

Dental Anthropology at the University of Geneva

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ABSTRACT This article presents research currently being conducted in the field of dental anthropology at the Department of Anthropology and Ecology of the University of Geneva, Switzerland. The first author, S. Eades, is carrying out a doctoral thesis on the familiarity of dental morphological traits and their use as “familial” indicators in the case of multivariate and univariate analyses of interindividual distances. Her methods are based on the modern collection of Burlington (Ontario),

and her results shall be applied to the Protohistorical necropolis of Kerma (Sudan) and the Neolithic multiple graves of Chamblandes (Switzerland). The second author, J. Desideri, began her graduate work on an interpopulational comparison of Swiss Neolithic populations based on their dental morphology. She is currently undertaking a doctoral thesis on the same problem, but tackling the whole of Europe.

Non-metric traits have been studied at our Department since the beginning of the 1990's,¹ when two studies were carried out concerning intra- and interpopulational analysis of cranial non-metric traits, under the direction of Dr. Christian Simon (Gemmerich, 1999; Eades, 1996; Eades and Simon, 1996). In 1997, S. Eades became interested in dental non-metric traits during her preparation of a Master's degree at the University of Bradford, England (Eades, 1997). On her return to the University of Geneva in 1998, she undertook a doctoral thesis² on these traits, bearing on their familial determination (or familiarity) and the calculation of interindividual distances. At the same time, J. Desideri began her graduate work on an interpopulational comparison of Swiss Neolithic populations based on their dental morphology (Desideri, 2001).³ She is currently undertaking a doctoral thesis⁴ on the same problematic, but on a wider, European scale.

The traits recorded at our Laboratory of Paleoanthropology include those of the ASU system (using the reference casts; Turner, Nichol and Scott, 1991), those of Freiburg University (Alt, 1997; Alt, Pichler and Vach, unpublished data), when they did not overlap with those of the American system, and a few traits defined by Moskona et al. (1997), Kraus and Furr (1953) and Ludwig (1957).

INTERPOPULATION ANALYSIS

The first author (S. Eades) is examining the dental non-metric traits of a recent skeletal sample, namely, the Burlington collection (Toronto, Canada). The dental casts making up this sample were taken from several hundred families living in Burlington between 1952 and 1971 (Popovich, 1956). The goal of her thesis is to identify the traits expressing the greatest familiarity and to use these traits for univariate and multivariate interindividual comparisons.

Dental traits are studied by two fields of research: genetics (for the determination of their mode of

inheritance and their heritability), and archeology (for the application of these results when comparing ancient populations or individuals).

The link between the genotype and the phenotype of dental traits appears stronger than for other possibly inherited morphological variants such as non-metric traits of the cranial and post-cranial skeleton. Different studies have shown that there is a strong genetic component in the distribution of at least some dental characters, since there is a higher concordance between monozygotic twins than between dizygotic twins (Biggerstaff, 1973, 1979; Berry, 1978; Scott and Potter, 1984; Kaul et al., 1985; Townsend et al., 1988, 1992). Given this strong genetic determination, two types of studies have been carried out: the search for the mode of inheritance of these traits, and the calculation of their heritability. We shall see that these approaches did not give forth the results that were hoped for initially.

At first, researchers looked for a simple, Mendelian, mode of inheritance (see for instance Kraus, 1951). Deviations from this model were explained by incomplete penetrance and/or variable expressivity. During a second phase, a multifactorial, or polygenic inheritance was proposed (Sofaer, 1970; Goose and Lee, 1971; Lee and Goose, 1972), based on the model of quasi-continuous variation developed by Falconer (1960, 1965). Finally, the advent of computers led to the development of new techniques named complex segregation analyses, which test for the presence of major genes within polygenic systems. These were applied to dental non-metric traits by Kolakowski et al. (1980) on Carabelli's trait, and by Nichol (1989, 1990) on a number of dental traits. In many cases,

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inheritance was found to be polygenic, but influenced by a major gene. As the mode of inheritance could not be established with certainty for several traits, the necessity for more advanced methods of segregation was perceived.

As for the calculation of heritabilities, a wide range of figures has been obtained on different traits (see Scott and Turner, 1997, for a summary). The degree of heritability of a trait is the portion of total variance that is due to genetic variance, as opposed to environmental variance. It does not tell us what portion of an individual's phenotype can be associated with its heredity or its environment (Falconer, 1960, 1965). Furthermore, it is chrono-specific, population-specific, and requires a polygenic mode of inheritance, which, as we have seen, is not always the case for dental traits.

