into ‘old’ territories.

The example offered by the history of the early medieval research in the Pannonian Plain, can be paralleled, although not literally, to the studies of Late Pleistocene human populations. The interactions of different groups of people during the Late Pleistocene undoubtedly happened – exchanges of ideas, material and genes. Moreover, there is no way to demarcate or set apart such groups based on any criterion that researchers posit as crucial in defining behavioral, morphological or cultural modernity. The tendency to typologize and delineate these groups does not likely reflect how these groups actually interacted amongst themselves. It is of course impossible to know and fully understand how notions of “self” and “other” applied to the Late Pleistocene groups and how they defined community. We cannot assume that Late Pleistocene group acted in the same way as the peoples of early medieval times – but

some themes can be extrapolated and parallels drawn in the studies of the two time periods in this dissertation. Instead of viewing Late Pleistocene groups as discrete, 'isolated' populations, a new view is becoming more and more apparent: that is that variation, integration, and hybridization of diversity (both cultural and biological) is crucial in forming 'new' communities, and that this regularly happens (Kapuściński 2008). In fact communities are never static, but are always a process more than a bounded thing. The choice we face is how we regard these interactions – something different, unusual, and uncommon, or something crucial, something that contributed to making us what we are today.

Appendix A

Data collection sheets

NON-METRIC CRANIAL TRAITS

Specimen No:	Site:	Sex: M F ?
Burial Number:	Period:	Age: YA OA
Institution:	Date Examined:	

#	Trait	L	R
OSSICLES			
1	Coronal ossicles 0=none; 1=present [1, 2, 3, 4, 5, 6]		
2	Bregmatic ossicle 0=none; 1=present		
3	Sagittal ossicles 0=none; 1=present [1, 2, 3, 4, 5, 6]		
4	Lambdic bone 0=absent; 1=present [ossicle; bone; <i>os inca</i> ; half of <i>os inca</i> ; tripartite <i>os inca</i> ; <i>os inca</i> + bone; bipartite <i>os inca</i> ; trace; 9=1/3 <i>os inca</i>]		
5	Lambdoid ossicles 0=none; 1=present [1, 2, 3, 4, 5, 6]		
6	Asterionic ossicle 0=absent; 1=present		
7	Parietal notch bone 0=absent; 1=present [1, 2, 3]		
8	Epipteris bone 0=absent; 1=present [1, 2, 3]		
9	Squamosal ossicles 0=none; 1=present [1, 2, 3, 4, 5, 6]		
10	Occipitomastoid ossicles 0=none; 1=present [1, 2, 3, 4, 5, 6]		
I. NORMA VERTICALIS			
11	Position of the greatest breadth as seen from the above 0=middle; 1=posterior		
12	Brows above orbits 0=strongly angled; 1=not strongly angled		
13	Passage from the torus to the frontal on the sides 0=straight or convex; 1=concave		
14	Outline from the postorbital constriction to the tuber parietal 0=straight; 1=convex		
15	Frontal keeling 0=none; 1=present		
16	Sagittal keeling 0=none; 1=present		
II. NORMA LATERALIS			
17	Forehead 0=rounded; 1=receding		
18	Prebregmatic eminence 0=absent; 1=present		
19	The sagittal line continues to rise behind the bregma 0=no; 1=yes		
20	Prelambdoidal flattening 0=no; 1=yes		
21	Nuchal area strongly convex (not flattened) 0=no; 1=yes		
IIa. FACIAL PROFILE			
22	Nasion located in a depression 0=no; 1=yes		
23	Projection of the glabellar point 0=no; 1=yes		
24	Nasal bones angled right from nasion 0=no [flat below nasion]; 1=yes		
25	Subnasal region surface [acanthion to prosthion] 0=straight to convex; 1=concave		
26	Alveolar prognathism 0=absent; 1=present		
27	Significant forward projection of the lateral boundary of the nasal aperture from the orbit 0=no; 1=yes		
28	Deep furrow between the above feature 0=no; 1=yes		
IIb. LATERAL REGION OF THE HEAD			
29	Auditory exostosis 0=absent; 1=present		
30	Suprameatal spine 0=absent; 1=present [crest-like; triangular protrusion]		
31	Hyperostosis of tympanic (tympanic thickening) 0=absent; 1=present		
32	Foramen of Huschke (tympanic dehiscence) 0=absent; 1=present		
33	Prominent temporal crest on parietal 0=no; 1=yes		
34	Angular torus 0=absent; 1=present		
35	Supramastoid crest 0=weak; 1=prominent		
36	Mastoid crest 0=weak; 1=prominent		
37	Mastoid tubercle 0=absent; 1=present		
38	Massive mastoid process 0=no; 1=yes		

39	Mastoid shape 0=cone; 1=cylinder		
40	Mastoid's summit 0=blunt; 1=sharp		
41	Mastoid suture 0=absent; 1=present [trace; partial; complete]		
42	Exposure of the digastric fossa on the lateral side of the skull 0=no; 1=yes		
43	EAM angle 0=vertical long axis; 1=tilted long axis		
44	EAM shape 0=round; 1=oval		
45	Upper margin of the zygomatic arch 0=straight; 1=wavy or concave		
46	Root of the zygomatic arch begins anterior to EAM [seen from above] 0=no; 1=yes		
47	The anterior zygomatic tubercle is very salient 0=no; 1=yes [TMJ tubercle]		
III. NORMA FACIALIS			
48	Metopic suture 0=absent; 1=present [only nasal, only bregmatic, nasal + bregmatic (not connected), metopic ossicle, metopic fissure]		
49	Frontal groove 0=absent; 1=single or more		
50	Supraorbital notch [NOT foramen-like] 0=absence; 1=present		
51	Deep supraorbital notch 0=no; 1=yes		
52	Infraorbital foramen 0=single; 1=double, divided or multiple		
53	Infraorbital suture 0=absent; 1=present		
54	Zygomaxillary tubercle 0=absence; 1=present [trace; medium; strong]		
55	Zygomaxillary suture 0=broadest at the base or equal; 1=broadest above the base		
56	Nasal-frontal suture 0=arched; 1=straight		
57	Nasal suture deflection 0=none; 1=present		
58	Supraorbital structure 0=absent; 1=present [is there any expression of arches/torus]		
59	Supraorbital region 0=superciliary arches; 1=supraorbital torus		
60	Shallow groove that passes obliquely outwards and upwards between the medial and lateral element of supraorbitals 0=absent; 1=present (enough to just palpate)		
61	Glabella dips downward 0=no; 1=yes		
62	Projecting glabella 0=no [groove between 2 prominent arches/torus]; 1=yes [no groove]		
63	Lateral extension of supraglabellar sulcus (furrow) 0=no; 1=yes		
64	Downward dislocation of lateral superior orbital margin 0=no; 1=yes		
65	Superior margin of the orbit 0=sharp; 1=blunt		
66	Orbit shape 0=rounded; 1=rectangular		
67	Orbit height 0=high; 1=low		
68	Narrow nasal bones 0=no; 1=yes		
69	Flat nasal roof 0=no (saddle-shape); 1=yes		
70	Nasal spine 0=not prominent; 1=prominent		
71	Subnasal margin 0=sharp; 1=blurred		
72	Double lower nasal margin (internal and external) 0=absent; 1=present		
73	Zygomaxillary ridge 0=absent; 1=present		
74	Canine fossa 0=absent; 1=present		
75	Malar pillar of the maxilla 0=shelved; 1=notched		
76	Thick maxillofrontalia 0=no; 1=yes		
77	Ascending (orbital) process of the malar 0=small; 1=large		
78	Malar body 0=small; 1=large		
79	Bending of the orbital process of malar on the body of the bone 0=no; 1=yes		
80	Zygo-facial foramen 0=none or single; 1=double or more		
81	Marginal tubercle 0=absence; 1=present [weak; medium; strong]		
IV. NORMA OCCIPITALIS			
82	Parietal foramen 0=absent or single; 1=more		
83	Position of the greatest breadth as seen from the rear 0=mid-cranium; 1=high		
84	Cranial rear rounded 0=no (parallel sided); 1=yes		
85	Mastoid process projects minimally 0=no; 1=yes		
86	Mastoid well detached from the petrosal bone 0=no (less detached); 1=yes		
87	Laterally convex surface of mastoid 0=no; 1=yes		
88	Mastoid tip 0=converges towards the sagittal plane; 1=points straight downwards		

89	Mastoid foramen 0=absent; 1=present [sutural; exsutural]		
90	Torus occipitalis (between supreme and superior line) 0=absent; 1=present		
91	Torus breadth equals semispinalis breadth 0=no; 1=yes		
92	Supreme nuchal lines away from midline 0=absent or weak (only palpable); 1=medium or strong (visible)		
93	Supreme nuchal lines come together to form external occipital protuberance 0=no; 1=yes		
94	Superior nuchal lines come together to form the tuberculum linearum 0=no; 1=yes		
95	Location of the EOP and tuberculum linearum coincides 0=no; 1=yes		
96	Occipital bun 0=absent; 1=present		
97	Elliptical suprainiac fossa 0=no; 1=yes		
98	Semispinalis capitis attachment 0=not well excavated; 1=well excavated		
99	Lateral boundary of semispinalis indicated by a prominent ridge 0=no; 1=yes		
100	External occipital crest above the inferior nuchal lines 0=absent; 1=present		
101	External occipital crest below the inferior nuchal lines 0=absent; 1=present		
102	Well individualized rectus capitis p.m. bulges 0=absent; 1=present		
103	Sutura mendosa 0=absent; 1=present [trace (1 cm or <); well expressed (> 1 cm)]		
V. NORMA BASILARIS			
104	Maxillary torus 0=none; 1=present [lingual; buccal; lingual + buccal]		
105	Palatine torus 0=absent; 1=present		
106	Maxillaries laterally connect with the malar forming a clear-cut angle [instead of just curved rounded transition] 0=no; 1=yes		
107	Anterior temporal fossa border angled 0=no (vertical); 1=yes		
108	Attachment of the masseter muscle advanced anterior to ZM suture 0=no; 1=yes		
109	Digastric sulcus is fairly wide 0=no; 1=yes		
110	Digastric sulcus is shallow 0=no; 1=yes		
111	Juxtamastoid crest 0=non prominent; 1=prominent		
112	Occipitomastoid crest 0=non prominent; 1=prominent		
113	Linea obliquus 0=non prominent; 1=prominent		
114	Ovale-spinosum 0=completely separated; 1=ovale spinosum confluence (any incomplete)		
115	Foramen of Vesalius 0=absent; 1=present		
116	Pterygo-spinous bridge 0=absent; 1=present		
117	Precondylar tubercle 0=absent; 1=present		
118	Hypoglossal canal double 0=single; 1=double		
119	Condylar facet double 0=single; 1=double		
120	Glenoid cavity has significant anterior vertical surface 0=no; 1=yes		
121	Medial glenoid (temporal) spine 0=absent; 1=present		
122	Post-glenoid process (spine) 0=absent; 1=present		
123	Basilar process of the occipital convex from side to side 0=no (flat); 1=yes		
VI. DENTITION			
124	Central incisor curved or straight 0=curved; 1=straight		
125	Central incisor has marginal ridges 0=no; 1=yes		
126	Central incisor has central tubercle 0=no; 1=yes		
127	Lateral incisor curved or straight 0=curved; 1=straight		
128	Lateral incisor has marginal ridges 0=no; 1=yes		
129	Lateral incisor has central tubercle 0=no; 1=yes		
130	Canine has a lingual tubercle 0=no; 1=yes		
131	Peg like M ¹ [small and one cusp tooth] 0=no; 1=yes		
132	Accessory cusp on molar [any molar - L M ¹ , M ² , M ³ - R M ¹ , M ² , M ³] 0=absent; 1=present		

Appendix B
Scoring procedures

1. Position of the greatest breadth as seen from the above

Definition – Greatest cranial breadth is defined as “*maximum width of skull perpendicular to midsagittal plane wherever it is located*”, determined by spreading calipers (Buikstra and Ubelaker 1994:74). The trait is observable in *norma verticalis*, in which the position of the widest breadth of the skull is scored. This trait was chosen because of Suzuki’s assessment of Amud I having its maximum breadth shifted backwards (1970:151).

Scoring procedure – The skull is observed in *norma verticalis* and with the help of spreading caliper the greatest breadth of the skull is determined. The position of the greatest breadth in regard to the whole skull is being noted as positioned in the middle or shifted more backwards (posterior to the vertical crossing the mastoid process). Anterior or at the mastoid process location is scored as the middle position of the skull, and posterior to the mastoid process is scored as posterior.

0=middle



1=posterior



2. Brows above orbits

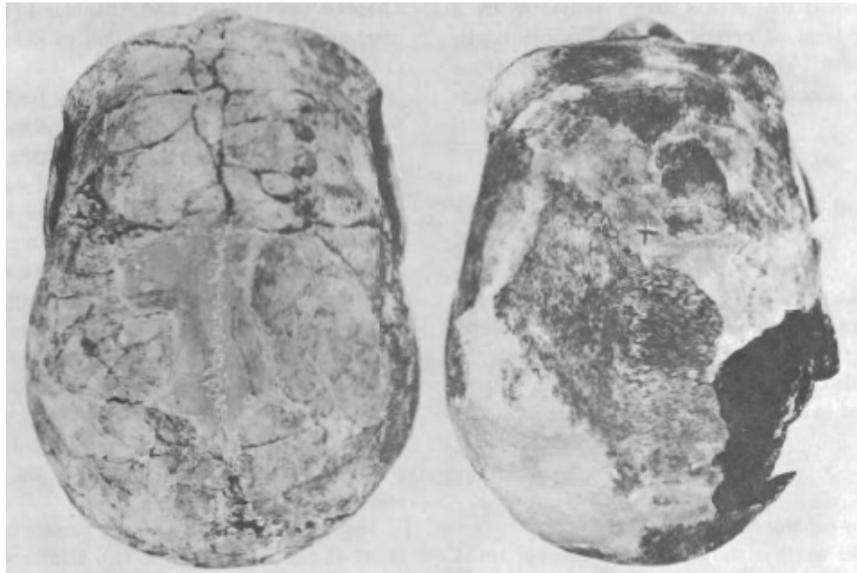
Definition – The trait is observable in *norma verticalis*, where the frontal outline of the brows is expressed as either strongly angles or not. Suzuki noticed that although classic Neandertals, and other West Asian Neandertals (Shanidar I), show pronounced convexity in the outline of the anterior surface of brows above the orbits, Amud I does not show such convexity (1970:138). Measuring the angle of the torus convexity among classic Neandertals and West Asian fossil specimens, Suzuki (1970:137) observed that Amud I

exhibits less acute angle (133°) at the glabellar region of torus than those found in other Neandertals (La Chapelle 144° , Shanidar I 160°). However, the angle is exactly the same as that of Skhul IV (133°).

Scoring procedure – When skull is in *norma verticalis*, brows above orbits are being observed as either strongly angled between each other or not. The illustration presented was taken as the standardized reference in differentiating two different outlines. The illustration (taken from Suzuki 1970:138) demonstrate Shanidar I specimen on the left and Amud I specimen on the right.

0=strongly angled (Shanidar)

1=not strongly angled (Amud)



3. Continuous passage from the torus to the frontal on the sides with no significant depression

Definition – The passage from the most lateral ends of the supraorbital torus towards the superior part of the frontal bone is being observed. This trait was chosen following Vallois and Vandermeersch description of Qafzeh VI having “continuous passage from the torus to the frontal with no depression” (1975:446).

Scoring procedure – It is scored as either straight to convex or concave. In the case of concavity it has to be either observable or palpable.

0=straight or convex



1=concave



4. Outline from the postorbital constriction to the tuber parietalis

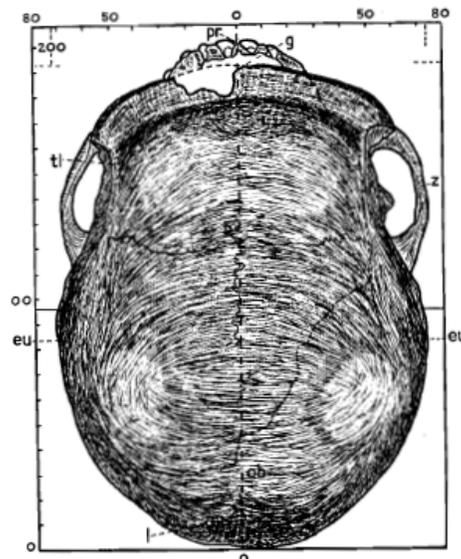
Definition – The outline, observable in *norma verticalis*, connects the postorbital constriction to the *tuber parietalis*. Suzuki states (1970:151) that this outline is convex in modern sapient man and concave in the Amud I specimen.

Scoring procedure – Outline from the postorbital constriction to the tuber parietalis is scored as being either straight to concave or convex. The scoring is done by comparing the specimens to the cranial outlines in *norma verticalis* of Amud I (considered straight to concave, Suzuki 1970:151) versus Skhul V (considered convex).

0=straight (Amud I)



1=convex (Skhul V)



5. Frontal keeling

Definition – Frontal keeling is the thickening of bone on part or all of the midline of the frontal bone.

Frontal keeling is scored as positive (present) whenever there is a palpable elevation on the surface of the frontal bone in the midline area of the frontal bone (where metopic suture would be). Narrow frontal keeling said to be a regional feature characterizing East Asian Pleistocene human fossil sample (Wolpoff 1999).

Scoring procedure – The specimen on the left photo is scored negatively, while the specimen on the right photo is scored positively.

0=none



1=present



6. Sagittal keeling

Definition – Sagittal keeling is the thickening of parietals bone(s) along or at the sagittal suture.

Scoring procedure – Sagittal keeling is scored as positive (present) whenever there is a palpable elevation on the surfaces of the parietal bones in the area of the sagittal suture. It is scored as present even in the cases of “double” keeling.

0=none



1=present



7. Forehead

Definition – The outline of the forehead in the lateral view is observed. Vallois and Vandermeersch (1975) described Qafzeh VI specimen as having frontal convexity that is comparable to those of modern man. In contrast, Neandertal specimen show backward slope of the frontal bone in the lateral view (Vallois and Vandermeersch 1975:446). Following Vallois and Vandermeersch (1975), this is the first non-metric trait that describes the sagittal outline of the skull. In addition, McCown and Keith describes Skhul V as having less sloping forehead than what is usual for European Neandertals (1939:240,241).

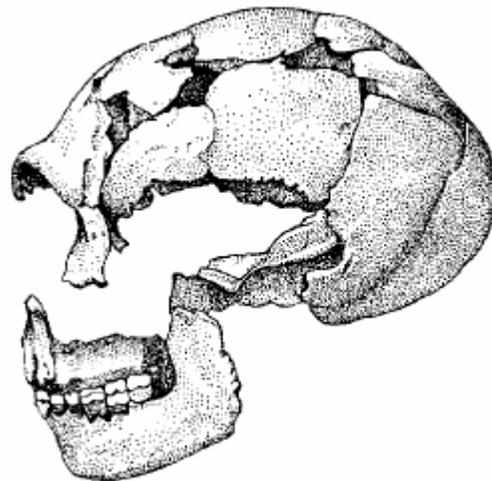
Scoring procedure – The shape of the forehead in the lateral view is scored as either rounded or receding.

The following photos are differentiating one version from the other.

0=rounded (Qafzeh VI)



1=receding (Spy I)

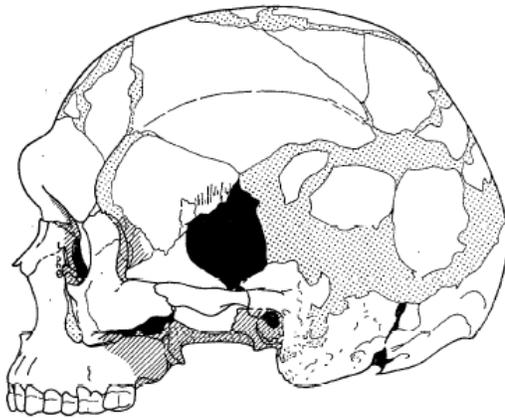


8. Prebregmatic eminence

Definition – Prebregmatic eminence is a thickening of the frontal bone anterior to bregma. This trait has been integrated into the study because of Vallois and Vandermeersch's description of the sagittal outline in the lateral view of Qafzeh VI specimen. Following Vallois and Vandermeersch (1975), this is the second non-metric trait that describes part of the sagittal outline of the skull.

Scoring procedure – Following the sagittal outline across the frontal bone in the lateral view, bone thickening and elevation right before reaching bregma is scored as present.

0=absent (Qafzeh VI)



1=present (WLH-50)



(from Wolpoff *et al.* 2001:294)

9. The sagittal line continues to rise behind the bregma

Definition – This trait was described in the case of Qafzeh VI by Vallois and Vandermeersch (1975) as continuously but slightly rising behind the bregma which positioned the vertex of Qafzeh VI in the middle of the cranial dome (1975:448). This trait has been integrated into the study because of Vallois and Vandermeersch's description of the sagittal outline in the lateral view of Qafzeh VI specimen. Following Vallois and Vandermeersch (1975), this is the third non-metric trait that describes part of the sagittal outline of the skull.

Scoring procedure – This trait is scored as positive (the outline continues to rise posterior to bregma) or negative (the outline discontinues to rise behind posterior to bregma). In order to score the trait, skull is positioned in the Frankfort horizontal.

0=no



1=yes (Qafzeh VI)



10. Prelambdoidal flattening

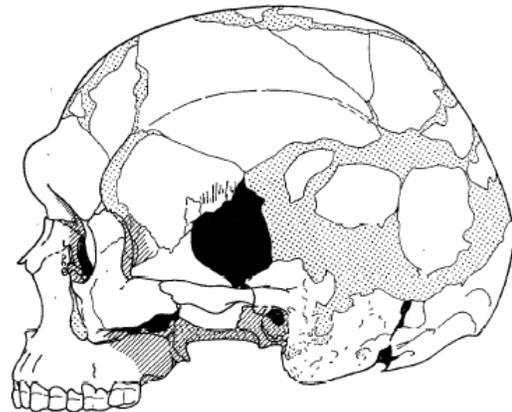
Definition – Prelambdoidal flattening is described as straight appearance of the sagittal outline from the vertex of the skull toward and anterior to lambda. This characteristic has been noted on Qafzeh VI specimen by Vallois and Vandermeersch (1975:448). Following Vallois and Vandermeersch (1975), this is the fourth non-metric trait that describes part of the sagittal outline of the skull. It is described as unique Neandertal feature, although many other Pleistocene populations (Wolpoff 1999:203).

Scoring procedure – Flattened sagittal outline, from the vertex and anterior to lambda, is scored as positive for the prelambdoidal flattening if observed in the lateral view.

