METHODOLOGY AND PROBLEMS IN THE EXCAVATION AND ANALYSIS OF HUMAN SKELETAL REMAINS

Cemetery excavation

The first logical question to ask is “Why excavate cemeteries”? It is usually difficult, and always time-consuming. Much can be learned by excavating material culture, for example: family size, preferred house type, pottery used, and much else. However, when we excavate a cemetery we are uncovering the remains of those individuals who actually conceived of, manufactured and produced this material culture. The bones of these individuals can give us such information as: the demography of the population (age-sex structure), the health of the population, genetic make-up, or family groups. The careful stratigraphic excavation of a cemetery can add data to all of these aspects. Faunal and paleobotanical sampling of the site is also necessary.

Anyone who embarks upon the excavation of human skeletons should have a basic knowledge of skeletal anatomy. Small bones can be easily lost if their existence is unknown, and pathological processes can be missed. Extensive field photography is a must.

The bibliography attached to this manuscript is suggested to be used by anyone who is faced with the excavation of human burials. The reader is also directed to BASS 1987, UBELAKER 1978 and BROTHWELL 1981.

As was illustrated by slides, during the presentation of this paper, the archaeologist can expect many things from a grave site. It is important to carefully note the stratigraphic sequencing, as one would with any feature. Recognition of single redeposited individuals, and partial articulation in the field is necessary. Later this information may be very useful in interpreting burial customs, and attitudes toward death. If it is possible, the ideal situation is to have an osteologist in the field. Trained individuals will not miss anomalies, and they are also able to excavate skeletons more quickly than someone with no experience. This saves the archaeologist time, and retains the preservation of the skeletal material.

Excavation methods

The chosen method must depend on the burial type, time allowed, and the preservation of the burials themselves. In addition, if certain questions are to be asked which demand analyses, these must be considered ahead of time. Bone samples for blood grouping must not be handled, soil samples for parasite analysis must be taken before excavation is completed. These and other analytical techniques will be discussed below.

In general:
1. Define the burial by clearing the surface (if possible).
2. Define the edges of the pit (if possible).
3. Measurements, drawings, and photographs of the burial feature are then done.
4. The soil is then cleared to define the limits of the burial. This can be done with brushes or vacuum cleaners. It must be done quickly and carefully, as over exposure to the
elements can damage the bones very quickly.

5. Draw and photograph the burial and any grave goods which are found. Stick person drawings are sufficient. Use a burial recording form if available, this acts as a checklist so that no details are forgotten.

6. Remove the burial and place in bags by side and element (ie) left and right feet, cervical vertebrae, left arm etc. Be sure that all bags are labelled clearly, and that the bones are not in danger of falling out.

All of these steps are ones which you would follow in excavating any archaeological feature. However, special problems arise in excavating skeletal remains. The position of the body must be carefully noted, as must any disturbance. If careful attention is paid, interesting things may be found, for instance, calcified parasitic cysts, dislocation of the neck (causing death), and fetal bones in situ. If preservation is particularly bad, consolidants may be used. White glue and water is the safest and most easily available. Acrylic bonders may also be used. In extreme circumstances, for example a very old or very important burial, the entire thing may be encased in plaster and removed as a block. Generally, bones which are broken can be measured in situ, and later restored in the lab. I hesitate to condone the use of acrylic consolidators, even though we have done so at Rocca San Silvestro. Their effect on chemical analyses can be devastating, and radiographs can not be done after the bone has been impregnated. Adequate tests have not been conducted as to their long term effects on bones in storage.

Analysis

Before analysis can begin, the bones must be cleaned and mended. Water will not hurt the bones, but it is generally not necessary. The soil should be allowed to dry (not in the sun), and then brushed off. If bones are to be stored and analyzed at a later date, the soil should be scanned off before packing. Never leave a skull full of wet dirt. The drying action causes the skull to warp, with the result that measurements are not accurate. As in the field, it is recommended that a recording form be used for skeletal analysis, in order to be consistent in data collection.

Age estimation

The following are lists of the methods which may be used for aging adults and juveniles. The reader is referred to the references for details on how to utilize the methods. It should be kept in mind that there are other methods available, however, some of these have not been adequately tested, so it is the standard accepted methods which are listed below.

*Infants and children:*

1) dental calcification and eruption (UBELAKER 1978) 2) diaphyseal length (UBELAKER 1978, BASS 1987)

3) fusion of epiphyses (BASS 1987, GENTRY-STEELE and BRAMBLETT 1988, WILLIAMS and WARWICK 1980)
4) thin sectioning of teeth to determine the annular growth increments (H~LLsoN 1986). This method may also be used in palaeopathological studies of diet and health status of an individual.

