Computers and the study of past human populations - their ecology and disease.

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Diseases are the result of interaction between the physiology and environment of an organism, thus making useful ecological indicators for past populations. A study has been made of demography, trauma, oral health, growth, joint disease and chronic anaemias in human skeletal material from the Nile valley. Only oral and joint diseases will be mentioned here.

Oral disease.

The investigation included enamel hypoplasia, periodontal disease, caries and calculus formation. Hypoplasia is an enamel defect caused by disturbances during tooth formation, periodontal disease is the inflammation of gingival tissue caused by bacteria in dental plaque. The overall balance of carbohydrate and protein in the diet is the main determinant of caries or calculus occurrence.

Joint disease.

The most common joint condition in the study was osteoarthrosis which is apparently caused by wear.

Method.

Skeletal material came from the following sites; Hawara, Sedment, Badari, Abydos and El Amrah in Egypt, and Biga, Shellal, Scandinavian Joint Expedition sites 277, 35, 270, 185 and 25, and Kerma in Nubia. A system of numerical scores and recording sheets was prepared for information on the diseases, excavation particulars, age, sex and skeletal measurements. 941 individuals were examined, with 1759 variables. Excavated skeletons are usually fragmentary and incomplete, so that many variables may be missing for each individual. To avoid the repetitive punching of missing value codes, a Fortran program was written allowing the termination of sections of the data by a flag number. On encountering a flag the program filled any unspecified variables with missing value codes. Much time was saved in this way, and the

program also provided a final check on the data before it was stored on magnetic tape.

Only simple statistics were required, such as frequency distributions, contingency tables, scatter diagrams and some multivariate methods. The ability to select, combine and transform variables was also needed, and the Statistical Package for the Social Sciences (SPSS) fulfilled most of these requirements. Additional programs were written to avoid the limitations of SPSS. Most of the results were to be presented finally as histograms, and Fortran programs were written to produce these histograms on microfilm, which could then be enlarged and printed. The diagrams which follow have been produced by this method.

Results.

Before considering the pathology, it is neccessary to examine any biological variation between the different groups of material. Such variation may imply genetic differences between the populations from which the groups were drawn, some of which may confer differing resistance to disease. The only physical characteristic available for comparison in the present study was skull morphology. All the available published analyses of skull measurements for sites and series from Egypt, Nubia and Africa south of the Nile were collected. Most of these studies only published the mean measurements and it was decided to compare the male means of five measurements common to all studies.

This comparison of site means was accomplished by calculating the Euclidean distances between them. M-D-Scal, a multi-dimensional scaling program was then used to calculate a two-dimensional plot from these distances. The plot showed that most of the skull series were not greatly different from one another. African series from south of the Nile were slightly divergent, and another group of sites diverged in a different direction. This latter group contained the site of Sedment and other sites widely separated in time and space. Thus, although some trends are apparent, most of the site means appear remarkably similar. This was bourne out by

