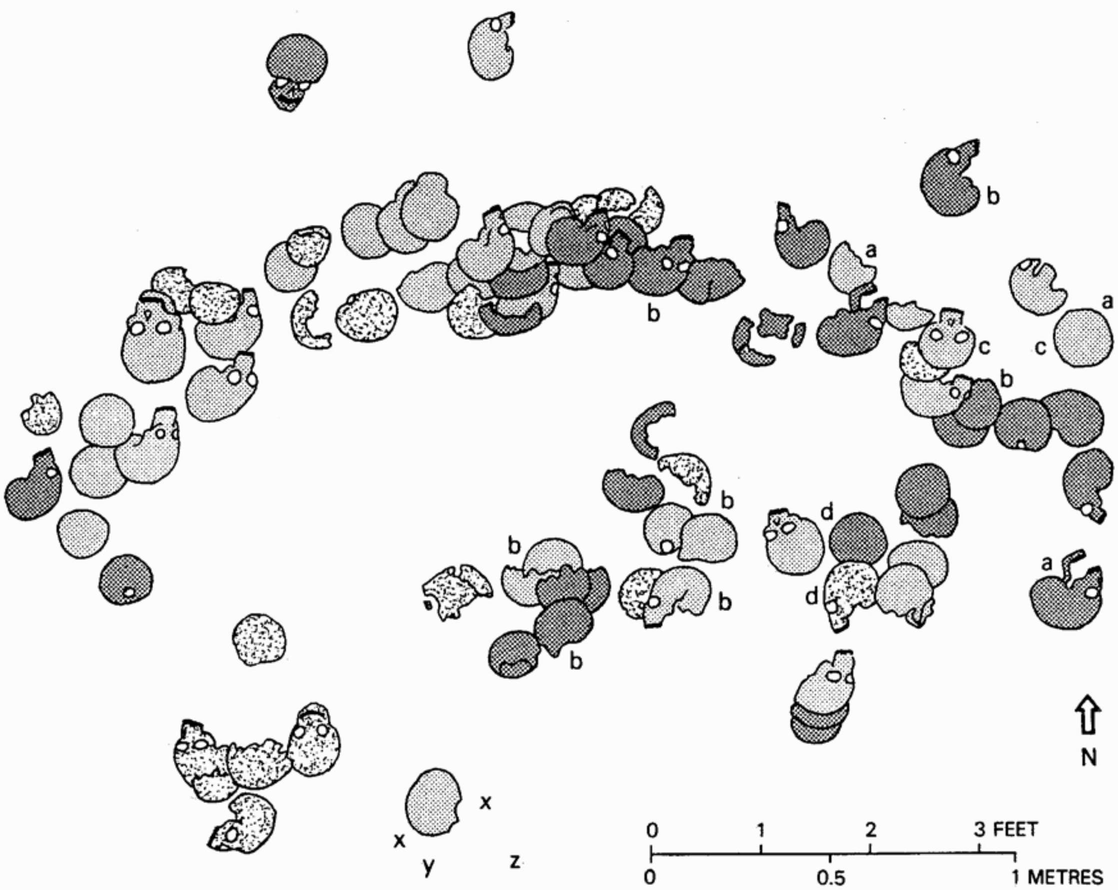
THE OSTEOLOGY OF THE GRIMSBY SITE

Mary Jackes



Edmonton, 1988

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ABSTRACT

Grimsby Cemetery provided the opportunity to study Neutral skeletal material of the Contact Period from an almost undisturbed site, containing a minimum of 373 individuals, some of them complete skeletons. The possibility of analyses of growth patterns; of metrical, morphological, pathological, traumatic and degenerative characters, by age and sex, offsets the limitations of a study done under a salvage project. Analysis of complete Ontario Iroquoian skeletons is rarely possible; here pathology can be studied in more detail than is usual, and it is possible to observe the simultaneous occurrence in one individual of a number of pathologies and anomalies. Amongst the pathological conditions considered are smallpox osteomyelitis and Perthès' disease.

The study encompasses several objectives:

1. To give an account of the amount and type of information which can be derived from the rapid analysis of material from a salvage site where immediate reburial is required.

2. To give the fullest possible description of Neutral osteology in such a way as to benefit those working on adjacent populations.

3. To use the Grimsby material together with available ethnohistorical sources to gain an understanding of Neutral life and Neutral burial practices.

4. To give a short account of what the data contributes to an understanding of issues in Iroquoian and more general skeletal biology: e.g. the sex and age association of non-metric traits; the causes of ossification into ligaments; patterns of degenerative change and dental pathology; age assessment; and biases in skeletal samples used in palaeodemographic studies.

The excavation and analysis were done in 1977, and the report considers available literature up to 1985.

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PREFACE

The Grimsby Site (Borden Number AhGv-1) is located in the town of Grimsby, Lincoln County, southern Ontario. It lies on a narrow strip of land between the western shore of Lake Ontario and the Niagara Escarpment. The site was excavated during the winter of 1976-1977 by Dr. Walter Kenyon of the Royal Ontario Museum. The archaeological report has been published as a Special Monograph of the R.O.M. (Kenyon 1982).

As no skeletal material could be removed from the area of Grimsby, the radiography was done by the kindness of the staff of the X-ray unit at the local hospital. Photography was done using my own camera and an X-ray table lent by Erindale College, University of Toronto. David Lubell spent a weekend taking closeup photographs of some pathological specimens, and Charles Tausky of Grimsby took on the task of recording the skulls on colour slides. Susan Pfeiffer spent a day at Grimsby talking over some problems with me, including Fe 9/1. Peter Hall spent a month working on the dentition and making dental casts, and Chris Koch examined many of the femora, tibiae and fibulae from Feature 62. Anne Mercer provided valuable help in sorting and recording.

Dr. W.P. Cockshott of McMaster University gave invaluable advice on Fe 1/33. Dr. J. Mayhall of the University of Toronto and Dr. G. Sperber of the University of Alberta read over Chapter 10 for me and I am grateful for their advice. My thanks to Dr. Gerd Weih of Edmonton for long and interesting discussions on the pathological specimens. The Department of Anthropology, University of Alberta, provided me (as an Honorary Research Associate) with computer funds which aided me considerably. Kathy Mills did the basic work on Figure 26, and Geoffrey Lester and the staff of Cartographic Services, Department of Geography, University of Alberta produced the excellent final versions of the figures.

I also wish to thank Peta Daniels of the Royal Ontario Museum for her understanding during the long period of time I spent on the Grimsby analysis, interrupted by complex family matters. I wish to record my gratitude to David Lubell for indispensible help in the preparation of this report. Finally, my thanks to Walter Kenyon who, as director of the excavation, kept me cheerful at Grimsby.

Edmonton, March 1982

Addendum:

Jane Ravenhurst drew the sketch which appears as Figure 21. Additional work on the plates has been undertaken by several members of the University of Alberta: I am especially grateful to David Epp, Department of Geography and Mme. G. Dupont, Photographic Services, University of Alberta for their assistance.

INTRODUCTION

Every people deserves a place in history. Those of whom little is known and who have no descendants as the result of war and conquest, merit every effort on our part to give them their place. The Neutral Indians who lived at Grimsby deserve our attention for many reasons. Little was recorded of them by the French before they were annihilated. In comparison with the Huron, the Neutral have no memorials. But the cemetery at Grimsby, full of interesting grave goods and with a complex and almost unique pattern of burial, places the Neutral firmly in Canadian history as something more than 'people who were like the Huron, did not welcome the French and were wiped out by the Iroquois'.

It is especially unfortunate then that this osteological report is not as full as it should be. While it suggests answers to questions, it cannot prove those answers right. It suggests that the corporate unit important to them was smaller than that for the Huron; that the Neutral did not intermarry with the Huron to any great extent; that the men worked much harder than early French accounts indicate; that there was some integration of and respect for Europeans; and finally, something of what the Neutral suffered before their annihilation. So many more questions could have been asked and answered had the Grimsby people been analyzed fully. But a complete study of such a large number of skeletons would have taken a year or more, with experts cooperating and being consulted, students assisting, radiologists and photographers helping, good laboratory space, fine equipment, a library for reference, and above all time to decide on what should have been examined in detail and on methods. None of this was available. The study of the bones was done in two months in the spring of 1977. The bones could not be cleaned or marked and, therefore, individuals could not be checked and cross-checked. The bones were sometimes examined on site directly from the ground and then placed straight into boxes for reburial. Most of the work was carried out in an isolated disused snowplough shed, kindly lent by the town of Grimsby. The bones could not be moved from the area of Grimsby and were reburied near the original site in the summer of 1977.

The analysis was done according to the system drawn up by F.J. Melbye of the University of Toronto to allow for comparison with other samples. Not all the material could be examined in detail, but in the interests of avoiding non-random selection, all reasonably well preserved adult bones were analyzed except for ribs, wrist and most ankle bones, hands, feet, scapulae and clavicles, sterna and fibulae. In addition, while some attention was paid to juveniles, it was decided not to code them in full. This is unfortunate, but Grimsby was a salvage excavation and not a full-scale osteological research project. The work was made more complicated by the fact that the features were so varied. Each feature had to be dealt with differently because of the varying burial practices, but also because several features had been vandalized. As a result, the kind of information provided by the excavators (ably supervised by K. Mills) differed from feature to feature and sometimes from individual to individual. In some cases, attribution to individuals was certain, in others the excavators had to make guesses. Several of the burial features (e.g. Feature 45 and Feature 11) had to be dealt with as ossuaries. Unfortunately, pathological bones were often removed from context and very often unattributable to individuals.

I hope in this report to provide some information to fill the great gaps in our knowledge of the Neutral, so that the Neutral come to have something of the colour and reality that the Huron have for us. I hope also to provide data which can be used by other osteologists since the bones are no longer available for study. The bones could have provided information of major importance to anthropologists, had they have been catalogued, sorted and studied fully. I hope to give sufficient detail so that others can judge the shortcomings of the emergency procedures, but also so that others can gain by the provision of information on Southern Ontario Indians which is broken down by sex and age categories. However uncertain the sex and age categories (and I have tried to indicate where more or less confidence should be placed in them), the loss of this data would be a loss to Ontario anthropology, which has so often been based on disarticulated remains from Huron ossuaries.

The task of writing a report on material potentially so rich was depressing: so many questions would never be answered. The task was protracted, being interrupted by other work and by family matters. Nevertheless, it has been well worth doing, for there can be no doubt that few osteologists are able to work on a site so fascinating and so complex as Grimsby.

A long delay in the preparation of the plates has permitted the inclusion of additional information up to June, 1985. Firstly, a relatively large amount of material has become available on southern Ontario skeletal biology since 1981 when the first draft of this report was written: it is thus possible to include more comparative data, setting Grimsby in the context of surrounding groups (see Fig. 1 and Table 1). Secondly, I have been able to benefit from the extremely careful work of G.S. Tait on Grimsby dental morphology as part of his University of Alberta M.A. thesis research and we have collaborated on work on Grimsby morphology, arch and tooth dimensions, the results summarized in Appendix I.

The delay also highlights an extremely important aspect of this report. The Grimsby skeletons were analyzed in early 1977. As requested, all material was immediately reburied apart from one small cranial fragment and several teeth which inadvertently were not boxed for burial. Since 1977, techniques have become available which, with little or no destruction of bone, would give us immense amounts of important additional data on diet, nutritional status, health, age. The potential of studies on trace elements, stable isotopes, bone mineral content, cortical bone thickness and density and micromorphology is enormous. In future, bone samples should be taken for study by these new techniques and by techniques yet to be applied in anthropology. The chance retention of several teeth from Feature 1 allowed a limited trace element analysis to be undertaken. The report completed in 1988 by K.N.Schneider is included here as Appendix III and adds considerably to our understanding of the Neutral diet just before the destruction of the nation. That report underlines the enormous amount of information which could have been gained in our attempt to give the Neutral the memorial they deserved.□

Addendum: The text was prepared for distribution in pdf format in 2007. No changes in formatting were made other than altering the plates for screen viewing. Despite developments since 1988 when this was first distributed, no changes to content were made except in the calculations of *r* in Tables 121 and 122.

Table 1: Information on Ontario Sites

	Sites	Township	County	Date A.D.	Association	References
1.	Ball	Medonte	Simcoe	1590-1600	Late Ontario Iroquois Northern division	Melbye 1983
2.	Carton	Nassagawega	Halton	1585-1615	Late Ontario Iroquois (Neutral-Milton)	P.J. Wright 1974 Molto 1980
3.	Cooper	Tuscarora	Brant	1640-1650	Historic Neutral	Schwarcz *et al.* 1985
4.	Fairty	Vaughan	York	1300-1400	Middle Ontario Iroquois Middleport substage	Anderson 1963 Melbye 1981
5.	Garland	Pickering	Ontario	1500-1550	Late Ontario Iroquois Huron Southern division	Webb 1969
6.	Glen Williams	Nassagawega	Halton	1400-1500	Middle/Late Ontario Iroquois (Neutral)	Hartney 1978
7.	Kleinburg	Vaughan	York	1580-1600	Late Ontario Iroquois Southern division	Pfeiffer 1979
8.	Maurice	Tiny	Simcoe	ca. 1640	Historic Huron	Jerkic 1975
9.	Milton	Esquesing	Halton	1600-1620	Late Ontario Iroquois (Neutral-Milton)	Hartney 1978
10.	Orchid	Bertie	Welland	?	Middle/Late Ontario Iroquois	Molto 1980 Patterson 1984
11.	Ossossané	Tiny	Simcoe	1636	Historic Huron	Katzenberg and White 1979
12.	Serpent Mounds	Ontonabee	Peterborough	300-500	Middle Woodland Point Peninsula	see Molto 1980 Schwarcz *et al.*1985
13.	Shaver Hill	Beverly	Wentworth	1600-1620	Historic Neutral	Stothers 1971
14.	Sopher	Orillia	Simcoe	1580-1610	Late Ontario Iroquois Northern division	see P. Wright 1974
15.	Tabor Hill	Scarborough	York	1300-1350	Middle Ontario Iroquois Middleport substage	Churcher and Kenyon 1960
16.	Uxbridge	Uxbridge	Durham	1490-1530	Late Ontario Iroquois	Pfeiffer 1984
17.	Walker	Onondaga	Brant	1640	Historic Neutral	M.J. Wright 1981

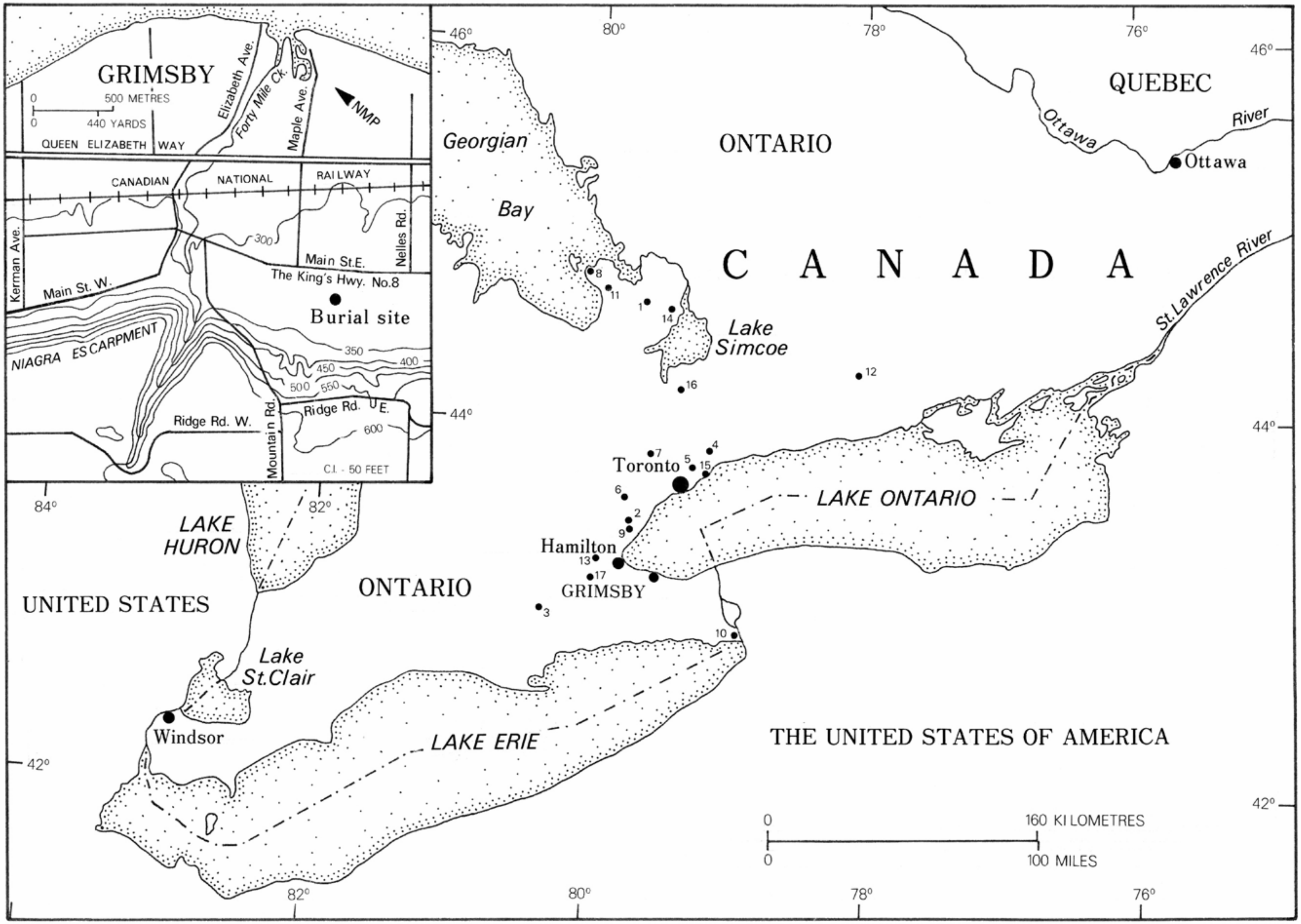


Figure 1: Map of site location

CHAPTER 1

THE GRIMSBY POPULATION

Methods

When a cemetery contains only individual burials, there is little difficulty in determining the number of people buried there. In a cemetery such as that at Grimsby, where burial pits ('features') (see Fig. 2) included from one to over 100 people, the minimum number of individuals must be estimated. Graves which were undisturbed and contained few individuals presented no problem. But several small features contained one or two isolated skeletal elements in addition to more complete individuals. Larger features, and especially those such as Feature 11 and Feature 36 which had been disturbed, had to be treated as separate ossuaries: the skeletal element which gave the highest count was used to estimate the number of people present. To this were added any individuals known to be unrepresented in that count. For example, the highest count might be given by distal humeri but amongst the humeri none were below six years of age, while two mandibular fragments indicated the presence of a three year old and a one year old.

