

## INTRODUCTION

The Neolithic is associated with dramatic changes in technology, subsistence, and social structure associated with the adoption of new material culture and the domestication of plants and animals.

While archaeological investigations have extensively contributed to our understanding of the period, little is known about the social organization of these communities as lifestyles changed. Previous research by Pilloud and Larsen (2011) using dental metrics and morphology of both permanent and deciduous dentitions found little evidence that biological kin were the fundamental social unit at Çatalhöyük, a large Neolithic site in central Anatolia. Rather, fluid relationships were developed, possibly as a form of “practical” kin for socioeconomic activities.

This present research investigates the social organization of multiple settlements spanning throughout the Neolithic to understand how the adoption of agriculture and of new lifeways affected the social structure of these communities. Settlements in Central Anatolia (Çatalhöyük, Aşıklı Höyük, and Boncuklu) and Northwestern Anatolia (Barcın Höyük) were used to test the hypothesis that *mortuary practices, and by extension social structure, is not linked to biological kin.*

## MATERIALS & METHODS

Dental morphological and metric data were collected on permanent dentition at several sites across Anatolia, including Çatalhöyük, Aşıklı Höyük, Boncuklu, and Barcın Höyük (Figure 1). The standards outlined by Turner and colleagues (1991) were utilized for morphological data collection. The standards outlined by Hillson and colleagues (2005) for collection of crown and cervical dimensions of the teeth were used. Age and sex estimates were established using standard protocols (Buikstra and Ubelaker, 1994)



Figure 1. Map of sites included in the study.

T-tests identified sexually dimorphic measurements, which were removed from statistical analyses. As missing data affects the relationships displayed between individuals, several treatments were conducted. Metrics missing more than 50% of data, then individuals missing more than 50% of data were removed from the analysis. All remaining missing measurements were imputed using k-nearest neighbor imputation in the *vimgui* package based on the recommendations of Kenyhercz and Passalacqua (2016). These were then converted to principal components to accommodate multicollinearity. For morphological data, pairwise Kendall's tau-b was used to examine correlated variables, which were removed from analyses. Morphological traits missing more than 50% data were also removed.

Gower's coefficient of similarity was utilized to assess kinship as both morphological and metric data sets may be used in the same analysis (R package *statmatch*). Results were displayed using average linkage hierarchical cluster analysis (R packages *stats* and *dendextend*). Statistical patterns of phenotypic variation were then compared to burial location to individuals buried in the same building, or in spatially close areas of the site. Individuals are color coded according to provenience in building/space.

