Media vita in morte sumus.

Different dynamics of the living and dead populations at Bärenthal

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Abstract: Based on some of the findings from the early medieval graveyard of Bärenthal, Germany, the mathematical difference of the spheres of living and dead populations will be illustrated. The aim of the paper is to show that some caveats which were first described in the palaeodemographic and palaeoepidemiological literature are important to consider when archaeologists and osteologists interpret numerical data from cemetery sites. Only very few aspects are a simple reflection of the static dead population. The dynamics of living populations are more difficult to reconstruct. Three specific results based on a study of the Bärenthal site will be discussed in that light and can be linked with some of the other papers presented in the session. The number of definitely identified coffins and the position of the upper extremities tell the archaeologist something about the sphere of death. In contrast to that, disease rates, though drawn from the buried skeletons, have more to do with the lives and living conditions of the dynamic population that formed the cemetery than the accumulated and finally excavated dead population. I argue that such differences and dynamics of the living and dead populations can be illustrated with computer models. Modelling will help archaeologists and osteologists interpret mathematical data and analyse the intrinsic complexity in the cemetery context.

Keywords: prevalence, frequency, demography, living and dead populations, computer modelling

Introduction

Life and death are not equally represented in archaeology. Life, on the one hand, is what we are interested in, what governs our research questions and drives our interpretations. Death, on the other hand, is what dominates our sources. Although steadily improving, the settlement record for the early medieval period is still poor (SCHREG 2006; HAMEROW 2002; 2012). Most of what we think we know of that period comes from the analysis of human remains and the accompanying grave goods (ibid.). Life precedes death and forms the picture seen by archaeologists on cemetery sites. But that does not mean that both spheres are equal. Many methodical and methodological issues have been raised in the last decades that have questioned simple approaches which interpreted cemeteries as straightforward representations of the populations that formed the site in the past. New aspects such as gender, group determinants, burial rites, rites of passage, etc. have been added to methodological considerations when it comes to interpreting the excavated material remains (PEARSON 2009). Most of these caveats are very well established and raised interesting further questions. But what is still missing is a closer look at numerical data drawn from cemetery studies such as palaeodemographical numbers, prevalence rates of diseases, artefact counts and many more. These numbers form the quantitative data set with which archaeologists and physical anthropologists categorise and compare their "populations". Archaeologists, on the one hand, frequently neglect this

empirical base of archaeological interpretation and are misled by superimposing theoretical frameworks and theories too early, i.e. before having had a close look at the raw numbers and their trustworthiness. Physical Anthropologists, on the other hand, rarely contextualise the summed up numerical data and behave as if the mentioning of raw numbers was *per se* a scientific result (ROBERTS & MANCHESTER 2005; ROBERTS 2009). These general accusations should not put off the reader but draw his or her attention to reconsider some of the common interpretative procedures at the interface of osteology and archaeology.
This brief paper is designed to classify a handful of aspects from a showcase cemetery study into the two spheres of life and death. This artificial categorisation might seem to be a crude one but it will support a better understanding of the problems of empirical data from cemetery studies. The paper will use data from the early medieval graveyard of Bärenthal in SW Germany. The results of my Master's thesis at the University of Tübingen have still been only partly published (KLUG-TREPPE & WAHL 2009; KLUG-TREPPE 2010; DUERING & WAHL 2010; KLUG-TREPPE & VOLKMER-PERROT 2011; DUERING 2011a; 2011b; DUERING & WAHL 2013) and this conference paper cannot give more than a general overview of the site, the function of which is to give the reader a few general points of orientation in which context the more theoretical aims of the paper can be placed. After a brief description of the site and the findings I will consequently present examples of the sphere of death and then lead over to the aspects which can only be understood through the more complex sphere of life. By then the intrinsic numerical difference must be obvious. This leads to a momentary pause in which I try to sum up why it is necessary to work with such at first ominous categories, before I conclude the paper with an outlook that sympathises with computer modelling. Mathematical simulations can be a powerful tool for archaeologists who want to categorise empirical data and test them against interpretative scenarios.