In analyzing Grimsby, I assumed that each feature was a discrete single or multiple burial and the final estimate for total number of individuals is based on a count of the members of features.

Disturbed surface material had been collected prior to excavation. This material could not be checked against the contents of each feature in the time available to me. Though I counted such elements as temporals, left canine sockets and distal humeri in order to have a complete record, this analysis is based primarily on material assigned by the excavators to features and sufficiently complete to allow an estimation of age and sex. The minimum number of individuals was assessed as 373, and ages were assigned to 347 individuals.

Age assessment

The approximate age of subadults can be estimated on the basis of dental eruption and epiphyseal fusion. There is little agreement on the time of epiphyseal fusion, which is known to differ between males and females and to be somewhat dependent upon health and nutritional status. Therefore the age estimates, especially for late adolescents, can only be correct within a broad range. In analyzing Grimsby I assumed that fusion of all long bones and of innominates was complete by 20 to 21 years, but the distinction between a 19 year old and a 21 year old is not absolute. The basic reference for age of epiphyseal union was Stewart (1970). Anderson (1962), Bass (1971) and Gray's Anatomy (1918) were the other laboratory reference books, consulted on epiphyseal fusion, as on other points. The ages of younger individuals can be estimated with more certainty, using the standard Schour and Massler (1944) dental chart. This method will give reasonably accurate relative ages.

Assessment of the ages of adults is less certain. Once the epiphyses of the long bones and the basi-occipital synchondrosis are fused, one must rely upon features which are very variable. Such features as cranial suture closure, onset of joint degeneration and osteoporosis, and tooth wear and loss, provide a basis for broad age groupings only. The form of the pubic symphysis, checked against standard McKern and Stewart models for males and against descriptions and illustrations (Gilbert and McKern 1973) for females, was used for more accurate assignment to age groups. Age assessments were at times rechecked using the Todd (1920) method, without contradictory results. The pubic symphyses were, however, often damaged or broken off.

In the small features which contained only one or two individuals, the bone was often in poor condition, and therefore age assessment was relatively unreliable.

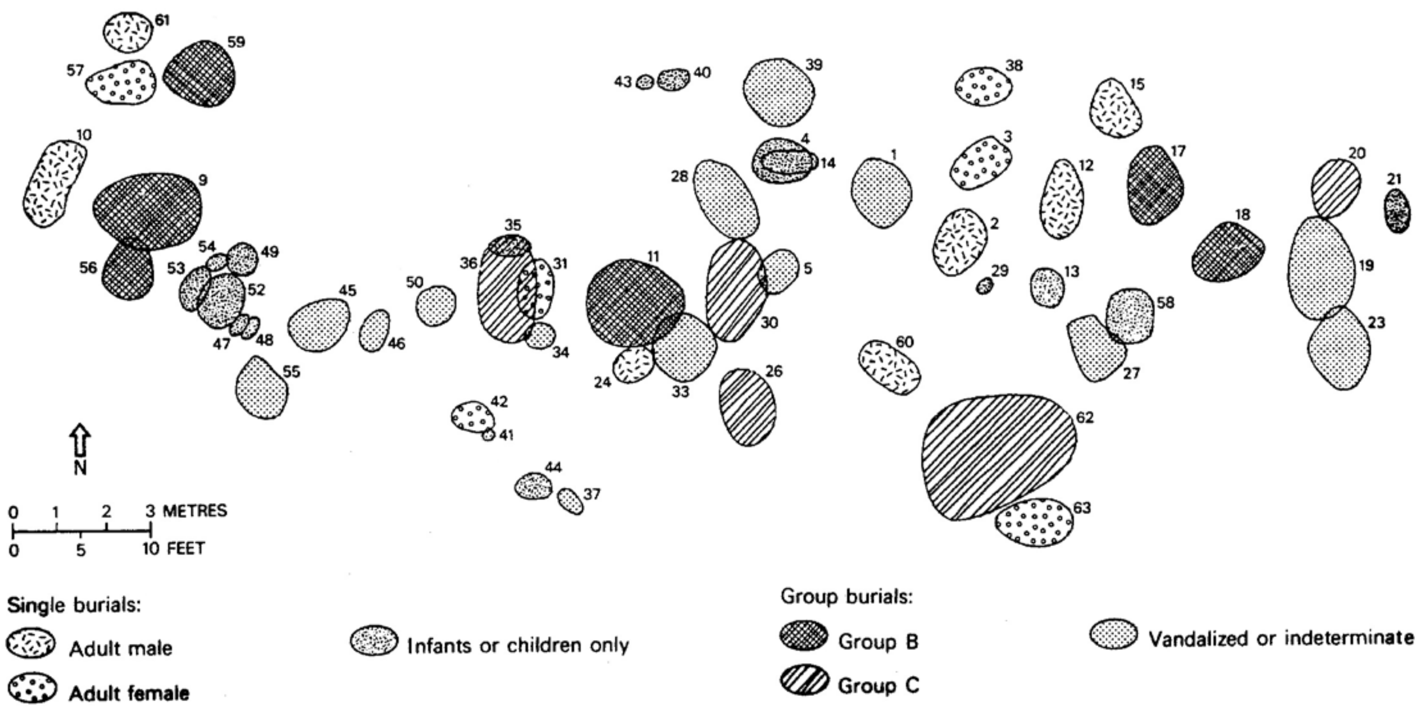


Figure 2: Map of feature distribution

When bone preservation was such that the whole skeleton could be used, criteria could be weighed against each other, resulting in more accurate age estimates. The larger features were treated more or less as ossuaries, and required complex assessments. For example, the minimum number of adult individuals would be determined. Complete skulls would next be observed for suture closure, dentitions would be examined for tooth wear and any pubic symphyses in good condition would be aged. All information would then be pooled for the best assessment of the age breakdown of the adults. Feature 62, since it contained so many adults, presented a particular problem of juggling cranial, dental and pubic data.

Adults from Feature 62 whose ages were based only on cranial and dental characters are recorded as "adults of unknown age" in Table 2 and were excluded from the initial life table calculations in Chapter 11. The adult age distribution for Fe 62 was determined on the basis of the innominates.

A number of reasons underlie the decision to rely on the innominates in the analysis of Feature 62. There were 82 innominates over puberty (51 male and 31 female), but only 76 skulls complete enough for study and considered to be about 15 years and older. The skulls were all given definite or, rarely, uncertain sex assignment. Forty skulls were considered to be female and 36 male. The chances are very high that male skulls were being misidentified as female, especially as there are only 31 cases in which the skull and innominates can incontrovertibly be considered associated (16 males and 15 females).

Apart from the possibility that sex assignments of skulls were in error, it is undesirable to give age estimates based only on cranial and dental data. Firstly, Grimsby females may have suffered more dental pathology than the males. Secondly, of those skulls in Feature 62 aged 15 years and over, one third of the males (12/36) but only 12.5% of the females (5/40) had endocranial suture closure. There are three possible explanations for this pattern: (a) the females may have indeed been younger; (b) delayed suture fusion in females ("lapsed union" cf. Ruff 1981) may have given them the appearance of being younger; or (c) older female skulls may have been identified as male. The pubic symphyses which could be analyzed did not confirm the presence of such a large percentage of older males. More reliance was placed on pubic symphysis than on cranial age assessments with the other Grimsby burial features and it is necessary to have consistent treatment across the site. While pubic symphysis age estimations may well be error prone, they are generally considered more accurate than those based on suture closure. The information presented here can therefore be considered comparable with that of other published age distributions analyzed with the major weight of reliance placed upon the McKern and Stewart (1957) and Gilbert and McKern (1973) pubic modification techniques.

In some of the larger features, there was a mixture of "stray" bones and bones that had been assigned to individuals by the excavators. The individuals were examined to make sure that they were not comprised of elements of obviously different age (for example, a young skull and a very arthritic or porotic vertebral column), as sometimes happened. Whenever it seemed likely that individuals were correctly identified, their ages were assessed on the basis of all skeletal parts present. However, because of the amount of unassigned bone, and the uncertainty of the assignments to individuals in most cases, all large features were treated more or less as ossuaries.

Sex assignment

Sex was determined mainly on the basis of the innominates, using the presence or absence of a preauricular sulcus, the shape of the sciatic notch and the form of the medial portion of the pubis as suggested by Phenice (1967). In all cases in which the skull seemed female but the innominates male (and the nature of the feature and careful re-examination of the total skeleton gave some certainty that mixing could not have occurred), the individual was called male. During later analysis long bone proportions were checked one against the other and against skull and mandible dimensions. Notes and coded information on the innominates were re-examined, and if there was any uncertainty the individual lost his "individual" status.

One individual (Fe 17/1), called male in the field laboratory on the basis of the innominates (after some hesitation), had a well-associated skull that grouped closely with females when the BMDP O7M programme (Dixon 1973) was used. The long bones indicated a female of average height (159.7 cm., 5'2") and robusticity. Fe 17/1, however, had no obvious female characteristics in the innominates. Fe 17/1 has been classified as a female, and will be discussed further in later chapters. The possible existence of some rather masculine female innominates might lead to errors in assessment of adult pelves in the larger features in which there were few or uncertain associations among bones.

The sex ratio

The sex of 243 individuals over the age of 15 could be determined. The adult sex ratio is approximately 1:1 (Table 3). Those dead by violence were excluded from ossuary burial (Tooker 1964:132), and we should therefore expect underrepresentation of males in a Huron ossuary. There is no sign of this at Grimsby, though it might have been expected, since Lalement recorded a Neutral army of 2,000 raiding the Fire Nation in 1640 (Thwaites 1898 21:195; 27:25,27).

There is no archaeological evidence that would help determine the sex ratio to be expected in an Ontario site, whether Huron or Neutral. The Ossossané ratio is .94, but with an apparent over-representation of young males (Katzenberg and White 1979). Kleinburg (Pfeiffer 1979b) may have had a sex ratio of about 1:1 and this is true also of Fairty and Garland and Glen Williams (see Fig. 1 and Table 1 for information on Ontario sites). However, it seems that Maurice had many more females (male/female ratio = .73), and Uxbridge (.83) and Tabor Hill (.54 - the value is based only on skulls) may follow the same pattern. Sex ratios derived from ossuary material may well be subject to systematic errors. The first assessments for Kleinburg gave the impression that 60% of the adults were females, a ratio of around .67 based on atlas vertebrae and skulls (Jackes 1977; Pfeiffer 1974).

Table 2: Age and Sex Distribution by Feature

Feature	MNI	Subadults Age	Subadults n	Males Age	Males n	Females Age	Females n
1	17	1-5	2	20-25	1	20-25	2
		5-10	2	25-30	2	25-30	1
		10-15	1	30-35	1	50-55	1
		15-20	2	45-50	1		
				?	1		
2	1			25-30	1		
3	1					45-50	1
4	1	0-1	1				
5	4	5-10	1	30-35	1	25-30	2
6	2	5-10	1	25-30	1		
7	3					20-25	2
						30-35	1
9	58	0-1	1	30-35	2	20-25	5
		1-5	7			25-30	4
		5-10	16			30-35	4
		10-15	11			40-45	1
		15-20	7				
10	1			35-40	1		
11	25	1-5	3	20-25	2	20-25	5
		5-10	3	45-50	1	30-35	1
		10-15	2				
		15-20	7				
				+ 1 indeterminate adult			
12	1			25-30	1		
13	1	5-10	1				
14	2	1-5	2				
15	1			25-30	1		
17	6	15-20	1	20-25	1	20-25	2
						35-40	1
						55-60	1
18	8	0-1	2	25-30	1		
		1-5	1				
		5-10	1				
		10-15	1				
		15-20	2				
19	4	5-10	1	25-30	1	25-30	2
20	3	1-5	1	25-30	1		
				45-50	1		
21	1	1-5	1				
23	3	5-10	1	45-50	1	35-40	1
24	1			25-30	1		
26	15	0-1	1	25-30	2	20-25	2
		1-5	1	30-35	1		
		5-10	1	35-40	3		
		10-15	1	40-45	2		
				45-50	1		
27	3	10-15	1	25-30	1	45-50	1
28	10	1-5	1	20-25	1	20-25	1
		5-10	3	25-30	1	30-35	1
				35-40	1	35-40	1
29	1	0-1	1				
30	6	5-10	1	20-25	2		
				25-30	1		
				35-40	1		
				45-50	1		
31	1			25-30	1		

33	2			35-40	1	35-40	1
34	2			2 indeterminate adults			
35	1	0-1	1				
36	20	1-5	1	20-25	5	20-25	3
		5-10	1	25-30	1	25-30	1
		10-15	1	30-35	1	35-40	1
		15-20	2	35-40	2		
				+ 1 indeterminate adult			
37	2	0-1	1			25-30	1
38	1					30-35	1
39	2					20-25	1
						25-30	1
40	1	5-10	1				
41	1	1-5	1				
42	1					35-40	1
43	1	0-1	1				
44	1	5-10	1				
45	18	1-5	2	20-25	2	20-25	4
		5-10	1	25-30	1	25-30	2
		15-20	3	40-45	1	50-55	1
				+ 1 indeterminate adult			
46	4	1-5	1	30-35	1	25-30	1
		15-20	1				
47	1	1-5	1				
48	2	1-5	1				
		5-10	1				
49	1	1-5	1				
50	3	0-1	1	45-50	1	50-55	1
51	5	10-15	1	30-35	1	25-30	1
		15-20	1			50-55	1
52	1	10-15	1				
53	1	5-10	1				
54	2	0-1	1				
		10-15	1				
55	2					30-35	1
						35-40	1
56	4	10-15	1	25-30	1	25-30	1
		15-20	1				
57	1					25-30	1
58	3	1-5	1				
		5-10	1				
		10-15	1				
59	4	1-5	1			20-25	1
		5-10	1			40-45	1
60	1			45-50	1		
61	1			45-50	1		
62	103	0-1	2	20-25	9	20-25	2
		1-5	5	25-30	12	25-30	3
		5-10	5	30-35	2	30-35	4
		10-15	7	35-40	3	35-40	6
		15-20	11	40-45	4	40-45	2
				45-50	1	45-50	1
				50-55	2	55-60	2
				?	12	?	8
63	1					25-30	1

Saunders (1974) calculated a .87 sex ratio based on 140 adult left innominates analyzed by the Phenice method (this sample would, however, constitute only about 70% of the adults in the ossuary). Pfeiffer's suggestion (1979b) of a 1:1 sex ratio for Kleinburg is on the basis of split points estimated for femoral head diameters, leaving around 30% of adult femora unclassified as to sex. We cannot yet judge whether there are errors in sex assignment or cultural factors underlying the apparent trend towards more adult females than males in Ontario sites.

Throughout this report definite sex and age assignments for individuals are made only when there is no possibility of mixing. The next chapter presents adult post-cranial measurements and explains how the association of long bones with a sexable innominate was verified. The extent to which individuals were mixed during burial and/or excavation will be shown.□

Table 3: Age Classes at Time of Death for Males and Females

Age Classes	Males	Females
15-20	14	21
20-25	23	30
25-30	30	23
30-35	10	13
35-40	12	13
40-45	7	4
45-50	10	3
50-55	2	4
55-60	0	3
indet. adults	13	8
Total	121	122

CHAPTER 2

ADULT POST-CRANIAL MEASUREMENTS AND SEX ASSIGNMENT

This chapter presents information derived from the measurement of adult post-cranial skeletons. It also demonstrates how these data were used to check the association of long bones and innominates. The data will assist in the sex assignment of disarticulated long bones from other Ontario Iroquois sites. Only three long bones are discussed in detail, the humerus, the femur and the tibia. The association of radii and ulnae with skulls and/or innominates was too often questionable, and too few were ascribed to individuals by the excavators, to warrant full discussion here.

Humeri (Tables 4-6)

The humeri were analyzed by side and although there were differences in variance, *t*-tests showed no significant differences between left and right. Differences between male and female humeri, however, were found for all but the maximum shaft diameter measurement.

The humerus was analyzed by BMDP 7M programme (Dixon and Brown 1979) (stepwise discriminant analysis on 24 cases and 8 variables) to determine whether unknown individuals could be assigned to a gender. The discrimination was made entirely on the maximum head diameter, the classical method of differentiating male and female humeri. However, the measurement does not solve the problem of individuals such as Fe 62/84, reclassified as male because the left humerus maximum head diameter was 44 mm., even though the maximum length was only 292 mm. Removing the maximum head diameter from the analysis results in discrimination on the basis of epicondylar breadth, then minimum head diameter and minimum shaft diameter. Length measurements are not included in the differentiation. Plotting maximum head diameter against epicondylar breadth is a satisfactory method of sexing humeri.

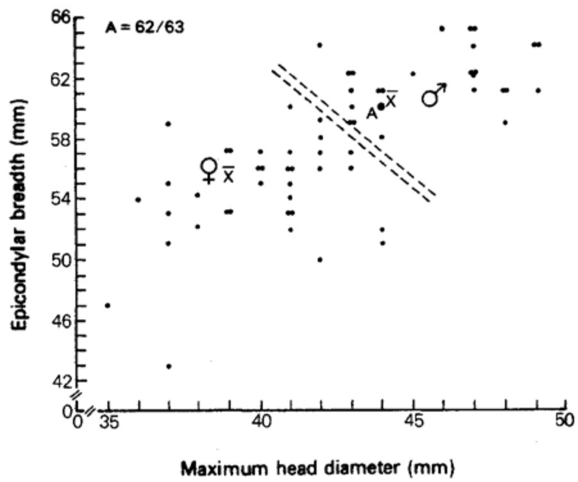


Figure 3: Sex differentiation of humeri

In Fig. 3, the double dashed line shows the separation between males and females as determined from other evidence. Fe 62/84 groups with the females but Fe 62/63 (individual "A") who falls near the male mean becomes problematic. The innominates were female, aged at 20-24 years. The cranial sutures were not fused, but the dentition (found separately but associated with the individual by the excavators) was extremely worn and tooth loss was extensive. The skull and mandible measurements suggest a female, but too few measurements could be taken for any certainty. Fe 62/63 is also shown as "A" in Figs. 4 and 6.