All these studies have demonstrated that dental traits are genetically determined, whatever the degree of this determination or the mode of inheritance, making them appropriate for infra-population analyses in an archaeological context. These analyses (which are also often based on other types of non-metric traits) are of three types:

- The study of residence patterns (see for instance Lane, 1977; Lane and Sublett, 1972; Spence, 1974a,b),
- The development of microchronologies in an archeological context (see Konigsberg, 1986, 1987, 1990; Crubézy, 1991),
- The identification of related individuals or lineages.

The last type of study is the subject of S. Eades' doctoral thesis. Although such studies have been carried out before (see for instance Alt, 1997, Alt et al., 1995, 1997; Crubézy, 1991; Howell et al., 1996; Corrucini and Shimada, 2002), they have rarely been based on individuals of known parentage (but see Eades, 1997 and Gemmerich, 1999). Based on data recorded on the Burlington collection (parents and children), S. Eades has estimated the familiarity of 107 dental traits derived from concordance analysis (Ludwig, 1957). Those traits which were the most concordant in their expression within families, as well as their most useful format for such purposes (dichotomous, graded or dichotomized), were identified. Different univariate and multivariate analyses were carried out on these traits and on a selection of families with well-preserved dentitions. The multivariate analyses in particular gave forth some very encouraging results, which she would like to publish by next year. Their application in the field of skeletal archeology seems possible; obviously, dental morphological traits are not as powerful as DNA analysis, but it seems that in the case of clear groupings of graves or individuals (that is, when the presence of family units is suspected) over a restricted timespan, it is possible to indicate whether specific individuals are related or not.

S. Eades is currently applying these methods to the Neolithic necropolis of Kerma (Sudan, Bonnet, 1990,

2000), where it is suspected that the multiple burials with sacrificed individuals represent genetically linked family members. She shall also study multiple burials in stone cists from the Swiss Neolithic necropolis of Chamblandes (Moinat and Simon, 1986).

INTRAPOPULATION ANALYSIS

The second author (J. Desideri) is studying the Bell Beaker phenomenon. This period is primarily known as a pottery style found over most of Europe at the end of the Neolithic. This entity differs from previous archaeological cultures by its material culture, its funerary rituals and its diffusion processes. The Bell Beaker Culture has been studied extensively,⁵ and research based on its associated artifacts has indicated either continuity or rupture in the peopling. However, there have been very few studies of the physical anthropology of the individuals making up this civilization.

The biometrician R. Menk (1979, 1981) proposed a synthesis of the Bell Beaker complex on an European scale, based on multivariate craniometric methods. He tried to isolate the morphological characteristics of these individuals in order to demonstrate the existence of a Bell Beaker "humanity" associated with its various cultural expressions and to deduce its origins and impact in different regions of Europe. According to Menk, this Bell Beaker "humanity" possessed a very different morphology to that of the local substrate. In the nuclear zone (central Germany, Moravia, Bohemia and Poland), the morphology is homogeneous; however, in peripheral areas, the Bell Beaker physical type becomes minoritarian and decreases as a function of the distance from the central zone.

J. Desideri's interest during her graduate work (Desideri, 2001) was to clarify the biological relationships between the local, Middle and Late Neolithic populations, and the later, culturally dissimilar Bell Beaker populations in Western Switzerland, by studying dental non-metric traits. She studied ten samples dating from the Middle Neolithic to the Early Bronze Age (Table 1). Craniometric analyses (Menk, 1979, 1981) and the evolution of funerary rituals (Bocksberger, 1976, 1978; Gallay, 1978, 1998) both pointed to a major event taking place around 2600 BC with the arrival of the Bell Beaker Culture in Western Switzerland. At this time, Late Neolithic dolmens were emptied and Bell Beaker remains were deposited in their place (M VI dolmen), furthermore, a new type of cist inhumation appeared (M XI dolmen). Dental traits were particularly appropriate to this purpose, as the crania recovered in the different dolmens are particularly fragmented, making for low sample numbers and insufficient population representation. In total, only five skulls could be measured; they were very different in their morphology from those preceding and following them chronologically, giving credence to population