The Early Medieval Cemetery of Bärenthal

The excavations at Bärenthal, a small village in the Upper Danube region, Kreis Tuttlingen, in Germany, took place between 2008 and 2010 after the first discoveries of human remains during the expansion of an industrial area (KLUG-TREPPE & WAHL 2009). Two groups of Palaeoanthropology students and several Archaeology students from the University of Tübingen excavated the site in close cooperation with the project director, Dr. J. Klug-Treppe from the Regierungspräsidium Freiburg. The M.A. dissertation of Andreas Duering, which was supervised by Prof. Dr. J. Staecker and Prof. Dr. J. Wahl, presents and discusses the first 66 graves of the cemetery of Bärenthal (DUERING 2011b). Radiocarbon dates of human bone indicate that the burial place was used from the 7th to the 10th century AD. Very few grave goods were found, and the burials followed an east-west alignment commensurate with the context of an early Christian cemetery (Fig. 1). It is very likely that the slight rotation out of the strict east-west alignment of some graves was caused by the slope on that side of the valley. In the second excavation campaign, foundations of an east-west aligned two-phased stone building were found which could be linked to the surrounding burials through the laws of stratigraphy: a layer of burned material separated the two phases of the building. Structural contexts such as a possible mortar mixer, alignment, topographic position, placement inside the graveyard, isochronism and materiality support the interpretation that the building represents the remains of a church (KLUG-TREPPE & VOLKMER-PERROT 2011; Duering 2011b).