Femora (Tables 7-12)

Measurements for the total normal population of Grimsby femora are presented. Sex differences were found for all measurements except the midshaft diameters. Length was plotted against head diameter to test some pathological specimens (see Fig. 22 in Chpt. 7) and to check the sex and association of femora (Fig. 4).

In Fig. 4, "C" represents the position of Fe 62/G, post-cranials

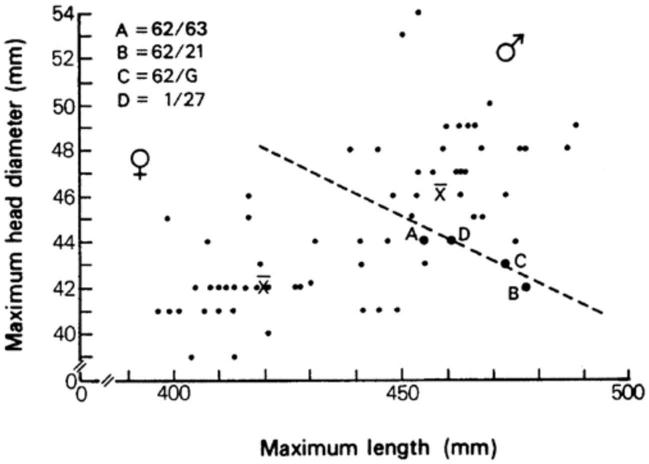


Figure 4: Sex differentiation of femora

without an associated skull. The plot shows the femur exactly on the male/female dividing line but the individual was an unequivocal male whose bones were all well associated. Fe 62/63 appears here as a robust female, while Fe 62/21 has remarkably long femora.

The "D" in Fig. 4 represents Fe 1/27 who was apparently buried with a pipe and thought of as male by the excavators (K. Mills, personal communication, 1979). The innominates were broken at the pubes but the sciatic notch was wide. Skull features were ambivalent, the cranial measurements were in the female range, but most mandibular measurements were in the male range. The humeri and tibiae were too fragmentary to be useful, but the left humeral shaft diameters were in the female range. The femora fall on the male/female division line in Fig. 4. If Fe 1/27 was a male he was rather "feminized". Fe 1/27 has been counted as a female.

The neck/shaft angle was measured on a sample of femora to establish the angle of inclination; the results were mean = 127.3°, σ = 2.6, n = 11. The mean is congruent with the mean values for Europeans (Tönnis 1976; Pick *et al*. 1941), among whom normal adult values range from 120° to 140° (Ratliff 1978:181). The neck/shaft angle was measured directly on non-pathological Grimsby bones (a number of abnormal femora were present and are discussed in detail in Chpt. 7).

The angle of anteversion was determined on a small sample of normal bones: there was great variation, even between sides in one individual. The difference between right and left sides ranged from 2° to 23° in seven individuals whose femora were photographed in craniad view. The angle was measured by projecting a line which bisected the line of the plane surface where it touched the greater trochanters of the two specimens. Table 8 records the figures obtained by this method. The figures are much higher than those usually quoted for European adults (Kingsley and Omsted 1948) and for some North American Indians, but higher angles have been recorded for some populations (Manuel and Yusof bin Mohd 1974; Schofield 1959). There is much less retroversion among the Grimsby femora than would be expected in a white American population.

The platymeric index does not exhibit significant side differences, although there is a tendency for the platymeric index to have a higher value on the left. Overall, the distribution of the index is markedly unimodal.

Stature (Tables 13, 14)

Stature was calculated from femora; a number of regression formulae are available, giving slightly different results. The formulae used in this report are those calculated by Neumann and Waldman (1967) since these formulae were derived from North American Indians. The results obtained from the maximum length of the femur are the most reliable because of the closer association with sexable innominates. Two of the three tallest women are buried close together in the same feature and both have inca bones (Fe 62/21 and Fe 62/23) (Fig. 4 and see also Fig. 42 in Chpt. 12). The third tall female was Fe 62/63, discussed previously. The innominates were female in all characteristics, but the long bones fall variably in the male and female ranges. Fe 62/63 has been given "unknown sex" status for

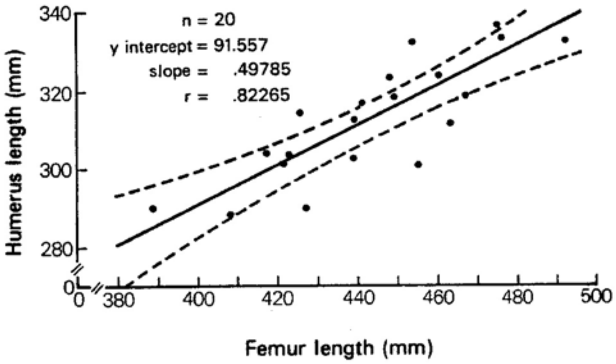


Figure 5: Regression of femur length on humerus length with 95% confidence limits

most calculations because of the possibility of mixing. The other markedly tall female is Fe 9/1 (165 cm., 5'4"), a woman who is possibly of mixed Neutral/European ancestry (see Chpt. 4).

Bone proportions

Fig. 5 plots humerus and femur lengths using only those cases where the two bones were present on the same side and mixing seemed unlikely. It is, however, clear that one individual (Fe 62/23) whose point is the lowest below the line at 455 mm. femur length, was mixed with Fe 62/22 whose point appears nearby at 463 mm. and the humerus of Fe 62/22 has been replotted with the femur of Fe 62/23. This method of plotting also confirmed that Fe 62/111 and Fe 62/110 had been mixed together. The point high above the line at 455 mm. femur length is that of Fe 62/85 who will be discussed in Chapter 7.

Tibiae (Tables 15, 16)

Fig. 6 and Tables 15 and 16 summarize tibial metrical data and sex differences.

As discussed in the previous chapter, Fe 17/1 was initially called "male" on the basis of the innominates. Nevertheless, the skull grouped with females on the stepwise discriminant analysis and the long bone proportions seemed female. When plotted, the long bones of Fe 17/2 were also shown to be rather female in their proportions, and the tibiae fall within the female range. Fe 17/2 ("F") is female according to Fig. 6, but the innominates were male. In almost all other cases of doubt about sex there was a high chance of mixing, but Fe 17/1 and Fe 17/2 seem to be two complete, unmixed individuals. They were buried together in a single bundle (Kenyon 1982) without grave goods. In the following analyses Fe 17/1 is "female", while Fe 17/2 who is much taller, is classified as a male, despite the possibility that they are closely related "feminized" males. Furthermore, Fe 17/1, whose tibiae and fibulae were pathological, might have had some growth disturbance but this is not evident on X-rays of the tibia (see Plate 11 in Chpt. 7) or the femora.

By itself, maximum length is almost a sufficient sex discriminator for tibiae. There is a division falling between 365 and 370 mm. (Fig. 6). Although 9 of 74 female tibiae fall above this, the totally different distributions for the platycnemic index when sex attribution is based on maximum length (Fig. 7) support the use of maximum length and a split point between 365 and 370 mm. for sex discrimination.

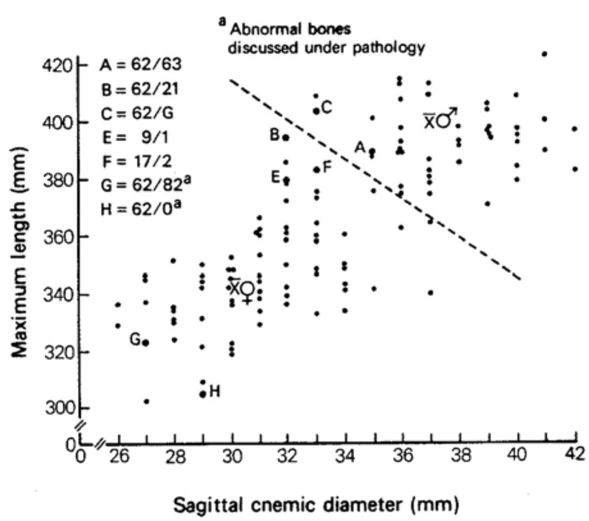


Figure 6: Sex differentiation of tibia

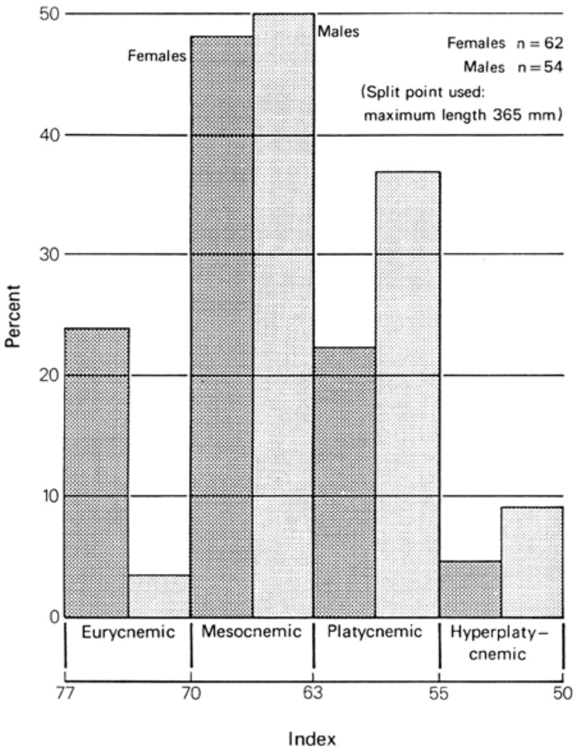


Figure 7: Distribution of the platycnemic index by sex

Sacra

Attempts were made to distinguish males and females by plotting centrum breadth against alar breadth. There was complete overlap of the male and female distributions. The correlation coefficients were rather low, about .5, and the male and female regression lines were virtually parallel. The sacrum of Fe 9/U, a female to be discussed in Chapter 7, was quite outside the normal range because it was extremely narrow.

Innominates (Tables 17, 18)

Measurements were made on a small sample of Feature 62 innominates to attempt to establish norms for acetabular width (maximum width across margins of the acetabulum in the sagittal plane), and acetabular depth (depth of the joint surface on the ventral portion perpendicular to the plane of the width measurement). The results are given in Table 17. A ratio of width/depth gives a mean of 2.86 (σ = .437, n = 56) without a clear distinction between males and females, although females tend to have a higher ratio value. The distribution is given in Table 18.

Other post-cranial elements (Tables 19,20)

The radius and ulna data are not presented separately for each sex because of relatively infrequent association with individuals or with sexable skeletal elements. The ulna physiological length is not included because, though it had almost perfect correlation with the ulna maximum length, its coefficient of variation was 15.77. Other post-cranial length measurements have coefficients of variation of 6 or 7 and the ulna physiological length measurement may have been taken inconsistently.

Comparative studies

Few metrical data are available for comparison, although comparative analyses are important if data from Grimsby are to be used for reference in studies of sex or age differences among Ontario samples. Recent analyses of other samples have not dealt with post-cranial measurement. Some earlier studies (e.g. Anderson 1963; Stothers 1971) presented insufficient information, but Jerkic (1975) and Webb (1969) provide full metrical data for Maurice and Garland respectively. For Kleinburg, only data for femora and humeri are available (Pfeiffer 1979b, 1980). The Kleinburg humeri used are from adults older than about 25 years, whereas all adult femora are used. The Kleinburg humerus data (Pfeiffer 1980) are presented with younger and older adults separated: the young adult sample is small and a bias in favour of females cannot be excluded. The following discussion assumes a 1:1 adult sex ratio.

The Jesuits (Thwaites 1898, 21:199) maintained that the Neutral were taller and more robust than the Huron. In fact, the Grimsby people do not appear to have been taller than the contemporaneous Huron buried at Maurice. The measurements of the Maurice humeri do not differ significantly from those at Grimsby, but Maurice femora are more robust in the sub-trochanteric diameters (*t* for unequal sample size = 5.894 on sagittal diameter, and 3.943 on transverse diameter). Data available on femora from two other Huron sites (Garland and Kleinburg) suggest that Huron were not only different in sub-trochanteric dimensions, but larger in mid-shaft diameters. The discussion is complicated by side differences, but in general Garland and Kleinburg femoral diameters are greater than Grimsby equivalents, except for the Kleinburg sub-trochanteric transverse diameter (an ill-defined measurement, possibly subject to inter-observer differences).

Garland measurements are generally the largest and there is a suggestion of change through time, especially in the humerus (see Table 1 for dates). Grimsby and Maurice humeri do not differ (and this seems to be true also of Shaver Hill humeri). Grimsby and Kleinburg humeri differ slightly, most especially at the maximum mid-shaft diameter (*t* = 5.963 when right side compared). Kleinburg and Garland differ significantly on all tests made (right side: maximum length, maximum mid-shaft diameter, maximum head diameter, epicondylar breadth). However, the summed *t* value across the same four humeral measurements for a Garland-Grimsby comparison is greater (19.315) than for a Kleinburg-Garland comparison (14.378, all tests significant). A Kleinburg-Grimsby comparison gives a summed *t* value of 11.312, with only one test of the four significant.

Conclusion

While it seems likely that the Neutral and Huron of the historic period did not differ in size, and while it is possible that robusticity decreased in the historic period, no categorical statements can be made without a full analysis of southern Ontario post-cranial material with full attention to error, as well as the effect of the age structure and sex ratio upon mean measurements.□

Table 4: Measurements of All Adult Humeri

	mean	δ	n
Maximum length	311.175	17.629	97
Physiological length	309.169	16.960	89
Maximum shaft diameter	20.841	3.016	107
Minimum shaft diameter	16.093	3.310	107
Maximum head diameter	41.855	3.265	131
Minimum head diameter	38.917	4.096	84
Epicondylar breadth	57.534	4.811	146
Distal articular breadth	40.748	4.628	143

Table 5: Tests of Side Differences in the Humerus

	n	mean	δ	*t*	P
Maximum length					
Right	56	312.3	16.611	0.71	0.478
Left	41	309.7	19.041		
Physiological length					
Right	50	310.4	15.696	0.79	0.434
Left	39	307.6	18.540		
Maximum shaft diameter					
Right	57	20.6	2.112	-0.93	0.357*
Left	50	21.1	3.796		
Minimum shaft diameter					
Right	57	16.0	2.228	-0.19	0.852*
Left	50	16.2	4.244		
Maximum head diameter					
Right	72	41.6	2.980	-0.64	0.405
Left	59	42.1	3.592		
Minimum head diameter					
Right	52	38.6	4.641	-1.07	0.288*
Left	32	39.5	2.994		
Epicondylar breadth					
Right	75	57.6	5.176	0.10	0.920
Left	71	57.5	4.430		
Distal articular surface breadth					
Right	77	41.0	5.447	0.76	0.447*
Left	66	40.4	3.451		

* separate variance estimate used

Table 6: Tests of Sex Differences in the Humerus

	n	mean	δ	*t*	P
Maximum length					
Male	44	322.3	14.077	7.76	0.000
Female	41	298.6	14.028		
Physiological length					
Male	44	318.5	13.744	6.89	0.000
Female	34	298.6	14.039		
Maximum shaft diameter					
Male	34	21.9	4.587	1.83	0.073*
Female	38	20.3	2.026		
Minimum shaft diameter					
Male	34	17.9	4.868	3.11	0.003*
Female	38	15.1	1.711		
Maximum head diameter					
Male	49	44.2	2.868	8.53	0.000
Female	47	39.6	2.394		
Minimum head diameter					
Male	35	41.3	2.774	4.53	0.000*
Female	27	36.4	5.078		
Epicondylar breadth					
Male	59	60.1	3.710	6.87	0.000
Female	44	54.5	4.547		
Distal articular surface breadth					
Male	53	42.6	3.564	3.02	0.004*
Female	42	39.3	6.379		

* separate variance estimate used

Table 7: Measurements of All Adult Femora

	mean	δ	n	F[a]
Maximum length				
All	438.54	27.78	116	
Right	438.98	28.14	56	.027
Left	438.13	27.68	60	
Physiological length				
All	432.36	28.40	105	
Right	430.71	28.52	55	.389
Left	434.18	28.46	50	
Proximal anterior/posterior diameter				
All	23.23	2.27	307	
Right	23.12	2.32	152	.702
Left	23.34	2.22	155	
Proximal transverse diameter				
All	30.80	2.83	306	
Right	30.98	2.90	151	.798
Left	30.69	2.77	155	
Anterior/posterior midshaft diameter				
All	25.68	2.40	19	
Right	25.00	2.14	11	2.263
Left	26.62	2.56	8	
Transverse midshaft diameter				
All	23.95	2.01	19	
Right	23.18	1.66	11	4.516[c]
Left	25.00	2.07	8	
Maximum head diameter				
All	44.14	3.18	105	
Right	43.80	2.92	54	1.321
Left	44.51	3.43	51	
Anterior-Posterior mid-neck diameter				
All	29.00	3.03	73	
Right	29.12	3.28	43	1.454
Left	28.86	2.72	29	
Platymeric index[b]				
All	75.40			
Right	74.60			
Left	76.00			

[a] figures refer to comparison of right and left
[b] index calculated from means for the subtrochanteric shaft diameter
[c] F and *t* are both significant at the .05 level

Table 8: The Angle of Anteversion

	mean	δ	n	range
Total	27.2	11.26	18	5 - 46
Right	30.8	12.90	9	5 - 46
Left	23.5	8.50	9	7 - 34

Table 9: Tests of Sex Differences in the Femur

	n	mean	δ	*t*	P
Maximum length					
Male	43	458.5	18.191	8.57	0.000
Female	44	420.8	22.551		
Physiological length					
Male	40	452.1	20.280	7.92	0.000
Female	44	415.1	22.299		
Proximal anterior/posterior diameter					
Male	93	24.6	2.000	7.37	0.000
Female	93	22.5	1.981		
Proximal transverse diameter					
Male	93	32.2	2.730	5.75	0.000*
Female	93	30.1	2.191		
Anterior/posterior midshaft diameter					
Male	4	27.5	2.380	1.83	0.094
Female	9	25.1	2.088		
Transverse midshaft diameter					
Male	4	24.5	2.887	0.14	0.893
Female	9	24.3	1.581		
Maximum head diameter					
Male	39	46.1	2.968	6.89	0.000
Female	39	42.2	1.918		
Platymeric index					
Male	93	76.9	6.939	1.97	0.051
Female	93	74.9	6.621		

* separate variance estimates used.