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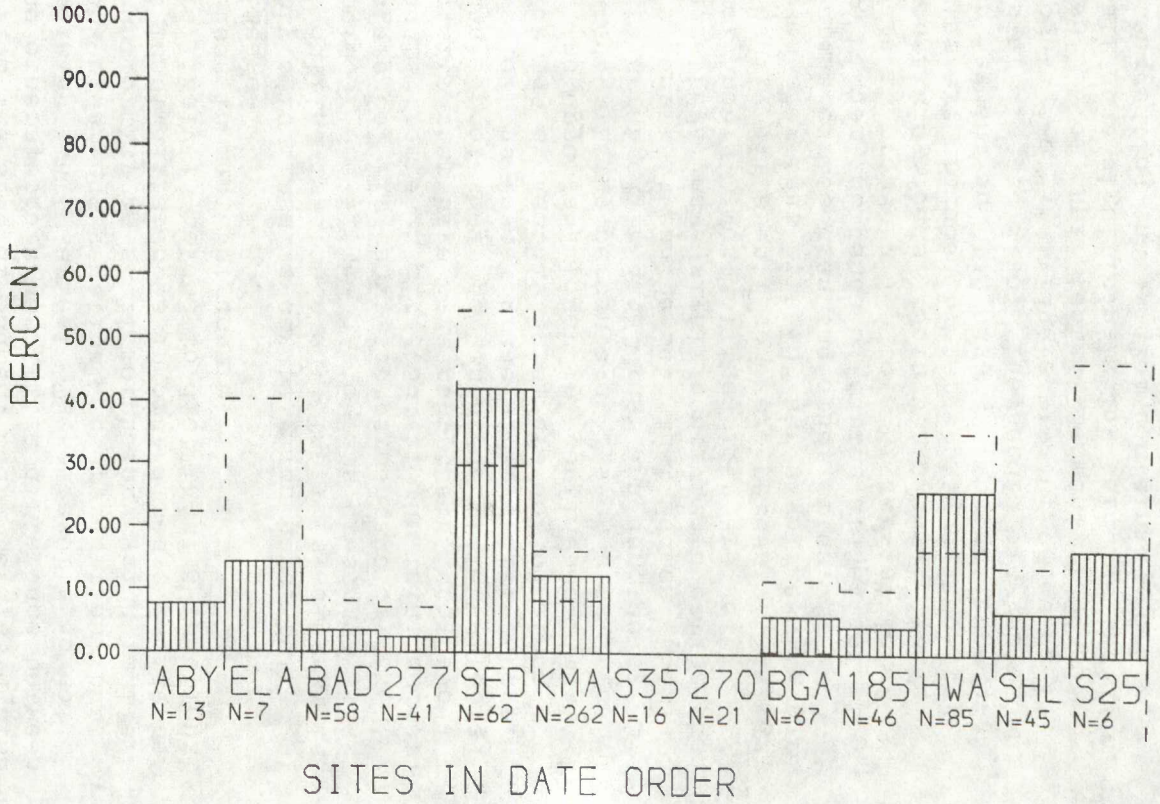

discriminant function analysis carried out upon measurements taken in the present study. Although skulls from the site of Sedment could be distinguished from the others, there was little difference between the remaining skull series. These results do not allow any clear-cut genetical interpretation, but show a uniformity in skull morphology which implies that at least differences in oral disease incidence are more likely to be due to diet than to functional differences in mouth structure.

Oral diseases.

Only a few results can be given here, but a general outline is attempted. The first diagram is an example of one of the histograms presented at the conference. It shows the percentage of individuals from each site (out of the total number at each site that have permanent teeth) who have more than 10% of their permanent dentition affected by caries of the lowest grade of severity. Above and below the shaded histogram are dotted lines marking the upper and lower 95% confidence limits associated with the percentage of each site. The sites are arranged in date order and denoted by abbreviations. It can be seen that Sedment (SED) and Hawara (HWA) have significantly more caries than their neighbours. Most of the sites are not significantly different from zero percent. Similar histograms show that site 185 has significantly more higher grade caries than the other sites.

The higher incidence of caries at Sedment, 185 and Hawara is probably due to a higher intake of sugar containing foods. Both periodontal disease and caries are produced by large plaque deposits, and both Sedment and 185 have a high incidence of periodontal disease also. The second diagram shows the percentage of individuals without calculus in more than 10% of their teeth. Sedment, 185 and Hawara all have significantly low calculus incidences, further suggesting that a diet containing more carbohydrate than protein was eaten. Calculus incidence in the three earliest sites, Abydos,

