Biological Imperialism and Romanization:

A Microevolutionary Analysis of Population Change in the Roman Adriatic

by

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ABSTRACT

This dissertation examines microevolutionary changes in the Eastern Adriatic and hinterland during Roman imperialism, evaluating changing patterns of variation among indigenous groups with varying histories of acceptance or defiance to Roman rule. Despite the prevalence of Roman influence, trade, and the accommodating nature of Roman political authority administered through existing local leaders, Eastern Adriatic and hinterland peoples underwent significant cultural transformations. Unlike the Roman-allied Liburnians, Romanization was not a voluntary and amicable process for the resisting Delmatae, Histri, Japodes, and Pannonians. The violent experiences of locals during the late Republican Period and early Roman Empire, including death, enslavement, conscription, and displacement, contrast with the eventual integration of the region by the end of the Roman Empire, when their descendants were Roman citizens. These complex histories make it challenging to understand local identities and the impact of Romanization.

Biological distance analyses of dental morphology from Liburnian, Delmatae, Japodes, and Pannonian samples representing 313 individuals dating to the Iron Age (c. 700- 400 BCE), and Roman Period (Roman Republic c. 200- 0 BCE; Roman Empire c. 1-500 CE), were contextualized with archaeological data and classical research. Results indicated no significant differences within Eastern Adriatic and hinterland populations across the time periods. However, interpretations of the results for Roman Period Liburnians, descendants of Roman allies, suggest differentiation from contemporaneous Italic Romans. Conversely, the descendants of resisting populations were not statistically

different from Roman Empire Italics, potentially influenced by their ancestors' experiences of war affecting subsequent admixture, community formation, and adherence to prevailing norms.

Roman laws that managed access to advantageous status identities through marriage and citizenship may also explain the findings that all surveyed local populations demonstrate continuity between ancestors and descendants. The dynamic of being identified as Roman, and yet descending from the people who fought against Rome, is further discussed as a form of biological imperialism, consequentially shaping indigenous ancestral ties within a pan-regional Roman citizenry. While Roman multiculturalism is often considered exemplary of Antique Period diversity, Roman values prioritized diversity when it was advantageous and used pluralism to encourage cultural assimilation and define outsiders.

DEDICATION

Dedicated to the three that nurtured my veracious childhood curiosity, my mother Yvette, father David, and stepfather Lynn; and my best friend and greatest supporter, Matthew.

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PREFACE

Critical consideration of identity assumptions both within and among locally associated populations are central to this study's goals. The results are not to be interpreted through an absolutist lens, where each population is distinct. Ideally, every sample could be used in one analysis to find the results, however population sizes and temporal clustering prohibit this approach. Instead, each group examined here is a piece of a larger population that exhibits different relationships to one another depending on how they are compared. With the addition of different traits and/or populations, or in comparison between analyses, results can differ. This is true for all biological distance analyses. Insight from one comparison is used to contextualize another but does not necessarily mean that what is borne out from one analysis is true in every situation. Adherence to strict group identification without respect for other factors or within group variation would perpetuate an incorrect mono- ethnic or essentialized view of local relationships. This dissertation attempts to explain in detail the methodologies behind biological distance as they are easily misunderstood and misused; while also redefining its practice in ways more scientifically accurate and in opposition to its racialist legacy.

For archaeology, an observational science, appreciating any complexity in the past is in large part subjective (Douglas, 2007; Kincaid, 2007; Roush, 2007). Interpretations are considered robust if they retain their explanatory capacity with the accumulation of new evidence (Millett, 1995, p. 31). In my interpretation this is a strength in archaeology because it manifests as a hyper-subjective practice, whereby each empirical component is an element of the wider context. Examination of how people relate to one another based on an inferred framework contributes to reconsideration of the framework itself. These comparisons provide insight on the variation within what we research, which then sparks additional questions about the bigger picture. The picture is a mosaic of blending that makes populations difficult to isolate because they are exemplary of the complexities of time and movement, and not distinction. As such, limitations have been carefully considered in interpretation of the results, while these and other caveats have been presented throughout the dissertation. These discussions are important for subsequent work in the region, and engagement with biological distance methods. Ultimately, the results of this study are complex, yet they do support conclusions made with other means. Nevertheless, they are not the last word and I invite new critical, careful, and ethical research.

CHAPTER 1 INTRODUCTION

Despite evidence from scholars showing that the integration of pre-Roman people into Roman society was a complex reality with coexisting native ideas and Roman influence, scholarship largely portrays the local Roman citizens, potentially descendants of pre-Roman locals, as assimilated and Romanized (Džino, 2010a, 2013; Karlović, Milotić, & Petrak, 2015). The primary objective of this dissertation is to address the lack of knowledge regarding the transformation of pre-Roman people in the Eastern Adriatic and hinterland region following their integration into the Roman Empire. Broadly, prior studies of persisting local continuity and acculturation due to Roman influence have relied on epigraphy, linguistics, and Roman historical accounts. The difficulty in evaluating regional population changes arise from the complex nature of identity formation and the limitations of relying on material culture and one-sided Roman texts, which are known to be biased and provide an incomplete picture (Grant, 2004; Marincola, 2010; Mellor, 2012). Furthermore, assertions about indigenous continuity, potentially extending to the foundations of modern peoples, have been entangled in controversies related to identity prejudice and justification of Roman imperialism over perceived barbarian peoples in the region and elsewhere (Džino, 2008a, 2008b; Terrenato, 2008). Additionally, the study of Romanization has its own contentious history, which subjects any research in this area to scrutiny. These concerns ignite interesting questions about Romanization, cultural erasure, and endurance of indigenous identities which can benefit from additional methodological comparatives to the existing Roman scholarship.

Historical and archaeological data have established that there were multiple cultural groups living in the Eastern Adriatic and hinterland during the Iron Age before Roman intervention, including the Delmatae, Histri, Japodes, Pannonians, and Liburnians. This is demonstrated by each groups' material cultures, subsistence patterns, and natural physical barriers that were used by archaeologists as indicators of ascribed cultural identity. Subsequently in the Adriatic, all local tribes became "Roman" either by force or by choice. The identity politics here are complex, but notably the Liburnians are historically recorded as being receptive to Rome in ways their neighbors were not. The Delmatae, Histri, Japodes, and Pannonians resisted Roman colonization in their lands. Despite the differences between the Liburnians and others, all of their fates were the same--Romanization. The archaeological record of cultural similarities and differences among Eastern Adriatic coastal and hinterland groups indicates that interactions existed among these populations prior to Romanization, despite the preservation of their own cultural identities. According to principles of population genetics, cross community gene flow would have been more likely between geographic neighbors than across longer distances, such as with Romans residing west of the physical barrier, the Adriatic Sea, in Italia (modern Italy). Therefore, it is expected that as Roman influence increased in the region, so too would genetic diversity, an indication of gene flow between these interacting populations (Olalde et al., 2023). However, the historical knowledge that one group, the Liburnians, were more receptive to Roman colonists, established early alliances with Romans, and ultimately were more easily acculturated than the others provides an interesting distinction between the local groups that could manifest in patterns of biological variation. Specifically, receptivity to Rome could result in increased gene flow between Liburnians and Roman Italics, while on the contrary, the resistance to Roman rule among the Delmatae, Histri, Japodes, and Pannonians would not; inferences which are not currently addressed using traditional classical scholarship.

Therefore, this research applies a method that has not previously been used to explore patterns of cultural and biological variation in this region. It analyzes and describes admixture and population change of pre-Roman Iron Age Adriatic and hinterland groups (Delmatae, Histri, Japodes, Pannonians, and Liburnians), by examining shared genetic history between the local populations, their Roman descendants, and Roman Italics using microevolutionary analyses of human dentition. Changing patterns of heritable dental phenotypic data allow estimation of biological distances among populations through time, revealing changes in interaction patterns through three periods of Roman influence (Iron Age c. 600- 200 BCE; Roman Republic c. 200- 0 BCE; Roman Empire c. 1- 500 CE). With the exception of attribution in burial monuments, little is known about the ancestral relations among these groups that in one period are indigenous and in another are described as Roman. Furthermore, these residents share an attribution as Roman during the Empire, which contrasts with their local ancestors' different initial reactions to Rome. Therefore, this research documents both the changes in population relationships and determines whether gene flow from Romanizing Italics was the same for descendants of all indigenous Eastern Adriatic groups during the Roman Empire. These results are scrutinized within the broader literature on Roman imperialism to contribute a multi-disciplinary and more nuanced way of considering Romanization in

Adriatic and hinterland groups. This dissertation considers that Roman intervention had an identifiable effect on biological relationships in the region, which is referred to here as biological imperialism. Within the sphere of Roman influence, there was room for ethnic diversity and yet also a cultural expectation to be Roman, prompting future research to scrutinize displays of identity in Adriatic descendant Romans more closely. Last, this dissertation tackles the distraction of the Romanization debate, putting back into focus the outcomes of imperialism and the negotiation of ancestry and identity.

HYPOTHESIS AND QUESTIONS

Null hypothesis: Dental morphological microevolutionary analyses do not support statistically significant differences among Adriatic, hinterland, and Italic populations during the Iron Age and Roman Periods; despite their historically identifiable geographic, political, and material changes attributed to interaction and Romanization.

Alternative hypothesis: Dental morphological microevolutionary analyses support evidence of statistically significant differences among Adriatic, hinterland, and Italic populations during the Iron Age and Roman Periods, possibly demonstrating changes in gene flow consistent with historically identifiable geographic, political, and material changes, attributed to interaction and Romanization.

This research assesses the hypothesis through the following questions:

1. Were indigenous peoples of the Adriatic and hinterland phenetically indistinguishable from one another or the Italic Romans at the end of the Iron Age?
2. Do the populations of the Eastern Adriatic and hinterland, who are considered Roman and were potentially local descendants of the indigenous peoples, demonstrate gene flow

between each other or Romans from the Italian peninsula after the expansion of the Roman Republic and Roman Empire?

3. Do variations in gene flow, if present, correlate with a history of either conflict or allyship with Rome among potentially indigenous-descended peoples who were Romanized?

Expectations of Analyses

This study aims to evaluate against the null hypothesis of no statistically significant differences in population relationships between Adriatic, hinterland, and Italic populations during the Iron Age and Roman Periods by analyzing dental non-metric traits as proxies for gene flow following ASUDAS protocols and using biological distance analysis. Historically documented geographic, political, and material changes associated with interaction and Romanization suggest potential microevolutionary processes. If the results fail to reject the null hypothesis, this would indicate no phenetic differences between two or more of the populations. The significance of this result would depend on the specific populations and timeframe, as shared genetic ancestry is more or less likely depending on the context. Conversely, rejecting the null hypothesis would suggest statistically significant differences, which could be expected in some cases but is less likely between populations with no prior differences. Contrasting patterns across time periods could then be attributed to changes in gene flow between populations, potentially explained by Roman influence given the established cultural dynamics. With both the biological and cultural components identified, more detailed processes can be examined.

This biological imperialism, which I use to describe cultural Romanization co-occurring with admixture, will be examined among all populations, but with special attention to the Liburnians and Romans as they had established early positive alliances. The most basic expectation would be that immediately following the Iron Age, non-allied Adriatic and hinterland populations (Delmatae, Histri, Japodes, and Pannonians) would show genetic differences from the Italics, while the Liburnians would not due to their increased interaction with the Romans. This differentiation is also expected to continue among Liburnian-descended Romans during the Empire. Based on these findings, one would also expect that all later Roman populations be local descendants, however, they would have more genetic similarity to Italics during the Empire than their ancestors. That is, as cultural exchange increases between peoples so does gene flow. A deviation from this expectation, where gene flow and allyship do not correlate, could nevertheless provide new insights on Roman heterogeneity, acculturation, and identity as shared ancestry would not be a component in shared experiences.

Bioarchaeology and Contextually Informed Presentation of Data

The analyses in this study are being conducted with a model-free methodology. In other words, the products of the analyses are not fixed genetic measurements, but relative distances interpreted among those populations included in the analyses and, therefore, interpretations need to be bio-culturally informed. This way of examining archaeological human remains is integral to bioarchaeological research (Buikstra, 1977; Goodman, 2013; Zuckerman & Armelagos, 2011; Zuckerman & Martin, 2016). Bioarchaeologists study archaeological human remains from past societies as a way to understand the intersections of culture, biology, and history (Agarwal & Glencross, 2011; Baadsgaard, Boutin, & Buikstra, 2011). This highly contextual work involves considering both the physical and the theoretical within the frame of history and culture to avoid "morphological essentialism", where the body is the sole interpreter of an individual's identity or the physical becomes the "true reality" (Babić et al., 2017; Kakaliouras, 2010; J. R. Sofaer, 2006; Voss, 2015). The word bioarchaeology as used in European archaeology refers to the analysis of organic materials including human remains, but also fauna and flora from archaeological sites (Buikstra & Beck, 2017; Clark, 1972, 1978). In the sense that this research utilizes human dental and osteological remains, it does also fall under the category of osteoarchaeology, a term more commonly used in Europe, and "anthropology," a term that refers to biological anthropology in Croatia. However, in this application what differentiates bioarchaeology from both of these similar terms is the contextual, historical, and culturally centered approach originally outlined by Jane Buikstra (1977), which has grown into an anthropologically grounded, cross-field integrated discipline when successfully applied. Bioarchaeologists incorporate various sources of evidence to gain a deeper understanding of the multifaceted nature of human experience and to explore alternatives to conventional explanations of archaeological people's experiences and identities (Casella & Fowler, 2005; Gowland, 2017a; Gowland & Thompson, 2013; Gravlee, 2009; Torres-Rouff, 2009). As illustrated in Figure 1, which is adapted from Killgrove (2019, p. 11), one may "enter" the model with data available to them and follow the "path", incorporating other areas of study, each providing components for a more complete interpretation. Alone, a methodological approach may prompt a prediction or support previous interpretations, though when used together they provide new ideas, contextualize existing understandings, and strengthen prior results.

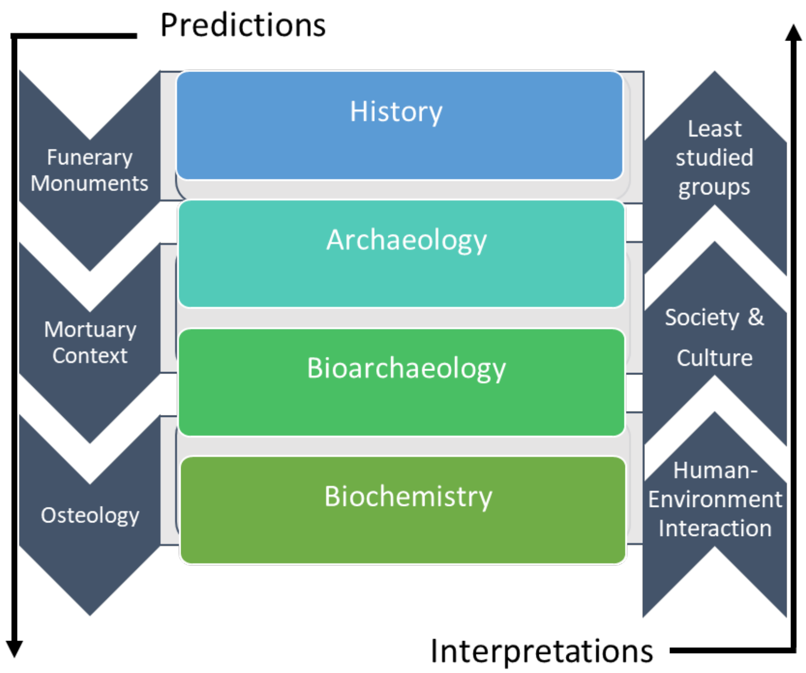


Figure 1 Integrative model to visualize and explore information within their larger context. Adapted from Killgrove (2019, p. 11).

In bioarchaeology, identity studies are fundamental to interpretation of the past, appreciation of individuals and populations, and interpreting culture change. Intertwined with ethnic identity, group and individual identity, and cultural dynamics, the literature associated with Roman imperial influence, generally termed Romanization, is discussed at length. This subject has been, and to a lesser degree continues to be, controversial with a long history of internal debates creating aversion in the academic psyche (Breeze, 2011; De Mola, 2012; Haeussler, 2013; Herskovits, 1938; Jones, 2002; Mattingly, 2013; Slofstra, 1983).

Motivations for Research

Cultural boundaries, often explored through group identities like ethnicity, are important aspects of archaeological research as they can be a starting point for understanding changes experienced by past peoples. However, in scholarly criticism, the practice of assigning "ethnic labels" to sites, objects, and ancient populations, has long been recognized as challenging, even problematic (Babić, 2005; Barth, 1969; Insoll, 2007; Jenkins, 1994; Jones, 2002; G. S. Webster, 2008; Williams, 2001). These are further exacerbated by the limitations of the surviving evidence, non-perishable material culture and occasionally written texts or epigraphy. Nevertheless, these continue to be the primary way to learn about ancient cultural identities, whereas bioarchaeological approaches are still relatively rare in comparison.

This is particularly pernicious within the field of classical archaeology (Killgrove, 2019; Pitts, 2007). Greco-Roman Classical studies predate many other areas of historical and archaeological scholarship. A noteworthy example is the extensive six volume set, *The History of the Decline and Fall of the Roman Empire*, initially published between 1776 and 1789 by Edward Gibbon (1776; see also Mommsen & Dickson, 1863; Ovid, 1839). Despite this scholarly longevity, Roman bioarchaeology was until recently a less integrated, novel approach in the study of classical Rome and the Empire, or when applied, not incorporated into broader historical studies (Killgrove, 2014, 2019; Sperduti, Bondioli, Craig, Prowse, & Garnsey, 2018). As a relatively new undertaking for its own sake, not as an appended report, bioarchaeology has helped examine Roman demographic makeup, disease, health, diet, and migration throughout the imperial lands (Gowland, 2017a; Gowland & Walther, 2018; Killgrove, 2014, 2019; Marklein, 2020; Moles, Reade, Jourdan, & Stevens, 2022; Montgomery, Evans, Chenery, Pashley, & Killgrove, 2010; Pearce, 2020; Prowse, 2011, 2016; Redfern, Harlow, & Laurence, 2007; S. K. Smith, 2013; Sperduti et al., 2018). The majority of this research has been done on the city of Rome and in Roman Britain, but in recent years there has been growth in Eastern Europe and the western Balkans.

In the Iron Age and Roman Eastern Adriatic and hinterland specifically, bioarchaeology is a growing addition to other archaeological research in understanding the lived experiences of people from this region. For example, there are also numerous publications on indigenous identity (C. Barnett, 2015, 2016, 2019; Dizdar, 2012; Džino, 2008a, 2010a, 2010c, 2010b, 2012, 2013, 2014b, 2014a, 2018; Džino & Kunić, 2012, 2013, 2018; Janković, 2014; Potrebica & Dizdar, 2014; Vranić, 2014). Nevertheless, examinations have not been adequately combined with analyses of gene flow between the indigenous inhabitants and newcomers during the period of Romanization. Key to understanding these changes, the identities of individuals and communities are shaped by perceptions of self and others that often have biological factors. Biology is one vehicle of interaction with constructed and ascribed identities, which is embodied during life and materially manifested in death (Babić, 2005; Gravlee, 2009; Knudson & Stojanowski, 2008, 2009; Meskell, 2002; Mina, Triantaphyllou, & Papadatos, 2016; J. R. Sofaer, 2006). The biological dimensions of identity can be used to examine how people present themselves and how archaeology has interpreted their presentation (Gowland, 2017a). Combined with epigraphic and material sources, Roman bioarchaeology can provide valuable information about relationships, identity, and movement that material culture alone does not provide (Gowland, 2017a; Killgrove, 2010; Leach, Lewis, Chenery, Müldner, & Eckardt, 2009; Prowse, 2011; Redfern et al., 2007; Stark et al., 2020).

This dissertation applies biological distance methods within a theoretical framework that considers the historical context of shared ascribed identities to illuminate the experiences of these Adriatic and hinterland peoples. It utilizes these concepts, not to make deterministic assertions about the boundaries of cultures, but instead to consider how they combine or layer. The material manifestations of experience in the body may challenge what appears historically and archaeologically evident when people do not "look" the way we expect. Only after resolving what is unknown, "how were people related?" can what is historically and archaeologically known about Romanization be fully used to characterize the impact of Roman imperialism on post-Iron Age Adriatic people. While Roman studies have provided valuable insights, revealing the intricate and multifaceted nature of social identities during that era, they miss components essential to an embodied experience. In such circumstances, Lucy (2007, p. 108), invites archaeologists to begin with "identifying people who chose to act or look the same," and then "explore the contexts in which they did so, and whether these changed through time."

Terminology Issues

In this dissertation, some terms have a controversial history and may have different meanings depending on the context. To provide clarity on how these terms are used, definitions can be found either within the text or in the appendix. At times, the context of the text will make the meaning clear, however, differences between different disciplinary and colloquial language conventions may be cumbersome. Also, this research is primarily on a geographic region that is modern-day Croatia, but it is acknowledged that these borders did not exist in the past, and the sources, results, limitations, and future work extend to nearby regions.

Figure 2 Map of Adriatic Sea and surrounding modern countries. Google Maps, 2023.

The study discusses various populations, and to produce feasible sample sizes or to highlight broader changes, samples have been pooled. The term "local" refers to populations that share the same relative geography on the eastern side of Adriatic Sea and hinterland such as the Delmatae, Histri, Japodes, Pannonians, and Liburnians, or when discussing populations within the Italic peninsula. The Italic peninsula refers to the modern-day mainland Italy, which projects into the Mediterranean and borders the Adriatic Sea on the west. “Regional” refers to the wider Adriatic region, including the coast, hinterland, Pannonian basin, and the most northern parts of the Ionian/ Mediterranean Seas (see Figure 2). Similarly, cities are discussed using both their original names from antiquity and modern names or locations. The text will use, “the city of” for modern day metropolitan areas and use temporal descriptors such as “the Roman city of,” or “the ancient city of” when referring to their prior titles unless this is otherwise clear by the context of the paragraph. An exception to most of the other uses of terms is Delmatae and Dalmatia. Delmatae will be used to refer to the indigenous peoples of this region and their descendants. During the Roman Empire, the area where they lived is referred to by its Roman provincial name, Dalmatia. However, the term Dalmatians, as a group descriptor, will not be used except when citing others that use this term.

Populations have been pooled based on their shared local geography and time period. The Roman Italic supplemental samples span three time periods, the Iron Age (c. 800- 500 BCE), the Republican Period (509 to 31 BCE) and Roman Empire (31 to 476 CE). The western Adriatic Iron Age began before the creation of the city of Rome and is not included here in the (Roman) Iron Age. Supplemental sources used in this research refer to Middle and Late Iron Ages (c. 800- 500 BCE, c. 500- 200 BCE) (Coppa, Cucina, Lucci, Mancinelli, & Vargiu, 2007; Coppa, Cucina, Mancinelli, Vargiu, & Calcagno, 1998). However, other sources locate the Roman Iron Age as ending by 500 BCE, at the beginning of the Republican Period (Suano & Scopacasa, 2013), combining archaeological and political time periods. As the political terminology frames the cultural changes this research highlights, the term Roman Republican Period is used instead of Late Iron Age for Italic samples, recognizing that the end date is different from the regional archaeological Iron Age.

The two major temporal periods for the Eastern Adriatic and hinterland are the Iron Age and the Roman Period. The Iron Age dates vary throughout the Mediterranean. However, in the Adriatic region it generally includes c. 800- 200 BCE. During the end of this period there was about a 100-year span when the Roman Republic initiated more deliberate and confrontational interaction among the Eastern Adriatic populations (c. 200 BCE). Following this, changes occurred quickly and therefore the Republican Period (locally, c. 200 to 31 BCE) and Roman Empire (31 to 476 CE) are referred to together as the "Roman Period", referencing dates after Roman influence. Therefore, the Eastern Adriatic Iron Age and Roman Periods overlap with the Roman Republican Period. Classical Antiquity, the Antique Period, and Ancient Rome/ Greece are more colloquial terms that refer to all of the formative Greco-Roman and Mediterranean history between the 8th century BCE and the 5th century CE. However, for regions such as the Eastern Adriatic, the Antique Period is commonly used only for periods of Roman influence and is therefore more consistent with the Roman Period. History and dates are discussed in more detail in Chapters 2 and 5.

To enhance clarity in the analysis, various acronyms have been used to represent the different sites and populations under investigation. For supplemental data, the original naming schema used from the source material have been retained. While there is not a standardized schema for new data as this would result in very similar names, "IA" generally denotes the Iron Age, "R" represents the Roman Period, "C" refers to the coastal regions of Croatia, and "H" stands for the hinterland. For the populations of primary interest in this study, the first letter or letters of their names have been used in the acronym. For instance, "DIA" stands for the Iron Age Delmatae. All acronyms are defined in Tables 2 and 3.

Finally, throughout the text primary classical sources are cited. These Greek and Roman writers' works were sourced through English translations and therefore the in-text citations use the original translation year and cite the translators as co-authors in the bibliography. Nevertheless, the original author is cited for in-text citations or are referred to in the text to avoid any confusion. Short biographies are given for each of the Classical Antiquity authors in the glossary. These authors and other notable Antique Period figures will be referred to by their most commonly used name, even if that name was also a title that they did not hold until later in life. For example, Octavius Caesar Augustus and Tiberius Caesar Augustus did not receive the name "Caesar Augustus" until after becoming Emperors. However, to avoid confusion with their predecessor Julius Caesar, Augustus and Tiberius will be referenced with these singular names.

OUTLINE AND ORGANIZATION OF DISCUSSION

The dissertation is organized into seven chapters. The chapters of this thesis are presented in the following order:

Chapter 1 Introduction and Hypotheses

Chapter 2 History of Roman and Adriatic Peoples

This chapter discusses the history of the peoples who lived along the Eastern Adriatic Sea and hinterland lands west of the Danube River during the Late Iron Age into the Late Antique Period. The chapter focuses on the impact of Romanization on these peoples, and how they responded to Roman intervention. Despite diverse cultural backgrounds and interactions with Rome, all of these peoples were eventually Romanized. The contrast between these populations provides the basis for exploring their population relationships phenetically and whether or not these relationships vary considering their distinct histories.

Chapter 3 Romanization and Identity

The chapter discusses the history of Roman studies and how the Romanization debate shaped much of this research. Roman imperialism and Romanization literature are reviewed as they directly relate to the study of culture change and the dynamics between Romans and native inhabitants of lands they conquered. This chapter also presents discussion of ethnic and social identity insofar as they relate to ethnic attribution and naming of cultural groups, with similar issues to the greater Romanization debate. Archaeological and classical studies in the Eastern Adriatic and Croatia are also examined. A short summary of bioarchaeological research is also reviewed to establish that biological distance studies of the Iron Age and Roman inhabitants in this region are not common.

Chapter 4 Methodology

This chapter introduces the study of dental morphological traits and the quantitative genetic theory that supports their use in this analysis. It provides a summary of dental development demonstrating additive and polygenic effects on patterns of dental morphological variation. Finally, this chapter examines how dental traits provide evidence of microevolutionary change.

Chapter 5 Materials and Methods

This chapter outlines the materials used in the study, including a brief overview of each sample's provenience, the number of individuals analyzed, and their associated time periods and populations. Specific methods including data cleaning and analyses are provided. Mortuary traditions among Adriatic and Roman populations are also reviewed.

Chapter 6 Results

This chapter provides the results of the dissertation research and their interpretations. Results do not demonstrate significant differences between Adriatic and hinterland populations or between Iron Age Liburnians and Iron Age Italics. However, comparisons between Roman Period Liburnians and Italics (their contemporaries) reject the null hypothesis that they are indistinguishable. Comparisons with other Roman Period Adriatic populations fail to reject the null, providing a contrast that is explored through the historical context.

Chapter 7 Discussion and Conclusion

Chapter 7 develops the interpretive framework for the results presented in Chapter 6. Specifically, it considers three major findings: 1) why populations demonstrate admixture during the Roman Period, considering factors such as relocation and movement of local populations that contributed to exogamy; 2) why despite evidence for admixture, there is a pattern of continued ancestor/ descendant relationships and; 3) that descendants of Rome's primary ally, the Liburnians, may not have shared the same relationship to Italics--an unexpected juxtaposition. The discussion considers Rome's classism as a contributor to the observed patterns of biological variation. Classism in Rome deviated from modern understandings of ethnic discrimination though was contradictory to Rome's established multi-cultural nature. However, when advantageous, Roman pluralism was integral to construction of an in-group which shares values that supported the expanding empire and integration of new peoples, while maintaining hierarchy. Therefore, Roman cultural influence and conceptions of identity are discussed to provide reasons why local populations may have been compelled to assimilate. In fact, their past differences in ancestry may have been helpful in promoting Rome's reach and portrayal as a global entity. Catalysts to these changes, such as war, are considered key to these assertions. The discussion necessitates revisiting Romanization debates, reconsideration of criticisms, and how these distract from experiences of imperialism. The chapter section concludes with a discussion of Romanization as a type of biological imperialism. As the pressure to culturally assimilate and Roman displacement of populations coalesce, ancestral connections were renegotiated to meet the new reality while maintaining imperial order. Chapter 7 ends with the conclusion of the dissertation and summarizes next steps for future research and considers implications for the research in the broader context of Croatian bioarchaeology and Romanization studies.

CHAPTER 2 HISTORY OF ROMAN AND ADRIATIC PEOPLES

The Adriatic region was home to a diverse range of groups who maintained different mortuary, subsistence, material, and religious traditions (discussed in the next section), that nevertheless also traded among each other and shared cultural similarities (fibulae, pottery styles, mound use etc.) (Benac, 1987b; Demicheli, 2015; Potrebica & Dizdar, 2014). This chapter briefly discusses regional Roman history and initial interactions with Eastern Adriatic populations. It also provides some historical and archaeological context on the populations relevant to this research and their responses to Rome's actions in the region, highlighting the similarities and differences in their experiences.

The complex local histories complicate interpretation of ties to the past among Adriatic and hinterland descendants who were becoming a part of the Roman Empire while simultaneously creating new cultural alliances (Benac, 1987b; Bilić, 2019). Furthermore, Romanization is itself a complex and contentious subject creating additional vagueness in our current understanding of the Eastern Adriatic (De Mola, 2012; Džino, 2018; Jones, 2002; Versluys, 2014). All local groups, regardless of their original self-identification, are, subsequent to Romanization, collectively referred to as Roman. Interestingly, their shared outcome occurred despite the varied responses by the tribes towards Rome, as documented in historical literature (Džino, 2012; Džino & Kunić, 2018; Šašel Kos, 2011, 2013; Shpuza, 2013). Many groups warred with the Romans, nevertheless all were eventually subsumed under Roman hegemony. However, assessment of local descendant identities and acculturation have yet to consider genetic relationships alongside other historical and archaeological evidence of identity. To fully appreciate the contributions of genetic data, proxied here through biological distance analyses, this chapter reviews the course of research in this region and what the literature says about these populations leading up to Romanization.

ROMAN HISTORY

Classical Antiquity, sometimes termed the Antique Period, refers to Greco-Roman and Mediterranean history between the 8^{th} century BCE and the 5th century CE. Ancient Roman history (i.e., before the Eastern Roman capital in Constantinople, modern Italy, or the Vatican) is organized into three major political periods beginning with the Kingdom of Rome or the Monarchy (753 to 509 BCE), which overlaps with the Roman Iron Age. This is followed by the Roman Republic (509 to 31 BCE) and finally the Roman Empire (31 BCE to 476 CE), which is sometimes recorded as starting on 27 BCE (Everitt, 2013; Goldsworthy, 2016). Other commonly used terms include the Late Antique Period or Late Antiquity after the fall of Rome as the capital city (4th to 6th centuries CE).

According to Roman legend the Kingdom of Rome began after Romulus founded the city and established the Senate uniting neighboring Italic tribes, the Latins, Sabines, and Etruscans, with him and the Sabine ruler Titus Tatius co-ruling as the first kings (Strabo, 1932b). During the Roman Republic, the political structure was more of an oligarchical city-state, ruled by influential families through the republican Senate (Campbell, 2016; J. D. Evans, 2013). From the fourth century BCE onwards, Rome's authority spread throughout central Italy with the granting of full Roman citizenship across Italic tribes (Burton, 2019, p. 18).[1] This period also involved military conflict across the Mediterranean and Greece, civil war, and finally reorganization and expansion that would become the Roman Empire (Appian, 2012; Beard, 2015; Everitt, 2013; Mommsen & Dickson, 1863; Woolf, 2021a).

When discussing the Eastern Adriatic, much of the history is focused on before, during, or after the reign of Octavius Caesar Augustus (63 BCE to 14 CE), the first emperor of the Roman Empire and successor of Julius Caesar (Eck, 2003; MacMullen, 2000a). Augustus spent many years renovating Rome and ordering mandates for food distribution, appeasing a weary population after years of the Illyrian wars (229 to 168 BCE), Punic Wars with Spain and Carthage (North Africa) (264 to 146 BCE), the dictatorship of Julius Caesar, and the civil war (100 to 44 BCE) (Campbell, 2016; MacMullen, 2000a; Woolf, 2021a). Consequently, Augustus is remembered for peace and stability – the *Pax Romana* (Eck, 2003; Goldsworthy, 2016; Syme, 2002). Yet, despite his legacy of having brought in 200 or so years of "peace," Augustus had initiated the military doubling of Rome's reach and the colonization of land that now makes up 40 modern nation states (MacMullen, 2000a). He would acquire a mythical nature in Roman history, despite a violent reign whose force was so powerful it had, in his words, turned Rome from "clay to marble" (Eck, 2003; Syme, 2002). Although parts of Dalmatia were already conquered by Julius Caesar, including the Liburnian port town of Iader (modern Zadar), Augustus was instrumental in the conquest of lands east of the Adriatic, including

[1] In 212 CE the Constitution of Antoninus, also called "Edict of Caracalla" was issued declaring that all free men in the Roman Empire be given full Roman citizenship, with the exception of war prisoners and freed slaves, regardless of their origins.

much of Dalmatia and Pannonia (Eck, 2003) (see Figure 3). Augustus was succeeded by Tiberius Caesar Augustus (14 to 37 CE), who led campaigns in Pannonia as well (Šašel Kos, 2011). The Empire would end only a few hundred years later and the Romans would be pushed from this region by the Ostrogoths around 600 CE. The lands were inhabited by Slavic speaking peoples and others, ending Roman dominion but also creating a narrative whereby the pre-Roman peoples ceased to exist and are now only appreciated from their archaeological remnants (Džino, 2010b; Jovanović, 2017; Wilkes, 1995).

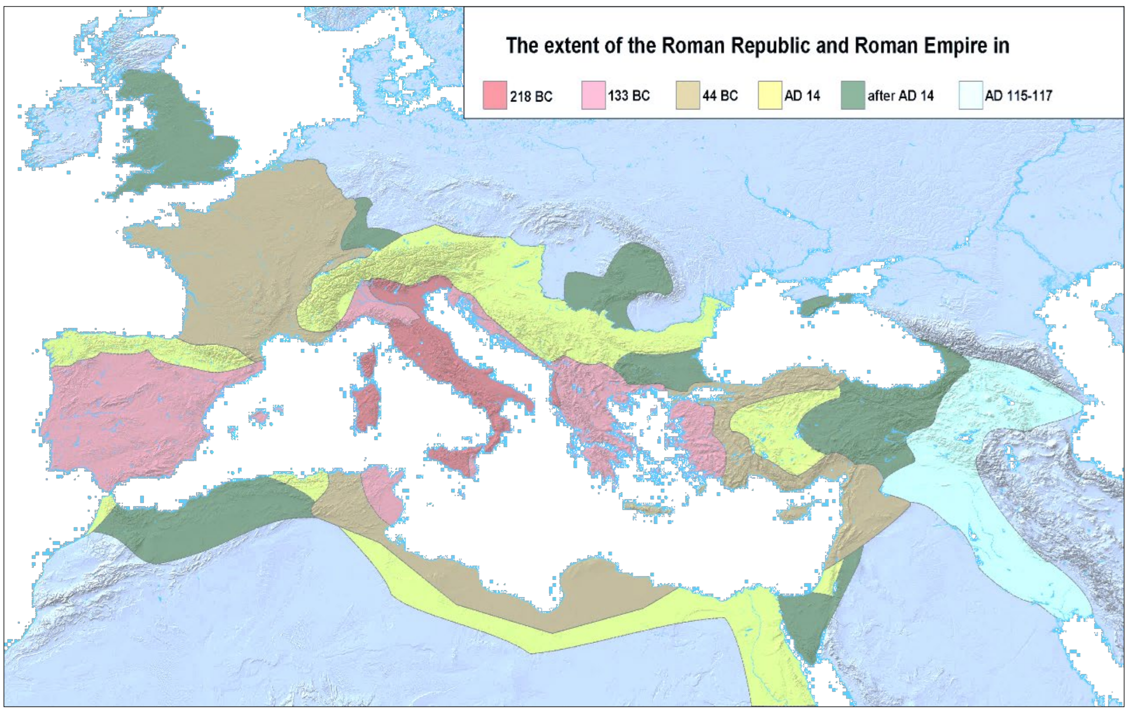
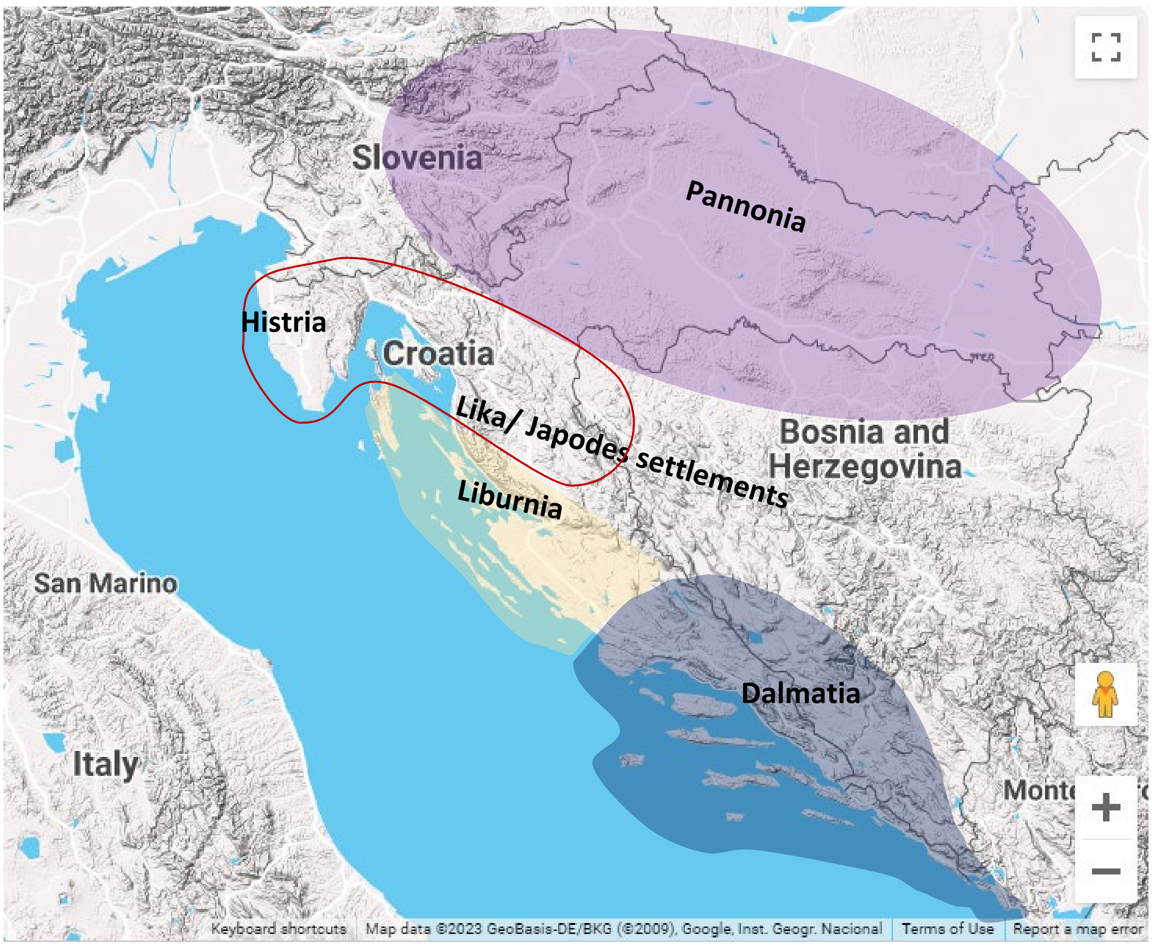


Figure 3 Map of geographic extent of Roman campaigns during the Republic and Empire. The image is by an unknown author and reused under CC BY-SA-NC. A similar version of this image appears in Mattingly (2013).

REGIONAL CULTURAL GROUPS

This dissertation focuses on the groups defined historically and archaeologically as the Liburnians, Delmatae/ Dalmatians, and Pannonii/ Pannonians (see Figure 4).

However, samples analyzed include small numbers of Japodes. The historical review also includes the Illyrians and the Histri, as these were some of the first Eastern Adriatic groups encountered by Roman Italics. Also, their close proximity to the other tribes makes boundary identification complicated, and they are referred to throughout discussion of other groups.



Red outline= Histri and Japodes settlements
Purple area= Pannonia/ Pannonian settlements
Yellow area= Liburnia/ Liburnian settlements
Blue area= Dalmatia/ Delmatae settlements

Figure 4 Map of approximated population settlements layered over a modern map. Dalmatian, Pannonian, and Liburnian regions are overlaid and labelled. The Histrian and Japodian regions are outlined in red together. Google Maps, 2023.

The pre-Roman Adriatic and hinterland peoples show evidence for long term inhabitation of the region with local continuity beginning in the Late Bronze Age (9th- 6th century BCE) (Batović, 1987; Benac, 1983, 1983, 1987b; J. Chapman, Shields, & Batović, 1996; Freilich et al., 2021; Gavranović & Sejfuli, 2018; Lightfoot, Šlaus, Šikanjić, & O'Connell, 2015; Popa & Stoddart, 2014; Porčić & Stefanović, 2009; Šikanjić, 2006; Wilkes, 1995). Numerous cultures influenced the peoples in this region, such as the Greeks, Thracians, La Tène Celts, and others who moved alongside or traded with them (Popa & Stoddart, 2014; Potrebica & Dizdar, 2014; Tonc, Radman-Livaja, & Dizdar, 2013). Greeks traveled in the Adriatic region before the end of the Adriatic Iron Age and Greek Hellenistic Period, recording their encounters with the peoples of the Adriatic and providing many of the tribe names which are still used (Paterculus, 1924; Pseudo-Scylax & Shipley, 2011). For example, the Greek historian *Periplus of Pseudo-Scylax* wrote of travels in the Adriatic with specific mention of the Liburnians between the 6th- 4th century BCE (Hecataeus & Klausen, 1831, p. 7; Pseudo-Scylax & Shipley, 2011). Additionally, there were Greek settlers in Dalmatia during the 4th century BCE (Domines Peter, 2019). Greek military campaigns were also traveling throughout the Adriatic, out of concern for Etruscan naval power (Praga, 1993, p. 16). Greek settlements, interaction at Hvar island, the Liburnian colony on the Greek island of Corcyra and the Liburnian colony on coastal east Italy in Picenum also demonstrate early opportunities for culture exchange (Pliny, 1942; Strabo, 1932a). The histories of the tribes are discussed below in chronological order of major encounters with Roman movements that resulted in permanent regional change. The Liburnians are discussed last because of their distinctly different interactions with Rome.

Figure 5 Map of modern countries and geography. Main geographic boundaries such as rivers and mountains have been identified Google Earth, 2023.

Illyrians

Major Roman involvement in this region began in the late 3rd century BCE after Roman control of the southern Italian peninsula was secured and Illyrian[2] piracy of ships

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[2] See definitions for details on use of this term.

on Adriatic trade routes to Greece became a major concern (Džino, 2010c, p. 44). The Illyrian Kingdoms were located around the modern city of Dubrovnik, Croatia and in the modern countries of Albania and Montenegro and neighbors (see Figure 5). They were culturally similar communities and politically interconnected, wherein the leader of the most powerful community held a role which Greek historians referred to as a king (Džino, 2010c, p. 45). Rome's concern had as much to do with regional influence as it did access to trade routes, particularly between Greece and Italy. Rome sent a delegation to the island of Issa (c. 230 BCE) to discuss these concerns; however, they were ambushed by an Illyrian fleet (Appian, 1899). In retaliation, and due to strategic and economic reasons, the Roman Republic spent most of the next 80 years in conflict during three Illyrian wars between 229 BCE and 168 BCE. Finally, the last Illyrian King Genthius was conquered in 168 BCE, marking the beginning of Roman domination in the Adriatic (Šašel Kos, 2013; Wacher, 2013; Wilkes, 1995).

Histri

The Histri were an Iron Age population residing in Histria, or what is modern day Istria, the large peninsula extending into the Northern Adriatic between modern Croatia, Italy, and Slovenia (see Figure 4) (Čače, 1989; Mihovilić, 2013). The Roman city and Istrian metropolis of Pula lies at the very end of the peninsula, which served as a major port. Though land routes to other Adriatic peoples would have been made difficult by the Velebit Mountain range (more than 300 km between Pula and Zadar over land), sea routes were less so (140 km between Pula and Zadar by sea). Its main governing center/ capital was Nesactium/ Nezakcij near modern Muntić, Croatia and not far from the larger city of Pula. The Histri pre-Roman political organization was similar to a monarchy or kingdom, consisting of a head reigning figure or king over a number of communities or municipalities (Čače, 1989). After falling to the Romans in 177 BCE, Histria became an important corridor for Roman movement east (Šašel Kos, 2013; Wilkes, 1995). As Emperor Augustus came into power (27 BCE), the Romans built a forum and amphitheater in the port city of Pula and the Histrian lands went from being Roman owned estates, *latifundium* or *fundus,* to being incorporated into the Roman mainland of Italia as *Venetia et Histria* (Jurkić-Girardi, 1988; Matijašić, 2017; Šprem, 2020; Starac, 2001, 2022).

The Romans viewed, and history portrays, many of the groups in this region as pirate thieves or violent barbarians (Appian, 2012; Campbell, 2016). The Histri, as well as the Liburnians, were characterized as fierce pirates, ambushing trade ships while also patrolling and protecting their coastal territory in the Adriatic Sea (Šašel Kos, 2013; Wilkes, 1995). When writing on people sailing in the Adriatic in 300 BCE, Livy refers to the "Illyrians" (here including the Histri and Liburnians) as "savage tribes and notorious most of them for their piracies" (Livy, 1926, pp. 364–365). Wilkes (1995, p. 63) considered the Histri a distinct cultural group by the 8th century BCE through interpretation of cremation, dress, and jewelry. Sometimes the people from this region are referred to as Venetic peoples, as well as Illyrian (Jurkić-Girardi, 1988; Wilkes, 1995). Despite this, there were cross-cultural features that associated them with their easterly neighbors, the Pannonians (Wilkes, 1995).

Pannonians

Pliny the Elder (1942), a Roman historian and naturalist, described the Pannonian region as the acorn-producing land along the less formidable slopes of the Alps, run through by the Sava River. This west to east path through the Alps along the Sava facilitated trade and connected areas of what is continental Croatia today, regions that otherwise seem distant from one another, yet are separated from the geographically closer Dalmatia by mountains (see Figure 5). Appian (2012), also wrote of the Pannonians (though at times mixing them up with the Paeones south of Thrace), calling them renowned among the Illyrians, inspiring fear in the Italics. Discussions of pre-Roman Pannonians generally distinguish them from their neighbors and though they may be referred to as an Illyrian tribe, they are not considered among the Illyrian Kingdoms who lived further south (Potrebica & Dizdar, 2014; Wilkes, 1995, p. 87).

Although this area and people are referred to singularly with the Romano-political title, Pannonia, the name is thought to have come from Greek descriptions of people that inhabited the region before the Romans, the Pannonii. The pre-Roman residents south of the Drava river that borders modern Croatia, Hungary, Slovenia, and Italy are often termed Pannonians, Pannonii, Illyrian, and sometimes Celtic interchangeably (Appian, 2012).[3] Sharing land, cultural elements, and conflict with the Celtic La Tène in the north, and being counted among the Illyrian tribes to the south, make defining and grouping the Iron Age peoples here challenging (Džino & Kunić, 2012). A shared ethnic Pannonian

[3] In this paper, pre-Roman residents and Roman residents will be referred to as Pannonians, as this is common in the English language literature.

identity is not assumed, though there existed a shared *habitus* during the *Bellum Batonianum* war (6- 9 CE), due to their opposition with the Delmatae against the Romans (Džino & Kunić, 2012, p. 100). Furthermore, the intensity of Romanization is considered a persistent local feature that makes them stand out when compared to Romans (Potrebica & Dizdar, 2014).

Archaeological evidence provides a picture of a shared cultural milieu on the plains around the Sava River. The Pannonian communities during the La Tène/ Late Iron Age are considered to be a blend of local indigenous populations and their Celtic neighbors, culturally and otherwise, with maintenance of local distinct material culture and continuity with the past (Džino & Kunić, 2012; Potrebica & Dizdar, 2014). La Tène pottery found in the region was originally imported, but in the 4th century BCE, shaped locally produced wares (Drnić & Miletić Čakširan, 2014, p. 192). This cultural impact coincides with the beginnings of Celtic movement southeast of the Alps, into the Balkans in hostility with Thracian and Greek peoples (Džino, 2007; Popa & Stoddart, 2014). The end of outside Celtic influence is considered identifiable in the Late Iron Age as regional Roman conquest interrupted communication networks (Drnić & Miletić Čakširan, 2014, p. 197). Western neighbors in what is now North Italy and along the Histrian and Pannonian borders in modern Slovenia have been shown to share material cultural, religious, and linguistic cross over with La Tène Celtic tribes as well (Marchesini & Roncador, 2016; Potrebica & Dizdar, 2014). The dynamism between Celtic neighbors demonstrates a cultural diffusion with Pannonians that is distinctive from some of the Adriatic tribes further south.

Pannonia, in the later Roman Period use of the term, specifically refers to the Roman Empire Province bordered on the north of the Adriatic hinterland by the Danube River in what is modern day Hungary and over much of continental Croatia into a part of western Serbia (Šašel Kos, 2011). The region then extends south to border with Roman Dalmatia and Moesia in modern north Bosnia and Herzegovina. To the west, Pannonia continued into modern Austria, Slovenia, and the Province's south-westerly delineation follows the natural barrier of the Dinaric Alps east of the Adriatic that separates the coast from the hinterland (Pliny, 1942). Established around 20 CE, Pannonia would eventually be split into Superior and Inferior Pannonia, and then again into four regions in the late 3rd century, though the entire area before and after Roman influence is referenced as Pannonia.

Japodes

The Japodes (also written Iapodes and sometimes incorrectly Iapydes), controlled the Adriatic coast in the north just short of Istria and bordered the Liburnians in the southwest by the river Zrmanja (Suić, 1990). Spanning across the Velebit Mountain range, they extended east through what is northern Bosnia/ Herzegovina bordering the Pannonians to the northeast (Drechsler-Bižić, 1987; Wilkes, 1995, p. 57). The Japodes are referred to as having "mixed affinities" with Pannonians, Celts, and Illyrians (Wilkes, 1995). The various influences from their neighbors even contribute to differences within Japodian communities. The Lika (western) and Una River (eastern) Japodes have been found to have material culture differences, such that the Lika Japodes have been characterized as having a "special character that set them apart" (Marić, 2002, p. 293;

Olujić, 2007). This is thought to be due to Pannonian influence and an influx of Pannonian migrations around 500 BCE, however material culture also demonstrate far reaching trade networks from the Baltics to Greece (Cesarik & Kramberger, 2018; Drechsler-Bižić, 1987; Marić, 2002; Zavodny, 2020). However, between 500-360 BCE there was a notable reduction in differences, with a blending of indigenous and western Pannonian elements (Marić, 2002, p. 300). By the 5th century, burials in the east are said to have a strong Lika (western) Japodian influence that lasts through the Roman period (Wilkes, 1995, p. 57). They also similarly practiced extended inhumations and burials in urns up to the Roman period (Bakarić, 1986; Balen-Letunić, 1999; Zavodny, 2022). After the Pannonian migrations, the Japodian material culture then is characterized as having major elements from western Pannonian and an Urnfield cultural impact, with minor elements from Histria and Liburnia (Cvitkovič, 2016; Marić, 2002). During the Iron Age, Roman Period transition, people in this area were already connected widely to the outside world before coming under the Roman Empire as has been shown through coinage from Carthage, Sicily, Southern Italic communities, Macedon, and Hellenistic Egypt (Cesarik & Kramberger, 2018).