Table 10: Femoral Side Differences

	mean	δ	n	F	P
Maximum length					
Right	439.0	28.141	56027	.870	
Left	438.1	27.677	60		
Physiological length					
Right	430.7	28.517	55389	.543	
Left	434.2	28.465	50		
Proximal anterior/posterior diameter					
Right	23.1	2.317	152707	.403	
Left	23.3	2.220	155		
Proximal transverse diameter					
Right	31.0	2.904	151798	.372	
Left	30.7	2.772	155		
Anterior/posterior midshaft diameter					
Right	25.0	2.145	21263	.151	
Left	26.6	2.560	8		
Transverse midshaft diameter					
Right	23.2	1.662	41516	.048	
Left	25.0	2.070	8		
Maximum head diameter					
Right	43.8	2.923	54321	.253	
Left	44.5	3.432	51		

Table 11: Platymeric Index by Sex and Side

	mean	δ	n	*t*
Males				
Right	76.4	7.268	45623	
Left	77.3	6.659	48	
Females				
Right	73.5	5.870	48151	
Left	76.4	7.107	45	

Table 12: Distribution of the Platymeric Index in Fe 62

Index	n
60-64.9	1
65-69.9	26
60-74.9	32
75-79.9	49
80-84.9	18
85-89.9	12
90-94.9	5

Table 13: Comparison of Stature Estimates Derived from Various Formulae

		Femur	Tibia
Genovés (1967)			
	Male	170.0	170.0
	Female	158.7	156.7
Trotter & Gleser (1958)			
	Male	171.1	174.5
	Female	163.0	163.1
Neumann & Waldman (1967)			
	Male	169.7	169.7
	Female	159.7	156.6

Table 14: Stature Range

Males			
maximum	173.5 cm	5'7"	(Fe 62/14)
minimum	162.6 cm	5'3"	(Fe 26/9)
mean	169.7 cm	5'6"	
Females			
maximum	166.5 cm	5'5"	(Fe 62/21)
minimum	155.8 cm	5'1"	(Fe 1/43)
mean	159.7 cm	5'2"	

Table 15: Measurement of All Adult Tibiae

	mean	δ	n
Maximum length	364.555	27.249	128
Condylar breadth	71.308	4.837	13
Transverse cnemic diameter	21.513	2.430	273
Sagittal cnemic diameter	33.206	3.930	272
Transverse shaft diameter	19.357	1.705	84
Sagittal shaft diameter	28.590	3.415	83
Platycnemic index	65.060	5.853	272

Table 16: Sex Differences in the Tibia

	mean	δ	n	*t**
Maximum length				
Males	389.4	13.754	60	20.20
Females	341.5	12.816	66	
Condylar breadth				
Males	74.8	3.899	5	
Females	66.0	2.449	4	
Transverse cnemic diameter				
Males	23.3	1.818	54	10.08
Females	20.1	1.600	62	
Sagittal cnemic diameter				
Males	36.9	2.706	54	5.78
Females	30.8	2.562	62	
Platycnemic Index				
Males	63.3	5.191	54	3.08
Females	65.6	5.722	62	
Transverse shaft diameter				
Males	20.7	1.320	18	5.68
Females	18.4	1.338	27	
Sagittal shaft diameter				
Males	31.0	2.904	17	4.30
Females	27.6	2.309	27	

*all results significant.

Table 17: Acetabular Measurements

	Males		Females	
	Width	Depth	Width	Depth
Mean	48.50	18.13	47.04	15.50
δ	3.20	2.58	2.06	2.47
n	39	39	22	23
Range	43-57	12-23	43-51	11-22

Table 18: Width/Depth Ratio for the Acetabulum

Width/depth ratio	frequency	% males
2.0-2.4	5	80.0
2.5-2.9	31	74.0
3.0-3.4	16	37.5
3.5-3.9	1	0.0
4.0-4.4	2	50.0
Total	55	

Table 20: Indices of Thoracic and Lumbar Vertebrae

Vertebra	Males	Females	All
T.1	102.3	109.0	104.4
T.2	101.5	101.4	101.1
T.3	102.0	105.2	102.3
T.4	108.3	103.4	105.3
T.5	109.1	110.0	110.5
T.6	108.4	107.8	107.8
T.7	105.2	112.7	107.6
T.8	105.0	105.4	104.7
T.9	102.3	101.9	102.5
T.10	104.0	108.4	105.3
T.11	114.2	115.4	114.8
T.12	113.3	110.8	112.4
L.1	111.7	110.7	111.6
L.2	108.9	105.8	107.4
L.3	105.8	102.8	105.0
L.4	98.0	95.6	97.0
L.5	87.1	83.9	85.7

Table 19: Measurements of Post-cranial Elements

Bone	Measurement	mean	δ	n
Radius				
	Maximum length	239.3	17.185	62
	Physiological length	228.6	16.230	126
	Head diameter	20.5	1.189	27
	Distal breadth	29.3	2.636	69
Ulna				
	Maximum length	264.4	16.198	60
	Olecranon height	30.5	3.513	178
	Olecranon breadth	24.4	2.681	114
Scapula				
	Glenoid fossa length	35.0	3.20	23
	Glenoid fossa breadth	25.3	1.45	17
Clavicle				
	Shaft diameter	10.9	1.39	44
Sacrum				
	Alar width	115.6	7.93	26
	Centrum width	49.9	4.22	28
Patella				
	Length	38.8	4.065	29
	Breadth	40.0	5.143	23
	Thickness	17.9	2.168	63
Talus				
	Maximum length	49.3	3.69	52
	Maximum breadth	42.6	4.06	17
Calcaneus				
	Maximum length	70.9	5.65	32
	Maximum breadth	39.4	2.40	15
	Minimum breadth	27.4	3.49	22

CHAPTER 3

JUVENILE POST-CRANIAL METRICAL DATA

Methods

Juvenile material was abundant in the Grimsby cemetery and juvenile bones were measured whenever possible: (a) to check for mixing; (b) to control for errors and for unusual eruption patterns; (c) to check the age of some individuals whose skulls were stolen or vandalized, or whose skulls were not associated with their post-cranials; (d) because the loss of all information on such a good sample of juveniles would have been unfortunate, data for growth curves and proportional bone lengths were collected.

Diaphyseal lengths of clavicles, humeri, radii, ulnae, femora, tibiae, fibulae and calcanei were taken, as well as measurements of the scapula, ilium, ischium, pubis and basi-occipital lengths. These latter measurements proved to be less useful than those of the long bones because sample sizes are too small and, with reference to basi-occipital length, the measurement seems to be less correlated with age than might be expected. It should be noted that the length of the ilium is used (not the maximum breadth as used by Merchant and Ubelaker 1977), and that the scapula measurements may not have made in a totally consistent manner.

Examples of three of the possibilities mentioned above (mixing, unusual eruptions patterns and missing skulls) were encountered in the four cases discussed below.

Fe 9/29 consisted of the two halves of a maxilla, uncoded but judged to be six years of age based on the Schour and Massler chart. An associated vertebral column indicates an age of between four and six years. The lengths of the associated long bones suggest they are unlikely to be more than two

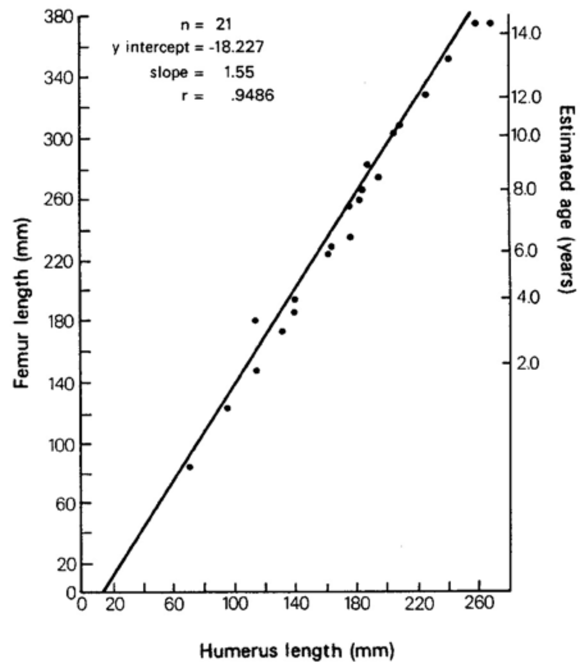


Figure 8: Plot of femur and humerus diaphyseal lengths

years of age; a clear case of mixing.

A more complicated case arose with Fe 62/103 and Fe 62/104. In both only mandibular dentition was recovered. In both there was an intact right deciduous second molar in place. Fe 62/104 still had the roots of the right deciduous first molar in place and the M_2 was unerupted. Fe 62/104 should therefore have been around nine years of age. In Fe 62/103 the RM_2 was erupting which would indicate an age of around 12 years, though the dm_2 indicated an age of 10 years.

These two individuals were buried so close together that the excavators attributed the radius and ulna of Fe 62/103 to Fe 62/104 and the ilium of Fe 62/104 to Fe 62/103. It seems likely that the two shared some anomaly. In each case the long bones are far too long for the assumed dental age. Fe 62/104 is aged at 11 to 12 years and Fe 62/103 at 13 to 14 years old on long bone measurements. One can only split the difference between dental and bone ages.

The skull of Fe 62/30 was missing, but from the long bone lengths he can be assumed to have been around eight years old. Without some indication of dental age, Fe 62/30 cannot be used to construct growth curves (see Fig. 14).

In Figs. 8 to 13 diaphyseal lengths of long bones are shown in bivariate plots together with dental age estimates and the regression line for the distribution (Fig. 8, femur and humerus; Fig. 9, femur and ilium; Fig. 10, femur and tibia; Fig. 11, humerus and clavicle; Fig. 12, radius and ulna; Fig. 13, humerus and ulna). Reference to these will allow future workers in Neutral osteology, and perhaps in Huron osteology, to predict whether long bones come from the same individual.

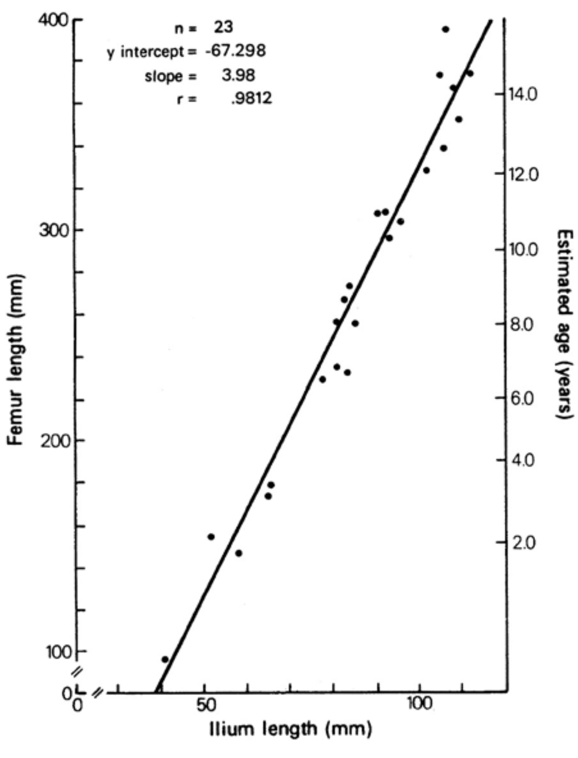


Figure 9: Ilium and femoral diaphyseal length

Growth curves

Fig. 14 shows growth curves for Grimsby based on a limited number of individuals (Table 21); this gives more consistency to the curves than might arise from larger samples. Nevertheless, the curves are comparable to the Schour and Massler curves published by Ubelaker (1977, 1978). They all show the growth spurt from five to seven years, the expected pre-adolescent plateau (see e.g. Anderson, Green and Messner 1978) and an adolescent growth spurt. Comparison with Ubelaker's curves (Fig. 15) for the Mobridge site (39WW1, Arikara of South Dakota, AD 1675-1700 see Ubelaker 1978; Merchant and Ubelaker 1977; Jantz and Owsley 1984) based on the Schour and Massler chart, indicate slightly slower growth rates for the Grimsby population. Ethnohistorical records indicate that the Grimsby population may have suffered prolonged famine and disease, and slower growth rates could therefore be expected. Nevertheless, evidence from the Ball Site (Melbye 1983), to be discussed below, indicates that Grimsby growth rates were no different from those of precontact Ontario Iroquois.

Fig. 16 plots the femoral diaphyseal lengths against estimated age for 29 Grimsby juveniles. The regression for an analysis of this distribution is usually best expressed in curvilinear rather than linear form. In general, growth data of this sort involve allometry and an equation of the Y = aXb type. The allometric equation is computed as log Y = log a + b log X, where b, the slope, is the "growth coefficient". This equation gives a better fit of the line to the data than an equation in which only length is transformed into logarithmic form. The best fit is given when the regression of age on diaphyseal length (Y on X) is plotted. In actual fact, of course, length is dependent on age, but in this case age is not "error free" and we want to use length as a predictor of age. From the analysis of variance for the lineal regression it is clear that both S and Se are lower when Y = age (Table 22).

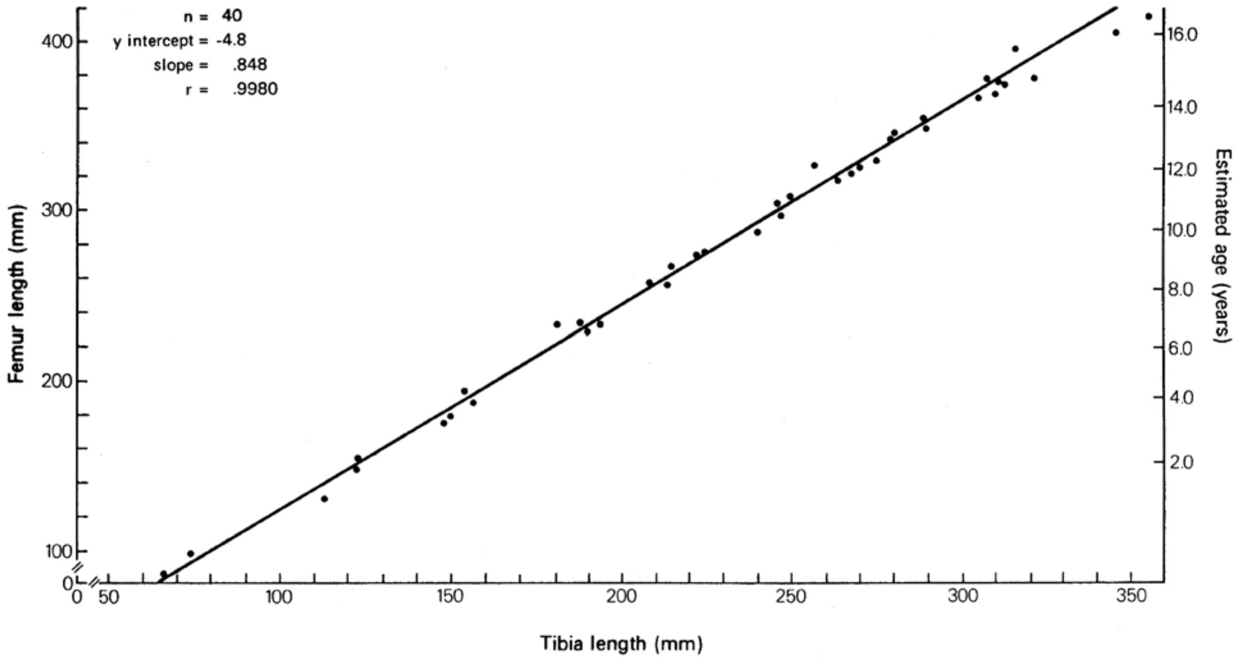


Figure 10: Femoral and tibial diaphyseal lengths

Fig. 16 demonstrates that from age 12 the fit of the line is not good. Growth levels off, and there is more variability, doubtless because of the increasing differentiation of males and females in terms of timing of growth spurts, ultimate length and timing of the cessation of diaphyseal growth. A further factor is that it is much more difficult to give accurate dental ages to adolescents than to younger children. It is perhaps for these reasons that the best fit is provided by a straight line.

Diaphyseal lengths and age prediction

Can osteologists analyzing disarticulated Huron and Neutral remains use the Grimsby data as a "standard" for the derivation of accurate estimates of the age of juvenile long bones?

Even for well-studied Caucasian populations, osteologists would encounter problems in using a "standard" because of nutritional and other differences. There is, for example, disagreement on the age at which bone growth ceases. Estimates for the lower limb range from 14 for girls and 16 for boys (Danish, and with a standard deviation of 1 year) to 18 or 19 for boys and 16 for girls (American, 1942; see Nordentoft 1964:215). Furthermore, the Schour and Massler chart does not provide exact ages. Despite these reservations, the high correlations listed in Table 23 suggest that predictions of relative dental age from long bone lengths can be made using the data provided here.