## RESULTS

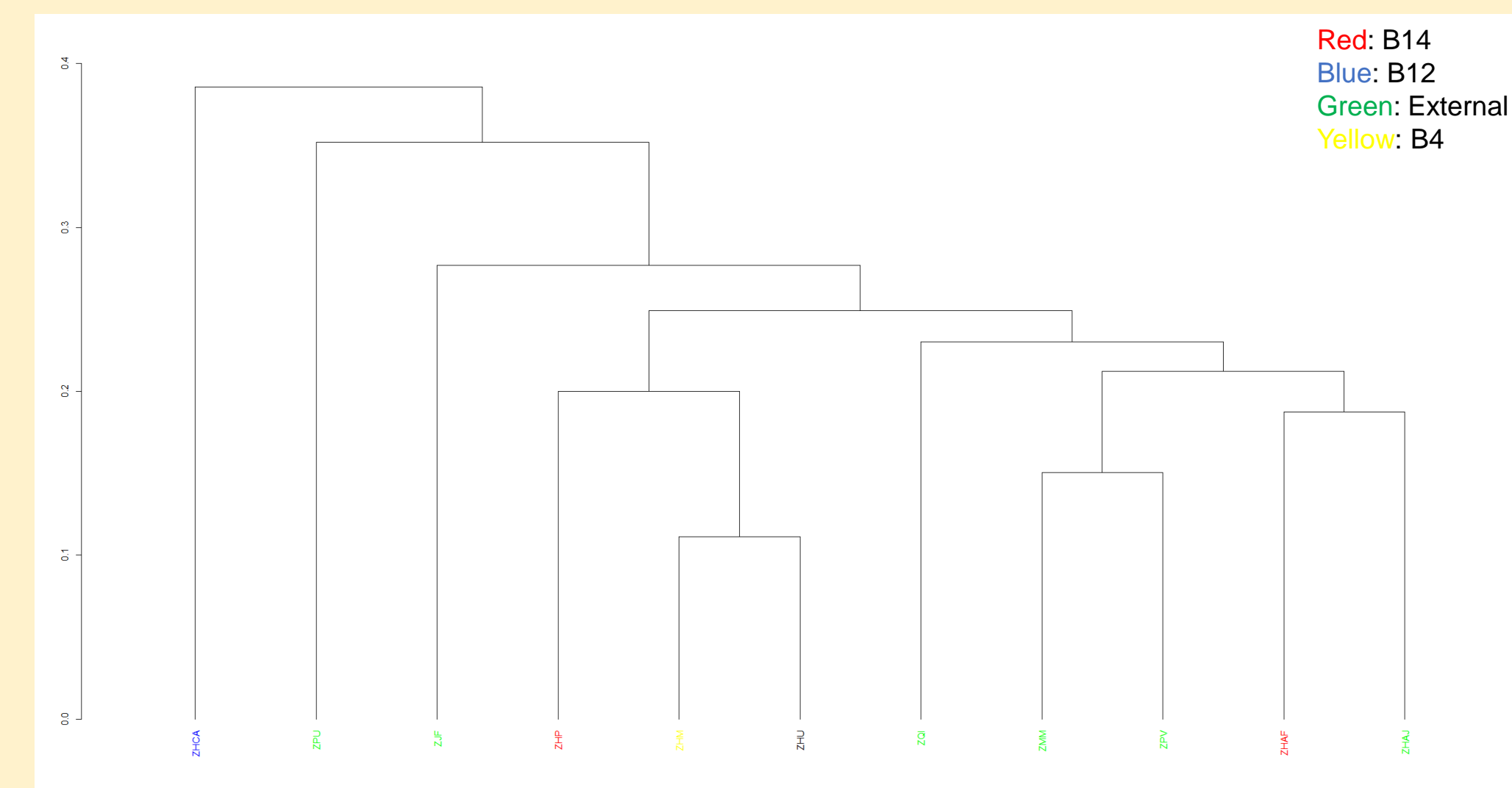


Figure 2. Hierarchical cluster analysis with average linkage of branches of Boncuklu Gower dissimilarity matrix.