These temporal changes and cultural complexities have made Japodian ethnic identity a topic of debate, particularly since Strabo discussed them and others as Celtic, Illyrian, or an ethnic mix of both with local inhabitants (Džino, 2008b; Olujić, 2007; Strabo, 1932b; Zavodny, 2020). However, arguments suggesting that Japodes were not their own group have largely been dismissed, finding Japodian cultural traditions influenced strongly by neighboring Pannonians, but not "Celtic or other, potentially a mix that itself is a separate cultural complex" (Olujić, 2007, p. 185). In scholarship they are not considered ethnically related to the Liburnians, though they overlap with them geographically and culturally (Blečić Kavur & Podrug, 2014; Šašel Kos, 2013).

Delmatae

The Delmatae inhabited the region where Liburnia ended, at the city of Scardona (modern Skradin near Šibenik), south of the Krka river (Pliny, 1942). Their territory extended beyond the Dinaric Alps into the hinterland of modern-day Bosnia and Herzegovina, reaching south through the karst Popovo Polje (fields) to the Neretva River, which flows through Mostar (Čović, 1987). The Roman Province of Dalmatia, like Pannonia, derived its name from its association with the people, in this case, the Delmatae of the southern Adriatic. It is worth noting that the Delmatae are sometimes referred to as Illyrian, and the region of Dalmatia includes areas where both Liburnians and Illyrians lived (Wilkes, 1969).

The Delmatae are often discussed in plural as they constituted a political alliance composed of various local tribes united to resist regional conflicts (Čače, 2003). They are thought to have been a large Illyrian tribe but became independent right before the Illyrian kingdoms were destroyed (Džino, 2010c, p. 40). In the southern regions, tribes were affected by conflicts among eastern Macedonia, Dardania, and other groups, resulting in shifting political and social interactions which at times resembled federated republics and sometimes kingdoms (Wilkes, 1995, p. 157). After the 2nd and 3rd century BCE, but before Romanization, politization and urbanization spread throughout these regions, passing between them Mediterranean and Greek influence (Džino, 2010c, p. 38).

Culturally they had religious elements attributed to Hellenistic/ Grecian influence and religious symbols which shared similarities with Pannonia, such as the oft discussed similarities to the cult of Silvanus (Cambi, 2013; Džino, 2010c, p. 39; Lulić, 2015; Rendić-Miočević, 1979). Indeed, they are sometimes discussed as ethnically related to the Pannonians in the northeastern hinterland regions (Šašel Kos, 2013). There were nevertheless differences in religious and material culture that set the Delmatae apart from both of their northern neighbors, the Liburnians and Pannonians (Cambi, 2013; Rendić-Miočević, 1979).

After the fall of the Illyrian kingdom, the Delmatae were strengthened and militarily opposed the Romans (Glogović, 2014). They became the "most significant indigenous formation" and Rome's biggest opponent in the region- Romanizing later than almost all other tribes (Džino, 2010c, p. 39). However, this opposition took many forms, including at different times between 78 BCE and 9 CE, paying tribute, raiding Roman strongholds, and allying with anti- Julius Caesar forces during the Roman civil wars (Abdale, 2019; Appian, 2012; Goldsworthy, 2014). In a late show of strength, 12,000 Delmatae fighters were described by Appian as emboldened against Augustus and the Liburnians after capturing the Liburnian town Promona (just east of Skradin) during the late Republican Period (Appian, 2012; Wilkes, 1962). Even so, these battles would end with their loss to Rome and hundreds taken captive (discussed below and in Chapter 7).

Liburnians

The Liburnian people included 14 communities that lived along the Eastern Adriatic coast from the 2nd millennium to the first century CE, between the northern extent of the Velebit Mountain range and the Krka river in the south, west of the Dinaric Alps (Pliny, 1942). They were seafarers, known for their fast-sailing and lightweight ships called pinnaces and biremes (Appian, 2012). The Liburnians are known to have longstanding economic ties throughout the Adriatic, with "Hellenistic" societies, and with their Roman neighbors (Batović, 2005; A. Evans, 2006; Glogović, 2014; Mirosavljević, Rendić-Miočević, & Suić, 1970). Liburnians traded with people throughout the region from the Northwest Balkans to Greece and "Hellenistic" influenced areas during the Iron Age; even Roman coinage started appearing during the 2nd century BCE (Batović, 1974). During the Iron Age, Romans and other outsiders viewed the Liburnians as an Illyrian people, however, onomastic and linguistic differences set them apart from their Illyrian neighbors (Džino, 2010c; Wilkes, 1995, p. 78). Despite the Liburnians' integration in regional trade and numerous shared cultural elements, they are considered geographically, archaeologically (Batović, 2005; Glogović, 2014), and politically (C. Barnett, 2019) differentiated from their neighbors and from Rome.

A key component for this dissertation is that the Liburnians' alliance with the Romans was a departure from the behavior of their neighbors, who continued to resist Roman expansion. Liburnians were, "quite open to Roman influence and collaborated with them even before the organization of provinces," accelerating cultural exchange between the two nations (Kurilić & Serventi, 2015, p. 1). During the Roman Civil War between Julius Caesar and Pompey (49 BCE), Caesar (1955, p. 79) refers to the men of *Iadera* (Iader/ modern Zadar), as, "those devoted supporters of the commonwealth, who were unsurpassed in their constant loyalty." During Augustus' naval engagements in the

Adriatic (31 to 36 CE), they encountered pirates both Liburnian and otherwise (Šašel Kos, 2013). The non-Liburnian pirates were "exterminated" while the Liburnian ones were spared, only having their ships confiscated as they were, "more cooperative than hostile" (Šašel Kos, 2013, p. 190). Additionally, people identified as Liburnian fought for Rome against the Japodes and Delmatae (Appian, 2012; Suić, 1992). The Liburnian's support by Julius Caesar early on and subsequent positive interaction put them in a prime position for Roman influence, culminating in Liburnian *immunitas* (exemption from tribute), and the *colonia* status of the coastal town of Iader around 40 BCE (Mirosavljević et al., 1970; Suić, 1981).

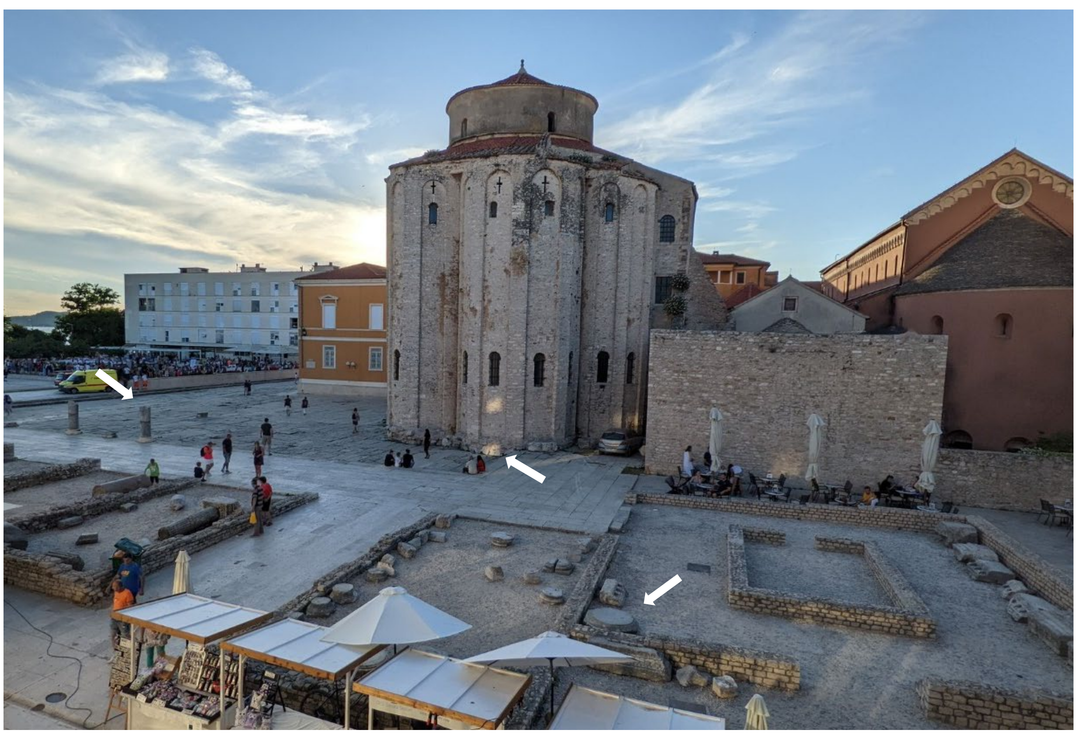

Figure 6 Photograph of Roman forum in modern Zadar, Croatia. Note Roman columns (white arrows) incorporated with later Middle Ages and modern architecture. Photo by author, 2022.

Considering Liburnia's strategic location in the Eastern Adriatic, it is unsurprising that this region has been characterized as "the best Romanized and urbanized area of Dalmatia" (translated from German) (Alföldy, 1963, p. 193). Zadar and Pula to the north were both common retirement areas for Roman veterans around the end of the 1st century BCE. The peninsula in Zadar particularly received extensive Roman style architectural remolding to Roman cultural, political, and religious styles which last to this day (MacMullen, 2000b). During the early years of the Empire, Liburnia was more than just an ally but also a buffer zone, which allowed naval support, making the extension into the hinterland possible and successful (Suić, 1992). This resulted in "essential and fundamental" changes in the region during the 1st century CE (Batović, 1974, p. 243). Local leaders and cities became key to provincial administration and Roman political leadership in the whole region throughout the early Empire, earning Liburnians the rights of Latin citizens (Batović, 1987).

Barnett's 2019 dissertation, *Cultural Integration, Social Change and Identities in Late Iron Age and Roman Liburnia,* in particular integrates various types of evidence (archaeological, mortuary, onomastic, numismatic, epigraphic etc.) to suggest a distinctive Liburnian "character" in the Iron Age. Further, he shows how many, but not all, who would be identified as Liburnian had friendly relations with Rome as these communities gained imperial patronage. Similar to the Histri, the Liburnians were first considered pirates and agitators by the Romans, leading researchers to interpret some Iron Age (c. 360 BCE) and Republican Period (c. 129 BCE) clashes between Romans and pirates/ Illyrians as describing the Liburnians (C. Barnett, 2019, p. 163; Čače, 2013a, p.

21). Although there are other references to Liburnian skirmishes with Roman forces, information confirming an antagonistic relationship between the two has been characterized as "scarce and inconclusive" (Čače, 2013a, p. 24). Barnett (2019) considers the evidence of early conflict, though scant, as one indication of Liburnian ethnic construction because it negates previous explanations of "Liburnian" as merely a Roman political formation (Čače, 2013a). His summation is relevant because it not only supports a regionally understood identity construction, but also highlights how prior interpretation of "Liburnian" as a Roman political entity demonstrates their alliance. Barnett also highlighted how the process of integration was not one-way and called for more regional study to find the nuances in this socio-cultural integration. Liburnian distinctiveness, their openness to the Republic and Empire, and the assets they provided Rome set them apart from the other groups in the region in ways worth exploring further.

THE CONFLICTS

Though Rome came to dominate in the region by sea, they proceeded east by land over the northern connection of Histria, through what is modern Italy to modern Slovenia and Croatia (Petković, 2008; Praga, 1993, p. 16). During the Illyrian wars, the Histri were engaged in numerous seaborne battles with Rome (Campbell, 2016; Šašel Kos, 2013). Then c. 221 BCE Rome invaded the Histri, which was their first land-based strike (Čače, 1989). Rome's reason for intervening in Histria was similar to other places in the region, to counter piracy; however, authors have suggested that Rome did not simply engage for punitive reasons. It is thought that Rome meant to compel the leadership to become a *foedus*, a kind of Roman patronage relationship similar to a patron-client agreement, but without a formal contract (Bandelli, 1981). However, others find the goal was neither annexation nor establishment of a *foedus*, but instead to secure informal allyships amicable to Roman presence in the region as it pressed beyond (Čače, 1989). Nevertheless, the Histri were one of the first to be conquered in 177 BCE after two military campaigns, creating a buffer with Celtic tribes to the north and ingress into the Eastern Adriatic (Džino, 2010c; Šašel Kos, 2013; Wilkes, 1995).

Following the Illyrian Wars (c. 168 BCE) and control of the Histri (c. 177 BCE), Rome rapidly gained influence, facilitating local cultural and economic integration into the Roman and Hellenistic worlds (Čače & Milivojević, 2017; Škegro, 1999). After defeating the Histri, Rome's attention turned to the Japodes, considered well-fortified and skilled in battle (Olujić, 2007; Šarić, 1983). Archaeological evidence has also shown that the Japodes were skilled miners and metal workers with access to those resources and other rare materials like amber through long reaching trade routes (Olujić, 2007; Zavodny, 2020). Roman conflict with the Japodes started in 171 BCE, with an initial defeat in 129 BCE (Džino, 2013). Then they attempted a rebellion, but Augustus conquered "the whole of Japodia … at once" in a single campaign in 35 BCE (Olujić, 2007, p. 122; Wacher, 2013).

The Pannonians, further inland on continental Croatia and Bosnia Herzegovina, were the next obstacle to Roman engagement with Celts to the north and Delmatae to the south. Conflict began in the second and first centuries BCE. Significant imperial forces had to be deployed to the hinterland as Augustus wanted Segestica as a supply base (Džino, 2010b; Šašel Kos, 2013). The Romans were successful in conquering Pannonian

Segestica in 35 BCE and staged a garrison of 25 cohorts (12,000 soldiers) there while continuing on (Šašel Kos, 2013). This, however, did not bring about a sudden end for the inhabitants of this area since the locals continued to be the basis of the population (Drnić & Miletić Čakširan, 2014, p. 199). Nevertheless, the ability for Pannonians to reorganize would end with the Pannonian War (c. 11 BCE) and the *Bellum Batonianum* alongside the Delmatae as Rome would limit future uprisings through relocation of people (Džino, 2012). For example, historians recorded how Tiberius took away Pannonian weapons and sold the youth abroad (Šašel Kos, 2011).

The Delmatae, south of the Liburnians near the modern city of Split, initially fought against Roman allies at the southern Adriatic island of Issa, a main adversary to Rome regionally after the Illyrian Kingdom fell (Culham, 1993; Šašel Kos, 2013). The Delmatae were very resistant to Roman rule, forming local coalitions in opposition to Roman movement throughout the region (Džino, 2012; Džino & Kunić, 2012; Paterculus, 1924). A major battle occurred in 155 BCE when the Roman forces destroyed their capital, Delminium (Šašel Kos, 2013). Over the next century they resisted and were pushed inland by major offensives from Roman commanders engaged in both intra-Roman conflicts and later Augustus's reorganization of the province (Šašel Kos, 2013). These battles culminated in the War of Batos, the *Bellum Batonianum* from 6 to 9 CE (Džino, 2013; Džino & Kunić, 2012; Radman-Livaja & Dizdar, 2010; Šašel Kos, 2011). The reasons for the uprising are numerous. The building and securing of roads and routes through the Sava Valley, specifically from Salona into the interior, contributed to the rebellion (Mommsen & Dickson, 1863; Radman-Livaja & Dizdar, 2010). These road building projects were important to Rome "for the centralization of the state and the civilizing of the subjugated barbarian districts" (Mommsen & Dickson, 1863, p. 404). However, the main reasons were widespread conscription of locals to fight Germanic tribes on the borders, and for the Batos, there was great concern over disruption in their pastoral lifeways (Suić, 1992). Chieftains from the Daesitiatae and the Breuci tribes, Bato the Daesitiate and Bato the Breucian led Pannonians and remnants of Illyrian and Delmatae in a combined revolt against Rome in the War of Batos. Although not all at once, Rome was successful in defeating the Batos' armies, selling many as slaves and deporting them (Alföldy, 1963; Šašel Kos, 2011; Wilkes, 1995).

Resistance to Roman rule in the Adriatic, at least initially, predominated among the different groups with the Liburnians as the sole exception (Suić, 1992). Not only were the Liburnians different from their neighbors in this regard, but they could also be seen as integral to Rome's greater impact on the region as they fought with Romans against the Delmatae (Džino, 2010c; Šašel Kos, 2011; Suić, 1992). As early as Augustus' reign, but into Tiberus' reign, a coastal road between Liburnian Iader in the north, through Asseria, Salona, and down to Nanona was key in defeating the Delmatae uprising and connecting allied forces that were previously linked by sea (Čače, 2008). Additionally, during Rome's battles with the Japodes, Liburnian ships were essential and Džino (2010c, p. 108) describes Rome's success as impossible without Liburnian logistical support.

THE ROMAN ADRIATIC

Following the conflicts with local tribes, Roman political alliances and armies advanced east from newly formed provinces along the Adriatic, including the province of

Illyricum (27 BCE), which would be separated into Pannonia in the north, between the Sava and Drava rivers, and Dalmatia in the south (c. 70 CE) (Praga, 1993). During the Roman Empire, much of the Balkan peninsula, including the Pannonian and Dalmatian Provinces, would reside within the much larger Prefecture of Illyricum, reusing the name of the previous province (c. 375 CE). This territory extended to modern Slovenia in the north, Serbia in the east, and Greece in the south, shaping much of the shared regional cultural history throughout the Roman Empire and is still evident today. The provincial societies that would emerge along the Adriatic over the next four centuries were constructed by Rome's imperial advancement. However, even after 200 years of Roman military intervention, daily life did not make an immediate shift because of the way Roman authority was implemented, as discussed in the next section. The result, however, was a gradual, but forceful Roman military dominance that allowed indirect influence of the Roman Empire through local actors (Džino, 2013).

Local Romanization

Romanization in the Adriatic, though specific to its own situations, shares similarities with other Roman provinces. As with Roman Britain, Roman influence in the region was felt long before large scale violence (Millett, 1995). In Roman Britain, local elites were the conduit through which political power transpired (see Strabo, 1932b). Babić (2005, p. 80) discusses how in the central hinterland kinship status was displayed through objects of authority as leadership and lineal descent were intertwined. Similarly, in the Eastern Adriatic and hinterland, political and social organizations based on ancestral lineages and kinship systems united into larger fraternities/ broader communities with shared social, economic, and spiritual spheres (Benac, 1987a, p. 740). They were granted self-governance under the sovereignty of Rome, with management by native rulers configured according to ancient tribal administrative organization (Alföldy, 1963, p. 195; Praga, 1993, p. 18).

Figure 7 Map shows the Roman Province of Illyricum, 1st century CE, with reference to pre-Roman peoples in Dalmatia, Pannonia, and Liburnia. Notice reference to the “Illyricans” (Illyrians) in the south near Macedon. *Map of Illyricum* was published in 1780 CE by an unknown author and is in the public domain at Wikimedia Commons.

Rome’s system of indirect local governance allowed it to politically and economically exploit conquered regions from afar (Shpuza, 2013; Škegro, 1999). A patron-client relationship was a hierarchical but mutually beneficial symbiotic relationship between local leaders and the Roman center of power. Roman custom required that there be a "proactive basis to the relationship with [its] client" (Mattingly, 2013, p. 80). Patronage started during the Republic, but in the early Empire, emperors and Roman elites cultivated patron-client relationships with foreign leaders in conquered lands (Goldsworthy, 2014). Giving gifts to and staying in favor with Rome and Roman patrons could secure local leaders' positions (Goldsworthy, 2014). Even after relenting regional power to Rome in the Adriatic and hinterland, in-fighting over territory still occurred and local communities were conscripted against new leaders that were out of favor (Petković, 2008). As such, local elites who were instated by Rome took advantage of their alliance to settle pre-existing local disputes, as some scholars interpret (Džino, 2012). Rome was aware of these inter-regional rivalries and the cooperative or disputed trade networks they affected. Therefore, local leaders were ideal vehicles through which Rome could influence a locality as authority was already generally centralized. This was part of Rome's strategy, allowing independence while cultivating economic and social integration that made the inhabitants reliant on the alliance. This move successfully reconfigured civic identity and foreign policy prerogatives to meet Rome's ideals, while permitting local autonomy (Burton, 2019, p. 18; Potrebica & Dizdar, 2014).

New Romans

Despite established variations among the local responses to Rome, the outcomes for the descendants of the Eastern Adriatic and hinterland were the same (Breeze, 2011; Gardner, 2019; Janković & Bandović, 2014; Janković, Mihajlović, & Babić, 2014; Vranić, 2013). During the 1st and 2nd centuries CE, inhabitants of the Adriatic were under an administrative structure which granted them *peregrine civitates* or "foreign" citizenship until 212 CE when all free individuals became full citizens (Džino, 2014b; Mesihović, 2011). By the end of the Empire c. 5th century CE, the Eastern Adriatic and hinterland was Roman.

Figure 8 The Prefecture of Illyricum, 318- 379 CE during the Roman Empire. The image is from Wikimedia Commons and is in the public domain.

Since Medieval and Renaissance intellectual traditions invigorated classical engagement, the final shape or character of the last pre-Slavic peoples is framed as predominately Roman (Gudelj, 2017). Scholarship refers to the peoples of this time period as such with little discussion of ancestral origins except when debating whether the last remnants were incorporated into immigrating Slavic peoples (Curta, 2010; Džino, 2021). After the Romans "succeeded in subduing Illyricum and pacifying Thrace" (13 to 9 BCE), the historical events of the region are predominately discussed as being between the Romans and outside groups (e.g., Huns) (Gavrilović Vitas, 2021, p. 8). In discussion on early Avar, Slavic, and other settlements in the Adriatic and hinterland around 600 CE, the incoming populations are said to have settled in mostly abandoned "native Roman" sites and hilltops and previous "Roman soil", following the dissolution of the Roman frontier (Curta, 2010). Modern relationships, cultural and otherwise, to the Roman and indigenous people of the Eastern Adriatic have their own scholarly debates (Jovanović, 2017), which will not be discussed here. However, acknowledging these discussions is relevant because modern identification with local ancient roots, particularly between the coastal port cities from Pula to Split, has relied on narratives in Greek and Roman histories, not native ones (Jovanović, 2017).

The discontinuity of the pre-Roman tribes is attributed to Romanization which is presumed to have resulted in their total assimilation (Rendić-Miočević, 2002). Appian (2012, p. 437) wrote how Augustus "subjugated others that had been independent from the beginning" and in this act "mastered all the tribes that inhabit the summits of the Alps, barbarous and warlike peoples". Drawing from Greek and Roman historians who recorded the pre-Roman cultural groups, they are understood to have been "vollstandig aufgelost" or "completely resolved" at the beginning of the Empire due to urbanization and Romanization (Alföldy, 1963, p. 195). The impact was so complete that terms such as "collapse," "assimilated in toto" (total), and "erased" are frequently used throughout the literature (Džino, 2021; Jovanović, 2017; Rendić-Miočević, 2002).

Nevertheless, there is evidence that Roman and indigenous identities were represented in parallel by Roman Adriatic descendants (Džino, 2010a; Tonc et al., 2013). Džino (2010a, 2010c, 2014b) describes identity construction during this time as hybrid, recombining, and merging of indigenous and outside. This is demonstrated well in funerary inscriptions of soldiers whose Roman names are identified in Latin, as well as their ancestral communities in Dalmatia (Džino, 2010b, 2010a). With Roman influence, social organization would change, however, and people are described as identifying with their "imperially constructed identities" (Džino, 2010b). Still, material culture within the Roman state combined local objects with those imported, creating a local yet Roman provincial material culture (Drnić & Miletić Čakširan, 2014, p. 199).

SUMMARY

This chapter provides historical background on the pre-Roman inhabitants of the Eastern Adriatic and hinterland regions, including the Illyrians, Delmatae, Histri, Japodes, Pannonians and Liburnians. It describes how the Romans gradually conquered these groups between the 3rd century BCE and the early 1st century CE through a series of wars. The Liburnians were unique in allying early with Rome against other local tribes. While Adriatic and hinterland indigenous sentiment is difficult to characterize since much of the written history was penned by Romans, there is a clear history of resistance followed by capitulation (Bradley, 2004; Dench, 1995; Džino & Kunić, 2018;

Olujić, 1999; Pyy, 2018; Šašel Kos, 2011). The long periods of conflict with Rome resulted in new alliances between local groups that nevertheless ended in concessions of land and power (Džino, 2012; Džino & Kunić, 2012; Paterculus, 1924). Rome instated local leaders, broke up new rebellious alliances, and punished dissenters with conscription and enslavement. This turmoil affected movement and relationships between locals in addition to disruptions caused by displacement during rebellions and new allyship with neighbors.

Nevertheless, the populations underwent a gradual process of Romanization, incorporating Roman culture, names, citizenship, and identities, though local culture persisted for a time. Local elites were used to indirectly govern the region allowing Rome to influence and exploit the area while permitting some autonomy. The inhabitants of the late Roman period came from many backgrounds. While they included descendants of original inhabitants, they were not necessarily living in the same exact locations as their ancestral homelands. After Romanization, the lands were divided into provinces that for the most part shared ancestral geographic boundaries, Pannonia in the north and Dalmatia in the south.

By the late Roman period in the 5th century CE, the transformation of the Eastern Adriatic resulted in a prevailing perception of the entire region as Roman, limiting our understanding about native identities. Evidence shows some dual indigenous and Roman identities, yet population movement dynamics directly related to conflict, punishment, and rebellion creates difficulties in distinguishing local populations. Last, provincial and prefectorial identifiers were derived from pre-Roman cultural terminology, contributing to confusion for archaeological association among different peoples. These components add complexity to the interplay between Roman and native, which is key to understanding Romanization in the Eastern Adriatic and hinterland.

CHAPTER 3 THEORETICAL AND HISTORICAL BACKGROUND

To appreciate the extensive influence of Romanization and its lasting impact on the Eastern Adriatic, further exploration of this transformative process is crucial. By examining the complexities of Romanization, one can gain valuable insights into the dynamics of cultural assimilation. This chapter reviews how imperialism and Romanization are understood in Roman scholarship. It also provides a review of the debates about Romanization as these are key to the questions researchers find relevant.

IMPERIALISM AND EMPIRE

To understand Romanization, one must first consider imperialism, the power that enables the changes implied in the name. Imperialism, both in word and concept, were given life by the Roman Empire or *imperium*. The lasting effects of Roman imperialism, including language, money, law, art, customs, religion etc. survive to this day (Gortan, Vratović, & IJsewijn, 1971; Hingley, Webster, & Cooper, 1996). *Imperium* means "power" in Latin and was the root form for numerous magisterial positions, or *imperatores*, describing those possessing power (Morrison, 2001; Woolf, 2021a, p. 313). Empire, though used in many ways, refers back to a focus on the power, rule, or an expansive polity like the state (Morrison, 2001, pp. 2–3). *Imperium* was originally understood as a power possessed by the Roman people, however, by the turn of the millennium, the term was adapted to describe the ruler of the collective Roman space- the Roman emperor (Burton, 2019, p. 10). Imperialism is therefore the power exerted by the *imperium*, referring to both the "process and attitudes by which an empire is established and maintained" (Mattingly, 2013, p. 6). Early studies of imperialism focused on economically motivated enterprises of an Empire, which contributed to later interpretations of Romanization (P. Freeman, 1997b). The Roman Empire, the exemplar of imperialism, was a geopolitical manifestation of "relationships of control imposed by a state on the sovereignty of others," enabling rule over wide territories with or without consent (Mattingly, 2013, p. 6). These formal or informal imbalances, in which one state controls the effective political sovereignty of another political society, "can be achieved by force, by political collaboration, by economic, social, or cultural dependence" and are ultimately for the establishment and maintenance of power (Doyle, 1986, p. 45; Zevin, 1972). While colonialism and imperialism are not interchangeable and can mean different things, the Roman Empire engaged in both simultaneously, making them interrelated and part of the same process. Edward Said provided this distinction:

> [I]mperialism" means the practice, the theory, and the attitudes of a dominating metropolitan center ruling a distant territory; "colonialism," which is almost always a consequence of imperialism, is the implanting of settlements on distant territory.
>
> Said, 1994, p. 9

In the case of Rome, colonialism was the on-the-ground act of domination, while imperialism was the over-riding momentum of Empire building (J. Webster, 1996). While colonialism continues to be a subject of scholarly interest, the primary way imperialism is discussed in Roman studies is through the concept of Romanization.

Romanization Studies

Scholarly engagement with Roman studies has a longstanding history, with notable and detailed works such as *The History of the Decline and Fall of the Roman*

Empire, published in six volumes between 1776 and 1788, by Edward Gibbon (1737 to 1794), an English historian and politician. However, the term Romanization was first used by Theodor Mommsen (1817 to 1903) and translated by Rev. William Dickson (1745 to 1804) in *History of Rome* (Mommsen & Dickson, 1863). Technically, "Romanization" is the conversion of text from a different writing system to one which uses a Roman/ Latin script ("Romanization," 2023). Romanizing, not specifically about language, was first used to refer to Celtic inhabitants that were brought into the Roman war fleet, such as in Mommsen's statement, "Gracchus first distinctly developed the idea of colonizing, or in other word, of Romanizing, the provinces of the Roman state by Italian emigration…" (Mommsen & Dickson, 1863, pp. 240, 422). Later, Francis Haverfield (1860 to 1919) discussed Romanization in a talk in 1905 which he developed into the book *The Romanization of Roman Britain* (Haverfield, 1915). Haverfield used the term in a way that one might now refer to as acculturation and focused on cultural influence permeating society through elites (Çağlar, 2011; P. Freeman, 1997a; Mattingly, 2013; J. Webster, 2001). Robin George Collingwood (22 February 1889– 9 January 1943) was an early critic of a one-sided interpretation of Romanization and introduced a focus on cultural hybridity, in this case among Celtic La Tène, Germanic peoples, and Romans (Çağlar, 2011; Collingwood & Myres, 1936). Collingwood came to this conclusion by observing Romano-British material culture displaying what he considered a fusion of these two cultures and thus becoming something new: not simply one culture adopting another, in other words an ethnogenesis (Collingwood & Myres, 1936). Despite being a critic of Haverfield, like Haverfield, Collingwood, his contemporaries, and notable early Roman scholars such as Ronald Syme (1903 to 1989), still focused on elites, a practice that is now uniformly criticized (Çağlar, 2011; Mattingly, 2013). However, the early study of Romanization focused on the diffusion of Roman art, language, values, and material culture to the "frontiers" and "barbarians," "civilizing" much of Europe and planting the seed for western society.

Ancient Roman writers, perhaps aware of negative perceptions of Roman aspirations, "justified war" and positioned itself as a "world conquering force even before the Empire was in full swing" (Woolf, 2001, p. 319). Defense and pre-emptive movements were taken to "uphold our imperium" (Cicero, 1913, 2.26–27). Early modern historians would take these explanations at face value, even as exemplary, finding imperial validation in ancient texts. They defended Roman imperialism as moderate and "no harsher than necessary" by referencing ancient author's appeals that Rome, "rather than inflicting harm, [our] wars were waged on behalf of allies" (Cicero, 1913, 2.26–27; Frank, 1914; W. V. Harris, 1985). Frank (1914), described Rome as acting in defensive postures bringing stability, justice, good faith, peace, and "rules of equitable dealing which are observed by well-balanced individuals" (Frank, 1914, p. 10). He and others saw Rome as a "civilizing" force. Haverfield (1915, pp. 9–10) described Roman Imperial conquest as "an epoch of growth" where "the men of the Empire wrought for the betterment and the happiness of the world". Rome was held up as a model Empire (Alcock, D'Altroy, Morrison, & Sinopoli, 2001), whose work was to make "mankind civilized" (Haverfield, 1915, p. 10).

Many of the early modern portrayals of Roman Imperial power can be contextualized by the politics of the eras of their authors, in which their own imperial nations were judged as noble, corrupt, or otherwise (P. Freeman, 1997b; Van Oyen, 2015). For example, the United Kingdom and its global influence were compared to that of Rome (Cagnat, 1892); a viewpoint that was later described as an apologetic "defensive imperialism" (Vance, 2011). Admiration of Rome shaped, among others, British colonial policies and Mussolini's vision for fascist Italy (P. Freeman, 1997b; Mattingly, 2013, p. 10; Moreland, 2001, p. 395; Painter, 2005). Particularly between the 18th - 19th centuries, colonialism was celebrated and studied to be emulated (Van Dommelen, 1997). Historians and anthropologists alike attempted to explain why a "master race" like Rome could fall, blaming the subsequent "Dark Ages" on the loss of this civilizing force (Nilsson, 1921). Some even lamented its fall as the result of mixing with "barbarians" and "the lesser races" (Gibbon, 1776, p. 66). In popular thought and some scholarly media, Rome has been Romanticized as a positive force which modernized the world; notions which were common but not limited to the 19th century (Brunt, 1965; Burton, 2011; Hingley et al., 1996; Isaac, 1990; Khan, 2017; Patel, 2018). These ideas about Rome can range from tepid suggestions to find inspiration in Rome's reign to more forceful pronunciations for modern emulation. For example, Breeze (2011) finds the heart of Roman ideology to be about creating a united land with a united law, an aspiration that Breeze found should be welcomed in a united Europe and a source of inspiration.

Views of Rome therefore play a role in interpretations of Roman and native actions, their motivations, and outcomes. The Roman Republic and Empire's reach and influence extended over hundreds of years and as far as Asia (Kim, Lieu, & McLaughlin, 2021). Early investigations into Roman imperialism attempted to understand the reasons behind Rome's expansion beyond the confines of the middle and southern Italian peninsula, that itself underwent a lengthy unification process. The inquiry created a collective scholarly struggle aimed at establishing consensus regarding the presumed intentions of Roman leadership. Consequently, this ignited debate over Roman imperial advance and whether it was a deliberate and purposeful establishment of a uniform and hierarchical empire or not (Mattingly, 2004; Terrenato, 2008; Van Oyen, 2015). The historical significance of this debate lies in the fact that some viewed the potentially orchestrated cultural transformation as a model for progress (Forcey, 1997).

Roman Imperial Motivations

A key component to the Romanization controversy is whether or not, with foresight, "Rome deliberately and directly promoted Romanization" (Hanson, 1997, p. 76). In academic literature, many have subscribed to the idea that use of terms like Romanization and imperialism, imply "the execution of a deliberate policy" (Syme, 1988, p. 64). Embedded in this argument is the understanding that land, domination, glory, and economics were motivating factors (Garnsey & Whittaker, 1979). When considered closely, premeditated calculation versus execution of power and force are really separate attributions which some authors differentiate (Badian, 1968, pp. 7–19). Badian (1968, pp. 18–20) for example, calls an economic motive for Roman expansion a "myth" born from a “generation nourished on Marx”, but nevertheless characterizes Roman policy as openly aggressive hegemonial imperialism. According to Mattingly (1997, p. 17), Roman elite goals were ad hoc, not long-term plans; yet they were also vain, about ambition, and short term gains in reputation.

It is now accepted in scholarship that for all its similarities, the expansion of Rome’s empire was not characterized by a systematic or centralized approach; rather, it unfolded in different ways depending on local circumstances (Mattingly, 2013; Woolf, 1998). Additionally, elite Roman families had their own aims, not all beneficial for the core residents of Rome the city, or the Republic/ Empire (Galasso, 2012). There was no single Roman imperialism or homogenous Roman civilization to spread (MacMullen, 2000a; Mattingly, 2013; Morley, 2010; Woolf, 1998). Nevertheless, organized entities existed in service of territorial expansion. These were motivated by political and economic strategic planning that was bound up in a structure that emphasized military service (Brunt, 1965; Millett, 1992; Morley, 2010). Further martial motives were defense, fear, and glory, evidenced by Rome’s continual preparation for and investment in war, intervention, and conquest (Brunt, 1965; Cornwell, 2019; De Mola, 2012; Džino, 2013, 2014a; Galasso, 2012; Mattingly, 2013; Schumpeter, 1951). Motives like these are exemplified in the words of Velleius Paterculus, an ancient Roman historian and soldier during the end of the Republic who remarked, “Dalmatia, in rebellion for one hundred and twenty years, was pacified to the extent of definitely recognizing the sovereignty of Rome” (Paterculus, 1924). Augustus told the Senate, as recorded by Appian, that he freed Italy from “savage tribes” (transl.) who raided it (Appian, 2012). Whether or not the

Roman Empire, which grew out of the internal civil wars of the Republic, turned to aspirations of world domination is not a prerequisite for recognition of the motivations that kept it going. While not considered primary goals, economics and resource acquisition were important as annexation of land, confiscation of property, and exploitation of resources were also active components of Roman imperialism (Garnsey & Whittaker, 1979; Mattingly, 2013; Škegro, 1999; Van Oyen, 2020). Various factors such as economics, social status, influence, personal vendettas, and available resources were valid motives for separate events, often scalar and changing depending on elites' intentions and civil conflict. However, when it comes to the broader scope of ancient Rome's thousand-year history, it is difficult to attribute a single, overarching, purposeful, organized, and premeditated motive. Nevertheless, it is also evident that the persistent motivation of war and defense were formidable influences in both the creation and continuation of the Provinces. Martial motivations, premeditated or otherwise, would have an enormous impact on the relationships between Romans and natives in the Eastern Adriatic and hinterland.

The Debate, Roman and Native

Scholarly literature in ethnicity studies has investigated the phenomenon of "culture contact" between two groups through various models such as "acculturation" and "assimilation;" sometimes incorporating a third model of diffusion (Herskovits, 1938; Jones, 2002; Slofstra, 1983). In both acculturation and diffusion, each describes aspects of the process of transmission of culture from one group to another, whereas assimilation is the outcome of two groups achieving cultural synthesis or unity, often imposed by the dominant power (Herskovits, 1938). Romanization and Roman cultural exchange approaches apply all three models in varying degrees. Nevertheless, all incorporate a fundamental assumption that transmission of cultural traits or customs is heightened by interactions between groups, particularly during conflict (Agarwal & Glencross, 2011; Barth, 1969; Derks & Roymans, 2009; Jones, 2002; Mac Sweeney, 2009). As such, conflicts are a common path to understanding cultural change. As Romanization is tied closely to imperialism, much of the study of Roman cultural exchange has emphasized the military aspects of the Empire, male elites and soldiers, and reflections of power such as riches, war, and sex (P. Freeman, 1997b; Jones, 2002; Revell, 2010). Consequently, the interactions between Romans and natives have been presented as clashes between groups perceived as internally homogeneous and externally bounded, with little focus on the natives (Van Dommelen, 1997, p. 308). Analyses of Romanization have therefore been unilateral dialogues (Mattingly, 1997, p. 9).

With the rise of post-colonial archaeology and post-processualism, there was greater attention on non-elites, women, and children (Funari & GarraffFoni, 2018; Revell, 2010). This was initiated by *La résistance africaine à la romanization,* an exploration of resistance common in French post-modernist literature, revealing parallels between modern colonialism and Roman subjugation (Bénabou, 1976). Cultural influence was found to be mischaracterized as disproportionate (Wells, 2001). In response, many redirected scholarly focus "from centre to periphery, from Romans to Natives, from empire to resistance, from emperors to slaves, from city to countryside… etc." (Versluys, 2014, pp. 2–3). Post-colonial and nativist approaches competed with the modernist colonial approaches of Mommsen, Haverfield and others (C. Barnett, 2019; Forcey, 1997; Hingley et al., 1996; J. Webster, 2001). New ways of discussing Roman imperial culture exchange would emerge, including non-interventionist models (native elite proliferation), discrepant identity assessment (non-uniformity in participation), imperialism as colonialism, and discussion of agency and resistance (Alcock, 1997; Budja, 2010; Hingley, 1997; Joyce & Lopiparo, 2005; Mattingly, 1997, 2004; Millett, 1990; J. Webster, 1997). There were neo-imperialists who "extol" Rome and post-colonialists who "denigrate" it (Mattingly, 2004).

Eventually, discussion of Romanization in this way was also critiqued as reducing the question of cultural identity to a simple binary opposition between Roman and native, relying on the very dichotomy it was condemning (Barrett, 1997, pp. 51–64; Forcey, 1997, p. 17; Mattingly, 2004, p. 6; Woolf, 1997, 2021b, p. 21). Early on, Romanization was criticized as an essentialist and de-historicizing comedy of errors (Forcey, 1997). Yet later critics would characterize post-colonial discussions as also unsuccessful and merely anti-colonial (Hodos, 2014; Versluys, 2014). The emphasis on power imbalance was criticized for neglecting the agency of Romanized peoples caught in these dynamics (Revell, 2010; Van Oyen, 2015). Even early nativist views, those focused on native engagement, centered elites as the objects of native emulation (Millett, 1992). Writers highly critical of "reactive" post-colonialists dismissed their approaches as exploitative abstractions of Roman interventions, pointing to the openness of some inhabitants and the benefits they received in trade, technology, and growth (Versluys, 2014). If Romanization was likened to colonialism, an unequal exchange of cultural influence

(Herskovits, 1938; Slofstra, 1983), then such a generalization painted Romans with the broad-brush writers were trying to avoid (Woolf, 2014). The dualistic debate between Roman conquest as one which accommodated acculturation (magnanimously or not) versus one that forced assimilation would need to develop beyond explaining culture change through extremes (Barrett, 1997; De Mola, 2012; Haeussler, 2013; Hingley, 2014; Revell, 2010; Versluys, 2014; Woolf, 1997, 2014).

The debate picked up in the early 2000's when Romanization, the concept and even the very word, were considered so muddled that they must be broken, a redundant paradigm, an obstacle with a top-down perspective (Mattingly, 2004; Mihajlović, 2012). By some authors' assessments, Romanization was too grand a theory, a totalizing narrative, which attempts to answer "every question and the ultimate cause of all major changes" that could not be true everywhere all the time (Versluys, 2014; Woolf, 2021b, p. 21). It had been reified into something resembling an extra-historical force influencing people and things, a term that should be abandoned (Woolf, 1998, 2021b, p. 19). In a scathing rebuke of the state of Romanization studies, Versluys (2014, p. 3) condemns, "[p]rofiting, although indirectly, from the intellectual space created by postmodernism and its deconstruction of grand narratives." Versluys (2014) called for a refocusing on globalization, material culture, and cultural connectivity, with less emphasis on colonialism and power. Romanization was argued as more than conflict, competition, or interaction between two cultures, instead resulting in new forms, for both Romans and natives (Woolf, 1997, p. 341). This opened discussion of composite cultural entities and constellations of identities, not replacement of one culture with another (Terrenato, 1998, p. 23).

Post-modernist scholars remained interested in inequities, highlighting many of the same concerns as post-Romanizationists, noting that Roman studies have been moving away from static models towards “volatile balances of power… recognized for their fuzzy edges” (Stek, 2014, 37). Intensive state “precoordinated urban influence” had long been discarded (Roselaar, 2017). Deconstructive post-colonial approaches were combined with globalizing relations and the study of power relations, colonialism, and domination (Czajkowski & Eckhardt, 2018; Haeussler, 2013; Hingley, 2005; Hodos, 2014; Jenkins, 1994; Lawson & Tiffin, 2002; Van Dommelen, 1997; Van Dommelen & Rowlands, 2012; Versluys, 2014; J. Webster, 1996). Global and local dynamics were explored through concepts like hybridity (Ashcroft, Griffiths, & Tiffin, 2013; Tronchetti & Van Dommelen, 2005), creolization (J. Webster, 2001), queer theory (A. J. Barnett, 2012) and Mediterraneanization (Morris, 2003). The ambiguous nature of colonial situations were negotiated by recognition that imposition of a “structure of political domination and economic exploitation” can also be “dissolved in other domains” (Van Dommelen, 1997, p. 320). Van Dommelen (1997, p. 320) argued that, “the very co-presence and daily interaction of people living in the colonial situation, seen through hybridity”, dispels the “colonizers versus colonized dichotomy.” Additionally, major progress has been made in exploring the lives of non-elites, women, and children, urging more scholarly attention to the complex, fluid, and locally specific (Cornwell & Woolf, 2022; Revell, 2010).

The history of the critiques of Romanization are widely known, and research handles Romanization with recognition that it is not merely a colonized/ colonizer dichotomy (Killgrove, 2005, p. 62, 2017). Many scholars now prioritize approaches that go beyond mere Roman influence, recognizing that culture change encompasses a multidirectional cultural dynamic, co-created with the provinces (Alcock, 1997; Hingley et al., 1996; Killgrove, 2017; Munzi, 2001; Wallace-Hadrill, 2008; Wells, 2001; Woolf, 1998). Local identity, though existing within the *imperium,* was negotiated and redefined.

Romanization and early foundational literature were born during a time when scientific racism was writing its justifications into scholarship and literary interpretations. The Romanization debate is a child of this history and mired by its legacy. Perhaps critiques of "Romanization" which assert it depicts all Romans with explicit and conscious awareness of long-term imperial goals are rooted in concerns about the morality of imperialism. For example, an early explanation for Roman decisions was defensive imperialism, invoked as a (more palatable) preemptive violence that some could justify repeating (Burton, 2019; Vance, 2011). Western admiration of Rome and the portrayal of Romanization as "civilizing" were then challenged by deconstruction of western settler colonialism's justifications of actions made with this admiration in mind (Moreland, 2001, p. 395; Stek, 2014; Terrenato, 2008; Woolf, 1997, 2001, 2014). Therefore, it is unsurprising that critiques of Romanization were as much about imperial concepts connected to the word as they were about Roman scholarship. Nevertheless, connecting Romanization with determinative theories about Roman intentions, or extrapolation to modern intentions, are not prerequisites for examination of Roman imperialism, making assumptions about the term Romanization antithetical to the intentions of critiques in the first place.

IDENTITY STUDIES

In the Eastern Adriatic and hinterland, unraveling the complexities of Romanization is complicated by determining the identities of Romans and natives. This is partially due to their complex histories, but also due to the ways archaeology studies and identifies peoples. Group affiliation presents its own set of obstacles, demanding a comprehensive and multidisciplinary perspective. This section discusses these challenges for three reasons. First, a key aspect of group identity, ethnicity, or something like ethnicity (tribe, kin group, cultural group etc.), is a primary mode of analysis for many researching ancient populations. Therefore, this section discusses the difficulties inherent in studying group identity especially in that fundamental form, ethnic identity, which like Romanization, has a controversial scholarly history. Second, this study must address the question of how to refer to people, as group self-identifiers are not often found in archaeology. The pros and cons of making any identity attributions are considered and this studies' use of cultural group labels for populations is clarified. Third, an important aspect in the study of ethnic identity and culture is the impact on the physical body and what human remains can tell us about identities. Analysis of human remains for supplementing the enormous but complex historical knowledge has never been undertaken in this region.

Group and Ethnic Identity Studies

At its most basic, identity is the human capacity to know "who's who" and “what’s what” within a system of multidimensional classification and mapping of our human worlds, places, and people within (Jenkins, 2014). Said more succinctly, identity is the way in which individuals and collectives distinguish their social relations with others (Meskell, 2002). Identities are pliable, multiple, and intricately related to issues of power, religion, law, class, and gender, (Agarwal & Glencross, 2011; Barth, 1969; Cohen, 2002; Derks & Roymans, 2009; Díaz-Andreu, García, Lucy, Babić, & Edwards, 2005; Jones, 2002; Meskell, 2002). How people self-define is as important as how people define others “in pursuit of their own self-identification,” as group and the self are negotiated together (M. Chapman, 1993, p. 23). Social realities provide insights into individual identities, and vice versa, even though they are not perfectly aligned.

Ethnicity is defined as “the fact or state of belonging to a social group that has a common national or cultural tradition” (“Oxford,” 2004). The Greek word *ethnos* that makes the prefix of ethnicity is described as something similar to a “swarm” (M. Chapman, 1993). In antique times it was used to define outsiders, and often contrasted with *polis* or the nation state, solidifying in later understandings that the realness of one’s ethnic identity is amplified by its reflection against other’s ethnic identities (Mattingly, 2013, p. 210). Early ethnicity studies were of two approaches, primordialism, where ethnic identities and nationalities were considered fixed, natural, and essential and therefore cannot be changed; and instrumentalism, which saw identities as engineered in different ways, but in opposition to the fixed ideas of primordialism (Kataria, 2018).

Early anthropological description of peoples used typological ethnic group schema (e.g., Childe, 1929; Gorodzov, 1933; Morgan, 1877). They described lineally static groupings and for archaeological populations, made these determinations using pottery style, coinage, or tool assemblages. Both the attempts to classify ethnic identities and the classification of objects were common in early 20th century anthropology's mirroring of biological taxonomy as it tried to superimpose evolution on culture change (Thomas, 1982). Termed culture-history/ culture-historical, the typological approach distinguishes peoples in a particularistic manner, where human identities, behavior, and development are understood through patterns in material culture which are taken as representative of cultural norms (Trigger, 2006; G. S. Webster, 2008). Culture-history and the resulting ethnic abstractions are mostly descriptive and imply homogeneity within groups and marked differences with outsiders, becoming key to problematic ideas of essentialism and fixity (Insoll, 2007; Jones, 2002; Vranić, 2014). They have been widely critiqued for misrepresenting the associations between material culture and group identity while also ignoring variability (Barton, 1997). Culture-history models also overlook the negotiation of identity during times of power imbalances, such as colonial disruption, wherein diasporic communities and assimilated conscripts maneuver through multiple identities required for survival (Voss, 2018). Culture-history approaches in areas with complicated migration patterns have difficulties recognizing cultural sharing over permeable boundaries, both political and cultural (Barth, 1969; Zakrzewski, 2011). For example, descriptions of hybrid zones or political borderlands may only recognize people's material diversity as reflections of parental populations rather than appreciating complex material usage during times of turmoil (Bhabha, 1994; Jenkins, 1994, 2014; Slofstra, 1983; Wolpo, 2016). While culture-historical approaches have been challenged for decades, (Binford, 1962; Feinman & Neitzel, 2020; Lyman & O'Brien, 1997; Trigger, 2006; G. S. Webster, 2008), "ethnic labelling" of sites and objects in the culture-historical manner do continue, particularly in classical archaeology (Jones, 2002; G. S. Webster, 2008; Williams, 2001).

Theoretical changes in socio-cultural anthropology during the mid to late 20th century provided new perspectives on identity and ethnic identity for archaeology. Although not without its own issues, the processual "New Archaeology" recognized the flaws in fixed and deterministic past abstractions and applied structuralist approaches which recognized multifaceted systems of culture that influence peoples' decisions and interactions (Hodder & Hutson, 2003; Jenkins, 1994). Barth's (1969) influential book *Ethnic Groups and Boundaries* emphasized the transactional nature of ethnic identity, in that it involves both internal and external definitions by actors, actively participating in dialectical boundary maintenance. Identities are constructed and maintained through interaction, therefore people identify with broader groups on the basis of differences socially sanctioned as significant or relevant (Barth, 1969; Díaz-Andreu et al., 2005). The dynamic aspects of ethnic identity mean that despite individual identity, one's ethnic identity is perceived, constructed, validated, and shaped through interaction with the "other" (Derks & Roymans, 2009). This includes community members that co-create and enforce an identity together and outsiders that make judgements based on real or perceived ethnicities.

Despite growth in group identity studies, post-processual archaeologists criticized processualism for neglecting agency and the intricate role of individual identities in shaping groups (McGuire, 2022; Revell, 2016). Similar to Romanization studies and likely inspiring many of those changes, new approaches to the archaeology of identity include intersectionality theory (Crenshaw, 1990; Spencer-Wood & Trunzo, 2022), feminist theory (Battle-Baptiste, 2011; Revell, 2010; Sterling, 2015; Watkins, 2019), queer theory (Dowson, 2000; Seidman, 1996; Springate, 2020), and transnational perspectives (Brighton, 2009). Chapman (1993) suggested that ethnicity, as it has been studied, had been rooted in the external attribution of differentiation. Meskell (2002) highlighted this by describing group identity studies as seeming to be about the self-definitions of heritage, citizenship, and sameness, but underlying all of these was instead a focus on difference. This is illustrative of the fascination with the "other" that is fundamental to anthropological practice and explored in so many different aspects of the discipline (Blakey, 1991; Marks, 1994; Sarukkai, 1997). Criticism prompted more consideration of past self-identification in the creation of social identities (Hegmon, 2003; Hodder, 2001; Hodder & Hutson, 2003; Meskell, 2002). As such, social identity studies grew to focus on the process of group identity construction more than creating and defining ethnic categories (Barth, 1969; Curta, 2007; Jenkins, 1994; Mac Sweeney, 2009).

The Complexity of Identity and the Body

Modern archaeology acknowledges the limitations of approaches like culture-history; however, researchers are limited to what is preserved in the archaeological record to examine past societies. While there are few unambiguous material identifiers of shared cultural experience or identity, there are shared systems within which people operate.