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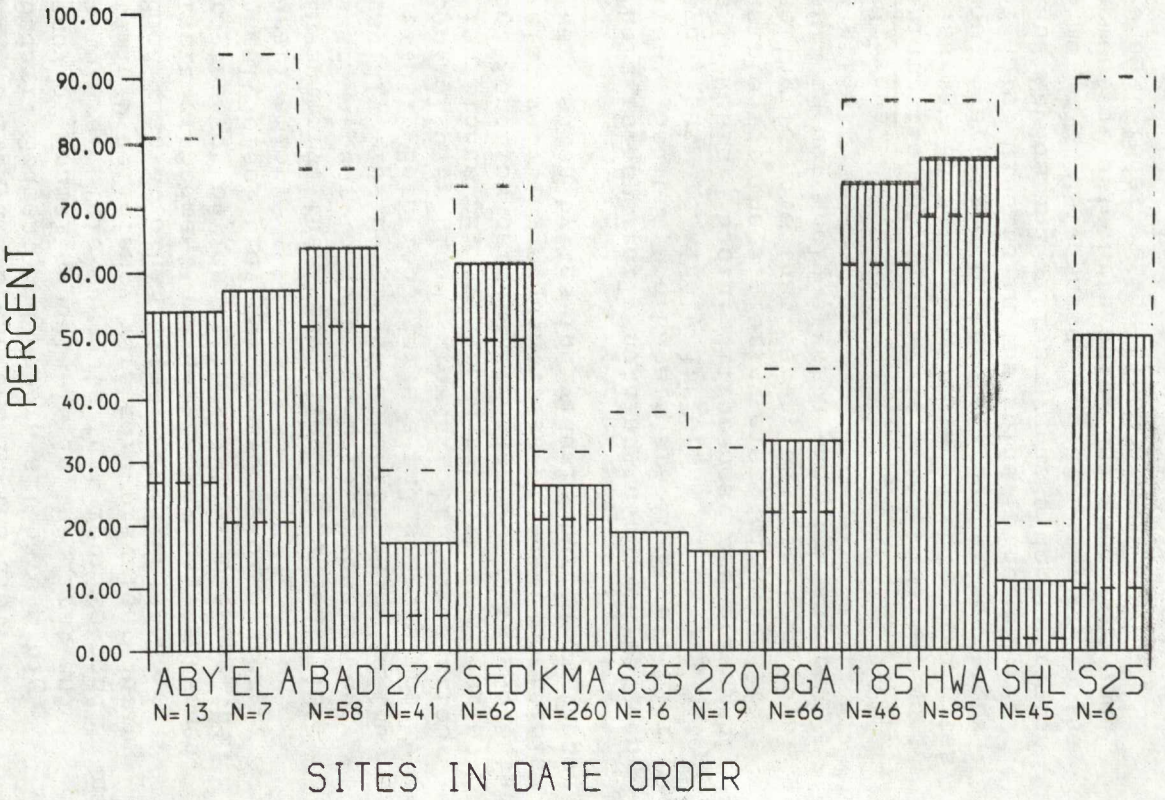


El Amrah and Badari is also low, but this is more likely due to less extensive plaque deposits than to a high carbohydrate content in the diet.

Badari, Sedment and Hawara all have a high frequency of enamel hypoplasia in the first and second molars. This suggests that febrile conditions or vitamin D deficiency were more prevalent during childhood than at other sites. The incidence of hypoplasia at Sedment and Hawara may have enhanced the progress of caries at these sites because the the enamel defect provides an avenue of easier demineralisation.