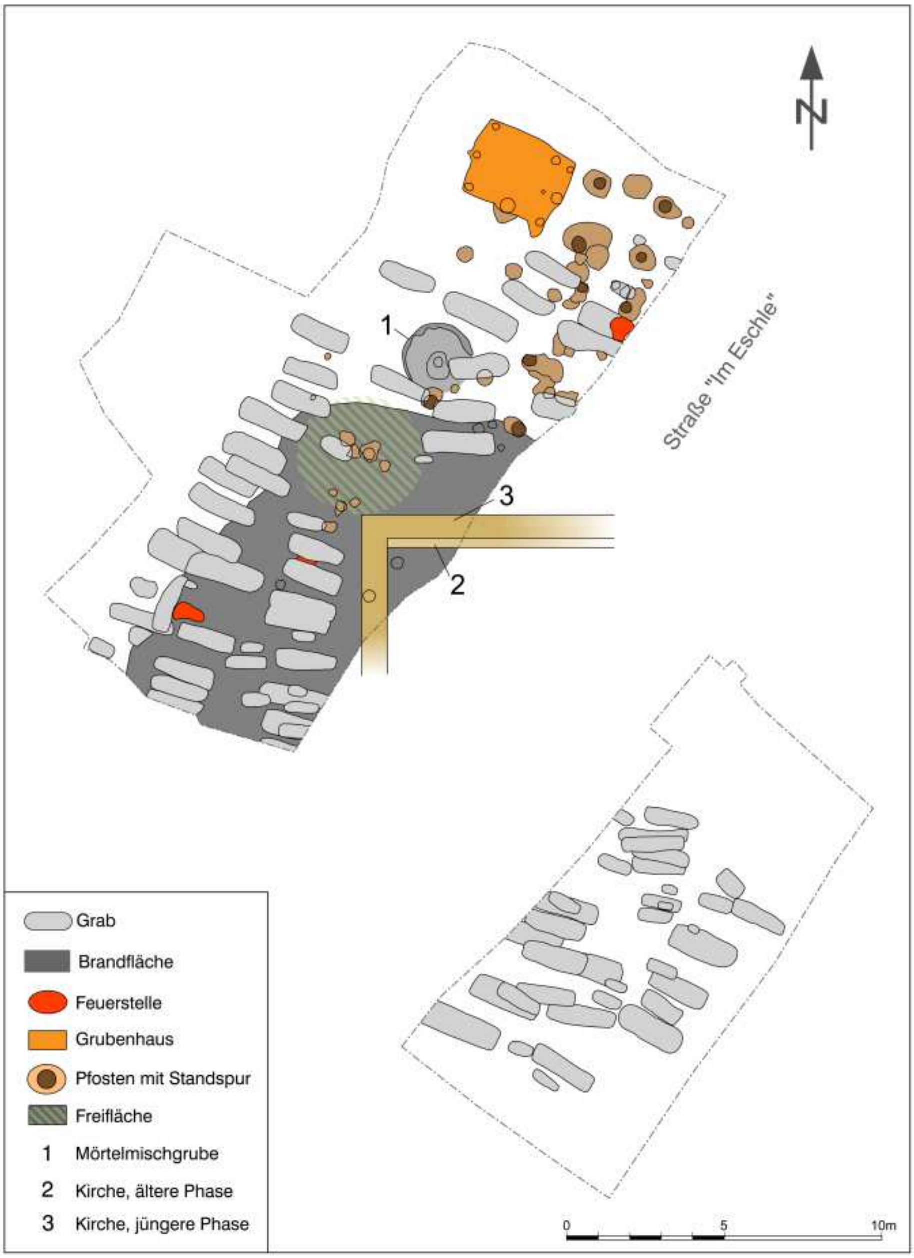

Fig. 1 – Plan of all three excavation campaigns 2008–2010 in Bärenthal. (KLUG-TREPPE & VOLKMER PERROT 2011; Copyright: Regierungspräsidium Freiburg)

The results on the living conditions of the population will be outlined first. The 66 individuals analysed for the M.A. thesis were subjected to several demographic tests designed to find out whether the skeletal sub-population represents an informative sample (DUERING 211b). At least according to the published criteria (WEISS 1973; BOCQUET & MASSET 1977), the Bärenthal population perfectly reflects a normal human group. The large number of children's graves (approx. 40%) seems exceptional in comparison with many cemeteries of the Alamanni from earlier periods (WAHL 2008). The few other contemporary cemeteries in the archaeological record, however, show a similar trend towards high rates of sub-adult burials (LOHRKE 2004; JUNGKLAUS 2010). The isochronal settlement and graveyard of Berslingen, Switzerland, for instance, shows interesting similarities (BÄNTELI et al. 2000). Contrary to the opinion raised in preliminary reports (KLUG-TREPPE & WAHL 2009) that the findings at Bärenthal revealed one or more epidemic events, I would rather argue for a continuous, attritional formation of the site. After conducting a complete demographic analysis I found no obvious signs of catastrophes in the mortality curves. What remained exceptional, however, was the general low life expectancy in comparison with a range of other sites in the region (DUERING 2011b; WAHL 2008). The human remains of early medieval Bärenthal show exceptional degenerative changes, most probably caused by a heavy daily work-load, and many skeletal conditions that can be only explained by long-lasting and recurring periods of malnutrition. Scurvy, a chronic deficiency of vitamin C, was particularly common in children and adults alike (Fig. 2) (DUERING 2011b; CARLI-THIELE 1996; LEWIS 2006). Infectious diseases like meningitis and tuberculosis yielded similarly high prevalence rates of the burial place. Thanks to the helpful support of the Landesamt für Denkmalpflege, a radiological analysis of some tibiae revealed a number of Harris-Lines of Arrested Growth that allowed me to acquire important information on phases of stress for the organisms (ibid.). I was furthermore able to compare such diagnoses with the study of enamel hypoplasia (ibid.). All these palaeopathological results can probably be explained by the poor soil conditions for growing domesticated plants and the generally challenging climate of the Westalb as well as the micro-climate of the valley in particular. In a charter dating to the year 1092, in which the village of Bärenthal is mentioned for the first time, the region is described as a mountain region named Scher or as being situated in the mountain county Scherra *(…in ipsa, quam diximus, villa Beroa sita in comitatu montium qui vocantur Serrae,…)* (NOTITIAE FUNDATIONIS 1092). The harsh environment of the settlement seems to have left a special impression on the authors of that document.