0=no



1=yes (Qafzeh VI)



11. Subnasal region surface (acanthion to prosthion)

Definition – The subnasal region is extending from the acanthion to prosthion. This trait is included because of McCown and Keith’s remark that “*the projection of the maxilla is remarkable in Skhul V and yet the prognathism is not due to a forward slope of the upper alveolus, for, as may be noted [...] the roots of the incisors are parallel to the upper facial angle*” McCown and Keith 1939:243). From this remark followed the need to examine the particular morphology of subnasal region across all the specimens in the Levantine sample. The morphology of this region is therefore examined by looking at two details of morphology that have various expressions, as noted by McCown and Keith. First one is looking at the convexity or concavity of the sagittal contour between acanthion and prosthion. The second one is presented below (alveolar prognathism).

Scoring procedure – The region from acanthion to prosthion is observed from the lateral view, and scored as being either straight to convex in its morphological expression, or concave.

0=straight to convex



1=concave



12. Alveolar prognathism

Definition – Alveolar prognathism is protrusion of the alveolar region of the face, observed in the lateral view. As described above (11. subnasal region), this feature is included because of McCown and Keith observation of particular subnasal morphology of Skhul V. Here, the alveolar prognathism is scored as absent or present.

Scoring procedure – The morphology of alveolar region is scored in lateral view as either exhibiting prognathism, or not.

0=absent



1=present



13. Suprameatal spine

Definition – Suprameatal spine is a bony protrusion situated superiorly and posteriorly to the external auditory meatus. It varies in its shape, size and location (Pensa 1907; Hauser and De Stefano 1989:188). It serves as an attachment point for the ligaments that attach cartilaginous parts of the meatus (Tandler 1926; Hauser and De Stefano 1989:188; Manzi *et al.* 1996).

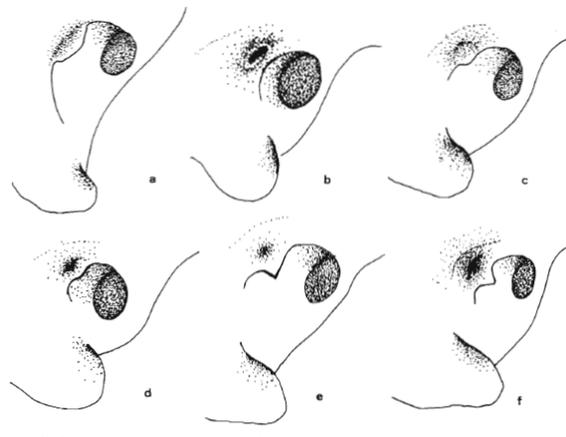
Scoring procedure – Although Hauser and De Stefano (1989:190) propose scoring of this trait according to its shape or size, the trait is scored in this study as either absent or present, regardless of its shape and size.

The following photos illustrate the presence versus the absence of the suprameatal spine in the samples used in this study.

0=absent



1=present (crest-like; triangular protrusion)



(from Hauser and De Stefano 1989:190)

14. Hyperostosis of tympanic

Definition – Tympanic plate forms the ring around the anterior and posterior lower parts of the external ear opening. The plate is said to be thickened in the archaic populations. The thickening of the rear part of the tympanic plate decreased over time (Suzuki 1970:148).

Scoring procedure – The tympanic plate is scored as either being not thickened, or thickened (hyperostotic).

The illustrations demonstrate the distinction between the two expressions.

0=absent



1=present



15. Foramen of Huschke

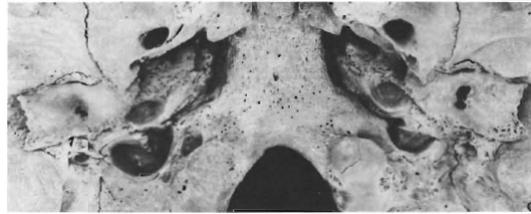
Definition – Sometimes the tympanic plate, which forms the floor of the external auditory meatus, does not ossify completely and has a dehiscence of variable size in the medial third of the plate (Hauser and De Stefano 1989:143; Anson and Singer 1955; Schmidt and Dahm 1977).

Scoring procedure – The trait is scored following the methodology of Berry and Berry (1967:368). Foramen of Huschke is scored as either absent or present. The following photos serve as illustration.

0=absent



1=present



16. Prominent temporal crest on parietal

Definition – Temporal crest is enlarged mark of the temporal lines, which indicated the superior attachment of the *temporalis* muscle and temporal fascia (White and Folkens 2005:93).

Scoring procedure – The trait is scored as either not prominent or prominent. The illustrations indicate the difference between the two scores.

0=no



1=yes



17. Angular torus

Definition – Angular torus is a thickened bony ridge that emerges where the posterior and inferior fibers of the *temporalis* muscle attach to the parietal bones of the skull, almost near the lambdoidal suture (Wolpoff 1999; Cartmill and Smith 2009). The feature is pronounced in a number of Pleistocene archaic specimens.

Scoring procedure – The trait is scored as either absent (not observable nor palpable) or present (palpable or observable).

0=absent



1=present



18. Supramastoid crest

Definition – Supramastoid crest is situated on the temporal bone, above the mastoid process. It is the posterior extensions of the root of the zygomatic process. The crest marks the attachment of the *temporalis* muscle and temporal fascia (White and Folkens 2005:95). This trait has been chosen because Vallois and Vandermeersch pointed out the complete absence of supramastoid crest in Qafzeh VI (1975:448). Suzuki mentions supramastoid crest as being well developed in the Amud I specimen (1070:146).

Scoring procedure – Depending on the specimen it is scored as either weak or prominent. The following photos make an example of distinction between the weak and prominent expression of supramastoid crest.

0=weak



1=prominent



19. Mastoid crest

Definition – Mastoid crest is situated on the surface of the mastoid process. It serves as the attachment point for the sternocleidomastoid muscle (Wood 2011). Neandertals and East Asian archaic fossils exhibit strongly developed mastoid crests (Wolpoff 1999).

Scoring procedure – The trait is scored as either weak or prominent in its expression. The following photos serve as a guide for the distinction of mastoid crest's expression.

0=weak



1=prominent



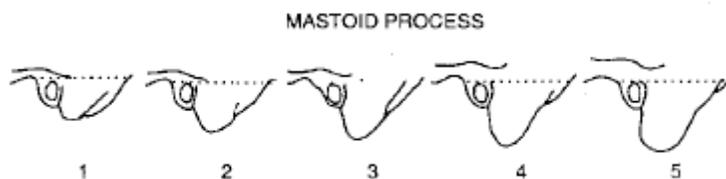
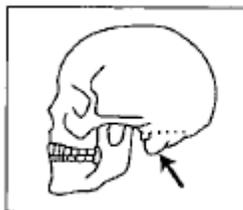
20. Massive mastoid process

Definition – Mastoid process is a massive bony protrusion of the temporal bone. Larger or massive mastoid processes are said to be characteristic for 'anatomically modern humans', while Neandertals exhibit not well developed mastoid processes (Wolpoff 1999). Vallois and Vandermeersch describe Qafzeh VI specimen as having extremely massive mastoid process (1975:448).

Scoring procedure – The mastoid process is scored as either massive or not. The following illustrations serve as a guide for the distinction between two scores (taken from Buikstra and Ubelaker 1994:20 after Acsádi and Nemeskéri 1970).

0=no (1-2)

1=yes (3-5)



21. Mastoid shape

Definition – Mastoid process is described above. Different Pleistocene specimens show variation in shape of the mastoid processes (McCown and Keith 1939).

Scoring procedure – Mastoid shape is being scored as either cone-like or cylinder-like. Cone shaped mastoid is broader at its base and it narrow down toward its summit. Cylinder shaper is of approximate same breadth from its base toward the summit. The following photographs illustrate the distinction between two described mastoid shapes.

0=cone



1=cylinder



22. Mastoid's summit

Definition – Mastoid process is described above. Here, the focus is put on the shape of mastoid's summit.

Blunt summit of mastoid is described in Qafzeh VI specimen by Vallois and Vandermeersch (1975:448).

Scoring procedure – The tip of the mastoid is scored as either blunt or sharp. The following photos illustrate the distinction between two different morphological expressions of the tip of the mastoid.

0=blunt



1=sharp



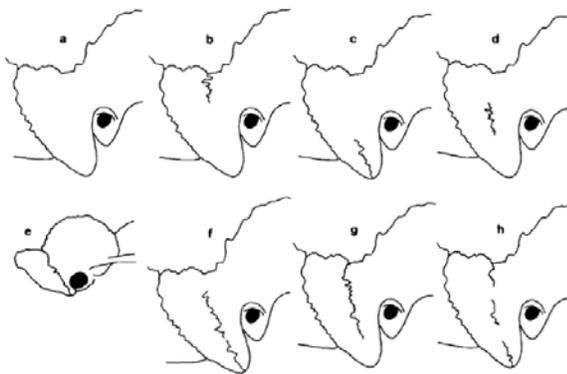
23. Mastoid suture

Definition – Mastoid suture represents a reminiscence of the fissure between the petrous and the squamous portion of the temporal bone that is present during growth processes (Hauser and De Stefano 1989:206).

The suture starts at the bottom of the parietal notch and it continues towards the mastoid summit.

Scoring procedure – Mastoid suture is scored as either completely absent or partially or completely present (Hauser and De Stefano 1989:206). The illustration below taken from Hauser and De Stefano 1989:207.

0=absent (a); 1=present (trace; partial; complete; b-h)



24. Exposure of the digastric fossa on the lateral side of the skull

Definition – Digastric sulcus is located medial to the mastoid process on the temporal bone. The sulcus is where the fibers of digastric muscle attach (White and Folkens 2005:96). This trait has been included

because different Levantine specimens exhibit its different expressions (McCown and Keith 1939; Suzuki 1970; Vallois and Vandermeersch 1975; Vandermeersch 1981).

Scoring procedure – Digastric sulcus is scored as either being exposed and observable in the lateral view of the skull, or not.

0=no



1=yes



25. External auditory meatus angle

Definition – External auditory meatus (EAM) is the opening for the ear canal (White and Folkens 2005:95).

This trait has been included because different Levantine specimens exhibit its different expressions (McCown and Keith 1939; Suzuki 1970; Vallois and Vandermeersch 1975; Vandermeersch 1981).

Scoring procedure – The angle of the external auditory meatus is scored as either having vertical or tilted long axis.

0=vertical long axis



1=tilted long axis



26. External auditory meatus shape

Definition – The authors of the original monographic publications of Levantine fossils mention the shape of the external auditory meatus in each specimen. Qafzeh VI is reported to have rounded opening of the external auditory meatus (Vallois and Vandermeersch 1975:449), while Skhul IV oval and elongated (McCown and Keith 1939:275).

Scoring procedure – The external auditory meatus is scored as either rounded or oval.

0=round



1=oval



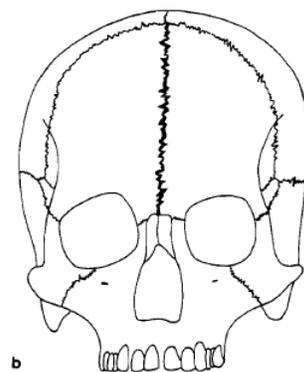
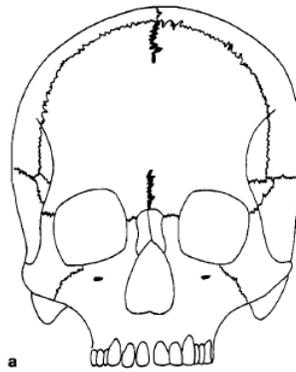
27. Metopic suture

Definition – The metopic suture represents the remnant of the interfrontal suture that is present in all newborn babies. The latter usually fuses by the second year of child's life, or at the latest by the eighth year, but in some cases it persists in the adults as well, either partially or completely expressed. The adult expression can begin to obliterate later in life (Milanesi *et al.* 1980; Hiltzman 1954), but again in some cases it stays open permanently (Hauser and De Stefano 1989:41).

Scoring procedure – Berry and Berry (1967) scored for presence or absence of this trait. Scoring recommendations from Berry and Berry (1967) are generally followed. The trait in this study is scored as present even if metopic suture is partially expressed. Present condition includes the following variants: complete; only nasal; only bregmatic; and nasal and bregmatic (not connected). Illustrations at the right below represent all the expressions scored as present (taken from Hauser and De Stefano 1989:41).

0=absent

1=present



28. Frontal groove

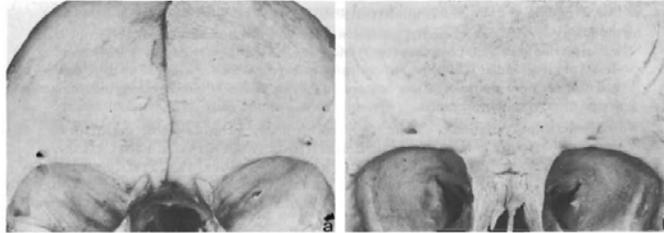
Definition – Frontal groove is an expression of single or multiple indentations located between the frontal tubers and temporal lines on the external surface of the frontal bone. They are thought to be caused by insufficient growth of one or more branches of the supraorbital (ophthalmic) nerve (Dixon 1904; Lang 1985). Due to growth and increasing curvature of frontal bone, the nerve of insufficient length is constricting the bone and therefore causing the indentation (Hauser and De Stefano 1989:48).

Scoring procedure – Frontal groove is scored as either present or absent, following Ossenberg's scoring procedures (Ossenberg 1969, 1970), no matter whether it is only one or multiple grooves present. The

photographs below show the absent expression (on the left) and the present expression (on the right). The photographs are taken from Hauser and De Stefano 1989:49.

0=absent

1=single or more



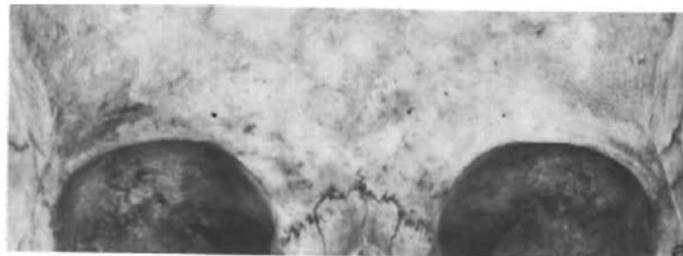
29. Supraorbital notch

Definition – Supraorbital notch is located on the medial side of the superior orbital rim of the frontal bone (White and Folkens 2005:88). It serves as passage containing the vessels and nerves that go from the orbits to the forehead (Hauser and De Stefano 1989:51).

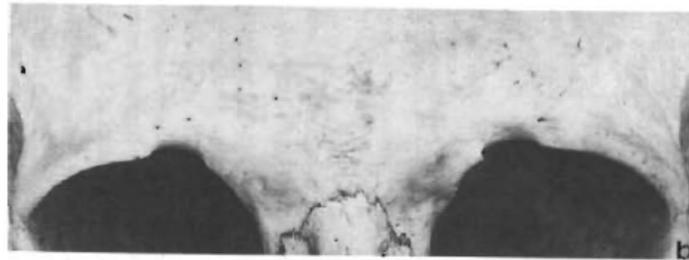
The presence of notch is said to be related to the different nerves and vessels patterns of growth (Hauser and De Stefano 1989:53).

Scoring procedure – Supraorbital notch is scored as either absent or present, differentiating small unclosed foramen-like notch, from the open, larger notches. The photographs presented below illustrate the absent (top) versus present (bottom) expression (taken from Hauser and De Stefano 1989:52).

0=absence



1=present

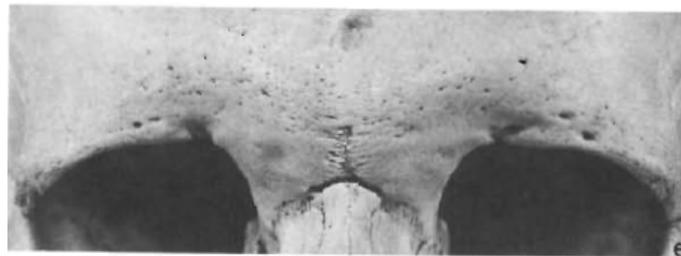


30. Deep supraorbital notch

Definition – Referring to the notch described above.

Scoring procedure – The difference between the narrow notch which is more open foramen-like versus large, open notch is being scored. The following illustration help differentiate between the two expressions of the supraorbital notch. Foramen-like notch is scored as not deep supraorbital notch (top). The photographs illustrating the distinction between the two expressions are presented below (taken from Hauser and De Stefano 1989:52).

0=no



1=yes



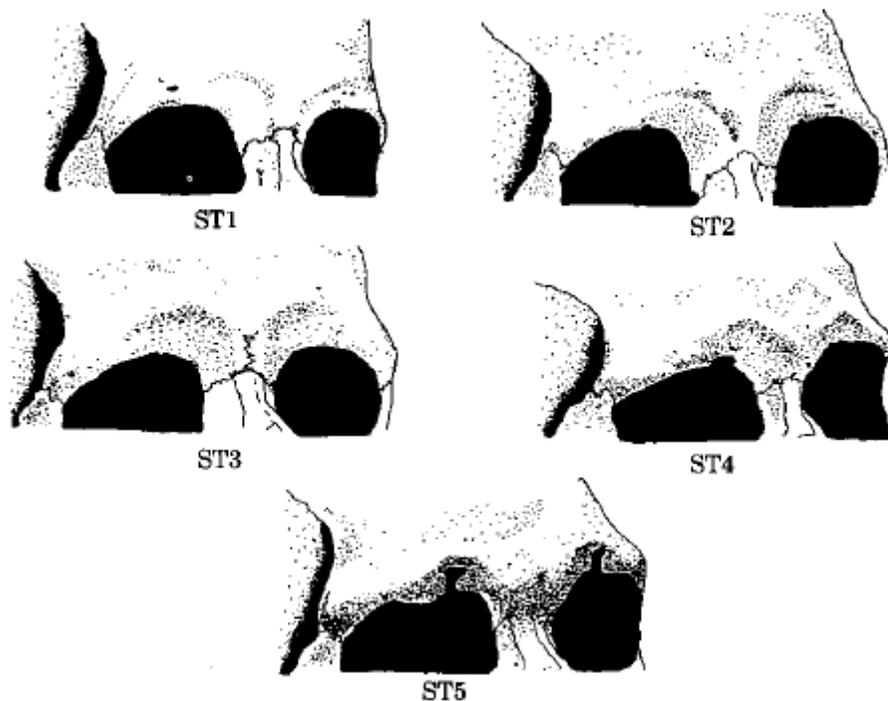
31. Supraorbital structure

Definition – Supraorbital structure is expressed as either superciliary arches or supraorbital torus. Both of these structures are described as bony thickenings on the frontal bone, above the orbits.

Scoring procedure – In case there is no bony thickening above the orbits, the trait is scored as absent. If superciliary arches or supraorbital torus can be observed above the orbit, the trait is scored as present.

Drawings presented in Lahr (1994:36) illustrate the presence of supraorbital structure (all the expressions, from ST1 to ST5).

0=absent (not illustrated); 1=present (ST1-ST5)



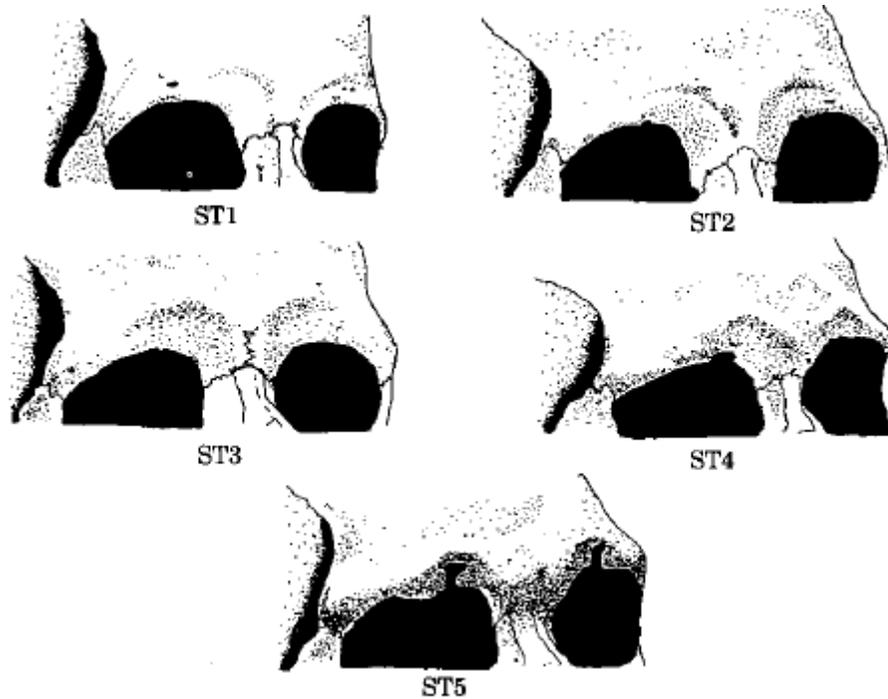
32. Supraorbital region

Definition – There are two different expressions of supraorbital structures – presence of superciliary arches or presence of supraorbital torus. The difference between the two structures is in the extent of the bony thickening above the orbits. Superciliary arches are expressed toward the midline of the frontal bone.

Supraorbital torus is present above the most of the extent of orbital rims, and is not confined to the midline region as superciliary arches.

Scoring procedure – If the above trait is scored as present for the specimen, supraorbital region is scored as having either superciliary arches or supraorbital torus. The illustration below are taken from Lahr 1994:36.

0=superciliary arches (ST1-ST4); 1=supraorbital torus (ST5)



33. Shallow groove that passes obliquely outwards and upwards between the medial and lateral element of supraorbitals

Definition – Shallow groove that passes obliquely outwards and upwards between the medial and lateral element of supraorbital structure is described for the right supraorbital of the Amud I specimen, while it is not so noticeable, or completely absent at the left side (Suzuki 1970:137).

Scoring procedure – Shallow groove is scored as either absent (not observable nor palpable) or present (enough to palpate, or observable).

0=absent (left supraorbital of Amud I below); *1=present* (enough to just palpate; right supraorbital of Amud I below)

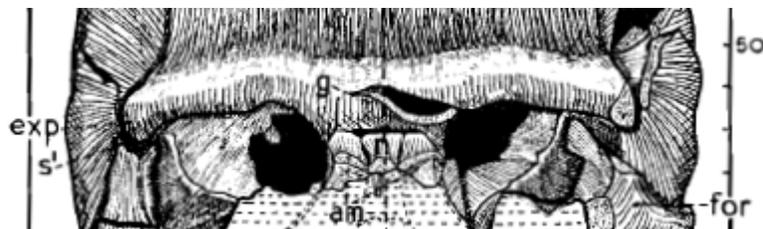


34. Glabella dips downward

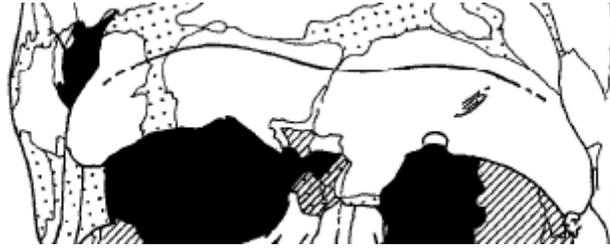
Definition – Glabella is defined as the most forward protruding point of cranial dome. It is located on the frontal bone, superior to the frontonasal suture and in between the eyebrows. McCown and Keith (1939) describe Skhul V specimen as not having a lowered portion of the supraorbital torus at the glabella point, while Vallois and Vandermeersch noticed the lowering at the glabella point in the Qafzeh VI specimen (1975:450).