Adults:

1) fusion of late fusing epiphyses (GENTRY-STEELE and BRAMBLETT 1988, BASS 1987, WTLLIAMS and WARWICK 1980)
2) morphological changes of the pubic symphysis and the auricular sur face of the pelvis (KROGAM 1962, BROTHWELL 1981, BASS 1987, and many others)
3) rib phase aging (requires recognition and separation of the 3rd, 4th and/or 5th rib in the field) (BASS 1987)
4) dental wear (BROTHWELL 1981)
5) degenerative bone changes (BASS 1987) 6) histomorphometrics (UBELAKER 1978) 7) cranial suture closure (STEWART 1979) 8) resorption of cancellous bone (section or x-rays) (EL-NAJJAR and MCTLTTAMS 1978).

In general, juveniles can be aged quite accurately by the above methods. One must keep in mind that there is variability within each population, and with the individuals within that population. An age estimation on a skeleton can never be absolute, a range of years must always be given, for example; 3 years ± 8 months.

Aging adult skeletons is much more difficult. As the age of the individual increases, our ability to obtain an accurate age decreases. The most reliable and tested method of aging is by pubic symphysis metamorphosis. It is unfortunate that the pubic symphysis is usually the first thing to be damaged on archaeological remains. A general rule is to use as many aging methods as possible on the remains which you have. You may then obtain an average age estimate. New research is constantly being done, and there may be some hope for the future of adult skeletal aging. At the moment, histomorphometrics and cranial suture closure appear to be the most promising areas of new research.

Sex estimation

Juveniles and children are not generally sexed until puberty, although some researchers do attempt it. It has been noted in modern populations that juvenile males grow more slowly than juvenile females, but that the dental development rate is the same. Therefore, if a skeleton has a diaphyseal and dental age which agree, then it is probably female, if there is disparity, then it is probably male. Other methods of sexing juveniles include statistics using the width of the ilium, and/or the depth of the sciatic notch and discriminant functions using deciduous tooth crown measurements.

In sexing adults, there are three areas on the skeleton which are looked at: pelvic morphological features: 98─o accurate, skull morphological features: 85─90% accurate, long bone measurements (alone or in discriminant function groupings): accuracy can vary depending on bone.

The reader is referred to BASS 1987, BROTHWELL 1981, or any of the general forensic osteology books in the bibliography for sex differentiating features.

Once age and sex have been determined, a population profile may be constructed, in
the way of a life table. This gives you such information as life expectancy, and highest age for death rate. These age at death profiles are often used to interpret something about the general nutrition of the population (e.g.) infant mortality and weaning etc.

**Metrics and morphology**

Metrics are used to describe and compare the population under study. There are hundreds of cranial and postcranial measurements which can be done. The researcher must decide which ones will be useful for interpretation of his particular population. (see BASS 1987, STEWART 1952, BROTHWELL 1981). Cranial measuring grew out of the “racial type” background of physical anthropology. In the early days, all skulls were given labels (e.g.) round head, long head (dolioccephalic etc.), and placed into racial groups or types. Of course, this does not take into account the inherent variation in populations. It is really only important today in forensic cases, where the racial background of a single individual is in question for facial reconstruction or the like. It is also useful for intrapopulation comparison. Long bone metrics provide a data base from which to calculate stature of an individual. Regression formulae are given for each bone. One or more bones may be used. Formulae also exist for calculating stature from fragmentary long bones, and from juvenile bones.

**Morphology**

Like metrics, one can also spend days recording these so-called genetic traits on a skeleton. Such things as: wormian bones, extra vertebral foramen, and shovel shaped incisors are quite common morphological traits. Some, like the clavicular bridge, septal aperture etc. are much less common. If one is dealing with a cemetery of hypothesized “family tombs” it may be possible to demonstrate genetic linkage through the discovery of a rare trait on more than one person in the tomb. More often, morphological traits, along with metrics are recorded and used as a way of describing the population being studied.

**Palaeopathology**

Of course, careful pathological studies are also done. Such things as trauma, infection, metabolic, and cancerous diseases are recorded, along with degenerative changes. The findings must be interpreted in light of the population can also be studied, not only for aging, but for dietary reconstruction, and general state of dental health.

**Field to lab analyses**

1. **Parasite, pollen analysis**

Soll samples must be taken in the field. One from the pelvis, one from the sacrum, and a control sample from elsewhere in the burial. First the soil is floated to determine whether there are any plant remains. This will give us an idea about diet. Then, the sample is further sampled, and rehydrated using any of a number of methods (EDTA, formalin and
ether etc.). This process should rehydrate the ova of any parasites which were in the lower intestine of the individual at death. Microscopic slides are made, and photos must be taken quickly. Things such as: hookworm, echinococcus, and tapeworm may be found. This is very time consuming, and to date has only been done on actual coprolites. However, I think that the method has merit, and we shall be doing it at Rocca San Silvestro (especially in light of the parasitic cyst found there).