Fig. 2 – Distal tibia of a male individual between 35 and 45 years of age (grave 49). The grey woven bone formations belong to a haemorrhage, maybe a symptom of scurvy. (Copyright: Andreas Düring)

Secondly, emphasis will be focused on the burial rites. It becomes obvious that the population buried in the cemetery was made up of a group of people with low social status – a conclusion arrived at after comparison with contemporary sites such as Berslingen and Nusplingen (DUERING 2011b; BÄNTELI et al. 2000; HALBAUER 2005). The church of Berslingen, for example, is quite similar to the building found at Bärenthal, yet the burials of Nusplingen, with their stone sarcophagi *intra muros*, clearly belong to a group with higher social status. But other interesting observations on the burial practice could also be made with respect to the cemetery of Bärenthal. Children under the age of approximately seven years were treated in a special way. Instead of ending up in the normal rows, defined by the burials of older individuals, they were interred either in groups or next to graves of adults of both sexes and very different age categories. This is why the old opinion of the historian Phillipe Ariès must be questioned by looking at the archaeological record (ARIÈS 1975; DUERING & WAHL 2013). The observed grouping of the burials does not support the theory that the harsh demographic conditions led only to very loose social relationships with children or a reduced concept of childhood in the Middle Ages. The results of the archaeological study at Bärenthal tie in well with the ideas developed by the historian Shulamith Shahar and the archaeologists Brigitte Lohrke and Sally Crawford but also expand them into later, Christianised, phases (SHAHAR 1991; CRAWFORD 1999; LOHRKE 2004). The upper extremities were mostly positioned parallel, which is the common picture in the early Middle Ages (SCHOLKMANN 2009), with some exceptions where the hands of the buried were probably folded. Some burials showed traces of coffins in the form of charcoal remains, or jumbled bones resulting from bloating through water inside the coffin cavity. One man in the middle-adult age category was interred at a right-angle to all the other burials as well as in the very west of the cemetery, the "least holy" area. A probably female child was buried in a sitting position. Coffins and arm positions were not ordered chronologically or according to rank, at least according to the limited skeletal evidence for this. However, a rough statistical analysis of 181 different anatomic variants (non-metric traits) of the skeletons of the first excavation campaign in 2008 revealed a tendency of similarity towards grouped individuals in comparison to random pair-comparisons (DUERING 2011b). Only because the pathological lesions and the coffins also formed uniform groups can an interpretation of family groupings be attempted. Perhaps the burial rites in early medieval Bärenthal were not so different from modern Christian habits, where family relations play an important role in determining a high percentage of burial positions. The settlement contexts, the few pieces of pottery and three iron knives which were found in the filling of graves and settlement structures belong to a slightly older phase because they are all cut by the graves. But the two-phased church (Fig. 1) and the structural contexts are contemporary with the graves surrounding them, according to the logic of archaeological stratigraphy. As the emphasis lies on the cemetery, the human remains and the following theoretical excursus, these contexts will not be considered here.

When these results were formulated, the established methodologies of physical anthropology and archaeology were used and most of my results could only be founded upon intra-site comparisons. But when it came to linking specific numerical results to other studies in order to contextualise the findings, it became obvious that a fundamental issue was almost always avoided in the literature: most osteoarchaeological data can only be interpreted in a comparative procedure, but there is no general framework that tells researchers who study sites which numbers are comparable and which are mathematically different in a way that prohibits direct comparison.

The sphere of death

Having established a general overview of the contexts of the site that is being used as an example, the specific problem will be focused on in the following paragraphs. I would like to draw the reader's attention to the position of the upper extremities and the distribution of coffins at Bärenthal. Of 66 graves, seven (11%) showed certain signs of coffins, either directly through preserved carbonised material (three, 5%) or indirectly through a special position of the bones (four, 6%). Eleven (17%) probable coffin burials could be additionally identified. In six (9%) cases the context seemed to suggest that there was no coffin or that it had collapsed before any movement of the bones had taken place, as almost all the skeletal remains were still exactly in their anatomical position. Temporarily existent space inside the coffin cavity could have allowed water to jumble up smaller and even larger bones and disassociate them from their anatomical position (DUERING 2011b). This links up with other studies presented in this session of the conference that explore the internal structure of burials, body positions and their highly informative and interesting character. But the presence or absence of coffins is *per se* no number or frequency that describes the situation of the living. It can be used to characterise the similarity or difference of the accumulated remains in a cemetery, but it can only indirectly tell us something about aspects such as wealth, socioeconomic structure and the availability of timber. The presence of a coffin is an indirect result of the individual's life, it is a result of a complex process that could have involved many other factors at the point of the individual's death such as a decision of the surviving members of his or her family. The presence of a coffin also only starts after death. The later presence of the coffin might be the result of some influences during the individual's life, but it numerically represents a state after death. In the specific case of Bärenthal there seem to be several spatial clusters of coffin burials which could be a sign of family relations or temporal preferences.