Scoring procedure – Glabella is scored as either positioned at the same height as the whole extent of the superciliary arches/supraorbital torus (it does not dip downward), or dipping downward toward the frontonasal suture.

0=no (Skhul V from McCown and Keith 1939)



I=yes (Qafzeh VI from Vallois and Vandermeersch 1975)



35. Projecting glabella

Definition – Glabella is described above. There is difference between two morphological expressions of the glabellar point. It is observed as protruding (projecting), or grooved between the superciliary arches, or supraorbital tori.

Scoring procedure – Glabella is scored as either not projecting (there is a groove between the supraorbital structures) or projecting (no groove).

0=no (groove between 2 prominent arches/torus)



1=yes (no groove)

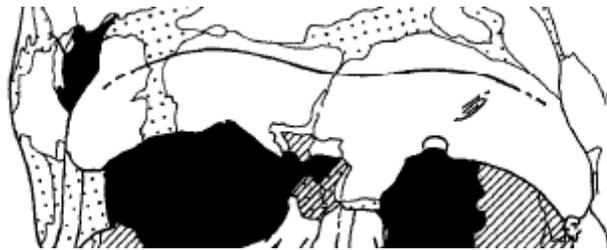


36. Lateral extension of supraglabellar sulcus/supratoral sulcus

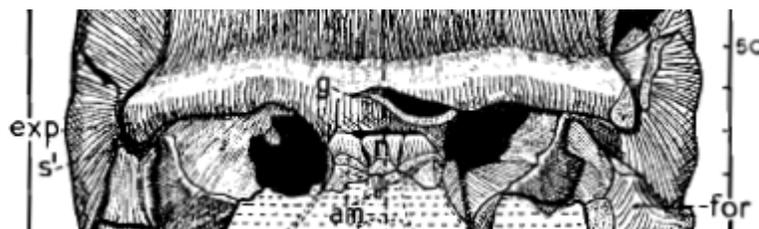
Definition – The area of the frontal bone superior to the supraorbital structure in some specimens exhibits a groove. That groove can be confined to the midline portion of the frontal bone, or extended to the lateral parts, along the supraorbital structure. The lateral extension of the groove is observable in Skhul V specimen (McCown and Keith 1939). Qafzeh VI exhibits the supratoral furrow in the glabellar region, but the furrow does not extend laterally (Vallois and Vandermeersch 1975). In Skhul V, it is truly a supratoral sulcus because it forms a broad depression along the complete length of the supraorbital torus.

Scoring procedure – Supraglabellar sulcus is scored as either confined to the midline area of the frontal bone, or extending above the lateral parts of the frontal bone. The illustrations below showing Qafzeh VI and Skhul V specimens serve as examples for no lateral extension of supratoral groove (Qafzeh VI – just supraglabellar groove), and lateral extension of supratoral groove present (Skhul V).

0=no (Qafzeh VI from Vallois and Vandermeersch 1975)



1=yes (Skhul V from McCown and Keith 1939)



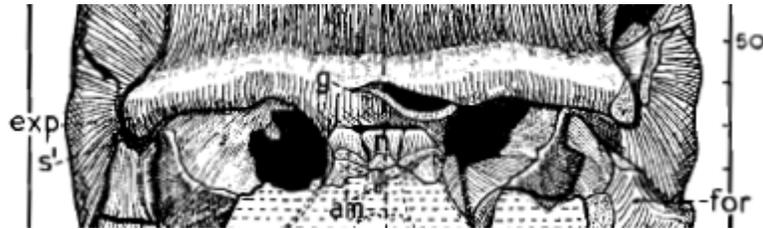
37. Downward dislocation of lateral superior orbital margin

Definition – The orientation of the most lateral parts of the superior orbital margins is observed. McCown and Keith mentioned that the Neanthropic skulls exhibit downward dislocation of the whole lateral supraorbital element. They notice that none of the Mount Carmel specimens show such tendency of

downward dislocation (McCown and Keith 1939:236). Qafzeh VI is said to differ in this aspect from the Mount Carmel specimens (Vallois and Vandermeersch 1975:449-450).

Scoring procedure – The lateral superior orbital margins are scored as either as straight continuation of the supraorbital region, or dislocated downwardly. The photos describe the distinction between two scores.

0=no (Skhul V)



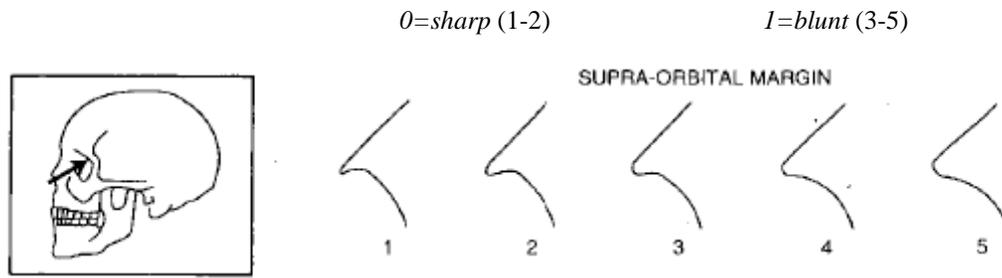
1=yes (Qafzeh VI)



38. Superior margin of the orbit

Definition – Superior margins are the upper edges of the orbits (White and Folkens 2005:88). When palpable, they are scored as either sharp or blunt (rounded).

Scoring procedure – The superior margins of the orbits are scored as either sharp or blunt following the recommendations by Acsádi and Nemeskéri (1970). Acsádi and Nemeskéri, however, recognized five different gradation types from sharp to blunt. In this study, only two of them used, sharp and blunt. The following illustration demonstrates the difference between the two scores (illustration taken from Buikstra and Ubelaker 1994:21, after Acsádi and Nemeskéri 1970).



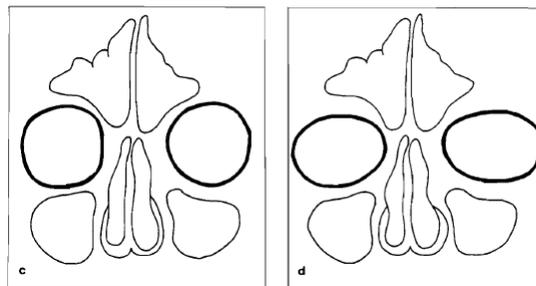
39. Orbit shape

Definition – Orbits are “anteriorly and slightly laterally situated openings of the pyramidal orbital cavity” (Hauser and De Stefano 1989:34). Orbits vary in their size and shape. In addition to individual variation, there are some general variation patterns correlated with sex and ancestral background (Byers 2005).

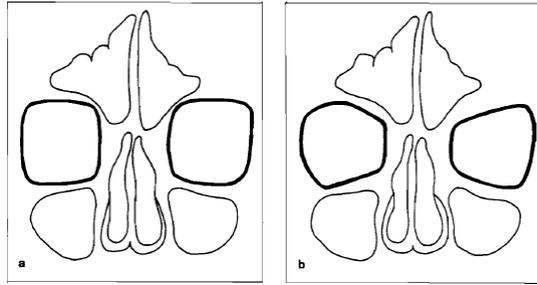
Szilvássy (1986) showed that there is a strong genetic determination of size and shape. Vallois and Vandermeersch describe the orbits of Qafzeh VI specimen as being quadrangular, modern-alike, and not like Neandertal, rounded orbits (1975:450).

Scoring procedure – The orbit shape is scored according to Szilvássy (1986) illustrations. However, whereas Szilvássy uses four distinct shape categories (square, trapezoid, round and ellipsoid), only two more generalized categories are used in this study. Following Szilvássy’s illustrations, trait is scored as either rounded (round and ellipsoid scores in Szilvássy’s illustrations) or rectangular (square and trapezoid in Szilvássy’s illustrations). This has been made to alleviate the difficulties in deciding on the minute details of the shape. The illustrations below are taken from Hauser and De Stefano 1989:34, after Szilvássy 1986.

0=rounded



1=rectangular



40. Nasal spine

Definition – Nasal spine is a bony projection at the midline of the inferior margin of the nasal aperture (White and Folkens 2005:106). The nasal spine is expressed differently in the Levantine specimens. For example, it is said to be “strong and blunt” in Skhul IV (McCown and Keith 1939:272) vs. “prismatic” in Amud I (Suzuki 1970:163).

Scoring procedure – Nasal spine is scored as either not prominent, or prominent. The illustrations describe the differentiations between the two scores.

0=not prominent



1=prominent



41. Subnasal margin

Definition – Subnasal margin is the inferior border of the nasal aperture. There are differences in the morphological expressions of the subnasal margins. The expressions are divided into either sharp or blurred categories.

Scoring procedure – The subnasal margin is scored as either sharp if discrete rim or rims are clearly observable. If there are no rim or rims observable, subnasal margin is scored as blurred. The illustration show the differentiations between two different expressions.

0=sharp



1=blurred

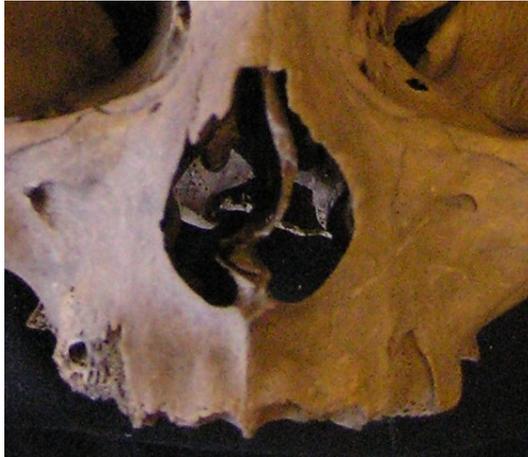


42. Double lower nasal margin (internal and external)

Definition – Subnasal margin is further scored for the presence of single or double subnasal margins.

Scoring procedure – The trait is scored as either absent (none or one margin present), or present (double margin present).

0=absent



1=present



43. Position of the greatest breadth as seen from the rear

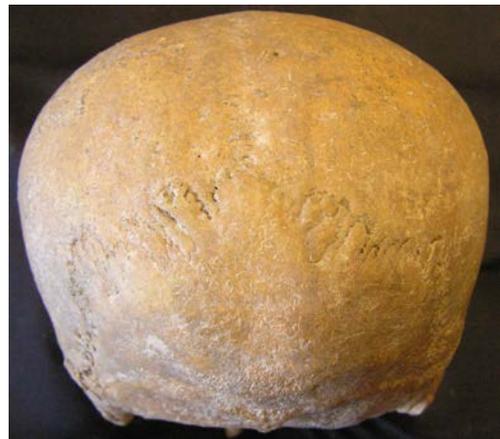
Definition – The skull is positioned in the Frankfort horizontal and the greatest breadth is determined using spreading calipers.

Scoring procedure – After determining the greatest breadth (see trait 1) in the posterior view, the position of the greatest breadth is scored as located along the mid-cranium, or high. Photographs illustrate differentiation between the two scores.

0=mid-cranium



1=high



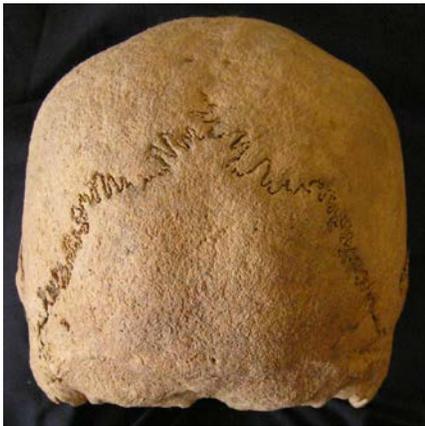
44. Cranial rear rounded

Definition – The skull is positioned in the Frankfort horizontal and observed from the posterior view.

Rounded outline of the posterior cranial vault, referred to “en bombe”, is said to be characteristic of Neandertals (Hublin 1978; Santa Luca 1978).

Scoring procedure – The outline of the skull in the posterior view is score as either having parallel parietal walls, or rounded. The illustrations differentiate between two different scores.

0=no (parallel sided)



1=yes



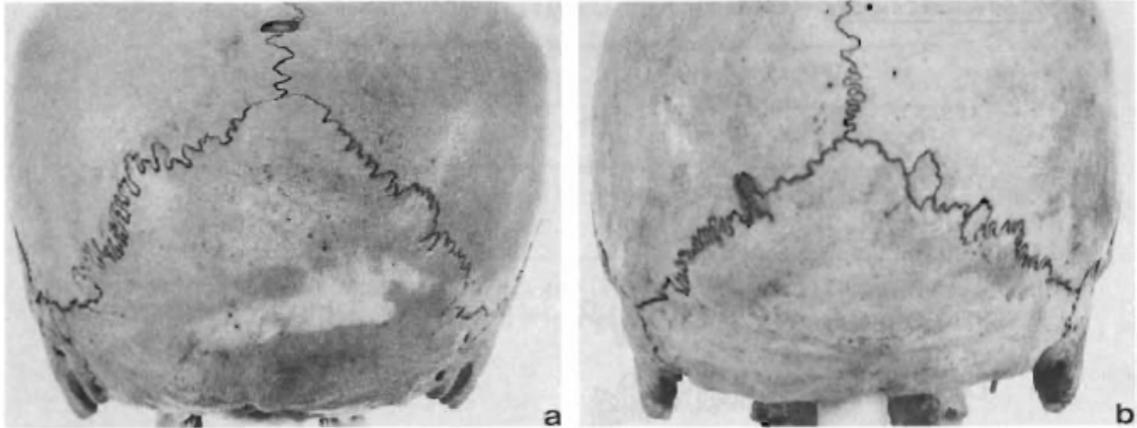
45. Mastoid process projects minimally

Definition – Mastoid process is described above. The skull is positioned in the Frankfort horizontal, and the extent of mastoid projection inferiorly is observed.

Scoring procedure – The skull is observed from the posterior view. Mastoid is scored as either projecting below the base of the cranium, or not projecting (projecting minimally). The illustrations differentiate between two different scores (taken from Hauser and De Stefano 1989:89).

0=no

1=yes



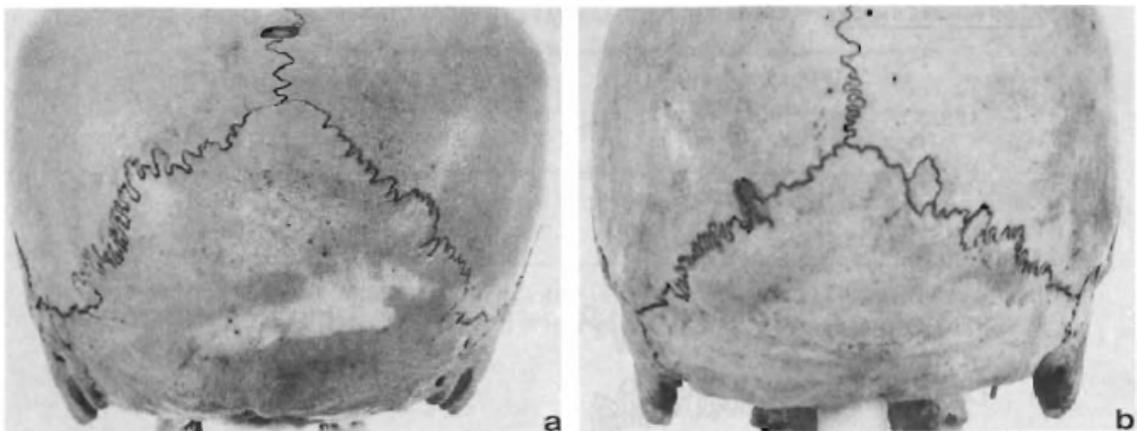
46. Mastoid well detached from the petrosal bone

Definition – In the description of Qafzeh VI specimen, Vallois and Vandermeersch (1975:448) mention that its mastoid process is less detached from the petrosal bone of the temporal than in recent modern humans.

Scoring procedure – The mastoid is scored as either being less detached from the petrosal part of the temporal bone, or more detached. The following photos (taken from Hauser and De Stefano 1989:89) illustrate mastoid process that is well detached from the petrosal portion of temporal versus one that is less detached (like Qafzeh VI).

0=no (less detached)

1=yes



47. Laterally convex surface of mastoid

Definition – The lateral surface of the mastoid process (described above) is being observed. This trait is included because Suzuki pointed out the convexity of lateral mastoid surface in Amud I specimen (1970:146).

Scoring procedure – The lateral surface of the mastoid process is scored as either straight (or concave) or convex. The photographs illustrate the difference between the two scores.

0=no



1=yes



48. Mastoid tip

Definition – The tip of the mastoid process is observed from the rear view of the cranium, while the skull is positioned in the Frankfort horizontal.

Scoring procedure – The tip of the mastoid is scored as either converging toward the sagittal plane, or pointing straight downwards. The photographs illustrate the difference between the two scores (photos taken from Hauser and De Stefano 1989:89).

0=converges towards the sagittal plane

1=points straight downwards



49. Torus occipitalis (between supreme and superior line)

Definition – Torus occipitalis (occipital torus) is described as smooth rounded ridge located on the occipital bone. It stretches (to various extent) transversely across the occipital, elevated between the supreme and superior nuchal lines (Hublin 1978; Caspari 1991). It is said to be common in archaic populations (Wolpoff 1999).

Scoring procedure – The torus occipitalis is scored as either absent (no ridge development between supreme and superior nuchal lines) or present (any ridge development between the supreme and superior nuchal lines).

0=absent

1=present



50. Torus breadth equals semispinalis breadth

Definition – Torus occipitalis is described above. Here, the breadth of the torus is observed in terms of its extent compared to the extent of the attachments of *semispinalis capitis* muscle. The attachments of the *semispinalis* are seen immediately below the superior nuchal lines (Caspari 1991).

Scoring procedure – The breadth of the occipital torus is scored as either not equal to the extent of the *semispinalis* attachments, or equal to the *semispinalis* attachments.

0=no



1=yes



51. Supreme nuchal lines away from midline

Definition – Supreme nuchal lines are the most superiorly positioned (if present) set of lines on the surface of the occipital bones. The supreme nuchal lines are where the epicranial aponeurosis (tough layer of dense fibrous tissue which covers the upper part of the cranium) attaches (Caspari 1991). The expression of the supreme nuchal lines varies.

Scoring procedure – Supreme nuchal lines away from the midline region are observed and scored as either absent of weak (only palpable), or visible or strong). The photos illustrate the distinction between two scores.

0=absent or weak (only palpable)



1=medium or strong (visible)



52. Supreme nuchal lines come together to form the external occipital protuberance

Definition – External occipital protuberance is a prominence of various expressions, located at the midline area of the occipital bone (Caspari 1991). It usually provides attachment for the *ligamentum nuchae* and *trapezius* muscle (Hublin 1978; Caspari 1991:19). The external occipital protuberance was originally considered to mark the point where two supreme nuchal lines meet (Merkel 1971 from Caspari 1991). Hublin (1978), however, pointed out that the external occipital protuberance can appear without the association to the supreme nuchal lines.

Scoring procedure – The trait is scores as absence of supreme nuchal lines coming together to form the external occipital protuberance, or presence of the supreme nuchal line coming together to form the external occipital protuberance.

0=no



1=yes



53. Superior nuchal lines come together to form the tuberculum linearum

Definition – *Tuberculum linearum* is the point where superior nuchal lines converge (Hublin 1978; Caspari 1991; Dean *et al.* 1998).

Scoring procedure – The trait is scored as either negative where it cannot be observed that superior nuchal lines converge to form the *tuberculum linearum*, or positive, where the superior lines do converge to form the *tuberculum linearum*.

0=no



1=yes



54. Locations of the external occipital protuberance and tuberculum linearum coincide

Definition – The locations of the external occipital protuberance and tuberculum linearum usually coincide in modern humans (Portela-Gomes 1968; Dean *et al.* 1998), while it is said the lack of coincident of these locations is a primitive characteristic (Dean *et al.* 1998).

Scoring procedure – The locations of both external occipital protuberance and tuberculum linearum are observed. The locations of those traits are scores as either at different positions, or coinciding. The photos illustrate the distinction between two expressions.

0=no



1=yes



55. Occipital bun

Definition – Occipital bun is a bony protuberance on the occipital bone. It is extending transversely across the occipital, with lambdoidal flattening positioned above it, and nuchal plane below it (Wolpoff 1999). It is said to be autapomorphic Neandertal trait (Boule 1911-1913; Hublin 1978, 1988; Stringer *et al.* 1984; Sergi 1991; Gunz and Harvati 2007), although some authors see the presence of this trait in other groups as well (Jelínek 1969; Smith 1982; Trinkaus and LeMay 1982; Caspari 1991; Wolpoff *et al.* 2001; Smith *et al.* 2005).

Scoring procedure – The occipital bun is scored as either absent or present. The illustrations differentiate between the two scores.

0=absent



1=present



56. Elliptical suprainiac fossa

Definition – Suprainiac fossa is broadly defined “as a depression above the inion whose expression is variable. It is ubiquitous in Neanderthals, and has often been considered a Neanderthal autapomorphy” (Caspari 2005:251; Hublin 1978). Some authors claim that this trait can be seen in modern human crania as well (Fruyer 1993, 1997; Trinkaus 2004; Wolpoff 1999). When it is expressed in the modern crania, suprainiac fossa is referred to as supranuchal fossa (Sládek 2000; Caspari 2005). Balzeau and Rougier (2010) suggested that the etiology of suprainiac fossa seen in the Neandertals differ from the one seen in modern human supranuchal fossae. However, Nowaczewska (2011) claims that the non-supranuchal fossa and suprainiac fossa are convergent traits. Elliptical suprainiac fossa is defined as one that “generally occurs in the area between the bilateral arches of the Neanderthal nuchal torus” (Caspari 2005:254).
Scoring procedure – The specimen is scored for either not having, or having elliptical suprainiac fossa. The photographs exhibit the difference between two scores.