TABLE 1. Presentation of the ten samples studied by J. Desideri for her graduate work (Desideri, 2001)

Dating	Site	Type of inhumation	Number of burials	References
Middle Neolithic : 4500-3200 BC	Barmaz I (canton of Valais)	Chamblandes-type cist, mostly single burials	41 graves, 49 subjects	Sauter, 1949, 1950, 1951; Honegger, 1996
	Barmaz II (canton of Valais)		21 graves, 22 subjects	Sauter, 1949, 1950, 1951
	Chamblandes (canton of Vaud)	Chamblandes-type cist, mostly collective burials	70 graves, 116 subjects	Moinat and Simon, 1986
	Corseaux (canton of Vaud)		27 graves, 60 subjects	Kramar et al., 1978; Baudais and Kramar, 1990
Late Neolithic : 3200-2600 BC	Dolmen M XII Sion Petit-Chasseur (canton of Valais)	Triangular-based dolmens	About 80 subjects	Favre and Mottet, 1990, 1995; Eades, 1996
	Dolmen M VI Sion Petit-Chasseur (canton of Valais)		About 40 subjects	Kramar, 1977; Gallay, 1986; Gallay and Chaix, 1984; Bocksberger, 1976, 1978
Bell Beaker Culture : 2600-2200 BC	Dolmen M VI Sion Petit-Chasseur (canton of Valais)	Triangular-based dolmens	About 10 subjects	Kramar, 1977; Gallay, 1986; Gallay and Chaix, 1984; Bocksberger, 1976, 1978
	Dolmen M XI Sion Petit-Chasseur (canton of Valais)	Lateral-entry dolmens	About 10 subjects	Gallay, 1986; Gallay and Chaix, 1984; Bocksberger, 1976, 1978; Claivaz-Caruzzo, 1975
Early Bronze Age : 2200-1550 BC	Sion Petit-Chasseur (canton of Valais)	Peripheral cists and graves	About 10 subjects	Bocksberger, 1976, 1978
	Barmaz I (canton of Valais)	Single graves	About 15 subjects	Honegger, 1996

movement theories.

The analyses, based on 61 uncorrelated traits after preliminary standard manipulations,⁶ made it possible to draw a picture of the different populations, and particularly the circumstances which led to the emergence of the Bell Beaker Culture in Western Switzerland.

During the Neolithic, the populations are homogeneous and morphologically similar, without major external influences. This is not the case for the Bell Beaker Culture, as these populations are not only very different from the preceding populations, but also from one another. As for the Bronze Age, two situations co-exist: some groups possess a Neolithic morphology, whereas others are clearly different from the anterior groups.

The analyses (multidimensional scaling and hierarchical cluster analysis) based on the Late Neolithic and Bell Beaker groups made it possible to propose three interpretative models which could explain the differences encountered during the Bell Beaker Culture

(Fig. 1). The models are based on the fact that the Bell Beaker dental remains were very different from those of preceding populations.

- The arrival of individuals from another population in Western Switzerland is possible. They may have completely replaced the preceding populations or, on the other hand, have been integrated into the local communities. These individuals may have belonged to two different groups, as the two Bell Beaker dolmens are quite distant from one another on these figures.
- It is possible that the new funerary rituals practiced by the members of this group may have played a major role, as Bell Beaker burials inside dolmens were restricted to a dozen individuals, whereas earlier necropoli (cist graves or similar dolmens) contained between 40 and 100 individuals. We may be looking at frequencies of a subset of the total population at this time (such as members of a single family or a social elite), and not population frequencies *sensu stricto*.
- The two preceding models are not exclusive. It is possible that these remains represent a subset of the