Theories on interactions between structures and agents (Giddens, 1984), and their material representations offer insights into power dynamics in past societies (Babić, 2005; Gardner, 2002; Hodder, 2001; Meskell, 2001; Shanks & Tilley, 1988; Thomas, 1982). Gardner (2007, pp. 18–19) like Giddens before him, suggests an appreciation of how agency and structure are mutually constitutive, recognizing that actors "deal with the world" through similarity and difference, which then becomes a medium through which the world "acts back" (2007:18). Identity becomes an interplay with the external world through objects, and although we cannot directly observe how people reasoned through that process, we can observe the outcomes of agents and structures acting upon one another. This suggests that boundary identifiers may be recognizable in the archaeological record. These elements are typically not arbitrary and are performed publicly, therefore the use of symbols and style have been key modes of inference in identity studies (see Jones, 2002 for a critical discussion of symbols which incorporates *habitus*) (Jenkins, 2014; Jones, 2002; Robb, 1998). The public nature of many symbols means that they can be informative about both individuals and communities, imagined or otherwise (Curta, 2007; Orizaga, 2013). Returning to Barth's foundational concept (1969), one could argue that if social identity and ethnic identity construction interact in producing distinctions across boundaries, ethnic identity can be an aspect of the self that is expressed materially which can be studied, albeit with the limitations in mind. If cautiously approached, materially ascribed identities can reveal many layers of both actively and passively constructed identities, and can tell us about the categorizers, as objects contextualize interactions (Jenkins, 1994; Revell, 2016, p. 107). Thus, an important goal of archaeological analysis is to consider objects which are crafted by social agents and those acting on behalf of social structures.

While material culture has a place in understanding ethnic identity and identity, human remains may offer a more direct connection to identities experienced by the body. Archaeologists cannot know definitively how individuals would have self-identified and archaeological contexts rarely provide one's own self-description (Casella & Fowler, 2005). Nevertheless, the passive, active, or relational making of identity within the broader structure is "body-mediated," as the body responds to the by-products of the dynamic social fabric (Gowland & Thompson, 2013, p. 175). Humans construct ingroup and outgroup associations in numerous ways, with biology as a fundamental, albeit only one of many contributors to these attitudes (Jenkins, 2014). Social science has demonstrated that humans tend to favor others with whom they know or perceive to have a similar biological background (Masuda & Fu, 2015; Montoya, Horton, & Kirchner, 2008). These biases are not true all the time and are not necessarily true because of perceived ancestral ties. For example, individuals may look more favorably to those that do share their ethnic group, however, in effect the ingroup perception may be more about perceived shared values, upbringing, religion, lifeways etc. Still, in times of crisis and conflict, ingroup and outgroup identities are strengthened, indicating that in part post-conflict relations could be indicative of how parochial exogamy is affected by those with the power to do so (Mijić, 2021; Zárate, Reyna, & Alvarez, 2019). Consequently, the experience of group norms crystallize aspects of our identity as social processes are embodied (Gowland & Thompson, 2013, p. 176). Therefore, bodies are central to identity, whether explicitly decided by the individual or not, making human remains an important piece in the wider goal to understand social change (Gowland & Thompson, 2013, p. 3; J. R. Sofaer, 2006).

However, the body as a way of examining identity is not without its own drawbacks. The various ways groups perceive relatedness and the amorphous nature of ethnic identity have been critiqued for applying heteronormative western constructions to past societies (Brück, 2021; Ensor, 2011; Frieman, 2021) and for inappropriate and prejudicial application (Blakey, 2004; Kakaliouras, 2010; Kanakamedala & Haga, 2012; Kitcher, 1999). A notable facet of biologically related identity is kinship. It was well established in early anthropological ethnographic work that humans construct social organization in the familial sense (kinship) in ways which run counter to unilineal biological gamete descent (Brück, 2021; Frieman, 2021; Holy, 1996). Despite established scholarship finding wide-ranging kin relationships, researchers argue that archaeology and anthropology continue to approach community formation through biologically reproductive monogamous western marriage and family ideas (TallBear, Clarke, & Haraway, 2018). Kin groups are often related to political and other cultural constructions; however, they also may be integral to establishing in and out groups and "principles of exogamy and alliance" (Jenkins, 2014, p. 86). The extent to which local kinship groups contribute to differences between large scale regional relations is difficult to determine without an ethnographic perspective. Nevertheless, these criticisms are important to consider when examining large-scale population changes as these may be tied to alterations in small scale interpersonal traditions and dynamics.

In addition, body linked identities have been superimposed on groups and used for violence. This can be seen best in the colloquial use of the word ethnicity, where it is closely linked to “race” (Agarwal & Glencross, 2011; M. Chapman, 1993; Montagu, 1951). There are numerous examples of co-opting of prescribed racial classifiers being used to discriminate against select populations or to claim racial superiority (Blakey, 1999; Harmon, 2018; Marks, 2017). A racial use of ethnicity highlights how identity encompasses both self-ascribed and externally perceived components, especially biology. Nevertheless, in cases where people have a common perceived identity, knowledge of this background can be important for identifying lived experiences since those with common origins may experience similar biological ramifications as a result of inequality. For example, descendants of enslaved African Americans in the American colonial and post-colonial periods shared higher mortality and morbidity despite living and working in different environments when compared to others (de la Cova, 2014; Franklin & Wilson, 2020). Although ethnicities are socially constructed and not solely based on biological associations, as this example demonstrates, they remain closely linked to the body. Therefore, the practice of assigning identities to human remains and populations can create “tension between the constructivist language that is required by academic correctness” and the foundationalist or essentialist message that results from practicing identity studies in an effective way (Brubaker & Cooper, 2000, p. 29). With these limitations in mind, interpretation of physical remains and past identities requires careful negotiation between the physical, theoretical, and historical.

Identity and ethnic identity are important for understanding how social context is embodied in material culture and human skeletal remains, and for this reason, continue to be key in archaeological research. The combination of group dynamics and physical embodiment leave a lasting mark on the individual whether one is aware of this or not. This has been demonstrated in Roman studies across both the Adriatic and wider Empire. For example, stable isotope analysis of bones and teeth have revealed dietary habits and geographic origins, aiding in reconstruction of individual experiences and population movement (Emery, 2018; Lightfoot et al., 2015; Moles et al., 2022; Prowse, 2016; Sorrentino et al., 2018). Additionally, skeletal pathologies and trauma have provided insights on injuries due to combat, health, and demographic changes (Loewen, Nystrom, & Čelhar, 2021; Prowse, 2011; Šlaus, 2002b; Sperduti et al., 2018). Furthermore, the examination of health disparities and the mortuary environment can provide information of the lived experience of status and class (Gowland, 2017a; Iorio et al., 2022). Mortuary elements are illustrative of what living survivors wish to convey about the dead, and their traditions may be dictated according to spiritual or legal obligations, within structural restrictions of access and means (Pearce & Weekes, 2017; C. A. Roberts, 2017). A volume which provides Roman Period illustrations of all of these approaches is the themed section in *Britannia* on *New Approaches to the Bioarchaeology of Roman Britain* (Gowland, 2017b, 2017a). The articles in this edition demonstrate how bioarchaeological methods identified individuals with African Mediterranean ancestry in Roman Britain, an individual who was gendered as feminine in burial and had a Y chromosome, and evidence of infant death and disease in urban and rural sub-adults (Hodson, 2017;

Redfern, Marshall, Eaton, & Poinar, 2017; Rohnbogner, 2017). As shown, bioarchaeological approaches are important complements to classical studies which assist in remedying some of the limitations each has on its own.

CLASSICS IN THE ADRIATIC

Roman influence on the peoples of the Adriatic region and its hinterland have been subjects of academic and archaeological interest for decades, particularly in the classics. However, Eastern Adriatic non-Roman prehistory has received less attention outside of the region until recently, likely due to an English language bias in western archaeology. Although engagement with the regional history has been lacking, it has increased in recent years. There has nevertheless been a rich history of local scholarship which deserves discussion for an appreciation of previous work and how this research fits with it. Therefore, a few significant figures who played key roles in the identification of cultural groups in the Adriatic and its hinterland and contributed to the Eastern Adriatic's visibility in the field of Roman studies are discussed as this dissertation would not be possible without their foundations.

An early figure in wider Balkan archaeology that produced broadly referenced material was British archaeologist Sir Arthur Evans (1851 to 1941) of Minoan archaeology fame. Evans at one point worked as an intelligence correspondent during the Austro-Hungarian rule in Bosnia and Herzegovina and traveled throughout the region, including Croatia, contributing to his later publications on Illyrian archaeological history (A. Evans, 2006; Wilkes, 1995, pp. 7–8). He would make his mark primarily on Greek and Minoan archaeology, while also influencing Roman and Celtic studies. Another influential archaeologist who wrote on the history of the region for English readers is John Wilkes, (born 1936), with his two works *Dalmatia* and *The Illyrians,* named for the Roman provinces (Wilkes, 1969, 1995). Géza Alföldy (1935 to 2011), a Hungarian historian, was also influential in Roman studies concerning eastern Europe and Pannonia, particularly religious and social history (Alföldy, 1963; Szabó & García, 2022).

Regarding the Adriatic Iron Age, two pivotal figures of prehistoric archaeology stand out, Šime Batović (1927 to 2016) and Slobodan Čače (1946 to 2020). Šime Batović worked as a curator and director at the Archaeological Museum in Zadar and a professor at the University of Zadar. His research contributions began in 1953 and established some of the first Neolithic and Iron Age chronologies, along with the first synthesis of Iron Age cultures of the Eastern Adriatic (Batović, 1965). Batović was instrumental in encouraging empirical standards and integrating prior knowledge. He wrote the first modern syntheses of the Liburnian, Histrian, and Delmatae cultures (Glogović, 2014; Kukoč, 2018, pp. 11–12), and he is considered a pioneer in Croatia prehistoric archaeology, periodization, chronology, development, and processes of cultural change (Kukoč, 2018, p. 14). Slobodan Čače focused on early antiquity and the Liburnian territories, as well on Latin and Greek writings. He was involved in numerous archaeological excavations, was published across classical antiquity, social history, and archaeology, and was involved in the founding of the University of Zadar (Kurilić, 2020). Both researchers' efforts towards empirically driven excavations opened discussion with other ex-Yugoslavian countries and European archaeology (Kukoč, 2018, p. 12). In addition to these influential figures, additional authors of note include Duje Rendić-Miočević, (1935 to 2020), co-author of

Adriatica praehistorica et antiqua, an expert in Greek and Latin epigraphy, onomastics, and numismatics of Illyria (Mirosavljević et al., 1970). Co-author Mate Suić (1915 to 2002), a Croatian historian and archaeologist, was influential and widely cited as well. An important title besides *Adriatica* worth mentioning is *Antički grad na istočnom Jadranu* (Suić, 1976) (*Antique city in the Eastern Adriatic*), on the development of urbanization during prehistory and the Antique Period.

An early contributor to Roman studies was the Croatian archaeologist Rev. Frane Bulić (1846 to 1934) who published major early works on Roman Emperor Diocletian (Bulić & Karaman, 1927; Dukić, 2017). Another prominent scholar of Roman era regional populations was Nenad Cambi (born 1937). Cambi was the Director of the Archaeological Museum in Split, and professor in Humanities and Social Studies at the University of Zadar ("HAZU," n.d.). Contributor to the German book *Kroatien in der Antike* (Sanader, 2007) and member of the Croatian Academy of Sciences and Arts, Cambi's prolific scholarship includes many contributions on Roman Dalmatia and the Emperor Diocletian (245 to 316 CE) (Cambi, 2002, 2016). Cambi's (2002, 2013) discussions, though ultimately about the Roman Antique, consider the pre-Roman indigenous populations and their religious synchronicities with Greek and Roman culture leading up to acculturation and Romanization. Finally, Mirjana Sanader (born 1954) made important contributions to Roman Provincial and Early medieval archaeology, including religion and the Roman military throughout Roman Dalmatia (Sanader, 2006, 2008). Lead editor of the aforementioned book *Kroatien in der Antike* (Sanader, 2007), Sanader's work provides contributions across archaeology and classical studies, as well as spanning prehistory and the antique (Sanader, 2003, 2006, 2007, 2008; Sanader & Bavoljak, 2004).

Even with historical documentation, an abundance of material culture, and the contributions of these scholars, there exist unexplored territories which this thesis applies in building on these ideas. Early archaeology, here and elsewhere, concentrated on identifying archaeological sites, ascribing cultural traditions, and establishing chronologies. Given the divergent historical paths of European archaeology and its American counterpart which has roots in American anthropology, it is unsurprising that the humanities focused practices in Europe have art and language at the fore particularly with classical Mediterranean studies. However, classical studies continue to face challenges related to typological approaches, though this varies across the region (Jones, 2002; G. S. Webster, 2008; Williams, 2001). Research in the Adriatic region and hinterland has had its own trajectory in relationship to, but still distinct from, western European archaeology (Babić, 2014). However, it too has had less engagement with the theories discussed in this dissertation as Eastern European academia negotiates its relationship to western European hegemonies and a history of positivism in archaeology (Babić et al., 2017). Ethnic studies particularly, have been described as evolutionary, in that cultures were labeled as proceeding through sequential ethnic layers (Džino, 2007, p. 60). Moreover, the emergence of biological anthropology and bioarchaeology as valuable tools in Eastern European and Adriatic archaeology has been gradual. Consequently, the persisting limitations of understanding peoples and identities through objects alone, as previously discussed, highlights the benefits of the bioarchaeological methods in this research.

In seeking to engage with regional literature on the native populations and their Romanization, this dissertation uses regional cultural and ethnic naming conventions; however, this does not make it uncomplicated. Scholarly literature in the Adriatic and hinterland have their own history and inner contestations (Novaković, 2011).[4] It also uses cultural naming that would typically be described as typological. Babić (2014) posits that regional inattention to ideas such as identity is perceived by the west as being a lack of interest in theoretical approaches. However, less engagement with what could be termed post-modern ideas which skew less typological may be more about prioritization of insights relevant to local interests (Babić, 2014). Nevertheless, with appreciation of underlying political sensitivities, concerns over archetypal naming schema whether in the present or past, numerous post-Yugoslavian scholars have turned a critical eye towards culture-historical ideas about Roman- local relationships in the region. Late 20th century political issues related to identity, nation, and difference have impacted these concerns, in part due to perceived ancestor-descendent relationships between geographically delimited tribes and modern ethnic groups (Janković, 2014; Vranić, 2014). Bias-laden terminology about pre-Roman "barbarian tribes," which are considered remnants of Roman propaganda, persist though recent attention has been made of the issues with archaeological group identifiers (Mihajlović, 2014). This dissertation draws heavily on Danijel Džino's (born 1971) research which primarily concerns the ancient and early

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[4] See glossary for discussion on the term Balkans.

medieval western and central Balkan peninsula, with a focus on Liburnian, Roman, Dalmatian, and Slavic identity construction.

Džino (2013) discusses that while the naming schema used to describe pre- and post- Iron Age peoples of the Adriatic are imperfect, they do represent shared local experiences. Considered at the time a "radical view," Benac (1987a, p. 737) wrote how "Iron Age Yugoslavian groups" were not ethnic groups, nevertheless dissuaded researchers from making the opposite error, seeing everyone the same.

> S druge strane, mnoge od kultura, odnosno grupa (ili kulturnih grupa) pokazuju daleko veću vlastitu kompaktnost i jedinstvo životnih navika, dalcko veću uniformnost materijalne i duhovne kulture. Zbog toga bi se ove kulture, odnosno grupc, u jednom primarnom (elementarnom) smislu mogle označiti i kao ctničke zajednice, ali samo u okviru gentilnog matrijarhalnog i patrijarhalnog društva. Dakle, u strogo ograničenom vrcmenskom i društveno-ekonom- skom okviru bila bi to neka vrsta primarne etničke zajednice.
>
> On the other hand, many of the cultures, i.e., groups (or cultural groups) show far greater compactness and unity of life habits, far greater uniformity of material and spiritual culture. Therefore, these cultures, i.e., groups, in one primary (elementary) sense could be marked as ethnic communities, but only within a gentile matriarchal and patriarchal society. Thus, in a strictly limited time and socio-economic framework, it would be a kind of primary ethnic community.
>
> Benac, 1987a, p. 737

Cultural groups or "tribes," in Benac's (1987a) estimation, were really local incorporations or fraternities of numerous related communities that while different, shared culture and political relationships. He therefore interpreted Roman historian writings of such groups, mindful that they had Greek *phyle* or tribes in mind, as recognition of peoples who shared both culture and governing (1987a). Therefore, Benac justified framing Adriatic populations in this way even though they were not what archaeologists of his time would traditionally consider tribes or ethnic groups. Larger cultural groups in this area (such as the Pannonians and Illyrians) were dynamic with internal mixed cultures that changed through time, an important consideration when examining lineages (Benac, 1987a; Džino, 2007; Mihajlović, 2014). Even in their larger form, they shared linguistic and spiritual features that suggest local and regional continuity which go back to the Neolithic (Batović, 1978; Benac, 1987a, p. 800; Mathieson et al., 2018; Wilkes, 1995, pp. 67–87).

Bioarchaeology in Croatia

As Adriatic archaeology and classical studies have their own local histories, so too does bioarchaeology. Biological anthropology and subsequently bioarchaeology in Croatia and the former Yugoslavia developed from analyses of the Krapina paleoanthropological remains in the early 1900's (Šlaus, Novak, & Vodanović, 2011). Subsequent research led to the formation of the Croatian Anthropological Society[5], and the journal *Collegium Antropologicum* in 1977 (INANTRO.HR, n.d.; Šlaus et al., 2011). Croatian bioarchaeology is also closely tied to the medico-legal needs brought about by the conflicts resulting from the dissolution of the former Yugoslavia between 1991-1995 (Šlaus et al., 2011; Šlaus & Petaros, 2015). In 1995 a cooperative US–Croatian forensic anthropology project, specialists from the Smithsonian Institution (Washington DC, USA), the University of Knoxville, Tennessee (USA), and the Croatian Academy of Sciences and Arts and the University of Zagreb (Croatia), a forensic database was started to record osteo-biological data from the recovered victims (Šlaus & Petaros, 2015, p. 40).

[5] Anthropology primarily refers to biological anthropology in Croatian sciences.

Under the direction of newly drafted human rights laws and tribunals, forensic archaeology, analyses, and care of human skeletal remains accelerated, growing with the establishment of the Institute for Anthropological Research in 1992 (INANTRO.HR, n.d.). As remains from this and earlier conflicts were increasingly encountered, salvage and forensic archaeology fostered interest in bioarchaeology, and the transferable skills between the two (Novak, 2012; Šlaus, 2002b). Subsequently, regional bioarchaeologists and colleagues have generated extensive academic discussion about prehistoric, Roman, and Medieval Adriatic population's health, origins, subsistence, and environments (Anđelinović, Balić, Kružić, & Bašić, 2010; Anđelinović, Kružić, Škorić, & Bašić, 2015; Freilich et al., 2021; Jerković, Bašić, Kružić, & Anđelinović, 2016; Lightfoot et al., 2015; Loewen et al., 2021; Novak, Šlaus, & Pasarić, 2010; Selak et al., 2022; Šlaus, 2002a, 2002b; Šlaus et al., 2013). Now, bioarchaeologists in Croatia are well prepared in biological anthropology with expertise in archaeological excavation, forensic anthropology, or both. Scholars contributing to the growth of bioarchaeology are employed by various institutions including the Anthropological Centre of the Croatian Academy of Sciences and Arts; the Institute for Anthropological Research; the Department of Archaeology at the University of Zagreb; and the Forensic and Biological Anthropology Laboratory at the University of Split, among others. They actively collaborate outside Croatia and continue with identification of recent human remains, archaeological and biomedical research, and sometimes restoration or conservation of the thousands of individuals in their care.

Despite the significant potential for bioarchaeological research in Croatia, the subfield is still small and developing. In this region and around the Adriatic, biological distance studies, in particular, are uncommon and when done, tend to focus on Medieval and Ottoman histories (Allen, Šlaus, Adamić Hadžić, & von Cramon-Taubadel, 2022; Allen & von Cramon-Taubadel, 2017; Bašić et al., 2015; Boljunčić, 2007; Kopp, 2002; Mikić, 2004; Thorson, 2018; Zupanič-Slavec, 2004), or identification of modern population structure through anthropometrics, serology, and surnames (Janićijević, Papiha, Chaventre, & Roberts, 1994; Roguljić, Rudan, & Rudan, 1997; Rudan, Campbell, & Rudan, 1999; Šimić & Rudan, 1990). The biodistance studies that have centered on Roman and earlier history often use methods other than dental morphology (Mathieson et al., 2018; Michael et al., 2023; Mikić, 1984, 1987; Salamon & Lengyel, 1980). Schaefer et al. (2006) studied dental arch asymmetry on the isolated Adriatic island Hvar. This population has been the subject of numerous studies due to its complex ethnohistory and high amount of endogamy. Others focused on brachycephalization or brain and cranial shape to determine, for example, continuity between Roman Dalmatia and the Middle Ages (Mikić, 1984). Recently, a study applying cranial non-metric analysis in the Late Bronze Age and Early Iron Age Balkans found results consistent with isolation by distance and a gradual process of integration rather than displacement or transformation in the region (Michael et al., 2023). These are the most conspicuous of biological distance studies that exist for the Adriatic coastal region (outside of strictly molecular studies) which are published with English abstracts or widely distributed. Also, the absence of biodistance in the region does not take into account older studies on cranial shape and cephalic type which have their origins in problematic early anthropology (Novaković, 2011). Nevertheless, the summary here represents much of the research of this kind, demonstrating little application of the methodology in this dissertation compared to other Roman studies and bioarchaeology.

Additionally, there are dental biological distance publications addressing population affinity of nearby cultural groups, such as the “Italian” Romans (Coppa & Macchiarelli, 1982; Coppa et al., 2007, 1998; Muzzall, 2015; Rathmann, Kyle, Nikita, Harvati, & Saltini Semerari, 2019; Rathmann, Reyes-Centeno, et al., 2017; Rathmann, Saltini Semerari, & Harvati, 2017; Rubini, Bonafede, Mogliazza, & Moreschini, 1997; Rubini, Mogliazza, & Corruccini, 2007; Sorrentino et al., 2018), and Greeks and Albanians (McIlvaine, Schepartz, Larsen, & Sciulli, 2014). In a biodistance analysis on the Iron Age proliferation of Celtic peoples inland and to the north of the Adriatic, dental morphology was used to examine their migration across Europe (Anctil, 2016, 2021). Similarly, Coppa and colleagues have published their metric and non-metric dental data for Iron Age Adriatic Italian populations (Coppa & Macchiarelli, 1982; Coppa et al., 2007, 1998). Few studies like these have been conducted in the Adriatic region, providing not only a larger gap in regional assessments, but also leaving a clear disparity in our understanding of local imperial populations and Romanization. For example, Rathmann and colleagues (2019), studied population changes in the Mediterranean/ Adriatic during the Iron Age and Roman Empire with nearby Greek and Roman Italics. They demonstrated migration and population change over time, providing insights into Greek colonization and Roman imperialism. These data provide an interesting context for comparison in the region, which is only limited by the absence of similar data from the Eastern Adriatic and hinterland, a primary goal of this study.

APPLYING IDENTITY IN THIS RESEARCH

This dissertation uses descriptors from regional scholarship such as “tribes,” “ethnic groups,” “societies”, “cultural complexes”, and “cultures”. These terms are applied here with recognition that they may have different meanings depending on the reader, in many instances with colonial and prejudicial baggage. Here, they are general terms that convey prior authors’ understanding of history and evaluation of material evidence which suggests shared experiences within and among the cultures. The dissertation also draws from established literature and modern scholars of the region to provide cultural names which reflect labels from antiquity. Although these simplify people as most associated with specific cultural groups, they are not meant to reflect the emic views of those to which they refer. Terminology is not meant to be prescriptive, confirmatory, or biologically essential, rather names are applied with the knowledge that within each group were numerous smaller, and sometimes autonomous cities and communities. Spatial and cultural boundaries can be porous, moving through time, and geographically guided but not fixed. As Janković (2014, p. 96) notes, material culture is a means of communication, and not a way to constrain people to exact times and locations.

Furthermore, this chapter discussed issues concerning the ways biological lineages relate to kinship, social organization, and ethnic identity construction. This research approach does not dispute these critiques. Instead, it utilizes expectations drawn from typified identities and established history to detect contradictions to these assumptions. Then, expectations are revisited to evaluate their validity and discover new ways of understanding how populations were impacted by Roman imperialism which heavily disrupted their ancestors' norms. The research applies a relative and contextually informed diachronic analysis which keeps at the fore the dynamic and relational nature of ethnic and cultural groups. Context is key in both identification and interpretation of results.

SUMMARY

This chapter provides background on the study of imperialism and Romanization, which are central to understanding cultural change in the Roman Adriatic and hinterland. Early scholars viewed Rome as a civilizing force, but later approaches critiqued this perspective. In summary, critiques related to the attributions of Roman imperial motivations and the concept of Romanization include:

- Romans were active constructors of groups while natives and "barbarians" were passive, sometimes referred to as unidirectional influence
- That Romanization was pre-planned, deliberate, and was the motivating driver or goal of conquering
- Cultural change happened with direct rule and influence, a transformative process that was the same everywhere and therefore evidence of rule is a predictor
- Roman power brought about homogenization
- The study of Romanization encouraged elite perspectives and focus on conquerors
- Changes in the local communities presuppose a normative approach to Roman culture, valued favorably in contrast to locals

(Forcey, 1997; Hanson, 1997; Mattingly, 1997, 2013; Mihajlović, 2012; Syme, 1988; Versluys, 2014; J. Webster, 2001; Woolf, 2021b, pp. 20–21)

The debate over Romanization led to reconsidering the dichotomy between Romans and natives and recognition of the multi-directional nature of cultural influence.

Nevertheless, these comparisons still predominately rely on material culture and are further complicated by debates related to ethnicity and identity formation and determination. Bioarchaeology can examine embodied identity, but approaches must be mindful of the complexities and misuse of these concepts. Additionally, the review of the important historical and theoretical background demonstrate that regional scholarship and established historical knowledge are essential complements to bioarchaeological analyses. Therefore, this research applies established terms for cultural groups cautiously to examine imperial disruption of ancestor-descendant relationships. Furthermore, the bioarchaeological approaches in this research have never been used in the Eastern Adriatic and hinterland and are an important addition to understanding Romanization and cultural change in the region.

This study asks, do people who have been associated geographically, temporally, and materially and who clearly interacted in historically identifiable ways demonstrate a different relationship to one another biologically after Romanization; and do these differ among them? The next chapter illustrates how biological distance methodologies can be used to study gene flow in past populations to reveal the effects of substantive cultural changes such as those documented in the Adriatic. By balancing historical knowledge with phenetic data, this dissertation highlights the interplay between local Eastern Adriatic and hinterland populations and the imposition of imperial Rome.

CHAPTER 4 METHODOLOGICAL BACKGROUND

This dissertation uses phenotypic data as a proxy measure of microevolutionary change among populations resulting from gene flow and migration, a research focus called biological distance analysis, or biodistance (Buikstra, et al., 1990). This methodology linking phenotypes to genotypes is based on the assumption that populations that are more genetically integrated by gene flow will be more phenotypically similar (S. Wright, 1943). Using phenotype as a proxy is justified because heritable phenotypic traits are polygenic and additive, meaning phenotypic variation is proportional to genotypic variation (Falconer & Mackay, 1996; Relethford & Lees, 1982). The foundation of biodistance analysis is important to review here, not only to clearly explain bioarchaeology's contributions to studies of evolutionary processes in the past, but also to clarify the ways in which phenotypic data are used in archaeological contexts to explore population dynamics. Misapplication and misunderstanding of biological distance methods and their interpretation are common (Stojanowski & Buikstra, 2004). As is the case with several other contentious academic subjects examined in this dissertation, misunderstandings of biological distance analyses derive from its academic history and relationship to typology and racism, compounded by misunderstanding concepts such as heritability and phenetic distance (Vitzthum, 2003). For example, a trait's heritability is not a measure of genetic determination but rather is a measure of the proportion of phenotypic variation that can be attributed to variation in genetic factors, which accounts for the role of environment (whether in utero, ecological, or localized, such as in the oral cavity) in determining final phenotypic form. A lack of deeper understanding of the theory behind the methods persists even among practitioners. The literal 2-dimensional relationships these methods produce are too easily interpreted as immutable and genetically determined. Therefore, this chapter explains the methodologies in detail, their literature and history, as well as similar work in the study region and how this project contributes to archaeological and broader historical questions about population dynamics.

BIOLOGICAL DISTANCE

Biological distance analysis, or "biodistance," is the assessment of patterns of phenotypic variation as a proxy for patterns of genetic relatedness at multiple scales of human organization– between individuals, subpopulations, or populations (Buikstra et al., 1990; Larsen, 2015, p. 69). The conceptual foundational is the assumption that individuals who share a closer genetic relationship will also be more phenotypically similar (Alt et al., 1997; Pilloud, Edgar, George, & Scott, 2016) due to shared genes, and to some extent, shared environments (Sciulli, 1990; S. Wright, 1943). This association results from specific phenotypic traits being affected by multiple genes (polygenic) each acting in an additive manner to contribute to a final phenotypic form that is observable along a gradient of expression (Buikstra et al., 1990; Relethford & Lees, 1982).

Biodistance methods are used by anthropologists to address questions of population structure, origin, and history (Adams, Van Gerven, & Levy, 1978; Buikstra, 1980; Relethford, 2016). Scott and Turner (1997) describe six scales of analysis, based on geography, from specific to general, 1) individual, 2) family, 3) local, 4) regional, 5) continental, and 6) global. Because of the flexibility between scales of "distance," biodistance methods are useful when exploring multiple subjects, including migration (González-José, Dahinten, Luis, Hernández, & Pucciarelli, 2001), histories of colonialism and imperialism (Allen & von Cramon-Taubadel, 2017; Delgado et al., 2019; Jackson et al., 2006), evolutionary patterns or origins (Sciulli & Mahaney, 1991), and ancestral affinity (Delgado et al., 2019; Relethford, 2002). These methods can also assist in understanding population structure, familial relations, or group subdivisions by intracemetery, spatial, marital, or demographic differences (Buikstra, 1980; Corruccini & Shimada, 2002; Larsen, 2007; Nystrom, 2006; Pilloud, 2009; Stojanowski, 2005), which can reveal connections between past social relationships and site formation processes (Stojanowski & Schillaci, 2006, p. 49). For example, examination of communities and regional groups can untangle localized migration patterns over relatively short periods of time. Intra-regional analyses compare biological relationships among peoples that historically may have shared ancestral or cultural roots within a localized geographic environment to capture patterns of interaction and population continuity. Larger scale analyses, such as global studies, use population data and scale up the effect over distance at the broader level of species-wide patterns of variation. Though all of the analyses involve some comparison of distance or geography, and diachronic analyses are used at any scale, comparisons between time periods are often used at smaller scales. This is because even though all of the analyses are cross-sectional, local studies are commonly used to represent ancestor-descendant populations. In pre-industrial populations, large scale analyses across continents inherently incorporate the element of time due to the extended geographical distances involved (Relethford, 2019).

Biodistance Background and Critiques

Biodistance studies have been a part of biological anthropology since its typological beginnings, sharing the same foundation as culture-history and identity debates as discussed in Chapter 4. In many ways, essentialist ideas about human variation still persist in biological distance studies and biological anthropology more broadly. Cranial analyses particularly are intimately tied with anthropology's racialist roots, eugenics, and the long-discredited pseudoscience of phrenology (Blakey, 1996; Caspari, 2003; Geller & Stojanowski, 2017; Stojanowski, 2019). This specter of an unsavory and ethically dubious past has rightfully drawn words of caution within the discipline (Armelagos & Van Gerven, 2003; Caspari, 2003; but see also Stojanowski & Buikstra, 2004). Additionally, analyses may only clarify biocultural interactions to the degree that ascribed or interpreted social organization corresponds well to the "biological referents of the kinship system" (Lane & Sublett, 1972, p. 186). In other words, results are contextualized by the variables used in the analysis. The process used to identify people or groups interacts with the interpretation or outcome of identification (Gowland & Thompson, 2013, p. 176). Therefore, what goes into an analysis and how the results are interpreted and presented must have these limitations in mind.

Noting these concerns and the advent of molecular genetics, a reasonable question is why use biological distance analyses? As with anthropological genetics, phenotypes are examined to understand underlying population genetic variation that reflects a complex series of evolutionary factors in aggregate. While all biological anthropological methods raise ethical concerns, molecular genetics pose additional challenges (Alpaslan-

Roodenberg et al., 2021; Claw et al., 2018; Hunt & Megyesi, 2008; Kowal et al., 2023; D. Roberts, 2011; Tsosie, Begay, Fox, & Garrison, 2020; Tsosie et al., 2020; Wagner et al., 2020). Paleogenomic, or whole genome ancient DNA (aDNA), analyses may provide very specific information on past individuals who may have living, identifiable descendants (Cui et al., 2013). This may be helpful and desirable in some circumstances but is intrusive and harmful in others, particularly for those related to controversial figures (Benn Torres, 2018; Wagner et al., 2020). Descendants, often unknown in advance, are likely not aware of the analyses and unable to consent (Wagner et al., 2020). Furthermore, aDNA provides information about individual' relatedness to one another, it also provides other information, such as disease predispositions and can reveal information about descendant communities that may be stigmatizing (Bardill et al., 2018; Wagner et al., 2020). An additional important concern with aDNA is that such analyses often involve the destruction of irreplaceable skeletal or dental tissues. Although analyses of skeletal phenotypes are an indirect way to reveal underlying evolutionary processes, they are non-destructive if done with care. Non-molecular biodistance methods alleviate many of these concerns, though with the consequence of lower genetic resolution in the data. Nevertheless, they are less expensive to collect and require less specialized equipment and laboratories than molecular approaches. Furthermore, they do not hinder future molecular, or other anthropological, examination of the materials and preserve the archaeological record in an archival sense. Destructive analyses can result in conservation, preservation, and repatriation issues and make future scientific study impossible (Austin, Sholts, Williams, Kistler, & Hofman, 2019; Wagner et al., 2020).

Many ethical concerns of biological distance research may be avoided with properly contextualized research design. Drawing from an eloquent statement, albeit in different circumstances, biodistance studies have importantly shifted away from their essentialist roots and toward:

> … analysis of in situ biological evolution in the context of established archaeological sequences. The result has been a biocultural approach wherein skeletal variation is viewed as dependent upon environmental factors both mediated by and resulting from patterns of cultural adaptation. The role of physical anthropology, according to this approach, is to determine the impact of cultural developments on population biology.
>
> Adams et al., 1978

When appropriately understood, applied, and explained, biodistance methods can illustrate the complex movements and relationships of past peoples, elucidating regional, political, marginal, and historical experiences otherwise not visible in the archaeological or historical record.

Quantitative Genetics

Quantitative genetics is the study of the underlying genes responsible for changes in phenotypes within a population (Walsh & Lynch, 2018). To identify changes in gene flow specifically, quantitative approaches make use of the portion of the genetic architecture that contributes to the phenotype of a biological structure, which are not easily altered by mutation (i.e., are neutral), natural selection, or genetic drift, ruling out these major causes of evolutionary change. The genes underpinning associated phenotypes are neutral because changes to a few alleles either do not affect the outcome of the genetic code, or the outcome is not beneficial or deleterious enough to affect survival. When evaluated over short-term time scales, allelic alterations are considered neutral or too small for mutation or selection to produce substantial fitness differences and therefore any changes are typically attributed to genetic drift or gene flow. This is called microevolution, and it precludes natural selection or mutation as the best explanations for phenotypic change (in so far as they act on the phenotype).

Selection of Phenotypes

In the most basic sense, phenotypes are conceptualized as outward expressions of genes, such as appearance and physical traits, i.e., bone and tooth structure. Relationships between genotype and phenotype can be established using comparisons between molecular and morphological data (Adachi et al., 2005; Dudar, Waye, & Saunders, 2003; Hubbard, Guatelli-Steinberg, & Irish, 2015; Ricaut et al., 2010; Shinoda & Kanai, 1999; Shinoda & Kunisada, 1994; H. F. Smith, 2009; H. F. Smith, Hulsey, & Cabana, 2016). However, determining the most appropriate phenotypes for biological distance analysis involves identifying phenotypes that occur at balanced levels within a population (i.e., the traits are not too rare), and are reliable indicators of gene flow (i.e., have a moderate to high heritability). Balanced levels in a population are determined after data collection and are a part of the data cleaning process discussed in Chapter 5. Essentially, the most appropriate phenotypes are those which range in frequency from around 20-80%. Excessively rare or common will not be able useful for differentiating groups from one another.

Microevolutionary studies use phenotypes that are neutral, meaning changes in phenotypes can be attributed to gene flow (new genetic material from one population to another) and/ or genetic drift (partitioning of genetic variation within a population) (G. R. Scott & Turner, 1988). The phenotypic or phenetic changes are termed microevolutionary because gene flow and genetic drift bring about "micro" scale population changes that can occur over short periods of time such as inter-generationally. These processes are direct markers of population structure and movement that biodistance is often trying to capture. Changes in the "biological distance" between peoples using these traits can then be explained by migration, population bottlenecks, and changes in mating patterns.

To make conclusions about interactions between two or more populations (gene flow), genetic drift must also be considered as it is a stochastic process and therefore difficult to account for without population statistics. Furthermore, over time, all neutral genetic variations will influence populations through genetic drift (M. Kimura, 1968, 1983; Walsh & Lynch, 2018). Therefore, in addition to limiting the time frame of analysis to rule out other processes, traits are chosen because of their polygenetic properties (reliant on multiple genes) and additive characteristics (more genes means greater expression), which makes them resistant to short term drift because there are so many genes involved in the expression of the trait, and that expression is not "on or off". The continuous phenotypes which this combination manifests are the "quantitative" aspect of quantitative genetics and integral to analyses at the population level (Gillespie, 2004). This is because they will approximate a Gaussian distribution in a population (Hauser & De Stefano, 1989; Stojanowski, 2005) where those with "less" of the many alleles responsible for the phenotype, and with recessive forms, will have weaker/ smaller expressions, while those with more of the dominant alleles will have stronger/ larger expressions (see Figure 8). The result is that, for these traits, not only is phenotype a clue to the genotype, but any expression of the phenotype is illustrative of genetic influence in a population. These attributes combine to make gene flow between people the most likely process to explain phenotypic change out of the four main mechanisms of evolution.

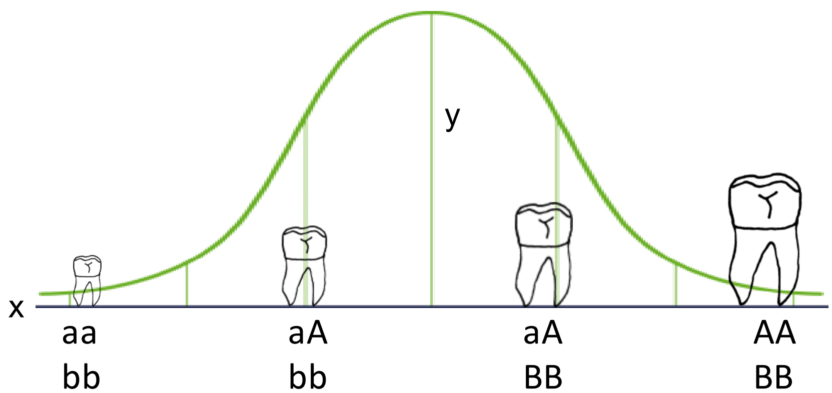


Figure 9 This basic illustration shows how multiple genes (polygenic inheritance) with small additive effects influence a trait in a population. The x-axis represents the influence of combined changes in alleles. The y-axis represents the expression of the trait (phenotype) in a population. Notice the Gaussian curve, where most individuals have an intermediate phenotype, and the extremes (largest and smallest) are less frequent.

Heritability

Heritability is an important factor in trait selection because it enables the identification of traits that pass from parents to offspring which are observable. However, heritability does not describe a direct association between genes and phenotype, but instead is used in the determination of traits for which variation in genetics has an effect on expression of variation in the phenotype. Narrow sense heritability, or simply, heritability (h^2), estimates the proportion of total phenotypic variation accounted for by additive genetic effects (Falconer & Mackay, 1996; Rizk, Amugongo, Mahaney, & Hlusko, 2008), as opposed to other contributors to the phenotype (see Figure 9).

$V_P = V_G + V_E$
$V_G = V_A + V_D + V_I$

Heritability$= H^2$
$H^2 = V_G / V_P$

Narrow Sense Heritability$= h^2$
$h^2 = V_A / V_P$

Variance in the Phenotype$= V_P$
Variance in the Genotype$= V_G$
Variance in the Environment$= V_E$
Variance in Additive Effects$= V_A$
Variance in Dominance Effects$= V_D$
Variance in Epistatic/ Interactive Effects$= V_I$

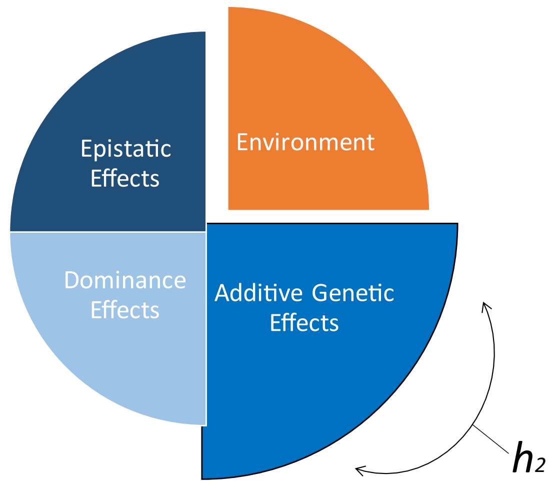


Figure 10 The entire pie is variance in the phenotype= V_P. The three blue pieces are variance in the genotype= V_G. Narrow sense heritability, h^2, is the large blue piece divided by the entire pie.

The narrow sense heritability proportion (additive genetic effects) also excludes the other factors that together with additive effects make up broad sense heritability (H^2), which are dominance (Mendelian) effects and epistatic (interactive) effects. Dominance effects are less likely to have explanatory power for traits that express phenotypically because recessive expression is “hidden.” Epistatic effects are similarly obscured by modifier genes. Since examination of phenotypic interactions require precise control regimes, their interactions can be difficult to detect with any statistical significance (Vitzthum, 2003). Narrow sense genetic effects are amplified by their zygosity; therefore, expression of a trait reflects the underlying genetic contribution in a scaled additive and equal way (see Figure 8). Traits with moderate to high narrow sense heritability will have lower environmental variance, relative to the total genotypic variance in a population, and therefore the phenotypic differences in a population are due to changes in the genetic variance passed from the previous generation.

Trait heritability can be an interesting metric on its own, for example, to test aspects of development or to explore environmental effects; but in anthropology it is primarily used as a broader justification for trait selection in biodistance studies (Stojanowski, 2005). Research in identifying traits with moderate to high heritability often utilizes people with known family relationships, such as twins (Dempsey, Townsend, Martin, & Neale, 1995; Eguchi, Townsend, Hughes, & Kasai, 2004; Jamison, Meier, & Thompson-Jacob, 1989; Ludwig, 1957; Paul, Stojanowski, Hughes, Brook, & Townsend, 2022), to interpret the source of phenotypic differences observed between those who otherwise share 100% or near 100% of their DNA (Falconer & Mackay, 1996). In two such individuals, additive genetic variance would be exactly the same, and the only other area of influence on the phenotype would be environmental (Cavalli-Sforza & Bodmer, 1999). To examine the effects of narrow sense heritability, researchers place a control on environmental influence by studying dizygotic twins or other closely related, but genetically different, individuals who may share a birth or lived environment. If this pair of otherwise very similar people show differences in their phenotype, under similar environmental conditions, a percentage of their differences may be attributable to how they differ in allelic expressions of the same gene or genes (Paul, Feezell, Hughes, & Brook, 2022). The differences are therefore described according to their narrow sense, or additive effects, and not epistatic and dominance effects because only additive effects have a discernible relationship between phenotype and genotype (Saunders, 1989).

Data Recording and Analyses

Researchers have numerous methodological approaches they can draw from depending on the preservation of skeletal remains or the goals of the study. Some of these procedures, such as 2- and 3-dimensional morphometrics, are more common in developmental studies, primatology, and paleoanthropology (McKeown & Jantz, 2005; Pietrusewsky, 2018; Slice, 2006). In bioarchaeology, crania and teeth are the most common phenotypes used for biological distance analyses and they are typically examined as craniometrics, cranial non-metric traits, dental metrics, or dental morphology. Data recording will vary in both procedure and analysis depending on the part of the body examined. Although the examination of postcranial elements or other anthropometrics are less common in biodistance, they are used occasionally (Case, Jones, & offenbecker, 2017; Williams-Blangero, 1989; Williams-Blangero & Blangero, 1989). Postcranial anthropometrics are very susceptible to environmental changes because stature is intrinsically tied to nutrition and health (Steckel, 1995); so very rare non-metric traits tend to dominate analyses (Case et al., 2017). Most research utilizes either crania (H. F. Smith et al., 2016), or teeth (Pilloud et al., 2016; Pilloud & Kenyhercz, 2016). Both cranial and dental phenotypes are analyzed with metric measurement of elements or between landmarks, and examination of non-metric traits or morphology, which are then scored by size or expression.

Analyses of Quantitative Traits

Biodistance analyses apply multivariate statistical comparisons to ascertain patterns of similarity and differences. These vary depending on whether populations are being compared to one another or, as in forensic applications, individuals are being placed within populations. Numerous exhaustive reviews of biodistance methods specific to biological anthropology have already been provided, therefore the most commonly used or influential methods will be discussed here (Hefner, Pilloud, Buikstra, & Vogelsberg, 2016, p. 1; Konigsberg, 2006). Many of these methods are fundamentally the same, statistically comparing shape and size variation within populations by comparing means or centroids.

Metric data are often analyzed with Euclidean or Mahalanobis distances. Euclidean distance provides a measure of relationships between populations, but distances can be affected by correlated traits (Relethford, 2016). Mahalanobis distances solve this problem by accounting for intercorrelation of traits but perform poorly with small samples or when there is missing data (Relethford, 2016). Furthermore, both distances require use of the individual level data that is continuous and quantitative in scale.

The dissimilarity statistic, Smith's Mean Measure of Divergence (MMD), is commonly used for non-metric traits that are discontinuous in scale and can be converted into site level frequencies (Berry & Berry, 1967; Berry, Berry, & Ucko, 1967). Berry and Berry developed the MMD for use in biological anthropology from a non-human model by Grewal (1962), popularizing the method as it involved less complex transformation of data (Berry et al., 1967; Hefner et al., 2016, p. 1). The main benefit of the MMD is that it can be calculated using site level summary data as long as the sample size and trait frequency is known. Additionally, it can be used with missing data and not every population needs the same sample size, so MMD has come to dominate analyses of dental morphological variation.

The relative nature of the statistics discussed above can be described as model-free analyses. This means they show relationships within the parameters of the study and do not provide any actual measures of specific models (Howells, 1973; Irish, 2010; Relethford, 2016; Relethford & Lees, 1982). However, in analyses that rely on established theoretical models, such as in quantitative genetics, the distinctions may be blurred (Relethford, 2016). Model-bound analyses estimate a specific parameter and therefore are more comparable to genetic analysis.

R-matrix analysis is a model-bound approach useful for testing relationships between groups within a larger population (Relethford, 1996; Relethford & Blangero, 1990; Williams-Blangero & Blangero, 1989). R-matrices use a matrix of variance and co-variances to test the significance of inter-group distances from a centroid, or between each other, and estimate average group distance from the centroid. The latter provides an estimate of F_{ST}. F_{ST} (or Q_{ST} the quantitative genetic equivalent) is a neutral measure of "genetic differentiation among groups relative to the total amount of genetic variation expected under no subdivision" (Relethford, 2016, p. 26). These methods are based on comparisons between expected and observed allele/ haplotype frequencies (Harpending & Ward, 1982). They have been adapted for use with quantitative traits because additive genetic variance within a population is directly proportional to trait heterozygosity (Relethford & Blangero, 1990; Williams-Blangero, 1989). The most useful property of F_{ST} estimates is that they can be compared among the same set of populations measured at different points in time. An increase in F_{ST} through time indicates the populations' experienced divergence, likely due to decreasing gene flow and increasing genetic drift. A decrease in F_{ST} through time indicates greater gene flow or migration among the populations, or an increase in population size reducing the effects of genetic drift. However, F_{ST} has disadvantages in archaeological settings.

Time is an important parameter in biodistance since skeletal "populations" are not true biological populations (Bocquet-Appel & Masset, 1982; R. W. Chapman, 2005; L. E. Wright & Yoder, 2003). It is not equally likely that any one individual had the opportunity or ability to breed with any other (Cadien, Harris, Jones, & Mandarino, 1974). This distinction may be said for any bioarchaeological population study, that archaeological samples are instead collections of lineages, with time depth and presumed genetic continuity (Cadien et al., 1974). However, R-matrix analyses require heritability estimates and population size, two components that are often unknown about past populations. Populations which change significantly through time due to other evolutionary mechanisms (such as mutation or selection) will artificially increase measures of variation (and hence F_{ST}), therefore including samples of differential temporal duration, adds potential bias to the estimates. F_{ST} is most accurately a synchronic measure of genetic difference (Relethford, 2016, p. 28) and may be inappropriate in many studies which make diachronic comparisons.

Cranial Phenotypes in Biodistance

Craniometrics and non-metric cranial traits have the longest history of use in biological anthropology because they have many distinct morphological traits (including teeth) which are less susceptible to plasticity than the post-crania (Allen & von Cramon-Taubadel, 2017; Alt et al., 1997; Brace & Hunt, 1990; Hefner, 2018; Jantz & Ousley, 2005; Sciulli, 1990; Sjøvold, 1976). Crania are most often used to distinguish large scale evolutionary changes and population movement (Hanihara, 1996; Pinhasi & von Cramon-Taubadel, 2009; Relethford, 1994, 2002; Relethford & Blangero, 1990; Relethford & Harpending, 1994; von Cramon-Taubadel & Weaver, 2009). Additionally, craniometrics and macromorphology are used in ancestry estimation of modern populations for medico-legal purposes (Hefner, 2018; Jantz & Ousley, 2005; Pilloud & Hefner, 2016). Cranial morphology is examined by scoring the degree in expression of cranial traits or their presence/ absence. Some examples include the presence of a supraorbital notch/ foramen or variation in and number of ossicles at the cranial landmark lambda (Berry & Berry, 1967; Buikstra & Ubelaker, 1994; Hauser & De Stefano, 1989). Craniometrics involve the measurement of distances between specific points on the skull, such as bregma (the point where the sagittal and coronal sutures intersect) and nasion (the midpoint of the nasofrontal suture). Many measurements are collected for each individual as a way to capture overall shape, size, and maximize coverage of the underlying genome.

Despite their long and complex history, the applicability of cranial data in various research fields remains an active area of investigation, considering cranial susceptibility to selective pressures and epigenetic modifications (González-José, Van Der Molen, González-Pérez, & Hernández, 2004; Hubbe, Hanihara, & Harvati, 2009; H. F. Smith, 2009). Human cranial shape exhibits ecological adaptability, particularly over long time scales and across global populations making it difficult to attribute change to gene flow or migration alone (Devor, 1987; González-José et al., 2004; Hanihara, 1996; Hubbe et al., 2009). Further evaluation of specific cranial bones or localized cranio-facial features demonstrate that selection pressures, plasticity, and narrow sense heritabilities may vary for different parts of the skull (Carson, 2006a; Neves & Hubbe, 2005; Schroeder & von Cramon-Taubadel, 2017; H. F. Smith, 2009). One limitation for craniometric based assessments of biodistance, is that they require excellent preservation of human skeletal remains with minimal fragmentation or warping. Furthermore, when landmarks are missing, results show high inter-observer error rates (Jamison & Zegura, 1974; H. F. Smith et al., 2016). At smaller scales, cranial non-metrics and morphology have had varied success in identifying individuals with close biological relationships (Berry, 1975). Ricaut et al., (2010) recommend against using non-metric traits for kinship analysis because they found low resolution with familial relationships. In a correspondence study of mtDNA and craniometric data, Smith and colleagues (2016) found that cranial measures did not reliably sort individuals by maternal lineage. Linear measurements did demonstrate low correlation levels, but these were not significant. However, additional testing against a global sample, and with Bonferroni corrections, did produce significant results (H. F. Smith et al., 2016). Nevertheless, there is consensus among researchers of modern human global movement that cranial variation is dependable for identifying evolutionary processes (Falk & Corruccini, 1982; Rathmann et al., 2023; Relethford, 1994).