Since the Grimsby analysis was undertaken, other studies have been published allowing the prediction of dental age from diaphyseal long bone lengths (Merchant and Ubelaker 1977: Jantz and Owsley 1984). The Merchant and Ubelaker (1977) data with dental age assessed from tooth formation standards (Moorees *et al.* 1963) can be expected to differ from that presented here. Based on the regression of femur on age, for example, an Arikara femur 190 mm. in length would be given an age of just under 3.5 years. The comparable Grimsby femur would have a predicted

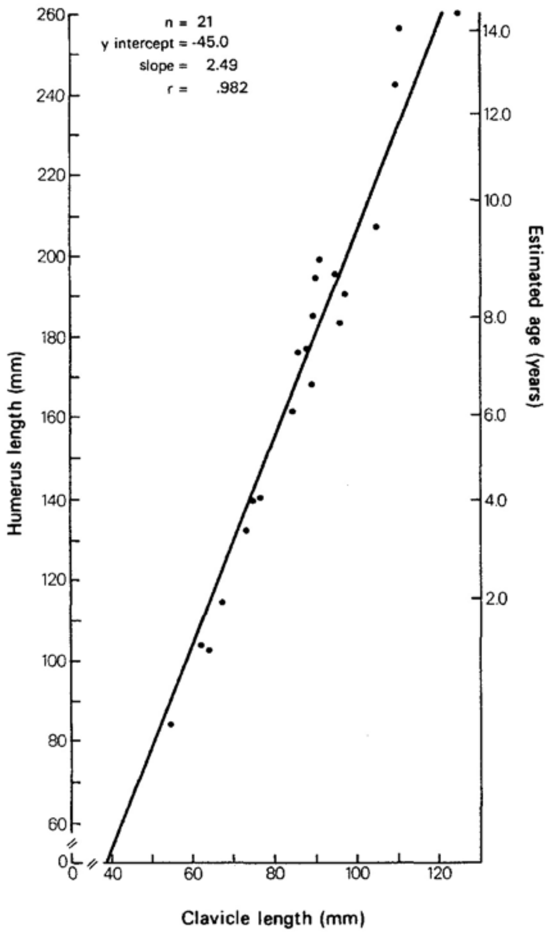


Figure 11: Humerus and clavicle lengths

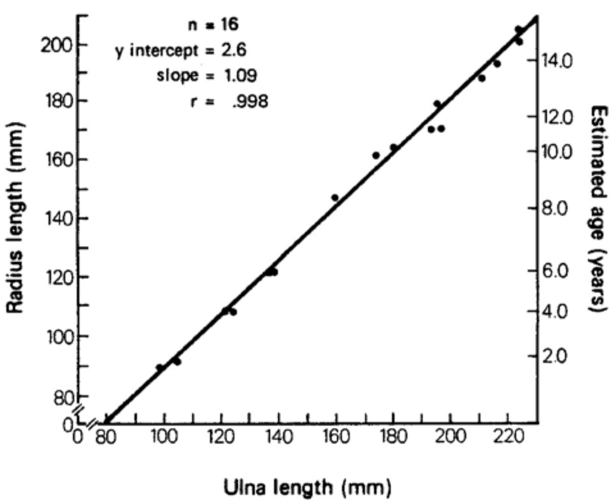


Figure 12: Ulna and radius diaphyseal lengths

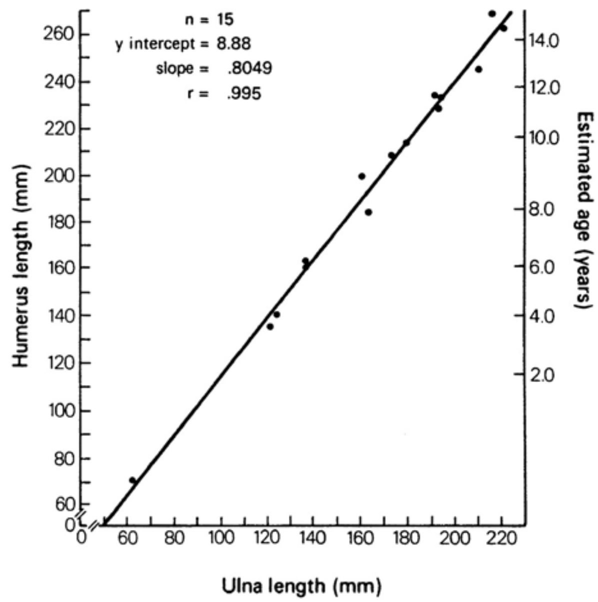


Figure 13: Humerus and ulna lengths

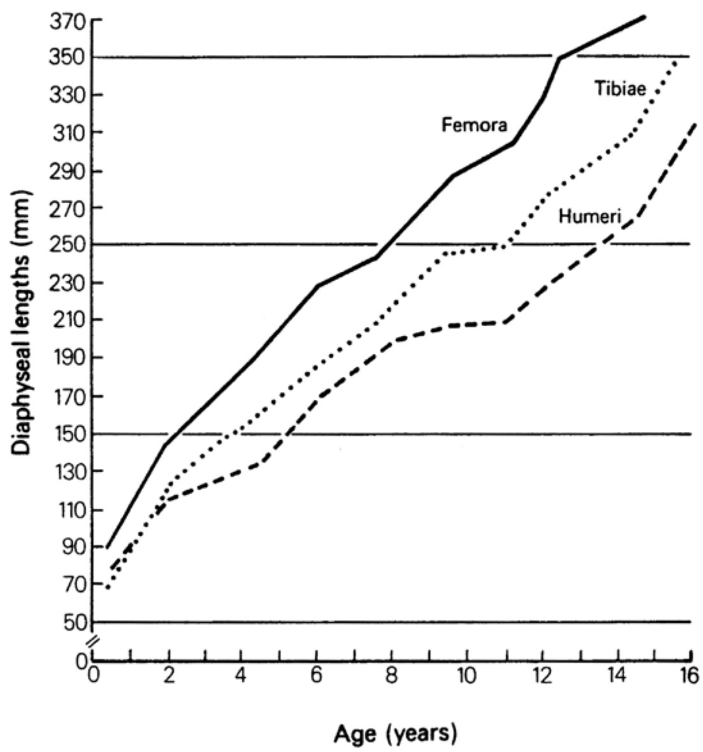


Figure 14: Growth curves for major long bones

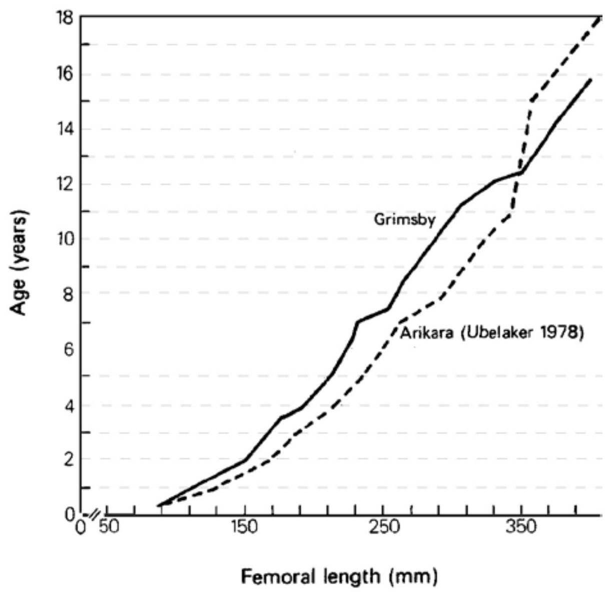


Figure 15: Comparison of Neutral and Arikara femoral growth curves

age of just over 4 (the Grimsby/ Mobridge differences reducing into adolescence). The differences in age assessment based on the humerus would be slightly greater (11 months, rather than 8.5 months), and the differences would not be reduced into adolescence. The differences between the Arikara and the Neutral at Grimsby are not, however, solely based on different techniques of age assessment (see Fig. 15).

One study (Melbye 1983) that uses methods comparable to those employed at Grimsby, allows a test of the propositions that the Neutral can serve as standards for the Huron, and that Grimsby long bone growth was not so disrupted by famine and disease to invalidate the use of this data to predict ages when studying other Ontario samples.

Melbye published information on several subadult skeletons from the Ball Site village dated around AD 1600. He used Schour and Massler age estimates adjusted to accord better with the Arikara age estimates derived from Moorees *et al*. (1963). Burial 1 (8 - 9 years, Schour and Massler) has humerus/femur proportions falling precisely in line with those established for Grimsby. The individual would have been close in age to Fe 62/101 and Fe 9/M. The femur/tibia proportions are also perfectly concordant with those for Grimsby. An age between Fe 62/30 and Fe 62/101 is confirmed. The estimated clavicle length for Ball Burial 1 may be slightly high, but the proportions are very close to those of Fe 62/101 and Fe 9/M. Fe 62/101 was given a dental age of 8.5 years (see Table 24).

Based on Ubelaker's ages determined by the Moorees *et al*. (1963) technique, Ball 1 would have an age of 7 years 9.5 months on the femur, and 7 years 5.5 months on the humerus. The Grimsby regressions would predict higher ages, 8 years 4.5 months on both the humerus and femur. Had the estimates for both sites been based on Schour and Massler techniques, the age discrepancies would have been greater (Fig. 15).

Ball Burial 3 falls within the 95% confidence limits for the humerus/clavicle regression line, and is almost exactly congruent with Fe 18/6 for femur/tibia proportions and humerus/femur proportions. Melbye hesitated over age assignment for this individual because of possible growth retardation and eruption anomalies: the upper second molars were erupting simultaneously with the second premolars (Melbye 1983:19). Similarly, the canines and premolars of Grimsby Fe 18/6 were slightly delayed in eruption, judging from the degree of root development of the lower second molar. The concordance between Ball Burial 3 and Grimsby Fe 18/6, coupled with the indications from Fe 62/103 and 104 (mentioned above), suggests that there was no growth disturbance in Ball Burial 3, despite tuberculosis of the spine, and that delayed eruption of the second premolars may not be unusual among Ontario Iroquois. On bone lengths, Ball Burial 3 would be aged at 11.5 years by Grimsby standards, confirming Melbye's estimates.

On the humerus/ulna and humerus/femur proportions established for Grimsby, Ball Burial 6 would be aged at 7 months, slightly below the Schour and Massler age of 9 months, but within the error range.

On this evidence, the data from the Grimsby juvenile long bones may be used with some confidence by osteologists studying disarticulated Ontario skeletal material. The Arikara data are less suitable because growth rates in Ontario were probably slower. Coupled with this is the possibility that arm/leg proportions differed slightly between the Arikara and the Neutral during growth.□

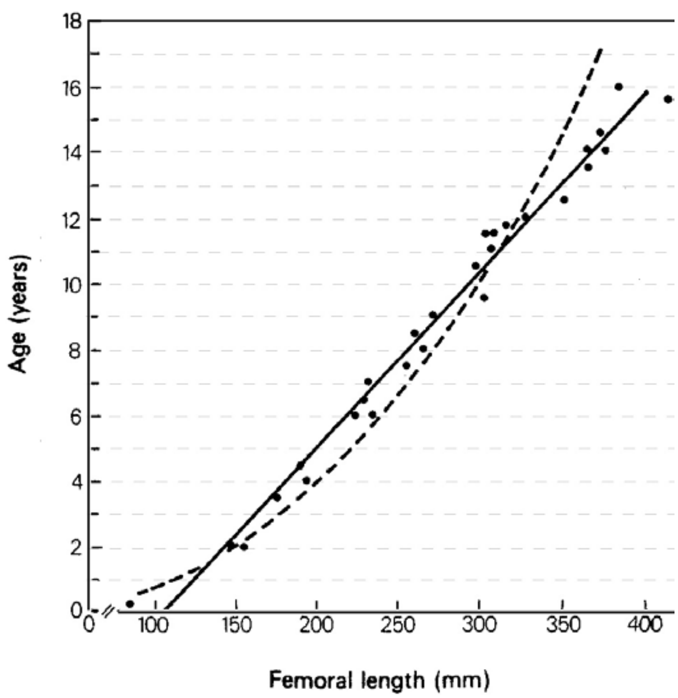


Figure 16: Comparison of fit of regression line and log.log curve

Table 21: Individuals Providing Data for Growth Curves

Age	Humerus	Femur	Tibia
15			
	18/1:56/2	18/2:18/1	18/2:18/1
		56/2:62/17	56/2:62/17
14			
13			
	62/H	62/H	62/H
12	18/6	18/6	18/6
		58/1:62/6	
11	9/33:1/51	1/51	1/51
		56/3	
10			
	62/S	62/S	62/S
9		62/101	
8	9/3		
	26/8	62/E	62/E
7		1/34	
6	18/3:30/6	18/3:30/6	18/3:30/6
5			
4	62/40	62/40	62/40
	62/5	62/5	62/5
3			
2	62/107	62/107	62/107
1	18/5:62/43		
	18/7:26/10	18/7	18/7
0			

Table 22: Analysis of Variance of Linear Regression, Age and Femur Length

A. Length = X, age = Y.

Source of Variation		Sum of Squares	DF	Mean Square
Total		550.384	28	19.657
Explained		540.503	1	540.503
Residual		9.880	27	.366
	R^2	.982	(i.e. 98% of the variance	
	r	.991	(correlation coefficient)	
	S	.605	(standard error of the estimate)	
	Se_b	.001	(standard error of the regression	

B. Age = X, length = Y.

Source of Variation		Sum of Squares	DF	Mean Square
Total		192384.964	28	6870.892
Explained		188931.470	1	188931.470
Residual		3454.495	27	127.907
	R^2	.982		
	r	.991		
	S	11.309		
	Se_b	.482		

* With non-linear regression only 94.8% of the variance is explained.

Table 23: Grimsby Juvenile Post-cranial Correlation Coefficients

A. Correlations of bone length with age

ilium	.069
femur	.974
tibia	.992
humerus	.988
basiocciput	.743

B. Correlations between bone lengths

femur and ilium	.981
femur and tibia	.998
radius and ulna	.998
humerus and clavicle	.982
humerus and ulna	.995
femur and humerus	.949

Table 24: Epiphyseal Lengths of Bones of the More Complete Subadult Individuals

Individual		Age	Clav.	Hum.	Rad.	Ulna	Femur	Tibia	Fib.	Calc.	Scap.	Ilium	Isch.	Pubis
B.Occ.														
18/1	14.5	125	260	200	223	372	308	298	-	126	105	-	-	-
18/2	4.5	119	-	-	-	365	305	-	-	124	108	-	-	-
18/3	6.0	84	162	122	137	222	-	-	-	-	-	48	47	-
18/5	1.0	64	103	-	-	-	-	-	-	54	-	-	-	-
18/8	0.5	-	-	-	-	-	-	-	-	-	39	31	24	-
18/6	12.0	-	227	-	193	327	275	-	-	105	101	-	-	-
18/7	0.25	40	70	-	62	84	66	-	-	-	-	-	-	-
9/Al	[a]6.0	-	160	122	137	-	-	-	-	-	-	-	-	-
9/32	6.5	-	165	-	-	228	189	-	-	-	77	-	-	-
9/Y	[a]10.0	-	212	164	180	-	-	-	-	-	-	-	-	-
9/13	[b]11.0	-	232	170	193	-	-	-	-	-	-	-	-	-
9/Bundle E	[a]11.0	-	-	170	186	295	246	235	-	-	92	-	-	-
9/29	[b]2.5	-	-	89	99	153	123	117	30	43	50	-	-	-
9/Z	[a]13.0	-	-	192	215	342	280	-	-	-	-	-	-	-
1/34	6.5	-	-	-	-	231	180	-	45	-	82	-	-	-
1/51	11.0	-	210	-	-	307	249	-	53	-	90	-	-	-
30/6	6.25	86	176	-	-	234	187	-	-	-	80	-	-	-
56/2	14.5	-	272	209	-	372	311	300	-	-	111	-	-	-
62/E (+62/39b)	7.5	88	177	141	-	254	208	204	-	75	80	51	46	19
62/H	12.5	110	242	-	-	350	289	276	64	115	109	75	58	19
62/41	[a]3.5	76	140	-	-	187	156	-	-	-	-	-	-	-
62/5	3.5	73	132	-	-	174	148	-	-	-	63	41	33	-
62/45	8.5	-	-	-	-	258	-	-	-	86	-	-	-	-
62/70	[a]9.0	91	199	-	161	-	-	-	51	65	86	55	46	-
62/-	[a]12.0	-	232	178	195	-	246	-	-	-	88	-	-	-
62/17	14.5	-	-	-	-	376	321	312	-	-	-	-	-	-
62/101	8.5	90	195	-	-	271	224	-	-	-	83	-	50	-
62/30	[a]8.0	90	185	-	-	265	214	-	-	-	82	52	-	-
62/79	[a]12.5	-	-	179	-	338	279	-	-	-	105	-	-	-
62/103	[a]13.0	-	-	203	223	365	310	297	-	-	-	64	-	-
62/104	[a]11.0	-	-	-	-	316	263	254	-	-	91	55	-	-
62/J	[a]8.0	96	183	147	163	257	213	210	48	92	84	55	-	-
62/40	4.0	75	140	108	124	192	153	-	-	-	-	-	-	18
62/107	2.0	67	115	89	-	147	122	-	-	61	56	37	-	18
62/93	[a]9.5	-	-	-	-	287	239	-	-	-	92	59	49	-
62/S	9.5	105	207	161	174	302	245	-	-	102	95	-	-	-
62/Bundle 91a	[a]8.5	-	-	147	159	-	-	-	-	91	-	55	-	21
62/Bundle 91b	3.75	-	134	109	121	179	149	-	-	-	64	40	-	17
62/Bundle 91c	0.5	-	-	66	-	97	74	-	-	40	38	-	-	-
62/43	1.0	62	104	-	-	-	-	-	-	-	-	-	-	17

[a] No dentition, ages estimated from bone lengths. [b] Dental age indicates two individuals present.

CHAPTER 4

CRANIAL METRICAL DATA AND THE ANALYSIS OF THE SKULL OF FE 9/1

Method

All reasonably complete undistorted skulls were measured. Ideally skulls are measured several times after intervals and a mean measurement used: time constraints made this impossible. All skulls were, however, measured by one individual only, so inter-observer error does not enter into this study.

The measurements are those used for the University of Toronto, Skeletal Biology Data Bank and they follow the definitions of Howells (1973). I departed from Howell's definitions in one case, the zygomaxillare breadth: the lowest point, rather than the most anterior point, was used in the measurement. The means and standard deviations of the measurements are recorded in Table 25.

Sex differences

In Table 26 the results of F and *t*-tests between the sexes are given. Maximum and basion-nasion lengths, bizygomatic breadth, orbital and alveolar breadths, palatal breadth and length, biasterionic breadth, bijugal breadth, ectoconchion breadth, the frontal chord and arc, the parietal arc, minimum ramus breadth, ramus height, bigonial breadth and coronoid height are all significantly different between the sexes. Mandible length and basi-bregmatic height are marginally significant (see also Table 129).

Craniometric distance studies

A full craniometric study of material from a number of southern Ontario sites is now under way at McMaster University (S. Saunders and G. Heathcote, pers. comm.), and will include the Grimsby cranial data. Therefore, the data will not be discussed here because there is insufficient published comparative information now available.

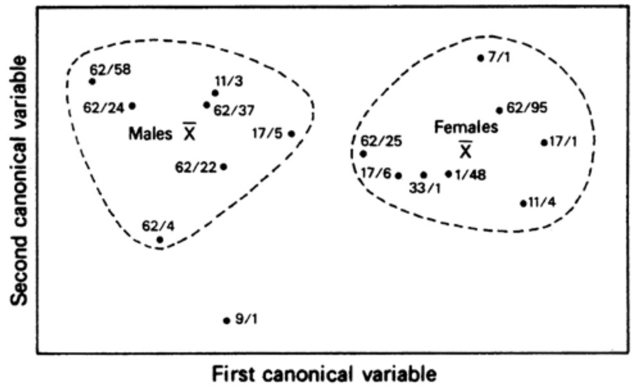


Figure 17: Fe 9/1 with Grimsby male and female clusters

Feature 9/1

Fe 9/1 was buried as a complete though not fully articulated individual, accompanied by sucking tubes. She was not entirely Neutral in her origins, for it was immediately apparent that her skull was not characteristically Indian. It seems likely that she was at least partly European.