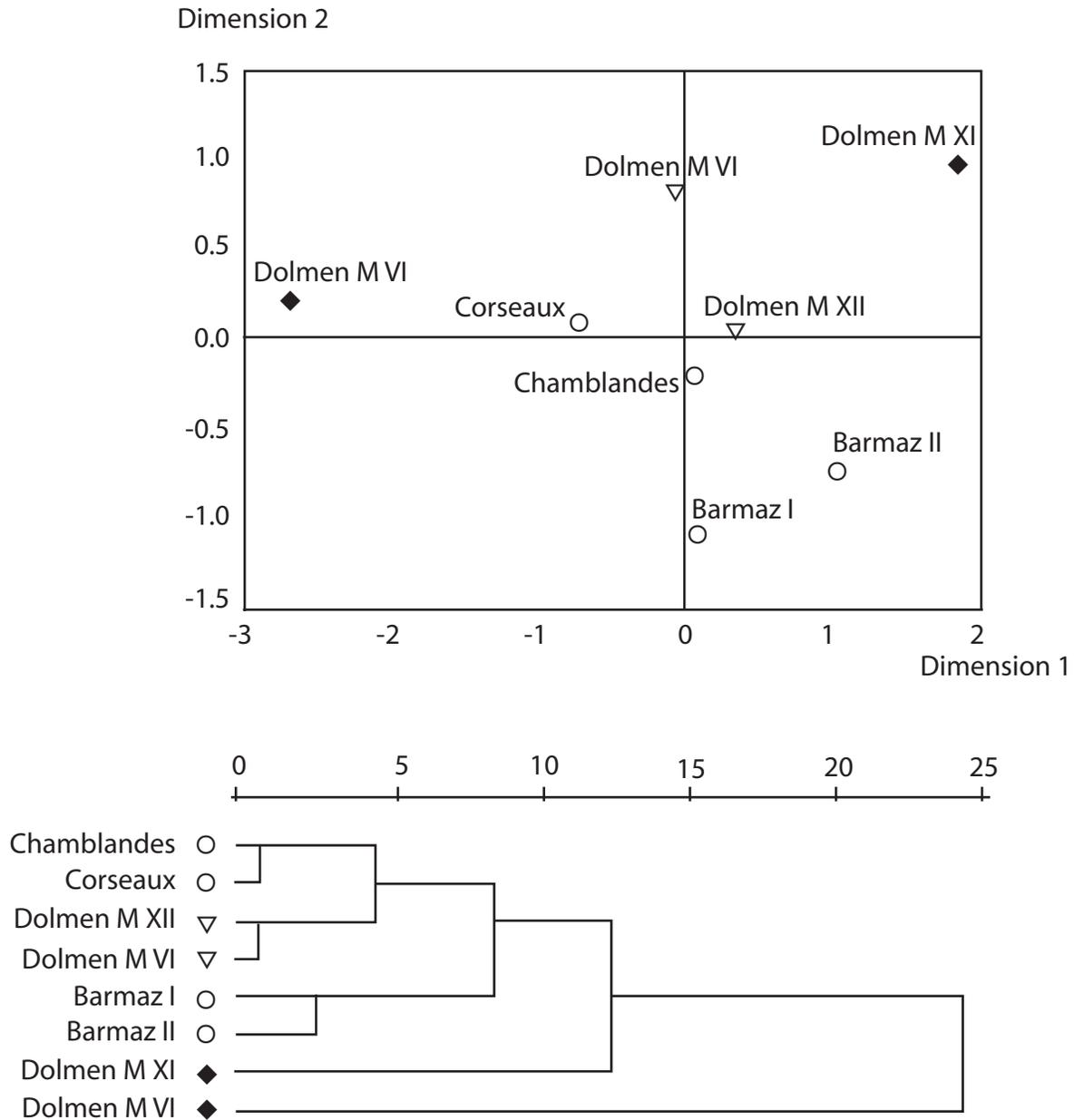


Fig. 1. Cluster analysis (Euclidean distance, UPGMA method), above, and multidimensional scaling (with a stress value of 5%), below, representing the position of different Middle Neolithic (symbolised by a circle), Late Neolithic (triangles) and Bell Beaker (lozenges) populations in Western Switzerland, based on the observation of 61 dental non-metric traits.

total population, including some individuals of foreign extraction, having arrived in Western Switzerland for trade or as specialized craftworkers, and having been integrated into the community. This would explain the extent of the morphological differences as well as the re-use of the Late Neolithic dolmens during the Bell Beaker period and the adoption of a new material culture around this time.

In summary, clear-cut differences were detected between Middle Neolithic and Bell Beaker dental remains. The reasons behind these differences are,

however, difficult to explain fully. For the moment, an adequate way of describing the appearance of the Bell Beaker Culture in western Switzerland is not “rupture”, nor “continuity”, but simply “difference”.