The position of hands and arms in the grave is the second example of the numerical sphere of death. Analysing the position of the upper extremities in the grave is an established method to crudely date medieval burials (SCHOLKMANN 2009). At the site of Bärenthal it told the archaeologists that the individuals were buried in the earlier phases of the Middle Ages before any radiocarbon dates needed to be made (KLUG-TREPPE & WAHL 2009). The majority of interred individuals had their upper extremities positioned parallel to their pelvis (47%), only a minority had other positions: probably folded or crossed over the pelvis (12%) and bent or one-sided (9%). 32% of the individuals were excluded from that study because the original position of hands and arms could not be reconstructed without too much speculation (DUERING 211b). The position of the upper limbs is also a property of the buried individual that did not precede or only indirectly preceded death. The individual had no specific arm position during life.

Both frequencies tell us something about the character of the graveyard and the treatment of bodies. A comparison with other sites is directly possible and can be made more informative by taking phasing and temporal changes into account. It can be argued that the presented signs of specific burial rites are a reflection of the actions of the living population. But when an archaeologist describes the number of burials with coffins and arm positions, these frequencies and numbers are attributes of the dead population solely and cannot directly be used to characterise the living. Disease, mortality rates and dress accessories, on the other hand, are categories of life that leave traces in the buried population. Numbers that describe the sphere of life are distinctly different from those that can only be calculated after the whole population had died.

The sphere of life

The sphere of life is more interesting and much more complex. Its general numerical properties can be calculated for a living population and change over time, i.e. mortality and disease rates are subject to dynamic change. Calculating such numbers on the basis of a dead population, the static end result of all these changes and dynamics of life, is counter-intuitive. But osteologists who study age, disease and stress-markers, as well as archaeologists who analyse grave goods do that all the time. Most osteological changes in a skeleton are a result of the life of the individual. Only perimortal trauma lesions, visible osseous symptoms of deadly diseases and the pure existence of a dead body with a specific age at death tell us something about death in the archaeological record. And even very drastic lesions can cloud causes of death which are invisible after the individual has turned into a skeleton. Death and the skeletal symptom of a disease can be completely unrelated, such as in most cases of arthritis and dental caries. The children who suffered from tuberculosis at Bärenthal could have died from hunger or other infections. It is therefore absolutely irrational that physical anthropologists and archaeologists are often misled to count up such signs in cemetery sites and directly use these numbers to describe living conditions of the populations that interred their deceased at these places. The seminal paper on the Osteological Paradox (WOOD et al. 1992), the palaeodemographic debate with its Rostock Manifesto (HOPPA & VAUPEL 2002) and the work on epidemiological mathematics for archaeologists by WALDRON (2007; 2009) present a multitude of evidence against this habit founded on very different layers of arguments that would go beyond the scope of that text. But all of these authors are connected by a rather simple underlying point which has to do with the different mathematical dynamics of the living and dead populations. Only this underlying point will be illustrated with the help of disease rates from Bärenthal.