0=no



1=yes



57. *Semispinalis capitis* attachment

Definition – The attachments of *semispinalis capitis* muscle are located on the occipital bone, between the superior and inferior nuchal lines. If the muscle attachment is well developed, bony development often referred to as nuchal crest might form at the superior end of the attachment (Wood 2011). McCown and Keith noted that the most remarkable muscle attachment seen on the occipital bone of Skhul V specimen is *semispinalis capitis* attachment. McCown and Keith noted that this attachment in Skhul V differs in its enormous extent from Gibraltar Neandertal specimen and other Australian crania McCown and Keith used for comparison (McCown and Keith 1939:248).

Scoring procedure – The attachments of the *semispinalis capitis* are scored as either not well excavated, or well excavated. The following illustrations show the difference between the two scores.

0=not well excavated



1=well excavated



58. *Sutura mendosa*

Definition – *Sutura mendosa*, or biasterionic suture, is a reminiscence of the fetal mendosal fissure that usually fuses by the second year of child's life (Hauser and De Stefano 1989:194-195). According to Aichel (1914) and Davida (1914b), this suture is not to be confused with the transverse occipital suture. Although both biasterionic and transverse occipital suture usually originate from the asterion region, the differentiation between the two can be based on the morphology of the sutures themselves. The biasterionic

is usually of simple pattern (Hauser and De Stefano 1989:99, 194), while the transverse occipital is complicated in its morphology (Hauser and De Stefano 1989:194).

Scoring procedure – *Sutura mendosa* is scored as either present or absent, following recommendation by Hauser and De Stefano (1989:196). Trait is being scored as present in both trace expression (10 mm or less) and well expressed variants (10 mm and more - Dodo 1974; Hauser and De Stefano 1989:196). The following photos illustrate presence versus the absence of *sutura mendosa*.

0=absent



1=present (trace-1 cm or <; well expressed > 1 cm)



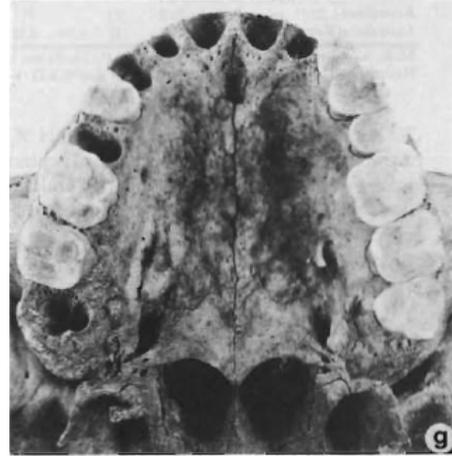
59. Maxillary torus

Definition – Maxillary torus refers to bony protrusions of varying sizes along the lingual margin of the alveolar process of maxillae. It is usually positioned in along the molar teeth (Hauser and De Stefano 1989:180).

Scoring procedure – Maxillary torus is scored as either absent or present. Illustrations demonstrate the difference between the two scores (illustration on left taken from Hauser and De Stefano 1989:181).

0=none

1=present



60. Digastric sulcus is fairly wide

Definition – Digastric sulcus is located medial to the mastoid process on the temporal bone. The sulcus is where the fibers of digastric muscle attach (White and Folkens 2005:96).

Scoring procedure – The trait is scored in the basal view. The following illustrations differentiate between narrow and wide expressions of digastric sulcus.

0=no

1=yes



61. Digastric sulcus is shallow

Definition – Digastric sulcus is located medial to the mastoid process on the temporal bone. The sulcus is where the fibers of digastric muscle attach (White and Folkens 2005:96).

Scoring procedure – The trait is scored in the basal view. The following illustrations differentiate between deep (well excavated) and shallow (not excavated) expressions of digastric sulcus.

0=no



1=yes



62. Juxtamastoid crest

Definition – Juxtamastoid crest is a bony eminence (process) located medial to the mastoid process on the temporal bone. It is said that Neandertals have large juxtamastoid processes, in some cases larger than the mastoid processes (Vallois 1969; Dean *et al.* 1998). Different authors use different nomenclature to refer to the structure medially adjacent to the mastoid process (Hublin 1978; Caspari 1991). Juxtamsastoid scored here is the one immediately medial to the mastoid process.

Scoring procedure – Juxtamastoid crest is scored as either non prominent, or prominently expressed. The illustrations demonstrate the distinction between the two scores.

0=non prominent



1=prominent



63. Glenoid cavity has significant anterior vertical surface

Definition – Glenoid cavity (mandibular fossa) is a cavity located on the temporal bone, where the mandibular condyle articulates. The articular eminence forms the anterior wall of the cavity. The anterior vertical surface of the cavity is said to be very small in Neandertals, opposed to larger vertical surface of the ‘anatomically modern humans’ (Suzuki 1970:146).

Scoring procedure – The anterior wall of the glenoid cavity is scored as either significantly sized, or small.

The illustrations demonstrate the difference between the two scores.

0=no



1=yes



64. Medial glenoid (temporal) spine

Definition – Medial glenoid spine forms the medial wall of the glenoid cavity (mandibular fossa). This feature is observed in apes and human fossil specimens but according to Suzuki (1970:146) rarely in modern man. In Amud I (Suzuki 1970:146) and Tabun I (McCown and Keith 1939) specimen medial glenoid spine is present, as well as in some other European Neandertal specimens (Krapina and Spy:

Gorjanović-Kramberger 1906; La Chapelle: Boule 1911-1913). In Skhul population, McCown and Keith did not encounter the presence of the medial glenoid spine (1939; Suzuki 1970:146).

Scoring procedure – Medial glenoid spine is scored as either present or absent.

0=absent



1=present



65. Post-glenoid process (spine)

Definition – Post-glenoid process is situated posteriorly to the glenoid (mandibular) fossa of the temporal bone. In Amud I (Suzuki 1970:146) specimen and Qafzeh VI (Vallois and Vandermeersch 1975:449) this process is well developed.

Scoring procedure – The trait is scored as either absent or present. The following photos illustrate the presence versus the absence of the post-glenoid process.

0=absent



1=present



66. Peg like M³

Definition – Third maxillary molar is in some of the specimens of the Late Pleistocene Levantine sample expressed as small peg-like molar. Such is the case in Amud I specimen (Sakura 1970:220).

Scoring procedure – Maxillary third molars are observed and scored as either not peg-like, or peg-like, as is the case in Amud I. Photographs show the distinction between the two expressions.

0=no



1=yes (Amud I)



67. Accessory cusp on molar (any molar)

Definition – There is an expression of additional accessory cusp on maxillary molars of the Levantine sample. The presence of extra buccal cusp is observed on the upper left third molar of Skhul V specimen (McCown and Keith 1939:2020).

Scoring procedure – All the maxillary molars are observed for the absence or presence of the accessory cusps (no matter on which of the molars the accessory cusp is situated). The extra cups is indicated by ‘a’ in Skhul V specimen illustration (both illustrations taken from McCown and Keith 1939).

0=absent



1=present (Skhul V)



Appendix C

Non-metric cranial scores for the Levantine and Pannonian samples

Bibliography

- Abi-Rached, L., M.J. Jobin, S. Kulkarni, A. McWhinnie, K. Dalva, L. Gragert, F. Babrzadeh, B. Gharizadeh, M. Luo, F.A. Plummer, J. Kimani, M. Carrington, D. Middleton, R. Rajalingam, M. Beksac, G.E. Marsh, M. Maiers, L.A. Guethlein, S. Tavoularis, A.-M. Little, R.E. Green, P.J. Norman and P. Parham
2011 The shaping of modern human immune systems by multiregional admixture with archaic humans. *Science* 334(6052):89-94.
- Acsádi, G. and J. Nemeskéri
1970 *History of human life span and mortality*. Akadémiai Kiadó, Budapest.
- Ahern, J.C.M.
2006 Non-metric variation in recent humans as a model for understanding Neanderthal-early modern human differences: just how “unique” are Neanderthal unique traits? In *Neanderthals Revisited: New Approaches and Perspectives*, eds. K. Harvati and T. Harrison, pp. 255-268. Springer, Dordrecht.
- Ahern, J.C.M., J.D. Hawks and S.-H. Lee
2005 Neanderthal taxonomy reconsidered...again: a response to Harvati. *Journal of Human Evolution* 48(6):647-652.
- Aichel, O.
1914 Die normale Entwicklung der Schuppe des Hinterhauptbeines, die Entstehung der “Incabein” genannten Anomalie der Schuppe und die kausale Grundlage für die typischen Einschnitte der Schuppe. *Arch. Anthropol.* 13:130-168.
- Akazawa, T., Y. Dodo, S. Muhesen, A. Abdul-Salam, Y. Abe, O. Kondo and Y. Mizoguchi
1993 The Neanderthal remains from Dederiyeh cave, Syria: interim report. *Anthropological Science* 101(4):361-387.
1995 Neanderthal infant burial. *Nature* 377:585-586.
- Albert, R.M., O. Lavi, L. Estroff, S. Weiner, A. Tsatskin, A. Ronen and S. Lev-Yadun
1999 Mode of occupation of Tabun cave, Mt Carmel, Israel during the Mousterian period: a study of the sediments and phytoliths. *Journal of Archaeological Science* 26:1249-1260.
- Allen, W.L. and J.B. Richardson
1971 The reconstruction of kinship from archaeological data: the concepts, the methods, and the feasibility. *American Antiquity* 36(1):41-52.
- Alperson, N., O. Barzilai, D. Dag, G. Hartman and Z. Matskevich
2000 The age and context of the Tabun I skeleton: a reply to Schwarz *et al.*. *Journal of Human Evolution* 38:849-853.
- Alvesalo, L. and M. Kari
1972 Dental survey in Hailuoto V. Torus mandibularis: incidence and some viewpoints connected with inheritance. *Suomen Hammaslaaka Riseuran Toimituksia* 68:307-314.
- Ammianus Marcellinus
Rerum gestarum libri. Tr. W. Hamilton. Penguin Classics, New York, 1986.

- Anderson, J.E.
1969 The Bennett site. *National Museum of Canada Bulletin* 229:121-143.
- Ando, C.
2009 Narrating decline and fall. In *A companion to Late Antiquity*, ed. P. Rousseau, pp. 59-76. Blackwell Publishing Ltd.
- Anoutchine, D.N.
1878 Sur la conformation du pterion chez diverses races humaines et les primates. *Bulletin de la société anthropologique* 1 :330-333.
- Anson, D. and J. Singer
1955 Growth of the tympanic plate. *Ann. Otol. Rhinol. Laryng.* 55:147-169.
- Ansorge, H.
2001 Assessing non-metric skeleton characters as a morphological tool. *Zoology* 104:268-277.
- Arambourg, C.
1955 Sur l'attitude en station verticale, des Néanderthaliens. *Comptes rendus de l'Académie des Sciences Paris* 240D:804-806.
- Arensburg, B. and A. Belfer-Cohen
1998 Sapiens and Neandertals: rethinking the Levantine Middle Paleolithic hominids. In *Neandertals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 311-322. Plenum Press, New York.
- Arensburg, B., O. Bar-Yosef, A. Belfer-Cohen and Y. Rak
1990 Mousterian and Aurignacian human remains from Hayonim cave, Israel. *Paléorient* 16:107-109.
- Ashley-Montagu, M.F.
1940 Review of McCown, T.D., and A. Keith, 1939. *American Anthropologist* 42:518-522.
- Bailey, S.E., T.D. Weaver and J.-J. Hublin
2009 Who made the Aurignacian and other early Upper Paleolithic industries? *Journal of Human Evolution* 57:11-26.
- Balzeau, A. and H. Rougier
2010 Is the suprainiac fossa a Neandertal autapomorphy? A complementary external and internal investigation. *Journal of Human Evolution* 58:1-22.
- Barker, G., H. Barton, M. Bird, P. Daly, I. Datan, A. Dykes, L. Farr, D. Gilbertson, B. Harrison, C. Hunt, T. Higham, L. Kealhofer, J. Krigbaum, H. Lewis, S. McLaren, V. Paz, A. Pike, P. Piper, B. Pyatt, R. Rabett, T. Reynolds, J. Rose, G. Rushworth, M. Stephens, C. Thompson and C. Turney
2007 The 'human revolution' in lowland tropical Southeast Asia: the antiquity and behavior of anatomically modern humans at Niah Cave (Sarawak, Borneo). *Journal of Human Evolution* 52:243-261.
- Barkóczy, L.
1980 History of Pannonia. In *The Archaeology of Roman Pannonia*, eds. A. Lengyel & G.T.B. Radan, pp. 85-124. Akadémiai Kiadó, Budapest.
- Barnes, T.D.
1998 *Ammianus Marcellinus and the representation of historical reality*. Cornell University Press, Ithaca, N.Y.

- Bartucz, L.
 1929 Über die anthropologischen Ergebnisse der Ausgrabungen von Mosonszentjános, Ungarn. In *Bronzeguss und Nomadenkunst*, ed. N. Fettich. *Skythika* 2.
 1950 Adatok a magyarországi avarok etnikai és demográfiai jelentőségéhez – Indications sur l'importance ethnique et démographique des Avars de Hongrie. *Acta Universitatis Szegediensis, Sectio Scient. Nat. Pars Anthropol.* 1:1-27.
- Bar-Yosef, O.
 1998 The chronology of the Middle Paleolithic of the Levant. In *Neandertals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 39-56. Plenum Press, New York.
- Bar-Yosef, O. and J. Callander
 1999 The woman from Tabun: Garrod's doubts in historical perspective. *Journal of Human Evolution* 37:879-885.
 2004 Dorothy Annie Elizabeth Garrod. In *Breaking ground: pioneering women archaeologists*, eds. G.M. Cohen and M.S. Joukowsky, pp. 380-424. University of Michigan Press, Ann Arbor.
- Bar-Yosef, O. and B. Vandermeersch
 1981 Note concerning the possible age of the Mousterian layers in Qafzeh cave. In *Préhistoire du Levant*, eds. J. Cauvin and P. Sanlaville, pp. 281-285. C.N.R.S., Paris.
 1991a Premiers hommes modernes et Néandertaliens au Proche-Orient : chronologie et culture. In *Aux origines d'Homo sapiens*, eds. J.J. Hublin and A.M. Tillier, pp. 217-250. P.U.F., Paris.
 1991b *Le squelette Moustérien de Kebara 2*. Cahiers de Paléanthropologie. Centre National de la Recherche Scientifique, Paris.
 1993 Modern humans in the Levant. *Scientific American* 268(4):94-100.
- Bátai, E.B.
 1952 A váchartyáni avar temető csontvázleteleinek embertani vizsgálata – Le cimetière avar de Váchartyán. *Annales historico-naturales Musei nationalis hungarici* 2:213-224.
- Batty, R.
 2007 *Rome and the nomads: the Pontic-Danubian realm in antiquity*. Oxford University Press, Oxford.
- Bayer, J.
 1922 Das Aurignac-Alter der Artefakte und menschlichen Skelettreste aus der Fürst-Johanns-Höhle bei Lautsch in Mähren. *Mitteilungen der Anthropologischen Gesellschaft in Wien* 52(4):173-185.
- Bell-Fialkoff, A., ed.
 2000 *The role of migration in the history of the Eurasian Steppe*. St. Martin's Press, New York.
- Bernert, Zs.
 2003 Anthropological analysis of the Avar period cemetery of Kereki-Homokbánya (Kereki sand pit). *Annales historico-naturales Musei nationalis hungarici* 95:125-309.

- 2005 Anthropological data of Kereki-Homokbánya cemetery. *Anthropological Data of Hungarian Historical Populations* 3:3-26.
- Berry, A.C.
1975 Factors affecting the incidence of non-metrical skeletal variants. *Journal of Anatomy* 120:519-535.
- Berry, A.C. and R. Berry
1967 Epigenetic variation in the human cranium. *Journal of Anatomy* 101:361-379.
- Berry, R.J.
1963 Epigenetic polymorphisms in wild populations of *Mus musculus*. *Genetical Research* 4:193-220.
1968 The biology of non-metrical variation in mice and men. In *The skeletal biology of earlier human populations*, ed. D.R. Brothwell, pp. 103-133. Pergamon Press, Oxford.
1969 Non-metrical skull variation in two Scottish colonies of the grey seal. *Journal of Zoology* 157:11-18.
- Berry, R.J. and A.G. Searle
1963 Epigenetic polymorphism of the rodent skeleton. *Proceedings of the Zoological Society of London* 140:557-615.
- Bertelli, D.
1892 Forami mentonieri nell'uomo ed in altri mamiferi. *Monitore Zoologico Italiano* 3:52-55, 80-83, 89-99.
- Binford, S.R.
1966 Me'arat Shovakh (Mugharet esh-Shubbabiq). *Israel Exploration Journal* 16:18-32, 96-103.
- Birkby, W.K.
1973 *Discontinuous morphological traits of the skull as population markers in the prehistoric Southwest*. Ph. D. dissertation. University of Arizona.
- Black, D.
1927 On a lower molar hominid tooth from the Chou Kou Tien deposit. *Palaeontologia Sinica*, Series D 7(1):1-28.
- Black, D., P. Teilhard de Chardin, C.C. Young and W. Pei
1933 Fossil man in China. *Memoirs of the Geological Survey of China*, Series A 11:1-166.
- Blockley, R.C.
1985 *The History of Menander the Guardsman*. Francis Cairns, Liverpool.
- Blom, D.E., B. Hallgrímsson, L. Keng, M.C. Lozada Cerna and J.E. Buikstra
1998 Tiwanaku 'colonization': bioarchaeological implications for migration in the Moquegua Valley, Peru. *World Archaeology* 30:238-261.
- Blumenbach, J.F.
1776 *De generis humani varietate nativa*. Dietrich, Göttingen.
- Bocquet-Appel, J.P.
1984 *Anthropologie et histoire: un essai de reconstitution de la variation d'une population européenne au XIXe siècle*. Ph.D. dissertation. Université de Paris VII.
- Bocquet-Appel, J.-P. and O. Bar-Yosef, eds.

- 2008 *The Neolithic demographic transition and its consequences*. Springer.
- Bocquet-Appel, J.P. and M.H. Xavier de Morais
 1987 *Anthropologie et histoire: un essai de reconstitution de la variation de la variation biologique de la population portugaise au XIX^{ème} siècle*. Fondation C. Gubelkian, Paris.
- Bóna, I.
 1976 *The dawn of the Dark Ages*. Athenaeum Printing House, Budapest.
- Bonfante, L. ed.
 2011 *The barbarians of ancient Europe: realities and interactions*. Cambridge University Press, Cambridge.
- Bordes, F.
 1966 More on the fate of the “classic” Neanderthals. *Current Anthropology* 7(2):205.
- Bouchud, J.
 1974 Étude préliminaire de la faune provenant de la grotte du Djebel Qafzeh près de Nazareth (Israël). *Paléorient* 2(1):87-102.
- Boule, M.
 1911 L’homme fossile de La Chapelle-aux-Saints. *Annales de Paléontologie* 6:111-172.
 1912 L’homme fossile de La Chapelle-aux-Saints. *Annales de Paléontologie* 7:21-192.
 1913 L’homme fossile de La Chapelle-aux-Saints. *Annales de Paléontologie* 8:1-70.
 1915 La paleontology humaine en Angleterre. *L’Anthropologie* 26(1):1-3.
 1921 *Les hommes fossiles: éléments de paléontologie humaine*. Masson et C^{ie}, Paris.
 1923 *Les hommes fossiles: éléments de paléontologie humaine*. 2nd ed. Masson et C^{ie}, Paris.
- Boule, M. and H.V. Vallois
 1957 *Fossil men*. Thames & Hudson, London.
- Bouyssonie, A., J. Bouyssonie and L. Bardon
 1908 Découvert d’un squelette humain mousterian à la bouffia de la Chapelle-aux-Saints (Corèze). *L’Anthropologie* 19:513-519.
- Brace, C.L.
 1964 The fate of ‘classic’ Neanderthals: a consideration of hominid catastrophism. *Current Anthropology* 5:3-43.
 1995 *The stages of human evolution*. 5th ed. Prentice Hall, Upper Saddle River, New Jersey.
- Brasili, P., L. Zaccagni and E. Gualdi-Russo
 1999 Scoring of nonmetric cranial traits: a population study. *Journal of Anatomy* 195:551-562.
- Bräuer, G.
 1978 The morphological differentiation of anatomically modern man in Africa, with special regard to recent finds from East Africa. *Zeitschrift für Morphologie und Anthropologie* 69(3):266-292.

- 1984 The 'Afro-European sapiens hypothesis' and hominid evolution in East Asia during the Late Middle and Upper Pleistocene. In *The early evolution of man, with special emphasis on Southeast Asia and Africa*, eds. P. Andrews and J.L. Franzen, pp. 145-165. Courier Forschungsinstitut Senckenberg 69.
- 2001 Zum Ursprung des modernen Menschen – Modelle und neue Forschungsergebnisse. In *Homo – unsere Herkunft und Zukunft*, eds. M. Shultz, K. Atzwanger, G. Bräuer, K. Christiansen, J. Forster, H. Greil, W. Henke, U. Jaeger, C. Niemitz, C. Scheffler, W. Schiefenhövel, I. Schröder and I. Wiechmann, pp. 18-26. Cuvillier, Göttingen.
- Bräuer, G., H. Broeg and C.B. Stringer
2006 Earliest Upper Paleolithic crania from Mladeč, Czech Republic, and the question of Neanderthal-modern continuity: metrical evidence from the fronto-facial region. In *Neanderthals revisited: new approaches and perspectives*, eds. K. Harvati and T. Harrison, pp. 269-279. Springer, Dordrecht.
- Broca, P.
1868 Sur les crânes et ossements des Eyzies. *Bulletins de la Société d'Anthropologie de Paris Série 2, Tome 3*:350-392.
- Brooks, S.T.
1969 Theodore Doney McCown: 1908-1969. *American Journal of Physical Anthropology* 32:165-166.
- Brothwell, D.R.
1958 The use of non-metrical characters of the skull in differentiating populations. *Homo* [Supplement (Bericht über die 6. Tagung der Deutschen Gesellschaft für Anthropologie in Kiel 1958)]:103-109. Musterschmidt-Verlag, Göttingen.
- Buikstra, J.E.
1972 Techniques for coping with the age regressive nature of non-metric traits. *American Journal of Physical Anthropology* 37:431-432 (Abstract).
1980 Epigenetic distance: a study of biological variability in the lower Illinois River valley. In *Early Native Americans: prehistoric demography, economy and technology*, ed. D.L. Browman, pp. 271-299. Mouton, The Hague.
- Buikstra, J.E., S.R. Frankenberg and L.W. Konigsberg
1990 Skeletal biological distance studies in American physical anthropology: recent trends. *American Journal of Physical Anthropology* 82:1-7.
- Buikstra, J.E. and D. Ubelaker, eds.
1994 *Standards for data collection from skeletal remains*. Arkansas Archaeological Survey Research Series, No. 44.
- Bury, J.B.
1958 *History of the later Roman Empire: from the death of Theodosius I to the death of Justinian*. Vol. 1. Dover Publications, Inc., New York.
- Byers, S.N.
2008 *Introduction to forensic anthropology*. 3rd ed. Pearson/Allyn and Bacon, Boston.