3. Blood grouping, HLA typing, antibody absorption

Specimens must be taken in the field, I usually chose a vertebra with cancellous bone. The specimens cannot be touched, and must be placed in sterile bags as soon as possible. Testing is expensive, time consuming and subject to contamination. The false positive rate is very high. Usefulness of the method: when you have specific genetic questions to ask of a population, ie) San Vincenzo al Volturno and the impact of the Saracens, which changed the blood group gene frequency.

4. Histomorphometrics

Microscopic age determination. Thin sections of long bones are made, and the number of bone cells (osteons) are counted and then plugged into a formula from which an age may be obtained. It is very popular in Ontario now. Many people are working on perfecting the method, although the results are not that great, considering that it is bone destructive, necessary equipment is expensive and it is again, time consuming. It serves a need though, because the accuracy of aging adult skeletons is tenuous.

5. Carbon Isotope Analysis

Plants are either C3 or C4 (this relates to their method of photosynthesis). Mammals eat the plants, and snow certain rates of C13 or C12 in their bones. Through the use of a mass spectrometer, the collagen or carbonate fraction of bone can be tested, which should provide information about the relative consumption of C3 and C4 plants in humans. Ex) corn is very high in C4, and this isotope has been studied to derive the precise time of the origin of agriculture in the New World, and probably in the old world as well. But there are problems! If humans eat the animals which grazed on C4 plants, they would be ingesting a lot of C4, and the conclusion could be incorrect. Similarly, marine organisms have a high C13 concentration, which is similar to C4 plants when ingested. Therefore, the environment must be known from palaeobotanical studies before conclusions can be made. This avenue of analysis is time consuming, expensive and subject to many problems. If you know what they are eating from the botanical remains, then there should be a specific question you need to answer about the population in order to make this type of study worthwhile.

6. Trace Element Analysis

This type of analysis can answer many questions about diet and contamination or poisoning of an individual. The body of literature on this subject is ever growing. Very basically, it is hypothesized that there are mean elemental concentrations in certain
foodstuffs. Zinc, copper, nolybdenum and selenium are usually associated with animal protein, while strontium, magnesium, manganese, cobalt and nickel are generally found in vegetable matter. Such things as nuts and berries, however contain high concentrations of all trace elements, and can throw your dietary reconstruction way off. Samples of the same bones from different individuals are necessary (as many as possible). Soil sample are needed to test the P1. of the soil (acid soils remove zinc, copper and manganese), also the soil must be tested for its concentration of trace elements because of the possible diagenetic effects on the bones. Samples must be washed with de-ionized distilled water and packed in sterile containers (plastic bags). Destructive methods of analysis include emission spectroscopy, and atomic absorptiometry. Non destructive methods of analysis include emission spectroscopy, and atomic absorptiometry. Non-destructive methods of analysis include X-ray fluorescence, electron microprobe and neutron activation. The choice of method depends on how much money you have and whether or not the sample can be destroyed. Most studies have focused on the level of strontium to calcium ratio in the bones to determine the amount of animal protein being ingested. The diagenetic effects for strontium are being heatedly debated at present. Also, testing a range of trace elements is a popular method, when it can be used to make intrapopulation hypotheses. The problem with this is again the diagenetic effects, and determining the "proper" level of the element, in the living person. When does it become inadequate? When one tries to place a certain element as being derived from a certain foodstuff, the picture becomes even more complicated.

7. **Heavy Metal Analysis**

This is very similar to trace element analysis, and the same techniques are employed. Neutron activation is usually the method of choice. One very popular metal is lead. Lead may be found in bones, but how it got there is another problem. The diagenetic effects of soil contamination have not been well researched, although it seems that for this metal, there is little effect. The problems is, that very high concentrations of lead can be stored in the bones before it becomes toxic to the individual. Ingested lead seems to present a problem in that it is not usually metabolized, so these theories about the Romans leave me puzzled. At RSS, we will do lead analysis, because it is highly likely that the inhalation of the by-products of smelting did cause dangerously high levels of lead in the system. Other heavy metals can be tested for in the same way. Ie; iron (this one is problematic because of the many different metabolites it can present, and the many ways in which it can get into the system), and other elements and minerals which could be potentially poisonous if the limits in the body exceed the norm. Note of caution, in any of these elemental or isotopic, or bloodtype etc. studies, soil samples must always be submitted with the sample to be tested. Contamination and diagenetic effects must be ruled out before the results can be accepted.

8. **X-ray analysis**

Pathological lesions are usually x-rayed as well as photographed. Such things as transverse lines of increased density on the tibiae are thought to provide information about dietary stress. The theory is that during a period of illness, or malnutrition, growth stops.
When the problem is solved, growth recovers with the result that there is a line of increased density from this over-exuberance of osteoblastic activity. These lines can also occur as a result of lead, bismuth and other heavy metal poisoning. This should be kept in mind.

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