Stepwise discriminant analysis (Dixon 1973; Dixon and Brown 1979) was used in an analysis of the skull, and 8 variables were chosen which (1) were assumed to be uncorrelated, which (2) gave a maximum number of cases with a minimum number needing replacement of missing data by group means, and which (3) could be used in comparison with some European data. The 8 variables were: glabello-occipital length, maximum cranial breadth, basion-bregma height, basion-nasion length, minimum frontal breadth, orbital height, nasal breadth and nasal length.

Sixteen Grimsby skulls were analyzed and the first result (using the BMDP 07M programme, Dixon 1973) confirmed that the skull of Fe 17/1 as well as that of Fe 9/1 was female. In this analysis, 9 females and 7 males were all confirmed as correctly classified with discrimination being based on basion-nasion length and

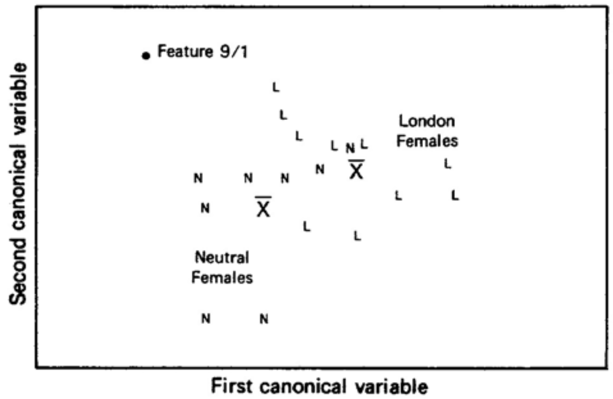


Figure 18: Fe 9/1 with Grimsby and London females

nasal breadth. Maximum cranial length was the third discriminating variable.

When Fe 9/1 was specified as belonging to a separate group there was confirmation of its difference, but the discrimination was still based on basion-nasion length and nasal breadth (Fig. 17).

Finally the Neutral females were tested against 11 females from the Farringdon Street 17th century sample (Hooke 1926), a group of Londoners presumably showing something of the same degree of Celtic/Norman mix as the northern French of the 17th century, though perhaps with more "anglo-saxon" features. The London and Neutral female clusters overlap and the discrimination, based on basion-nasion length and maximum cranial breadth, removes Fe 9/1 from both groups (using BMDP 7M programme, Dixon and Brown 1979) (Fig. 18).

Including the Neutral males does not clarify the problem: the discrimination comes to be based wholly on basion-nasion length and thus only one canonical variable is plotted.

From Fig. 18 it is clear that Fe 9/1 has a much greater basion-nasion length than the Londoners, but a cranial breadth which is closer to that of the Europeans than to the other Grimsby females.

Fe 9/1 appears to differ from the other Neutral people, but multivariate analysis did not pinpoint the nature of the differences. In order to clarify the differences, a method was devised whereby the male and female deviations from the overall means for each cranial and mandibular measurement are plotted. The female means are calculated with Fe 9/1 excluded. Fe 9/1 measurements are then compared with the mean values and this is shown in Fig. 19, where the hatched area indicates the male/female divergences from the overall mean (which is non-symmetrical because Fe 9/1 is included in the overall mean so as not to influence the outcome unduly). The single solid line represents Fe 9/1 and clearly shows that the shape of her skull differs markedly from that of other Grimsby Neutrals (series of indices simply serve to confirm this, see Table 27).

In comparison with other Grimsby females, Fe 9/1 has a short broad skull with a very broad forehead, high orbits, a broad maxilla and a long palate (Pl. 1). The mandible is correspondingly long but the mandibular ramus is very low, although the chin is deep. In spite of the broad skull, forehead and maxilla, the face is narrower across the orbits and cheekbones. The face is quite long. The frontal and especially the parietal bones are comparatively long, while the occiput is short.

Comparison of Fe 9/1 directly with all the possible measurements on the Farringdon Street skulls shows that, although the London female skulls are like Fe 9/1 in being long and broad, they are much lower than either Fe 9/1 or the Grimsby female mean. The basion-prosthion and basion-nasion measurements also have much lower values for the Londoners than for the Grimsby females including Fe 9/1. Other measurements show little divergence between London and Neutral females except for the arc and chord measurements over the skull length. It is precisely in these chord and arc measurements that Fe 9/1 differs so markedly from the other Neutral

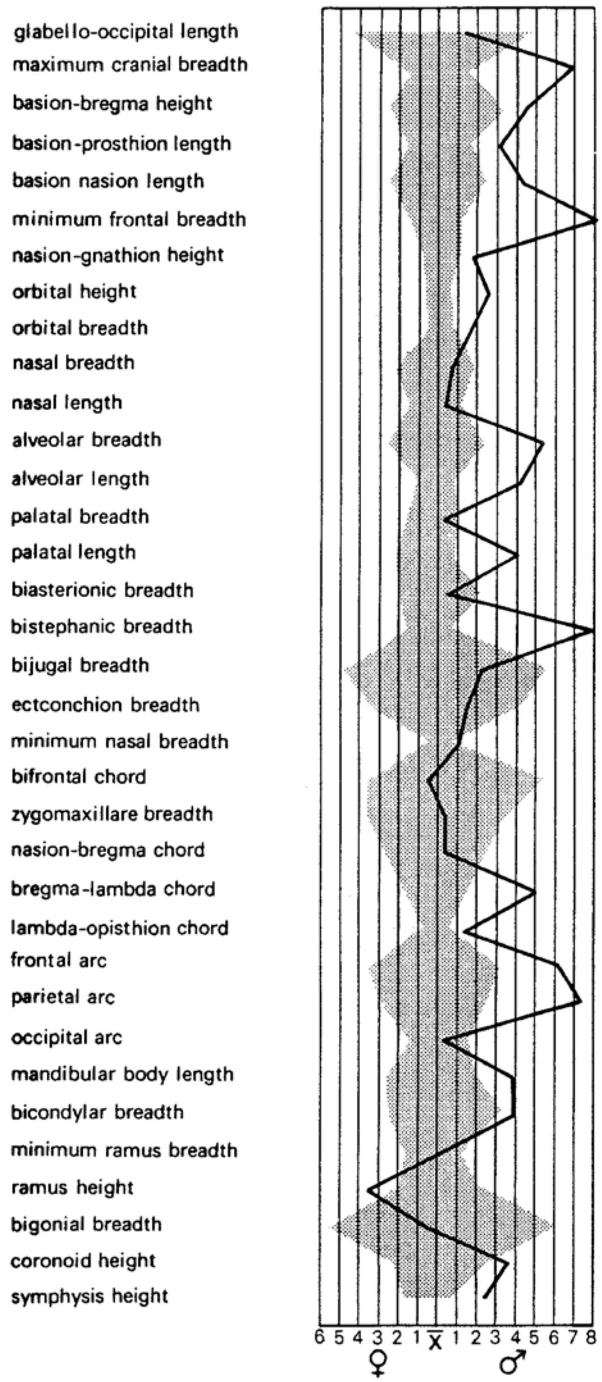


Figure 19: Deviation around the overall mean cranial measurements

females and it is in these measurements that the same pattern is seen in Fe 9/1 and in the Farringdon Street females.

Fe 9/1 was around 30 years of age when she died about 1640, and it would not be surprising if European genes entered the Neutral gene pool soon after 1610.

Ethnohistorical sources

Champlain, who was remembered for "his continence with regard to women" (Trigger 1976:328), spent the winter of 1615-16 in Huron country. He wrote of the Neutrals but did not visit them, discouraged by the Huron. However, his assistant Etienne Brûlé, who had been in Huronia as early as 1610, passed through Neutral territory; whether by canoe along the shores of Lake Ontario (Anon. 1913:8) or overland (Trigger 1976:306) has been a matter for discussion.

From all accounts the Huron permitted and even encouraged free sexual relations, long or short term, between the French traders and Huron women (Trudel 1973:155; Trigger 1976:367-369), although this practice displeased the missionaries. Something like 16 laymen were in Huronia in 1615, and 5 or 6 may have returned before 1623 when they were joined by 11 others.

The Huron journeyed into Neutral country every spring and autumn on trading expeditions (Trigger 1976:355) and many of the French who lived with the Huron accompanied them (Thwaites 1898 21:203). The Hurons, however, discouraged the French from wintering among the Neutrals: they took firm action to stop the winter plans of even the Recollet Father Daillon, for the Huron did not wish to lose their monopoly of the French trade. Nevertheless, there *were* Frenchmen in Neutral territory from the early years and of course the Huron had constant contact with the French as well as with the Neutral people. Some Huron and probably some Neutral Indians must have had French fathers from 1610 on. The statement that Fe 9/1 was partly European need come as no surprise whether she was a Neutral or a Huron refugee. The interest lies in her special burial, which is indicative of respected status.

Hers was not a burial 'in flesh' since the excavators noted that her arms were not correctly articulated. Furthermore, her hands were absent. This is not the only instance of a lack of hands, for the excavators (K. Mills, personal communication, 1979) noted that individuals in Features 12, 38, 39 (2 people) and 42 also had no hands and that one individual had no feet. This latter individual was in Feature 55, which was unusual in having one skeleton and an extra skull. All of these individuals were females except Feature 12.

Feature 12 must have been disturbed by vandals: there were fresh shovel marks on the skull which had been broken up. All the bones (except an extra left femur) were thought to belong to the same individual, a young adult male with a worn but complete dentition and an infected right tibia. All observable characteristics were male.

The Neutral custom of keeping bodies around the village until final burial (Thwaites 1898 21:199), might have led to the loss of hands and feet. A second explanation, because of the predominance of females, is brought to mind by the French assertion that the Neutral tortured female as well as male prisoners of war (Thwaites 1898 21:195), the only nation to do so. It seems unlikely that Fe 9/1 was a prisoner of war: it seems likely that prisoners of war would at best be given primary, unceremonious burials, even if they had shown marked bravery. Probably detailed analysis of all the bones in all the features would have shown many individuals lacking at least some bones of hands and feet.□

Table 25: Skull and Mandible Measurements for all Measurable Skulls

	mean	δ	n
glabello-occipital length	179.8	7.73	30
maximum cranial breadth	134.8	7.67	28
basion-bregma height	135.2	7.05	29
basion-prosthion length	101.5	4.27	18
basion-nasion length	105.2	5.94	26
minimum frontal breadth	93.5	5.00	44
nasion-gnathion height	118.2	4.40	6
nasion-prosthion height	66.2	3.54	20
bizygomatic breadth	132.2	10.98	6
orbital height	34.0	2.09	20
orbital breadth	38.8	1.89	18
nasal breadth	25.1	4.51	21
nasal length	49.6	3.32	22
alveolar breadth	65.0	3.95	22
alveolar length	53.3	4.10	19
palatal breadth	40.8	2.94	24
palatal length	46.5	2.82	26
biasterionic breadth	108.6	5.41	33
biastephanic breadth	107.6	6.24	23
bijugal breadth	113.4	6.29	12
ectoconchion breadth	97.2	5.36	13
minimum nasal breadth	8.8	1.69	22
bifrontal chord	99.1	6.58	14
zygomillare breadth	99.5	6.65	13
nasion-bregma chord	110.5	5.08	52
bregma-lambda chord	108.5	6.00	51
lambda-opisthion chord	95.9	5.84	43
frontal arc	123.4	6.89	51
parietal arc	120.1	7.59	52
occipital arc	113.9	7.66	41
mandibular body length	103.9	4.33	23
bicondylar breadth	130.7	5.16	11
minimum ramus breadth	33.7	3.33	97
ramus height	55.4	6.91	75
bigonial breadth	100.3	9.04	24
coronoid height	60.1	5.21	77
symphysis height	34.6	3.62	49

Table 26: Results of Tests of Metrical Differences Between Male and Female Skulls and Mandibles

variable	n	mean	δ	*t*	P
Glabello-occipital length					
Male	14	184.8	6.647	4.21	0.000
Female	16	175.2	5.833		
Maximum cranial breadth					
Male	9	136.4	6.747	1.00	0.324
Female	20	133.3	8.202		
Basion-bregma height					
Male	12	138.5	6.961	2.09	0.047
Female	16	133.3	6.298		
Basion-prosthion length					
Male	10	103.3	4.244	2.05	0.054
Female	12	100.1	3.118		
Basion-nasion length					
Male	14	107.8	4.441	2.31	0.028
Female	16	103.4	5.680		
Minimum frontal breadth					
Male	22	94.6	5.067	1.64	0.108
Female	23	92.3	4.634		
Nasion-gnathion height					
Male	4	119.2	4.113	-0.18	0.861
Female	1	120.0	0.000		
Nasion-prosthion height					
Male	9	67.1	4.256	0.95	0.354
Female	11	65.5	3.110		
Bizygomatic breadth					
Male	2	143.5	2.121	3.22	0.032
Female	4	122.8	8.500		
Orbital height					
Male	8	34.6	2.560	1.30	0.210
Female	12	33.4	1.621		
Orbital breadth					
Male	7	39.6	1.272	2.64	0.018
Female	11	37.5	1.753		
Nasal breadth					
Male	10	27.1	2.132	2.19	0.051*
Female	10	22.9	5.666		
Nasal length					
Male	10	50.8	4.315	1.44	0.175*
Female	12	48.7	1.969		
Alveolar breadth					
Male	9	67.3	3.162	2.87	0.009
Female	13	63.0	3.674		
Alveolar length					
Male	7	54.1	3.934	-0.09	0.925
Female	11	54.2	4.423		
Palatal breadth					
Male	13	41.8	3.004	2.32	0.030
Female	11	39.1	2.587		
Palatal length					
Male	15	47.5	2.326	2.57	0.017
Female	10	44.5	3.472		
Biasterionic breadth					
Male	15	110.7	4.949	2.43	0.021
Female	19	106.3	5.488		
Bistephanic breadth					
Male	11	108.1	5.941	0.81	0.425
Female	13	105.9	6.946		

Bijugal breadth					
Male	5	118.8	4.266	3.96	0.003
Female	7	108.6	4.504		
Ectoconchion breadth					
Male	5	101.8	3.768	3.53	0.005
Female	8	93.2	4.496		
Minimum nasal breadth					
Male	11	8.8	1.722	-0.26	0.795
Female	12	9.0	1.595		
Bifrontal chord					
Male	5	104.8	4.712	3.73	0.003
Female	10	94.3	5.314		
Zygomaxillare breadth					
Male	6	103.0	8.367	1.86	0.092
Female	6	96.2	3.251		
Nasion-bregma chord					
Male	26	112.9	4.685	3.73	0.000
Female	26	108.2	4.391		
Bregma-lambda chord					
Male	22	109.8	4.827	1.56	0.126
Female	27	107.1	6.747		
Lambda-opisthion chord					
Male	19	96.3	5.945	0.31	0.757
Female	23	95.7	5.979		
Frontal arc					
Male	26	126.5	5.132	3.58	0.001
Female	25	120.2	7.137		
Parietal arc					
Male	24	122.6	5.838	2.45	0.018
Female	26	117.6	8.491		
Occipital arc					
Male	17	115.1	7.688	0.83	0.410
Female	23	113.0	7.865		
Mandibular body length					
Male	10	105.9	4.202	2.12	0.048
Female	10	102.1	3.814		
Bicondylar breadth					
Male	5	132.4	4.615	1.84	0.109
Female	4	123.0	10.360		
Minimum ramus breadth					
Male	40	34.9	3.292	4.04	0.000*
Female	27	32.2	2.190		
Ramus height					
Male	31	57.7	6.501	2.54	0.014
Female	25	53.4	6.042		
Bigonial breadth					
Male	9	106.9	9.426	3.64	0.002
Female	12	94.8	5.833		
Coronoid height					
Male	33	62.7	4.659	3.49	0.001
Female	22	58.2	4.710		
Symphysis height					
Male	22	35.4	4.426	1.98	0.056*
Female	16	33.2	2.613		

* separate variance estimate used

Table 27: Some Cranial Indices

	All	Males	Females	9/1
breadth x 100 / length	74.9	73.8	76.2	78.4
basi-bregmtic height x 100 / maximum length	75.2	74.9	75.6	77.3
minimum frontal breadth x 100 / maximum breadth	69.4	69.4	68.8	71.8
orbital height x 100 / orbital breadth	87.7	87.4	86.7	100.0
palate breadth x 100 / palate length	87.7	88.0	89.0	80.4

CHAPTER 5

NON-METRICAL CRANIAL TRAITS

Methods

Non-metrical observations were made on all reasonably complete skulls using Heathcote's (1975) method following Ossenberg (1969), which is particularly suited to rapid recording since it is based on the simple presence or absence of traits.

Clinoid bridging was not recorded because it appeared to be absent from the population and because it is difficult and time consuming to observe.

The data are recorded in two forms, by side and by skull. The data by skull were coded as: (1) bilaterally present, (2) present on the left side only, (3) present on the right side only, and (4) bilaterally absent. In addition, the coding by skull included the age groupings suggested by Korey (1980): (1) adolescent - second molars erupted, (2) young adult - basioccipital synchrondrosis fused, (3) old adult - internal suture fusion complete.

The presence of the post-condylar canal is the most common trait, followed by the presence of a complete supraorbital foramen (Table 28). These high incidences are normal for North American Indians.

Sex, side and age differences

Of the traits listed in Table 28, only the post-condylar canal gives a significant side difference. The parietal notch bone shows a sex difference on the left side and tympanic plate dehiscence is more common in females.

G adjusted values (the log likelihood ratio test, Sokal and Rohlf 1969) were used to analyse the sex and side differences (Table 29). Tympanic plate dehiscence is significantly associated with sex, but the male-female difference is most marked on the right side. The parietal notch bone is not significantly associated with sex or side. Nevertheless, in males there is a significant difference between right and left side incidence. The presence of the post-condylar canal is independent of sex, but there is a significant side difference which is restricted to females. For the female x side test neither G adjusted nor X^2 give significant results. But G calculated without the Yates Correction for small sample size has a probability of less than .05. The use of Yates Correction on this type of problem may give overly conservative results (Sokal and Rohlf 1969:590).