- Cadien, J.D., E.F. Harris, W.P. Jones and L.D. Mandarino
 1974 Biological lineages, skeletal populations, and microevolution. *Yearbook of Physical Anthropology* 18:194-201.
- Cameron, A.
 1993 *The Mediterranean world in late antiquity, AD 395-600*. Routledge, London.
- Cann, R.L., M. Stoneking and A.C. Wilson
 1987 Mitochondrial DNA and human evolution. *Nature* 325:31-36.
- Carson, E.A.
 2006 Maximum-likelihood variance components analysis of heritabilities of cranial nonmetric traits. *Human Biology* 78(4):383-402.
- Cartmill, M., F.H. Smith and K.B. Brown
 2008 *The human lineage*. Wiley-Blackwell, Oxford.
- Cary, M. and H.H. Scullard
 1979 *A history of Rome down to the reign of Constantine*. 3rd ed. The Macmillan Press Ltd, London.
- Caspari, R.
 1991 *The evolution of the posterior cranial vault in the central European Upper Pleistocene*. Ph.D dissertation. University of Michigan.
 2005 The suprainiac fossa: the question of homology. *Anthropologie (Brno)* 43:229-239.
- Cheverud, J.M.
 1988 A comparison of genetic and phenotypic correlations. *Evolution* 42:958-968.
- Cheverud, J.M. and J.E. Buikstra
 1981a Quantitative genetics of skeletal non-metric traits in the rhesus macaques on Cayo Santiago I: single trait heritabilities. *American Journal of Physical Anthropology* 54:43-49.
 1981b Quantitative genetics of skeletal non-metric traits in the rhesus macaques on Cayo Santiago II: phenotypic genetic and environmental correlations between traits. *American Journal of Physical Anthropology* 54:51-58.
 1982 Quantitative genetics of skeletal non-metric traits in the rhesus macaques on Cayo Santiago III: relative heritability of skeletal non-metric and metric traits. *American Journal of Physical Anthropology* 59:151-155.
- Cheverud, J.M., J.E. Buikstra and E. Twitchell
 1979 Relationships between non-metric skeletal traits and cranial size and shape. *American Journal of Physical Anthropology* 50:191-198.
- Chinzei, K.
 1970 The Amud cave site and its deposits. In *The Amud man and his cave site*, eds. H. Suzuki and F. Takai, pp. 21-52. The University of Tokyo, Japan.
- Christensen, A.F.
 1998 Skeletal evidence for familial interments in the Valley of Oaxaca, Mexico. *Homo* 49:273-288.
- Christie, N.
 1995 *The Lombards*. Blackwell Publishers, Oxford.
- Comas, D., F. Calafell, E. Mateu, A. Pérez-Lezaun, E. Bosch and J. Bertranpetit

- 1997 Mitochondrial DNA variation and the origin of the Europeans. *Human Genetics* 99:443-449.
- Conard, N.J. and M. Bolus
2003 Radiocarbon dating the appearance of modern humans and timing of cultural innovations in Europe: new results and new challenges. *Journal of Human Evolution* 44:331-371.
- Coop, G., K. Bullaughey, F. Luca and M. Przeworski
2008 The timing of selection at the human FOXP2 gene. *Molecular Biology and Evolution* 25(7):1257-1259.
- Coppa, A., R. Grün, C. Stringer, S. Eggins and R. Vargiu
2005 Newly recognized Pleistocene teeth from Tabun cave, Israel. *Journal of Human Evolution* 49:301-315.
- Corruccini, R.S.
1974 An examination of the meaning of cranial discrete traits for human skeletal biological studies. *American Journal of Physical Anthropology* 40:425-446.
1976 The interaction between nonmetric and metric cranial variation. *American Journal of Physical Anthropology* 44:285-294.
1992 Metrical reconsideration of the Skhul IV and IX and Border Cave 1 crania in the context of modern human origins. *American Journal of Physical Anthropology* 87(4):433-445.
- Cosseddu, G.G. and G. Floris
1975 Sulla diversa localizzazione del foro parietale nei crani umani. *Quaderni di anatomia pratica* 31:31-39.
- Crowley, P.H.
1992 Resampling methods for computation-intensive data analysis in ecology and evolution. *Annual Review of Ecology and Systematics* 23:405-447.
- Crummett, T.
1994 *The evolution of shovel shaping: regional and temporal variation in human incisor morphology*. Ph. D. dissertation. University of Michigan.
- Currat, M. and L. Excoffier
2004 Modern humans did not admix with Neanderthals during their range expansion into Europe. *PLoS Biology* 2(12):2264-2274.
- Curta, F.
2001 *The making of the Slavs: history and archaeology of the Lower Danube region, ca. 500-700*. Cambridge University Press, Cambridge.
2007 Some remarks on ethnicity in medieval archaeology. *Early Medieval Europe* 15(2):159-185.
2008a Introduction. In *The other Europe in the Middle Ages: Avars, Bulgars, Khazars and Cumans*, eds. F. Curta and R. Kovalev, pp. 1-12. Brill, Leiden.
2008b The earliest Avar-age stirrups, or the ‘stirrup controversy’ revisited. In *The other Europe in the Middle Ages: Avars, Bulgars, Khazars and Cumans*, eds. F. Curta and R. Kovalev, pp. 297-326. Brill, Leiden.
- Cybulski, J.S.

- 2001 Human biological relationships for the northern Northwest coast. In *Perspectives on northern Northwest coast prehistory*, ed. J.S. Cybulski, pp. 107-144. Mercury Series, Archaeological Survey of Canada.
- Czarnetski, A.
 1975 On the question of correlation between the size of the epigenetic distance and the degree of allopatry in different populations. *Journal of Human Evolution* 4:483-489.
- Česnys, G.
 1985 Variability of discrete cranial traits in the skulls of Lithuanian children. *Anatomischer Anzeiger Jena* 159:43-54.
- Česnys, G. and T.S. Konduktorova
 1982 Non-metric features of the skull in people of the Chernyakhovskaya culture. *Voprosy antropologii* 70:62-76.
- Česnys, G. and J. Tutkuvienė
 2007 Topographical approach to kinship assessment within population according to discrete cranial traits: the 5th-6th cc. Plinkaigalis cemetery. *Acta Medica Lituanica* 14(1):7-16.
- Daim, F.
 2003 Avars and Avar archaeology: an introduction. In *Regna and gentes: the relationship between late antiquity and early medieval peoples and kingdoms in the transformation of the Roman world*, eds. H.-W. Goetz, J. Jarnut and W. Pohl, pp. 463-570. Brill, Leiden.
- Dart, R.A.
 1925 *Australopithecus africanus*: the man-ape of South Africa. *Nature* 115:195-199.
- Darwin, C.R.
 1859 *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. John Murray, London.
 1871 *The descent of man and selection in relation to sex*. John Murray, London.
- Dauid, E.
 1914 Beiträge zur Persistenz der tranitorischen Nähte. *Anat. Anz. Jena* 46:399-412.
- Dawson, C.
 1913 The Piltdown skull. *Hastings and East Sussex Naturalist* II.
- Dawson, C. and A. Smith Woodward
 1913 On the discovery of a Palaeolithic human skull and mandible in a flint-bearing gravel overlying the Wealden (Hastings Beds) at Piltdown, Fletching (Sussex). *Quarterly Journal of the Geological Society* 69:117-123.
- Dawson, J.W.
 1863 On the antiquity of man: a review of "Lyell" and "Wilson". *The Canadian Naturalist and Geologist* 8(2):113-135.
- Dean, D., J.-J. Hublin, R. Holloway and R. Ziegler
 1998 On the phylogenetics position of the pre-Neandertal specimen from Reilingen, Germany. *Journal of Human Evolution* 34:485-508.
- Del Papa, M.C. and S.I. Perez

- 2007 The influence of artificial cranial vault deformation on the expression of cranial nonmetric traits: its importance in the study of evolutionary relationships. *American Journal of Physical Anthropology* 134:251-262.
- Deol, M.S., H. Grüneberg, A.G. Searle and G.M. Truslove
 1957 Genetical differentiation involving morphological characteristics in an inbred strain of mice I: a British branch of the C57BL strain. *Journal of Morphology* 100:345-373.
- de Torres, T., J.E. Ortiz, R. Grün, S. Eggins, H. Valladas, N. Mercier, N. Tisnérat-Laborde, R. Juliá, V. Soler, E. Martínez, S. Sánchez-Moral, J.C. Cañaveras, J. Lario, E. Badal, C. Lalueza-Fox, A. Rosas, D. Santamaría, M. de la Rasilla and J. Fortea
 2009 Dating of the hominid (*Homo neanderthalensis*) remains accumulation from El Sidrón cave (Piloña, Asturias, North Spain): an example of a multi-methodological approach to the dating of Upper Pleistocene sites. *Archaeometry* 52(4):680-705.
- Diepeveen-Jansen, M.
 2001 *People, ideas and goods: new perspectives on 'Celtic barbarians' in Western and Central Europe (500-250 BC)*. Amsterdam University Press, Amsterdam.
- Dixon, A.F.
 1904 On certain markings due to nerves and blood vessels upon the cranial vault; significance and the relative frequency of their occurrence in the different races of mankind. *Journal of Anatomy* 38:377-398.
- Dobzhansky, T.G.
 1937 *Genetics and the origin of species*. Columbia University Press, New York.
 1944 On species and races of living and fossil man. *American Journal of Physical Anthropology* 2(1):251-265.
- Dodo, Y.
 1974 Non-metrical cranial traits in the Hokkaido Ainu and the Northern Japanese of recent times. *Journal of Anthropol. Soc. Nippon* 82:31-51.
- Domić Kunić, A.
 2006 Bellum Pannonicum (12-11 B.C.): posljednja faza osvajanja Južne Panonije. *Vjesnik Arheološkog muzeja u Zagrebu* 39:59-164.
- Dubois, E.
 1894 *Pithecanthropus erectus, Eine Menschenähnliche Uebergangsform aus Java*. Landesdruckerei, Batavia.
 1895 *Pithecanthropus erectus*, betrachtet als eine wirkliche Uebergangsform und als Stammform des Menschen. *Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte*, Ausserordentliche Sitzung vom 14. December:723-738.
- Duckworth, W.L.H.
 1904 *Morphology and anthropology*. Cambridge University Press, Cambridge.
- Eckhardt, R.B., M.H. Wolpoff and A.G. Thorne
 1993 Multiregional evolution. *Science* 262(5136):973-974.
- Edgar, H.J.H. and K.L. Hunley

- 2009 Race reconciled?: how biological anthropologists view human variation. *American Journal of Physical Anthropology* 139(1):1-4.
- Eldredge, N. and S.J. Gould
 1972 Punctuated equilibria: an alternative to phyletic gradualism. In *Models in paleobiology*, ed. T.J.M. Schopf, pp. 82-115. Freeman Cooper, San Francisco.
- Éry, K.
 1992 Anthropologische Untersuchungen an drei Populationen aus dem 9. Jahrhundert in Westungarn (Gräberfelder Garabonc I und II, Zalasabar-Dezsősziget). *Antaeus, Communicationes ex Instituto Archaeologico Academiae Scientiarum Hungaricae* 21:337-481.
- Estabrook, G.F.
 2002 Two hypotheses of independence for the recognition of qualitative co-occurrences in small amounts of data. *Historical Methods* 35(1):21-31.
 2005 Hypothesis formulation and prediction: a computational approach. (manuscript)
- Estabrook, C.B. and G.F. Estabrook
 1989 ACTUS: A solution to the problem of small samples in the analysis of two-way contingency tables. *Historical Methods* 22(1):5-8.
- Evans, P.D., N. Mekel-Bobrov, E.J. Vallender, R.R. Hudson and B.T. Lahn
 2006 Evidence that the adaptive allele of the brain size gene microcephalin introgressed into Homo sapiens from an archaic Homo lineage. *Proceedings of the National Academy of Sciences of the United States of America* 103(48):18178-18183.
- Évinger, S. and Zs. Bernert
 2005 Anthropological data of Kaposvár road 61, site no. 26 cemetery. *Anthropological Data of Hungarian Historical Populations* 2:3-25.
- Ewing, J.F.
 1956 Human types and prehistoric cultures at Ksâr 'Akir, Lebanon. *Selected papers, Fifth International Congress of Anthropological and Ethnological Sciences at Philadelphia* 535-539.
 1963 A probable Neanderthaloid from Ksar 'Akil, Lebanon. *American Journal of Physical Anthropology* 21(2):101-104.
- Farkas, Gy. and P. Hunya
 1984 Comparison of series from the Avar age by clustering. *Acta Biologica Szegediensis* 30:175-190.
- Ferencz, M.
 1981 Some data to the palaeoanthropology of the Avar Period's population in Hungary. *Anthropologia Hungarica* 17:23-64.
 1986 Anthropological analysis of Avar-age series from the location Csepel-Szabakikötő. *Anthropologia Hungarica* 19:23-49.
 1991 Comparison of Avar period anthropological series. *Human Evolution* 6 (3):213-223.
- Finnegan, M. and A. Marcsik

- 1979 A non-metric examination of the relationship between osteological remains from Hungary representing populations of Avar period. *Acta Biologica Szegediensis* 25:97-118.
- Fitz, J.
- 1980a Administration and army. In *The archaeology of Roman Pannonia*, eds. A. Lengyel & G.T.B. Radan, pp. 125-140. Akadémiai Kiadó, Budapest.
- 1980b Population. In *The archaeology of Roman Pannonia*, eds. A. Lengyel & G.T.B. Radan, pp. 141-159. Akadémiai Kiadó, Budapest.
- Fóthi, E.
- 2000 Anthropological conclusions of the study of Roman and Migration periods. *Acta Biologica Szegediensis* 44(1-4):87-94.
- Fraipont, J. and M. Lohest
- 1886 La race humaine de Néanderthal ou de Canstadt en Belgique. *Bulletin de l'Académie Royale de Belgique* 12:741-784.
- 1887 La race humaine de Néanderthal ou de Canstadt en Belgique. *Archives de Biologie* 7:587-757.
- Frayser, D.W.
- 1986 Cranial variation at Mladeč and the relationship between Mousterian and Upper Paleolithic hominids. In *Fossil man: new facts, new ideas*. Papers in honor of Jan Jelínek's life anniversary, eds. V.V. Novotný and A. Mizerová. *Anthropos* (Brno) 23:243-256.
- 1992 The persistence of Neanderthal features in post-Neanderthal Europeans. In *Continuity or replacement: controversies in Homo sapiens evolution*, eds. G. Bräuer and F.H. Smith, pp. 179-188. Balkema, Rotterdam.
- 1993 Evolution at the European edge: Neanderthal and Upper Palolithic relationships. *Préhistoire européenne* 2:9-69.
- Frayser, D.W., J. Jelínek, M. Oliva and M.H. Wolpoff
- 2006 Aurignacian male crania, jaws and teeth from the Mladeč caves, Moravia, Czech Republic. In *Early modern humans at the Moravian gate: the Mladeč caves and their remains*, ed. M. Teschler-Nicola, pp. 185-272. Springer-Verlag, Wien.
- Frayser, D.W., M.H. Wolpoff, A.G. Thorne, F.H. Smith and G.G. Pope
- 1993 Theories of modern human origins: the paleontological test. *American Anthropologist* 95(1):14-50.
- Friederichs, H.F. and F. Weidenreich
- 1932 Schädel und Unterkiefer von Piltown („*Eoanthropus dawsoni* Woodward“) in neuer Untersuchung. *Zeitschrift für Anatomie und Entwicklungsgeschichte* 98:199-262.
- Fuhlrott, J.C.
- 1857 Theilen des menschlichen skelettes im Neanderthal bei Hochdal. *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfalens, Korrespondenzblatt* 4:50.
- Gardiner, B.G.
- 2003 The Piltown forgery: a re-statement of the case against Hinton. *Zoological Journal of the Linnean Society* 139:315-335.
- Gardiner, B.G. and A. Currant

- 1996 *The Piltdown hoax who done it*. Linnean Society of London, Burlington House.
- Garrigan, D. and S.B. Kingan
2007 Archaic human admixture. *Current Anthropology* 48(6):895-902.
- Garrod, D.A.E.
1937 The Near East as a gateway of prehistoric migration. In *Early man as depicted by leading authorities at the International symposium, The Academy of Natural Sciences, Philadelphia, March 1937*, ed. G.G. MacCurdy, pp. 33-40. J.B. Lippincott Company, Philadelphia and New York.
1955 The Mugharet el-Emireh in Lower Galilee: type-station of the Emiran industry. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 85(1/2):141-162.
- Garrod, D.A.E. and D.M.A. Bate
1937 *The stone age of Mount Carmel: excavations at the Wady el-Mughara*. Clarendon Press, Oxford.
- Gemmerich Pfister, I.G.L.
1999 *Création d'une collection anthropologique de référence et application des caractères discrets dans le cas de généalogies connues*. Ph.D. dissertation. Université de Genève.
- Genovés, S.T.
1964 The fate of the "classic" Neanderthals: a consideration of hominid catastrophism; Comments. *Current Anthropology* 5(1):22-25.
- Getis, A., J. Getis and J.D. Fellmann
2000 *Introduction to geography*. 7th ed. McGraw Hill.
- Gibbon, E.
1781 *The history of the decline and fall of the Roman Empire*. Reprinted by Routledge/Thoemmes Press. London 1997.
- Gibbons, A.
2010 Close encounters of the prehistoric kind. *Science* 328:680-684.
- Gill, G.W. and S. Rhine, eds.
1990 *Skeletal attribution of race: methods for forensic anthropology*. Anthropological papers, Maxwell Museum of Anthropology 4:47-53.
- Gillett, A.
2006 Ethnogenesis: a contested model of early medieval Europe. *History Compass* 4/2:241-260.
- Goetz, H.-W.
2003 Introduction. In *Regna and gentes: the relationship between late antiquity and early medieval peoples and kingdoms in the transformation of the Roman world*, ed. H.-W. Goetz, J. Jarnut and W. Pohl, pp. 1-11. Brill, Leiden.
- Goffart, W.A.
1989 *Rome's fall and after*. Hambledon Press, London.
- Goldberg, P.
1973 *Sedimentology, stratigraphy and paleoclimatology of Et-Tabun cave, Mt. Carmel, Israel*. Ph.D. dissertation. University of Michigan.

- Golden, P.C.
2003 *Nomads and sedentary societies in Medieval Eurasia*. American Historical Association, Washington D.C.
- Goodrum, M.R. and C. Olson
2009 The quest for an absolute chronology in human prehistory: anthropologists, chemists and the fluorine dating method in palaeoanthropology. *British Society for the History of Science* 42(1):95-114.
- Gopher, A., R. Barkai, R. Shimelmitz, M. Khalaily, C. Lemorini, I. Hershkovitz and M. Stiner
2005 Qesem cave: an Amudian site in Central Israel. *Journal of The Israel Prehistoric Society* 35:69-92.
- Gordon, A.D., D.J. Green and B.G. Richmond
2008 Strong postcranial size dimorphism in *Australopithecus afarensis*: result from two new resampling methods for multivariate data sets with missing data. *American Journal of Physical Anthropology* 135:311-328.
- Goren-Inbar, N. and J.D. Speth, eds.
2004 *Human paleoecology in the Levantine corridor*. Oxbow Books. Oxford, England.
- Gorjanović-Kramberger, D.
1901 Der paläolithische Mensch und seine Zeitgenossen aus dem Diluvium von Krapina in Kroatien. *Mittheilungen der Anthropologischen Gesellschaft in Wien* 31:164-197.
1902 Der paläolithische Mensch und seine Zeitgenossen aus dem Diluvium von Krapina in Kroatien. *Mittheilungen der Anthropologischen Gesellschaft in Wien* 32:189-216.
1904a Die Variationen am Skelette des altdiluvialen Menschen. *Glasnik broatskoza naravoslovnog druztva*, Zagreb. 16.
1904b Potječe li moderni čovjek ravno od diluvijalnog Homo primigenius-a? *Prvi kongres srpskih lekara i prirodњака*, 5-7. September:1-8.
1904c Der paläolithische Mensch und seine Zeitgenossen aus dem Diluvium von Krapina in Kroatien. *Mittheilungen der Anthropologischen Gesellschaft in Wien* 34:187-199.
1905 Der paläolithische Mensch und seine Zeitgenossen aus dem Diluvium von Krapina in Kroatien. *Mittheilungen der Anthropologischen Gesellschaft in Wien* 35:197-229.
1906 *Der Diluviale Mensch von Krapina in Kroatien: ein Beitrag zur Paläoanthropologie*. C.W. Kriedel's Verlag, Wiesbaden.
- Green, R.E., J. Krause, S.E. Ptak, A.W. Briggs, M.T. Ronan, J.F. Simons, L. Du, M. Egholm, J.M. Rothberg, M. Paunović and S. Pääbo
2006 Analysis of one million base pairs of Neanderthal DNA. *Nature* 444(16):330-336.
- Green, R.E., A.-S. Malaspinas, J. Krause, A.W. Briggs, P.L.F. Johnson, C. Uhler, M. Meyer, J.M. Good, T. Maričić, U. Stenzel, K. Prüfer, M. Siebauer, H.A. Burbano, M. Ronan, J.M. Rothberg, M. Egholm, P. Rudan, D. Brajković, Ž. Kučan, I. Gušić, M. Wikström, L. Laakkonen, J. Kelso, M. Slatkin and S. Pääbo