Cranial and dental approaches in biological distance use similar methods, nevertheless, dental phenotypes are preferred in some cases. Dental data collection and analyses are discussed in the following section Dental Morphological and Metric Data, however, some of the differences between crania and teeth in trait selection overlap with the aforementioned concerns. Although there is no doubt that cranial form is genetically influenced, bone is a more plastic material compared to enamel, subject to change throughout development, aging, and in response to environmental and cultural factors (Agarwal, 2016; Devor, 1987; Falk & Corruccini, 1982; Roseman, 2004; Schroeder & von Cramon-Taubadel, 2017; Šešelj, Duren, & Sherwood, 2015). Dentitions also experience cultural modification and wear, which is often but not always the result of age related attrition from mastication (Brothwell, 1981; Hillson, 1996; Lovejoy, 1985). However, many dental traits survive masticatory wear to the extent that they may be observed in macromorphological analyses (Fidalgo, Wesolowski, & Hubbe, 2021). Selection between dental or cranial phenotypes may also be related to availability of the elements due to post-mortem taphonomy and peri-mortem alterations. Cranial bones, with the exception of the mandible, are very susceptible to breakage, fragmentation, and deformation from soil pressure and the burial environment (Buikstra & Ubelaker, 1994; Waldron, 1987). Craniometrics often require entire crania, including the intact splanchnocranium, necessitating difficult and time-consuming reconstruction of damaged crania. Teeth are a much more robust hard tissue and can survive considerably longer than skeletal remains, particularly for sub-adults (Kieser, 1990; G. R. Scott & Pilloud, 2018; Walker, Johnson, & Lambert, 1988). Finally, dental phenotypes have been shown to be highly conserved evolutionary traits with moderate to high heritabilities (Paul, Stojanowski, Hughes, Brook, & Townsend, 2020; Šešelj et al., 2015; Stojanowski, Paul, Seidel, Duncan, & Guatelli-Steinberg, 2018). The multi-factorial development of dentition early in life make them less plastic than cranial data and therefore more reflective of neutral genetic variation, thus providing reliable and robust sources of phenotype-genotype relationships.

DENTAL MORPHOLOGICAL AND METRIC DATA

Understanding odontogenesis is an important factor in establishing the connection between dental genetics and resulting phenotypes. The next section will discuss the necessary developmental background on the evolutionary and developmental processes that affect tooth ontogeny. This is followed by a review of dental heritability estimates, dental morphological approaches, and metric analyses.

Odontogenesis

Human odontogenesis shares roots with mammalian evolution and therefore their evolutionary systematics are important contributors to human dentition's shape and size, and overall crown morphology (Sperber, 2004). Not only do all human teeth across classes develop in more or less the same way, but generally, mammals (and broadly vertebrates) all develop teeth similarly, from a neural crest derived mesenchyme (Tucker & Sharpe, 2004; Ungar, 2016; Weiss, Stock, & Zhao, 1998). The developmental processes determine the shape of tooth crowns within a range of variation to a general form homologous among mammals (Van Valen, 1993; Weiss et al., 1998), brought about through evolutionary processes related to ecology and diet (Butler, 1983; Ungar, 2016). Microselection may have a small influence on phenotypic expression in shorter scales of evolutionary time, but are contingent on existing complexity and limited to developmental constraints (Salazar-Ciudad & Jernvall, 2010). The result is that increased complexity of phenotypic characteristics during developmental stages are more difficult unless tied to long-term evolutionary histories. The fixing of mutations alone is insufficient for explaining variation seen in populations over the short term. Therefore, despite a wide range of variation within a species, the general arrangement or number of morphological characteristics of teeth are highly conserved evolutionary traits that remain consistent and resilient to adaptation.

Dental Evolution and Development

Dental development begins during the 6th-8th weeks in utero for primary teeth and 3-5 months in utero for permanent teeth (Avery, Steele, & Avery, 2002). In the stomodeum (primitive oral cavity), maxillary and mandibular dental laminae form on thickened bands of oral epithelium derived from the ectoderm in the 1st pharyngeal arch (Avery et al., 2002; Tucker & Sharpe, 2004). Placodes, or groups of cells, then proliferate and begin to project from the dental lamina, interacting with ectomesenchyme cells derived from the neural crest (MacKenzie, Ferguson, & Sharpe, 1992). This is called the bud stage of odontogenesis and is typically described as being followed by two additional stages, the cap and bell stage. During the cap stage, this interaction of epithelial cells (low columnar and central polygonal cells that become stellate reticulum cells) and ectomesenchyme cells develop into the enamel organ, which will later form the enamel exterior of the tooth. Additionally, the dental papilla forms, which becomes the dentin and pulp, and the dental follicle forms surrounding the enamel organ as it will later contribute to cementum, periodontal ligaments, and alveolar bone.

Another component of tooth formation in multi-cusped teeth is the signals sent from enamel knots. This feature forms in the enamel organs' concavity during the cap stage of development, influencing the shape and patterning of tooth cusps (Avery et al., 2002; Jung, Green, Jung, & Kim, 2018; Thesleff, 2018). The enamel knot excretes different signaling proteins or growth factors regulating the folding and growth of the epithelium (Thesleff, 2018; Thesleff, Keranen, & Jernvall, 2001; Thesleff & Mikkola, 2002; Vaahtokari, Aberg, Jernvall, Keranen, & Thesleff, 1996). Primary enamel knots undergo apoptosis, but are followed by secondary enamel knots which appear at the tips of the cusps of multi-cusped teeth defining the location of where cusp tips form (Avery et al., 2002; Jernvall, Aberg, Kettunen, Keranen, & Thesleff, 1998; Matalova, Tucker, & Sharpe, 2004). Notably, the "cap" descriptor for this stage of development is named for the concave shape the tooth begins to take on within the enamel organ. This is due to unequal division and proliferation of cells, allowing some parts of the tooth cap to fold in and project (invagination). Within this concavity is where the dental papillae forms. The cap stage is followed by the bell stage, during which the enamel organ continues to grow and assumes more of a bell shape. There is still a concavity within the "bell," lined inside and outside with enamel epithelial cells. The inner epithelial cells differentiate into ameloblasts, and a layer of stratum intermedium forms between these ameloblasts and the stellate reticulum. This process is called amelogenesis or morpho-differentiation. Simultaneously, histodifferentiation or dentinogenesis occurs where dental papillary cells differentiate into odontoblasts. It is during this process that a combination of restriction by the cervical loop (where the inner and outer epithelial cells meet) and pressure from dividing cells gives rise to the future cusp tip shapes. Along the epithelial thickenings, secondary enamel knots influence epithelial folding and are where the ameloblasts and odontoblasts opposingly deposit their cellular matrix (apposition) and forms the site of future cusp tips (Jernvall, Kettunen, Karavanova, Martin, & Thesleff, 2002; Jernvall et al., 2002; Thesleff, 2018; Thesleff et al., 2001, 2001; Vaahtokari et al., 1996). Finally, during the bell stage, the dental lamina disintegrate, and the enamel and dentin begin to mineralize. If fragments from this process do not degenerate, they give rise to supernumerary teeth, cysts, and tumors (Jernvall & Thesleff, 2000). The process ends with formation of the tooth roots and eruption through the gingiva.

These developmental patterns are significant because they demonstrate how tightly genetically controlled teeth are and that many genetic signals are involved in the process of odontogenesis.

Genetic Control of Morphological Variation

Thorough reviews of the history of quantitative genetics of dental characters and within dental anthropology are important for understanding how variation in human tooth dimensions can be attributed to polygenic and additive effects (Bowden & Goose, 1969; Buikstra et al., 1990; Pilloud et al., 2016; Pilloud & Kenyhercz, 2016; Rizk et al., 2008; G. R. Scott, 1997; G. R. Scott & Turner, 1988, 1997; J. A. Sofaer, MacLean, & Bailit, 1972). The genetic inheritance of patterns of tooth morphology have been studied in depth (Dempsey et al., 1995; Lundström, 1948; Osborne, Horowitz, & De George, 1958;

Paul, Stojanowski, et al., 2022; Paul et al., 2020; Stojanowski, Paul, Seidel, Duncan, & Guatelli-Steinberg, 2017; Stojanowski et al., 2018; Townsend et al., 2012). These studies support the positive correlation between genes and dental morphology, though to varying degrees depending on the tooth and trait. They reveal that dental phenotypes are not determined by isolated genetic factors, but that they arise through a complex interplay of multiple genes weaving together genetic signals to form dental features.

Human dentition varies by class, (i.e., incisors vs. molars), dental arcade (maxillary vs. mandibular), and number within class (1^{st}, 2^{nd}, 3^{rd} tooth). Different classes of teeth express variation due to their development; and although all teeth within a class and arcade will be similar, they still have distinct morphological differences. Models for how within class differences emerge have been characterized by two primary hypotheses, field theory (Butler, 1939), and the clone model (Osborn, 1978). Despite their differences, both concepts involve an initial location of molecular information which influences the production of the other teeth in the class with similar forms in a modular fashion. Recent discussions have shown that these theories need not compete but rather complement each other, as both are influenced by homeobox genes originating in the neural crest ectomesenchyme (Mitsiadis & Smith, 2006; Sharpe, 1995; Thesleff & Sharpe, 1997; Townsend, Harris, Lesot, Clauss, & Brook, 2009). The outcome is the same in any case, teeth within a class are more similar than they may be to other teeth.

Specific genes have been associated with dental expressions, nevertheless complex mechanisms in the developmental process create variations in gene outcomes. *Shh*, *Fgf*, *Bmp*, and *Wnt* families of genes are all involved in odontogenesis, though at different times during early morphogenesis and specifically cusp development (Cobourne, Hardcastle, & Sharpe, 2001; Jernvall & Jung, 2000; Thesleff & Sharpe, 1997; Tucker & Sharpe, 2004). For example, the developmental signal from EDAR has been found to affect the gradation of marginally ridged incisors (R. Kimura et al., 2009). Within multi-cusped teeth, variations in tooth class arise from differential folding of the inner enamel epithelium, regulated by molecular genetic signals from the secondary enamel knots and surrounding tissues. Research identifies changes in cusp number, size, and shape by manipulating growth factors and protein signals during morphogenesis (Jernvall et al., 1998; Jernvall & Thesleff, 2012; Keränen, Kettunen, Aberg, Thesleff, & Jernvall, 1999; MacKenzie et al., 1992; Salazar-Ciudad & Jernvall, 2002, 2010; Vaahtokari et al., 1996). Experimentally altered traits require multiple cascading signals, including inhibitory ones, to generate changes in cultured or simulated teeth (Brook, 2009; Harjunmaa et al., 2012; Kangas, Evans, Thesleff, & Jernvall, 2004; Keränen et al., 1999). Gene expressions and timing are further affected by the pattern and spacing of enamel knots, to alter growth stimulation, cusp patterning, and tooth crown shape (Jernvall & Thesleff, 2000, 2012; Peters & Balling, 1999; Polly, 2013; Salazar-Ciudad & Jernvall, 2010; Thesleff et al., 2001). Studies also demonstrate numerous growth signals involved in crown formation, with separate developmental stages and location specific effects (E. F. Harris & Dinh, 2006). Over 300 different genes have been found to be involved with expression of dentition and these have been compiled into a graphic database at http://bite-it.helsinki.fi (Thesleff, 2018).

The association between dental phenotypes and genes are also supported by their moderate to high heritabilities (Eguchi et al., 2004; Kuba, 2006; Lundstrom, 1977; Rizk et al., 2008; G. R. Scott & Turner, 1997; Townsend et al., 2012). The following examples illustrate the wide range of heritabilities found for different dental attributes (e.g., shape, size, class, inclination, intercusp distances, morphology etc.), supporting the use of dentition in biodistance (Mizoguchi, 1978; Rizk et al., 2008; G. R. Scott & Turner, 1997; Townsend et al., 2012). Dental crown size (.60 to .90) and Carabelli trait (.90) have been reported to consistently show high narrow sense heritabilities in twin studies (Townsend et al., 2012). First and second molar variation has been shown also to have high heritabilities in South Australian twins (Higgins, Hughes, James, & Townsend, 2009). Eguchi and colleagues (2004) found high heritability (.76 to .84) for adolescent twins in the inclination of 1^{st} and 2^{nd} mandibular molars. Alvesalo and Tigerstedt (1974) also reported high h^2 for labiolingual dimensions (compared to mesiodistal), while Stojanowski et al., (2017, 2018) found moderate heritability scores for numerous dental traits and metrics in a genealogically matched sample (0.09 to 0.86; mean 0.51). There are, however, studies that have produced low heritabilities in some dental traits, though these are often attributed to population specific influences, such as endogamy, or as evidence of environmental variance (Stojanowski, Paul, Seidel, Duncan, & Guatelli-Steinberg, 2019). Research continues in this area, revealing the complex but interesting relationships between teeth and genes (Paul, Feezell, et al., 2022; Paul, Stojanowski, et al., 2022).

Dental biodistance methods

There are numerous methods used to quantify dental characteristics for biodistance analysis, including non-metric trait scoring, linear metric measures, geometric morphometric analyses of shape variation, and 3D calculation of surface complexity (G. R. Scott & Turner, 1997). Of the methods used, metric linear measurements (e.g., mesio-distal or buccolingual lengths/ widths) and morphological traits are the most common. Odontometrics are linear measurements of mesiodistal and buccolingual lengths/widths of tooth crowns and cervices (Goose, 1963; Kieser, 1990). The measurements, typically using key teeth, are then analyzed using univariate statistics such as ANOVA or with multivariate techniques such as Euclidean distances measures, discriminant function analysis, and PCA's (Pilloud & Kenyhercz, 2016; Stojanowski, 2005). Morphological traits are scored in a ranked or dichotomous fashion based on the presence and strength of anatomical variants of tooth crown characteristics, such as wrinkles, folds, cusps, and pits. Criteria for examining morphological features were first systematically described by Dahlberg (1956), later simplified (Berry et al., 1967), and ultimately developed into the Arizona State University Dental Anthropology System (ASUDAS) (Turner, Nichol, & Scott, 1991). ASUDAS is a series of scoring standards and plaques which allow consistent recording of adult dental morphological traits along ordinal grades of expression or rely on breakpoints in the scale to dichotomize data (i.e., presence-absence) (Edgar, 2017; G. R. Scott & Irish, 2017; Turner et al., 1991).

These two approaches (metric linear measurements and morphological traits) can at times result in different outcomes. Metric data tend to produce higher heritability estimates, but this may be an artifact of measurement scale (Rizk et al., 2008). Continuous measurements, often based on an entire crown, may capture more variation in the tooth amplifying its signal, conversely, dichotomously scored morphological traits lose some of their descriptive power (Ricaut et al., 2010; Rizk et al., 2008). However, Stojanowski (personal communication, 2023), finds that together, all tooth measurements do not add greatly to the genetic signal because they are highly intercorrelated whereas morphological traits have demonstrated more variation in correlation studies (Stojanowski et al., 2018, 2019). Morphological characters can be scored in an ordinal (ranked) fashion, but when dichotomously scored, they provide higher heritabilities under certain conditions (Carson, 2006b; Stojanowski et al., 2018). Even so, dichotomized traits can exacerbate dominance effects (Edgar & Ousley, 2016). Metric data can be less susceptible to inter-observer error and less affected by dental wear or attrition (Stojanowski, 2005; Stojanowski & Schillaci, 2006), however, this mostly applies to cervical measurements which are not as common thereby minimizing comparative analyses (Hillson, FitzGerald, & Flinn, 2005; Pilloud & Kenyhercz, 2016).

Clearly, both approaches have strengths and weaknesses, but nevertheless each are informative. This research uses dental morphology instead of dental metrics due to the amount of missing data and the requirement that continuous, quantitative distance statistics use the individual as the unit of analysis. Dental metric analyses do not permit missing data and their information cannot be included in a study or compared with existing data sets without altering analytical strategies. Also, soil acidity in parts of the Eastern Adriatic often affect the preservation of human cranial remains, not only limiting cranial analyses but also the dentition lasting in situ (Gordon & Buikstra, 1981; Loewen et al., 2021). This results in commingling and damage to dentition in the burial environment, potentially affecting the availability of some teeth. Although the condition of dental remains in this region can be a limiting factor in measurement-based analyses, the methods used for morphology can accommodate damaged teeth and missing data. This is discussed in detail in Chapter 5.

Methodological Issues

Among the methodological concerns with using dental morphological data are those regarding observer error, sexual dimorphism, age/ wear related data loss, and inter-trait correlations. Corrective tests can be conducted to mitigate the impact of these differences, as discussed in Chapter 5. Inter- and intra- observer error tests assist in identifying unreliable observers or traits with inconsistent performance. Additionally, correlation tests between ranked/ ordinal categories assist in identifying traits which are highly interrelated, thereby inflating their genetic signal (G. R. Scott, 1977b; G. R. Scott & Pilloud, 2018). Problematic traits are then removed from analyses.

Sexual dimorphism can contribute to differences in relative size and trait expression, potentially introducing error in dimension dependent assessments like ordinal scoring. Nevertheless, studies have found the overlapping spread of size polymorphism in humans to be minimal in most teeth apart from the canines; which makes sense in light of evolutionary considerations (Kuba, 2006; Lundstrom, 1977; G. R. Scott, 1977a; Yap Potter, 1972). Therefore, when doing analyses at the population level, traits are tested for sex correlation and excluded when necessary; otherwise sexes are typically pooled (G. R.

Scott & Turner, 1997). Size effects on morphological expression can also be population specific, regardless of sex correlation. For this reason, many morphological assessments are considered relative to overall tooth size and other attributions of an individual's dentition.

Similarly, the age of an individual at the time of death can affect the appearance of their dental trait size due to age-related size differences and age-related use wear. Populations with more young adults, those with fully erupted adult teeth and the least amount of wear, can be over-represented and bias results. Therefore, traits correlated with an age/ wear bias are also removed. Recently, researchers identified seven traits which are significantly associated with wear but also found that when analyses use many different traits and are not restricted to wear sensitive traits, they have a low impact on outcomes (Fidalgo et al., 2021).

As discussed, all members of a tooth class share underlying genetic factors and therefore have a high degree of intercorrelation which may produce inflated genetic signals. To ameliorate this concern, traits recorded for multiple teeth are represented by the key tooth, the tooth with the largest sample size, or the tooth with the lowest intercorrelation determined by previously mentioned tests. Furthermore, the trait selection and cleaning process ensures that anterior and posterior, and maxillary and mandibular dentition are represented in results.

SUMMARY

This chapter overviews biological distance analysis, which is a research methodology that uses phenotypic data as proxies for underlying genetic relationships between individuals and populations. There are advantages to biodistance methods, however, there are many limitations, common misunderstandings, and misuses which must be accounted for when utilizing these methods. Selecting phenotypes involves finding expressions that occur at balanced levels within a population, are reliable expressions of gene flow, and have moderate or high, but consistent heritabilities. According to quantitative genetic principles, phenotypes that meet these criteria will exhibit population level changes due to gene flow because of the polygenic and additive nature of their genes.

Many methodologies are used in biological distance studies including craniometrics, cranial non-metrics, dental metrics, and morphology. Dental morphological traits are reliable proxies for microevolutionary change because the complex developmental genetics of teeth make them resistant to short term evolutionary changes like selection or mutation, allowing differences between populations to be attributed to gene flow. A standardized data recording procedure called ASUDAS is often used to collect data which are then analyzed using statistical methods. Correlation tests are also used to refine data and mitigate methodological issues. Overall, biological distance methods can reveal population relationships and interactions when destructive methods are deemed unethical or cost prohibitive. When understood and applied appropriately, the results of biodistance analyses illustrate complex movements and histories of past peoples.

CHAPTER 5 MATERIALS AND METHODS

This chapter details the materials and methods used in this dissertation and is organized into two sections. The first section will discuss the samples used in the analyses, providing details on the cemeteries and sites they originated from and providing sample sizes. The second section discusses which and how data were collected and analyzed.

MATERIALS

Samples were housed at numerous institutions throughout Croatia, including The University of Split, Zadar University, Zadar Museum, Benkovac Kastel and Museum, Archaeological Museum in Zagreb, The Institute for Anthropology in Zagreb, Brdovec Museum, and Vinkovci Municipal Museum. Descriptive statistics have been provided for each sample. Time period estimations were provided by Croatian colleagues and were based on radiocarbon dates or material culture according to regional archaeological methodology. Some radiocarbon dates have been altered to general time periods and will not be reported at the request of colleagues as these data are yet to be published. Similarly dated and geographically located individuals were clustered into pseudo-population groups and were also provided by archaeologists who at times were directly involved in their excavation and prior analyses (See Preface and Chapter 3 for discussion). These political and cultural associations are not presented as and should not be mistaken for, "ethnicities," whether biological or cultural, as this is indeterminable.

Additionally, populations do not constitute true genetic "populations" in the traditional biological sense of a geographically and temporally isolated group of randomly mating individuals (Hedrick, 2011). As previously stated, with the phenotypic proxy of dentition, only 40%- 80% of phenotypic variation describes genetic variation (narrow sense h^2), meaning relationships owe a portion of their variance to other influences, such as environment, in addition to gene flow.

Population counts (N) of the examined individuals are listed in Table 1 by cultural group (e.g., Delmatae, Liburnian etc.) and time period (Iron Age, Roman Period). In Table 2, the samples are organized by archaeological sites and/ or locations from which they originate. After Table 2, the text discusses the samples organized geographically first (e.g., Northern Croatia/ Hinterland and Southern Croatia/ Coastal) and then by time period (Iron Age, Roman Period). Then the samples are further broken down by cultural group (e.g., Delmatae, Liburnian etc.), and sites names and/ or cities are listed underneath cultural group. These summaries also provide the number of individuals from specific site locations and time period. Some contextual information is provided for the analyzed individuals, though for many, specific information may be limited or has yet to be published by the original archaeologists. These data were supplemented by over 1,000 individuals from previously published studies which provided population trait ratios for groups and sites originating on the Italian peninsula and surrounding Mediterranean region (Coppa et al., 1998; Rathmann et al., 2019; Sorrentino et al., 2018). These are listed in Table 3 following the format from Table 2 and also including the publication they were recorded from, the abbreviation used in this publication, and the analysis they were used in.

Table 1

Collected data for cultural groups with number of individuals examined by general time period and totals.

Cultural Group	Iron Age	Roman	Totals
Delmatae	23	80	103
Japodes	12		12
Liburnian	96	50	146
Pannonian	14	38	52
Totals	**145**	**168**	**313**

Table 2

All sites or cities where data were collected, ordered by associated cultural group, time period, number of individuals examined, and abbreviated pooled population names.

Site or City (28)	Cultural Group	Period	N (313)	Combined in (9)		
Solin-Smiljanovac, Salona	Delmatae	Roman	58	DELMR	CLDR	CHR
Tugare	Delmatae	Iron Age	23	DHIA	DIA†	CHIA
Velić	Delmatae	Roman	3	DELMR	CLDR	CHR
Vranjic	Delmatae	Roman	19	DELMR	CLDR	CHR
Konjsko Brdo	Japodes	Iron Age	1	DHIA		CHIA
Mala Metaljka, Trojvrh & Josipdol	Japodes	Iron Age	1	DHIA		CHIA
Skradnik	Japodes	Iron Age	2	DHIA		CHIA
Smiljan, Lika	Japodes	Iron Age	8	DHIA		CHIA
Cvijina Gradina	Liburnian	Iron Age	27	LBIA		CHIA
Ljubač Venac	Liburnian	Iron Age	7	LBIA		CHIA
Malo Libinje, Kneževići	Liburnian	Iron Age	13	LBIA		CHIA
Nadin Necropolis	Liburnian	Iron Age	27	LBIA		CHIA
Nadin Necropolis	Liburnian	Roman	33	LBR	CLDR	CHR
Nadin Tumulus Mound 13	Liburnian	Iron Age	5	LBIA		CHIA
Nin, Ždrijac & Solana	Liburnian	Iron Age	2	LBIA		CHIA
Stankovci Velim	Liburnian	Iron Age	6	LBIA		CHIA

Virić	Liburnian	Iron Age	3	LBIA		CHIA
Vrsi	Liburnian	Iron Age	6	LBIA		CHIA
Zadar, Novi Kampus & Relja	Liburnian	Roman	17	LBR	CLDR	CHR
Anina 7 Site, Vinkovci	Pannonian	Roman	13	PANR		CHR
Kamenica, Vinkovci	Pannonian	Roman	1	PANR		CHR
Makart, Vinkovci	Pannonian	Roman	9	PANR		CHR
Osijek	Pannonian	Roman	10	PANR		CHR
Sisak	Pannonian	Roman	5	PANR		CHR
Ilok- Ki	Pannonian	Iron Age	1	DHIA		CHIA
Lovas	Pannonian	Iron Age	3	DHIA		CHIA
Sveti Križ	Pannonian	Iron Age	7	DHIA		CHIA
Vinkovci NAMA	Pannonian	Iron Age	3	DHIA		CHIA

Abbreviations: LBIA, Liburnian, Iron Age; LBR, Liburnian, Roman Period; DIA, Delmatae, Iron Age; DELMR, Delmatae, Roman Period; PANR, Pannonian, Roman Period; CHIA, Coastal/ Hinterland, Iron Age; CHR, Coastal/ Hinterland, Roman Period; DHIA, Delmatae/ Hinterland, Iron Age. †Used in additional analyses in Appendix.

North Croatia/ Hinterland

Iron Age, n= 26

Japodes, n= 12

These samples originate from the Lika region in Croatia, including Smiljan n= 8, Trojvrh n= 1, Skradnik = 2, and Konjsko Brdo n= 1. Sites at or near Trojvrh include hillfort burials and a flat necropolis (Velika and Mala Metaljka) with mixed contexts dating from the Late Bronze Age/ Early Iron Age into the Roman period, 800- 200 BCE (Zavodny, 2022). Burials in this area were commonly placed in tumuli during the Early Iron Age, which were eventually replaced by flat necropoli (Bakarić, 1986; Zavodny, 2022). Additionally, Iron Age graves in Smiljan contained material culture similar to those found in Liburnia, demonstrating a Liburnian sphere of influence and supporting the heterogeneous complexities of Japodian identity (Blečić Kavur & Podrug, 2014).

Pannonians, n= 14

These samples originate from the breadth of northern Croatia, the plateau, and the hinterland including Ilok n= 1, Lovas n= 3, Vinkovci n= 3, and Sveti Križ n= 7. The samples from this region originate from cemeteries in Ilok (Roman Cuccium) and modern Lovas, Croatia, in Vukovar-Syrmia County on the Croatian/ Serbian border. This region is known to have been inhabited by the Iron Age Scordisci (Celts/ Celtic Pannonians) (Džino, 2007; Mihajlović, 2014; Potrebica & Dizdar, 2014). Information on the individual from Lovas was provided by Novak and Carić in an unpublished report (2020). The Vinkovci NAMA data were collected from individuals from numerous excavations throughout the city of Vinkovci, that are currently housed at the Municipal Museum. These include the Vinkovci NAMA Iron Age skeletal series analyzed and re-individuated by Mario Šlaus (Šlaus, 2002b). The graves from NAMA date from the second half of the 5th century BCE to the first half of the 4th century (Majnarić-Pandžić 2000).

The individuals from Sveti Križ come from a flat cemetery near the border of Croatia and Slovenia and were previously analyzed for The Encounters and Transformations in Iron Age Europe (ENTRANS) Project (Ian Armit, Potrebica, Črešnar, Mason, & Büster, 2016, 2014; Nicholls, 2017). ENTRANS analyzed the human skeletal remains of Iron Age individuals throughout Slovenia and Northern Croatia, and found that though the individuals seemed culturally heterogeneous displaying different burial treatments and status, they were nevertheless locals (Cvitkovič, 2016; Nicholls, 2017).

Roman Period, n= 38

Pannonians, n= 38

Data were gathered using collections from numerous excavations throughout the city of Vinkovci, i.e., Roman Cibalae, that are currently housed at the Municipal Museum. These include burials from excavations on Makart street, Kamenica, and the Anina 7 Site (n= 23). Additionally, there are data from Siscia/ Segestica n= 5 and Osijek n= 10. Roman period samples housed at the Vinkovci Municipal Museum have been dated to the 3rd- 5th centuries (Peko & Vodanović, 2016; Šlaus, 2002b). The same Roman individuals examined for this dissertation were analyzed at the School of Dental Medicine in Zagreb for hypoplastic defects, caries, and other dental pathological lesions (Peko & Vodanović, 2016). The study found relatively low dental lesions and concluded this may represent a healthy population. Cibalae was the birth place of two Roman Emperors and the location of a large archaeological assemblage of silver plates and other dishware, perhaps suggesting that it was home to high status individuals (Vulić, Doračić, Hobbs, & Lang, 2017).

Also, many burials were excavated in modern day Sisak which was once a pair of neighboring settlements across the confluence of the Kupa and Sava rivers, Segestica/ Segesta, discussed in Chapter 2, and Siscia. However, after falling to the Roman Empire the area was only referred to as Siscia, also spelled Sescia. Siscia became a colony/ *colonia* in 71 CE, and was a key city of Roman Pannonia for its waterway and hinterland access and as mentioned in Chapter 2, bringing down Pannonian rebellion (Koščević & Makjanić, 1995). It was settled by Roman veterans and in literature demonstrates evidence of people from Hispania, and potentially the far east (Koščević & Makjanić, 1995). Many individuals were identified as possibly young males, which is expected if they were soldiers or conscripts. Roman Period Osijek, known as Mursa, became a *colonia* in 131 CE, and was also a main military settlement in Pannonia during the Roman Empire.

Southern Croatia/ Coastal Lands

Iron Age, n= 119

Liburnian, n= 96

The Liburnian samples include individuals from Cvijina Gradina n= 27, Nin Gulf and Ljubač Bay, n= 18, Malo Libinje Gradina Knežević near Starigrad n=13, Nadin flat necropolis and tumulus n= 32, and Stankovci Velim n= 6.

Cvijina Gradina, n= 27

Cvijina Gradina (n= 27) was a Liburnian cemetery in the ancient city of Ansium, in the modern village of Kruševo near Obrovac (Čondić & Jurjević, 2014). The Liburnian settlement sits atop a hillfort 356 meters high, a prominent feature in Northern Dalmatia (Šeparović, 2005). The cemetery is predominantly Liburnian inhumations and cremations, as well as three Roman cremation burials in amphorae and 1 inhumation. The Liburnian burials were within a stone mound/ tumuli north of the hillfort (Batović, 1987, pp. 343–344). The Liburnians, who date to the 6th -1st century BCE, were in communal graves with some metal grave goods and metal slag (note with remains) (Batović, 1987, p. 349). Also noted with the skeletal remains was that the grave was not lined which was typical for this time and region.

Nin Gulf and Ljubač Bay, n= 18

A cluster of samples, Nin n= 2, Viric n= 3, Vrsi n= 6, Ljubač n= 7, come from cities 20 km north of Zadar, south of Pag island on peninsulas in the Nin gulf and Ljubač Bay. The nearby hillfort of Venac looks over many of these sites including the modern town of Ljubač, in Zadar county and its associated tumuli. These Liburnian structures date to the late Bronze Age and early Iron Age overlap in use (Marijanović, 2012; Vujević, 2011). The tumuli at Ljubačka Kosa are considered local continuous family Liburnian burials. Nin later became the major Roman municipality of Aenona (Gluščević & Zglav-Martinac, 2016).

Malo Libinje Gradina Kneževići near Starigrad, n= 13

In the Paklenica area near the town of Starigrad, (10 km), are numerous sites including Malo Libinje Gradina Kneževići n= 13, (Dubolnić, 2006, 2007). This area includes fertile coastal land that connect the peaks of the Velebit Mountain range and the Adriatic Sea inlet. At 833 meters above sea level, it has been referred to as a pre-Roman southeastern, "outpost of the sea and land passages" (Dubolnić, 2006). The foothills of these rocky white mountains are roughly 3 km from the coast, with agricultural land all the way up to the shore (and is so even today) which resulted in mixed subsistence practices including animal husbandry and fishing (Glavičić, 1984). There are tumuli on the local hillfort with cremated remains (not recorded) as well as inhumations found in a flat necropolis (Kriletić, Vuković, & Carić, 2021). The necropolis has vertical stone lined pits with horizontal stone slabs, similar to those at Nadin (Glavičić, 1984; Kriletić et al., 2021; Kukoč, 2011). Individuals were buried in crouched positions and found with bronze hair pins and belt buckles dating to 500 BCE (Glavičić, 1984). This region later became Roman Argyruntum, an important cultural center (Dubolnić, 2006, 2007).

Nadin/ Nedinum, n= 32

Multiple individuals for both the Iron Age Liburnian and later Roman samples are from sites on the flatlands of Ravni Kotari in the modern town of Nadin, Croatia, very near coastal Zadar (21 km) (Plohl, 2018, p. 76). These numerous archaeological sites include Mound 13 and the Nadin Gradina. The early Iron Age tumulus called Mound 13, which dates to the 9th- 6th century BCE contained flexed and extended inhumations, as well as ceramic urns with cremains (Batović, 2005; Kukoč, 2009; Šikanjić, 2006). The archaeological site of Nadin Gradina, also Roman Nedinum, is a hilltop settlement enclosed by a fortification wall and a necropolis near the foot of the hill (Batović & Chapman, 1987; Kružić, Bašić, & Anđelinović, 2011; Kukoč, 2009; Kukoč & Čelhar, 2019; Loewen et al., 2021; Zaro & Čelhar, 2018). The Nadin flat necropolis, used from the Early Iron Age (7th century BCE) through the Roman periods (2nd century CE), includes flexed and extended Iron Age inhumations as well as Roman inhumations and cremations (Kukoč & Čelhar, 2019).

Stankovci/ Velim, n= 6

The burials from the Velim-Kosa site were excavated and reported in 2013 and 2014 as part of an environmental protection study for the construction of a solar power plant in Velim, Croatia (Čondić, 2014). Four tumuli were excavated, and numerous graves were recovered. There is some disagreement on the dating of this site, however, it has been attributed to the Late Bronze age to the early Iron Age (Carić, 2023; Čondić, 2014). Some of the individuals were included in aDNA and dietary isotopic studies which demonstrated typical values for individuals from the Eastern Adriatic coastal regions, including a balanced diet of millet and meat (Carić, 2023; Lazaridis et al., 2022; Patterson et al., 2022).

Delmatae, n= 23

In 2004 the local community in Tugare, Croatia assisted archaeologists in locating a rumored burial mound which had been disturbed during construction of a parking lot for the local parish (Delonga, 2016). With their assistance, archaeologists and local parishioners excavated the Iron Age tumulus and burials dated using pottery and fibulae. The Delmatae site in Tugare is 15 km southeast of present-day Split, (near Roman Solin), and immediately north of the island of Brač. Otherwise, little else has been published about this excavation compared to the 2006 excavation of a Medieval cemetery nearby (Petrinec, 2000; Šućur, 2019). It was noted in the 2004 excavation photos that a bronze chest plate had a similar form and style to those found in Liburnia.

Roman Period, n= 130

Liburnian, n= 50

The Liburnian data are from both Zadar, a coastal port, and Nadin, a hillfort on the Ravni Kotari agrarian plains; 21 km apart.

Nadin/ Nedinum, n= 33

As previously mentioned, the archaeological site of Nadin Gradina was also Roman Nedinum, a hilltop settlement enclosed by a fortification wall and a necropolis near the foot of the hill (Batović & Chapman, 1987; Kružić et al., 2011; Kukoč, 2009;

Kukoč & Čelhar, 2019; Loewen et al., 2021; Zaro & Čelhar, 2018). The Nadin flat necropolis was used through the Roman periods (2nd century CE), and includes Roman inhumations and cremations (Kukoč & Čelhar, 2019). Numerous individuals recorded for this dissertation come from communal graves in the necropolis dated to the Republican Period and early Empire (Čelhar & Ugarković, 2021). During the 1st century CE, the Nadin Iron Age flat necropolis was remodeled into a local form resembling the typical Roman "roadside" necropolis with linear plots enclosed in stone architecture and aligned on a road that passes through the necropolis (Kukoč & Čelhar, 2019). Nadin experienced urbanization throughout the Iron Age and this process picked up by the 1st century CE (J. Chapman et al., 1996; Zaro et al., 2023; Zaro, Čelhar, Borzić, & Vujević, 2021; Zaro & Čelhar, 2018). Despite this, architecture and resident patterns suggest in-situ native Liburnian local continuity as well as an influx of Roman residents from Zadar (Zaro et al., 2021).

Zadar, n= 17

The examined remains come from Relja, n= 13, Novi Campus, n= 3, and n= 1 from Cvijina Gradina that has been pooled with the Zadar sample. Iader or modern Zadar was an important Roman stronghold in the Adriatic, achieving *colonia* status around 40 BCE (Mirosavljević et al., 1970). Inhumations and cremated human remains were found dating to the 1st- 4th centuries CE (Z. Brusić & Gluščević, 1991; Ilkić, Gluščević, & Čelhar, 2008; Novak, 2007; Plohl, 2018; Štefanac, 2009). Grave goods included temporally specific Roman objects such as amphorae, glass vials, ceramics, and coinage

(Ilkić et al., 2008; Plohl, 2018; Štefanac, 2009). The sites were known to be inhabited by Roman soldiers, some conscripts and some from around the Empire (Gluščević, 2014).

Delmatae, n= 80

Solin- Smiljanovac n= 58

Just outside the modern cities of Split and Solin was the Roman capital of Dalmatia, Salona, and the necropolis Lora (Jerković et al., 2016). Salona was established in the 1st half of the 1st century CE and became a key Roman city and home to the 4th century CE Roman emperor, Diocletian (Bubić, 2016). The nearby palace of Diocletian stands today and is likely the most significant Roman historic site in Croatia next to the amphitheater in Pula. The cemetery Lora contained mostly cremations with glass urns, similar to the ceramic amphorae, and inhumations with stone walls, common of the region (Buljević, 2010). By the 2nd and 3rd centuries CE Roman stone stelae and sarcophagi were prominent burial monuments, demonstrating the extent to which the region had been transformed (Katunarić, 2022; Vrcelj, 2020). The individuals analyzed for this research have been dated to between the 1st and 4th centuries CE, with the majority of individuals in the 3rd and 4th centuries CE (Bubić, 2016). Bubić (2016), who details the excavations, dates, grave goods, and demographic data for the individuals analyzed here, discusses how the construction of the Roman style necropolis in Salona was a component in reordering the cultural landscape and development of Roman identity.

Velić n= 3

Velić is a small modern village in Dalmatia near Tugare and Solin but more towards the hinterland about 30 km east. Archaeological mapping and excavations through the University of Zagreb were conducted in Velić and neighboring Trilj and Jabuka from 2014-2016 (Bužanić et al., 2017). Velić dates to the Late Roman Period and the burials were stone tombs (Bubić, 2011). These characteristics are consistent with the surrounding areas association with the Roman veteran colony *Colonia Claudia Aequum* and evidence of a key Roman Road nearby (Bužanić et al., 2017).

Vranjic n= 19

Vranjic is a modern coastal village just north of the city of Split on both the Adriatic Sea and the Jadro River. The individuals analyzed here are from a recent unpublished excavation which dates to the Roman period when Vranjic was only 4 km from the key Roman city of Salona. Archaeological stele from Vranjic dated between 100- 300 CE offer some insight on the inhabitants; showing Roman style burial portraits, iconography, and Latin inscriptions, co-occurring with local hair styles in the deceased's portraits (Maršić, 2011).

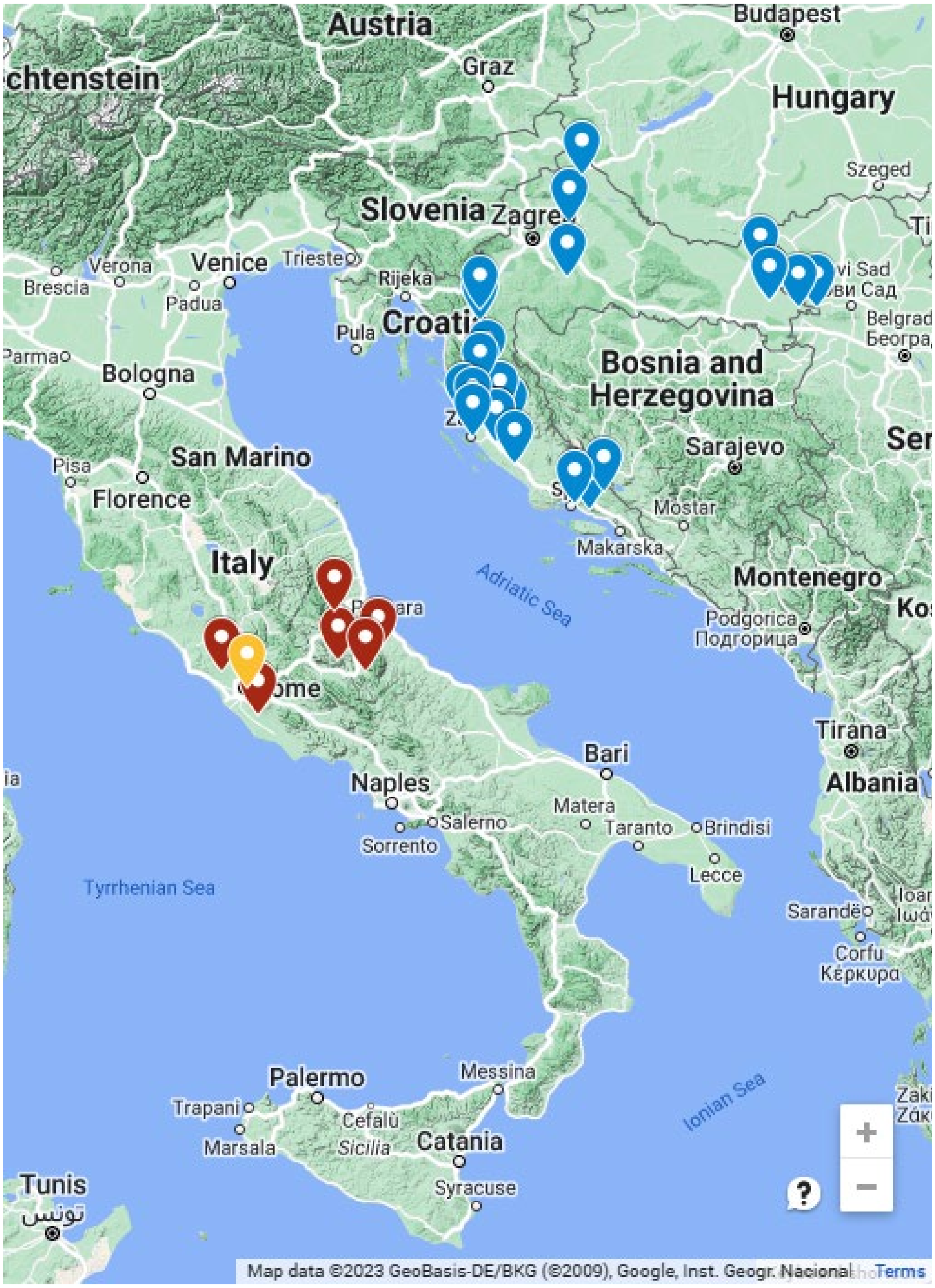


Figure 11 Locations of sites used in analyses on modern topographical map. Collected samples in blue, supplemental data in red, Rome in yellow. Google Maps, 2023.

Table 3

All supplemental samples using the name and abbreviation from the original paper.

Population	Author	Abbr.	Time period	Date			N	Pool-ed In	Used In
Roman	Coppa 2007	REM	Roman Empire	100	400	CE	1,169	REM	6.2, 6.3
Recent Latini	Coppa 1998	LAC	Late IA, Early Republic	450	200	BCE	94	RRP	6.2, 6.3
Recent Etruscans	Coppa 1998	ETC	Late IA, Early Republic	450	200	BCE	102	RRP	6.2
Recent Piceni	Coppa 1998	PCC	Late IA, Early Republic	450	200	BCE	211	RRP	6.2
Sulmona	Coppa 1998	SUL	Late IA, Early Republic	450	200	BCE	52	RRP	6.2
Latini	Coppa 1998	LAB	Iron Age Italic	750	500	BCE	41	RIA	6.2
Etruscans	Coppa 1998	ETB	Iron Age Italic	750	500	BCE	95	RIA	6.2
Piceni	Coppa 1998	PCB	Iron Age Italic	750	500	BCE	136	RIA	6.2
Montani	Coppa 1998	MON	Iron Age Italic	900	500	BCE	40	RIA	6.2
Sanniti	Coppa 1998	SAN	Iron Age Italic	750	500	BCE	163	RIA	6.2

Note: N shows the number of individuals included in the original sample and not necessarily the number of individuals in these analyses due to lack of overlapping traits. The pooled column shows the abbreviated names of the pooled samples and the analyses they were used in. The last column gives the corresponding chapter and section in this dissertation where they are discussed (Coppa et al., 2007, 1998).
Abbreviations: RRP, Roman Republican Period; RIA, Roman Iron Age; REM, Roman Empire.

Supplemental Samples

This dissertation uses a comparative analysis within the Adriatic region. In addition to the primary dataset, supplemental data of dental non-metric trait frequencies from previous studies that investigated population change have been incorporated. By integrating these additional sources of information, this research provides a more comprehensive comparison across the region of population dynamics during the Iron Age and Roman periods. The reported frequency data from these studies is used, and therefore limited to only the traits they made available and cannot incorporate the supplemental data in data cleaning tests. However, the complementary data come from studies which conducted their own inter-trait correlation and trait cleaning analyses. These include the following samples listed below.

Italic Roman Iron Age, RIA

This pooled Iron Age sample includes frequency data from Coppa et al.'s (1998) paper from the Italic peninsula between the 7th to 5th centuries BCE. In a later publication, Coppa et al. (2007), refer to this time span, the Middle Iron Age, as between c. 800- 600 BCE, or the 9th to 7th centuries BCE. RIA includes samples LAB, ETB, PCB, and SAN from the 7th to 5th centuries BCE, and MON from the early 9th to the 8th centuries BCE. The Campani/ CAB sample was excluded due to the geographic location southwest of the other samples. With both publications in mind, RIA is generalized to c. 800- 500 BCE.

Italic Late Iron Age, Republican Period, RRP

This pooled Late Iron Age/ Republican Period Italics sample includes frequency data from Coppa et al.'s (1998) paper from the Italic peninsula between the 4th – 2nd centuries BCE. RRP includes samples LAC, ETC, PCC, and SUL. The Campani/ CAC samples were excluded due to their geographic location southwest of the other samples.

As with RIA, these dates vary slightly between publications. Therefore, the Late Iron Age/ Republican Period samples are generalized to c. 500- 200 BCE.

Italic Roman Period, REM

The Roman Empire sample REM is from Coppa et al.'s (2007) paper originating From c. 100- 400 CE.

Dental Pathology

A brief discussion of dental pathological lesions is important. As previously addressed, there is generally less bioarchaeological work with Roman populations[6], and the discipline is relatively new in Croatia. Nevertheless, there have been many anthropological analyses of human dentition from the Eastern Adriatic and hinterland. The issue here is that pathological manifestations can affect dental wear and therefore dentition available for analyses, similar to mortuary customs, and these can also be class or health related (Rohnbogner & Lewis, 2016; Ullinger & Loewen, 2022). Despite the many reports on dentition at Iron Age and Antique sites, the consequential biocultural analyses needed to generalize population or class specific wear patterns are still an area of on-going work. Besides, class and health related generalizations with archaeological populations can be problematic, as addressed in detail in a discussion on Nadin Gradina (Loewen et al., 2021; Reitsema & McIlvaine, 2014). Furthermore, some publications do provide comparative analyses, however, Roman Empire residents in Pannonia and Dalmatia (3rd- 5th century CE) are not distinguished as ancestrally local or otherwise

[6] This is not a universally held sentiment, rather seems most applicable to biocultural approaches and relevance to classical studies.

(Peko & Vodanović, 2016; Šlaus, 2002b). In fairness, this distinction may not be possible and is a key reason why research such as this dissertation is relevant. For these reasons, it was not feasible to include population specific wear as a component in material selection. Finally, while sample bias can arise from differential wear patterns, recent research finds that this can be overcome depending on the way research is conducted (Fidalgo et al., 2021).

Mortuary Traditions

Mortuary treatment of the body can affect the survival and condition of human remains and therefore has the potential to skew what remains are preserved. As many populations throughout the region cremated their dead to a degree which makes dental analyses unfeasible, mortuary traditions and their potential impacts on sample availability must be addressed. Some data were collected from cremated dentition; however, most data were from inhumations. After careful review, this research finds that burial types, such as cremation vs. inhumation, in the region are so variable that there are no particular time periods, geographies, or populations to which they can solely be ascribed. However, there are variations in style and customs that researchers use to identify cemeteries, particularly in the Iron Age and earlier. Nevertheless, many of the mortuary changes in the Adriatic preceded Rome's arrival or were not immediately transitioned to after Roman influence. Additionally, it is difficult to use changes in burial types, styles, or mortuary traditions as the defining line between cultural Romanization or otherwise as influence came to the Eastern Adriatic from throughout the region. For example, from the 5th century BCE and later, Liburnian burials contained architecture and placement of pottery consistent with Hellenistic elite graves, and yet concurrent with locally produced pottery in non-elite graves (Glogović 2014; Batović 1974). In Histrian Istria, cremations in large communal cemeteries called urnfields were common, similar to nearby Pannonian and Celtic neighbors (Nicholls, 2017; Višnjić, Cavalli, Percan, & Innocenti, 2014, p. 37). Furthermore, Roman colonists utilized a variety of mortuary practices as well, incorporating local traditions into their rituals, while local peoples adopted different aspects of Roman traditions, creating new practices (Aarts & Heeren, 2017; Daniels, 2017; Pearce & Weekes, 2017). Moreover, identifying the actual origins of individuals during the Roman Period without epigraphic information is made difficult by the fact that Rome conscripted people from throughout the Empire and they could be repatriated or laid to rest where they were stationed or relocated (Prowse, 2016; Tybout, 2016). The next section reviews some of the mortuary customs in the region in order to demonstrate how many populations used similar customs with long term continuity, and yet they varied and changed over time.

Eastern Adriatic and the Hinterland

Tumuli burials were common during the Early Iron Age Adriatic which were slowly replaced by flat necropoli that then took on Roman cemetery layouts (Bakarić, 1986; Zavodny, 2022). Despite the change in cemetery layout, cremations and inhumations co-occurred among these sites throughout the different time periods (Balen-Letunić, 1981; Zavodny, 2020, 2022). Tumuli represent a major late Bronze Age and Early Iron age burial form along the Adriatic, from Slovenia to Albania (Potrebica & Dizdar, 2014; Šikanjić, 2006). These earthen barrows, sometimes ringed in stone, can contain ceremonial jars, urns, funeral pyres, and stone-lined inhumations (Wilkes, 2003). Flat necropoli were also common in the Iron Age, situated outside settlements or hillforts (Batović, 1974; Zdenko Brusić, 2005; Kukoč, 2009; Višnjić et al., 2014, p. 37). Inhumations are often found in stone-lined crypts on bedrock with single or multiple individuals in both supine and flexed positions. Necropoli were aligned along roads with lanes or pathways between the roads, as well as open areas throughout. Some had mausolea in closed structures or open sky walled chambers or rectangular stone enclosures containing large square monuments. Necropoli contained cremations, burial urns, and funerary pyres (Nicholls & Buckberry, 2016; Potrebica & Dizdar, 2014).

Despite the diversity in burial types there was some local continuity in burial style. For example, northern Adriatic groups were influenced by Celtic Late Urnfield populations, nevertheless, burial urns could differ greatly (Nicholls & Buckberry, 2016). House shaped conical vessels with pointy lids were used in southeast Slovenia and parts of nearby Croatia; connected to Celtic groups associated with Segestica/ Siscia (Drnić & Miletić Čakširan, 2014). The Japodes primarily used inhumation, but cremations with and without urns were more common around the 4th century BCE (Marić, 2002, p. 297; Wilkes, 1995, p. 57). Around the wider region of modern Zagreb in the northern hinterland, cremations contiguous with the Late Urnfield contained small bowl-like vessels, often buried with metal fibulae, hair rings, knives, and other material culture (Batović, 1974; Glogović, 2014, p. 3; Karavanić, 2013). These Pannonian burials, both cremations and inhumations, were differentiated from Japodes by their burial placement with weapons and jewelry (Marić, 2002, p. 297). Graves could also be lined with upright stone slabs or *tegulae* (overlapping ceramic roof tiles), with the cremated remains placed at the base of the grave.