Only 12 traits of those listed by side in Table 28 have cell frequencies high enough to give confidence in the use of statistical tests. Six tests of the type presented in Table 29 have been made on each of these 12 traits. Of these 72 tests, only 7% give significant results and 4.2% of them relate to the tympanic plate.

Only the Foramen of Huschke presented clearly significant results and tympanic plate dehiscence is thus a sex dependent trait in this population. The available literature indicates that it is always more frequent in females than in males (Akabori 1933:178; Berry 1975:523; Fenner 1939:295; Larnach and MacIntosh 1966:40; 1970:32; Perizonius 1979), perhaps the only trait of which one can say this.

Berry (1975:524) and Perizonius (1979:683) have both shown that tympanic plate dehiscence is more common in older individuals. Thus, the side data for the Grimsby population were tested for age differences between young and old adults. The probability levels at 1 df for the G adjusted values (males = .692, females = .469) indicate a lack of significant difference between younger and older adults when simple presence or absence is considered. This lack of age dependency holds true even when adolescents are included. The Foramen of Huschke was also examined for its incidence in young and old adults on bilateral presence, unilateral presence and bilateral absence. The result (G = 3.54, P at 3 df = .17) indicates that the Grimsby data do not follow the trend towards higher frequencies in older age groups.

There are three possible explanations for this result which contradicts Berry's findings.

Firstly, Berry's incidences increase dramatically after 60 years of age and Perizonius' older age group is 60-100 years. Thus, it may be that the trait is related to osteoporotic conditions in extreme old age and the Grimsby people were dying from famine and disease too early to exhibit the trait.

Secondly, the trait may be related to nutritional and disease conditions which did not apply during the childhood of the older Grimsby individuals. Berry showed tympanic plate dehiscence to be more common amongst Londoners born before 1749 than those born between 1750 and 1769. The former period is represented by individuals of whom 71% were over 60 and the latter by individuals of whom 68% were over 60; comparable proportions. The complex demographic and social history of eighteenth century London would have to be considered in any attempt to explain this, including health and immigration patterns.

The third possible explanation is that a sexual imbalance in the Grimsby sample might obscure the pattern. The incidence of tympanic plate dehiscence is significantly different between young adult males and females (P = .05) but not in old adults (P =.4) using G adjusted. However, there is a highly significant lack of older adult females at Grimsby (P = .000).

Berry's London material, on the other hand, contained more than twice as many females over 60 years of age as males. The age dependency of tympanic plate dehiscence for the London sample may thus be related to the overrepresentation of females. Similarly, the lack of age dependency for Grimsby may be related to the underrepresentation of females in the old age category. Nevertheless, the Grimsby females do not show an increase in the frequency of tympanic plate dehiscence with age using G (P = .369).

The BMDP P3F programme (Multiway Frequency Tables - The Log-Linear Model, Dixon and Brown 1979) gives a clear indication that the model which best fits the data is one of interaction among sex and age and sex and tympanic dehiscence. Checking this by partitioning (Table 30) shows the importance of the sex breakdown of the sample and the lack of relationship between age and tympanic dehiscence.

I conclude that tympanic plate dehiscence is definitely sex dependent but most probably not age dependent once adulthood is reached. This lack of age dependence is clearly seen from Akabori's (1933) Japanese data but will be obscured whenever there is a higher proportion of females than males surviving to old age.

Korey (1980) has stated that the supraorbital foramen is age dependent on the basis of his study of Haida material. Using side data no significant difference can be demonstrated between young and old adults for either Grimsby or Korey's Haida (G and G adjusted). Korey argues that the incidence increases with age; not only overall but also bilaterally. Statistical tests do not confirm this for Grimsby. Comparisons of young adults and old adults, however made, reveal no significant differences in the pattern of frequency and distribution of supraorbital foramina (Table 31).

Table 31 is based on age comparisons of skulls with supraorbital foramina bilaterally present, unilaterally present and bilaterally absent (i.e. a series of 2 x 3 tables). It reveals that Haida adolescents and old adults differ significantly but that no other differences exist.

A further test on this would be a multiway G analysis on the Grimsby supraorbital data presented in Table 32.

Testing for bilateral presence-absence gives the clearest indication that age is of no importance (Table 33). We can then check Korey's assertion by testing bilateral vs unilateral presence. Again, the partitioning of the G statistic indicates that age does not determine the pattern of incidence of supraorbital foramina in the Grimsby crania (Table 34).

Tables 35 and 36 present the information on the age and sex breakdown of non-metrical trait frequencies recorded for complete skulls.

A number of G tests were done on these tables using all four categories (3 df), grouping the unilateral frequencies (2 df), or combining categories to give 2 x 2 tests (1 df). Significant results were limited to those shown in Table 37.

Tympanic dehiscence has already been discussed in some detail. The two traits which appear age dependent must be viewed with some hesitancy. Firstly, we must assume that with increasing age and external suture fusion, occipito-mastoid wormians become difficult or impossible to observe. Secondly, there is a slight tendency (but P at 1 df = .152 only) for females to have a higher incidence of trochlear spurring. Either the small number of older females in the population, or the statistical uncertainty of testing when there are zero cell frequencies, may well make us wary of accepting that trochlear spur frequencies decrease with age. Nor can we overlook the possibility of chance significance.

Distance studies

Tables 38 and 40 represent an attempt to place Grimsby in the context of some other Ontario skeletal populations by the use of the Mean Measure of Divergence, employing the Freeman-Tukey Transformation and Bartlett's Adjustment for all 0 and 1 incidences (see Sjøvold 1973:226).

The frequencies of 18 Grimsby cranial traits were first compared with those from four other southern Ontario sites (data from Molto 1979:337). This initial test showed a clear divergence of Grimsby from the other sites: most distant from Serpent Mounds, then from Fairty, and lastly from Tabor Hill and Kleinburg (Table 38). Revised data has become available (Molto 1980) for 16 traits (paracondylar process and pharyngeal fossa removed; Table 39). Table 40 presents the mean measure of divergence matrix for nine southern Ontario sites including Grimsby. The degree of isolation (DI) has been estimated on the basis of DI = (MMD + 2) - 2δ. Any value over 2 is significant at the .05 level (negative values with signs changed are added to DI to assess significance). For ease of interpretation of the MMD matrix, Table 40 presents a second matrix showing DI and rankings of the DI values (most significant difference = rank 1).

The Huron sites (Kleinburg, Garland, Ossossané, Uxbridge and Maurice) together with Carton and Orchid, form a cluster in which none of the differences reach significance. Orchid is an unexpected member of this group, and Molto (1980:254) considers its apparent affinity as "casual". Carton was represented in a similar analysis of dental morphological traits (see Tables 125 and 126 in Appendix I) in which Carton and Shaver Hill diverged from the Huron site of Sopher, but at a rather low level of significance. The two Neutral sites of Carton and Shaver Hill are temporally and geographically close (Fig. 1 and Table 1), and the differences between them over 20 dental traits do not reach significance.

The summed rankings of cranial DI values (Table 40) demonstrate that Grimsby is most isolated from the groups represented by other southern Ontario sites. Glen Williams, an earlier Neutral site, is next in its degree of isolation. Carton, on the other hand, has an extremely high rank sum value (expressing the degree of relatedness); 210, compared with 163 as the mean for the four Huron sites, and 36 for Grimsby.

Some, at least, of the more northerly Neutral of the protohistoric and historic periods were apparently not isolated from the Huron: Carton appears as something of a bridge between the homogeneous Huron and the more genetically disparate Neutral. On the other hand, the Grimsby people were apparently isolated from the gene pool represented at the Huron sites, and were also significantly different from those buried at other Neutral cemetery sites.

Suture closure

Parietal squamosal suture closure is found only in two individuals: Fe 62/111 a male of advanced age, and Fe 62/82c a female who was much younger. In Fe 62/111 the parietal squamosal suture obliteration occurred only on the right and was not complete (Pl. 2a). Fe 62/111 was unusual in having the right occipito-mastoid suture also fused but ectocranially, not endocranially. The pubic symphysis of Fe 62/111 indicated that he was 45 to 50. Fe 62/82c seemed to be under 30 and only the left squamosal suture could be observed (see Table 68 in Chapter 7).

Inca bones

Only 4 individuals had inca bones: Fe 9/26 (male [?] ca. 16), Fe 62/63 (female [?] 20-24 [?]), Fe 62/21 (female 25) and Fe 23/1 (female 35-40). That of Fe 62/63 is interesting in that it is a "half" inca bone (Pl. 2b).

Mandibular characters

Several additional observations were also made on the mandible, of traits which are not of value in population relationships.

No mandibular tori were observed. Chin form could be examined on 80 mandibles, and the distribution by assumed sex is given in Table 41.

That a "pointed" chin is female and the "square" chin form is male is a common assumption underlying sex assignment. The assumption was checked by the association of chin form with bigonial breadth which is markedly different between males and females ($P = .002$). Indeed, in mandibles with "pointed" chins, the mean bigonial breadth is 12 mm. less than in mandibles with "square" chins ($P = .036$). Symphysis height, however, is not determined by chin form.

Gonial eversion was also noted. It is sex dependent and probably also age dependent. There are no side differences evident from the Grimsby sample ($n = 82$).

Dental characters

Morphological variants of the Grimsby dentition have been studied by G.S. Tait from dental stone casts made of 70 individuals, 67 maxillae and 66 mandibles, both subadults and adults (see Appendix I). In the field laboratory, only the most obvious morphological variants were observed.

Agenesis of M^3 has already been noted in Table 28. In one case, Fe 9/23, it is bilateral and it is interesting to note that a number of other individuals in Feature 9, all thought to be adolescent females, seemed to be showing either delayed eruption of M^3 and M_3 or else agenesis (Fe 9/9, 9/10, 9/25, 9/26).

In the mandibles there is suppression of M_3 three times on the left and three on the right. It is bilateral in one individual, Fe 62/26, and is also evident on the left in Fe 62/27, the only male to display M_3 agenesis. As with maxillary congenital absence, only individuals over 18 in whom the suppression is as certain as is possible in the absence of X-rays are accepted as having third molar agenesis.

Suppression of RI_2 in a young adult mandible of unknown sex from Feature 45 is the only other case of certain agenesis of permanent teeth, but Fe 62/43 appeared to lack both lateral incisors in the mandible (Pl. 3a). Fe 62/43 was a child of 2 to 3 years.

Peg teeth were present in Fe 27/3 (RM^3) (Pl. 3c) and 17/1 (LM^3) unilaterally (though perhaps bilaterally in both), and bilaterally in 1/27. Fe 20/1, who had LM^3 agenesis, had a peg RM^3. All but Fe 1/27 are males (and Fe 1/27 is an uncertain female). However, Fe 1/43, a young female, displays a much reduced RM^3 which suggests that the trait is not sex related.

Peg teeth were present in another form, supernumerary teeth. In jaws with much tooth loss and alveolar resorption it is difficult to be certain of the number of sockets, so only definite cases are recorded here. Fe 9/8, a young female, had an accessory tooth lingual to the RM^1 (Pl. 3b). Fe 1/37, a female, had an accessory molar buccal to and between LM^2 and LM^3. Fe 62/63, possibly female but not assigned a definite sex, had the root of a supernumerary tooth between RP^4 and RM^1 lingually.

Only one large paramolar cusp was present, an extra buccal cusp contiguous to the paracone on the left maxillary third molar of Fe 17/4.□

Table 28: Cranial Non-Metrical Traits by Side

	Left		Right		Total
	Males	Females	Males	Females	%
1. Os Japonicum trace	3/36	2/29	4/35	6/35	11.1
2. Infraorbital suture	9/26	6/19	10/30	10/26	34.6
3. Tympanic plate dehiscence	17/69	31/75	12/63	30/69	32.6
4. Foramen spinosum confluent with spheno-petrous fissure	3/42	3/43	3/40	1/49	5.7
5. Lambdoidal wormians (not by side)	25/48	27/54			51.0
6. Occipito-mastoid wormians	7/30	14/41	10/34	13/40	30.3
7. Parietal notch bone	7/40	1/48	1/44	6/51	8.2
8. Marginal foramen of the tympanic plate	1/58	3/64	1/58	2/62	2.9
9. Pterygospinous bridge	0/30	0/25	0/25	0/23	-
10. Pterygobasal bridge	0/29	1/25	0/24	0/33	0.9
11. Trochlear spur	3/50	5/51	1/52	5/59	6.6
12. Auditory exostoses	1/67	0/69	0/64	0/66	0.4
13. Intermediate condylar canal	9/40	5/46	8/33	9/43	19.1
14. Mylohyoid bridge	4/56	4/48	3/52	3/43	7.0
15. Supraorbital foramen	30/57	31/51	27/54	38/61	56.5
16. Post-condylar canal	31/43	37/47	34/40	44/47	82.5
17. Parietal process of the temporal sguama	1/30	2/39	7/40	2/38	8.2
18. Foramen of the lateral pterygoid plate	0/18	1/12	2/19	0/13	4.8
19. Accessory mental foramen	1/58	0/55	1/54	0/49	0.9
20. Accessory optic canal	0/17	0/13	0/17	0/14	-
21. Hypoglossal canal divided	6/57	9/64	6/54	9/64	12.5
22. Paracondylar process well developed	0/24	1/28	1/13	1/26	3.3
23. Upper third molar suppressed	1/52	2/67	1/48	2/67	2.6
24. Odonto-occipital articulation	1/53	1/58			1.8
25. Pharyngeal fossa	0/49	2/58			1.9

Table 29: Probabilities of the G_{adj} Values for Traits with Significant Sex or Side Differences (at one degree of freedom)

	Tympanic Plate	Parietal Notch	Post-condylar Canal
Left x Sex	.050	.088[b]	.627
Right x Sex	.004	.156[b]	.174
Side	.788[a]	.877	.022
Sex	.000	.639	.241
Male x Side	.572	.039[b]	.243
Female x Side	.929	.125[b]	.068

[a] G not adjusted
[b] 25% of cells have expected freguency of less than 5.

Table 30: Relationship Between Age (A), Sex (S) and Tympanic Dehiscence (H) for the Grimsby Population

	G	df	P
H x S independence	4.6	1	.032
H x A independence	1.0	1	.317
A x S independence	13.2	1	.000
H x S x A interaction	*0.0	1	-
H x S x A independence	18.8	4	.001

* G here is a negative value, probably the result of rounding errors (Fienberg, 1970:428)

Table 31: Probability Values for G Statistics on the Grimsby and Haida Populations (at three degrees of freedom)

	adolescent	adult	old adult
adolescent	-	.206	.022*
adult	.694	-	.795
old adult	.684	.537	-

Haida (above diagonal); Grimsby (below diagonal)

* significant

Table 32: Incidence of Supraorbital Foramina in the Grimsby Sample

	Young adults	Old adults
Bilateral presence		
Males	7	7
Females	20	1
Unilateral presence		
Males	5	6
Females	9	2
Bilateral absence		
Males	9	5
Females	11	2

Table 33: Relationship between Age (A), Sex (S) and Supraorbita1 Foramina (F) for the Grimsby Population

	G	df	P
F x S independence	.6	1	.438
F x A independence	.0	1	-
S x A independence	10.0	1	.002
F x S x A interaction	2.2	1	.138
F x S x A independence	12.8	4	.012

Table 34: Relationship between Age (A), Sex (S) and Supraorbital Foramina (F) when Testing Bilateral vs. Unilateral Presence

	G	df	P
F x S independence	.56	1	.454
F x A independence	1.1	1	.294
S x A independence	12.96	1	.003
F x S x A interaction	.834	1	.361
F x S x A independence	15.454	4	.004

Table 35: Frequency of Non-metrical Traits by Skull and by Sex

	All males				All females			
	A	B	C	D	A	B	C	D
1.	0	0	2	18	2	0	3	16
2.	4	1	2	8	2	1	3	8
3.	9	5	2	45	22	1	6	35
4.	1	2	3	25	0	3	0	31
5.	25	-	-	23	27	-	-	27
6.	4	1	2	18	4	4	7	16
7.	1	3	0	24	0	1	5	32
8.	0	0	0	47	2	1	0	47
9.	0	0	0	20	0	0	0	20
10.	0	0	0	19	0	1	0	19
11	0	2	1	39	1	4	2	39
12.	0	1	0	58	0	0	0	55
13.	2	5	6	18	3	1	6	28
14.	0	3	3	34	0	1	2	29
15.	18	6	6	16	23	6	6	13
16.	20	4	9	3	32	0	7	2
17	1	0	2	20	0	0	2	21
18.	0	0	1	13	0	1	0	8
19.	0	1	0	43	0	0	0	39
20.	0	0	0	16	0	0	0	12
21.	0	4	5	39	1	8	8	42
24.	1	-	-	52	1	-	-	57
25.	0	-	-	49	2	-	-	56
	86	38	44	658	122	34	57	672

For key to trait numbers see Table 28.
For this table and for Table 36:

A = bilaterally present,
B = present on left side only,
C = present on right side only,
D = bilaterally absent.

Table 36: Frequency of Non-metrical Traits by Skull and by Age

Trait	Young adults				Old adults			
	A	B	C	D	A	B	C	D
1.	2	0	4	23	0	0	0	7
2.	4	2	3	8	1	0	1	4
3.	23	3	7	47	7	1	0	23
4.	1	2	1	35	3	3	1	13
5.	34	-	-	33	8	-	-	13
6.	6	5	7	18	0	0	2	12
7.	1	3	4	34	0	1	1	14
8.	2	1	0	58	0	0	0	25
9.	0	0	0	24	0	0	0	10
10.	0	0	0	23	0	1	0	10
11.	1	6	2	47	0	0	0	22
12.	0	0	0	71	0	1	0	29
13.	3	2	7	35	2	3	3	8
14.	0	2	4	40	0	2	1	17
15.	27	6	8	20	8	4	4	7
16.	35	2	9	2	12	1	4	2
17.	0	0	1	26	1	0	2	10
18.	0	1	0	9	0	0	0	7
19.	0	1	0	51	0	0	0	22
20.	0	0	0	16	0	0	0	7
21.	0	10	7	55	0	2	4	16
22.	0	1	0	20	0	0	0	6
24.	1	-	-	74	1	-	-	21
25.	1	-	-	72	1	-	-	21

Table 37: Significant Results of Tests on Non-metrical Data

		P at 3df	P at 2df	P at 1df
Sex				
	Tympanic dehiscence	.008	.03	.000
Age				
	Occipitomastoid wormians	-	.036[a]	.003
	Trochlear spur	-	.05[a]	.006[b]

[a] delta = .1
[b] G_{adj}; delta = .05

Table 38: Mean Measure of Divergence Matrix for Five Southern Ontario Sites (data from Molto, 1979: 18 cranial traits)

MMD above and standard deviation below

	Serpent Mounds	Kleinburg	Fairty	Tabor Hill	Grimsby
SM	-	1.356	.708	.206	3.571
K	.076	-	.741	.273	1.662
F	.113	.079	-	.488	2.895
TH	.137	.113	.141	-	2.008
G	.008	.003	.079	.012	-

Distance Matrix with DI above
and rank order below with rank order sum

	Serpent Mounds	Kleinburg	Fairty	Tabor Hill	Grimsby
SM	-	3.204	2.482	1.932	5.555
K	5	-	2.583	2.047	3.656
F	7	6	-	2.206	4.737
TH	10	9	8	-	3.984
G	1	4	2	3	-
Rank sum	23	24	23	30	10

DI (degree of isolation) = (MMD + 2) - 2S: values less than two are not significant.