- 2008 A complete Neandertal mitochondrial genome sequence determined by high-throughput sequencing. *Cell* 134:416-426.
- Green, R.E., J. Krause, A.W. Briggs, T. Maričić, U. Stenzel, M. Kircher, N. Patterson, H. Li, W. Zhai, M. Hsi-Yang Fritz, N.F. Hansen, E.Y. Durand, A.-S. Malaspinas, J.D. Jensen, T. Marques-Bonet, C. Alkan, K. Prüfer, M. Meyer, H.A. Burbano, J.M. Good, R. Schultz, A. Aximu-Petri, A. Butthof, B. Höffner, M. Siegemund, A. Weihmann, C. Nusbaum, E.S. Lander, C. Russ, N. Novod, J. Affourtit, M. Egholm, C. Verna, P. Rudan, D. Brajković, Ž. Kucan, I. Gušić, V.B. Doronichev, L.V. Golovanova, C. Lalueza-Fox, M. de la Rasilla, J. Fortea, A. Rosas, R.W. Schmitz, P.L.F. Johnson, E.E. Eichler, D. Falush, E. Birney, J.C. Mullikin, M. Slatkin, R. Nielsen, J. Kelso, M. Lachmann, D. Reich and S. Pääbo
- 2010 A draft sequence of the Neandertal genome. *Science* 328:710-722.
- Groves, C.
- 2007 Species concepts and speciation: facts and fantasies. In *Handbook of paleoanthropology*, eds. W. Henke and I. Tattersall, pp. 1861-1879. Springer-Verlag, Berlin and Heidelberg.
- Gruber, W.
- 1852 Ursprung der Arteria temporalis profunda posterior von der A. meningea media aus der Schädelhöhle. In *Abhandlungen aus der menschlichen und vergleichenden Anatomie*, St. Petersburg. Kaiserliche Akademie der Wissenschaften zu Leipzig.
- 1870a Über congenital Theilung des Parietale durch eine quere oder schräge Sutura. *Archiv für pathologische Anatomie und Physiologie und für klinische Medicin* 50:113-124.
- 1870b Über congenital abnorm weite Foramina parietalia. *Archiv für pathologische Anatomie und Physiologie und für klinische Medicin* 50:124-134.
- Grün, R.
- 2006 Direct dating of human fossils. *Yearbook of Physical Anthropology* 49:2-48.
- Grün, R. and C.B. Stringer
- 2000 ESR and U-series analyses of dental material from Tabun C1. *Journal of Human Evolution* 39:601-612.
- Grün, R., C. Stringer, F. McDermott, R. Nathan, N. Porat, S. Robertson, L. Taylor, G. Mortimer, S. Eggins and M. McCulloch
- 2005 U-series and ESR analyses of bones and teeth relating to the human burials from Skhul. *Journal of Human Evolution* 49:316-334.
- Grün, R., C.B. Stringer and H. Schwarcz
- 1991 ESR dating of teeth from Garrod's Tabun cave collection. *Journal of Human Evolution* 20:231-248.
- Grüneberg, H.
- 1952 Genetical studies on the skeleton of the mouse IV: quasi-continuous variation. *Journal of Genetics* 51:95-114.
- 1954 Variation within inbred strain of mice. *Nature* 173:674-676.
- Gualdi-Russo, E., M.A. Tasca and P. Brasili

- 1999 Scoring of nonmetric cranial traits: a methodological approach. *Journal of Anatomy* 195:543-550.
- Gunz, P. and K. Harvati
2007 The Neanderthal „chignon“: variation, integration, and homology. *Journal of Human Evolution* 52:262-274.
- Gutiérrez, G., D. Sánchez and A. Marín
2002 A reanalysis of the ancient mitochondrial DNA sequences recovered from Neanderthal bones. *Molecular Biology and Evolution* 19(8):1359-1366.
- Haeckel, E.
1868 *Natürliche Schöpfungsgeschichte*. Georg Reimer, Berlin.
- Haile-Selassi, Y., B. Asfaw and T.D. White
2004 Homind cranial remains from Upper Pleistocene deposits at Aduma, Middle Awash, Ethiopia. *American Journal of Physical Anthropology* 123:1-10.
- Hallgrímsson, B., B. Ó Donnabháin, G.B. Walters, D.M.L. Cooper, D. Guðbjartsson and K. Stefánsson
2004 Composition of the founding population of Iceland: biological distance and morphological variation in early historic Atlantic Europe. *American Journal of Physical Anthropology* 124:257-274.
- Hammond, M.
1982 The expulsion of the Neanderthals from human ancestry: Marcellin Boule and the social context of scientific research. *Social Studies of Science* 12(1):1-36.
- Hanihara, T. and H. Ishida
2001a Frequency variations of discrete cranial traits in major human populations. I. Supernumerary ossicle variations. *Journal of Anatomy* 198:689-706.
2001b Frequency variations of discrete cranial traits in major human populations. II. Hypostotic variations. *Journal of Anatomy* 198:707-725.
2001c Frequency variations of discrete cranial traits in major human populations. III. Hyperostotic variations. *Journal of Anatomy* 199:251-272.
2001d Frequency variations of discrete cranial traits in major human populations. IV. Vessel and nerve related variations. *Journal of Anatomy* 199:273-287.
- Hanihara, T., H. Ishida and Y. Dodo
2003 Characterization of biological diversity through analysis of discrete cranial traits. *American Journal of Physical Anthropology* 121:241-251.
- Harpending, H.C., M.A. Batzer, M. Gurven, L.B. Jorde, A.R. Rogers and S.T. Sherry
1998 Genetic traces of ancient demography. *Proceedings of the National Academy of Sciences of the United States of America* 95(4):1961-1967.
- Harrison, R.G.
1990 Hybrid zones: windows on evolutionary process. *Oxford Surveys in Evolutionary Biology* 7:69-128.
- Harvati, K.
2003 The Neanderthal taxonomic position: models of intra- and inter-specific craniofacial variation. *Journal of Human Evolution* 44(1):107-132.
- Hauser, G. and G.F. De Stefano

- 1989 *Epigenetic Variants of the Human Skull*. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.
- Hawks, J.
2011 Is the biological species concept a "minority view"? February 7th, 2011. Retrieved from <http://johnhawks.net/weblog/topics/evolution/species/species-problem-gibbons-2011.html>
- Hawks, J. and G. Cochran
2006 Dynamics of adaptive introgression from archaic to modern humans. *PaleoAnthropology* 2006:101-115.
- Hawks, J., G. Cochran, H.C. Harpending and B.T. Lahn
2007 A genetic legacy from archaic *Homo*. *Trends in Genetics* 24(1):19-23.
- Heather, P.J.
1995 The Huns and the end of the Roman Empire in Western Europe. *English Historical Review* 110(435):4-41.
1997 *Foedera and foederati* of the forth century. In *Kingdoms of the Empire: the integration of barbarians in late antiquity*, ed. W. Pohl, pp. 57-74. Brill, Leiden.
2006 *The fall of the Roman Empire: a new history of Rome and the barbarians*. Oxford University Press, Oxford.
- Hey, J.
2001 The mind of the species problem. *Trends in Ecology and Evolution* 16:1326-1329.
- Hilborn, R.
1974 Inheritance of skeletal polymorphism in *Microtus californicus*. *Heredity* 33:87-121.
- Hillson, S.
1996 *Dental anthropology*. Cambridge University Press, Cambridge.
- Hilteman, H.
1954 Fonticulus metopicu und Sutura frontalis persistens mit Hypoplasie der Sinus frontales. *Fortschr. Röntgenstr.* 81 :407-409.
- Holliday, T.W.
2003 Species concepts, reticulation, and human evolution. *Current Anthropology* 44(5):653-673.
- Holtzman, S.
1973 On Brace's notion of hominid catastrophism. *Current Anthropology* 14:306-308.
- Hooton, E.A.
1946 *Up from the ape*. 2nd ed. Macmillan Co., New York.
- Horden, P. and N. Purcell
2000 *The corrupting sea: a study of Mediterranean history*. Blackwell Publishers, Oxford
- Hovers, E., Y. Rak, R. Lavi and W.H. Kimbel
1995 Hominid remains from Amud cave in the context of the Levantine Middle Paleolithic. *Paléorient* 21(2):47-61.
- Howell, F.C.

- 1957 The evolutionary significance of variation and varieties of “Neanderthal” man. *The Quarterly Review of Biology* 37(4):330-347.
- 1959 Upper Pleistocene stratigraphy and early man in the Levant. *Proceedings of the American Philosophical Society* 103(1):1-65.
- 1994 Thoughts on Eugène Dubois and the “*Pithecanthropus*” saga. In *100 years of Pithecanthropus: the Homo erectus problem*, ed. J.L. Franzen, 171:11-20. Courier Forschungsinstitut Senckenberg.
- 1998 Evolutionary implications of altered perspectives on hominine demes and populations in the Later Pleistocene of Western Eurasia. In *Neandertals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 5-27. Plenum Press, New York.
- Howells, W.W.
- 1942 Fossil man and the origin of races. *American Anthropologist* 44(2):182-193.
- 1944 *Mankind so far*. Doubleday and Co., Garden City, NY.
- Hrdlička, A.
- 1927 The Neanderthal phase of man. *Journal of the Royal Anthropological Institute* 57:249-269.
- 1930 *The skeletal remains of early man*. Smithsonian Miscellaneous Collections 83.
- Hublin, J.J.
- 1978a *Le torus occipital transverse et les structures associées: évolution dans le genre Homo*. Ph.D. dissertation. Université Paris VI, Paris, France.
- 1978b Quelques caractères apomorphes du crâne néandertalien et leur interprétation phylogénétique. *Comptes Rendus de l'Académie des Sciences Paris* 287 :923-925.
- 1988 Caractères dérivés de la région occipitomasto-dienne chez les Néandertaliens. *L'Anatomie* 3 :67-73.
- 1998 Climatic changes, paleogeography, and the evolution of the Neandertals. In *Neandertals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 295-310. Plenum Press, New York.
- Hyrtil, J.
- 1859 *Lehrbuch der Anatomie des Menschen*. 6th ed. Braumüller, Wien.
- Ishida, H. and Y. Dodo
- 1993 Nonmetric cranial variation and the populational affinities of the Pacific peoples. *American Journal of Physical Anthropology* 90:49-57.
- Jelinek, A.J.
- 1981 The Middle Paleolithic in the southern Levant from the perspective of the Tabun cave. In *Préhistoire du Levant*, eds. J. Cauvin and P. Sanlaville, pp. 265-280. CNRS, Paris.
- 1982 The Tabun cave and Paleolithic man in the Levant. *Science* 216(4553):1369-1375.
- Jelinek, A.J., W.R. Farrand, G. Haas, A. Horowitz and P. Goldberg
- 1973 New excavations at the Tabun cave, Mount Carmel, Israel, 1967-1972: a preliminary report. *Paléorient* 1(2):151-183.
- Jelínek, J.

- 1969 Neanderthal man and *Homo sapiens* in central and eastern Europe. *Current Anthropology* 10:475-503.
- 1976 The *Homo sapiens* neanderthalensis and *Homo sapiens sapiens* relationship in Central Europe. *Anthropologie* (Brno) 14:79-81.
- 1978 Comparison of mid-Pleistocene evolutionary process in Europe and in South-East Asia. *Proc. Symp. Natural Selection Liblice* 1978, pp. 251-267, Praha.
- 1985 The European, Near East, and North African finds after *Australopithecus* and the principal consequences for the picture of human evolution. *Anthropologie* (Brno) 21:57-64.
- Jeyasingh, P., S. Dua, A.K. Arora and C.D. Gupta
 1980 Study of epigenetic variants in the Northern Indian crania. *Anthropologischer Anzeiger* 38:212-219.
- Johnson, A.L. and N.C. Lovell
 1995 Dental morphological evidence for biological continuity between the A-group and C-group periods in Lower Nubia. *International Journal of Osteoarchaeology* 5:368-376.
- Kapuściński, R.
 2008 *The Other*. Verso, London, New York.
- Kaufman, D.
 2001 Comparison and the case for interaction among Neanderthals and early modern humans in the Levant. *Oxford Journal of Archaeology* 20(3):219-240.
- Keith, A.
 1895 *Pithecanthropus erectus* – a brief review of human fossil remains. *Science Progress* 3(17):348-369.
 1911 *Ancient types of man*. Harper & brothers, London.
 1915 *The antiquity of man*. Williams and Norgate, London.
 1921 *Review of Les Hommes Fossiles: Eléments de Paléontologie Humaine* by Prof. Marcellin Boule. *Nature* 107(2689):322-324.
 1927 Report on the Galilee skull. In *Researches in prehistoric Galilee, 1925-1926*, by F. Turville-Petre. The Council of the school, London.
 1931 *New discoveries relating to the antiquity of man*. Williams & Norgate, London.
 1938 The prehistoric people of Palestine. *Nature* 141(3564):340-342.
- Keith, A. and T.D. McCown
 1937 Mount Carmel man: his bearing on the ancestry of modern races. In *Early man as depicted by leading authorities at the International symposium, The Academy of Natural Sciences, Philadelphia, March 1937*, ed. G.G. MacCurdy, pp. 41-52. J.B. Lippincott Company, Philadelphia and New York.
- Kennedy, K.A.R. and S.T. Brooks
 1984 Theodore D. McCown: a perspective on a physical anthropologist. *Current Anthropology* 25(1):99-103.
- Kerckring, T.
 1670 *Spicilegium anatomicum*. Andreas Frisius, Amsterdam.
- Kimbel, W.H. and Y. Rak

- 1993 The importance of species taxa in paleoanthropology and an argument for the phylogenetic concept of the species category. In *Species, species concepts, and primate evolution*, eds. W.H. Kimbel and L.B. Martin, pp. 461-484. Plenum, New York.
- King, W.
1864 The reputed fossil man of the Neanderthal. *Quarterly Journal of Science* 1:88-97.
- Klaatsch, H.
1910 Die Aurignac-Rasse und ihre Stellung im Stammbaum der Menschheit. *Zeitschrift für Ethnologie* 42:513-577.
- Klein, R.G.
2003 Whither the Neanderthals? *Science* 299:1525-1527.
- Königsberg, L.W., L.A.P. Kohn and J.M. Cheverud
1993 Cranial deformation and nonmetric trait variation. *American Journal of Physical Anthropology* 90:35-48.
- Köppel, R.
1935 Das Alter der neuentdeckten Schädel von Nazareth. *Biblica* 16:58-73.
- Korey, K.
1970 *Characteristics of the distributions of non-metric variants of the skull*. M.A. dissertation. University of Chicago.
- Kramer, A., T.L. Crummett, and M.H. Wolpoff
2001 Out of Africa and into the Levant: replacement or admixture in Western Asia? *Quaternary International* 75:51-63.
- Krause, J., A.W. Briggs, M. Kircher, T. Maričić, N. Zwyns, A. Derevianko and S. Pääbo
2010 A complete mtDNA genome of an early modern human from Kostenki, Russia. *Current Biology* 20:231-236.
- Krause, J., C. Lalueza-Fox, L. Orlando, W. Enard, R.E. Green, H.A. Burbano, J.-J. Hublin, J. Bertranpetit, C. Hänni, J. Fortea, M. de la Rasilla, A. Rosas and S. Pääbo
2007 The derived FOXP2 variant of modern humans was shared with Neandertals. *Current Biology* 17(21):1908-1912.
- Krause, W.
1880 *Anatomische Varietäten*. Hahn'sche Hofbuchhandlung, Hannover.
- Krings, M., A. Stone, R.W. Schmitz, H. Krainitzki, M. Stoneking and S. Pääbo
1997 Neandertal DNA sequences and the origin of modern humans. *Cell* 90:19-30.
- Krings, M., H. Geisert, R.W. Schmitz, H. Krainitzki and S. Pääbo
1999 DNA sequence of the mitochondrial hypervariable region II from the Neandertal type specimen. *Proceedings of the National Academy of Sciences of the United States of America* 96:5581-5585.
- Krogman, W.M.
1932 The morphological characters of the Australian skull. *Journal of Anatomy* 66:399-413.
- Kulikowski, M.

- 2002 Nation versus army: a necessary contrast? In *On barbarian identity: critical approaches to ethnicity in the early Middle Ages*, ed. A. Gillett, pp. 69-84. Brepols, Turnhout, Belgium.
- Lahr, M.M.
 1994 The multiregional model of modern human origins: a reassessment of its morphological basis. *Journal of Human Evolution* 26:23-56.
- Lalueza-Fox, C.
 2009 The Neandertal genome project and beyond. *Contributions to Science* 5(2):169-175.
- Lalueza-Fox, C., H. Römpler, D. Caramelli, C. Stäubert, G. Catalano, D. Hughes, N. Rohland, E. Pilli, L. Longo, S. Condemi, M. de la Rasilla, J. Fortea, A. Rosas, M. Stoneking, T. Schöneberg, J. Bertranpetit and M. Hofreiter
 2007 A melanocortin 1 receptor allele suggests varying pigmentation among Neanderthals. *Science* 318:1453-1455.
- Lalueza-Fox, C., E. Gigli, M. de la Rasilla, J. Fortea, A. Rosas, J. Bertranpetit and J. Krause
 2008 Neanderthal paleogenomics in the ABO blood group gene. *BMC Evolutionary Biology* 8:342.
- Lalueza-Fox, C., E. Gigli, M. de la Rasilla, J. Fortea and A. Rosas
 2009 Bitter taste perception in Neanderthals through the analysis of the TAS2R38 gene. *Biology Letters* 5:809-811.
- Lambert, D.M. and C.D. Millar
 2006 Ancient genomics is born. *Nature* 444:275-276.
- Lane, R.A. and A.J. Sublett
 1972 Osteology of social organization: residence pattern. *American Antiquity* 37:186-201.
- Lang, J.
 1985 Kopf A: Übergeordnete Systeme. In. *Praktische Anatomie*, Vol. 1, Part 1A, eds. T. Von Lanz and W. Wachsmuth. Springer, Berlin.
- Lartet, L.
 1868 Une sépulture des troglodytes du Périgord (crânes des Eyzies). *Bulletin de la Société d'Anthropologie de Paris*, Série 2, Tome 3: 335-349.
- László, Gy.
 1956 Études archéologiques sur l'histoire de la société des Avars. *Archaeologica Hungarica* 34.
- Laughlin, W.S. and J.B. Jørgensen
 1956 Isolate variation in Greenlandic Eskimo crania. *Acta Genetica et Statistica Medica* 6:3-12.
- Le Double, A.F.
 1903 *Traité des variations des os du crane de l'homme et leur signification au point de vue de l'anthropologie zoologique*. Vigot Frères, Paris.
 1906 *Traité des variations des os de la face de l'homme et leur signification au point de vue de l'anthropologie zoologique*. Vigot Frères, Paris.
 1912 *Traité des variations de la colonne vertébrale de l'homme et leur signification au point de vue de l'anthropologie zoologique*. Vigot Frères, Paris.

- Lee, S.-H.
 1999 *Evolution of human sexual dimorphism: using assigned resampling method to estimate sexual dimorphism when individual sex is unknown*. Ph.D. dissertation. University of Michigan.
- Le Gros Clark, W.E.
 1955 *The fossil evidence for human evolution*. The University of Chicago Press, Chicago.
- Lengyel, A. and G.T.B. Radan, eds.
 1980 *The archaeology of Roman Pannonia*. Akadémiai Kiadó, Budapest.
- Lieberman, D.E., B.M. McBratney and G. Krovitz
 2002 The evolution and development of cranial form in *Homo sapiens*. *Proceedings of the National Academy of Sciences of the United States of America* 99(3):1134-1139.
- Lipták, P.
 1951 Étude anthropologique du cimetière avare d'Aporkai-Ürbőpuszta (Commune de Bugyi). *Annales historico-naturales Musei nationalis hungarici* 1:232-259.
 1955 *A Duna-Tisza köze antropológiájának főbb kérdései a VII-VIII. században*. Kandidátusi értekezés, Budapest.
 1955b Recherches anthropologiques sur les ossements avares des environs d'Üllő. *Acta Archaeologica Academiae Scientiarum Hungaricae* 6:231-316.
 1956 Nouvelles contributions à l'anthropologie de l'époque avare entre le Danube et la Tisza. *Crania Hungarica* 1:13-16.
 1957a A Homokmégy-halomi avarkori népesség – La population de Homokmégy-Halom dans l'époque des Avars. *Biol. Közl. Pars Anthrop.* 4:25-42.
 1957b Avar und Magyaren im Donau-Theiss-Zwischenstromgebiet. *Acta Archaeologica Academiae Scientiarum Hungaricae* 8:199-268.
 1959 The Avar Period Mongoloids in Hungary. *Acta Archaeologica Academiae Scientiarum Hungaricae* 10:251-279.
 1963 Budapest avarkori népességének antropológiája (Anthropology of the Avar period population of the Budapest area). Vol. I (Budapest-Népstadion). *Budapest Régiségei* 20:327-334.
 1970 A critical review of palaeoanthropological studies of the Avars in Hungary. *Acta Biologica Szegediensis* 16:117-127.
 1983 *Avar and ancient Hungarians*. Akadémiai Kiadó, Budapest.
- Louth, A.
 2008a Justinian and his legacy (500-600). In *The Cambridge history of the Byzantine Empire c. 500-1492*, ed. J. Shepard, pp. 99-129. Cambridge University Press, Cambridge.
- Lovejoy, C.
 1985 Dental wear in the Libben population: its functional pattern and role in the determination of adult skeletal age at death. *American Journal of Physical Anthropology* 68:47-56.
- MacCurdy, G.G.