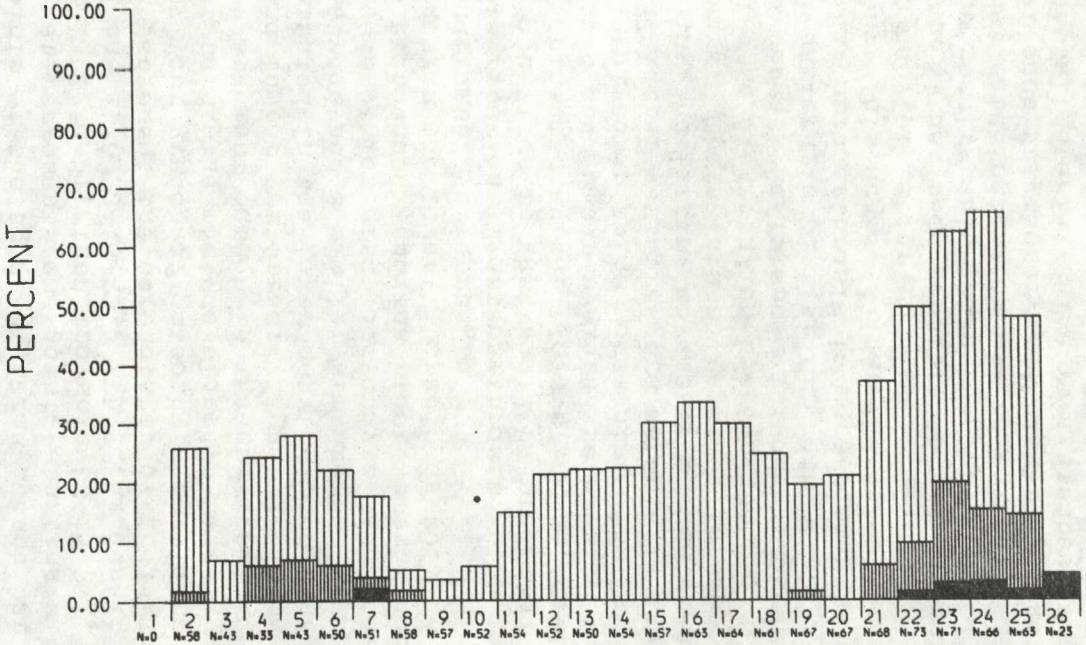
In summary, the three sites of Sedment, 185 and Hawara appear to have had more extensive and more rapidly growing plaque deposits than did the other sites. Both food texture and sucrose intake have control over plaque growth. All three sites had a low plaque pH, evidenced by both high caries incidence and low calculus frequency. This suggests that relatively large quantities of sugar containing foods were eaten by the individuals buried at these sites.

There is apparently nothing in common between the sites. Sedment and Hawara are in Egypt, near the Fayum, but are widely different in date. Site 185 is in Nubia. Social differences are presumably responsible for the differing diet, although it is interesting to note that Kerma, supposedly a royal cemetery, is not included with the high sugar-intake sites.

Joint disease.

Information on joints was often missing, so that less may be said about this aspect. Two sites had enough vertebrae to enable a comparison to be made of joint disease in the spine. These were Kerma and Abydos and will serve as a demonstration of the method. Osteophytes appear early on in the development of osteoarthrosis, and so may be used as a general index of the disease.

CENTRUM OSTEOPHYTES



The third diagram shows osteophyte development around the centrum (or body of the vertebra) for all the joints of the spine at Kerma. Each bar of the histogram represents one joint, starting with the cervical (1 to 8), then thoracic (8 to 20), lumbar and sacral (20 to 26). The four densities of shading represent the percentages of individuals affected by four grades of osteophyte development - the darkest being the most developed. Lowest grade osteophytes are most common in the cervical, lower thoracic and lumbar vertebrae. Higher grade changes are concentrated in the lower cervical and lumbar regions. Abydos has a similar arrangement except that the peaks of low grade osteophyte development are not as pronounced, and that there are higher grade changes in the lowest thoracic as well as cervical and lumbar vertebrae.

The distribution of osteoarthrosis which is common to both sites is what would be predicted by a study of spine mechanics. Joints in the cervical, lower thoracic and lumbar regions are usually the ones most involved in spine movements. The lowest thoracic and lumbar vertebrae are especially involved in the bending and lifting movements encountered in manual work. There are no major differences in joint disease distribution between the two sites which would suggest differences in work or occupation. The general pattern is similar for both sexes, excepting that osteoarthrosis is more common in males than females. This suggests that the males were involved in heavier labour.

Although it has been possible to present only a few of the results which have been obtained, it is hoped that some indication may be gained of the potential of such fragmentary and hitherto largely ignored skeletal material. The work has been supported by grants from the University of Birmingham (1974/5) and the Medical Research Council (1975-78).
I would like to thank Dr Ian Graham for his help with the computing.