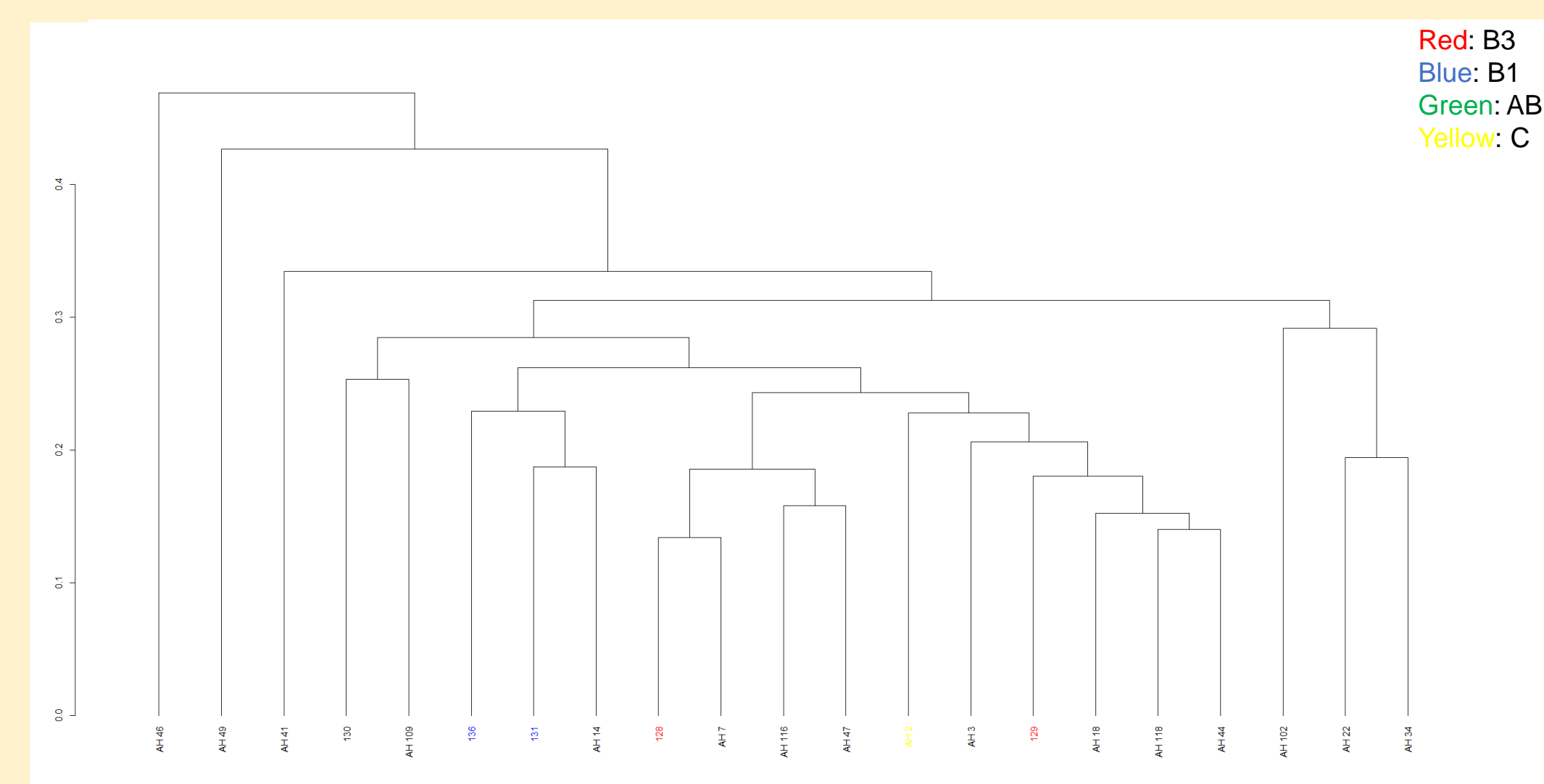


Figure 3. Hierarchical cluster analysis with average linkage of branches of Aşıklı Höyük Gower dissimilarity matrix.