- 1916 The revision of *Eoanthropus dawsoni*. *Science* 43(1103):228-231.
- Makra, Sz.
2010 Andor Thoma (1928-2003): biographical sketch and bibliography. *Annales historico-naturales Musei nationalis hungarici* 102:269-279.
- Mann, A., J. Monge, M. Lampl and J. Radovčić
2003 Patterns of crown variation in Neandertals and modern humans. In *Changements biologiques et culturels en Europe de la fin du Paléolithique moyen au Néolithique*, eds. J. Bruzek, B. Vandermeersch and M.D. Garralda, pp. 61-74. Laboratoire d'Anthropologie de Populations du Passé, Université de Bordeaux 1, Talence.
- Manzi, G., A. Vienna and G. Hauser
1996 Developmental stress and cranial hypostosis by epigenetic trait occurrence and distribution: an exploratory study on the Italian Neandertals. *Journal of Human Evolution* 30:511-527.
- Marks, A.E.
1992 Typological variability in the Levantine Middle Paleolithic. In *The Middle Paleolithic: adaptation, behavior, and variability*, eds. H.L. Dibble and P. Mellars, pp. 127-142. University Museum, University of Pennsylvania, Philadelphia.
- Marks, A.E., H.J. Hietala and J.K. Williams
2001 Tool standardization in the Middle and Upper Paleolithic: a close look. *Cambridge Archaeological Journal* 11(1):17-44.
- Matiegka, J.
1934 *Homo předmostensis. Fosilní clovek z Předmostí na Moravě*. Nákladem České Akademie Věd a Umění, v Praze.
- Mattingly, D.
1987 Libyans and the 'limes': culture and society in Roman Tripolitania. *Antiquités africaines* 23:71-94.
- Mayer, A.F.J.C.
1864 Über die fossilen Überreste eines menschlichen Shädels und Skelettes in einer Felsenhöhle des Düssel- eoder Neander-Thales. *Archiv für Anatomie, Physiologie und Wissenschaftliche Medecin* 1:1-26.
- Mayr, E.
1944 *Systematics and the origin of species from the viewpoint of a zoologist*. Columbia University Press, New York.
- McCown, T.D.
1937 Mugharet es-Skhül: description and excavations. In *The stone age of Mount Carmel: excavations at the Wady el-Mughara*, eds. D.A.E. Garrod and D.M.A. Bate, pp. 91-108. Clarendon Press, Oxford.
- McCown, T.D. and A. Keith
1939 *The Stone Age man of Mount Carmel: the fossil human remain from Levalloiso-Mousterian*. Clarendon Press, Oxford.
- McDermott, F., R. Grün, C.B. Stringer and C.J. Hawkesworth
1993 Mass-spectrometric U-series dates for Israeli Neanderthal/early modern hominid sites. *Nature* 363:252-255.
- McDougall, I., F.H. Brown and J.G. Fleagle

- 2005 Stratigraphic placement and age of modern humans from Kibish, Ethiopia. *Nature* 433:733-736.
- McGregor, J.H.
1938 Human origins and early man. In *General anthropology*, ed. F. Boas. D.C. Heath and company, Boston.
- McWilliams, K.R.
1974 *Gran Quivira Pueblo and biological distance in the U.S. Southwest*. Ph.D. dissertation. University of Arizona.
- Mercier, N. and H. Valladas
2003 Reassessment of TL age estimates of burnt flints from the Paleolithic site of Tabun cave, Israel. *Journal of Human Evolution* 45:401-409.
- Mercier, N., H. Valladas, O. Bar-Yosef, B. Vandermeersch, C. Stringer and J.L. Joron
1993 Thermoluminescence date for the Mousterian burial site of Es-Skhul, Mt. Carmel. *Journal of Archaeological Science* 20:169-174.
- Mercier, N., H. Valladas, G. Valladas, J.L. Reyss, A. Jelinek, L. Meignen and J.L. Joron
1995 TL dates of burnt flints from Jelinek's excavations at Tabun and their implications. *Journal of Archaeological Science* 22:495-509.
- Merkel, F.
1871 *Die linea nuchae suprema, anatomische und anthropologisch betrachtet*. Eingelmann, Leipzig.
- Milanesi, Q., V. Rossi and P. Messeri
1980 Alcune osservazioni preliminary sui crani metopici di popolazioni europee ed extraeuropee conservati nella cranioteca del Museo Nazionale di Antropologia ed Etnologia di Firenze. *Sem. Sci. Antrop.* 2:129-154.
- Millar, R.
1972 *The Piltdown men*. St. Martin's Press, New York.
- Millard, A.R. and A.W.G. Pike
1999 Uranium-series dating of the Tabun Neanderthal: a cautionary note. *Journal of Human Evolution* 36:581-585.
- Miller, G.S., Jr.
1918 The Piltdown jaw. *American Journal of Physical Anthropology* 1(1):25-57.
- Minugh-Purvis, N.
1998 The search for the earliest modern Europeans: a comparison of the Es-Skhul 1 and Krapina 1 juveniles. In *Neandertals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 339-352. Plenum Press, New York.
- Mócsy, A.
1962 Pannonia. In *Paulys Realencyclopädie Der Classischen Altertumswissenschaft*, Supplementband IX, pp. 516-776. Alfred Druckenmüller Verlag in Stuttgart.
- Molto, J.E.
1983 *Biological relationships of Southern Ontario Woodland peoples: the evidence of discontinuous cranial morphology*. National Museum of Canada, Archaeological Survey of Canada, Paper No. 117.
- Moorhead, J.

- 2008 Western approaches (500-600). In *The Cambridge history of the Byzantine Empire c. 500-1492*, ed. J. Shepard, pp. 196-220. Cambridge University Press, Cambridge.
- Moorrees, C.F.C., R.H. Osborne and E. Wilde
 1952 Torus mandibularis: its occurrence in Aleut children and its genetic determinants. *American Journal of Physical Anthropology* 10:319-329.
- Mouri, T.
 1976 A study of non-metrical cranial variants of the modern Japanese in the Kinki district. *Journal of Anthropological Society of Nippon* 84:191-203.
- Neuville, R.
 1934 Le préhistorique de Palestine. *Rev. Bibliq.* 43:249.
 1936 Excavations in Plaestine 1934-1935. *Q. Dep. Antiqs. Palest.* 5:199
 1951 *Le Paléolithique et le Mésolithique du desert de Judée*. Archives de l'Institut de Paléontologie Humaine. Masson, Paris.
- Noonan, J.P., G. Coop, S. Kudaravalli, D. Smith, J. Krause, J. Alessi, F. Chen, D. Platt, S. Pääbo, J.K. Pritchard and E.M. Rubin
 2006 Sequencing and analysis of Neanderthal genomic DNA. *Science* 314:1113-1118.
- Nowaczewska, W.
 2011 Are Homo sapiens nonsupranuchal fossa and Neanderthal suprainiac fossa convergent traits? *American Journal of Physical Anthropology* 144:552-563.
- Ohl, M.
 2007 Principles of taxonomy and classification: current procedures for naming and classifying organisms. In *Handbook of paleoanthropology*, eds. W. Henke and I. Tattersall, pp. 141-166. Springer-Verlag, Berlin and Heidelberg.
- Okladnikov, A.D.
 1949 Issledovanie mustierskoi stoyanki I pogrebenia neandertaltsa v grote Teshik-Tash, Yuzhnyi Uzbekistan, Srednyaya Azia. In *Teshik-Tash: paleontologicheskij chelovek*, ed. M.A. Gremyatsky, pp. 7-85. Izdatelstvo Moskovskogo Universiteta, Moscow.
- Ossenberg, N.S.
 1969 *Discontinuous morphological variation in the human cranium. Ph.D. dissertation*. University of Toronto.
 1970 The influence of artificial cranial deformation on discontinuous morphological traits. *American Journal of Physical Anthropology* 33:357-372.
 1976 Within and between race distances in population studies based on discrete traits of the human skull. *American Journal of Physical Anthropology* 45:701-709.
- Pääbo, S.
 1989 Ancient DNA: extraction, characterization, molecular cloning, and enzymatic amplification. *Proceedings of the National Academy of Sciences of the United States of America* 86:1939-1943.
 1993 Ancient DNA. *Scientific American* 269(5):60-66.

- 1999 Human evolution. *Trends in Cell Biology* 9(12):M13-M16.
- Pääbo, S., H. Poinar, D. Serre, V. Jaenicke-Després, J. Hebler, N. Rohland, M. Kuch, J. Krause, L. Vigilant and M. Hofreiter
 2004 Genetic analyses from ancient DNA. *Annual Review of Genetics* 38:645-679.
- Pardoe, C.
 1991 Competing paradigms and ancient human remains: the state of the discipline. *Archaeologia Oceania* 26:79-85.
- Pei, W.-C.
 1930 An account of the discovery of an adult *Sinanthropus* skull in the Chou Kou Tien deposit. *Bulletin of the Geological Society of China* 8(3):203-205.
 1931 Notice of the discovery of quartz and other stone artifacts in the Lower Pleistocene hominid-bearing sediments of the Chou Kou Tien deposit. *Bulletin of the Geological Society of China* 11(2):109-139.
- Pensa, A.
 1907 Osservazioni sulla "spina supra meatum". *Boll. Soc. Med.-Chir. Pavia* 21:272-284.
- Perizonius, W.R.K.
 1979a Non-metric cranial traits: sex difference and age dependence. *Journal of Human Evolution* 8:679-684.
 1979b Non-metric cranial traits: symmetry and side difference, I, II. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen (series C)* 82:91-112.
- Pinhasi, R. and M. Pluciennik
 2004 A regional approach to the spread of farming in Europe. *Current Anthropology* 45(S4):S59-S82.
- Piontek, J.
 1979 Natural selection and microevolutionary variability of non-metric traits in medieval populations of Poland. *Studies in Physical Anthropology* 5:95-110.
- Piontek, J. and A. Śmiszkiewicz-Skwarska
 1994 Metrical and non-metrical analysis of Polish crania from early medieval to modern times. *Anthropologie* 32(1):77-84.
- Piveteau, J.
 1957 *Traité de paléontologie. Tome VII: Primates paléontologie humaine.* Masson et C^{ie}, Paris.
 1983 *Origine et destine de l'homme.* 2nd ed. Masson, Paris.
- Pohl, W.
 1988 *Die Awaren – Ein Steppenvolk in Mitteleuropa 567-822 n.Chr.* Verlag C.H. Beck, München.
 1991 Conceptions of ethnicity in Early Medieval studies. *Archaeologia Polona* 29:39-49.
 1997a Introduction: the Empire and the integration of barbarians. In *Kingdoms of the Empire: the integration of barbarians in late antiquity*, ed. W. Pohl, pp. 1-11. Brill, Leiden.

- 1997b The Empire and the Lombards: treaties and negotiations in the sixth century. In *Kingdoms of the Empire: the integration of barbarians in late antiquity*, ed. W. Pohl, pp. 75-133. Brill, Leiden.
- 1998 Telling the difference: signs of ethnic identity. In *Strategies of distinction: the construction of ethnic communities, 300-800*, eds. W. Pohl and H. Reimitz, pp. 17-69. Brill, Leiden.
- 2003 A non-Roman Empire in Central Europe: the Avars. In *Regna and gentes: the relationship between late antiquity and early medieval peoples and kingdoms in the transformation of the Roman world*, eds. H.-W. Goetz, J. Jarnut and W. Pohl, pp. 571-595. Brill, Leiden.
- Pollard, N.
 2006 The Roman army. In *A Companion to the Roman Empire*, ed. D.S. Potter, pp. 206-227. Blackwell Publishing, Malden, MA.
- Potter, D.S.
 2006 The transformation of the Empire: 235-337 CE. In *A Companion to the Roman Empire*, ed. D.S. Potter, pp. 153-173. Blackwell Publishing, Malden, MA.
- Protsch, R.
 1975 The absolute dating of Upper Pleistocene Sub-Saharan fossil hominids and their place in human evolution. *Journal of Human Evolution* 4:297-322.
- Prowse, T.L. and N.C. Lovell
 1995 Biological continuity between the A- and C-groups in Lower Nubia: evidence from cranial non-metric traits. *International Journal of Osteoarchaeology* 5:103-114.
- 1996 Concordance of cranial and dental morphological traits and evidence for endogamy in ancient Egypt. *American Journal of Physical Anthropology* 101:237-246.
- Pruner-Bey, F.I.
 1863 Observations sur le crâne de Neanderthal. *Bulletin de la Société d'Anthropologie de Paris* 4:318-323.
- 1864 The Neanderthal skull. Letter, April 19, to C. Carter Blake. *The Anthropological Review* 2(5):145-146.
- de Puydt, M. and M. Lohest
 1886 L'homme contemporain du Mammouth à Spy. *Annales de la Fédération Archéologique de Belgique* 2:207-235.
- Quain, J.
 1908 *Quain's elements of anatomy*. Eds. E.A. Schafer, J. Symington and T.H. Bryce. Longmans Green, London.
- Quam, R.M. and F.H. Smith
 1998 A reassessment of the Tabun C2 mandible. In *Neandertals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 405-421. Plenum Press, New York.
- Radovčić, J.
 1988 *Dragutin Gorjanović-Kramberger i krapinski pračovjek: počeci suvremene paleoantropologije*. Hrvatski prirodoslovni muzej, Zagreb.
- Radovčić, J., F.H. Smith, E. Trinkaus and M.H. Wolpoff

- 1988 The Krapina hominids: an illustrated catalog of the skeletal collection. Mladost, Zagreb.
- Rak, Y.
 1993 Morphological variation in *Homo neanderthalensis* and *Homo sapiens* in the Levant. In *Species, species concepts, and primate Evolution*, eds. W.H. Kimbel and L. Martin, pp. 523-536. Plenum, New York.
 1998 Does any Mousterian cave present evidence of two hominid species? In *Neanderthals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 353-366. Plenum, New York.
- Rak, Y., E. Hovers and W.H. Kimbel
 1994 A Neandertal infant from Amud cave, Israel. *Journal of Human Evolution* 26(4):313-324.
- Rak, Y. and W.L. Hylander
 2003 Neandertal facial morphology and increased jaw gape. *American Journal of Physical Anthropology* 120:S36, 174.
- Rak, Y., W.H. Kimbel and E. Hovers
 1996 On Neandertal autapomorphies discernible in Neandertal infants: a response to Creed-Miles *et al.* *Journal of Human Evolution* 30(2):155-158.
- Rak, Y., A. Ginzburg and E. Geffen
 2002 Does *Homo neanderthalensis* play a role in modern human ancestry? The mandibular evidence. *American Journal of Physical Anthropology* 119: 199-204.
- Reich, D., R.E. Green, M. Kircher, J. Krause, N. Patterson, E.Y. Durand, B. Viola, A.W. Briggs, U. Stenzel, P.L.F. Johnson, T. Maričić, J.M. Good, T. Marques-Bonet, C. Alkan, Q. Fu, S. Mallick, H. Li, M. Meyer, E.E. Eichler, M. Stoneking, M. Richards, S. Talamo, M.V. Shunkov, A.P. Derevianko, J.-J. Hublin, J. Kelso, M. Slatkin and S. Pääbo
 2010 Genetic history of an archaic hominin group from Denisova cave in Siberia. *Nature* 468:1053-1060.
- Relethford, J.H.
 1998 Genetics of modern human origins and diversity. *Annual Review of Anthropology* 27:1-23.
 2001 Absence of regional affinities of Neandertal DNA with living humans does not reject multiregional evolution. *American Journal of Physical Anthropology* 115:95-98.
- Richards, L.C. and S.L. Miller
 1991 Relationships between age and dental attrition in Australian aboriginals. *American Journal of Physical Anthropology* 84(2):159-164.
- Rightmire, G.P.
 1972 Cranial measurements and discrete traits compared in distance studies of African Negro skulls. *Human Biology* 44:263-276.
 1976 Metric versus discrete traits in African skulls. In *The measures of man*, eds. E. Giles and J.S. Friedländer, pp. 383-407. Peabody Museum Press.
- Rink, W.J., H.P. Schwarcz, H.K. Lee, J. Rees-Jones, R. Rabinovich and E. Hovers

- 2001 Electron spin resonance (ESR) and thermal ionization mass spectrometric (TIMS) $^{230}\text{Th}/^{234}\text{U}$ dating of teeth in Middle Paleolithic layers at Amud cave, Israel. *Geoarchaeology: An International Journal* 16(6):701-717.
- Rink, W.J., H.P. Schwarcz, A. Ronen and A. Tsatskin
2004 Confirmation of a near 400 ka age for the Yabrudian industry at Tabun cave, Israel. *Journal of Archaeological Science* 31:15-20.
- Roff, D.A.
1995 The estimation of genetic correlations from phenotypic correlations: a test of Cheverud's conjecture. *Heredity* 74:481-490.
- Rogers, A.R. and H.C. Harpending
1983 Population structure and quantitative characters. *Genetics* 105:985-1002.
- Róna-Tas, A.
1999 *Hungarians and Europe in the early Middle Ages: an introduction to early Hungarian history*. Central European University Press, Budapest.
- Ronen, A. and A. Tsatskin
1995 New interpretation of the oldest part of the Tabun cave sequence, Mount Carmel, Israel. In *Man and environment in the Paleolithic*, ed. H. Ullrich, pp. 265-281. ERAUL, Liège.
- Rösing, F.W.
1982 Discreta des menschlichen Skeletts – ein kritischer Überblick. *Homo* 33:100-125.
- Russell, F.
1900 Studies in cranial variation. *American Naturalist* 34:737-745.
- Salamon, Á. and Á.Cs. Sós
1980 Pannonia – fifth to ninth centuries. In *The archaeology of Roman Pannonia*, eds. A. Lengyel and G.T.B. Radan, pp. 397-425. Akadémiai Kiadó, Budapest.
- Santa Luca, A.P.
1978 A re-examination of presumed Neandertal-like fossils. *Journal of Human Evolution* 7:619-636.
- Saunders, S.R.
1978 *The development and distribution of discontinuous morphological variation of the human infracranial skeleton*. National Museum of Man Mercury Series, Archaeological Survey of Canada, No. 81. National Museum of Man, Ottawa.
1989 Nonmetric skeletal variation. In *Reconstruction of Life from the Skeleton*, eds. M.Y. Işcan and K.A.R. Kennedy, pp. 95-108. Alan R. Liss, New York.
- Saunders, S.R. and D.L. Rainey
2008 Nonmetric trait variation in the skeleton: abnormalities, anomalies, and atavisms. In *Biological anthropology of the human skeleton*, eds. M.A. Katzenberg and S.R. Saunders, pp. 533-559. 2nd ed. Wiley & Sons, Inc.
- Scarsini, C., V. Rossi and P. Messeri
1980 Caratteri cranici discontinui in Sardi di Nuoro. *Sem. Sci. Antrop.* 2:1-127.
- Schaffhausen, H.

- 1858 Zur Kenntniss der ältesten Rassenschädel. *Archiv für Anatomie, Physiologie und Wissenschaftliche Medecin* 453-478.
- Schlegel, F. v.
1808 *Über die Sprache und Weisheit der Indier: Ein Beitrag zur Begründung der Alterthumskunde*. Mohr & Zimmer, Heidelberg.
- Schmitz, R.W., D. Serre, G. Bonani, S. Feine, F. Hillgruber, H. Krainitzki, S. Pääbo and F.H. Smith
2002 The Neandertal type site revisited: interdisciplinary investigations of skeletal remains from the Neander valley, Germany. *Proceedings of the National Academy of Sciences of the United States of America* 99(20):13342-13347.
- Schultz, A.H.
1919 Der Canalis cranio-pharyngeus persistens beim Mensch und bei den Affen. *Gegenbaurs morphologisches Jahrbuch* 50:417-426.
- Schwalbe, G.
1906 *Studien zur Vorgeschichte des Menschen*. E. Schweizerbartsche Verlagsbuchhandlung (E. Nägele), Stuttgart.
- Schwarcz, H.P., R. Grün, B. Vandermeersch, O. Bar-Yosef, H. Valladas and E. Tchernov
1988 ESR dates for the hominid burial site of Qafzeh in Israel. *Journal of Human Evolution* 17:733-737.
- Schwarcz, H.P. and W.J. Rink
1998 Progress in ESR and U-series chronology of the Levantine Paleolithic. In *Neandertals and modern humans in Western Asia*, eds. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 57-67. Plenum Press, New York.
- Schwarcz, H.P., J.J. Simpson and C.B. Stringer
1998 Neanderthal skeleton from Tabun: U-series data by γ -ray spectrometry. *Journal of Human Evolution* 35:635-645.
- Schwartz, J.H. and I. Tattersall
1996a Toward distinguishing *Homo neanderthalensis* from *Homo sapiens*, and vice versa. *Anthropologie (Brno)* 34:79-88.
1996b Significance of some previously unrecognized apomorphies in the nasal region of *Homo neanderthalensis*. *Proceedings of the National Academy of Sciences of the United States of America* 93:10852-10854.
- Searle, A.G.
1954a Genetical studies on the skeleton of the mouse IX. Causes of skeletal variation within pure lines. *Journal of Genetics* 52:68-102.
1954b Genetical studies on the skeleton of the mouse XI. The influence of diet on variation with pure lines. *Journal of Genetics* 52:413-424.
- Sergi, S.
1948 The palaeanthropi in Italy: the fossil men of Saccopastore and Circeo. Part I. Introduction and description. *Man* 48:61-64. Part II. Discussion and interpretation. *Man* 48:76-79.
1991 The Neanderthal cranium of Monte Circeo (Circeo 1). In *The Circeo 1 Neanderthal skull: studies and documentation*, eds. M. Piperno and G. Scichilone. Instituto Poligrafico e Zecca dello Stato, Rome.

- Serre, D., A. Langaney, M. Chech, M. Teschler-Nicola, M. Paunović, P. Menecier, M. Hofreiter, G. Possnert and S. Pääbo
 2004 No evidence of Neandertal mtDNA contribution to early modern humans. *PLoS Biology* 2(3):0313-0317.
- Shea, J.J.
 2003 The Middle Paleolithic of the East Mediterranean Levant. *Journal of World Prehistory* 17(4):313-394.
 2006 The Middle Paleolithic of the Levant: recursion and convergence. In *Transitions before transition: evolution and stability in the Middle Paleolithic and Middle Stone Age*, eds. E. Hovers and S.L. Kuhn, pp. 189-211. Springer.
- Shepherd, F.J.
 1893 Symmetrical depressions on the exterior surface of the parietal bones. *Journal of Anatomy and Physiology* 27:501-504.
- Shipman, P.
 2001 *The man who found the missing link: Eugène Dubois and his lifelong quest to prove Darwin right*. Simon and Schuster, New York.
- Shipman, P. and P. Storm
 2002 Missing links: Eugène Dubois and the origins of paleoanthropology. *Evolutionary Anthropology* 11:108-116.
- Simmons, T. and F.H. Smith
 1991 Human population relationships in the Late Pleistocene. *Current Anthropology* 32(5):623-627.
- Simpson, G.G.
 1944 *Tempo and mode in evolution*. Columbia University Press, New York.
- Sinor, D.
 2005 Reflections on the history and historiography of the nomad empires of Central Asia. *Acta Orientalia Scientiarum Hungaricae* 58(1):3-14.
- Sjøvold, T.
 1976/7 A method for familial studies based on minor skeletal variants. *Ossa* 3/4:97-107.
 1984 A report on the heritability of some cranial measurements and non-metric traits. In *Multivariate statistics in Physical Anthropology*, eds. G.N. Van Vark & W.W. Howells, pp. 223-246. D. Reidel, Dordrecht.
- Skinner, A.R., B.A.B. Blackwell, S. Martin, A. Ortega, J.I.B. Blickstein, L.V. Golovanova and V.B. Doronichev
 2005 ESR dating at Mezmaiskaya cave, Russia. *Applied Radiation and Isotopes* 62(2):219-224.
- Sládek, V.
 2000 *Evolution des hominides en Europe central durant le Pléistocène supérieur: origine des hommes anatomiquement modernes*. Ph.D. dissertation. Université Bordeaux I, Bordeaux, France.
- Smith, F.H.
 1982 Upper Pleistocene hominid evolution in South-Central Europe: A review of the evidence and analysis of trends. *Current Anthropology* 23:667-703.
 1984 Fossil hominids from the Upper Pleistocene of Central Europe and the