The presentation of a frequency of a skeletal lesion is equal to the calculation of a prevalence rate (WALDRON 2009; ROBERTS 2009). Crude rates of lesions and changes in the bone, i.e. rates that are based on the total number of individuals, are almost useless as they are often inaccurate and do not account for cases where a diagnosis was impossible, such as in the case of bad preservation (ROBERTS 2005). That is why this paper only deals with frequencies that were calculated on the basis of all recordable cases. Several other recording problems must be ignored here, too, as they are not the focus of the paper. Only 61 of 66 individuals of the Bärenthal population were credited recordable for scurvy. 18.0% of those individuals showed secure signs of scurvy based on the visual aspect of the bone lesions and their distribution over the body of the individuals. In addition to all the possible cases of scurvy the prevalence rate would rise to 37.7% (DUERING 2011b). This is the total or mean rate for the accumulated buried population over the complete period of use. Because of the lack of datable material goods and because only a handful of individuals were dated via radiocarbon, that number is of negligible value. It would be hasty to take it and compare it with such numbers calculated by researchers of other sites - a general bad habit of palaeopathologists and physical anthropologists. After the tiring exercise of counting up all the cases and after having dealt with all the preservation issues, observer biases, etc., it might be tempting to overestimate that number. But to rely too much on such a frequency would be a grave mathematical error. Why that is so will be first described with the help of a theoretical exercise and secondly illustrated by a simple computer simulation for those who need to be disillusioned by stronger visual means.

So why is the scurvy rate so different from the coffin rate? A buried population in realistic archaeological scenarios is no cohort, which means a generation of people with the same age at a specific point of time. On the contrary, a dynamic living population of people with different ages fed the cemetery over the period of its use. The archaeological site is constantly growing and accumulating graves over time where the living population might stagnate, boom or bust. If the living population diminishes, the cemetery still grows, only more slowly. If the living population grows rapidly, the cemetery grows faster and faster. This means that if a part of the living population develops signs of scurvy because of a single bad winter, the frequency of the disease rises to a certain level in the living population and remains zero in the dead population as long as no malnourished individual dies. With the growing death rate of the diseased individuals the frequency of scurvy in the cemetery goes up, and if no individuals develop new signs of malnutrition after that harsh winter the prevalence rate becomes stable for a brief period of time and then goes down again when individuals who did not suffer from scurvy after the single incident die. As time goes by the rate of scurvy in the cemetery decreases steadily as a consequence of a growing total population accumulating until the end of the use of the site. Apart from that there is another dynamic factor at work which leads to an underrepresentation of the prevalence rate in the living population. Scurvy lesions, the woven bone formations on the surface of the bone, can vanish from sight because of healing. If the malnourished individual dies as long as the defects are visible he/she contributes to the frequency, but if he/she survives and heals before death the temporary symptoms do not leave a trace in the burial record. The frequency of scurvy cases is fundamentally different in the living and the dead population. In practice that means that there had probably never been a time at Bärenthal when 18.0% individuals in the living population suffered from scurvy so severely that they developed skeletal traces of their disease. That disease frequencies can behave paradoxically different in living and dead populations is no new discovery (WOOD et al. 1992; WRIGHT & YODER 2003). A temporary high epidemic of a disease and a much lower rate of constant infection and malnourishment can look quite similar in the cemetery data. It is therefore surprising that many osteoarchaeologists still practise the unreliable art of inter-site comparisons without any check on some of the described scenarios.

Is it prudent to mention rates from comparable sites because of peer pressure in publications? I think it has come to the point where common procedures must be questioned. That is the reason for my interest in agent-based modelling that has the power to simulate a group of virtual individuals with a plurality of properties (KAHN & NOBLE 2010). These problems of data interpretation can be tackled by the development of virtual scenarios that reconstruct a living population with the same parameters of population size, age distribution, mortality, fertility, growth, etc. that are being published alongside disease frequencies, often within the same volumes. The procedure then records not only the development of the living and dead population but also accumulates a cemetery over a specific period of time. It also plots the disease frequency in both entities at each point of time. By setting up a framework of specific virtual rules, various ideas and scenarios can be tested. For instance one can test if better fits can be found by the assumption of one epidemic or a continuous infection of a smaller part of the population. But here it suffices to illustrate the inaccuracy of the assumption that rates of living and dead populations are similar. If one gives a virtual living population the prevalence rate of a disease which was calculated on the basis of the cemetery, it probably does not reproduce a cemetery with the same frequency because of many reasons, some of which I described above. The following experiment will illustrate the different dynamics of living and dead populations:

I used the modelling4all (www.modelling4all.org, KAHN & NOBLE 2010) Behaviour Composer, which is based on the NetLogo programming language, for the simulation of a more or less stable population of 30 males and 30 females with mortality data taken from the Bärenthal life-tables (DUERING 2011b) and a hypothetical fertility rate that levels out the risk of death. One run of the simulation lasts for 250 years, the approximate time of use of the site. Then I added a purely hypothetical disease routine which infects 20% of the living males aged 30. In the following graphs I plotted the population size of the living population (upper left), the accumulating buried population in the virtual cemetery (upper right) and the frequency of the hypothetical disease in the complete population (lower right) and the subgroup of males aged 30 plus (lower left).