These results led J. Desideri to extend her research to the rest of Europe for her doctoral thesis. She shall base her research on the different geographical domains (Fig. 2) defined by M. Besse’s (2001) study of Bell Beaker common ware,⁷ by compiling a corpus including pre-Bell Beaker (Late Neolithic), Bell Beaker and post-Bell Beaker (Bronze age) individuals. The eastern domain shall be

represented by a series of subjects from sites located mostly in the Czech Republic, but also from Hungary, Austria and Poland. The southern domain will cover funerary assemblages from Switzerland, Northern Italy and France. Finally, the northern domain shall include individuals from Belgium, the Netherlands, and part of Germany.

J. Desideri shall try to answer certain questions that should make it possible to reconstruct the history of these populations before, during, and after the Bell Beaker culture. She shall more specifically try to determine whether this culture is characterized by a rupture or a continuity of the local population, and whether it is responsible for the emergence of the Early Bronze age. By confronting her results with data from other archaeological and anthropological studies, she hopes to understand the modalities which made possible the emergence of such a widespread phenomenon.

CONCLUSION

So far, work on dental non-metric traits carried out at the Department of Anthropology and Ecology of Geneva University has proved promising. Hypotheses concerning the population of Western Switzerland during the Late Neolithic have been arrived at, and data collected on individuals of known family relationships is currently being exploited. At the moment, little work is being carried out in Europe on dental non-metric traits, and the two authors have few opportunities to confront their results and methods with fellow researchers in this domain. We hope that this brief presentation in the papers of the DAA will be of interest to dental anthropologists working in America or elsewhere; any comments or suggestions concerning these two research subjects will be highly appreciated. The authors would like to thank Dr. Christiane Kramar for her help in writing this article.

ACKNOWLEDGEMENTS

Suzanne Eades would like to thank the Fonds National Suisse de la Recherche Scientifique, the Fondation Ernst et Lucie Schmidheiny and the Société de Physique et d'Histoire Naturelle de Genève for their crucial financial support. Her study was made possible by use of material from the Burlington Growth Center, Faculty of Dentistry, University of Toronto, which was supported by funds provided by Grant (1) (N° 605-7-299) National Health Grant (Canada), (data collection); (2) Province of Ontario Grant PR 33 (duplicating) and (3) the Varsity Fund (for housing and collection). Jocelyne Desideri would like to thank the Académie Suisse des Sciences Naturelles, the Société Suisse d'Anthropologie and the Department of Anthropology and Ecology of the University of Geneva for their financial support.

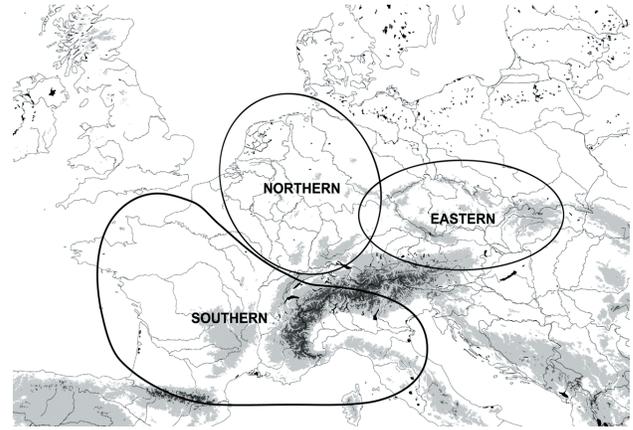


Fig. 2. The three geographic areas defined by Bell Beaker common ware in continental Europe (after Besse 2001; Fig. 238).

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FOOTNOTES

¹ With the exception of a pioneering work by H. Muller in 1977.

² Under the direction of Profs. André Langaney and Alain Gallay from this Department.

³ Under the direction of Dr. Christian Simon, Lecturer at the Department of Anthropology, who unfortunately passed away at the beginning of 2000, and Prof. Alain Gallay.

⁴ Under the direction of Prof. André Langaney, Director, and Marie Besse, assistant professor, both at the Department of Anthropology of Geneva University.

⁵ Sangmeister, 1963; Gimbutas, 1970; Lanting and Van der Waals, 1976; Gallay, 1978; 1998; Guilaine, 1998; Besse, 2001.

⁶ Elimination of invariant expressions, of sexually dimorphic traits, fusion of bilaterally expressed traits, estimation of trait population incidences on mesial teeth by Turner's (1985) expression count.

⁷ Besse defined three geographic areas in continental Europe based on the study of cultural differences according to the Bell Beaker common ware (Besse 2001): a northern, a southern and an eastern domain.