- origin of modern Europeans. In *The origins of modern humans: a world survey of the fossil evidence*, eds. F.H. Smith and F. Spencer, pp. 137-209. Alan R. Liss, Inc., New York.
- 1985 Continuity and change in the origin of modern *Homo sapiens*. *Zeitschrift für Morphologie und Anthropologie* 75(2):197-222.
- 1991 The Neandertals: evolutionary dead ends or ancestors of modern people? *Journal of Anthropological Research* 47(2):219-238.
- 1992 The role of continuity in modern human origins. In *Continuity or replacement: controversies in Homo sapiens evolution*, eds. G. Bräuer and F.H. Smith, pp. 145-156. Balkema, Rotterdam.
- Smith, F.H. and M.O. Smith
- 1986 On the significance of anomalous nasal bones in the Neandertals from Krapina. In *Fossil man: new facts, new ideas*. Papers in honor of Jan Jelínek's life anniversary, eds. V.V. Novotný and A. Mizerová. *Anthropos* (Brno) 23:217-226.
- Smith, F.H., I. Janković and I. Karavanić
- 2005 The assimilation model, modern human origins in Europe, and the extinction of Neandertals. *Quaternary International* 137:7-19.
- Smith Woodward, A.
- 1913 Note on the Piltdown man (*Eoanthropus dawsoni*). *The Geological Magazine*. October, 1913.
- Soproni, S.
- 1980 Geography of Pannonia. In *The archaeology of Roman Pannonia*, eds. A. Lengyel & G.T.B. Radan, pp. 57-63. Akadémiai Kiadó, Budapest.
- Spamer, E.E.
- 1999 Know thyself: responsible science and the lectotype of *Homo sapiens* Linnaeus, 1758. *Proceedings of the Academy of Natural Sciences of Philadelphia* 149:109-114.
- Stojanowski, C.M. and M.A. Schillaci
- 2006 Phenotypic approaches for understanding patterns of intracemetery biological variation. *Yearbook of Physical Anthropology* 49:49-88.
- Stolyhwo, K.
- 1908 *Homo primigenius* appartient-il à une espèce distincte de *Homo sapiens*? *L'Anthropologie* 19:191-216.
- 1937 Les praenéanderthaloides et postnéanderthaloides et leur rapport avec la race du Neanderthal. *Glasnik Etnografskega Muzeja v Ljubljani* 10.
- Stoneking, M. and R.L. Cann
- 1989 African origins of human mitochondrial DNA. In *The human revolution: behavioural and biological perspectives on the origins of modern humans*, eds. P. Mellars and C.B. Stringer, pp. 17-30. Edinburgh University Press, Edinburgh, Scotland.
- Straus, W.L. and A.J.E. Cave
- 1957 Pathology and the posture of Neanderthal man. *The Quarterly Review of Biology* 32:348-363.
- Stringer, C.B.
- 1985 Middle Pleistocene hominid variability and the origin of Late Pleistocene

- humans. In *Ancestors: the hard evidence*, ed. E. Delson, pp. 289-295. Alan R. Liss, New York.
- 1992 Replacement, continuity and the origin of *Homo sapiens*. In *Continuity or replacement: controversies in Homo sapiens evolution*, eds. G. Bräuer and F.H. Smith, pp. 9-24. AA Balkema, Rotterdam.
- 2003 Out of Ethiopia. *Nature* 423:692-694.
- 2006 The Neanderthal-*H. sapiens* interface in Eurasia. In *Neanderthals revisited: new approaches and perspectives*, eds. K. Harvati and T. Harrison, pp. 315-323. Springer, Dordrecht.
- Stringer, C.B. and P. Andrews
- 1988 Genetic and fossil evidence for the origin of modern humans. *Science* 239: 1263-1268.
- Stringer, C.B. and C. Gamble
- 1993 *In search of the Neanderthals: solving the puzzle of human origins*. Thames and Hudson, New York.
- Stringer, C., R. Grün, H. Schwarcz and P. Goldberg
- 1989 ESR dates for the hominid burial site of Es Skhul in Israel. *Nature* 338:756-758.
- Suchey, J.M.
- 1975 *Biological distance of prehistoric Central California populations derived from non-metric traits of the cranium*. Ph.D. dissertation. University of California.
- Suzuki, H.
- 1970 Introduction. In *The Amud man and his cave site*, eds. H. Suzuki and F. Takai, pp. 3-6. The University of Tokyo, Japan.
- Suzuki, H. and F. Takai, eds.
- 1970 *The Amud man and his cave site*. The University of Tokyo, Japan.
- Suzuki, M. and T. Sakai
- 1960 A familial study of torus palatinus and torus mandibularis. *American Journal of Physical Anthropology* 18:263-272.
- Symmers, W.S.C.
- 1895 A skull with enormous parietal foramina. *Journal of Anatomy and Physiology* 29:329-330.
- Szalay, F.S.
- 1993 Species concepts: the tested, the untestable, and the redundant. In *Species, species concepts, and primate evolution*, eds. W.H. Kimbel and L.B. Martin, pp. 345-371. Plenum, New York.
- Szilvássy, J.
- 1986 Eine neue Methode zur intraserialen Analyse von Gräberfeldern. *Mitt. Berliner Ges. Anthrop. Ethnol. Urgesch.* 7:49-62.
- Szilvássy, J., H. Kritscher and E. Vlček
- 1987 Die Bedeutung röntgenologischer Methoden für anthropologische Untersuchung ur- und frühgeschichtlicher Gräberfelder. *Annals of the Vienna Natural History Museum* 89:313-352.
- Szombathy, J.

- 1925 Die diluvialen Menschenreste aus der Fürst-Johanns-Höhle bei Lautsch in Mähren. *Die Eiszeit* 2:1-34, 73-95.
- Takai, F.
1970 Fossil mammals from the Amud cave. In *The Amud man and his cave site*, eds. H. Suzuki and F. Takai, pp. 53-76. The University of Tokyo, Japan.
- Tandler, J.
1926 *Lehrbuch der systematischen Anatomie*. Vol. 1,2. Edit. Vogel, Leipzig.
- Tattersall, I.
1992 Species concepts and species identification in human evolution. *Journal of Human Evolution* 22:341-349.
1995 *The fossil trail*. Oxford University Press, New York, Oxford.
- Tattersall, I. and K. Mowbray
2005 Species and paleoanthropology. *Theory in Biosciences* 123:371-379.
- Tattersall, I. and J.H. Schwartz
1999 Hominids and hybrids: the place of Neanderthals in human evolution. *Proceedings of the National Academy of Sciences of the United States of America* 96:7117-7119.
2006 The distinctiveness and systematic context of *Homo neanderthalensis*. In *Neanderthals revisited: new approaches and perspectives*, eds. K. Harvati and T. Harrison, pp. 9-22. Springer, Dordrecht.
- Tchernov, E.
1988 The biogeographical history of the Southern Levant. In *The zoogeography of Israel: distribution and abundance at a zoogeographical crossroad*, eds. Y. Yom-Tov and E. Tchernov, pp. 159-250. Monographiae Biologicae 62. W. Junk, Dordrecht, The Netherlands.
1992 Eurasian-African biotic exchanges through the Levantine corridor during the Neogene and Quaternary. In *Mammalian migration and dispersal events in the European Quaternary*, eds. W. Von Koenigswald and L. Wardelin, pp. 103-123. Courier Forschungs-Institut Senckenberg 153. Senckenbergischen Naturforschenden Gesellschaft, Frankfurt, Germany.
- Templeton, A.R.
1994 Eve: hypothesis compatibility versus hypothesis testing. *American Anthropologist* 96(1):141-147.
1996 Gene lineages and human evolution. *Science* 272:1363.
2002 Out of Africa again and again. *Nature* 416:45-51.
- Testut, L.
1889a Recherches anthropologiques sur le squelette quaternaire de Chancelade. *Bulletin de la Société d'Anthropologie de Lyon* 8:131-246.
1889b *Traité d'anatomie humaine*. Doin & Cie, Paris.
- Theunissen, B.
1889 *Eugène Dubois and the ape-man from Java*. Reidel, Dordrecht.
- Thoma, A.
1957 Métissage ou transformation? Essai sur les homes fossiles de Palestine. *L'Anthropologie* 61:470-502.
1958 Métissage ou transformation? Essai sur les homes fossiles de Palestine. *L'Anthropologie* 62:30-52.

- 1978 Quasi-kontinuierliche Variabilität und genetische Einheitlichkeit der Hominoidea. *Zeitschrift für Morphologie und Anthropologie* 69:7-15.
- 1979 Further studies on quasi-continuous variation in Hominoidea. *Zeitschrift für Morphologie und Anthropologie* 70:104-112.
- 1981 The pattern of quasi-continuous variation in *Homo sapiens*. *Journal of Human Evolution* 10:303-310.
- Thompson, E.A.
1996 *The Huns*. Blackwell, Oxford, UK.
- Thorne, A.G. and M.H. Wolpoff
1992 The multiregional evolution of humans. *Scientific American* 266(4):76-83.
- Thorne, A.G., M.H. Wolpoff and R.B. Eckhardt
1993 Genetic variation in Africa. *Science* 261(5128):1507-1508.
- Tillier, A.-m.
2007 The earliest *Homo sapiens (sapiens)*: biological, chronological and taxonomic perspectives. *Diogenes* 214:110-121.
- Tobias, P.V.
1967 The hominid skeletal remains of Haua Fteah. In *The Haua Fteah (Cyrenaica) and the stone age of the South-East Mediterranean*, ed. C.B.M. McBurney, pp. 338-352. Cambridge University Press, Cambridge.
- Tóth, T.
1964 The German cemetery of Hegykő. *Annales historico-naturales Musei nationalis hungarici* 56:529-558.
- Trinkaus, E.
1987 The Upper Pleistocene human molar from Me'arat Shovakh (Mugharet esh-Shubbabiq), Israel. *Paléorient* 13(1):95-100.
1995 Near Eastern late archaic humans. *Paléorient* 21(2):9-24.
2004 Eyasi 1 and the suprainiac fossa. *American Journal of Physical Anthropology* 124:28-32.
2006 Modern human versus Neandertal evolutionary distinctiveness. *Current Anthropology* 47(4):597-620.
2011 Late Neandertals and early modern humans in Europe, population dynamics and paleobiology. In *Continuity and discontinuity in the peopling of Europe: one hundred fifty years of Neanderthal study*, eds. S. Condemi and G.-C. Weniger, pp. 315-329. Springer.
- Trinkaus, E. And M. LeMay
1982 Occipital bunning among later Pleistocene hominids. *American Journal of Physical Anthropology* 57:27-35.
- Trinkaus, E., O. Moldovan, Ş. Milota, A. Bîlgăr, L. Sarcina, S. Athreya, S.E. Bailey, R. Rodrigo, M. Gherase, T. Higham, C. Bronk Ramsey and J. van der Plicht
2003 An early modern human from Peştera cu Oase, Romania. *Proceedings of the National Academy of Sciences of the United States of America* 100:11231-11236.
- Trinkaus, E. and P. Shipman
1993 *The Neandertals: changing the image of mankind*. Knopf, New York.
- Turner, C.G. II, C.R. Nichol and G.R. Scott

- 1991 Scoring procedures for key morphological traits of the permanent dentition: the Arizona State University dental anthropology system. In *Advances in dental anthropology*, eds. M. Kelley and C. Larsen, pp. 13-31. Wiley-Liss, New York.
- Turville-Petre, F.
1927 *Researches in prehistoric Galilee 1925-1926*. Council of the British School of Archaeology in Jerusalem, London.
- Tyrrell, A.J.
2000 Skeletal non-metric traits and the assessment of inter- and intra-population diversity: past problems and future potential. In *Human osteology in archaeology and forensic science*, eds. M. Cox and S. Mays, pp. 289-306. Cambridge University Press, Cambridge.
- Tyrrell, A.J and A.T. Chamberlain
1998 Non-metric trait evidence for modern human affinities and the distinctiveness of Neanderthals. *Journal of Human Evolution* 34:549-554.
- Valladas, H., N. Mercier, L. Froget, E. Hovers, J.-L. Joron, W.H. Kimbel and Y. Rak
1999 TL dates for the Neanderthal site of the Amud cave, Israel. *Journal of Archaeological Science* 26:259-268.
- Valladas, H., J.L. Reyss, J.-L. Joron, G. Valladas, O. Bar-Yosef and B. Vandermeersch
1988 Thermoluminescence dating of Mousterian “Proto-Cro-Magnon” remains from Israel and the origin of modern man. *Nature* 331:614-616.
- Vallois, H.V.
1954 Neandertals and praesapiens. *Journal of the Royal Anthropological Institute of Great Britain and Ireland* 84:111-130.
1966 More on the Fate of the “Classic” Neanderthals. *Current Anthropology* 7(2):205-208.
1969 Le temporal Néandertalien H 27 de La Quina. *L’Anthropologie* 73 :365-400, 525-544.
- Vallois, H.V. and B. Vandermeersch
1975 The Mousterian skull of Qafzeh (Homo VI). An anthropological study. *Journal of Human Evolution* 4:445-455.
- Vandermeersch, B.
1981 *Les hommes fossiles de Qafzeh*. Éditions du Centre National de la Recherche Scientifique, Paris.
1992 The Near Eastern hominids and the origins of modern humans in Eurasia. In *The Evolution and dispersal of modern humans in Asia*, eds. T. Akazawa, K. Aoki and T. Kimura, pp. 29-38. Hokusen-sha, Tokyo.
2006 Ce que nous apprennent les premières sépultures. *Comptes Rendus Palevol* 5:161-167.
- Van Reybrouck, D.
2002 Boule’s error: on the social context of scientific knowledge. *Antiquity* 76:158-164.
- Varga, P., Zs. Bernert, Gy. Gyenis and E. Fóthi
2003a Multivariate statistics on Roman and Migration period populations of the Carpathian Basin. *Anthropologie* 41(1-2):135-144.
- Varga, P., Zs. Bernert, E. Fóthi and Gy. Gyenis

- 2003b The anthropological analysis of the skeletal material excavated in the environs of Keszthely by Vilmos Lipp. In “*Hadak útján*” konferenciakötet, Gyula, ed. I. Szatmári, pp. 449-477. *A Békés Megyei Múzeumok Közleményei* 24-25.
- Varga, P., Zs. Bernert, E. Fóthi and Gy. Gyenis
2005 Anthropological data of Keszthely-Fenekpuszta cemetery. *Anthropological Data of Hungarian Historical Populations* 4:3-24.
- Verneau, R.
1902 Les fouilles du Prince de Monaco aux Baoussé-Roussé, un nouveau type humain. *L'Anthropologie* 13:561-585.
1906 Les Grottes de Grimaldi. Résumé et conclusions des études anthropologiques. *L'Anthropologie* 17:291-320.
1907 A propos de la race de Grimaldi (Réponse aux critiques de M. Paul Raymond). *L'Anthropologie* 18:619-625.
1924 Neanderthal man and Grimaldi man: their role in the evolution of mankind. *Nature* 114(2877):899-901.
- Verworn, M., R. Bonnet and G. Steinmann
1914 Der diluviale Menschenfund von Obercassel bei Bonn. *Die Naturwissenschaften* 27. S. 649/650.
- Vida, T.
2007 Late Roman territorial organization and the settlement of the barbarian *gentes* in Pannonia. *Hortus artium medievalium* 13(2):319-331.
2008 Conflict and coexistence: the local population of the Carpathian Basin under the Avar rule (sixth to seventh century). In *The other Europe in the Middle Ages: Avars, Bulgars, Khazars and Cumans*, eds. F. Curta and R. Kovalev, pp. 13-46. Brill, Leiden.
- Virchow, R.
1872 Untersuchung des Neanderthal-Schädels. *Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte* 4:157-165.
1875 *Über einige Merkmale niederer Menschenrassen am Schädel*. Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin.
1895 *Pithecanthropus erectus* Dub. *Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte*. Ausserordentliche Sitzung vom 14. December. 744-747.
- Walker, P., G. Dean and P. Shapiro
1991 Estimating age from tooth wear in archaeological populations. In *Advances in dental anthropology*, eds. M. Kelley and C.S. Larsen, pp. 169-178. Wiley-Liss, New York.
- Wall, J.D. and M.F. Hammer
2006 Archaic admixture in the human genome. *Current Opinion in Genetics & Development* 16:606-610.
- Watanabe, H.
1970 A Paleolithic industry from the Amud cave. In *The Amud man and his cave site*, eds. H. Suzuki and F. Takai, pp. 77-95. The University of Tokyo, Japan.
- Waterston, D.

- 1913 The Piltdown mandible. *Nature*, November 13:319.
- Webster, J.
2001 Creolizing the Roman provinces. *American Journal of Archaeology* 105(2):209-225.
- Weidenreich, F.
1943a The "Neanderthal man" and the ancestors of *Homo sapiens*. *American Anthropologist* 45:39-48.
1943b The skull of *Sinanthropus pekinensis*: a comparative study on a primitive skull. *Palaeontologica sinica* 10(127). Geological Survey of China, Pehpei, Chungking.
1944 *Review of* The stone age of Mount Carmel: the fossil human remains from the Levalloiso-Mousterian. *American Journal of Physical Anthropology* 2(2):221-224.
1946 *Apes, giants and man*. University of Chicago Press, Chicago.
- Weiner, J.S.
1955 *The Piltdown forgery*. Oxford University Press, London.
1979 Piltdown hoax: new light. *Nature* 277:10.
- Weiner, J.S., K.P. Oakley and W. LeGros Clark
1953 The solution of the Piltdown problem. *Bulletin of the British Museum (Natural History) Geology*.
- Weiner, S., P. Goldberg and O. Bar-Yosef
2002 Three-dimensional distribution of minerals in the sediments of Hayonim cave, Israel: diagenetic processes and archaeological implications. *Journal of Archaeological Science* 29:1289-1308.
- Weinert, H.
1925 *Der Schädel des eiszeitlichen Menschen von le Moustier in neuer Zusammensetzung*. J. Springer, Berlin.
- Wells, P.S.
1998 Identity and material culture in the later prehistory of Central Europe. *Journal of Archaeological Research* 6(3):239-298.
- Wenger, S.
1952 Contributions à l'anthropologie des avars en Hongrie (Le cimetière d'Alattyán-Tulát). *Annales historico-naturales Musei nationalis hungarici* 2:205-212.
1957 Données ostéométriques sur le matériel anthropologiques de cimetière d'Alattyán-Tulát, provenant de l'époque Avare. *Crania Hungarica* 2:1-55.
1972 Data to the anthropology of the Avar period population in the Northern Plains, Hungary. *Annales historico-naturales Musei nationalis hungarici* 64:401-413.
- Whitby, M. and M. Whitby
1986 *The History of Theophylact Simocatta: an English translation with introduction and notes*. Clarendon Press, Oxford.
- White, T.D., B. Asfaw, D. DeGusta, H. Gilbert, G.D. Richards, G. Suwa and F.C. Howell
2003 Pleistocene *Homo sapiens* from Middle Awash, Ethiopia. *Nature* 423: 742-747.
- White, T.D. and P.A. Folkens

- 2005 *The human bone manual*. Elsevier Academic, Amsterdam.
- Wiesemüller, B., H. Rothe and W. Henke
 2000 Good characters and homology. *Evolutionary Anthropology* 9(4):151-152.
- Wilson, A.C. and R.L. Cann
 1992 The recent African genesis of humans. *Scientific American* 266(4):68-73.
- Wirth, G.
 1997 Rome and its Germanic partners in the fourth century. In *Kingdoms of the Empire: the integration of barbarians in late antiquity*, ed. W. Pohl, pp. 13-55. Brill, Leiden.
- Wolfram, H.
 1997 Neglected evidence on the accommodation of barbarians in Gaul. In *Kingdoms of the Empire: the integration of barbarians in late antiquity*, ed. W. Pohl, pp. 181-183. Brill, Leiden.
- Wolpoff, M.H.
 1989 Multiregional evolution: the fossil alternative to Eden. In *The human revolution: behavioural and biological perspectives on the origins of modern humans*, eds. P. Mellars and C.B. Stringer, pp. 62-108. Edinburgh University Press, Edinburgh, Scotland.
 1996 Interpretations of multiregional evolution. *Science* 274(5288):704-705.
 1999 *Paleoanthropology*. McGraw-Hill, Boston.
 2003 Species concepts, reticulation, and human evolution; Comments. *Current Anthropology* 44(5):666-667.
- Wolpoff, M.H. and A.G. Thorne
 1991 The case against Eve. *New Scientist* 22(1774):33-37.
- Wolpoff, M.H. and R. Caspari
 2011 Neandertals and the roots of human recency. In *Continuity and discontinuity in the peopling of Europe: one hundred fifty years of Neanderthal study*, eds. S. Condemi and G.-C. Weniger, pp. 367-377. Springer.
- Wolpoff, M.H. and S.-H. Lee
 2001 The Late Pleistocene human species of Israel. *Buletins et Mémoires de la Société d'Anthropologie de Paris* 13(3-4):291-310.
- Wolpoff, M.H., J. Hawks, D.W. Frayer and K. Hunley
 2001 Modern human ancestry at the peripheries: a test of the replacement theory. *Science* 291:293-297.
- Wolpoff, M.H., B. Mannheim, A. Mann, J. Hawks, R. Caspari, K.R. Rosenberg, D.W. Frayer, G.W. Gill and G. Clark
 2004 Why not the Neandertals? *World Archaeology* 36(4):527-546.
- Wolpoff, M.H., X. Wu and A.G. Thorne
 1984 Modern Homo sapiens origins: a general theory of hominid evolution involving fossil evidence from East Asia. In *The origins of modern humans: a world survey of the fossil evidence*, eds. F.H. Smith and F. Spencer, pp. 411-483. Alan R. Liss, New York.
- Wood, B. ed.
 2011 *Wiley-Blackwell encyclopedia of human evolution*. Blackwell Publishing Ltd.

- Wood Jones, F.
- 1931a The non-metrical morphological characters of the skull as criteria for racial diagnosis. Part I: general discussion of the morphological characters employed in racial diagnoses. *Journal of Anatomy* 65:179-195.
 - 1931b The non-metrical morphological characters of the skull as criteria for racial diagnosis. Part II: the non-metrical morphological characters of the Hawaiian skull. *Journal of Anatomy* 65:368-378.
 - 1931c The non-metrical morphological characters of the skull as criteria for racial diagnosis. Part III: the non-metrical morphological characters of prehistoric inhabitants of Guam. *Journal of Anatomy* 65:438-445.
- Yokoyama, Y., C. Falgueres and M.A. de Lumley
- 1997 Datation directe d'un crâne Proto-Cro-Magnon de Qafzeh par la spectrometrie gamma non destructive. *Comptes Rendus de l'Académie des Sciences Paris, Série II* 324:773-779.
- Yotova, V., J.-F. Lefebvre, C. Moreau, E. Gbeha, K. Hovhannesyán. S. Bourgeois, S. Bédarida, L. Azevedo, A. Amorim, T. Sarkisian, P.H. Avogbe, N. Chabi, M.H. Dicko, E.S.K.'S. Amouzou, A. Sanni, J. Roberts-Thomson, B. Boettcher, R.J. Scott and D. Labuda
- 2011 An X-linked haplotype of Neandertal origin is present among all non-African populations. *Molecular Biology and Evolution* 28(7):1957-1962.
- Zilhão, J. and E. Trinkaus, eds.
- 2002 Portrait of the artist as a child. *Trabalhos de Arqueologia Ser.* 22.
- Zimonyi, I.
- 2005 The nomadic factor in mediaeval European history. *Acta Orientalia Scientiarum Hungaricae* 58(1):33-40.