Liburnian burial formations also included cremations, inhumations, or both. The typical Liburnian burial tradition during the Iron Age, continuing from the Bronze Age, was a contracted inhumation in a cist with four unworked stone slab vertical walls covered with another unworked slab (Batović, 1974, p. 222; Glogović, 2014, p. 3). These graves were reused, potentially as family plots similar to some tumuli. The reuse resulted in commingling and fragmentation of remains and transformed singular inhumations into multiple burial plots (I. Armit et al., 2022; Glogović, 2014, p. 3; Loewen et al., 2021). With Roman influence, burial style did change, such as the use of amphorae and glass vessels, however, burial types persisted from the Bronze Age through the Roman Period. Burial plans also changed as there were local versions of the linear Roman necropolis constructed in the Eastern Adriatic around the period of early Roman influence (Zdenko Brusić, 2005; Kukoč, 2009; Kukoč & Čelhar, 2019).

Roman mortuary practices

Roman mortuary practices and traditions are well known as they were written and even dictated by law (e.g., *the lex duodecim tabularum*[7] or *Sumptuariae Leges,* laws on extravagance). Romans believed in life after death and, in some ways, the dead could interact with the living. Writings from the 1st and 2nd century BCE suggest that there was belief in a collectivity of spirit ancestors that could haunt the living and be capable of providing both aid or harm (Toynbee, 1996, p. 35). The deceased acted back upon the

[7] See definition in the appendix.

living, necessitating objects and customs to mediate interaction between the two (Ackers, 2018). Through time, and eventually with the influence of Christianity, Romans believed in different places the soul could reside, such as Elysium, the underworld, or with the spirit deities, the *manes* (King, 2020). There is a consistent tone in writings, art, and poetry that works during life could affect the state of an individual's soul after death and additionally, that mortuary behaviors and practices by the living also affect the soul of the dead (King, 2020). Both individuated and collective ideas of after-life existence were held through the Republican era, increasingly becoming individuated into the Imperial period with the influence of foreign aristocrats, Stoicism, and other philosophies (Giunio & Alihodžić, 2019, p. 35).

Cremation was a common practice, but not universal. From about 400 BCE, cremation was considered the normal practice in Northern Italy and inhumation was typical in the south with the popular ancillary customs of elaborate ash-urns, ash-chests, and cremation of pets up until the 1st century CE (Davies, 1977; Toynbee, 1996, p. 40). Around that time the decision to cremate or inhumate was a personal, family, and sometimes financial decision, and either cremation or inhumation was acceptable (King, 2020). Communal cremation mausoleums called *columbaria* also become common (M. Scott, 2012). Cremation was practiced in different ways. The burning of a body or bodies could be conducted at the cemetery on a centralized pyre (*ustrinae)* or done at the grave itself (*bustum*) (Šostaric, Dizdar, Kusan, Hrsak, & Mareković, 2006), and then doused with wine, water, and oils (Ovid, 1839, p. 561; Toynbee, 1996). The charred remains were sometimes placed in urns, and in Southern Pannonia during the early Roman Period, there is evidence of a cremation placed in a wooden coffin (Šostaric et al., 2006). Libation holes or pipes could also be placed in the grave with an opening on the surface so mourners could provide votive gifts (Wolski & Berciu, 1973). Or the tube could be hidden in a vase or stele above the burial. Furthermore, grave offerings could be included in both inhumations and cremations, and sometimes burned with the pyre or placed in the grave after the cremation. Other grave offerings included oils and perfumes in bottles, lentils, fruits, olives, and other foods, and other common grave goods like jewelry (Ovid, 1839; Šostaric et al., 2006). Embalming was also practiced, though less often.

Graves became increasingly more ornate and in more public locations during the Republican period. By the 2nd century CE, elaborate sarcophagi gained in popularity, contributing to inhumations becoming widespread once again and eventually the norm in later periods with early Christians (M. Scott, 2012). When inhumation was used, the poor were placed directly in the ground, fully extended in trench graves, while the wealthy were laid extended in stone cut sarcophagi which were buried or placed in catacombs (Toynbee 1996:49). The sarcophagi could be very ornate, as were the above ground mausolea or tombs that some were laid in or under, often surrounded by gardens. Additionally, enslaved Romans were buried by their owners and therefore the owner determined the burial style. As inhumation would have been less expensive than cremation, enslaved and the poor may have been inhumed despite their ancestral customs (Giunio & Alihodžić, 2019, p. 38). Nevertheless, burial style is not a reliable interpreter of class since during the first century CE, the presence of foreign aristocrats influenced inhumation frequency among the upper class and eventually it predominated by the 5th century (Giunio & Alihodžić, 2019, p. 38).

Roman mortuary influence

The Roman conquest of the Adriatic region did impact local mortuary customs. One of the most notable changes is evident in cemeteries such as the necropolis at Nadin, where multiple burial styles co-occurred around 100 BCE, however, there was a general shift to extended inhumations. Indeed, inhumation style, flexed vs. supine, appears to be more telling of temporal differences than other practices. The burials before this tended to be crouched inhumations, though occasionally supine inhumations were used, becoming more common towards the Roman period even while cremation was still used (Batović, 1974, p. 222; Zdenko Brusić, 2005; Glogović, 2014). Eventually, flat cemeteries became the norm, however, tumuli may have continued up to the Roman Period (Batović, 1974, p. 243). Other forms of Roman influence on mortuary customs have been documented, including the adoption of *cippi*, a type of marker stone, stele, or pedestal that could also be a tomb stone (see image below). Cemeteries in Dalmatia and Liburnia show changes in the plan of the necropoli to reflect local versions of Roman layouts, including changes in foot traffic pathing (Kukoč, 2009; Kukoč & Čelhar, 2019; Wilkes, 2003). Although customs were cross-adopted from Romanized regions and may be a reflection of Roman conquest and influence, they do not broadly differentiate between Romans and non-Romans, civilians and soldiers, elites and non-elites, or those who were Romanized and those who were not (Mason & Županek, 2018). Instead, the mixing of past and present traditions seems to be motivated by local factors and gradual influence.

Figure 12 Photographs, Left: The placard states that this is the "Liburnian Cippus of Rubria Maxmilla, 1st century, limestone, Asseria (Podgrađe near Benkovac)". Currently located at the Archaeological Museum in Split. Right: Nadin necropolis, 2016. Both photos by author.

METHODS

Fifty-two dental non-metric ASUDAS traits were scored for 313 individuals from 31 archaeological sites in 27 locations across Croatia (Table 2). The author was provided with data on the identification, dating, and sometimes osteological analyses of these individuals, which was collected by archaeologists involved in their excavation and research. When archaeologists or collection managers did not provide age and sex data, they were estimated by the author for all individuals with well-preserved skeletal remains. Data were recorded over four months during the spring and summer of 2022 at numerous research facilities throughout Croatia, mentioned previously. The methods are discussed in detail below.

Data Collection Protocols

Dental maxillary and mandibular morphological data were observed using a supplemental light source and 1.5 X magnification according to the Arizona State University Dental Anthropology System (ASUDAS) standards outlined in Turner, Nichol, and Scott (1991), and Scott and Irish (2017) (Table 35, Appendix VII). Data were recorded from both right and left sides of each dental arcade and the highest of the two raw scores were used in later dichotomization. When preservation prohibited observation of one side, the other side was used. Regionally, preservation can be poor as it is affected by acidic and sandy soils and farming (Nicholls & Buckberry, 2016). Before tests were conducted, traits with very low observations were removed.

Osteological Analyses

Osteological age and sex, population identifiers, dates and date ranges were provided for many individuals by colleagues at the Croatian institutions. When age was not provided, analyses using osteological and dental methods were conducted to determine an individual's possible age. For younger ages, childhood through early adulthood, development was accessed using fusion of skeletal epiphyses (Buikstra & Ubelaker, 1994; M. Schaefer, Black, & Scheuer, 2009), and dental eruption (Buikstra & Ubelaker, 1994; Massler, Schour, & Poncher, 1941). For older individuals and when post-crania were available age was assessed using osteological methods (Brooks & Suchey, 1990; Buckberry & Chamberlain, 2002), and dental wear (Lovejoy, 1985), to provide a general age category of adult or older adult. Individuals were then categorized into six groups for analyses: young child (under 6); juvenile (6- 12 years old); adolescent (12 to 20 years old); young adult (about 21 to 35 years old); adult (showing signs of complete union, but not degeneration); and mature adult (adult showing signs of age-related skeletal degeneration). Although correlated, dental wear may not always be indicative of age (Benazzi, Bonetti, Cilli, & Gruppioni, 2008; Družijanić, Vodanović, Šlaus, Čapkun, & Brkić, 2019; Mays, Zakrzewski, & Field, 2022), therefore, other indicators of senescence, such as arthritis and mandibular response to tooth loss, were considered when assigning a general age category.

Osteological sex estimations are proxies for chromosomal attributes of individuals and rely on the robusticity and size of skeletal components produced by chromosomally controlled hormones. Many individuals may fall between the traditional assignment of male and female, therefore, non-dichotomous sex categorization was used to incorporate the spectrum of human variation more accurately. When sex was not provided or post-crania were present, sex was estimated using both cranial and post-cranial morphological variation (Buikstra & Ubelaker, 1994; Jerković et al., 2016; Šlaus, 2006, 2021). This study uses the traditional monikers of male and female, however, in recognition of biological variation, individuals that either displayed intermediate or combined morphology (neither or both robust and gracile features using multiple methods) were assigned a third category. This category differs from "unknown," which indicates that no sex estimation methods were possible, or the individual was too young. Unlike typical osteological sex estimations which identify individuals as (possibly) "probable male/ female" vs. "(likely) "male/ female," all estimates here should be considered "probable" and in no way definitive or indicative of gender or gender roles.

Pre-Analysis Data Cleaning

Prior to estimating distances, data were "cleaned" using pre-analysis treatments to maximize genotypic coverage and minimize bias caused by sample differences across sites. Data cleaning involves testing for observer error, assessing traits for age/ sex correlations, and finally estimating inter-trait correlations to minimize trait redundancy. Typically, these tests are conducted in the order presented and traits are removed before the subsequent test. However, due to the ease of analyses in the programming platform R, many statistics were conducted at the same time for most of the traits (R Core Team, 2018). The methods are explained below in more detail. The last step in data cleaning is conducted during analysis. Data were analyzed in the R package AnthropMMD (discussed in detail below), which allows non-polymorphic traits, those which do not vary between groups, to be excluded (Santos, 2018). As discussed in the Chapter 4 discussion on trait selection, non-polymorphic traits are not useful for biological distance analysis because they do not provide any information about the gene flow as each population already shares those traits.

Inter- and intra- observer error tests

Inter-observer error tests were performed between the author and Ana Curić at the University of Split. Inter-observer tests between Loewen and Curić involved examining the same loose dentition (traits, n= 41) according to ASUDAS. They were analyzed using a Cohen's Kappa (Jacob Cohen, 1960), of all examinations to test agreement between the two raters. A score of $\kappa > .41$ indicates moderate agreement or higher.

Similarly, comparisons were made between repeated recordings of the same individuals (n= 9; dentition, n=113) using both in-person reexamination and examination of detailed photographs of the dentition by the author. Previous intra-observer tests found that photographs and casts were scored consistently, suggesting that using multiple observation methods should not have a significant impact (Loewen & Scott, 2022). Intra-observer tests (Tables 23- 24, Appendix V) were conducted for two primary purposes. First, the tests assessed the accuracy and repeatability of the observer(s). Second, the tests measure the agreement between observations of each individual ASUDAS trait's raw scores from different recording sessions to identify those traits which are not reproducible. The tests were analyzed using the same statistic as the inter-observer test, Cohen's Kappa (Jacob Cohen, 1960), however, the intra-observer test is conducted differently. All observations may be analyzed together to test repeatability, however, to test trait reliability specifically, each trait is observed multiple times on many sets of dentitions (see Figure 11). Traits with a score of $\kappa < .20$ were excluded.

Cohen's Kappa is one of the most common statistics for inter- and intra- observer error. However, the statistic $\kappa = (Pr(a)-Pr(e))/(1-Pr(e))$, has limitations. Kappa calculates observed accuracy Pr(a) and expected accuracy Pr(e) before computing interrater reliability. Expected accuracy involves an element of random chance to account for false positives. This means that the closer these values are to each other, the lower the numerator, resulting in a lower κ. Therefore, even if observed accuracy and expected accuracy are very high, κ will still be low. These statistical caveats were considered by observing the raw data and Pr(a) before making final trait exclusions (see Table 6).

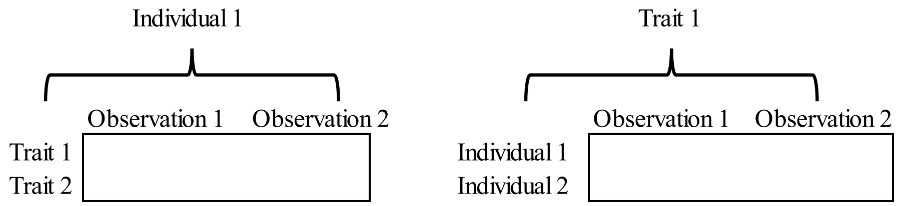


Figure 13 Visual aide to explain the differences between a Cohen's Kappa testing repeatability (left) and trait reliability (right).

Age and Sex

Data treatment is conducted to remove traits that reflect age and sex dependency. Raw ASUDAS scores for each trait were first collapsed between right and left sides to produce either the side recorded or the highest of the two (G. R. Scott & Turner, 1997, pp. 90–91). Three statistics were used; the first two being polychoric correlation and Kendall's Tau-b, assessed on a trait-by-trait basis. Kendall's Tau-b (τ_B), is used to test for an association between two ordered, ranked, and paired sets (Kendall, 1938). Kendall's Tau-b is used to identify individual traits which correlate with age which are then removed. Kendall's Tau-b is considered the standard statistic in biological distance, however, statistically a polychoric correlation may be appropriate as it can identify potential correlations between age and trait scores which follow a normal distribution. Due to wear effects of older individuals' teeth commonly producing declining trait scores, the correlation between raw scores and age may deviate from an ordinal relationship. A polychoric correlation (r), analysis is similar to a bi-serial correlation coefficient and tests a pair of dichotomous or ordered categorical variables that assume a "normal" distribution of a bivariate binned data set. The polychoric results are most applicable to age, though it was used with sex for comparison. Finally, Spearman's correlation coefficient (ρ) is used to test the relationship between each pair of variables. All three statistics use a -1 to 1 scale, with 0 having no correlation at all. Therefore, all three have been examined with the threshold of 0.5 ($-0.5 < x < 0.5$), however p-values with an alpha of 0.05 for Spearman's rho and Kendall's tau are provided.

Inter-trait Correlation

Human dental characteristics are inter-related (Kangas et al., 2004). However, as discussed in Chapter 4, traits which are highly inter-related inflate their genetic signal in the resulting biological distance, thus biasing the results (G. R. Scott, 1977b; G. R. Scott & Pilloud, 2018). Therefore, a pair-wise assessment of inter-trait correlation was conducted for every pair of traits using the tetrachoric correlation statistic, which is similar to the polychoric correlation (Drasgow, 1986). The analysis was conducted on dichotomized data and when associations were identified above a 0.4 threshold, the trait with the largest sample size was used. If sample sizes were similar, the key trait was used.

Calculating Distances

After data cleaning, the next step was to estimate distances between relevant archaeological site groupings. Distances were estimated using the Mean Measure of Divergence (MMD), the most commonly used distance statistic for non-metric traits that quantifies relative relationships among populations (Berry & Berry, 1967; E. F. Harris & Sjøvold, 2004). The MMD converts a series of trait frequencies into a numerical value so that the more dissimilar two samples are, the higher the value returned and therefore the greater their biological distance from each other. The MMD is preferred as it is based on summary data (sample sizes and frequencies), which allows one to use comparative data sets (E. F. Harris & Sjøvold, 2004; Irish, 2010). This contrasts with other distance statistics which require data for every individual. In addition, because the estimate is based on site-level frequencies and does not require complete data matrices for every individual, it can be used with missing data and not every population needs the same sample size. Finally, MMD produces distances which are comparable to Mahalanobis distances, the preferred statistic in biological distance analyses using continuous scale data (E. F. Harris & Sjøvold, 2004; Irish, 2010).

Site level data were first dichotomized into binary variables according to trait-specific breakpoints (G. R. Scott & Irish, 2017; Turner et al., 1991) for the purposes of estimating site frequencies, and then consolidated to sample size and frequency for each trait and population. These data were then transformed using Anscombe's angular transformation to stabilize variances using the R package AnthropMMD (Santos, 2018). AnthropMMD provides two methods for data transformation, however, both Anscombe's and Freeman-Tukey transformations produced nearly identical results (Anscombe, 1948; M. F. Freeman & Tukey, 1950; E. F. Harris & Sjøvold, 2004). The program provides a matrix of biological distances and their p-values according to the equation presented below (R Core Team, 2018; Santos, 2018).

$$\mathrm{MMD} = \frac{1}{r}\sum_{i=1}^{r}\left[(\theta_{1i}-\theta_{2i})^2-\left(\frac{1}{n_{1i}+0.5}+\frac{1}{n_{2i}+0.5}\right)\right]$$

The R package AnthropMMD provides a graphical user interface (GUI) to input different populations according to the user's hypothesis and testing needs. The results were derived by configuring AnthropMMD's GUI to maximize trait selection and population size, with attention to representation of both dental arcades and a balanced dispersion of MD across traits (Santos, 2018). Results are considered significant when the MMD is greater than twice their standard deviation (Sjøvold, 1973). AnthropMMD also provides two graphical representations of the results. The first is a representation of ordinated distances using Multidimensional scaling (MDS) to graphically plot patterns of similarity and difference among the samples (Santos, 2018). The MDS plot, also called a Principal Coordinates Analysis (PCoA), visually scales distances in a 2 or 3-dimensional graphical representation so population relationships can be observed. The second graphic represents distances using Ward's method of hierarchical clustering analysis. Ward's cluster analysis provides a dendrogram to visualize an agglomerative hierarchy of clusters (Ward, 1963).

Table 4

List of all dental ASUDAS traits which were recorded.

Maxillary traits		**Mandibular traits**	
I1DblMargRdg	I1 Double Marginal Ridge	LCMargRdg	Canine Marginal Ridge
I1MargRdg	I1 Marginal Ridge	LCDAR	Canine Distal Accessory Ridge
I2MargRdg	I2 Marginal Ridge	LCRootNum	Canine Root Number
I1Intgroov	I1 Interruption Groove	P3TomeRt	P3 Tome's Root
I2Intgroov	I2 Interruption Groove	LP4LingCuspVar	P4 Lingual Cusp Variation
I2Mesialbend	I2 Mesial Bend	LM2Groove	M2 Groove Pattern
I1tuberdent	I1 Tuberculum Dentale	LM1AntFovea	M1Anterior Fovea

I2TubDent	I2 Tuberculum Dentale	LM1EnmlExt	M1 Enamel Extension
I2PegRedAgenU	I2 Peg shaped Reduced Agenesis	LM1Protostylid	M1 Protostylid
CTubDentU	Canine Tuberculum Dentale	LM1C5Hypoconulid	M1 C5 Hypoconulid
CDARU	Canine Distal Accessory Ridge	LM2C5Hypoconulid	M2 C5 Hypoconulid
CRtNumbU	Canine Root Number	LM1Cusp6	M1 Cusp 6
UP3Acusp	P3 Accessory Cusps	LM1Cusp7	M1 Cusp 7
UP3MXPAR	P3 Accessory Ridges	LM1RootNum	M1 Root Number
UP4MXPAR	P4 Accessory Ridges	LM2RootNum	M2 Root Number
P3rootnum	P3 Root Number	LM2Protostylid	M2 Protostylid
M1MesAccU	M1 Mesial Accessory Cusp	LM3AGEN	M3 Peg shaped Reduced Agenesis
M2metacone	M2 Metacone	LM3Protostylid	M3 Protostylid
M3metacone	M3 Metacone	Odontomes	Odontomes
M2hypocone	M2 Hypocone	EnamelPearl	Enamel Pearls
M3hypocone	M3 Hypocone		
M2cusp5	M2 Cusp 5		
M3cusp5	M3 Cusp 5		
M1Carabelli	M1 Carabelli		
M3Carabelli	M3 Carabelli		
M1parastyle	M1 Parastyle		
M3parastyle	M3 Parastyle		
E0mExtUM1	M1 Enamel Extension		
M1rootnumU	M1 Root Number		
M2rootnumU	M2 Root Number		
M3rootnumU	M3 Root Number		
M3pegshape	M3 Peg shaped Reduced Agenesis		

Note: Traits are listed in the first and third columns in abbreviated form and as they appeared in analyses. Their full names are listed to the right of the abbreviations in the second and fourth columns.

CHAPTER 6 RESULTS

This chapter presents the results of the pre-analytical data treatments including inter- and intra- observer tests, age and sex correlation, and inter-trait correlation analyses. These are followed by the results of the biological distance analyses using MMD which address the hypotheses discussed in Chapter 1. These are presented with graphical interpretations of the determined relationships using MDS and hierarchical cluster analyses. The interpretation of the results and their significance to this study's hypotheses are enumerated in the discussion section. A summary of the data collected from the skeletal and dental samples, including frequency data and sample sizes, is also provided. As previously stated, traits with very low observations were removed. These were maxillary I2, M3, and mandibular M3 dentition with peg shape, reduction, or agenesis as well as all odontomes and enamel pearls.

DATA CLEANING

Inter- and intra- observer error tests

Inter-observer error tests demonstrated consistent repeatability between Loewen and Curić with higher than moderate agreement (n=41, Pr(a)= .85, Pr(e)= .70, κ= 0.50). Additionally, Loewen conducted intra-observer error analyses, which demonstrated repeatability for all traits across multiple recording sessions (observations, n=113, Pr(a)= .85, Pr(e)= .50, κ= 0.68) and regardless of side (left, n= 67, Pr(a)= .82, Pr(e)= .50, κ= 0.64; right, n= 46, Pr(a)= .86, Pr(e)= .50, κ= 0.74).

Intra-observer error tests were conducted to identify inconsistent traits. Traits lower than 0.2 (fair agreement) were excluded, with a few exceptions. The following five traits were excluded: (maxillary), I2 marginal ridge, M3 Carabelli's cusp; (mandibular), M1 root number, M1 anterior fovea, C marginal ridge (See Appendix V). Protostylid was kept in the analyses due to examination of the raw data which shows a variation not present in ASUDAS. The breakpoint assignment for mandibular M1 protostylid was set at 2 to avoid the pronounced "pit" manifestation from affecting the analysis (see Appendix VII). Also, maxillary I1 and I2 Interruption grooves and maxillary M1 enamel extension were kept as they had high Pr(a), observed accuracy, or the results were inconclusive due to the effect described in Chapter 5.

Age

Age correlation was assessed using Spearman's rho, polychoric correlation, and Kendall's Tau. Results are presented in Table 21, with the following traits excluded (alpha= .05): maxillary canine tuberculum dentale, n= 113; maxillary P3 MXPAR premolar accessory ridge, n= 79; maxillary M1 Carabelli's cusp, n= 125; mandibular M1 Cusp 6, n= 89 (see Table 6).

Sex

Sex correlation was assessed using Spearman's rho, polychoric correlation, and Kendall's Tau. Results are presented in Table 22, with the following six traits excluded (alpha= .05): (maxillary) Canine tuberculum dentale, n= 56; Canine distal accessory ridge, n= 34; (mandibular) Canine root number, n= 70; M1 Cusp 7, n= 52; M1 Root number, n= 37; M2 Protostylid, n= 68 (see Table 6).

Inter-trait Correlation

Inter-trait correlation does not alone exclude a trait from consideration, since to some degree all teeth, teeth in the same arcade, and those of the same field/ class will share genetic overlap. However, if traits from the same field (i.e., M1 and M3 Carabelli's cusp) did show statistical correlation, the one with either the greater sample size or greatest number of populations was retained in the analyses, as previously discussed in Chapter 5. Correlated traits are listed in Table 5 and full matrices are in Appendix V. Traits that were removed for inter-trait correlation alone are maxillary I2 Tuberculum dentale and mandibular M3 Protostylid.

Table 5

Traits correlated to one another using tetrachoric correlations.

Trait Examined	Correlated traits above 0.4 threshold		
I1DblMargRdg			
I1MargRdg	I2MargRdg		
I2MargRdg	I1MargRdg	LM3Protostylid	
I1Intgroov	LCRootNum		
I2Intgroov	I2TubDent		
I2Mesialbend			
I1tuberdent	M1rootnumU		
I2TubDent	I2Intgroov		
I2PegRedAgenU	LM1EnmlExt		
CTubDentU			
CDARU			
CRtNumbU			
UP3Acusp			
UP3MXPAR			
UP4MXPAR	LM1C5Hypoconulid	LM2RootNum	
P3rootnum	M2metacone		
M1MesAccU	M3cusp5		
M2metacone	P3rootnum	LM2Protostylid	
M3metacone			

M2hypocone			
M3hypocone	LCDAR		
M2cusp5	M1parastyle	LCMargRdg	
M3cusp5	M1MesAccU	LM1C5Hypoconulid	
M1Carabelli			
M3Carabelli			
M1parastyle	M2cusp5		
M3parastyle			
E0mExtUM1			
M1rootnumU	I1tuberdent	LM1Cusp7	
M2rootnumU			
M3rootnumU			
M3pegshape			
LCMargRdg	M2cusp5		
LCDAR	M3hypocone		
LCRootNum	I1Intgroov		
P3TomeRt	LM3Protostylid		
LP4LingCuspVar			
LM2Groove	LM3Protostylid		
LM1AntFovea			
LM1EnmlExt	I2PegRedAgenU		
LM1Protostylid			
LM1C5Hypoconulid	UP4MXPAR	M3cusp5	
LM2C5Hypoconulid			
LM1Cusp6			
LM1Cusp7	M1rootnumU		
LM1RootNum			
LM2RootNum	UP4MXPAR		
LM2Protostylid	M2metacone		
LM3AGEN			
LM3Protostylid	I2MargRdg	P3TomeRt	LM2Groove

Abbreviations: U, upper/ maxillary traits; L, lower/ mandibular traits.

Removed traits

In summary, due to correlations with age, sex, other traits, observer error, or poor sample size, the following traits were removed before final analyses: (maxillary) I2 marginal ridge; I2 tuberculum dentale; Canine tuberculum dentale; Canine marginal ridge; Canine distal accessory ridge; P3 MXPAR premolar accessory ridge; M1 and M3 Carabelli's cusp; (mandibular) Canine root number; M1 Cusp 6; M1 Root number; M2 and M3 Protostylid, M1 Anterior fovea. Also, maxillary I2, M3, and mandibular M3 dentition with peg shape, reduction, or agenesis, odontomes and enamel pearls were excluded. Of the remaining traits, some were included in local analyses but excluded from analyses with supplemental data due to differences in breakpoints.

Table 6

List of all dental ASUDAS traits collected.

Maxillary traits		**Mandibular traits**
I1DblMargRdg	M3 Metacone	LCMargRdg†
I1MargRdg†	M2 Hypocone	LCDAR
I2MargRdg	M3 Hypocone	LCRootNum†
I1 Inter. Groove‡§	M2 Cusp 5‡	P3TomeRt‡
I2 Inter. Groove‡§	M3 Cusp 5	LP4LingCuspVar‡
Mesial Bend‡	M1 Carabelli†	LM2Groove‡
I1 Tub Dentale	M3 Carabelli†	LM1AntFovea†
I2 Tub Dentale†	M1 Parastyle‡	LM1EnmlExt
I2 Peg Red Agen†	M3 Parastyle	**LM1Protostylid**‡§
Canine Tub. Dentale†	**E0mExtUM1**‡§	LM1C5Hypoconulid
CDARU†	M1 Root Number	LM2C5Hypoconulid‡
Canine Root Number	M2rootnumU	LM1Cusp6†
P3 Accessory Cusp	M3 Root Num‡	LM1Cusp7‡
P3 MXPAR†	M3 Peg Red Agen†	LM1RootNum†
P4 MXPAR		LM2RootNum
P3 Root Number		LM2Protostylid†
M1MesAccU		LM3AGEN†
M2metacone		LM3Protostylid†
		Odontomes†
		Enamel Pearl†

†traits removed prior to analyses; also highlighted in tan
‡traits used in analyses; also highlighted in blue.
§traits which were flagged on any of the tests but were also left in analyses are bolded and discussed in the text.

Results of Non-Metric Analyses

The following results provide relationships of grouped samples by temporal and geopolitical population labels with local (from the same side of the Adriatic) and regional (within the wider Adriatic, hinterland, Pannonian basin, and north Mediterranean region) origins. Populations have been pooled by time periods, the Iron Age or Roman Period. The one exception are the supplemental data from Coppa et al., (2007) wherein the Roman Empire sample "REM" is from the 1st- 4th century CE Italian peninsula which complement Coppa et al., (1998) Italic Roman Iron Age and Republican Period samples (c. 800- 500 BCE and c. 500- 200 BCE respectively) providing three temporal periods from the Italian peninsula. While these periods do not align with the greater region's separation into the Iron Age (c. 800- 200 BCE), and Roman Period (Roman Republic c. 200- 1 BCE; Roman Empire c. 1- 500 CE), this is considered in interpretations. Due to sample size issues some populations are pooled or excluded from some analyses. All tables and figures were provided by AnthropMMD (Santos, 2018), except for maps. These results address the hypothesis and three core questions of this dissertation (repeated from Chapter 1 below), while supplementary data may be found in the appendix which provide additional context.

Null hypothesis: Dental morphological microevolutionary analyses do not support statistically significant differences among Adriatic, hinterland, and Italic populations during the Iron Age and Roman Periods; despite their historically identifiable geographic, political, and material changes attributed to interaction and Romanization.

Alternative hypothesis: Dental morphological microevolutionary analyses support evidence of statistically significant differences among Adriatic, hinterland, and Italic populations during the Iron Age and Roman Periods, possibly demonstrating changes in gene flow consistent with historically identifiable geographic, political, and material changes, attributed to interaction and Romanization.

This research assesses the hypothesis through the following questions:

1. Were indigenous peoples of the Adriatic and hinterland phenetically indistinguishable from one another or the Italic Romans around the beginning of region-wide interactions at the end of the Iron Age?
2. Do the populations of the Eastern Adriatic and hinterland, who are considered Roman and were potentially local descendants of the indigenous peoples, demonstrate gene flow between each other or Romans from the Italian peninsula after the expansion of the Roman Republic and Roman Empire?
3. Do variations of gene flow, if present, correlate with a history of either conflict or allyship with Rome among indigenous-descended peoples who were Romanized?

The results are broken down into three sections, roughly addressing each of the three questions:

6.1 Discusses results using only the data collected in person by the author and only the Eastern Adriatic and hinterland populations.

6.2 Discusses results using Eastern Adriatic and hinterland samples with supplemental data in multi-period analyses which address the core questions.

6.3 Considers the previous analyses and then using Eastern Adriatic and hinterland samples with supplemental data in multi-period analyses, attempts to address the hypothesis as it relates to the Liburnians specifically.

6.1 Recorded Data Only, Local Focus

Eastern Adriatic and hinterland relationships were analyzed using two Iron Age samples and three Roman Period samples, (9 traits, minimum of n= 22 per trait), LBIA (Iron Age Liburnian), DHIA (Iron Age Delmatae, Pannonians, and Japodes), PANR (Roman Period Pannonian), LBR (Roman Period Liburnian), and DELMR (Roman Period Delmatae). Liburnians (LBIA) were compared to the combined (DHIA) sample to increase sample size as Japodes have been shown to overlap culturally and geographically with Pannonians (see Chapter 2). Two conclusions based on this analysis follow.

First, the results of this analysis do not support any statistically significant differences among the Eastern Adriatic and hinterland populations. Results show phenetic agreement between populations during both the Iron Age (IA) and Roman (R) Periods. Additionally, this analysis does not find differences within groups between ancestors and descendants; for example, between the Iron Age Liburnian (LBIA) and Roman Liburnians (LBR). Statistical significances are presented in Tables 9 and 10.

Table 7

MMD values in upper triangular area of matrix and flagging of significance in lower.

	PANR	LBR	LBIA	DELMR	DHIA
PANR	NA	0.015	0	0	0.02
LBR	NS	NA	0.018	0.015	0
LBIA	NS	NS	NA	0	0.001
DELMR	NS	NS	NS	NA	0.001
DHIA	NS	NS	NS	NS	NA

Note: For analysis 6.1.
Abbreviations: NS, Not significant; NA, Not applicable; *, significant. Significance is identified if MMD is higher than twice their standard deviation.

Table 8

MMD values in upper triangular area of matrix and standard deviation (SD) values in lower.

	PANR	LBR	LBIA	DELMR	DHIA
PANR	0.000	0.015	0.000	0.000	0.020
LBR	0.034	0.000	0.018	0.015	0.000
LBIA	0.029	0.027	0.000	0.000	0.001
DELMR	0.028	0.025	0.020	0.000	0.001
DHIA	0.034	0.032	0.027	0.025	0.000

Note: The significance threshold is twice the standard deviation. For analysis 6.1.

Table 9

Overall measure of divergence for each trait identified in analysis, sorted by decreasing discriminatory power.

	Overall MD
UM1Para	0.586
UM1EnExt	0.247
LM2C5	0.187
LM1Prto	0.081
LP3TomesRt	-0.082
LM2GroovP	-0.139

LP4LingCVar	-0.148
UM2C5	-0.254
LM1C7	-0.485

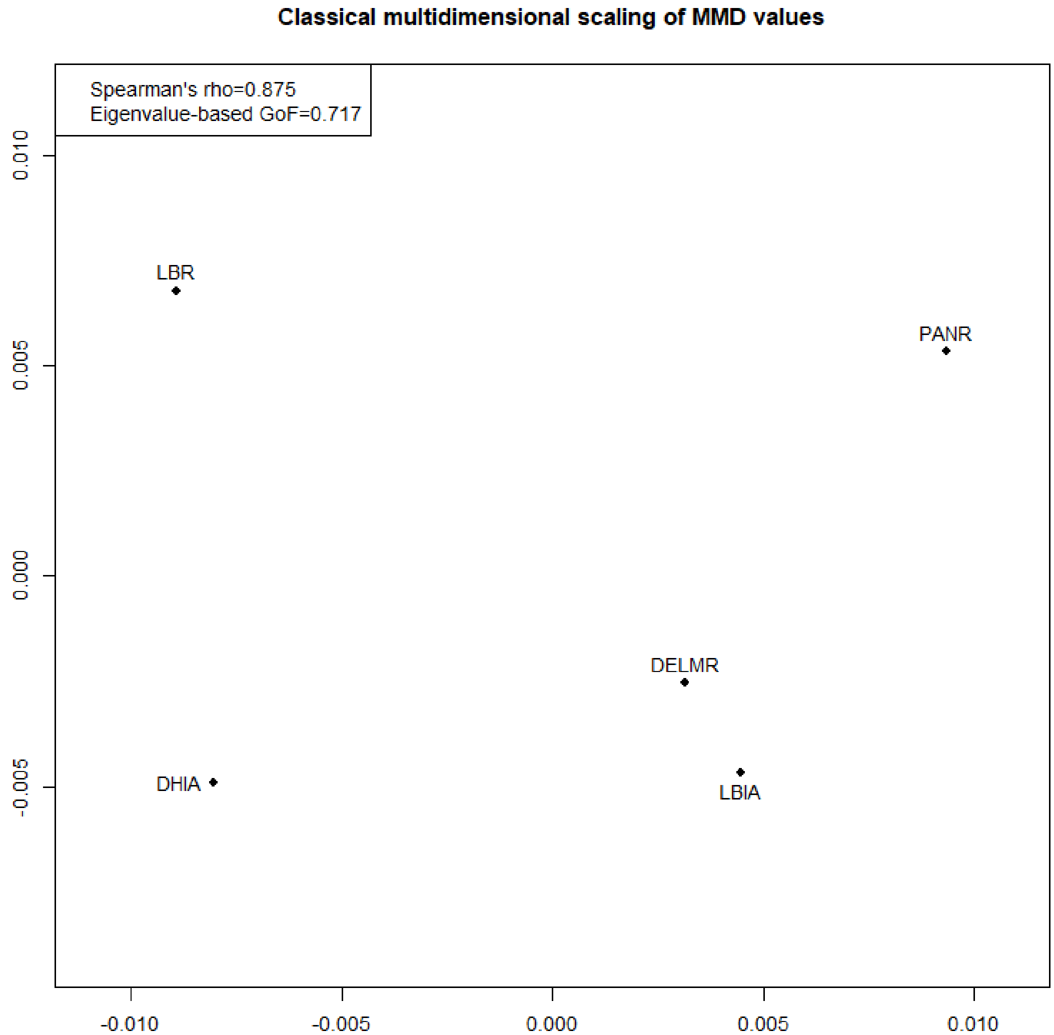
Note: For analysis 6.1.

Table 10

Number of individuals and relative frequencies for each active trait within each group.

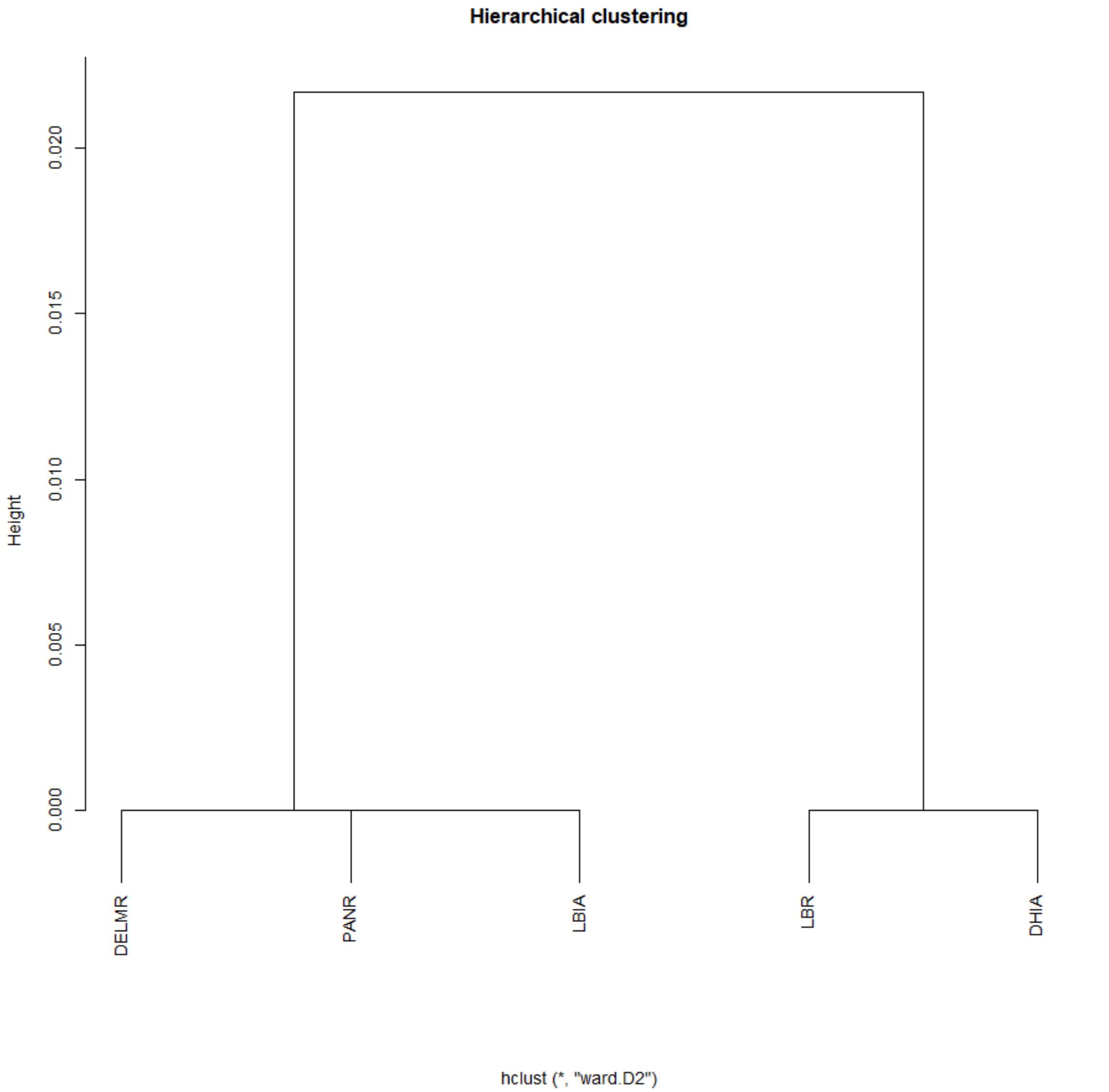
	UM1 Para	**UM1 En Ext**	**UM2 C5**	**LP3 Tome Rt**	**LP4 Ling CVar**	**LM1 Prto**	**LM1 C7**	**LM2 Groov P**	**LM2 C5**
N_ PANR	22	25	22	24	30	31	23	29	26
N_ LBR	36	26	28	27	22	37	34	31	30
N_ LBIA	46	56	47	51	29	46	39	49	50
N_ DELMR	48	51	45	38	59	57	49	52	50
N_ DHIA	29	35	25	36	25	31	26	31	29
Freq_ PANR	0.136	0.160	0.409	0.125	0.600	0.581	0.130	0.379	0.385
Freq_ LBR	0.306	0.385	0.321	0.222	0.773	0.649	0.118	0.452	0.567
Freq_ LBIA	0.304	0.304	0.277	0.078	0.586	0.565	0.077	0.265	0.400
Freq_ DELMR	0.188	0.255	0.400	0.132	0.661	0.632	0.122	0.346	0.300
Freq_ DHIA	0.414	0.371	0.440	0.194	0.600	0.774	0.077	0.323	0.379

Note: For analysis 6.1.



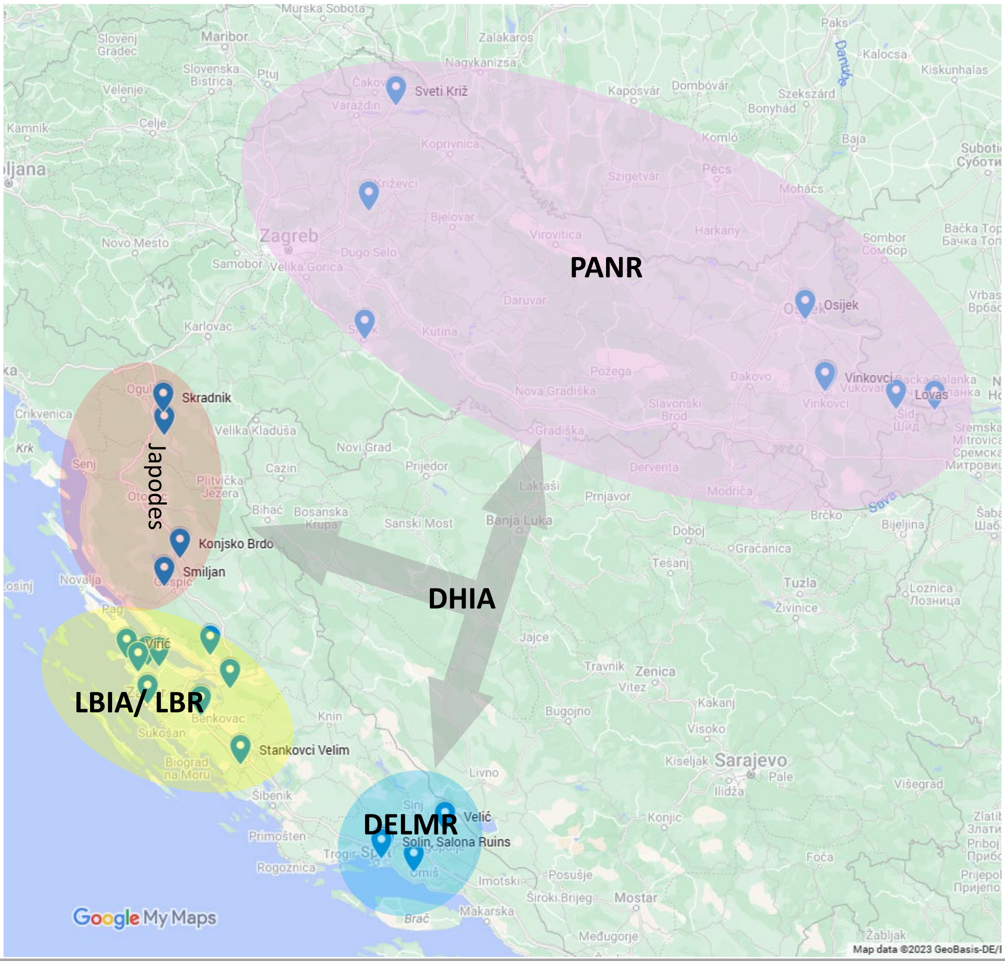
LBIA, Iron Age Liburnian
DHIA, Iron Age Delmatae, Pannonians, and Japodes
DELMR, Roman Delmatae
LBR, Roman Liburnian
PANR, Roman Pannonian

Figure 14 Classical MDS of MMD values for analysis 6.1.



LBIA, Iron Age Liburnian
DHIA, Iron Age Delmatae, Pannonians, and Japodes
DELMR, Roman Delmatae
LBR, Roman Liburnian
PANR, Roman Pannonian

Figure 15 Hierarchical analysis dendrogram in analysis 6.1.



LBIA, Iron Age Liburnian
DHIA, Iron Age Delmatae, Pannonians, and Japodes
DELMR, Roman Delmatae
LBR, Roman Liburnian
PANR, Roman Pannonian

Figure 16 Geographic location of samples used in analysis 6.1. Base map from Google Maps, 2023.

6.2 With Supplemental Data, Regional Focus

For this analysis, combined Liburnian, Delmatae, and Pannonian samples were compared to regional supplemental data of Late Iron Age, Republican Period, and Roman Empire Italics to identify broad relationships.

The supplemental samples, Iron Age Italics (RIA), Late Iron Age/ Republican Period Italics (RRP), and Roman Empire Italics (REM) were added (Coppa et al., 2007, 1998). These were compared to the pooled Iron Age Adriatic coastal and hinterland groups (CHIA), as well as the Roman Period Adriatic coastal and hinterland samples (CHR) (c, coastal, h, hinterland).

The results show statistically significant differences among most of the samples (6 traits, minimum of n= 53 per trait; see Table 11), with the only cross-Adriatic exceptions being between Iron Age Adriatic coastal and hinterland groups (CHIA) and both Late Iron Age/ Republican Period Italics (RRP), and Roman Empire Italics (REM). The results generally concur with previous preliminary analyses which found heterogeneity among Iron Age regional groups, meaning that culturally separated populations (Italics, Celts, Greeks etc.) were distinct when broadly compared to each other (Loewen & Anctil, 2021). However, in contrast to this but also similar to findings by Coppa et al. (1998), populations from the same time period temporally cluster, even when comparing across large geographic separation. This is shown here in the association between CHIA and RIA, which could be explained by the shared history of influence from southern Italic Greek colonies or simply the centuries of trade connections between the Delmatae, Liburnians, and Italics across the Adriatic Sea. The two conclusions when considered together suggest early relations between the Eastern Adriatic and Italics which nonetheless do not affect local Liburnian or Delmatae continuity.

Table 11

MMD values in upper triangular area of matrix and flagging of significance in lower.

	RRP	RIA	REM	CHR	CHIA
RRP	NA	0.042	0.057	0.091	0.142
RIA	*	NA	0	0.015	0.016
REM	*	NS	NA	0.024	0.011
CHR	*	*	*	NA	0.003
CHIA	*	NS	NS	NS	NA

Note: For analysis 6.2.
Abbreviations: NS, Not significant; NA, Not applicable; *, significant. Significance is identified if MMD is higher than twice their standard deviation.

Table 12

MMD values in upper triangular area of matrix and standard deviation (SD) values in lower.

	RRP	RIA	REM	CHR	CHIA
RRP	0.000	0.042	0.057	0.091	0.142
RIA	0.008	0.000	0.000	0.015	0.016
REM	0.006	0.006	0.000	0.024	0.011
CHR	0.010	0.010	0.008	0.000	0.003
CHIA	0.013	0.013	0.011	0.015	0.000

Note: The significance threshold is twice the standard deviation. For analysis 6.2.

Table 13

Overall measure of divergence for each trait identified in analysis, sorted by decreasing discriminatory power.

	Overall MD
UI2MesBend	1.129764
UM1Para	0.569499
UM3RootNum	0.415121
LM2GroovP	0.271658
LM1C7	0.107627
UI2IntGrv	-0.11874

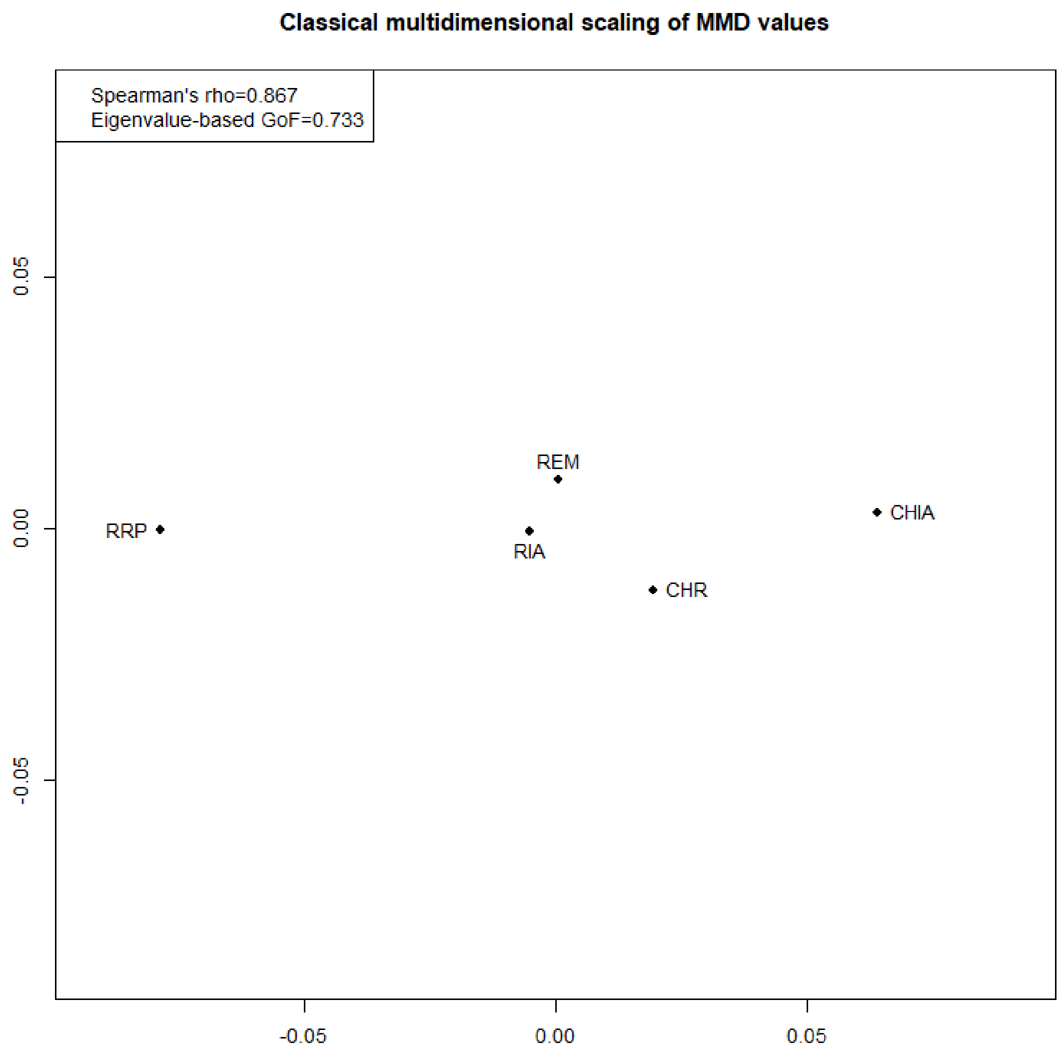
Note: For analysis 6.2.

Table 14

Number of individuals and relative frequencies for each active trait within each group.