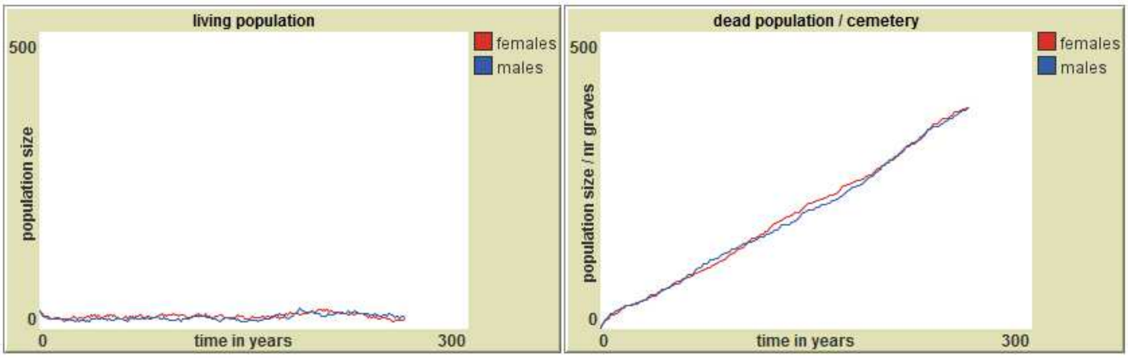

Fig. 3 – Plot of the living and dead population sizes of one simulation run with Bärenthal demographic data for over 250 years. (Copyright: Andreas Düring)

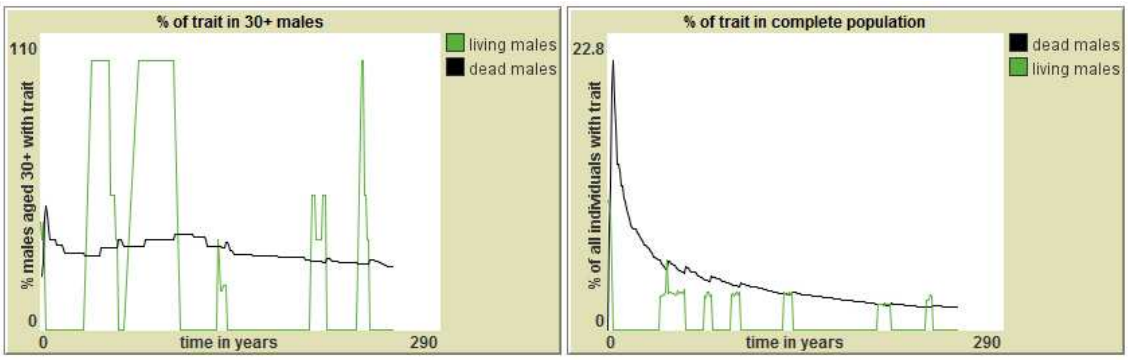

Fig. 4 – Plot of the frequency of a disease which the programme gives to 20% of the living males aged 30. The disease has no influence on the mortality rates in that scenario. (Copyright: Andreas Düring)

The graphs (Figs. 3 & 4) show that demographic dynamics and stochasticity are responsible for the effect that the accumulated prevalence rates in the buried population are very different from those in the living group. The black curves (Fig. 4) and the green curves show differing dynamics. In the first years of the simulation the irregular effects of small numbers prohibit any interpretation. This is why cemetery sites that have been used for only one generation and data of periods that come close to one generation must be treated with extreme caution. Once a more or less steady state of the cemetery rates has been reached the black curves converge towards 20% in the subgroup of males aged 30+ and towards 1.5% in the complete