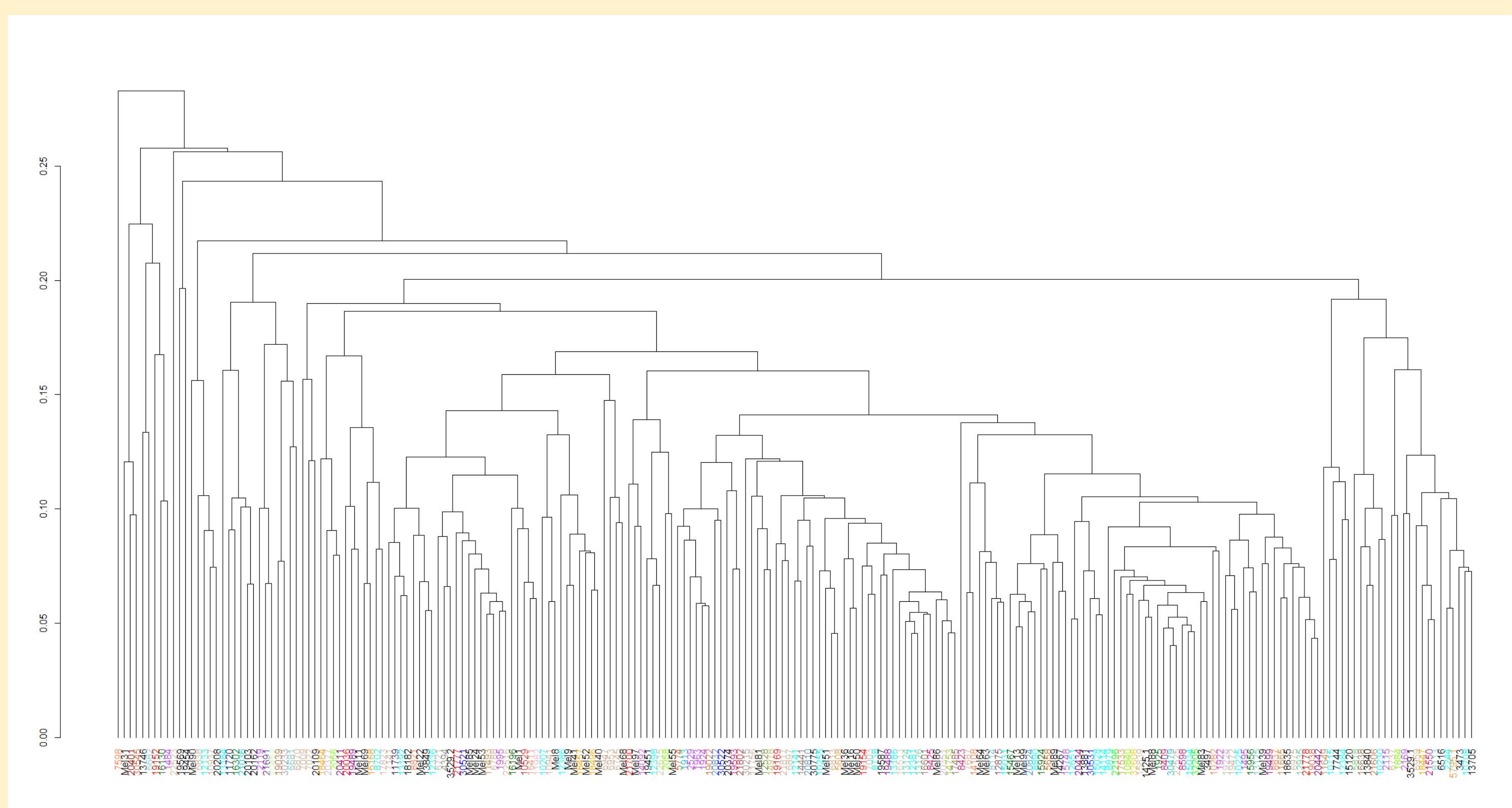


Figure 4. Hierarchical cluster analysis with average linkage of branches of Çatalhöyük Gower dissimilarity matrix.