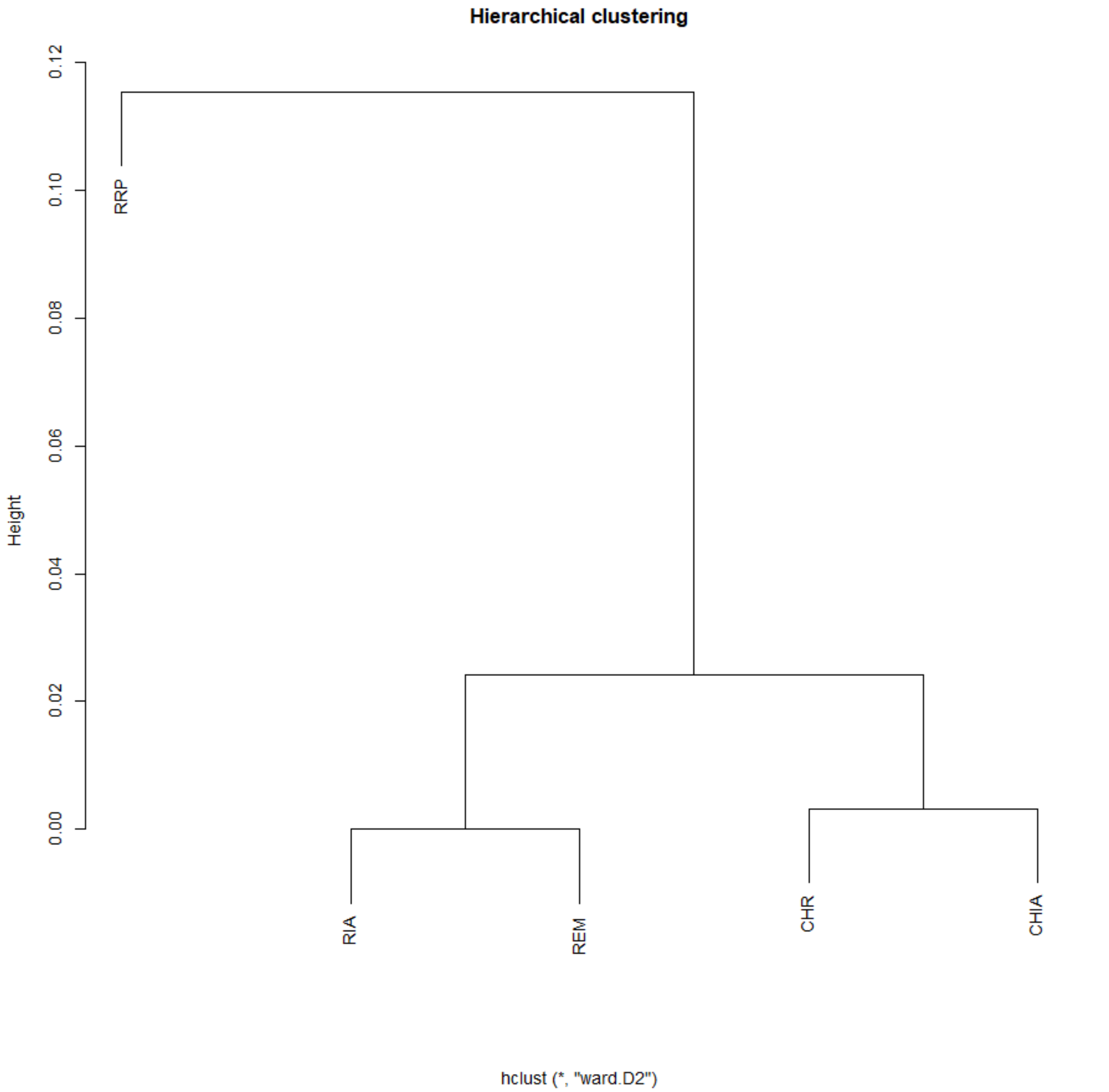
	UI2 IntGrv	**UI2Mes Bend**	**UM1 Para**	**UM3 RootNum**	**LM1 C7**	**LM2 GroovP**
N_RRP	131	176	186	88	219	219
N_RIA	134	170	226	83	210	206
N_REM	303	305	459	157	626	633
N_CHR	88	97	106	68	106	112
N_CHIA	55	60	75	53	65	80
Freq_RRP	0.664	0.602	0.134	0.216	0.142	0.224
Freq_RIA	0.687	0.453	0.248	0.361	0.071	0.243
Freq_REM	0.667	0.413	0.283	0.325	0.067	0.242
Freq_CHR	0.716	0.351	0.217	0.426	0.123	0.384
Freq_CHIA	0.727	0.267	0.347	0.415	0.077	0.288

Note: For analysis 6.2.



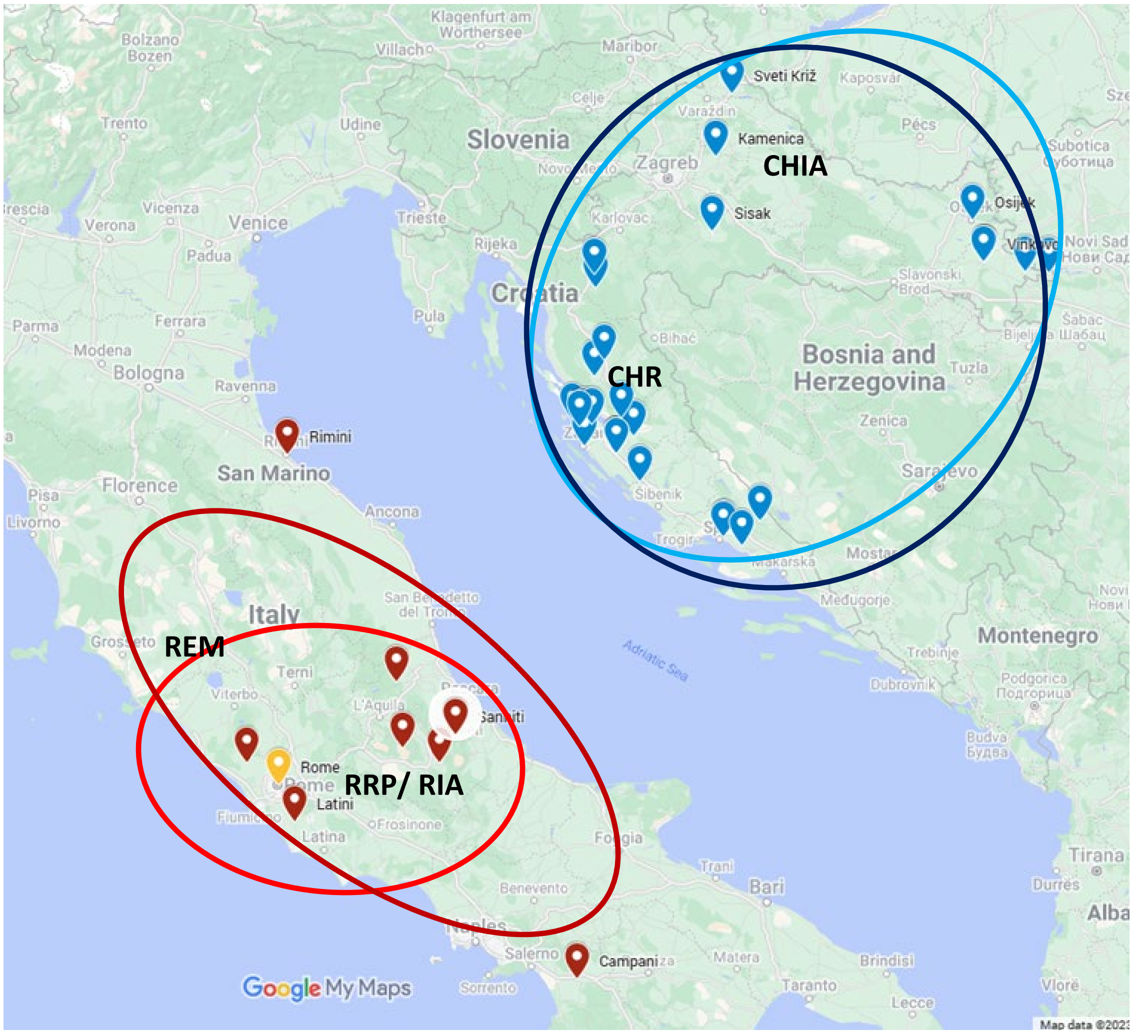
CHIA, Iron Age Adriatic coastal and hinterland
CHR, Roman Period Adriatic coastal and hinterland
RIA, Iron Age Italics
RRP, Late Iron Age/ Republican Period Italics
REM, Roman Empire Italics

Figure 17 Classical MDS of MMD values for analysis 6.2.



CHIA, Iron Age Adriatic coastal and hinterland
CHR, Roman Period Adriatic coastal and hinterland
RIA, Iron Age Italics
RRP, Late Iron Age/ Republican Period Italics
REM, Roman Empire Italics

Figure 18 Hierarchical analysis dendrogram in analysis 6.2.



CHIA, Iron Age Adriatic coastal and hinterland
CHR, Roman Period Adriatic coastal and hinterland
RIA, Iron Age Italics
RRP, Late Iron Age/ Republican Period Italics
REM, Roman Empire Italics

Figure 19 Geographic location of samples used in analysis 6.2. Base map from Google Maps, 2023.

6.3 With Supplemental Data, Liburnian Focus

The analyses in 6.1 and 6.2 provide evidence for local population continuity and wider regional differences. To answer a primary question of this thesis concerning whether Liburnian and Roman phenetic population change existed or differed from others, population specific supplemental data and Eastern Adriatic and hinterland samples were compared. These were subjected to repeated analyses to identify the most accurate pooling to maximize sample size and trait representation.

The supplemental samples, Late Iron Age/ Republican Period Latini (LAC), and Roman Empire Italics (REM) (Coppa et al., 2007, 1998), were compared to the pooled Iron Age Adriatic coastal and hinterland groups (CHIA) and Roman Pannonians (PANR). LAC was used instead of RRP, as had been used in the previous analysis, 6.2. The variation demonstrated by RRP did not affect the other population relationships or contribute new information different than the results in 6.2. LAC, Latini around the city of Rome, were used instead to prioritize geographic specificity. A limited sample for REM was not provided in publications.

Additionally, Roman Period Liburnians and Delmatae samples were combined (CLDR; c= coastal) to increase sample size as analyses with Liburnians alone were inconclusive due to low trait overlap. Following this, CLDR was replaced with just the Roman Delmatae sample (DELMR; see Appendix VI) and the results between these two were compared. The results (5 traits, minimum of n= 22 per trait) do not show statistically significant differences among most of the samples. Additionally, two key conclusions based on these data follow.

First, results of these analyses demonstrate statistically significant differences between pooled Roman Period Liburnians and Delmatae (CLDR) compared to Roman Empire Italics (REM). However, statistically significance differences between Roman Empire Italics and either the Roman Period Pannonians (PANR) or Delmatae (DELMR; see Appendix VI) are not demonstrated. Therefore, a deviation is identified. This is discussed further below.

Second, neither Roman Period Liburnians and Delmatae (CLDR) nor Iron Age Adriatic coastal and hinterland groups (CHIA) demonstrate statistically significant differences from each other or the Roman Period Pannonian sample (PANR), demonstrating local continuity.

Table 15

MMD values in upper triangular area of matrix and flagging of significance in lower.

	REM	**PANR**	**LAC**	**CLDR**	**CHIA**
REM	NA	0.031	0.035	0.016	0.011
PANR	NS	NA	0.025	0	0.004
LAC	*	NS	NA	0.009	0.069
CLDR	*	NS	NS	NA	0.006
CHIA	NS	NS	*	NS	NA

Note: For analysis 6.3.
Abbreviations: NS, Not significant; NA, Not applicable; *, significant. Significance is identified if MMD is higher than twice their standard deviation.

Table 16

MMD values in upper triangular area of matrix and standard deviation (SD) values in lower.

	REM	**PANR**	**LAC**	**CLDR**	**CHIA**
REM	0.000	0.031	0.035	0.016	0.011
PANR	0.028	0.000	0.025	0.000	0.004

LAC	0.022	0.046	0.000	0.009	0.069
CLDR	0.010	0.034	0.029	0.000	0.006
CHIA	0.011	0.036	0.030	0.018	0.000

Note: The significance threshold is twice the standard deviation. For analysis 6.3.

Table 17

Overall measure of divergence for each trait identified in analysis, sorted by decreasing discriminatory power.

	Overall MD
LM1C7	0.483
UI2MesBend	0.452
UM1Para	0.198
LM2GroovP	0.038
UI2IntGrv	-0.303

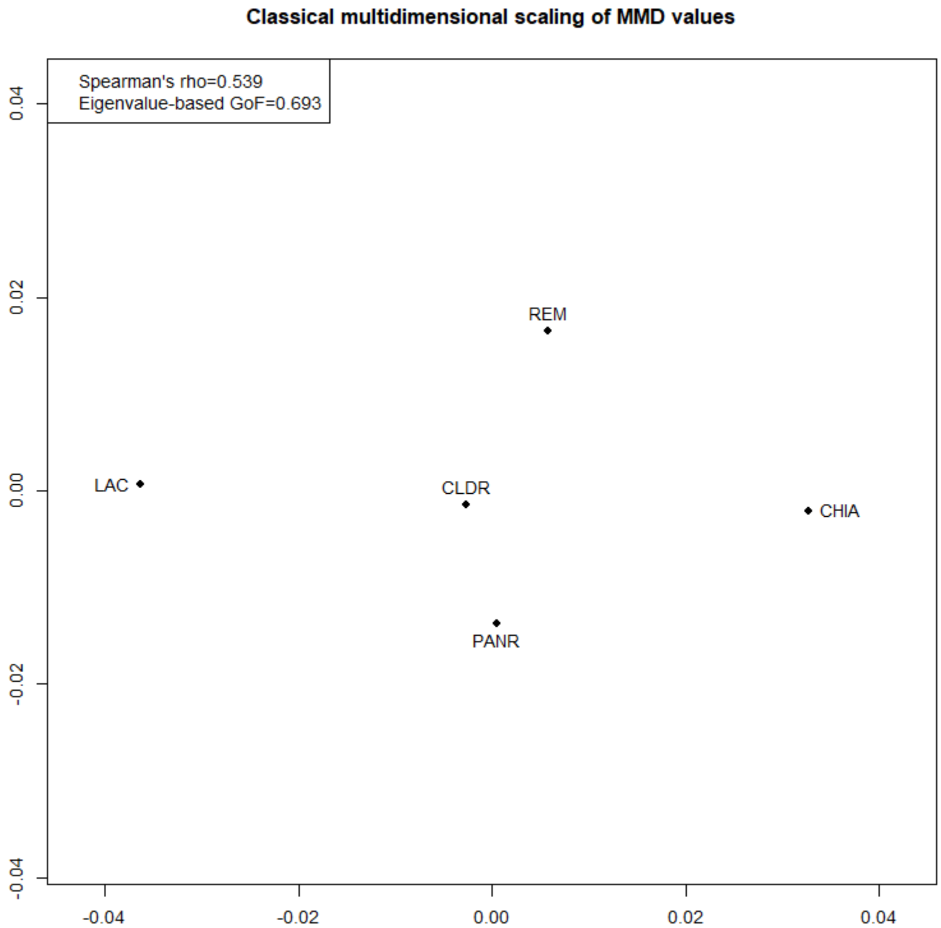
Note: For analysis 6.3.

Table 18

Number of individuals and relative frequencies for each active trait within each group.

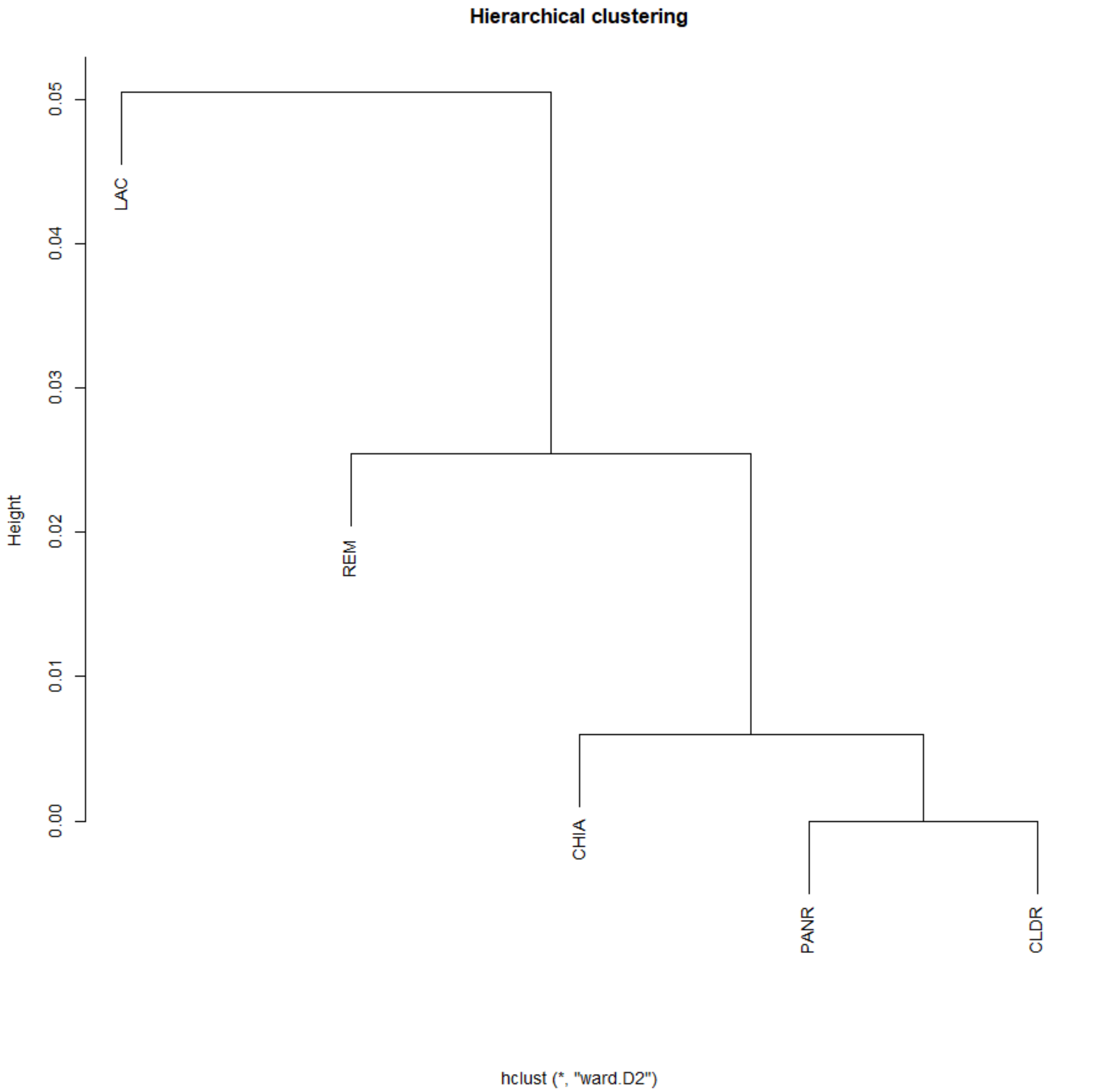
	UI2IntGrv	**UI2MesBend**	**UM1Para**	**LM1C7**	**LM2GroovP**
N_REM	303	305	459	626	633
N_PANR	24	22	22	23	29
N_LAC	22	29	37	40	36
N_CLDR	64	75	84	83	83
N_CHIA	55	60	75	65	80
Freq_REM	0.667	0.413	0.283	0.067	0.242
Freq_PANR	0.750	0.273	0.136	0.130	0.379
Freq_LAC	0.636	0.517	0.243	0.250	0.278
Freq_CLDR	0.703	0.373	0.238	0.120	0.386
Freq_CHIA	0.727	0.267	0.347	0.077	0.288

Note: For analysis 6.3.



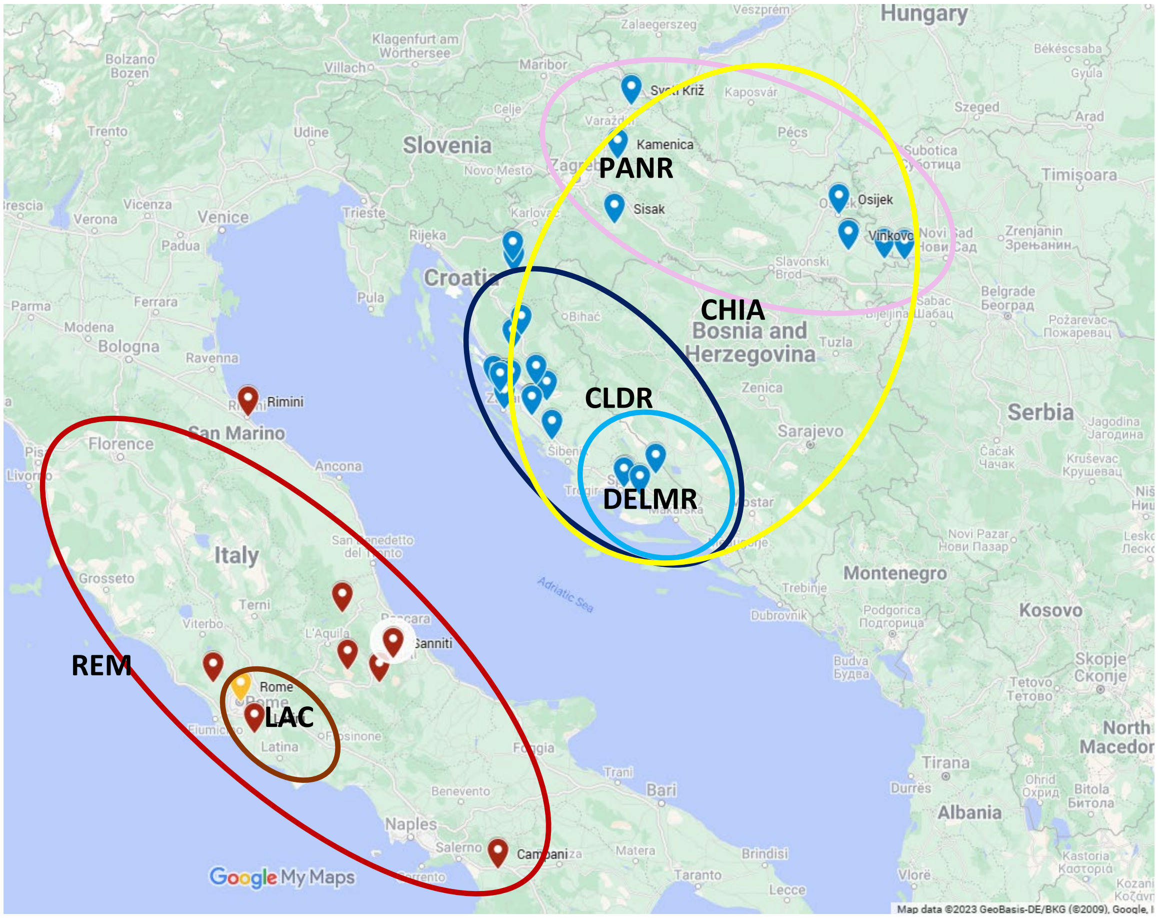
CHIA, Iron Age Adriatic coastal and hinterland
CLDR, Roman Period Adriatic coastal
LAC, Late Iron Age/ Republican Period Latini
PANR, Roman Pannonian
REM, Roman Empire Italics

Figure 20 Classical MDS of MMD values for analysis 6.3.



CHIA, Iron Age Adriatic coastal and hinterland
CLDR, Roman Period Adriatic coastal
LAC, Late Iron Age/ Republican Period Latini
PANR, Roman Pannonian
REM, Roman Empire Italics

Figure 21 Hierarchical analysis dendrogram in analysis 6.3.



CHIA, Iron Age Adriatic coastal and hinterland
CLDR, Roman Period Adriatic coastal
LAC, Late Iron Age/ Republican Period Latini
PANR, Roman Pannonian
REM, Roman Empire Italics

Figure 22 Geographic location of samples used in analysis 6.3. Base map from Google Maps, 2023.

Additional analyses were conducted and are presented in Appendix VI. As previously stated, the Roman Period Liburnians and Delmatae (CLDR) did not demonstrate the same overlap with Roman Empire Italics (REM) that Roman Period Pannonians (PANR) and even Iron Age Adriatic groups show. To examine whether this deviation is specific to either the Liburnians or Delmatae, dyadic comparisons were conducted with local populations alongside Roman populations to isolate their relative associations without influencing each other. However, the Roman Period Delmatae (DELMR) (trait= 5, n= 22; see also Appendix VI, Table 26), were not statistically significantly different from the Roman Empire Italics (REM), even though they maintain similarity with other Adriatic groups regardless of time period (including Liburnians). The Roman Period Pannonians did not present any additional conclusions and results were identical to those in Table 26. Therefore, we can infer that the results here may be due to the influence of the Roman Liburnians in CLDR.

SUMMARY

The null hypothesis in this dissertation assumes "recent genetic similarity." The relevance in support or refutation of the null varies depending on the context and the questions being asked. For example, finding "recent genetic similarity" between neighbors would be meaningfully different from finding the same results between groups who did not interact, even though the results are not statistically significant.
Results were interpreted by addressing the following questions:

1. Were indigenous peoples of the Adriatic and hinterland phenetically indistinguishable from one another or the Italic Romans around the beginning of region-wide interactions at the end of the Iron Age?

Analysis 6.1 did not show deviation from the null for the Adriatic and hinterland populations, finding them relatively indistinguishable during every time period (see 6.1). In analysis 6.2 the pooled Iron Age Adratic populations are not significantly different from the Iron Age Roman Italics either. Nevertheless, all Adriatic populations continue to demonstrate within population continuity and genetic similarity with one another.

2. Do the populations of the Eastern Adriatic and hinterland, who are considered Roman and were potentially local descendants of the indigenous peoples, demonstrate gene flow between each other or Romans from the Italian peninsula after the expansion of the Roman Republic and Roman Empire?

The results of analysis 6.2 do not reject within group continuity between Iron Age and Roman Period pooled Adriatic and hinterland populations, indicating that there had not been significant population turnover or replacement, suggesting ancestor/ descendant relations. This is consistent with the archaeological record. The phenetic similarity among Adriatic and hinterland groups persists during the Roman Period as shown in analysis 6.3. Their Roman descendants are not significantly different from one another, clustering in the same way as their Adriatic ancestors in 6.1.

However, results in 6.3 do not reject gene flow from Italics throughout the time periods, a finding consistent with established history on movement and trade by all populations throughout the region. There is nevertheless no consistent temporal or geographic pattern to gene flow between Italics and Eastern Adriatic populations, such as expected with isolation by distance. This is interesting as it suggests other influences on gene flow as explored in question 3.

3. Do variations of gene flow, if present, correlate with a history of either conflict or allyship with Rome among indigenous-descended peoples who were Romanized?

Results presented here do demonstrate some Roman influenced population change in the Adriatic that varies depending on the population analyzed. There is some indication of gene flow between the Roman Empire Italics and Roman Period Pannonians and Delmatae (section 6.3). Gene flow among these groups during the Roman Periods aligns with well-identified historical changes in locality, politics, and material culture, which are attributed to interaction and Romanization.

However, analysis 6.3 also fails to support the same similarity between CLDR and Roman Empire Italics. Upon close examination, this phenetic influence may be due to the Roman Period Liburnians, who were allied with Rome, though more analyses are needed for a robust assessment. These results are interpreted despite Iron Age and Roman Period Liburnians lacking significant differences between each other (see section 6.1). Wider regional analyses may not always produce statistically significant differences between CLDR and Romans though, as the small variation between them could be overridden by greater regional variation. Nevertheless, considering the lack of differentiation between the Romans and Eastern Adriatic and hinterland inhabitants during the Iron Age (RIA and CHIA; see 6.2), it is unexpected that similarity is not as consistently represented between Roman Empire Liburnians and Italics, their contemporaries.

Also, the analyses reflect a lack of statistically significant support for gene flow among Adriatic, hinterland, and Italic populations that would supersede local relationships, which concurs with established archaeological associations among them, but may be in opposition to the way some scholarship discusses Roman Period Adriatic residents as singularly "Roman."

Some important limitations to consider that may affect the results are population sizes, low trait overlap between populations regardless of size, and temporal lag (the time it takes time for gene flow to diffuse throughout a population). This dissertation has relied on dating, population identification, and supplemental data from colleagues and other authors; discrepancies in these could affect the results of this work. Class also may have a role if it resulted in differential burial practices or dental pathological lesions and as mentioned in the materials chapter discussions. Last, the overall MD in 6.2 and the appendices are higher than 6.1 and 6.3, demonstrating that the variability examined in those analyses is relatively low. Ultimately, all of the differences among these populations is small, but the variation among them is identifiable with careful examination.

CHAPTER 7 DISCUSSION AND CONCLUSION

This dissertation draws from historical data, the archaeological context, and biological distance methods to explore gene flow across the Adriatic between the Late Iron Age and Roman Empire. Since Romanization has such a clear role in regional changes, what if anything about the regional changes brought by Rome are clarified with this new information? How does this new information contribute to the Romanization debate? During the end of the Republican Period (c. 200 BCE- 1 CE), Rome was at war with most of the Adriatic populations with the exception of the Liburnians. Subsequently, all descendant populations regardless of initial alliances are uniformly understood as Roman, and ancestral tribes and cultures ended with Romanization. Nevertheless, Roman policies and actions that both prevented and facilitated admixture complicate our interpretations of local identities, introducing questions regarding the relationship between cultural assimilation and population change. It is important to note that the relationship between biology and identity in Roman times differed from the racial concepts prevalent in the 20th and 21st centuries (Woolf, 2001, p. 311). Roman governance through local leaders, often presented as a "hands off" style, contributes to the understanding that Roman-ness was not biological and was flexible. Yet, Roman citizenship and affiliation was a valuable status, and identities associated with belonging existed.

This discussion chapter contextualizes the impact of Romanization previously discussed in light of Roman social perspectives of the "other" while considering the biological data. In summary, the results of this research demonstrate that during the expansion of the Roman Empire into the Adriatic region, despite accommodating practices, people did not simply continue on in isolation, as can be observed by the biological outcomes in the form of genetic admixture. The results concur with what has been recorded about the Roman assimilation of the Eastern Adriatic, understood through historical and material evidence. Namely, Eastern Adriatic coastal populations and those in the hinterland integrated with Italics that originated from outside the region during the Roman Republic and Empire. Although this research does not assert a strategy by the Roman Empire broadly to integrate new Romans through biological means or even ethnocide, it does highlight ways in which Roman disruption may have resulted in the changes demonstrated. The lived realities under Romanization in the Adriatic involved a complicated blend of interaction and accommodation, facilitated by greater movement among the Adriatic and hinterland populations.

These results present a more complicated picture of population change as they neither assert local genetic isolation after becoming Roman, nor do they support a linear genetic change due to acculturation. Although the results demonstrate local admixture, they also show local ancestral continuity, and potentially suggest a more complicated experience for Rome's early ally, the Liburnians. The results are interpreted as suggesting a different dynamic between the Liburnians and Roman Empire Italics, potentially connected to their prior associations. For the Liburnians, admixture with Romans occurred before the Roman Empire (see analysis 6.3). However, during the Imperial Period (c. 1- 500 CE) Roman Liburnians did not demonstrate statistically significant biological affinity with Roman Empire Italics, even though other Adriatic populations did. The decoupling of biology and citizenship for the descendants demonstrates how Roman-making advanced through cultural and political expectations which included accommodation and cultural hybridity. Changes in Roman policies related to marriage and citizenship reveal how, at various points in time, the ideological milieu around difference was altered to manage identity boundaries, and therefore status in the Empire.

Were war not a primary instigator of the aforementioned dynamics, the cultural negotiations around identity and new ways of being might be taken as innocuous, as an ethnogenesis, cohesion. Yet, history is clear that conflict and power dynamics were key stimuli of changes in this region, suggesting that Roman inclusion was also about control. Embedded in a history that starts with war and ends with a narrative of total acculturation, although Romanization may or may not have been a preplanned strategy, the end results show that it all advanced the empire.

Taking scholarly discussions into account, this chapter also deliberates on Roman imperial motivations and Romanization. The outcomes of Roman actions in the Eastern Adriatic, although not a "grand narrative" as some critics debate, are referred to here as Romanization (Versluys, 2014; Woolf, 2014). Modern grievances on Romanization have similarities to past disputes over Roman imperial motivations. This dissertation carefully considers the causes of culture and population change in the Adriatic without attributing intentional schemes, but also not dismissing the outcomes of violent actions.

LIBURNIAN ALLIES

Interestingly, the results of this dissertation, with the data currently available, reject the null hypothesis of phenetic similarity between Roman Italics and Roman

Liburnians. However, the Liburnian Roman descendants maintained a relatedness to their ancestors and their neighbors. Also, the pooled coastal and hinterland population, which included Liburnians, did not identify a significant difference with the Roman Iron Age sample either. The results are thought-provoking because the Liburnians did not have the same violent confrontational history as the Delmatae or Pannonians and enjoyed *immunitas* from tribute (Suić, 1981). They did fight in local wars, sometimes for Rome, but history records far more devastation to other Adriatic and hinterland populations during the time that Liburnian cities were growing. During Augustus' time, the Liburnian/ Roman relationship exemplified the indirect local governance described previously and in Chapter 2. The port city of Zadar and nearby Nadin (Iader and Nedinum during Roman times) have been shown to have undergone population growth and urbanization around the turn of the millennium (J. Chapman & Shiel, 1991; Loewen et al., 2021; Zaro, Čelhar, Vujevic, & Nystrom, 2016). Iader was a Roman *colonia* and trade was widening, implying an influx of new people.

These points provide one possible explanation for the results. Liburnian descendants may have remained among themselves, less connected to the wider region. Or conversely, they may have always been and maintained a very heterogeneous society, and therefore the wide range of variation within the population makes them stand out from others. Another possibility is that the Late Iron Age and Republican period samples already included Roman colonists through movements that pre-date the rest of the region. If these peoples later left, died, or did not contribute to the local population, the results would lack their genetic contribution. This could explain the early association with Iron

Age Italics, even though ancestor and descendant Liburnians were not statistically significantly different from one another. Indeed, one explanation for their receptivity to Rome has been attributed to a history of "connectivity, historical context, and existing sociopolitical and cultural templates" (C. Barnett, 2015, p. 32). Most soldiers in the late Republic were from the northern part of the Italic peninsula, though this later changed (Roselaar, 2016). Early colonists may have corresponded with this demographic makeup, while later inhabitants were descendants. However, eventually the military was made up mostly of conscripts, and the wider provincial inhabitants were from all over the Empire. Perhaps the comparative Italic samples also reflected the growing diversity and migration into Rome from elsewhere (Cascio, 2016; De Ligt & Tacoma, 2016; Killgrove & Montgomery, 2016).

Lastly, perhaps understanding the Liburnian experience is explained by considering what happened to those around them, the Delmatae and Pannonians. Rome's presence in the Adriatic region influenced gene flow among the local populations through movement and disruption (section Movement of Local Populations). Similarly, it is conceivable that as the indigenous groups integrated themselves into Roman culture, out of want or necessity, the pressures on them were different enough from those on the Liburnians that admixture happened differently. Afterall, Roman expansion was "facilitated by what the conquerors shared with their new subjects" (Woolf, 2021a, p. 67). In either scenario, identity negotiation by those we call Roman was experienced by mixed indigenous descendants in a world that accepted the whole of them through a lens of their Roman-ness. As agents in their own right, Roman descendants likely had a new identity, different from their ancestors. Though these experiences should not be dismissed, and the next section considers this history in detail.

ADMIXTURE IN THE ROMAN ADRIATIC

The results of this study suggest that population admixture occurred across the region. From a biological perspective, the gene flow that is revealed by the relationship between Roman Italics and Roman Adriatic descendants suggests no difference between them. However, throughout regional history there were laws and norms which managed and defined endogamous groups. Geo-local availability of "mates" does not equate to cultural availability. This section examines the historical factors which may assist an interpretation of the results. There is an established history of Roman influenced movement and relocation of peoples existing alongside Roman laws about marriage and social norms on exogamy which were followed and broken. This is not an exhaustive discussion of local and Roman marital views, nevertheless exogamy, movement, law, culture, and social expectations may have played roles in population change. Additionally, a component of endogamy construction, Roman-ness, was influenced by Rome's own creation story and wielded differently as the Empire changed.

Exogamy

The Romans both resisted and embraced exogamy and borrowed from other cultures as a means of defining their own identity and exerting power over others (Pandey, 2021). Exogamy is the practice of marrying outside of one's own group, (ant. endogamy). Given the focus of this dissertation is population admixture, *how it happened* is what gives weight to *that it happened*.

According to Roman myth, Sabine wives of the Roman Kingdom's northern Apennine neighbors were stolen by Romulus and followers in the 8th century BCE, and their offspring contributed to the foundation of the new city of Rome (Ovid, 1929). Thus, a worldview of blending was baked into Roman ideology from the start. The mythos of the overtaking and incorporation of the Sabines is thought to have been spread in the 4th and 1st centuries BCE as a political tactic to justify incorporation and citizenship of Samnites and others to avoid further conflict (Holden, 2008). Below is a translated quote from Livy (1926) in the retelling of a Roman Senator discussing mixing with the Sabines and the Roman citizen Canuleius's reply. The Senator decries plebeians and patricians mingling like beasts. Canuleius then provides numerous examples of "blood" mixing and how they increased Rome's dominion. The bracketed numbers are line numbers.

> It was a year of quarrels (445 BCE) both at home and abroad. For at its commencement Gaius Canuleius, a tribune of the plebs, proposed a bill regarding the intermarriage of patricians and plebeians which the patricians looked upon as involving the debasement of their blood and the subversion of the principles inhering in the gentes, or families;
>
> For what else, they asked, was the object of promiscuous marriages, if not that plebeians and patricians might mingle together almost like the beasts? [7] The son of such a marriage would be ignorant to what blood and to what worship he belonged; he would pertain half to the patricians, half to the plebs, and be at strife even with himself.
>
> Come! Would you believe the story was ever heard how Numa Pompilius —not only no patrician, but not even a Roman citizen —was sent for from the country of the Sabines, and reigned at Rome, by command of the people and with the senators' consent? [11] And again, how Lucius Tarquinius, who was not even of Italian stock —not to mention Roman —being the son of Demaratus of Corinth, and an immigrant from Tarquinii, was made king, while the sons of Ancus were still living? [12] And how after him Servius Tullius, son of a captive woman from Corniculum, who had nobody for his father and a bond-woman for his mother, held the royal power by his innate ability and worth? For why should I speak of Titus Tatius the Sabine, with whom Romulus himself, the Father of the

> City, shared his sovereignty? [13] Well then, so long as men despised no family that could produce conspicuous excellence, the dominion of Rome increased.
>
> Livy, transl. 1926, Book 4, Chapter 2, 7-13

Fervent justifications as these were needed because Roman laws prohibited marriage with those outside one's class as far back as 450 BCE with the *Lex duodecim tabularum* or Twelve Tables, laws on the rights and duties of Roman citizens (Mommsen & Dickson, 1863; Treggiari, 1991; Warmington & Lucilius, 1938). The Twelve Tables and other very specific rules about marriage and adultery between citizens and non-citizens continued through the early Empire (Treggiari, 1991). Bans related to soldiers taking foreign wives are attributed to Augustus during the late Republic, only lifted some 200 years later by Septimius Severus in 197 CE (Herodian, 1969). In some places, however, there is clear evidence of wives travelling with spouses, even into battle (Tacoma & Tybout, 2016). And concubines certainly had children, but there were restrictive rules on whether or not they or their children could be *familia* or citizens (Treggiari, 1991).

The limits of Roman control over exogamous relationships is evidenced by the presence of families with Roman soldiers despite the ban (Allison, 2010, 2013, 2017; Greene, 2015). Skeletal assemblages in the Adriatic region demonstrate that the inhabitants of military towns were not just men, they were women, children, older adults, and perhaps generations of lineal descendants (Karlović et al., 2015). Epigraphic evidence shows both Roman and local naming conventions together on mortuary monuments and stele (stone markers/ tombstones) (Rendić-Miočević, 1964; Šašel Kos, 2017). In the northern area (modern Slovenia), late 1st century epigraphy names native women marrying Roman citizens and a Roman woman marrying a native man (Šašel Kos, 2017). More broadly, Rome the city was changing with expansion while material culture "was becoming even more 'global' with people being able to tap into an empire-wide Mediterranean network" (Haeussler, 2013, p. 23). Tacitus (1937 passage 44) observed that households in the city of Rome comprised people of many nations with many customs. This diversity was akin to a small version of the empire, and multiethnic friendship and intimacy were normal (Pandey, 2021). Romanized societies were indeed expanding, becoming more polyglot and polyethnic; "simultaneously multicultural, yet decidedly Roman" (De Mola, 2012, p. 1). Italic soldiers made up less of the military as ranks grew with new citizens and conscripts, sharing cultural elements that would come to be perceived as Roman (Haynes, 2001; Roselaar, 2016; Scheidel, 2004). Studies using ancient DNA support this back and forth admixture between Romans and their territories as they expanded beginning in the Iron Age (Antonio et al., 2019; Cerezo et al., 2012; Emery, 2018; Leach, Eckardt, Chenery, Müldner, & Lewis, 2010; Leach et al., 2009; Sarno et al., 2017; Tofanelli et al., 2016). At the beginning of the Empire during Augustus' reign, the Empire extended between modern-day France and Slovenia in the north, Portugal to the west, parts of north Africa and Egypt in the south, and areas of modern Syria in the east, roughly spanning 3000 km. However, by 117 CE, only 200 years later, the Empire extended as far as the modern United Kingdom and Romania in the north and Iraq in the east, with much further trade networks (see map in Appendix IV). While distance across the 5000 km wide Empire most certainly limited admixture, the shared imperial connections nevertheless enabled opportunities for much broader movement among the provinces.

Movement of Local Populations

Another aspect of Romanization that demonstrates the Roman Empire's large-scale impact on population change is the movement and migration of people around the empire. One of the ways Roman emperors established and maintained provincial order was by relocating people, and at times entire tribes (Roymans, 2004). There is some debate on how much relocation happened and if these events were coordinated with a predetermined plan. Large scale movements like these are thought to have been implemented selectively or when tribes volunteered (Roselaar, 2015, 2016; Woolf, 2017). While this did happen, scholars do not claim voluntary relocation was the norm either (Heather, 2007). Migration was both voluntary and forced; though this binary does not encapsulate the ways people may have viewed relocation as advantageous, or conversely how voluntary movement may have been acquiescence within a power imbalance. Though, it has been demonstrated and is generally accepted that Rome moved individuals and communities against their will (Hirt, 2019; Jewell, 2019; Roselaar, 2016; Roymans, Derks, & Heeren, 2020; Woolf, 2017).

State-sponsored re-settlement occurred, with as many as two and a half million adults relocated during the last two centuries BCE (Scheidel, 2004). For example, after the Delmatae and Pannonian uprisings that ended in the *Bellum Batonianum (*6 to 9 CE)*,* the young men were sold into slavery, though one 10 year old captive is recorded on a cenotaph as having been drowned (Šašel Kos, 2011). There is evidence of military conscripts from far away assigned to the Adriatic, such as the 4th century CE burial of a Germanic Gothic carpenter in Relja, Zadar (Gluščević, 2014, p. 53). Roman historians describe military enlistment as typically voluntary, but soldiers had no say in where they were sent and could be in service for 25 years (De la Bédoyère, 2020; Haynes, 2001; Roselaar, 2016). *Dilectus* were forced conscripts, and though this practice was seen as troublesome, internal drafts were conducted and defeated populations were conscripted (Haynes, 2001). An often cited time which called for these "desperate measures" was the *Bellum Batonianum*, as Augustus' needed to make up for the loss of 15,000 legionaries by having men draw lots (De la Bédoyère, 2020; Dio, 1924). Then after their service, many veterans chose to stay near the forts where they were stationed (Mann, 1956). Evidence also shows that the Roman state engaged in expropriation or confiscation of land, particularly for giving to veterans (Bertrand, 2015; Isaac, 1990; Roselaar, 2015). And then there was the movement of enslaved people, many of which were from outside the Italic peninsula (Scheidel, 2005). Those forced into slavery, even those that earned their freedom, often settled, married, and had children where they were moved due to obligations to former owners, "further diversifying local communities and gene pools" (Pandey, 2020, p. 19). Regardless of whether or not movement and military service were voluntary or forced, they had a "major impact" on the identities of the newcomers and affected the residents with whom they mingled (Haynes, 1999; Haynes, 2001, p. 73).

THE APPEAL OF CITIZENSHIP, STATUS, AND PEACE

As discussed, the results of this dissertation reveal local and Roman admixture, with the possible exception of the Liburnians. The results also show that there was local population continuity. As historical accounts do not record long-term pre-Roman population persistence and switch to referencing Pannonian and Dalmatian occupants as Roman, the understanding that they are local descendants of prior war enemies seeks additional context to resolve what is not necessarily contradictory, but certainly complex. The next section discusses how one "becomes Roman." The section resolves these results as being emblematic of the coercive power of Romanization within an environment where people had no other choice.

***Romanitas* and Identity**

To examine the dynamics of being Roman while also having an ancestral history outside of the Italic peninsula, this dissertation considers the socio-cultural pressures in the Roman Empire Adriatic and hinterland (c. 1 CE+). Multi-identity representations are often part of discourse on indigenous resilience to colonialism, agency and ethnogenesis, as well as modern identification with the past (Brighton, 2009; Melvin, 2022; R. Scott & O'Carroll, 2015; J. Webster, 1997). Being from different cultures was not unusual for people living in Rome, known for having a tolerant society which saw diversity as normal (Woolf, 2001, p. 311). This cosmopolitan perspective almost makes Rome sound like a true melting pot (Gleason, 1964), and leads one to ask, where was the Roman-ness (Haeussler, 2013)? Legitimate efforts notwithstanding, there was an element of cultural imperialism to the multiculturalism that allowed the Roman Empire to maintain its power and dominance.

Rome was a political and ethnic community where ethnic identity was not necessarily a matter of descent (alone), but instead it was conferred through managing moral and cultural obligations (Woolf, 2001, p. 316). *Romanitas*, the closest concept to "Roman-ness" was about valuing a shared way of life; an excellence that one would strive for (Orizaga, 2013; Revell, 2009; Versluys, 2013; Woolf, 2001, p. 311). The term itself was used late in the Roman Empire, but conceptually, the values date back to the Republic (Green, 2010). This virtue was exemplified in shared ideologies called *mores maiorum*, propelling individuals to live up to a code of personal responsibility, commitment, discipline, perseverance, and dignity among other values (Foucault, 1988; Haeussler, 2013; Huskinson, 2000; Orizaga, 2013). Hard work and the performance of your duties was honorable and even "patriotic" in a sense of the word; and adoption of these manners of being would have been prioritized, particularly for those aspiring to citizenship (MacMullen, 2000a). For elites, *romanitas* was achieved through consumption and performance (in the anthropological sense) of lavishness and virtue; for instance, with the funding and building of grand architecture (Laurence & Berry, 2001; MacMullen, 1980; Wacher, 2013; Wells, 2001). Woolf (2021a) finds Roman elite displays were a byproduct of the type of democracy they practiced (compared to Athens). In Roman society where one's voice was small, power and fortune were key political levers, and therefore so were wealth and honor signals (Woolf, 2021a). Roman identity was an expansive category based on shared practices and values, and though it varied in local expression, it was still rooted in civic duty (Balsdon, 1979; Pandey, 2020, p. 18). As the success of society brought honor to oneself, then it was proper and desirable to fulfill one's service to the state. Roman-ness shaped peoples into "civilized" and "honorable" ways of being (Arno, 2012; Galasso, 2012; Gavrielatos, 2017). Deviation from shared values around cultural change, religious dissent, and political division were “particularly threatening to Romans’ collective sense of self” (Woolf, 2001, p. 317).

In the decades following Augustus, Roman identity and its significance spread throughout the Roman Empire and native provinces. *Romanitas* and being Roman was not the same as nationality, though it was closely linked to Roman citizenship (Woolf, 2001, p. 316). Place and family names are a particularly useful way to track the spread of Roman influence as naming practices, citizenship, status, and geographic origin were connected (Mirosavljević et al., 1970; Wilkes, 1969). Names, known as *tria nomina* (see onomastics in the Appendix II), indicated *gens*, or clan/ tribe, and *nomen* or, family name that was not necessarily through lineal descent, but were dictated by marriage laws and local customs (Salway, 1994; Treggiari, 1991; Wilkes, 1962, p. 549). For example, Japodian praepositus Proculus Parmanicus’ name was latinized, yet also kept Pharm, a local variant (Cambi, 2013, p. 75). The different types of citizenship, or *civitas*, were communal and individual contracts, with benefits and responsibilities, providing important signifiers of status and conveying identities that were earned or negotiated. Roman citizens had marriage and inheritance rights, could earn land grants, and receive legal/political rights, as well as opportunities for advancement (Goldsworthy, 2016). Citizenship conferred privileges to even the poorest local inhabitants which carried great appeal (MacMullen, 2000a). Deeds were rewarded, implying that there was vertical mobility despite clear stratification. Cicero (1935, 2.5.167) wrote in 70 BCE, that “poor men of humble birth sail across the seas to shores… among strangers”, yet they know that with citizenship, they can “count on being safe”.

There were contractual alliances with non-citizens as well. The highest degree of social conformity was found at the upper levels of society through gifting and patronage (Mattingly, 2004, p. 5). *Amicita,* friendship defined by gift exchange, had an element of competitive nurturing (Burton, 2004). It began as subsidies between the Empire and other rulers but developed into a form of diplomatic gifting that went from being enticement to an expectation. By the 2nd century CE, gifting became a defensive maneuver by Rome (Kemp, 2018). Like citizenship, gifting was mutually beneficial. Rome used friendly city-states and local clientele to manage and balance control (Munzi, 2001, p. 51; Terrenato, 2008). As discussed in Chapter 2, Roman law allowed a system of indirect local governance and patron-client relationships. *Peregrine civitates* were the local autonomous political units that ensured legal status to the peoples residing within managed lands during the first century CE. This status organized people into Roman and non-Roman, with the non-Roman generally falling under leadership they previously knew and thus continued a local and social association that was crafted into a legal and regional identity (Mesihović, 2011). Even when people moved away (or were moved away), they were still associated with their *civitate* (Mesihović, 2011). While these people were not Roman citizens, they were free inhabitants with rights, could own land, and could earn citizenship through military service. They were also responsible for paying taxes, managed by their local magistrates. Additionally, within the Roman military, expatriate *peregrini* (non-citizens) were allowed, with limitations, to organize and practice their religions; though this flexibility did lead to occasional uprisings (Derks & Roymans, 2009; Džino, 2014b). Necessarily, relationships between Rome and outsiders changed over time and whether coercive or fortuitous, Roman allyship was desirable.

The Manipulative Aspects of Peace

Resource management was a matter of protection, trade, and friendship infused with elements of control. Chapman and Shiel (1991, p. 64) state that it is clear that Rome "not only exploited indigenous political divisions and tendencies in the immediate process of conquest and incorporation, but also looked to adopt intact whatever of the existing structure it could," only discarding what was not useful (Woolf, 2001). Rome used existing kinship and political structures on which it layered its own processes (Džino, 2013). The spread of Roman civilization was reliant on territorial, social, and economic integration (Abbott, 1915; Breeze, 2011; Shpuza, 2013). Colonies were about stabilization of new territory and protection of boundaries and less about demanding populations make strict renunciation of their prior lives (Roselaar, 2017). It was advantageous for Rome to cultivate an aura of peace as to not overextend military resources and uphold the impression that Roman rule brought security and prosperity (Goldsworthy, 2016). Roman laws incentivized good behavior as a way out of enslavement into free citizenry (Pandey, 2020, p. 18).

Appian (2012, p. 437) wrote of how Augustus "compelled them [those who had revolted] again to pay tribute" when discussing how the Illyrian tribes came under Roman rule. In this text he describes the "desperation" of the Delmatae during periods of conflict. They were so hungry and cut off from the outside that they surrendered up 700 children as tribute and for back taxes. Cassius Dio (1924, line 15) describes how during the Delmatae rebellions, deserters fought with other locals, some anxious for peace while some “craved liberty”, implying that many viewed capitulation as the better path. As the revolt came to an end, men were found scattered in the woods and women threw themselves and children into flames or the river to avoid servitude (Dio, 1924). Romans distrusted native populations during the years following the Great Illyrian Revolt up until Flavian’s reign (69- 96 CE), so citizenship granting was a slow process (Mesihović, 2011). Locals and non-elites did not have much say, farmers who were also soldiers could influence local politics to a small extent if they lived near the city but Rome never had a true democracy or equality (Goldsworthy, 2016; Woolf, 2021a).