population. However, the difference between the behaviour of both black curves, i.e. the frequency of the disease in the buried population, is striking. The frequency in the subgroup never comes close to the 20% rate that we would expect. Moreover it fluctuates between 35% and 22.5%. The frequency in the complete dead population does not peak around the year 100 and shows exponential smoothing with a general downward trend. The disease rates of dead populations which we calculate on the basis of cemeteries are equal to the numbers at the end point of the black curves at year 250. The green peaks show the really infected part of the living population over the period of study. 100% of all males aged 30+ were infected for two brief phases in the first third of the run, and in the middle of the run there was no case of virtual disease for over one generation. Is it also not surprising that the black rates in the complete population strongly overestimate the frequency of infection in comparison to the green peaks (Fig. 4, right), a trend that cannot be observed in the 30+ subgroup (left)? By now it must be obvious that (pre-)historic epidemiology remains elusive without a close consideration of demographic dynamics and complex stochastic effects.
The graphs of just one simple virtual experiment clearly show that inter-site comparisons of disease frequencies will not tell archaeologists anything of the living conditions of past living populations unless more advanced analytical methods are used. I conclude that, at that point, rates from the cemetery cannot be directly taken to describe the life of the group that buried their dead at Bärenthal.

Conclusion: The difference of living and dead populations

The problem illustrated with data taken from the Bärenthal site can be generalised. It appears in every study that involves archaeological material from a buried population. Archaeologists and physical anthropologists must not neglect the mathematical side of their work - even if the different dynamics described here immensely complicate the interpretative procedure. Archaeologists should furthermore be aware of the similarities between disease frequencies and artefact rates, e.g. the rate of objects that carry certain information about the wealth and social rank of the buried individual. 10% of weapon burials in a cemetery were probably caused by an entirely different frequency of armed individuals in the living community. Simply substitute the term "disease rate" by "artefact rate" in the model conducted above. I intentionally produced an example that better reflects the behaviour of many gendered artefacts than disease rates to show that this epidemiological problem of physical anthropologists is an archaeological conundrum just as well. Contrary to the frequencies of the definite sphere of death, i.e. from the coffins and arm positions at Bärenthal, disease and artefact rates cannot be directly compared between cemetery sites unless we are absolutely sure that the demographic dynamics and the living conditions, etc. were very similar between the two groups. The accumulated cemetery rates are an intermediate step in the interpretative procedure and no end result. In the sphere of life only living groups can be compared, which additionally makes it very unlikely that single scenarios are a useful concept for interpretations. Multiple scenarios must be tested for plausibility in consideration of the complexity of the study subject: dynamic human populations.

Outlook: A virtual solution?

There are two main reasons for discussing the problem of living and dead populations in the context of this conference: the conference's interdisciplinary character and its affection for technology. But the conference also presents a platform for practitioners of osteology and archaeology who might not all be easily influenced in their day-to-day work by theoretical considerations from inside the Ivory Tower. The published palaeodemographic simulations which partly address the problems of living and dead populations did not resound very much in the practical world of archaeology and physical anthropology. It is very likely that the very specialised subfields of bioarchaeology (WRIGHT & YODER 2003) have a communication problem. Complexity and applicability must be balanced and it is desirable to design procedures which are inclusive and facilitate a dialogue (POLLARD 2011). A more common and wide-spread use of approachable computer simulations would be desirable. Simulations can not only help to illustrate the difficulty referred to of reconstructing (pre-)historical living conditions but might also present a practical way out. Archaeologists must work with mathematical procedures and computer technology not only for data presentation, collection, ordering, in multivariate analysis, but also for the development of interpretative procedures based on the modelling of possible scenarios. To apply virtual experiments to make crude and unintuitive numerical results talk is a necessary step most scientific fields have already taken. Many archaeological results based on oversimplified mathematical procedures must be reconsidered and computer modelling approaches must be explored. Their theoretical accuracy and practical value can be tested best when they are used by many researchers as an additional tool. The computer model with which I illustrated my examples in the above text will be made freely available on the Internet in the first quarter of 2013. It is a result of my practical work at the site of Bärenthal, and will hopefully inspire at least those who were also feeling uneasy when artefact and disease rates had to be compared in their first archaeological site study.

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