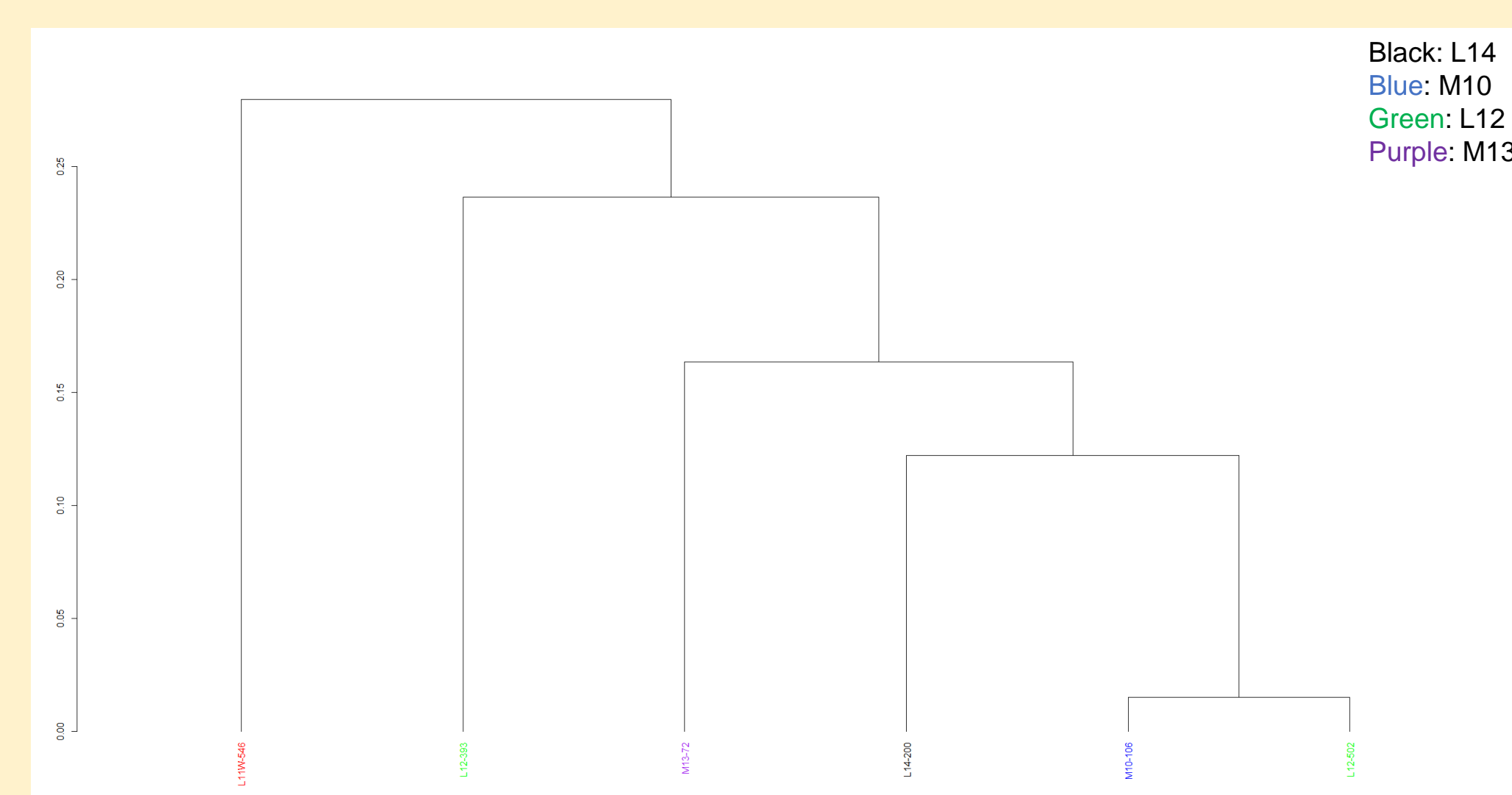


Figure 5. Hierarchical cluster analysis with average linkage of branches of Barcın Höyük Gower dissimilarity matrix.



Figure 6. Example of recording dental metrics.

## DISCUSSION & CONCLUSIONS

Results indicate shifting patterns of kinship throughout the Neolithic. At Boncuklu, phenotypically similar individuals are often buried in the same buildings (Figure 2). By the later Neolithic, at sites like Çatalhöyük and Barcın Höyük (Figures 4 and 5), there is less clustering of phenotypically similar individuals in the same buildings and spaces. At Çatalhöyük, there is minimal clustering present, with some individuals in Spaces 405 and 1002 located on closely associated branches. There are two areas on the HCA dendrogram in which clusters of Space 405 individuals are located; however, these two clusters are not in close approximation to each other, indicating Space 405 is not composed of biologically similar individuals as a whole. Barcın Höyük, although composed of the smallest sample size, does not show clustering of the two individuals from the same space. Results suggest a shifting definition of kinship throughout the Neolithic. The early Neolithic exhibits more of a biological definition of kinship, with a more socially-fluid construction by the end.

At least in mortuary practices, the role of biological kin wanes over time suggesting changing social structures in relation to the intensification of economies and growth of settlement sizes. This changing relationship to biological kin may reflect a shift towards less egalitarian societies moving into the Chalcolithic and Bronze Age. Further research will incorporate aDNA in conjunction with these dental data to better identify biological kin and migration patterns throughout the Neolithic period in Anatolia.



Figure 7. Maxilla from Çatalhöyük.

## REFERENCES

- Buikstra, J. E., & Ubelaker, D. H. (1994). *Standards for Data Collection from Human Skeletal Remains*. Fayetteville, AR: Arkansas Archaeological Survey Research Series, No. 44.
- Hillson, S., FitzGerald, C., & Flinn, H. (2005). Alternative dental measurements: Proposals and relationships with other measurements. *American Journal of Physical Anthropology*, 126, 413-426.
- Kenyhercz, M. W., & Passalacqua, N. V. (2016). Missing data imputation methods and their performance with biometric distance analyses. In M. A. Pilloud & J. T. Hefner. *Biological Distance Analyses: Bioarchaeological and Forensic Perspectives*. (pp. 181-194). Amsterdam, Netherlands: Academic Press.
- Pilloud, M. A., & Larsen, C. S. (2011). "Official" and "practical" kin: Inferring social and community structure from dental phenotype at Neolithic Çatalhöyük, Turkey. *American Journal of Physical Anthropology*, 145, 519-530.
- Turner, II, C. G., Nichol, C. R., & Scott, G. R. (1991). Scoring procedures for key morphological traits of the permanent dentition: The Arizona State University dental anthropology system. In M. A. Kelley, & C. S. Larsen (Eds.), *Advances in Dental Anthropology*. (pp. 13-31). New York: Wiley-Liss.

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