Roman subjects, both citizens and *peregrini civitates* were not without agency and affected Roman culture. Conquered individuals and communities that had previously warred with Rome may have “actively adopted new symbols and ideas to create or maintain control of power relations,” while having freedom to mediate domination through more subtle acts of subversion or opposition (Hingley et al., 1996; Van Dommelen, 1997). Even as Roman identity was reinforced by the entrenchment of hierarchies that incentivized conformity to Roman values, identities were situationally negotiated by some to their benefit (Čače, 2013b; Vallat, 2001). For example, Gallo Roman resistance applied Roman culture against itself by rising up through the ranks and winning enough power to have control over their own ways of being (Woolf, 1998, p. 22). Many rebels against Rome had a previous history of close relations and not deep-seated anti-Roman sentiment (Mattingly, 2013, p. 80). While the resources of Rome may have benefited some native peoples, De Mola (2012) describes this relationship as being voluntary and desired by some as much as it was imposed and resisted by others.

Nevertheless, avoiding further confrontation, particularly in an environment where one's local leadership and ways remained relatively the same, at least for a time, would have been attractive. Derks and Roymans (2009) illustrate how those under Roman rule in loose knit communities retained their ethnic identities, in contrast to groups on the edge of the empire who were annihilated or split up by Rome to avoid their active resistance (e.g., the Pannonians). Empires cultivate new ethnic communities in some parts, while "denying, marginalizing, or destroying" existing ones elsewhere (Derks & Roymans, 2009, p. 4). For example, it has been suggested that demands on some populations for military recruitment (Breeze, 2011), may have disrupted gender and family relationships enough to produce distinct forms of social transformation compared to other regions (Revell, 2010). As Pandey (2020, p. 18) notes, Varro (116 to 27 BCE) advised households to draw on people from different regions for their enslaved workforce as a way to avoid disputes (Varro, 1935). Local leaders may have retained local power, but their decisions would be dictated by their responsibilities to Rome, who in turn wielded power over the people, their labor, their expectations, and in essence- their bodies.

A consequence of these conditions was an expectant environment. For those that had access to citizenship it was an attractive status; a compelling reason to work towards a cultural frame which was seen as the right way (Millett, 1992; Terrenato, 2008). Before the mid-first century CE many Roman legionaries were voluntary Italian recruits, however, afterward there was a gradual shift with over 50% of the army made up of descendants and provincial recruits (Haynes, 2001; Roselaar, 2016). Extending beneficial opportunities (to recently defeated foes) implies a way "not to be," and centers Roman-ness as a resolution. The often hailed ability of the enslaved to "earn" their freedom (which had been previously taken away) was a manipulation tactic for control and political conformity (Pandey, 2020, p. 18). Progress could be withheld through citizenship, mediated through resettlement, or suppressed by horizontal transfers of powers, endemic during the early Republic (Goldsworthy, 2016; Keay & Terrenato, 2001, p. 4). Change and acculturation were not uni-directional, and were gradual; nevertheless, such an environment creates distinctions between those that are working towards the goal, and those that are not. In this way Rome "kept a firm grip on their own sense of the "self-other" opposition," going as far as to impose re-ordered ethnicities on the map of Europe through its politics and place-names (M. Chapman, 1993, p. 26; Galasso, 2012).

"Though these peoples speak in diverse languages, nevertheless they speak as one"[8]

Roman-ness was not practiced as a solitary identity (Fischer, 2005; Nicoulin, 2016), though it could replace or co-exist with other identities and significantly, was important in relationship to other identities. Rome was actively involved in the crafting of social memory and deliberately constructed their own history and identity through monuments and other forms of public art (Alcock, 2001, p. 323). This is demonstrated in

[8] From a poem by Martial, Book of Spectacles 3 (1993) commemorating the emperor Titus's 80 CE dedication of the Colosseum

Rome's co-opting religious symbols through practices like *evocation* or adopting foreign gods and religious symbols. Rome was known for "reviving ancient cults and moral values" as "exempla for élite lifestyle and conduct" (Haeussler, 2013, p. 23). For example, Rome recognized similarities in regional goddesses as having the *numina* or essence of Roman ones in Germanic lands (Cambi, 2013). In Roman Britain, a slow syncretism occurred whereby local gods names were prefixed onto Roman gods, and with time these prefixes dropped until Roman names were used exclusively (Cambi, 2013, p. 71). Romans used *interpretatio romana* which internationalized religion specifically through renaming (Ando, 2005). Rendić-Miočević (1964) discusses Illyrian resistance in naming practices stemming from distrust of Roman *interpretatio romana* negating local religious practices through tolerance and indifference. This was a two-way process though, locals incorporating Roman deities and Roman colonists adopting local gods (Cambi, 2013, p. 73). Additionally, some Delmatae gods, though at times sharing Roman names, were not synchronized with their Roman counterparts but kept their original regional attributes or developed new ones, such as with Mercury or Silvanus (Cambi, 2013, p. 76; Lulić, 2015, 2018). The differences between Roman and native versions of deities would have been recognized by locals creating hybrid or new religious interpretations (Gavrilović Vitas, 2021; Lulić, 2018). Conversely, with *evocation* Romans also transferred effigies to Rome, expanding the pantheon by placing the gods on their side before taking over a city (Orlin, 2010). This demonstrates Rome's openness to incorporating new features of other cultures into their own. However, it also shows how this was a manipulative process of appropriation and revisionism (Orlin, 2010, p. 38; J.

Webster, 1997).

Being Roman was not so much adoption of an Italic culture, but of a mixture of Roman, Classical Greek, and European influences (Millett, 1995, p. 53). The new imperial culture "supplanted earlier Roman cultures just as much as it did the earlier cultures of indigenous peoples" (Woolf, 1997, p. 341)—Rome was "leveling up" to use a modern phrase. In the Adriatic, these influences were already happening, mostly through trade, demonstrating a regional diffusion closer to Woolf's idea of glocalization or "the long view" (Woolf, 2021b, p. 27). Romanization would not then be characterized by any one specific "style," but instead by valuing or accepting a heterogeneous flux throughout the way society and life are organized. This differs from glocalization, however, because the central organizing feature is a shared Roman-ness. In the same way that religious syncretism opens up a religion to heterogeneity in service of conformity, so too might new citizens have very different backgrounds and still all be Roman. Pandey notes a pan-Mediterranean scene extending into the afterlife when describing, "one Roman tomb contained a Theban eye doctor, a man from Smyrna, women from Phrygia and Carthage, and someone born locally to enslaved parents" (CIL 1.2965a) (Pandey, 2020, p. 19). Modern psychology might attribute an othering bias predicated on within group variability as out-group homogeneity bias, where in-group members are seen as more diverse than others (Haslam, Oakes, & Turner, 1996).

Therefore, diversity was a part of being Roman, the "melting pot with a sense of unity" (Woolf, 2001, p. 317). What was "Roman" could be interpreted as imperial pluralism, the push to connect all roads, exchange all goods, and believe each other's gods. It was everyone's duty to share those values, creating how "us and them" were defined. Rome was building a global culture within which "the individual could use to express his/her identities depending on context" (Haeussler, 2013, p. 23). Haeussler (2013, p. 23) asks, "what was particularly Roman about a cosmopolitan culture?", adding to the question, 'beyond reliance on infrastructure, the intensifying interaction, and symbols of power relating to Roman ideology'? Part of the answer is in the query; it is infrastructure. However, this infrastructure does not refer to roads, political, or military organization. The infrastructure of the Empire was people and their participation in maintaining Roman ideology. Romans negotiated their priorities and new provincial clients provided resources that could be shared among those with the right position:

> [T]he benefits and burdens of empire were unevenly distributed… to reap the fruits of power the Romans were forced to utilize their provincial clients and thus to share power… the real effect of empire was to increase social differentiation.
>
> Garnsey & Whittaker, 1979, p. 6

A particularly Roman type of diversity was "cultivated by elites, for elites, and served to the people on top," becoming "a tool for controlling the oppressed" (Pandey, 2020, pp. 18, 20). The values that would later become *Romanitas,* personified in citizenship and status, were associated with coercion (Millett, 1995, p. 53). Heterogeneity could be a means to an end, such as with the taking of Sabine woman to populate the foundling city of Rome. The previous example of how Canuleius drew from the beginning of the city of Rome to promote expanding the citizenry stands in contrast to the mythos later minted on coinage (89 BCE) portraying martial victory alongside assault of the cities' Sabine mothers (Holden, 2008). The commemorative coins were given away at public events during a period of civil uprising, and served both to demonstrate Rome's acceptance of others, and its ability to compel others to it, blending violence and unification (Holden, 2008). Romans did not see all people as the same, they had an idea of ethnicity or difference (Pandey, 2021). However, flexibility in group identity formation could be advantageous for ad-hoc alteration of who is included.

Roman values were used as justification for enslavement and war. Dominance, which is exercised through virtues (Woolf, 2001, p. 314), seems to have been less about valuing differences and more about pacifying commodities. Rome was a state and a people, so in this way imperialism was not just mastery of one state by another, but also was the "power of one people over another" (Richardson, 1991; Woolf, 2001, p. 314). Cassius Dio wrote of barbarian conformity to Roman-ness by saying:

> The barbarians were adapting themselves to Roman ways, were becoming accustomed to hold markets, and were meeting in peaceful assemblages. They had not, however, forgotten their ancestral habits, their native manners, their old life of independence, or the power derived from arms. Hence, so long as they were unlearning these customs gradually and by the way, as one may say, under careful watching, they were not disturbed by the change in their manner of life, and were becoming different without knowing it.
>
> Cassius Dio, transl. 1924, book 56, line 18

Cornwell (2019, p. 480), discusses similar Roman rhetoric which abandons attempts at justification to instead revel in the "ignorance" of those under the "veneer of independence". When advantageous, such as for expanding the tax base, blended Roman identity could be cultivated in recognition of the diversity of people living under Roman rule (Pandey, 2021). Despite this, practices such as blended *tria nomina*, were, " just one of the ways in which Romanization had to dissolve or blunt the ethnic purity of the highland populations, and thus possible resistance to the conqueror" (Rendić-Miočević, 1964).

The Bodily Imperialism of the Eastern Adriatic and Hinterland

Over the last 200 years BCE, the Delmatae, Histri, Japodes, and Pannonians, among others, had numerous wars and rebellions with Rome and Roman generals, in contrast to the coastal Liburnians. These conflicts resulted in enormous changes for the entire Adriatic region, and as this research has shown, Roman descendants in the Adriatic were mixed populations. Non-singular identities and histories do not make descendants any less indigenous or Roman but highlight the complex negotiations around identity. Regional biological structure, informed by historical context, has demonstrated that the "transcendent identities" of imperial and colonial subjects varied greatly and yet could be predicated on the closeness of shared ancestral ties. In the Eastern Adriatic and hinterland, lineal descent was the primary vessel of authority, implying an importance on knowing one's heritage. Chapter 2 discusses how Eastern Adriatic and hinterland Roman and indigenous identities were represented in parallel by Roman Adriatic descendants (Džino, 2010a; Tonc et al., 2013). This is shown in onomastics, funerary inscriptions, and records by Roman historians. Still, the resources of cultural and ancestral memory were shaped and co-opted to serve the goals of those in power. Integration of indigenous people both culturally and biologically has been documented as having lasting impacts on descendent identities (Healy et al., 2017). It is likely that in moments of change, citizens and inhabitants responded in ways that were within their means and upheld the values that served them and their survival, while abandoning those that did not. Archaeologists have found that colonized peoples maintained ancestral ties, adopted new customs, and reacted with agency to their changing landscapes (Klaus & Tam Chang, 2011; Ortiz, Murphy, Toohey, & Gaither, 2017; R. Scott & O'Carroll, 2015; Stojanowski, 2010). Similarly, in the Adriatic it eventually became advantageous for Adriatic peoples to assimilate, and in many ways, they were constrained to doing just that. As has been discussed, populations were relocated, conscripted to Roman allegiance, and at threat of enslavement or death. They observed spatial, religious, and material displays of the benefits of Roman citizenship, coexisting with a life where at first not much changed for the average individual. Within this milieu, Roman colonists and locals adopted each other's customs, and an appropriative atmosphere of a shared heritage and future could have seemed less intimidating, even appealing. It is from this environment that despite a diversity of peoples coexisting, they are all remembered as Roman.

The changes in the biological landscape due to imperialism could be described as "bioimperialism." The term bio-imperialism, as applied here, is new to bioarchaeology but does exist in other scholarship. It is primarily used in ecological studies to describe one party's control over the resources, food, and access to weapons and medicine of another (Crosby, 2004; D'Arcangelis, 2020; Dorsey, 2005). It has also been used in anthropological literature to describe the collection of American Indigenous people's genomes, in a way analogous to the Indigenous Peoples Council on Biocolonialism's (IPCB) use of biocolonialism (Harry & Kanehe, 2007; Kressing, 2012; Tsosie et al., 2020). These processes, often spurred by unequal collaboration or trade, can result in a dominant political power taking advantage of others. Similarly, a bodily bioimperialism makes one party subject to allegiance with or dependence on another in a way that instigates assimilation as beneficial or even necessary. It also allows us to think about more than culture change when we consider two populations with increased interaction or radically shifting dynamics. The term, in part, motivates archaeology to reflect on the interconnectedness of nature and society, as the word's origins imply (Crosby, 2004; Kosiba, 2019).

ROMANIZATION REVISITED

Changes in the Adriatic and hinterland are commonly referred to as Romanization, which is reviewed in Chapter 3. Following Terrenato's (1998, p. 25) discussion on identifying Romanization is helpful. It suggests considering, even in bricolage, native elite continued status and community involvement, introduction of new elements in society, intensification and/or specialization of production, new field boundaries or forms of control created in the landscape, and adoption of Roman law and Roman forms of dependence (Keay & Terrenato, 2001; Terrenato, 1998, p. 25). These indicators have been consistently demonstrated by Adriatic and hinterland regional archaeological and historical research showing longer supply chains, local contributions to armies, and major shifts in subsistence practices and resource utilization (e.g., seafaring to agriculture) (Cambi, 2013; Domines Peter, 2019; Kovač, 2022; Matijašić, 2017; Zotović, 2003; Županek, 2008).

The Romanization debate began with questions on how to characterize the transformations experienced by people who initially were in little to no interaction with Rome but eventually became Roman themselves. It is widely accepted that Roman influence in the Adriatic provinces involved war, death, power, and political entanglements, which played significant roles in the collective transformation of societies. Past arguments that the concept of Romanization fails to move beyond the binary distinction of Roman versus native imply that there is a separate realm where the two do not intertwine. Discussing the "native" cannot be done without considering the influence of Rome, and vice versa. The historical context of how new peoples emerged necessarily must recognize the role of Rome. The dichotomy between Romans and others will always exist due to Rome's imperial expansion into neighboring regions.

Perhaps critique of Romanization is less about conceptualizing the past, and more about operationalizing it, highlighting the difficulty in producing substantive research or clear comparisons that teach us something new which is more than mere description. But in archaeology, many of these potentially intriguing insights cannot be hypothesized in a traditional scientific approach. Nevertheless, within those realities there are interesting and potentially unexpected things to discover. Perhaps less of a focus on theoretical re-imaginings of Romanization, and more exploration of methodological approaches is needed. Avoiding dichotomies does not mean ignoring differences- it means exploring them in a new way. From a population-level perspective, through bioarchaeology, this dissertation brings attention to the fact that individual communities and groups may have had biological ties that are not obvious in their cultural identifiers.

Similarly, the solutions for defining or engaging with Romanization are often presented in opposition, as if Romanization needs to be replaced with a more appropriate model or word. While it is valid to examine connectivity, local dynamics, and global trends, among many other suggested alternatives, it is crucial to acknowledge the reality of imperialism and its impact. The interactions between Rome and other regions were not merely cultural exchanges as power imbalance and imperialism had a profound impact on the lives of the Empire's inhabitants (Fernández-Götz, Maschek, & Roymans, 2020; Jiménez, 2020; Roymans et al., 2020). Romanization does not need to be everything or nothing; using it as a general descriptor does not equate to its use as a grand theory. Williams (2001, p. 95) explains this by presenting the "third way":

> The detailed archaeology of a region may indeed suggest that what we call Romanization was an untidy, regional process of negotiated change with variable consequences in the world of material culture, rather than the rigid application and adoption of a single Roman matrix. But this conclusion cannot then be used as proof of the thesis that the Romans were as a rule essentially laissez faire in the way in which they set about dealing with newly conquered areas and their populations. Conversely, to argue that various attitudes held and actions performed by Romans had something to do with the direction taken by post-conquest changes evident in a particular area does not commit us to the view that Roman culture only spread as a consequence of paternalistic intervention, or that Roman interventionism explains everything that happened in a region…
>
> Williams, 2001, page 95

CONCLUSION

The goal of this dissertation was to understand if microevolutionary population change occurred in the Eastern Adriatic and hinterland and, if so, how those changes were different for allied Liburnians versus local populations that were less acquiescent to

Roman incursions (Delmatae, Histri, Japodes, and Pannonians). These findings were contextualized by archaeological and classical research in the Eastern Adriatic and Croatia. Cultural attribution of local Roman individuals to particular ancestral tribes is based on material culture, onomastics, and epigraphy. However, there is a general lack of knowledge about lineal and ancestral origins of the Roman Empire period residents of the Eastern Adriatic and hinterland who are broadly referred to as Roman.

Furthermore, the Eastern Adriatic region is an outlier when compared to other places where pre-Roman linguistic, cultural, and ethnic identities may have persisted after the fall of the Roman Empire and have living descendants. In contrast, the Eastern Adriatic and hinterland is understood to have experienced a totalizing Romanization that resulted in the complete assimilation of local populations. These complexities make understanding local identities and how Romanization affected the region more difficult. Despite identity being a key subject of interest, biological distance studies of the Iron Age and Roman inhabitants in this region are not common. These factors provided the impetus to examine whether there was biological admixture between those in the Eastern Adriatic and hinterland and Roman Italics, and to determine whether population relationships varied with respect to each group's distinct histories.

This research, therefore, applied the study of dental morphology to questions of population affinity. As the anatomy and development of teeth provide a specific phenetic response that can be attributed to gene flow, microevolutionary changes were examined through dental phenotypic analysis. Results do not indicate any significant distinctions among the Eastern Adriatic and hinterland populations at any point in time. However, the

Roman Period Liburnian population was found to have a statistically significant differentiation from their contemporary allies, the Roman Period Italics; whereas other Roman Period Adriatic populations do not exhibit such differentiation. This difference could be interpreted as a result of the historical alliance between the Liburnians and Rome. This alliance potentially placed the Liburnians in unique circumstances compared to other local populations, leading to variations in terms of mobility, integration with Roman society, and connection to their ancestral heritage, resulting in diverse outcomes of genetic admixture. Conversely, the descendants of the resistant populations were not statistically different from Roman Empire Italics. This could be explained by their ancestors' experiences of war, enslavement, displacement, and enlistment which could have affected who they could have built communities with thereafter.

Moreover, all of the populations demonstrate local continuity between ancestors and descendants. This seeming incongruity, being identified as Roman and yet descending from people who fought against Rome, is analyzed in the context of Roman history. Laws limiting marriage and citizenship which categorized people through class status in the Late Republic and early Empire may have contributed to the continuation of earlier phenetic affiliations. However, local populations and colonists exchanged traditions and eventually, Roman laws changed, and the Adriatic peoples were included with many others in receiving Roman citizenship.

Furthermore, as Rome grew, so did its multi-cultural, poly-theistic, and global integration. These are often understood as examples of how the Roman Antique was diverse, unlike modern ethnocentric ideas. Nevertheless, this dissertation considered these values in light of the violent historical origins of the Roman Adriatic, the history of Rome's use of citizenship and allyship, and how identity and power were related. In such a context, Roman values were found to prioritize diversity when it was advantageous, and then use pluralism as a way to encourage cultural assimilation and define outsiders.

This text also explored the topic of Romanization and its controversies. In light of Adriatic history, this dissertation determined that the word is not as important as finding new ways to understand past people, while also not minimizing their experience of imperialism. Considering the results of the biological distance analysis and the broader implications of Romanization, this dissertation discusses the outcomes as a form of biological imperialism.

These findings contribute to studies on Roman inter-marriage, ancestral alliances, and indigenous experiences of ancestral ties despite being part of a pan-regional Roman citizenry by the end of the Western Empire. This work is the first biological distance investigation of human dentition dating to the Iron Age or Roman period from across the Eastern Adriatic coast and hinterland. The study has attempted to build upon previous archaeological work investigating ethnic and social change in the region due to the influence of the Roman Republic and Empire by adding relational population information.

Future Research

Archaeologists continue to learn more about the local responses to Romanization, and how the Adriatic coastal and hinterland peoples changed within regional dynamics. Future work should aim to explore these further, utilizing larger sample sizes and employing analytical approaches that consider genetic variation among local and regional populations. As detection of biological variation is sensitive to the overall variation of the populations compared, more data can refine the results providing better analytical groupings. One approach will be to revisit analyses using north and south focused groupings across both the Italic Peninsula and Eastern Adriatic. Future questions can also address Pannonian and Celtic associations as well as Greek and Delmatae relations. Additionally, next steps include examination of dental metrics gathered in Croatia using Mahalanobis distances to consider trait correlation in the data set. R-matrices can be used to estimate Fst, a measure of genetic differentiation among populations that can more widely compare with supplemental data as Fst can provide model-bound indicators, unlike the model-free relative approach with non-metrics (Irish, 2010; Konigsberg, 2006; Relethford & Blangero, 1990). Biocultural research such as this can shed light on the experiences of admixed populations, hybrid materiality, and blended cultural experiences in colonialist and imperialist settings (Ortiz et al., 2017; R. Scott & O'Carroll, 2015).

Finally, expanding the study of Roman history and archaeology with bioarchaeology holds promising opportunities for a deeper understanding of the bio-cultural dynamics of this region and cultural practices during and beyond the Roman Empire. Despite the popularity of Roman history and archaeology in the public imagination, there continue to be relatively few Roman bioarchaeologists and even fewer specializing in the Eastern Adriatic region (Joshel, Malamud, & Jr, 2005; Killgrove, 2019; Novak, 2012). Importantly, researchers from different disciplines bring their own frames of reference and together, interdisciplinary collaboration may help resolve old methodological questions and theoretical debates. This research will certainly spark curiosity and future collaborations.

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APPENDIX I

CLASSICAL PERIOD HISTORIANS AND AUTHORS

Appian (born c. 95- 160 CE):

Appian of Alexandria, Egypt, was a Roman citizen who wrote extensively on Roman military conquests in Greek, his native language (Mellor, 2012). Appian's texts covered politics and state leaders, inclined to present the Roman point of view of events. He depicted leaders as benevolent, particularly Julius Caesar who he portrayed as preemptive, insightful, and alert (Grant, 2004; Marincola, 2010). Despite his biases, Appian's 24-volume historical work, of which 10 volumes survive, offer valuable insights into the perspectives of a historian writing recent events for a contemporary audience.

Cassius Dio (163 to 235 CE):

Cassius Dio Cocceianus was a Greek historian from the western Anatolian region. He wrote an expansive 80 book history of Rome from its founding through 229 CE. He moved to Rome around 180 CE and likely served as a praetor (magistrate or commander) and a consul (highest elected public official) twice (Grant, 2004; Marincola, 2010). Cassius Dio has been criticized for inaccuracies on Tiberius, however he also been considered to have first person experience with Senatorial matters and perhaps was a member at some point (Grant, 2004; Marincola, 2010).

Cicero (c. 100- 43 BCE):

Marcus Tullius Cicero came from a wealthy family and was a well-educated Roman politician. Cicero was also a lawyer, poet, orator, and philosopher who read and wrote in Greek and Latin. Cicero was a Republican advocate and influential rhetorician, therefore his assassination by Mark Antony for opposing Julius Caesar is considered the end of the Roman Republic and beginning of the Empire (Grant, 2004; Marincola, 2010).

Herodian (170 to 240 CE):

Herodian was a Greek historian and author of a *History of the Roman Empire since the Death of Marcus Aurelius*. He, likely a Roman government public worker, wrote to an eastern audience such as his native city of Antioch (Lendering, 2004).

Livy (c. 60 BCE- 10 CE):

Titus Livius (Livy) was born in Cisalpine Gaul (north Italy), though lived in Rome for many years. He authored a volume of over 100 books called the *History of Rome* which chronicled Roman history from the cities founding around 800 BCE through roughly 10 BCE. He also wrote extensively on the Punic Wars. Livy drew on other historians including Greek historians, and is sometimes criticized for repeating others inaccuracies and having a patriotic bias (Grant, 2004).

Ovid (c. 43 BCE to 17 CE):

Publius Ovidius Naso was a Roman poet who lived during the reign of Augustus. Ovid wrote extensively on love and myth, however his numerous writings shift between these subjects and history, providing both serious and farcical perspectives which are debated to this day (Boyd, 2002).

Paterculus (c. 19 BCE to 30 CE):

Velleius Paterculus wrote a history of Rome which has been criticized for being "enthusiastic" about Rome and Tiberius. It has been referred to as propaganda, but is nevertheless interesting for the way he represents Tiberius, who he admired, in contrast to Tacitus and Augustus (Gowing, 2007; Grant, 2004).

Pliny the Elder (c. 23 to 79 CE):

Gaius Plinius Secondus is called Pliny the Elder, not to be confused with his nephew Pliny the Younger. He was a geographer and historian, and wrote encyclopedic Naturalis Historia (Natural History), which became of model for future encyclopedias. Pliny was also a military commander but dies in the eruption of Mount Vesuvius in 79 CE (Grant, 2004; Marincola, 2010).

Pseudo-Scylax, also Pseudo-Skylax (mid-fourth century BCE):

Pseudo-Scylax was a Greek geographer that traveled the entire Mediterranean and wrote of the peoples he encountered. The name, as implied in "Pseudo" was likely not his actual name and was a moniker that has been used for other writings of the time. It is thought that he could have been Skylax of Karyanda, though there are issues with dating (Pseudo-Scylax & Shipley, 2011).

Strabo (65 BCE to 25 CE)

Strabo of Amaseia (modern Türkiye), was a Greek geographer, historian, and philosopher who travelled around the Mediterranean and Adriatic recording on his travels. His firsthand accounts are considered some of the most important accounts of the region's geographies and cultures. His 17-book volume, *Geography*, provides important historical details during the reign of Augustus. Strabo also cites prior geographic works by Eratosthenes, who first used the term "geography," as well as authors whose writings have otherwise been lost (Roller, 2015).

Tacitus (pre-75 to 117 CE):

Publius Cornelius Tacitus was a Roman orator, official, and historian who had studied rhetoric in Rome and subsequently became proconsul of Asia (112 CE). He wrote many volumes including The Annuals and Histories which dealt with Roman history 14 CE to 96 CE between them (Grant, 2004).

Varro (116 to 27 BCE):

Marcus Terentius Varro was a Roman praetor from central Italy near Rome. He wrote on the history of Rome, language, arithmetic, and genealogy among other subjects (Bravo, 2007; Grant, 2004; Marincola, 2010).

APPENDIX II

GLOSSARY

This reference section gives definitions to terminology used throughout the paper that may be discipline specific jargon, language specific terminology, uncommon historical information, or out of favor terminology which will be better understood with a definition, context, or explanation of why it is used here. Some definitions have been taken from the reference book, *Post Colonial Studies* (Ashcroft et al., 2013).

Antique Period:

Chapter 1 explains dating terminology in detail; however, the Antique Period is discussed here as this phrasing is considered an older term that is nevertheless very common in Eastern Adriatic archaeology. The term Antique Period is very broad and covers the entirety of Roman and Greek history (c. 800 BCE- 500 CE). This time period is sometimes also referred to as Classical Antiquity. The term Antique Period is widely used in Croatian literature, however, and this dissertation reflects that usage. In the Adriatic region, this period begins with Roman influence; c. 200 BCE depending on the population. However, one could interpret the Antique Period in the Eastern Adriatic and hinterland more generally as lasting from around 50 BCE to the end of the western Roman Empire.

Admixture:

Admixture is shared genetic diversity between groups of people. The term is negatively connected to the problematic history of biological distance and scientific racism. The issues some authors have with this term will not be covered here, as this author does not fundamentally disagree with critics. In short, the concerns may be summed up with the term having deterministic, essentialist connotations. It is also a term used with non-human animals and be misinterpreted to imply "subspecies" mixing or that human admixture is unnatural. This dissertation has been clear on its position to the problematic history of biological anthropology, rejecting erroneous concepts (e.g., essentialism, subspecies, etc.), and challenging uncritical use of biological distance methodologies. As a mixed individual who personally identifies with the term "admixed" over terms like bi-racial; this author uses "admixture" within this work to encourage critical engagement with the contextualization and representation of such terminology in scholarship. Other scientific terminology like genetic variation or ancestral diversity may also be used.

Balkans:

This term often refers to the geographic region in the Mediterranean peninsula bordered by southeastern Europe between the Adriatic and Ionian seas on the west and the Aegean and Black seas on the east (*Merriam-Webster.Com Dictionary*, n.d.). This term is frowned upon by some authors considering the large ecological and political differences (see modern discussions on Balkanization) in the region. It is also critiqued because it overgeneralizes people in the region in a way that has been compared to Orientalism (Kuzmanović & Vranić, 2013). This dissertation uses the term when legitimately referencing the larger peninsula or when mirroring the language of the citation under discussion.

Colonialism:

Colonialism as defined by Van Dommelen (1997, p. 306) is "one or more groups of foreign people in a region at some distance from their place of origin (the 'colonizers') and the existence of asymmetrical socio-economic relationships of domination or exploitation between the colonizing groups and the inhabitants of the colonized region." This dissertation briefly discussed colonialism with imperialism in Chapter 3 and has determined that it applies to the experiences of inhabitants in the Eastern Adriatic despite some Romanists objections. For more discussion on this term, Prochaska (2002, pp. 8–11) discusses different forms of colonialism and their consequences.

Epigraphy:

These are ancient inscriptions and, in this region, tend to be inscriptions in stone.

Heterodont:

The Oxford online dictionary ("Oxford," 2004) defines heterodont as, "describing animals that possess teeth of more than one type (i.e., incisors, canine teeth, premolars, and molars), each with a particular function. Most mammals are heterodont."

Hybridity:

This is another term that is problematic when used to refer to people biologically, though it is typically used in relationship to culture. This dissertation follows Van Dommelen (1997, p. 309), who defines hybridization as "the ways in which social, economic or ethnic groups of people construct a distinct identity within the colonial context and situate themselves with respect to the dominant, i.e., colonial culture."

Illyrian:

This term references different groups over various time periods which is discussed in Chapters 1 and 2. It is important to note that in modern contexts the term has been politicized and can be used derogatorily to distinguish southern Balkan peoples, such as Albanians and Macedonians, from those residing in Dalmatia and more northerly lands of former Yugoslavia. These prejudicial assertions target those who are thought to descend from othered “barbarian” peoples and are compounded by interpretations of Slavic origins that distinguish and place value judgements on different ancestries (Jovanović, 2017). Despite the fact that this term will be used to denote the prehistoric peoples of the southern region, there is no implied continuity with modern peoples and this author is unaware of any founded assertions of direct lineal descent between any past group and modern populations. Even if there were, those associations would be irrelevant and should not have any prejudicial connotation. Additionally, Roman historians used this term to describe people throughout the coastal and hinterland region, as far north as the Danube River. Typically, Illyrian refers to the past peoples of pre-Roman Illyrian Kingdoms from the southern Adriatic coast. Therefore, in this text, Illyrian will refer to these pre-Roman residents. After Roman Illyricum was instated, the term Illyrian is no longer specific to the prior Kingdoms, but a political term referring to the people that once resided in the Roman province or wider prefecture. This text avoids the term except when citing references that use it. When discussing a source that generalizes the wider region as Illyrian or those from Illyrian tribes (referring to residents outside of the Illyrian Kingdoms but before Illyricum was instated), “Illyrian” or “Illyrian tribes” will be used. Because of the provincial naming schema, Dalmatian and Pannonian are also used to refer to peoples in the broader region, but these confusingly can describe either temporally specific residents of the provinces or their local ancestors.

Indigenous:

In the Americas, Indigenous is often used to refer to the original residents on North and South America before colonization and their descendants. It is often capitalized for many reasons including its use as a proper noun, like a name, particularly when specific Tribal names are unknown. In this dissertation, indigenous is used in a general sense to refer to peoples of the Adriatic before Rome. It is not capitalized as this convention and historical circumstances are very different to the Americas.' The same circumstance applies to the word tribe as well. The usage follows local scholarship by people who are the closest group to extant descendants.

Italic:

This is a general term used in some Classical literature which refers to people from the Italian peninsula before it was Italy. It is used as an ethnolinguistic label for those who are identified by their use of the Italic languages, one of the branches of Indo-European languages. Outside of specialized linguistic literature, the term is also used to describe the ancient peoples of Italy as defined in Roman times, including, Latins, Etruscans, and Samnites (de Grummond, 2015)

Numismatics:

The study of coins and currency.

Onomastics:

The study of the history of names and naming practices. Roman citizens used a *tria nomina*, or three name system where men had a *praenomen*, *nomen*, and *cognomen* or personal name, clan name, and a third name that could be a nickname, honorary name, or family name. After the Late Republic, women were only referred to by their *nomen* and occasionally a *cognomen* or name giving their birth order (Salway, 1994).

Roman period:

This is a general term that describes the late Republican period and western Roman Empire. Other terms are used to provide more precise temporal ranges. However, numerous social and political processes that existed in one period extended into another. Therefore, the general “Roman Period” term is used. In the case when discussing a geographic location that did not have Roman interference until a specific time, the Roman Period is everything after that engagement. See “Antique Period.”

APPENDIX III

SAŽETAK/ ABSTRACT IN CROATIAN

Ova doktorska disertacija bavi se mikroevolucijskim promjenama na istočnoj obali Jadrana i zaleđu tijekom rimskog razdoblja, propitujući promjenjive obrasce varijacija među autohtonim stanovništvom s raznolikom poviješću prihvaćanja ili odupiranja rimskoj vlasti. Usprkos premoći rimskog utjecaja, trgovine te relativno tolerantne prirode rimske političke vlasti koji su ostvarivani kroz postojeće lokalne vođe, ljudi istočnojadranske obale i zaleđa izloženi su značajnim kulturnim promjenama. Za razliku od rimskih saveznika Liburna, za Delmate, Histre, Japode i Panone, koji su se odupirali rimskoj vlasti, romanizacija nije bila dobrovoljan proces. Nasilje koje je lokalno stanovništvo proživljavalo tijekom kasne rimske republike i ranog carstva, uključujući smrt, ropstvo, vojnu obavezu te nasilno preseljavanje, u suprotnosti su s konačnom integracijom ovog područja postignutom do kraja Rimskog Carstva, kada njihovi potomci postaju rimski državljani. Ova komplicirana povijest predstavlja izazov razumijevanju lokalnih identiteta i utjecaja romanizacije.

Analize biološke udaljenosti temeljene na dentalnoj morfologiji 313 osoba iz liburnskih, delmatskih, japodskih i panonskih uzoraka iz razdoblja željeznog doba (cca 700.-400. god. pr. Kr.), rimske republike (cca 200. pr. Kr.-1. god. n. e.) i rimskog carstva (cca 1.-500. god. n. e.) smještene su u kontekst arheoloških i klasičnih istraživanja. Rezultati ukazuju na odsustvo značajnih razlika među populacijama istočnog Jadrana i zaleđa tijekom ovih razdoblja. Međutim, rezultati vezani uz Liburne iz rimskog perioda, dakle potomke rimskih saveznika, ukazuju na diferencijaciju od istodobnih italskih Rimljana. Suprotno tome, potomci populacija koje su se odupirale Rimu statistički se ne razlikuju od Italika iz doba rimskog carstva, što možebitno odražava utjecaj ratnih iskustava njihovih predaka, koja su utjecala na kasnije miješanje populacija, stvaranje zajednica te pridržavanje normi tog vremena.

Rimski zakoni koji su ograničavali pristup privilegiranom statusu putem bračnih veza i državljanstva također mogu objasniti činjenicu da sve analizirane populacije pokazuju kontinuitet između predaka i njihovih nasljednika. Dinamika da se netko smatrao Rimljanom usprkos tome što je potjecao od ljudi koji su se borili protiv Rima, propituje se kao vrsta biološkog imperijalizma, koja posljedično utječe na autohtone, predačke veze unutar pan-regionalnog rimskog stanovništva. Iako se rimski multikulturalizam često ističe kao primjer raznolikosti u kasnoj antici, rimski sustav vrijednosti davao je prioritet raznolikosti kad im je ona bila od koristi te je koristio pluralizam s ciljem poticanja kulturne asimilacije i definiranja "stranaca."

APPENDIX IV

MAPS


Map 1
Spain
Andorra
France
Guernsey
Jersey
Belgium
Netherlands
Luxembourg
Monaco
Switzerland
Liechtenstein
Germany
Italy
San Marino
Slovenia
Austria
Czechia
Croatia
Bosnia and Herzegovina
Hungary
Slovakia
Poland
Montenegro
Kosovo
Serbia
Albania
North Macedonia
Greece
Bulgaria
Romania
Keyboard shortcuts
Map data ©2023 GeoBasis-DE/BKG (©2009), Google, Inst. Geog

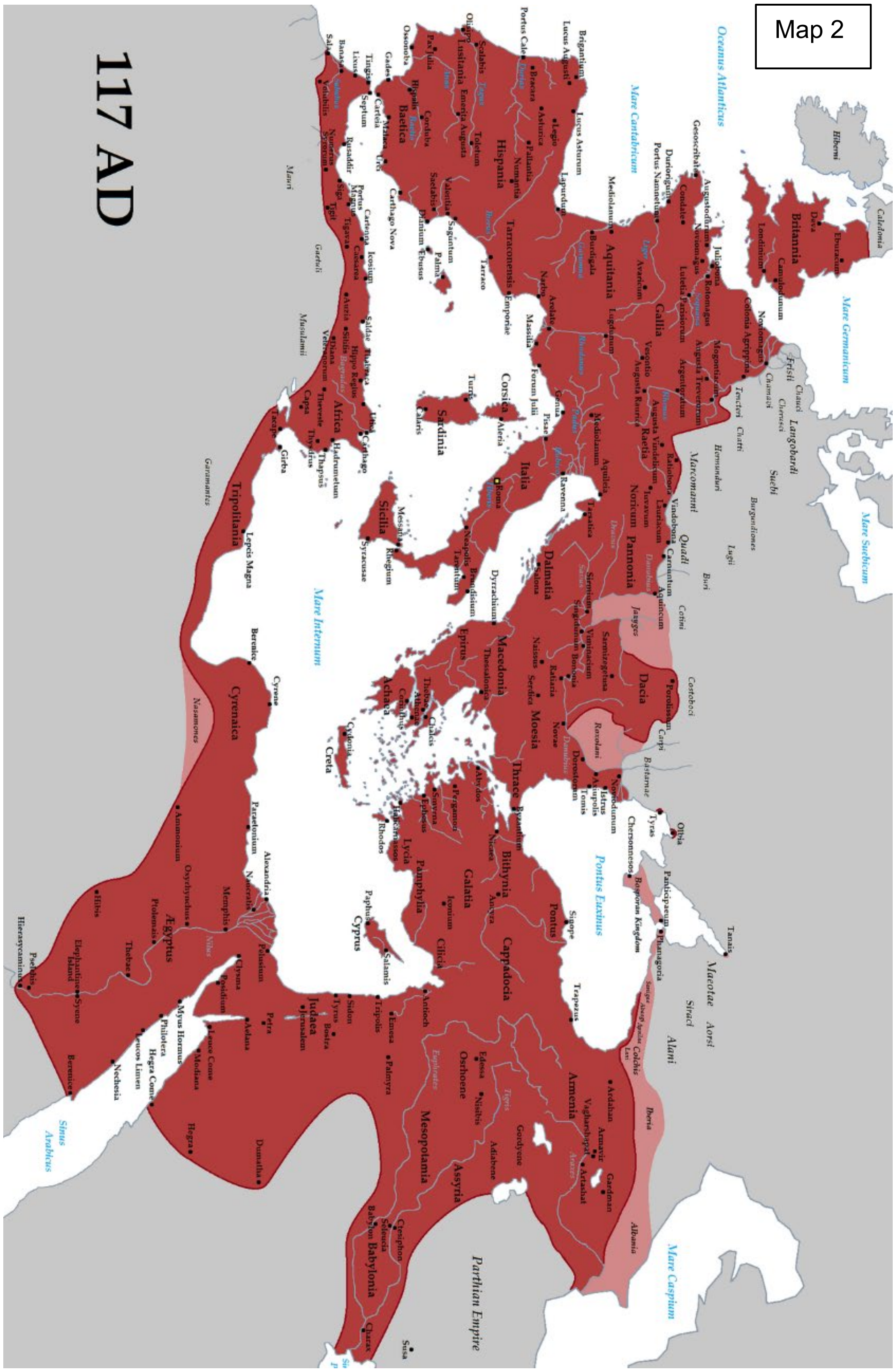


Figure 23 Maps of Europe at present day and during the Roman Empire. Map 1: Modern day Europe (Google Maps, 2009). Map 2: The Roman Empire in 117 CE at its greatest extent, near the time of Trajan's death; vassals in pink. Image from Wikimedia Commons and is in the public domain. Wikipedia, 2023.

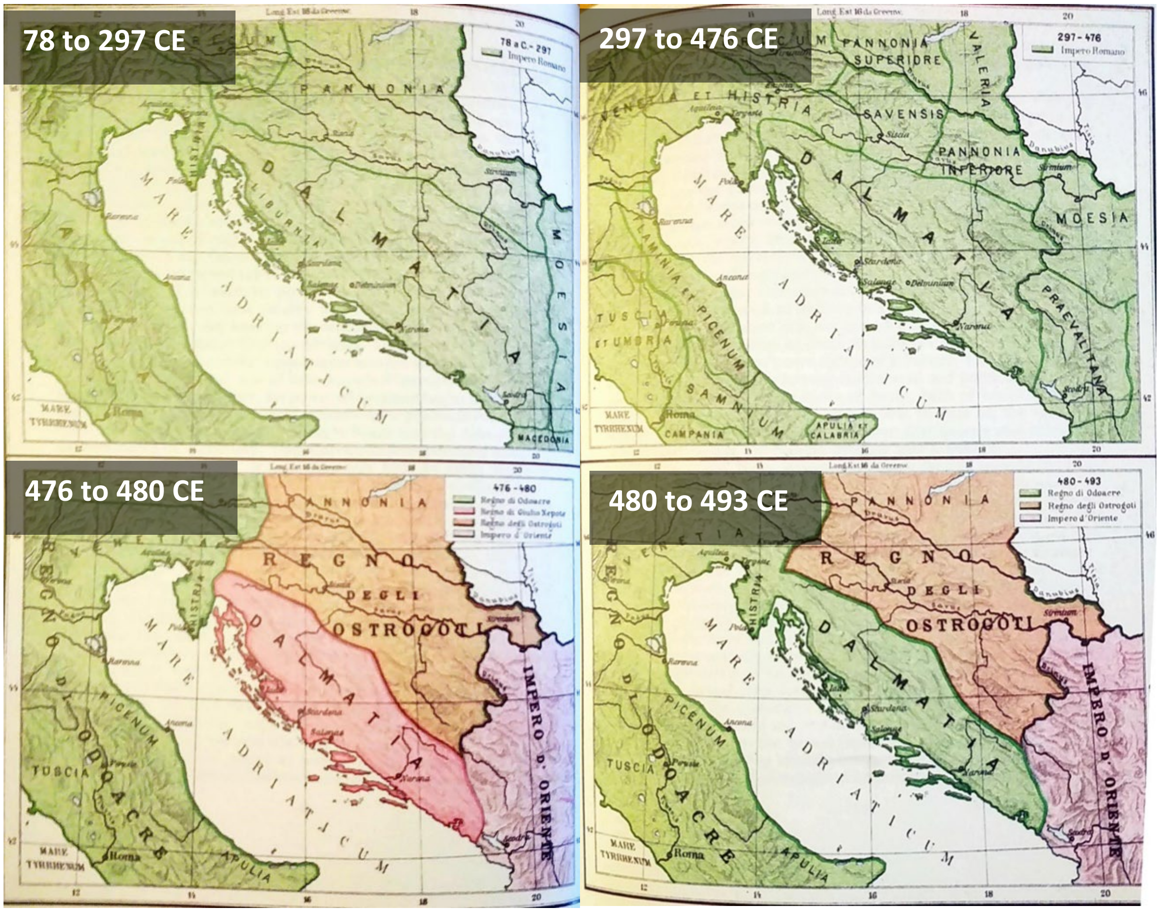


Figure 24 The Roman Empire in Dalmatia and Pannonia over 400 years. From the *History of Dalmatia* by Giuseppe Praga (1993, p. 24-25).

APPENDIX V

DATA CLEANING ANALYSES

Table 19

Age categories and numbers of analyzed individuals in age data cleaning.

Sites/ Age Groups	YC	J	T	YA	A	MA	Unknown	Totals
Sveti Kriz			1		2	2	2	7
Cvijina Gradina			1	3	7	4	13	28
Ilok- Ki						1		1
Kamenica			1					1
Knezevici Malo Libinje		1		5	2		5	13
Konjsko Brdo					1			1
Lovas				1	2			3
Makart		1	3	1	4			9
Nadin		2	5	5	10	3	40	65
NIN Ždrijac and Solana					1	1		2
Osijek		1		2	5		2	10
Sisak				1	2	1	1	5
Skradnik					2			2
Smiljan, Lika		2	1	1	2	1	1	8
Solin-Smiljanovac		2	6	16	27	1	6	58
Stankovci Velim				1	3		2	6
Trojvrh, Josipdol					1			1
Tugare		1		2	7	2	11	23
Velić				1			2	3
Ljubač Venac			1	1	4	1		7
Vinkovci NAMA				3	9		4	16
Virić		1	1	1				3
Vranjic			2	3	9	2	3	19
Vrsi		2	1	1	2			6
Zadar	2	3		3	5	2	1	16
Totals	**2**	**16**	**23**	**51**	**107**	**21**	**93**	**313**

Abbreviations: YC, young child, under 6; J, juvenile, 6- 12 years old; T, adolescent, 12 to 20 years old; YA, young adult, 21 to 35 years old; A, adult, showing signs of complete union, but not degeneration; MA, mature adult, adult showing signs of age-related skeletal degeneration.

Table 20

Sex and numbers of individuals in sex data cleaning.

Sites/ Sex Estimate	F	M	MF	Unknown	Totals
Sveti Kriz	2	1	1	3	7
Cvijina Gradina	2	1		25	28
Ilok- Ki		1			1
Kamenica				1	1
Gradina Knezevici Malo Libinje	2	1	1	9	13
Konjsko Brdo				1	1
Lovas	1	2			3
Makart				9	9
Nadin	5	2	1	57	65
NIN Ždrijac and Solana	1	1			2
OSVK		6	1	3	10
Sisak	1	2		2	5
Skradnik	1			1	2
Smiljan, Lika	1	1		6	8
Solin-Smiljanovac	23	18	1	16	58
Stankovci Velim		1		5	6
Trojvrh Mala Metaljka Josipdol			1		1
Tugare		2		21	23
Velić		1		2	3
Ljubač Venac	1			6	7
Vinkovci NAMA	2	3	1	10	16
Virić				3	3
Vranjic	2	8	2	7	19
Vrsi		1	1	4	6
Zadar	4	5	1	6	16
Totals	**48**	**57**	**11**	**197**	**313**

Abbreviations: F, probable female; M, probable male; MF, non-binary sex estimation; Unknown, unknown or indeterminate

Table 21

Age correlation test scores.

Age Correlation	**N**	**Spearmans Rho**		**polychoric**	**Kendall's tau**	
Maxillary Traits		ρ	p-value	r	τ_B	p-value
I1 Double Marginal Ridge	104	0.170	0.088	0.297	0.153	0.077
I1 Marginal Ridge	109	-0.016	0.867	0.008	-0.013	0.871
I2 Marginal Ridge	124	0.083	0.359	0.075	0.065	0.381
I1 Interruption Groove	85	0.120	0.270	0.100	0.100	0.290
I2 Interruption Groove	110	0.120	0.200	0.130	0.100	0.200
I2 Mesial Bend	132	-0.060	0.400	-0.070	-0.060	0.400
I1 Tuberculum Dentale	80	0.092	0.415	0.047	0.084	0.366
I2 Tuberculum Dentale	118	-0.019	0.836	-0.037	0.084	0.366
I2 Peg shaped Reduced Agenesis	†	†	†	†	†	†
Canine Tuberculum Dentale	113	0.297	0.001	0.333	0.245	0.002
Canine Distal Accessory Ridge	80	0.049	0.669	0.079	0.039	0.677
Canine Root Number	142	0.000	1.000	0.000	0.000	1.000
P3 Accessory Cusps	110	0.027	0.773	0.022	0.024	0.773
P3 Accessory Ridges	79	-0.279	0.013	-0.289	-0.247	0.011
P4 Accessory Ridges	65	-0.122	0.334	-0.149	-0.104	0.319
P3 Root Number	119	0.027	0.773	0.022	0.024	0.773
M1 Mesial Accessory Cusp	60	-0.175	0.181	-0.223	-0.146	0.201
M2 Metacone	168	0.009	0.909	-0.040	0.009	0.895
M3 Metacone	117	-0.115	0.216	-0.085	-0.101	0.208
M2 Hypocone	159	-0.072	0.368	-0.064	-0.058	0.383
M3 Hypocone	105	0.062	0.530	0.119	0.051	0.539
M2 Cusp 5	119	0.112	0.225	0.183	0.101	0.207
M3 Cusp 5	88	0.015	0.892	0.051	0.013	0.889
M1 Carabelli	125	-0.217	0.015	-0.275	-0.180	0.014

M3 Carabelli	93	-0.053	0.613	-0.096	-0.049	0.594
M1 Parastyle	125	-0.033	0.719	-0.039	-0.039	0.715
M3 Parastyle	86	-0.001	0.991	0.016	-0.002	0.986
M1 Enamel Extension	145	-0.047	0.577	-0.061	-0.042	0.573
M1 Root Number	91	0.073	0.489	0.120	0.067	0.490
M2 Root Number	107	-0.010	0.922	-0.039	-0.009	0.923
M3 Root Number	86	-0.133	0.223	-0.193	-0.119	0.221
M3 Peg shaped Reduced Agenesis	134	-0.008	0.929	0.014	-0.007	0.930
Mandibular Traits	N	ρ	p-value	r	τ_B	p-value
Canine Marginal Ridge	95	0.159	0.124	0.201	0.135	0.120
Canine Distal Accessory Ridge	94	0.138	0.184	0.189	0.121	0.169
Canine Root Number	137	-0.109	0.203	-0.233	-0.100	0.202
P3 Tome's Root	128	0.089	0.317	0.115	0.076	0.314
P4 Lingual Cusp Variation	137	0.037	0.664	0.037	0.035	0.648
M2 Groove Pattern	146	0.021	0.802	0.031	0.019	0.801
M1 Anterior Fovea	49	0.062	0.670	0.113	0.055	0.647
M1 Enamel Extension	154	0.059	0.469	0.052	0.053	0.460
M1 Protostylid	140	-0.067	0.428	-0.086	-0.059	0.425
M1 C5 Hypoconulid	119	-0.120	0.193	-0.125	-0.102	0.193
M2 C5 Hypoconulid	123	-0.063	0.491	-0.059	-0.056	0.482
M1 Cusp 6	89	0.213	0.045	0.393	0.195	0.042
M1 Cusp 7	112	-0.171	0.071	-0.323	-0.156	0.070
M1 Root Number	77	0.091	0.433	0.367	0.082	0.431
M2 Root Number	91	0.136	0.200	0.175	0.125	0.194
M2 Protostylid	130	0.067	0.446	0.089	0.061	0.427
M3 Peg-shaped Reduced Agenesis	116	-0.064	0.493	-0.100	-0.061	0.491
M3 Protostylid	87	-0.104	0.337	-0.174	-0.090	0.332
Odontomes	†	†	†	†	†	†
Enamel Pearls	†	†	†	†	†	†

Note: N, number of individuals with age group identification and trait observation, Spearman's Rho (ρ) and p-value, the polychoric correlation statistic (r), and Kendall's Tau-b (τ_B) and p-value are provided. Correlated traits are highlighted if the statistic score is < -0.5 or > 0.5 or the p-value is less than the alpha of 0.05 for Spearman's Rho and Kendall's Tau. †traits were removed prior to analysis.

Table 22

Sex correlation test scores.

Sex Correlation	**N**	**Spearmans Rho**		**polychoric**	**Kendall's tau**	
Maxillary Traits		ρ	p-value	r	τ_B	p-value
I1 Double Marginal Ridge	51	-0.041	0.776	-0.034	-0.038	0.770
I1 Marginal Ridge	52	0.074	0.601	0.141	0.076	0.538
I2 Marginal Ridge	67	0.180	0.146	0.228	0.158	0.140
I1 Interruption Groove	40	0.230	0.150	0.260	0.212	0.150
I2 Interruption Groove	61	-0.100	0.400	-0.100	-0.098	0.405
I2 Mesial Bend	74	0.090	-0.400	0.300	0.090	0.400
I1 Tuberculum Dentale	36	-0.058	0.735	-0.086	-0.048	0.749
I2 Tuberculum Dentale	61	0.245	0.056	0.305	0.205	0.065
I2 Peg shaped Reduced Agenesis	†	†	†	†	†	†
Canine Tuberculum Dentale	56	0.363	0.006	0.448	0.314	0.007
Canine Distal Accessory Ridge	34	0.350	0.043	0.478	0.312	0.041
Canine Root Number	82	0.000	1.000	0.000	0.000	1.000
P3 Accessory Cusps	54	0.055	0.644	0.076	0.053	0.639
P3 Accessory Ridges	32	0.143	0.435	0.189	0.124	0.454
P4 Accessory Ridges	26	0.218	0.286	0.269	0.186	0.293
P3 Root Number	72	0.055	0.644	0.076	0.053	0.639
M1 Mesial Accessory Cusp	21	0.325	0.151	†*	0.311	0.145

M2 Metacone	90	0.085	0.423	0.093	0.078	0.422
M3 Metacone	67	0.014	0.911	0.003	0.013	0.909
M2 Hypocone	84	0.167	0.128	0.216	0.145	0.131
M3 Hypocone	60	0.016	0.901	0.013	0.011	0.919
M2 Cusp 5	53	-0.220	0.113	-0.262	-0.192	0.121
M3 Cusp 5	46	-0.148	0.328	-0.166	-0.144	0.283
M1 Carabelli	60	0.127	0.332	0.210	0.113	0.314
M3 Carabelli	53	0.072	0.606	0.042	0.065	0.613
M1 Parastyle	64	-0.194	0.125	-0.366	-0.184	0.117
M3 Parastyle	53	0.135	0.335	0.261	0.126	0.335
M1 Enamel Extension	73	0.074	0.531	0.114	0.070	0.526
M1 Root Number	50	0.114	0.431	0.250	0.109	0.423
M2 Root Number	55	-0.105	0.447	-0.153	-0.097	0.442
M3 Root Number	54	0.137	0.323	0.159	0.119	0.332
M3 Peg shaped Reduced Agenesis	76	-0.146	0.210	-0.229	-0.136	0.207
Mandibular Traits	N	ρ	p-value	r	τ_B	p-value
Canine Marginal Ridge	52	0.205	0.144	0.277	0.186	0.134
Canine Distal Accessory Ridge	44	0.259	0.090	0.397	0.236	0.089
Canine Root Number	70	0.107	0.378	0.953	0.103	0.374
P3 Tome’s Root	67	-0.038	0.758	-0.036	-0.035	0.745
P4 Lingual Cusp Variation	79	-0.143	0.210	-0.165	-0.130	0.224
M2 Groove Pattern	72	-0.203	0.088	-0.305	-0.196	0.088
M1 Anterior Fovea	22	0.000	0.999	-0.078	0.000	1.000
M1 Enamel Extension	83	0.011	0.920	0.035	0.011	0.918
M1 Protostylid	73	-0.030	0.800	-0.077	-0.026	0.808
M1 C5 Hypoconulid	60	0.006	0.967	0.009	0.005	0.964
M2 C5 Hypoconulid	59	0.062	0.643	0.072	0.057	0.640
M1 Cusp 6	38	-0.204	0.219	-0.288	-0.186	0.222
M1 Cusp 7	52	0.238	0.089	**	0.229	0.089
M1 Root Number	37	-0.141	0.405	-0.975	-0.136	0.397

M2 Root Number	47	-0.182	0.220	-0.267	-0.172	0.214
M2 Protostylid	68	0.246	0.043	0.331	0.225	0.043
M3 Peg-shaped Reduced Agenesis	79	-0.085	0.458	-0.149	-0.082	0.455
M3 Protostylid	57	-0.116	0.391	-0.159	-0.105	0.369
Odontomes	†	†	†	†	†	†
Enamel Pearls	†	†	†	†	†	†

Note: N, number of individuals with identified sex and trait observation, Spearman's Rho (ρ) and p-value, the polychoric correlation statistic (r), and Kendall's Tau-b (τ_B) and p-value are provided. Correlated traits are highlighted if the statistic score is < -0.5 or > 0.5 or the p-value is less than the alpha of 0.05 for Spearman's Rho and Kendall's Tau. †traits were removed prior to analysis. ‡ analysis produced an error code.

Table 23

Cohen's Kappa intra-observer error test for maxillary traits.

MAXILLA	N	Pr(a)	Pr(e)	κ	continued	N	Pr(a)	Pr(e)	κ
I1 DblMargRdg	10	0.90	0.62	0.74	M2 metacone	**	**	**	**
I1 MargRdg	11	0.64	0.44	0.35	M3 Metacone	3	1.00	1.00	ND
I2 MargRdg	13	0.62	0.69	-0.23	M2 Hypocone	12	1.00	1.00	ND
I1 Inter. Groove	10	0.60	0.56	0.09	M3 Hypocone	3	0.33	0.33	0.00
I2 Inter. Groove	12	0.67	0.61	0.14	M2 Cusp 5	9	1.00	0.65	1.00
Mesial Bend	3	0.93	0.81	0.63	M3 Cusp 5	3	1.00	0.56	1.00
I1 Tub Dentale	8	0.63	0.50	0.25	M1 Carabelli	9	1.00	1.00	ND
I2 Tub Dentale	13	0.77	0.51	0.53	M3 Carabelli	10	0.50	0.42	0.14
I2 Peg Red Agen	†	†	†	†	M1 Parastyle	8	0.88	0.56	0.71
Canine Tub. Dentale	14	0.93	0.56	0.84	M3 Parastyle	**	**	**	**
CDARU	**	**	**	**	E0mExt UM1	9	0.78	0.80	-0.13
Canine Root Number	**	**	**	**	M1 Root Number	4	0.75	0.50	0.50

P3 Accessory Cusp	7	0.86	0.49	0.72	M2 Root Number	7	0.71	0.55	0.36
P3 MXPAR	**	**	**	**	M3 Root Num	6	0.67	0.56	0.25
P4 MXPAR	**	**	**	**	M3 Peg Red Agen	†	†	†	†
P3 Root Num	**	**	**	**					
M1 MesAccU	3	0.33	0.33	0.00					

Note: ND, no difference between the analyses. †, sample size too small for analysis. **, removed before analysis or analysis not conducted.

Table 24

Cohen's Kappa intra-observer error test for mandibular traits.

MANDIBLE	N	Pr(a)	Pr(e)	κ
LCMargRdg	10	0.300	0.500	-0.400
LCDAR	9	0.778	0.481	0.571
LCRootNum	4	1.000	0.500	1.000
P3TomeRt	7	1.000	0.592	1.000
LP4LingCuspVar	9	0.889	0.716	0.609
LM2Groove	12	0.917	0.917	0.000
LM1AntFovea	5	0.000	0.320	-0.471
LM1EnmlExt	13	1.000	0.858	1.000
LM1Protostylid	12	0.583	0.528	0.118
LM1C5Hypoconulid	14	1.000	1.000	ND
LM2C5Hypoconulid	11	0.818	0.537	0.607
LM1Cusp6	8	0.625	0.625	0.000
LM1Cusp7	14	0.929	0.806	0.632
LM1RootNum	10	0.600	0.520	0.167
LM2RootNum	5	1.000	0.680	1.000
LM2Protostylid	9	0.778	0.654	0.357
LM3AGEN	†	†	†	†
LM3Protostylid	5	1.000	0.520	1.000
EnamelPearl	†	†	†	†
Odontomes	†	†	†	†

Note: Removed traits are highlighted in tan and traits with equivalent Pr(a) and Pr(e) are highlighted in blue. See Chapter 5 for discussion. ND, no difference between the analyses. †, sample size too small for analysis. **, removed before analysis or analysis not conducted.

Table 25 Tetrachoric matrix for inter-trait correlation. All traits analyzed. See Table 22 for key (continued on next two pages).

	I1DblMar	I1MargRd	I2MargRd	I1Intgroo	I2Intgroo	I2Mesialt	I1tuberde	I2TubDen	I2PegRed	CTubDent	CDARU	CRtNumb	UP3Acusp	UP3MXPA	UP4MXPA	P3rootnu	M1MesAc	M2metac	M3metac	M2hypoc	M3hypoc	M2cusp5	M3cusp5	M1Carab	M3Carab
I1DblMar	1	0.103	0.027	0.031	-0.137	-0.285	0.111	-0.113	-0.059	0.073	-0.176	-0.217	0.264	0.02	-0.106	0.042	0.076	0.015	0.065	0.165	-0.064	0.273	0.029	0.232	0.139
I1MargRd	0.103	1	0.432	0.082	0.022	0.214	0.258	-0.008	-0.357	-0.204	0.035	-0.231	0.216	0.313	-0.05	-0.01	-0.08	-0.176	-0.269	0.224	-0.026	0.175	0.043	-0.12	0.242
I2MargRd	0.027	0.432	1	-0.107	0.123	0.194	0.119	0.071	-0.118	-0.011	0.229	-0.292	0.315	-0.047	-0.063	-0.219	0.062	-0.324	-0.246	0.137	-0.255	0.172	0.113	-0.128	0.203
I1Intgroo	0.031	0.082	-0.107	1	0.294	0.031	0.122	0.108	-0.099	0.346	-0.265	0.278	-0.086	-0.174	0.073	-0.06	-0.053	-0.044	0.229	-0.009	0.12	0.032	0.094	-0.063	-0.068
I2Intgroo	-0.137	0.022	0.123	0.294	1	0.154	0.247	0.422	0.093	-0.145	0.177	0.176	-0.146	-0.03	-0.114	0.096	0.143	0.071	0.119	0.207	-0.193	-0.229	-0.009	-0.126	-0.008
I2Mesialt	-0.285	0.214	0.194	0.031	0.154	1	0.176	0.242	0.092	0.032	0.158	0.251	0.038	0.194	0.019	-0.111	0.161	-0.08	-0.158	0.269	0.091	-0.127	0.043	-0.326	0.115
I1tuberde	0.111	0.258	0.119	0.122	0.247	0.176	1	0.297	-0.019	0.123	0.19	0.156	0.233	0.074	0.161	0.17	0.321	0	-0.156	0.181	-0.118	0.113	0.294	-0.011	0.192
I2TubDen	-0.113	-0.008	0.071	0.108	0.422	0.242	0.297	1	0.057	0.088	0.08	0.248	0.045	0.054	-0.093	-0.19	0.369	-0.091	0.093	0.115	0.06	-0.181	0.206	-0.007	0.216
I2PegRed	-0.059	-0.357	-0.118	-0.099	0.093	0.092	-0.019	0.057	1	-0.148	-0.05	-0.126	0.009	0.065	0.278	0.148	0.347	0.228	0.332	-0.147	-0.015	-0.25	0.185	-0.165	-0.268
CTubDent	0.073	-0.204	-0.011	0.346	-0.145	0.032	0.123	0.088	-0.148	1	0.012	0.305	0.215	-0.162	0.111	-0.172	0.112	-0.05	0.029	0.156	0.373	0.143	0.049	0.062	0.144
CDARU	-0.176	0.035	0.229	-0.265	0.177	0.158	0.19	0.08	-0.05	0.012	1	0.226	-0.146	-0.066	-0.108	-0.196	-0.121	-0.308	-0.175	0.187	0.051	0.084	0.09	-0.026	0.161
CRtNumb	-0.217	-0.231	-0.292	0.278	0.176	0.251	0.156	0.248	-0.126	0.305	0.226	1	-0.239	-0.277	0.288	-0.29	0.213	-0.39	-0.193	0.155	0.292	-0.218	0.225	-0.273	-0.199
UP3Acusp	0.264	0.216	0.315	-0.086	-0.146	0.038	0.233	0.045	0.009	0.215	-0.146	-0.239	1	0.042	-0.024	0.112	0.17	0.091	-0.098	0.053	-0.09	0.086	0.111	-0.128	-0.051
UP3MXPA	0.02	0.313	-0.047	-0.174	-0.03	0.194	0.074	0.054	0.065	-0.162	-0.066	-0.277	0.042	1	0.17	0.023	-0.04	0.366	0.025	0.281	-0.001	0.061	0.194	0.12	0.259
UP4MXPA	-0.106	-0.05	-0.063	0.073	-0.114	0.019	0.161	-0.093	0.278	0.111	-0.108	0.288	-0.024	0.17	1	-0.205	0.247	-0.128	0.023	-0.118	0.086	0.04	0.347	0.017	0.193
P3rootnu	0.042	-0.01	-0.219	-0.06	0.096	-0.111	0.17	-0.19	0.148	-0.172	-0.196	-0.29	0.112	0.023	-0.205	1	0.028	0.5	-0.139	-0.089	-0.157	-0.031	0.018	0.271	-0.197
M1MesAc	0.076	-0.08	0.062	-0.053	0.143	0.161	0.321	0.369	0.347	0.112	-0.121	0.213	0.17	-0.04	0.247	0.028	1	0.135	-0.031	0.188	-0.043	0.06	0.589	0.046	-0.173
M2metac	0.015	-0.176	-0.324	-0.044	0.071	-0.08	0	-0.091	0.228	-0.05	-0.308	-0.39	0.091	0.366	-0.128	0.5	0.135	1	0.187	0.046	-0.139	0.302	0.002	0.157	-0.163
M3metac	0.065	-0.269	-0.246	0.229	0.119	-0.158	-0.156	0.093	0.332	0.029	-0.175	-0.193	-0.098	0.025	0.023	-0.139	-0.031	0.187	1	-0.087	-0.013	-0.045	-0.103	0.108	-0.016
M2hypoc	0.165	0.224	0.137	-0.009	0.207	0.269	0.181	0.115	-0.147	0.156	0.187	0.155	0.053	0.281	-0.118	-0.089	0.188	0.046	-0.087	1	0.366	0.001	0.137	-0.05	0.015
M3hypoc	-0.064	-0.026	-0.255	0.12	-0.193	0.091	-0.118	0.06	-0.015	0.373	0.051	0.292	-0.09	-0.001	0.086	-0.157	-0.043	-0.139	-0.013	0.366	1	0.059	0.093	0.079	0.074
M2cusp5	0.273	0.175	0.172	0.032	-0.229	-0.127	0.113	-0.181	-0.25	0.143	0.084	-0.218	0.086	0.061	0.04	-0.031	0.06	0.302	-0.045	0.001	0.059	1	0.256	0.229	0.277
M3cusp5	0.029	0.043	0.113	0.094	-0.009	0.043	0.294	0.206	0.185	0.049	0.09	0.225	0.111	0.194	0.347	0.018	0.589	0.002	-0.103	0.137	0.093	0.256	1	0.195	0.008
M1Carab	0.232	-0.12	-0.128	-0.063	-0.126	-0.326	-0.011	-0.007	-0.165	0.062	-0.026	-0.273	-0.128	0.12	0.017	0.271	0.046	0.157	0.108	-0.05	0.079	0.229	0.195	1	0.307
M3Carab	0.139	0.242	0.203	-0.068	-0.008	0.115	0.192	0.216	-0.268	0.144	0.161	-0.199	-0.051	0.259	0.193	-0.197	-0.173	-0.163	-0.016	0.015	0.074	0.277	0.008	0.307	1
M1parast	0.065	0.108	0.097	-0.074	0.104	-0.221	-0.067	0.011	-0.24	-0.098	-0.046	-0.246	0.068	0.19	-0.008	-0.031	0.103	0.364	-0.104	0.152	0.107	0.402	0.018	0.278	0.157
M3parast	0.216	0.214	0.193	0.205	0.164	-0.064	0.359	0.209	0.13	0.046	-0.052	-0.237	0.204	0.053	0.124	0.068	0.286	0.136	0.297	0.01	-0.055	0.214	0.154	0.369	0.131
EOmExtUl	0.085	0.201	0.061	-0.013	-0.013	0.154	0.056	0.008	-0.016	-0.044	-0.132	-0.256	0.15	0.236	-0.104	0.116	0.03	0.171	-0.137	0.265	0.103	0.023	0.005	-0.064	-0.094
M1rootnu	-0.106	0.111	0.007	0.097	-0.062	0.159	-0.426	0.055	-0.243	-0.16	0.116	0.211	-0.046	-0.03	-0.272	-0.25	-0.093	-0.265	0.022	0.079	-0.103	-0.203	0.057	-0.157	-0.211
M2rootnu	-0.073	0.146	-0.01	-0.273	0.089	0.232	0.167	0.299	-0.2	-0.275	0.069	0.21	0.094	0.161	-0.069	-0.213	-0.103	-0.131	-0.148	-0.068	-0.101	-0.186	-0.042	-0.283	0.063
M3rootnu	-0.071	0.11	0.08	-0.071	-0.348	-0.053	0.085	0.039	-0.35	0.139	-0.186	-0.147	0.041	0.121	-0.125	0.044	0.085	0.135	0.073	0.067	-0.148	0.066	0.098	0.142	0.057
M3pegsh	0.156	-0.015	-0.095	-0.092	-0.138	-0.002	0.231	-0.306	0.118	-0.077	0.074	-0.186	0.022	-0.133	-0.105	0.052	0.011	0.025	-0.042	-0.179	-0.106	0.011	-0.144	0.066	-0.074
LCDAR	0.1	0.095	0.044	0.099	0.187	0.037	-0.058	0.081	-0.301	0.184	0.049	0.261	-0.27	0.11	0.101	-0.269	0.023	-0.006	-0.156	0.397	0.442	0.139	0.098	0.126	0.222
LCRootNu	0.037	-0.306	0.055	-0.468	-0.034	-0.054	-0.02	0.095	0.264	-0.051	0.294	-0.182	-0.05	0.005	-0.343	0.041	0.359	0.269	0.068	0.314	0.005	-0.023	0.012	0.166	-0.264
P3TomeR	0.089	0.074	0.125	-0.044	0.064	-0.237	-0.053	0.174	-0.339	0.083	-0.168	-0.24	0.018	-0.02	-0.161	-0.083	-0.249	-0.147	0.102	0.043	0.018	0.046	-0.193	0.079	0.316
LP4LingCu	-0.06	0.113	0.026	0.017	-0.007	0.003	-0.122	-0.023	0.087	-0.265	0.056	-0.278	-0.049	0.194	-0.035	-0.08	-0.098	-0.055	0.221	-0.033	0.221	0.2	0.048	0.167	0.166
LM2Groo	-0.166	0.075	0.129	0.162	0.252	-0.189	-0.109	-0.077	-0.029	-0.059	0.086	-0.282	-0.108	0.245	-0.097	-0.095	-0.275	-0.047	0.075	0.07	0.039	-0.268	-0.025	0.171	0.143
LM1Enml	0.056	0.015	-0.156	0.068	-0.106	0.068	-0.037	-0.034	-0.478	0.1	-0.006	0.326	0.013	-0.111	-0.02	-0.13	0.04	-0.171	0.005	0.143	0.119	0.1	0.03	0.087	-0.023
LM1Protc	-0.04	0.12	0.141	-0.123	-0.048	0.033	0.153	0.131	-0.22	0.055	-0.154	-0.279	0.253	0.212	-0.043	0.109	0.077	0.322	0.058	0.033	-0.14	0.183	0.187	0.343	0.092
LM1C5Hy	0.338	0.142	0.019	0.021	-0.329	0.103	0.281	0.087	-0.147	0.18	-0.288	0.128	0.033	0.285	0.425	-0.156	0.183	-0.154	-0.138	0.107	0.192	0.138	0.412	0.181	0.377
LM2C5Hy	-0.011	-0.153	0.089	0.025	0.049	0.125	0.064	0.251	-0.03	0.071	0.278	0.291	-0.23	0.08	0.11	-0.351	-0.067	-0.159	0.04	0.217	0.134	0.085	0.219	-0.051	0.089
LM1Cusp	0.346	0.156	0.162	-0.385	-0.364	0.083	-0.014	-0.08	0.086	-0.137	0.226	-0.273	0.136	0.012	0.019	0.006	-0.111	-0.18	-0.108	-0.21	0.083	0.204	0.011	0.059	0.349
LM1Cusp	-0.126	-0.089	-0.078	-0.025	-0.13	0.008	-0.23	0.194	-0.226	0.125	0.077	0.255	0.064	-0.142	0.107	-0.266	0.045	-0.372	0.086	0.038	0.303	-0.216	0.027	0.23	0.037
LM1Rootl	0.208	-0.172	-0.282	0.289	-0.237	-0.255	0.299	-0.226	-0.09	0.295	-0.33	0.158	0.22	-0.215	0.187	0.291	0.225	0.22	0.114	-0.272	-0.249	0.225	0.239	0.194	-0.238
LM2Rootl	0.096	-0.092	0.152	-0.156	-0.03	-0.184	-0.098	0.083	0.391	0.013	-0.195	-0.2	0.103	-0.016	0.445	0.042	0.362	0.012	0.161	-0.042	0.263	0.154	0.23	0.217	0.156
LM2Protc	0.17	-0.12	-0.061	-0.07	0.172	0.207	0.009	0.219	0.249	0.062	0.127	-0.274	-0.043	0.304	-0.019	0.219	0.072	0.418	0.033	0.215	0.078	0.08	-0.04	0.379	0.32
LM3AGEN	-0.162	0.356	0.23	0.053	0.188	0.304	0.308	0.206	-0.17	-0.143	-0.232	-0.049	0.293	0.271	-0.239	0.268	0.114	0.135	-0.255	0.189	-0.376	-0.205	0.198	-0.291	-0.177
LM3Protc	-0.128	0.085	0.421	-0.139	0.142	0.082	0.095	0.207	-0.016	0.023	-0.038	-0.29	-0.012	0.161	-0.024	-0.065	0.13	0.029	-0.207	0.101	-0.297	-0.043	0.071	0.027	0.38
LM1AntFc	0.192	0.273	0.165	0.241	0.122	0.254	0.086	0.084	-0.056	-0.184	-0.202	-0.225	-0.011	0.056	-0.26	-0.145	-0.083	-0.136	0.118	0.22	0.073	-0.098	-0.032	-0.003	0.179
LCMargRc	0.063	0.041	0.124	0.209	0.033	-0.177	-0.101	-0.213	-0.04	0.046	0.204	-0.243	-0.009	-0.026	-0.076	-0.073	-0.255	0.323	0.274	0.062	0.056	0.418	0.074	0.138	0.11

	M1parast	M3parast	E0mExtUI	M1rootnu	M2rootnu	M3rootnu	M3pegsh	LCDAR	LCRootNu	P3TomeR	LP4LingCu	LM2Groo	LM1Enml	LM1Protc	LM1C5Hy	LM2C5Hy	LM1Cusp	LM1Cusp	LM1Rootl	LM2Rootl	LM2Protc	LM3AGEN	LM3Protc	LM1AntFc	LCMargRc
I1DblMar	0.065	0.216	0.085	-0.106	-0.073	-0.071	0.156	0.100	0.037	0.089	-0.060	-0.166	0.056	-0.040	0.338	-0.011	0.346	-0.126	0.208	0.096	0.170	-0.162	-0.128	0.192	0.063
I1MargRd	0.108	0.214	0.201	0.111	0.146	0.110	-0.015	0.095	-0.306	0.074	0.113	0.075	0.015	0.120	0.142	-0.153	0.156	-0.089	-0.172	-0.092	-0.120	0.356	0.085	0.273	0.041
I2MargRd	0.097	0.193	0.061	0.007	-0.010	0.080	-0.095	0.044	0.055	0.125	0.026	0.129	-0.156	0.141	0.019	0.089	0.162	-0.078	-0.282	0.152	-0.061	0.230	0.421	0.165	0.124
I1Intgroo	-0.074	0.205	-0.013	0.097	-0.273	-0.071	-0.092	0.099	-0.468	-0.044	0.017	0.162	0.068	-0.123	0.021	0.025	-0.385	-0.025	0.289	-0.156	-0.070	0.053	-0.139	0.241	0.209
I2Intgroo	0.104	0.164	-0.013	-0.062	0.089	-0.348	-0.138	0.187	-0.034	0.064	-0.007	0.252	-0.106	-0.048	-0.329	0.049	-0.364	-0.130	-0.237	-0.030	0.172	0.188	0.142	0.122	0.033
I2Mesialt	-0.221	-0.064	0.154	0.159	0.232	-0.054	-0.002	0.037	-0.054	-0.237	0.003	-0.189	0.068	0.033	0.103	0.125	0.083	0.008	-0.255	-0.184	0.207	0.304	0.082	0.254	-0.177
I1tuberde	-0.067	0.359	0.056	-0.426	0.167	0.085	0.231	-0.058	-0.020	-0.053	-0.122	-0.109	-0.037	0.153	0.281	0.064	-0.014	-0.230	0.299	-0.098	0.009	0.308	0.095	0.086	-0.101
I2TubDen	0.011	0.209	0.008	0.055	0.299	0.039	-0.306	0.081	0.095	0.174	-0.023	-0.077	-0.034	0.131	0.087	0.251	-0.080	0.194	-0.226	0.083	0.219	0.206	0.207	0.084	-0.213
I2PegRed	-0.240	0.130	-0.016	-0.243	-0.200	-0.350	0.118	-0.301	0.264	-0.339	0.087	-0.029	-0.478	-0.220	-0.147	-0.030	0.086	-0.226	-0.090	0.391	0.249	-0.170	-0.016	-0.056	-0.040
CTubDent	-0.098	0.046	-0.044	-0.160	-0.275	0.139	-0.077	0.184	-0.051	0.083	-0.265	-0.059	0.100	0.055	0.180	0.071	-0.137	0.125	0.295	0.013	0.062	-0.143	0.023	-0.184	0.046
CDARU	-0.046	-0.052	-0.132	0.116	0.069	-0.186	0.074	0.049	0.294	-0.168	0.056	0.086	-0.006	-0.154	-0.288	0.278	0.226	0.077	-0.330	-0.195	0.127	-0.232	-0.038	-0.202	0.204
CRtNumb	-0.246	-0.237	-0.256	0.211	0.210	-0.147	-0.186	0.261	-0.182	-0.240	-0.278	-0.282	0.326	-0.279	0.128	0.291	-0.273	0.255	0.158	-0.200	-0.274	-0.049	-0.290	-0.225	-0.243
UP3Acusp	0.068	0.204	0.150	-0.046	0.094	0.041	0.022	-0.270	-0.050	0.018	-0.049	-0.108	0.013	0.253	0.033	-0.230	0.136	0.064	0.220	0.103	-0.043	0.293	-0.012	-0.011	-0.009
UP3MXPA	0.190	0.053	0.236	-0.030	0.161	0.121	-0.133	0.110	0.005	-0.020	0.194	0.245	-0.111	0.212	0.285	0.080	0.012	-0.142	-0.215	-0.016	0.304	0.271	0.161	0.056	-0.026
UP4MXPA	-0.008	0.124	-0.104	-0.272	-0.069	-0.125	-0.105	0.101	-0.343	-0.161	-0.035	-0.097	-0.020	-0.043	0.425	0.110	0.019	0.107	0.187	0.445	-0.019	-0.239	-0.024	-0.260	-0.076
P3rootnu	-0.031	0.068	0.116	-0.250	-0.213	0.044	0.052	-0.269	0.041	-0.083	-0.080	-0.095	-0.130	0.109	-0.156	-0.351	0.006	-0.266	0.291	0.042	0.219	0.268	-0.065	-0.145	-0.073
M1MesAc	0.103	0.286	0.030	-0.093	-0.103	0.085	0.011	0.023	0.359	-0.249	-0.098	-0.275	0.040	0.077	0.183	-0.067	-0.111	0.045	0.225	0.362	0.072	0.114	0.130	-0.083	-0.255
M2metac	0.364	0.136	0.171	-0.265	-0.131	0.135	0.025	-0.006	0.269	-0.147	-0.055	-0.047	-0.171	0.322	-0.154	-0.159	-0.180	-0.372	0.220	0.012	0.418	0.135	0.029	-0.136	0.323
M3metac	-0.104	0.297	-0.137	0.022	-0.148	0.073	-0.042	-0.156	0.068	0.102	0.221	0.075	0.005	0.058	-0.138	0.040	-0.108	0.086	0.114	0.161	0.033	-0.255	-0.207	0.118	0.274
M2hypoc	0.152	0.010	0.265	0.079	-0.068	0.067	-0.179	0.397	0.314	0.043	-0.033	0.070	0.143	0.033	0.107	0.217	-0.210	0.038	-0.272	-0.042	0.215	0.189	0.101	0.220	0.062
M3hypoc	0.107	-0.055	0.103	-0.103	-0.101	-0.148	-0.106	0.442	0.005	0.018	0.221	0.039	0.119	-0.140	0.192	0.134	0.083	0.303	-0.249	0.263	0.078	-0.376	-0.297	0.073	0.056
M2cusp5	0.402	0.214	0.023	-0.203	-0.186	0.066	0.011	0.139	-0.023	0.046	0.200	-0.268	0.100	0.183	0.138	0.085	0.204	-0.216	0.225	0.154	0.080	-0.205	-0.043	-0.098	0.418
M3cusp5	0.018	0.154	0.005	0.057	-0.042	0.098	-0.144	0.098	0.012	-0.193	0.048	-0.025	0.030	0.187	0.412	0.219	0.011	0.027	0.239	0.230	-0.040	0.198	0.071	-0.032	0.074
M1Carab	0.278	0.369	-0.064	-0.157	-0.283	0.142	0.066	0.126	0.166	0.079	0.167	0.171	0.087	0.343	0.181	-0.051	0.059	0.230	0.194	0.217	0.379	-0.291	0.027	-0.003	0.138
M3Carab	0.157	0.131	-0.094	-0.211	0.063	0.057	-0.074	0.222	-0.264	0.316	0.166	0.143	-0.023	0.092	0.377	0.089	0.349	0.037	-0.238	0.156	0.320	-0.177	0.380	0.179	0.110
M1parast	1.000	0.072	-0.033	-0.064	-0.012	-0.042	-0.043	0.295	0.160	0.012	0.265	0.267	0.058	0.145	-0.057	0.192	0.051	0.127	-0.241	0.239	0.313	-0.216	0.161	0.059	0.268
M3parast	0.072	1.000	0.097	-0.359	-0.190	0.088	0.248	0.228	0.178	-0.025	0.231	-0.058	-0.209	0.123	-0.006	-0.170	-0.094	0.079	0.202	0.210	0.186	-0.220	-0.088	-0.103	0.269
E0mExtUI	-0.033	0.097	1.000	-0.016	-0.012	0.043	-0.028	0.044	0.054	0.300	-0.014	0.101	0.052	0.228	0.072	-0.007	0.018	0.065	-0.198	0.096	0.215	0.291	0.078	0.095	-0.052
M1rootnu	-0.064	-0.359	-0.016	1.000	0.305	0.114	-0.355	-0.196	-0.115	0.021	0.029	0.071	0.346	-0.153	-0.233	0.210	0.012	0.444	-0.235	-0.324	-0.076	0.204	0.010	0.142	0.010
M2rootnu	-0.012	-0.190	-0.012	0.305	1.000	0.109	-0.172	0.082	-0.169	0.227	-0.088	-0.200	0.103	0.042	0.172	0.270	0.286	0.208	-0.267	-0.211	-0.086	0.289	0.023	0.157	-0.077
M3rootnu	-0.042	0.088	0.043	0.114	0.109	1.000	-0.275	0.074	0.263	0.074	-0.280	-0.219	0.090	0.216	0.385	-0.190	0.050	0.093	0.258	-0.011	-0.210	0.332	-0.023	0.112	0.148
M3pegsh	-0.043	0.248	-0.028	-0.355	-0.172	-0.275	1.000	-0.101	0.108	-0.099	0.181	0.186	-0.098	0.066	-0.177	-0.071	0.003	-0.224	0.220	-0.393	0.066	-0.233	0.055	-0.054	-0.071
LCDAR	0.295	0.228	0.044	-0.196	0.082	0.074	-0.101	1.000	0.108	0.005	0.009	0.017	-0.014	0.019	0.327	0.155	-0.052	0.125	-0.213	0.098	0.099	-0.275	-0.085	-0.013	0.318
LCRootNu	0.160	0.178	0.054	-0.115	-0.169	0.263	0.108	0.108	1.000	-0.286	-0.017	-0.088	-0.217	-0.001	-0.179	-0.070	0.050	0.019	-0.167	0.144	0.207	-0.171	-0.043	-0.079	0.088
P3TomeR	0.012	-0.025	0.300	0.021	0.227	0.074	-0.099	0.005	-0.286	1.000	0.036	0.132	0.025	0.170	0.019	0.224	0.015	0.220	-0.226	0.033	0.037	0.124	0.412	0.097	-0.129
LP4LingCu	0.265	0.231	-0.014	0.029	-0.088	-0.280	0.181	0.009	-0.017	0.036	1.000	0.256	0.101	-0.067	-0.178	0.104	0.176	0.111	-0.314	0.121	0.204	-0.345	0.011	0.077	0.106
LM2Groo	0.267	-0.058	0.101	0.071	-0.200	-0.219	0.186	0.017	-0.088	0.132	0.256	1.000	-0.085	0.115	-0.241	0.106	-0.259	0.027	-0.325	-0.167	0.183	0.016	0.411	0.183	0.115
LM1Enml	0.058	-0.209	0.052	0.346	0.103	0.090	-0.098	-0.014	-0.217	0.025	0.101	-0.085	1.000	0.077	0.094	0.068	-0.122	0.105	0.256	-0.210	-0.093	0.049	-0.243	-0.006	-0.008
LM1Protc	0.145	0.123	0.228	-0.153	0.042	0.216	0.066	0.019	-0.001	0.170	-0.067	0.115	0.077	1.000	0.187	0.065	-0.092	0.022	0.248	-0.081	0.102	0.367	0.298	-0.026	0.054
LM1C5Hy	-0.057	-0.006	0.072	-0.233	0.172	0.385	-0.177	0.327	-0.179	0.019	-0.178	-0.241	0.094	0.187	1.000	0.112	0.325	-0.016	0.209	0.284	-0.102	0.137	-0.057	0.314	-0.097
LM2C5Hy	0.192	-0.170	-0.007	0.210	0.270	-0.190	-0.071	0.155	-0.070	0.224	0.104	0.106	0.068	0.065	0.112	1.000	0.081	0.191	-0.292	-0.144	0.232	-0.090	0.255	-0.006	0.088
LM1Cusp	0.051	-0.094	0.018	0.012	0.286	0.050	0.003	-0.052	0.050	0.015	0.176	-0.259	-0.122	-0.092	0.325	0.081	1.000	0.125	-0.292	0.327	0.224	-0.265	-0.103	0.186	0.088
LM1Cusp	0.127	0.079	0.065	0.444	0.208	0.093	-0.224	0.125	0.019	0.220	0.111	0.027	0.105	0.022	-0.016	0.191	0.125	1.000	-0.240	0.192	-0.008	-0.260	-0.058	-0.103	-0.190
LM1Rootl	-0.241	0.202	-0.198	-0.235	-0.267	0.258	0.220	-0.213	-0.167	-0.226	-0.314	-0.325	0.256	0.248	0.209	-0.292	-0.292	-0.240	1.000	-0.169	-0.330	0.129	-0.301	-0.258	0.007
LM2Rootl	0.239	0.210	0.096	-0.324	-0.211	-0.011	-0.393	0.098	0.144	0.033	0.121	-0.167	-0.210	-0.081	0.284	-0.144	0.327	0.192	-0.169	1.000	0.089	-0.314	-0.082	0.042	-0.001
LM2Protc	0.313	0.186	0.215	-0.076	-0.086	-0.210	0.066	0.099	0.207	0.037	0.204	0.183	-0.093	0.102	-0.102	0.232	0.224	-0.008	-0.330	0.089	1.000	-0.221	0.324	0.003	0.207
LM3AGEN	-0.216	-0.220	0.291	0.204	0.289	0.332	-0.233	-0.275	-0.171	0.124	-0.345	0.016	0.049	0.367	0.137	-0.090	-0.265	-0.260	0.129	-0.314	-0.221	1.000	0.290	0.268	-0.253
LM3Protc	0.161	-0.088	0.078	0.010	0.023	-0.023	0.055	-0.085	-0.043	0.412	0.011	0.411	-0.243	0.298	-0.057	0.255	-0.103	-0.058	-0.301	-0.082	0.324	0.290	1.000	0.052	-0.167
LM1AntFc	0.059	-0.103	0.095	0.142	0.157	0.112	-0.054	-0.013	-0.079	0.097	0.077	0.183	-0.006	-0.026	0.314	-0.006	0.186	-0.103	-0.258	0.042	0.003	0.268	0.052	1.000	0.118
LCMargRc	0.268	0.269	-0.052	0.010	-0.077	0.148	-0.071	0.318	0.088	-0.129	0.106	0.115	-0.008	0.054	-0.097	0.088	0.088	-0.190	0.007	-0.001	0.207	-0.253	-0.167	0.118	1.000

APPENDIX VI

ADDITIONAL ANALYSIS

This section provides the results of the comparative analysis discussed in section 6.3. The original analysis was replicated, however, it replaced CLDR with DELMR to compare their results.

Table 26

MMD values in upper triangular area of matrix and flagging of significance in lower.

	REM	PANR	LAC	DELMR	CHIA
REM	NA	0.031	0.035	0.014	0.011
PANR	NS	NA	0.025	0	0.004
LAC	*	NS	NA	0.01	0.069
DELMR	NS	NS	NS	NA	0.004
CHIA	NS	NS	*	NS	NA

Note: NS, Not significant; NA, Not applicable; *, significant. Significance is identified if MMD is higher than twice their standard deviation.

Table 27

MMD values in upper triangular area of matrix and standard deviation (SD) values in lower.

	REM	PANR	LAC	DELMR	CHIA
REM	0.000	0.031	0.035	0.014	0.011
PANR	0.028	0.000	0.025	0.000	0.004
LAC	0.022	0.046	0.000	0.010	0.069
DELMR	0.014	0.039	0.033	0.000	0.004
CHIA	0.011	0.036	0.030	0.022	0.000

Note: The significance threshold is twice the standard deviation.

Table 28

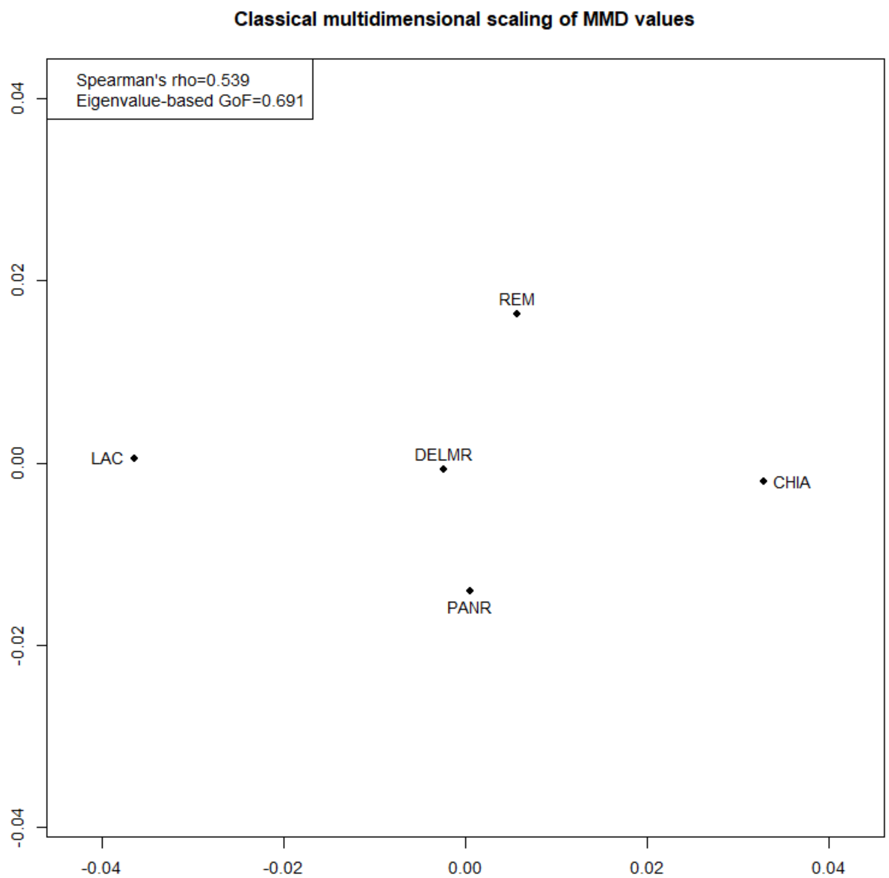
Overall measure of divergence for each trait identified in analysis, sorted by decreasing discriminatory power.

	Overall MD
UI2MesBend	0.467
LM1C7	0.449
UM1Para	0.246
LM2GroovP	-0.084
UI2IntGrv	-0.315

Table 29

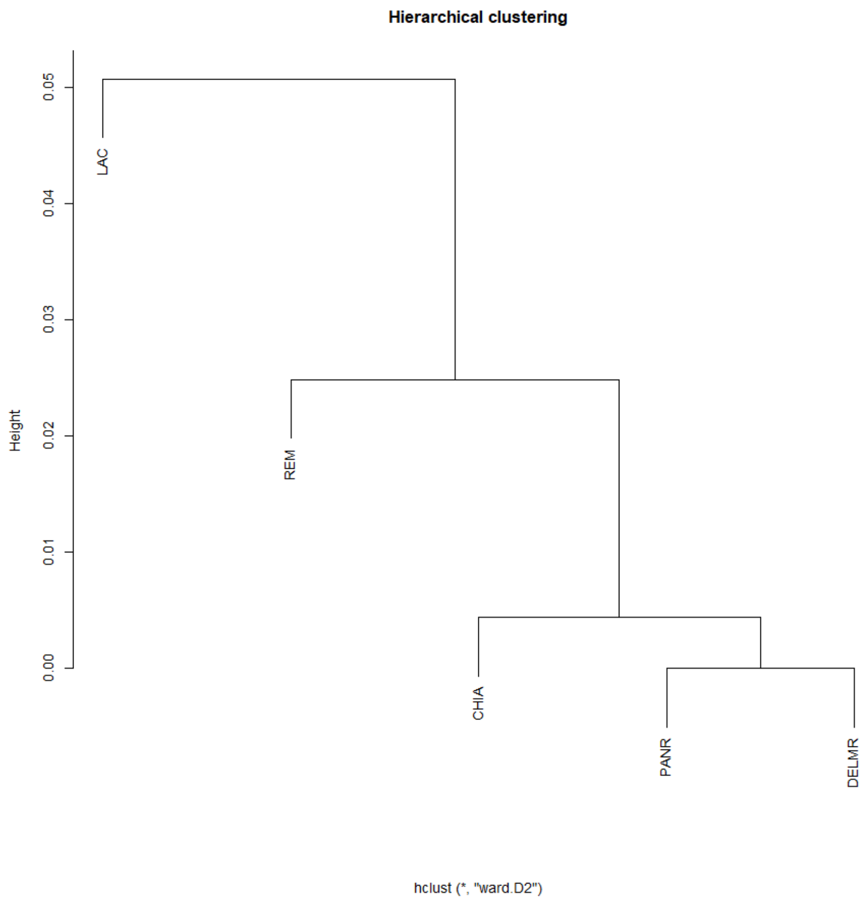
Number of individuals and relative frequencies for each active trait within each group.

	UI2IntGrv	UI2MesBend	UM1Para	LM1C7	LM2GroovP
N_REM	303	305	459	626	633
N_PANR	24	22	22	23	29
N_LAC	22	29	37	40	36
N_DELMR	49	56	48	49	52
N_CHIA	55	60	75	65	80
Freq_REM	0.667	0.413	0.283	0.067	0.242
Freq_PANR	0.750	0.273	0.136	0.130	0.379
Freq_LAC	0.636	0.517	0.243	0.250	0.278
Freq_DELMR	0.673	0.321	0.188	0.122	0.346
Freq_CHIA	0.727	0.267	0.347	0.077	0.288



CHIA, Iron Age Adriatic coastal and hinterland
DELMR, Roman Period Delmatae
LAC, Late Iron Age/ Republican Period Latini
PANR, Roman Pannonian
REM, Roman Empire Italics

Figure 25 Classical MDS of MMD values for analysis.



CHIA, Iron Age Adriatic coastal and hinterland
DELMR, Roman Period Delmatae
LAC, Late Iron Age/ Republican Period Latini
PANR, Roman Pannonian
REM, Roman Empire Italics

Figure 26 Hierarchical analysis dendrogram in analysis.

APPENDIX VII

ADDITIONAL TABLES FOR ANALYSES

Table 30

Sample sizes for pooled populations used in analysis 6.1.

Time Period and Group							
		LBIA	**DELMR**	**LBR**	**DHIA**	**PANR**	**Total**
Iron Age	Delmatae				23		23
	Japodes				12		12
	Liburnian	96					96
	Pannonian				14		14
Iron Age Total		96			49		145
Roman	Delmatae		80				80
	Liburnian			50			50
	Pannonian					38	38
Roman Total			80	50		38	168
Total		96	80	50	49	38	313

Table 31

Sample sizes for pooled populations used in analysis 6.2.

Time Period and Group						
	CHIA	**RRP**	**RIA**	**CHR**	**REM**	**Total**
Iron Age	145		475			620
Delmatae	23					23
Japodes	12					12
Liburnian	96					96
Pannonian	14					14
Italic			475			475
Roman				168	1169	1337
Delmatae				80		80
Liburnian				50		50
Pannonian				38		38
Italic					1169	1169
Roman Republic		459				459
Italic		459				459
Total	145	459	475	168	1169	2416

Table 32

Sample sizes for pooled populations used in analysis 6.3.

Time Period and Group						
	CLDR	**LAC**	**PANR**	**REM**	**CHIA**	**Total**
Iron Age					145	145
Dalmatian					23	23
Japodes					12	12
Liburnian					96	96
Pannonian					14	14
Roman	130		38	1169		1337
Dalmatian	80					80
Liburnian	50					50
Pannonian			38			38
Italic				1169		1169
Roman Republic		94				94
Italic		94				94
Total	130	94	38	1169	145	1576

Table 33

Sample sizes and frequencies of recorded maxillary data for use in AnthropMMD.

Groups	UI2 Marg Rdg	UI2 Int Grv	UI2 Mes Bend	UI1 TD	UI2 TD	UP3 AC	UM1 Para	UM1 EnExt	UM2 C5	UM3 Hypo	UM3 C5	UM3 Root Num
N_PANR	19	24	22	11	21	21	22	25	22	16	16	13
N_LBR	18	15	19	23	17	30	36	26	28	27	25	21
N_LBIA	36	31	36	33	32	43	46	56	47	35	34	31
N_DIA	11	10	12	7	11	12	17	16	16	15	12	15
N_DHIA	24	24	24	12	20	21	29	35	25	21	16	22
N_DELMR	55	49	56	40	52	44	48	51	45	45	34	34
N_CLDR	73	64	75	63	69	74	84	77	73	72	59	55
N_CHR	92	88	97	74	90	95	106	102	95	88	75	68
N_CHIA	60	55	60	45	52	64	75	91	72	56	50	53
Freq_PANR	13	18	6	7	14	11	3	4	9	5	10	8
Freq_LBR	13	12	10	10	9	13	11	10	9	10	13	7
Freq_LBIA	22	22	12	19	18	30	14	17	13	15	14	12
Freq_DIA	10	5	4	2	5	11	7	7	7	6	4	8
Freq_DHIA	17	18	4	5	12	15	12	13	11	8	8	10
Freq_DELMR	47	33	18	23	28	27	9	13	18	17	10	14
Freq_CLDR	60	45	28	33	37	40	20	23	27	27	23	21
Freq_CHR	73	63	34	40	51	51	23	27	36	32	33	29
Freq_CHIA	39	40	16	24	30	45	26	30	24	23	22	22

Note: DIA, Delmatae, Iron Age; n= 23

Table 34 Sample sizes and frequencies of recorded mandibular data for use in AnthropMMD

Groups	LC Marg Rdg	LP3 Tomes Rt	LP4 Ling CVar	LM1 Ant Fovea	LM1 Prto	LM1 C7	LM1 EnExt	LM2 GroovP	LM2 C5
N_PANR	29	24	30	22	31	23	34	29	26
N_LBR	11	27	22	25	37	34	29	31	30
N_LBIA	25	51	29	27	46	39	50	49	50
N_DIA	0	18	13	0	20	19	19	16	18
N_DHIA	15	36	25	8	31	26		31	29
N_DELMR	28	38	59	17	57	49	60	52	50
N_CLDR	39	65	81	42	94	83	89	83	80
N_CHR	68	89	111	64	125	106	123	112	106
N_CHIA	40	87	54	35	77	65	85	80	79
Freq_PANR	10	3	18	12	18	3	14	11	10
Freq_LBR	4	6	17	14	24	4	20	14	17
Freq_LBIA	7	4	17	9	26	3	23	13	20
Freq_DIA	0	4	4	0	14	1	12	3	7
Freq_DHIA	3	7	15	3	24	2		10	11
Freq_DELMR	14	5	39	4	36	6	25	18	15
Freq_CLDR	18	11	56	18	60	10	45	32	32
Freq_CHR	28	14	74	30	78	13	59	43	42
Freq_CHIA	10	11	32	12	50	5	41	23	31

Note: DIA, Delmatae, Iron Age; n= 23

Table 35

Breakpoints for ASUDAS used in data collection and analyses (mandibular traits continued on next page).

Maxillary traits		
I1DblMargRdg	I1 Double Marginal Ridge	+=2-7
I1MargRdg	I1 Marginal Ridge	+=2-6
I2MargRdg	I2 Marginal Ridge	+=2-7
I1Intgroov	I1 Interruption Groove	P/A
I2Intgroov	I2 Interruption Groove	P/A
I2Mesialbend	I2 Mesial Bend	P/A
I1tuberdent	I1 Tuberculum Dentale	+=2-6
I2TubDent	I2 Tuberculum Dentale	+=2-6
I2PegRedAgenU	I2 Peg shaped Reduced Agenesis	P/A
CTubDentU	Canine Tuberculum Dentale	+=2-7
CDARU	Canine Distal Accessory Ridge	+=2-5
CRtNumbU	Canine Root Number	+=1
UP3Acusp	P3 Accessory Cusps	P/A
UP3MXPAR	P3 Accessory Ridges	+=2-4
UP4MXPAR	P4 Accessory Ridges	+=2-4
P3rootnum	P3 Root Number	+=2-3
M1MesAccU	M1 Mesial Accessory Cusp	P/A
M2metacone	M2 Metacone	+=3.5-5
M3metacone	M3 Metacone	+=3.5-5
M2hypocone	M2 Hypocone	+=3-6
M3hypocone	M3 Hypocone	+=3-6
M2cusp5	M2 Cusp 5	+=1-5
M3cusp5	M3 Cusp 5	+=1-5
M1Carabelli	M1 Carabelli	+=2-7
M3Carabelli	M3 Carabelli	+=2-7
M1parastyle	M1 Parastyle	+=1-5
M3parastyle	M3 Parastyle	+=1-5
E0mExtUM1	M1 Enamel Extension	+=1-3
M1rootnumU	M1 Root Number	+=3
M2rootnumU	M2 Root Number	+=3
M3rootnumU	M3 Root Number	+=3
M3pegshape	M3 Peg shaped Reduced Agenesis	P/A

Mandibular traits		
LCDAR	Canine Distal Accessory Ridge	+=2-5
LCRootNum	Canine Root Number	+=2
P3TomeRt	P3 Tome's Root	+=4-5
LP4LingCuspVar	P4 Lingual Cusp Variation	+=2-3
LM2Groove	M2 Groove Pattern	+=Y
LM1EnmlExt	M1 Enamel Extension	P/A
LM1Protostylid	M1 Protostylid	+=2-7
LM1C5Hypoconulid	M1 C5 Hypoconulid	+=1-5
LM2C5Hypoconulid	M2 C5 Hypoconulid	+=1-5
LM1Cusp6	M1 Cusp 6	P/A
LM1Cusp7	M1 Cusp 7	+=1-4
LM1RootNum	M1 Root Number	+=3
LM2RootNum	M2 Root Number	+=3
LM2Protostylid	M2 Protostylid	+=2-7
LM3AGEN	M3 Peg shaped Reduced Agenesis	P/A
LM3Protostylid	M3 Protostylid	+=2-7
LM1AntFovea	M1Anterior Fovea	+=3-4
LCMargRdg	Canine Marginal Ridge	+=2
Odontomes	Odontomes	P/A
EnamelPearl	Enamel Pearls	P/A

Note: The first column is the acronym used in analyses, followed by the trait name, and the breakpoint.