Table 39: Frequencies and θ Values for Cranial Non-metrical Traits for Nine Southern Ontario Sites

		Grimsby		Uxbridge		Garland		Glen Williams		Carton		Ossossané		Maurice		Orchid		Kleinburg	
Trait	Molto #	n	θ	n	θ	n	θ	n	θ	n	θ	n	θ	n	θ	n	θ	n	θ
1	1	15/135	0.882	3/29	0.875	2/20	0.870	10/69	0.776	3/30	0.887	1/24	1.084	2/24	0.930	6/34	0.680	11/65	0.790
2	2	35/101	0.309	10/42	0.537	10/18	-0.106	32/71	0.097	23/45	-0.022	13/35	0.253	9/18	0	11/26	0.149	34/80	0.149
3	4	90/276	0.354	27/61	0.113	6/18	0.322	65/135	0.037	32/99	0.358	50/130	0.231	35/94	0.255	63/144	0.124	79/181	0.127
4	5	10/174	1.076	11/51	0.592	6/31	0.636	29/110	0.488	14/79	0.691	27/113	0.544	10/79	0.830	23/84	0.464	34/150	0.574
5	[a]30	52/102	-0.019	21/36	-0.163	16/24	-0.326	32/64	0	27/48	-0.123	38/73	-0.041	22/32	-0.372	44/68	-0.294	49/76	-0.291
6	32	44/145	0.401	5/54	0.928	3/34	0.929	11/87	0.831	9/68	0.811	7/82	0.960	8/31	0.488	8/75	0.889	27/144	0.670
7	33	15/183	0.982	6/67	0.943	9/42	0.592	26/118	0.588	15/84	0.688	20/112	0.691	18/57	0.371	10/111	0.949	31/163	0.664
8	9	7/242	1.218	15/58	0.495	15/54	0.452	32/109	0.422	20/92	0.593	17/113	0.766	16/81	0.640	31/115	0.474	33/164	0.636
10	12	1/111	1.342	8/64	0.831	9/34	0.475	14/123	0.873	14/86	0.730	24/118	0.629	14/82	0.708	14/99	0.790	31/155	0.639
11	20	14/212	1.043	4/64	1.039	1/37	1.177	4/78	1.090	7/92	0.995	8/99	0.979	1/58	1.255	2/52	1.135	6/151	1.154
13	17	31/162	0.660	12/46	0.487	13/37	0.294	40/95	0.157	23/70	0.345	29/80	0.275	10/54	0.667	14/36	0.218	58/153	0.243
15	24	126/223	-0.130	41/72	-0.137	44/56	-0.596	79/151	-0.046	67/123	-0.089	75/131	-0.144	51/88	-0.158	99/172	-0.151	101/188	-0.074
16	22	31/177	0.702	7/61	0.861	5/53	0.922	16/120	0.814	13/89	0.776	13/107	0.848	10/64	0.744	12/81	0.769	15/163	0.946
17	26	12/147	0.981	6/73	0.969	2/46	1.108	40/95	0.157	5/71	1.011	8/129	1.054	9/78	0.863	23/132	0.703	10/167	1.066
20	27	0/61	1.435	2/48	1.117	0/24	1.348	4/78	1.090	5/79	1.041	10/76	0.814	5/51	0.910	2/48	1.117	4/119	1.182
21	14	30/239	0.842	11/65	0.710	18/59	0.394	59/147	0.197	26/95	0.464	21/119	0.697	18/71	0.509	20/104	0.655	87/193	0.098

Bartlett's adjustment used for all traits with incidence of 0 or 1.

[a] By skull, all other traits total of sides.

Table 41: Distribution of Chin Form by Sex

Form	Sex		
	Unknown	Male	Female
Median	5	2	15
Bilateral	3	14	0
Mediobilateral	11	18	12

Table 40: Distance Matrix for Ontario Sites using data from Molto (1980) on 16 cranial traits

MMD value above and standard deviation below

	Grimsby	Uxbridge	Garland	Glen Williams	Carton	Ossossané	Maurice	Orchid	Kleinburg
Gr	.	1.186	2.255	2.911	1.354	1.721	1.413	1.733	2.080
U	.010	.	.367	.962	.046	-.031	.516	-.161	.440
Ga	.014	.019	.	1.104	-.153	.319	.184	.160	.029
GW	.006	.011	.016	.	.702	1.160	1.007	.366	.823
Ca	.008	.012	.017	.009	.	-.096	-.045	-.000	.055
Os	.008	.012	.017	.009	.011	.	.406	.235	.536
M	.011	.015	.020	.012	.014	.014	.	.497	.346
Or	.009	.013	.018	.010	.012	.012	.015	.	.307
K	.006	.010	.015	.007	.008	.008	.011	.009	.

Distance Matrix for Ontario sites: DI above and rank order below with rank order sum

Gr	.	3.167	4.226	4.898	3.338	3.705	3.391	3.715	4.069
Ux	8	.	2.329	2.941	2.030	1.944	2.486	1.813	2.420
Ga	2	21.5	.	3.073	1.812	2.285	2.144	2.124	1.999
GW	1	12	31	.	2.683	3.142	2.982	2.346	2.810
Ca	7	29	27	14	.	1.882	2.018	1.977	2.038
Os	5	33	26	9	34	.	2.378	2.212	2.519
M	6	16	24	11	30	19	.	2.467	2.323
Or	4	35	36	20	32	25	18	.	2.289
K	3	17	10	13	28	15	21.5	23	.
Rank Sum									
	36	171.5	177.5	90	210	155	147.5	184	151.5

DI (degree of isolation) = (MMD + 2) - 2σ: values less than two are not significant.

CHAPTER 6

POST-CRANIAL MORPHOLOGY

Methods

A variety of morphological (i.e. non-metrical) post-cranial traits were observed, including both those coded as present/absent, and those coded as absent/present in degrees 1 to 4. In general, the traits were those used by F.J. Melbye in the University of Toronto Codification System for Skeletal Biology. Subsequent work by Finnegan (1978) and Saunders (1978) has drawn attention to infracranial non-metrical observations. As research continues, the list of non-metrical traits observed in the post-cranial skeleton will no doubt be altered and refined. The traits used here are not all considered to be independent of age, sex, side and environmental factors; but in general, observations based on size of tuberosities, ridges and spurs have been excluded since they cannot be recorded without the possibility of observer error and their aetiology may be complex.

Sternum, clavicle and scapula

The few observations made on the sternum, clavicle and scapula are summarized in Table 42. No side differences were evident and sample sizes were too small to examine sex differences.

Humerus

Gray (1918:212) provides a good description of the supratrochlear spur of the humerus. This was seen only in two bones, not of the same individual. The sex of the two humeri was not known.

The septal aperture of the humerus is generally considered to be more common on the left which is true here, though the difference does not quite reach significance on the Chi Square test (P = .06). The view that septal apertures occur more often in females is supported (P = .008): the female incidence is 44.7% and the male incidence is 27.0%. The two adult age classes show no difference in incidence (young, 36/102; older 18/68; P =.226).

Multiway analysis results in an interesting conclusion: there is no interaction between septal aperture and side (based on 106 right and 99 left humeri). There is, however, interaction between sex and septal aperture (G = 7.0, P = .008). The trait is neither age nor side dependent, but is definitely sex dependent.

The supracondylar area of the humerus bears three fossae: the coronoid, radial and olecranon fossae. The surfaces of these are sometimes observed to see whether they are "cribriform". In no case were there side differences and the "cribriform" surfaces were always more common in males than females.

Table 43 shows the distribution of cribriform fossae with reference to septal apertures. The table demonstrates that a tendency to cribriform fossae is not associated with septal apertures. The septal aperture specifically perforates the olecranon and coronoid fossae (Table 44). A very large aperture would make it impossible to observe cribriform fossae. Nevertheless, the point is made that cribriform fossae are not antecedent to septal apertures. Indeed, septal aperture incidence is not influenced by age but the coronoid fossa incidence of cribriform surface decreases markedly with age (adolescents, 5/17 or 29.4%; young adults, 9/98 or 9.2%; older adults, 1/60 or 1.7%). The age decrease is significant (P @ 2df = .003). The decrease is less marked for the radial fossa and not present in the olecranon fossa incidence. That the three fossae show different age incidences is not surprising in that they seem independent. Of 286 humeri in which all three fossae could be observed, only 2 (0.7%) had all three surfaces cribriform. In six (2.1%) two fossae were cribriform, and in 28

(9.8%) one fossa was cribriform. Information on the humerus, ulna and radius traits is given in Table 45.

Vertebrae

The vertebrae present many features which can be called "non-metrical variants" and thus vertebrae were examined in detail.

The morphology of the atlas is presented in Table 46. Spina bifida (failure of fusion of the posterior arch) is present in Fe 62/74, a late adolescent male. Anterior arch non-fusion is just as rare, found only in the individual from Feature 52, an early adolescent, probably male. Bridging of the type seen in Pl. 4a was recorded without reference to spurring since atlas spurring is complex (Jackes 1977). Posterior bridging shows a marked tendency to occur on the right rather than the left ($X^2 = 4.518$, $P = .034$). The individual in Pl. 4a, Fe 62/111, shows also a paracondylar facet on the left. This is a characteristic shared with Fe 62/85 (see Pl. 27a), another male who is described in Chapter 7. No congenital fusions were observed.

Table 47 lists the morphological variants of the axis. Two individuals show congenital fusion of C.2 and C.3. These were a young adult female from Feature 28 and an individual from Feature 11. Ossified apical ligaments may increase with age: ossified ligaments do occur in adolescents (3/9) but it seems likely that old adults have a higher incidence (7/15) than young adults (9/32). The difference between the adult age categories is, however, not significant (P = .211).

Table 48 provides information on C.3 to C.7. There is a slight though non-significant tendency for the transverse foramen on the left to be more commonly simple. This can be seen from Table 49 in which grouped data are provided for comparison with ossuary samples. Table 50 demonstrates that in C.3 to C.7 bilateral symmetry is the norm. In only 19.4% of vertebrae (49/252) is there asymmetry and 30 of these cases involve the single/double foramen combination. Of these 49 cases of asymmetrical foramen form, while 20 (40.8%) have a double right foramen, only 10/49 (20.4%) have a double left foramen. For comparison with ossuary data it is recorded that of 188 C.3 to C.6, 31.9% have single spinous processes, while there are 13.3% parallel and 54.8% divergent spinous processes.

A tendency towards congenital fusion was seen in two subadults in Feature 9. In Fe 9/A-5 this was shown by anomalous facets at the right anterior tubercules of C.5 and C.6 (Pl. 4b). This individual had central noding in the thoracic spine from T.8 to T.12. Fe 9/F had fusion of C.7 and T.1 on the right side (Pl. 4c).

Finnegan (1978) uses cervical vertebrae and especially atlases in population distance studies based on non-metrical variables. Slight differences between Kleinburg and Grimsby atlas vertebrae can be seen (in frequencies of hourglass shaped condylar facets, atlas bridges and posterior arch notching). There is a significant difference evident from a Chi Square test in the occurrence of posterior bridges on the right (P = .05), the trait being twice as frequent at Grimsby as at Kleinburg. The major differences in the morphological variants of the cervical spine are found in the frequencies of transverse foramina variations. Although sample sizes are very different, we can see a greater tendency towards single transverse foramina at Grimsby than at Kleinburg. Frequencies of double foramina are almost equivalent in the two samples, but Grimsby cervical vertebrae have fewer spurred foramina. The difference is highly significant (P = .001 for C.3-6; P = .008 for C.7) on the right. On the left the C.3-6 difference is not significant and the C.7 significance is only P = .037.

Since intra-observer or inter-observer error is possible with transverse foramina spurs, Saunders (1978) suggests that for population comparison the trait observed be "transverse foramina double". There is no side difference for this trait, so the Grimsby and Kleinburg (Jackes 1977) data, pooled sides, were compared on double foramina in C.3-6. The X^2 value of 4.33 (P = .037, Grimsby/Kleinburg) suggests that this trait may well be used in population distance studies in Ontario. Saunders (1978) data are given by individuals and not by sides, so that it is not completely suitable for comparison with ossuary material.

Thoracic morphology

Thoracic morphological variants are limited. They include:

a *Spina bifida*. Fe 62/82 consisted of the crania of three individuals. The innominates were male but the post-cranials all seemed of female proportions. Nevertheless, the small stature may be explicable in view of the possibility that this individual suffered a hip disease (see Chapter 7). The Fe 62/82 post-cranials are classified as male, though excluded from the basic analyses as pathological. Fe 62/82 had non-fusion of the neural arch of T.2 (Pl. 5a).

b *Agenesis of facets*. Fe 33/2, a female, showed agenesis of the left inferior facet of T.12 and the left superior facet of L.1.

c *Congenital fusion*. Fe 62/4, a male with T.4/T.5 fusion (see Chapter 7 and Pl. 28a), and an example, unfortunately "stray" from Feature 45 of T.11/T.12 fusion (Pl. 5d).

d *Fused ribs on T.12*. Fe 62/11, an old female with the right rib fused, and Fe 62/K with fusion of the left rib. Fe 62/K had thoracic type facets inferiorly but Fe 62/11 was unusual and highly asymmetrical. The right upper facet was of thoracic type but the left was lumbar in form. The left rib met T.12 through an extremely large facet.

e *Lower thoracic costal facets* are variable in their presence or absence (Table 51).

f *Variations in number*. Only one individual, Fe 62/60, a male, had a lengthened thoracic spine with 13 thoracic vertebrae. On the other hand, only one individual, Fe 62/66, another male, had a shortened thoracic spine with a lumbarized T.12. A more useful method of examining the question of shortening or lengthening of the thoracic spine is to note facet orientation. This also allows us to examine the tendency to asymmetry in vertebrae. Table 52 shows the types of orientation of the inferior facets.

Lumbar morphology

Facet orientation can be studied for L.1 with a view to determining the length of the functional lumbar spine (Table 53). Less than a third of this population has the classic thoraco-lumbar junction: the tendency is towards a lengthened functional thoracic spine as has already been described for the Huron (Jackes 1974, 1977). There is no significant difference between T.12 and L.1 in the number of types of variants. Another variation in L.1 is the presence of a lumbar rib, that is, a detached lateral process articulating through a facet. This was present in two males, Fe 62/24 (Pl. 5b) and Fe 62/77. In both cases only the right side of L.1 showed a lumbar rib. Other variations are possible: Fe 9/V had no lateral processes at all (and had rupturing and wedging): Fe 62/1 had no right lateral process; and Fe 59/1 had both transverse (thoracic) and lateral (lumbar) processes at once.

Table 54 shows the variations in the neural arch of L.5. Pl. 5c, e and f illustrates full neural arch separation, unilateral separation and an interesting case (Fe 62/58) of secondary fusion on one side. The incidence of spondylolysis is about 5% and there is no spina bifida in the real sense.

The lumbar spine may be lengthened

by a lumbarized S.1 or a separate L.6. Fe 62/G, a male, showed this trait but the "L.6" was not completely separate since there was a sacral facet on the right lateral process.

Sacralization of an L.5 leads to a shortening of the functional spine. It occurred in eight individuals (see Table 55 and Pl. 6a and 33c). Fe 62/17 had a fully sacralized L.5 (probably a young adolescent male). In Fe 62/63, who on the basis of the innominates was a young adult female, there were bilateral facets rather than complete sacralization. This was true also of two adults from Feature 36. Fe 62/73, a young male post-cranially (though the skull was that of an old male), and a stray individual from Feature 62 with male innominates aged 29 years, each had unilateral semi-sacralization, left side in the former and a right side facet in the latter. The sacrum thus showed at the most 7.7% (11/143) of cases with variations at the lumbo-sacral border.

Another variation is extremely rare. It is the existence of bilateral mammillary foramina on the S.1 of Fe 1/39, something noted previously for Ontario Indian lumbar vertebrae (Jackes 1977) but not for sacral. A common morphological variant is the level of the sacral hiatus (Pl. 6b). Table 56 shows the incidence of the possible variations while Table 57 records the cases of S.1 neural arch cleft and shows that there is no association between hiatus level and the neural arch cleft. Another sacral variant is the accessory facet for the sacro-iliac articulation. The total right incidence was 6/84 (7.1%) and the left, 2/88 (2.3%). The male incidence on the right was 1/29 (3.4%) and on the left, 1/38 (2.6%) while the female incidence for the right was 2/23 (8.9%) and for the left, 0/18. The only other variation for the sacrum which was recorded is the fusion of the first and second sacral elements. This is, of course, an age dependent character and showed that by the 35+ age category fusion is to be expected. However, among younger adults complete fusion was seen in 23/51 (45.0%) of individuals.

Morphological variations of the vertebrae are potentially of great value in population distance studies. Sufficient information is not available on southern Ontario samples to allow such a study here, but Table 58 provides data from both Kleinburg (Jackes 1977) and Grimsby, demonstrating a significant difference in vertebral morphology between these two Ontario Iroquois populations.

Innominates

On the innominate several morphological variants were recorded for the articular surface of the acetabulum. These were the acetabular notch and the acetabular mark. The acetabular notch showed no side difference but a sex difference was hovering on the edge of significance (P = .053). The acetabular mark, a pit, crease or pleat, occured in 120/323 (37.2%) of all pelvic bones without a side difference. The mark was present with a notch in 23/122 (18.8%), without a notch in 84/122 (68.8%), and a notch appeared alone in 15/122 (12.3%). The varieties of the mark occurred as follows: pit 59, crease 24, pleat 37, absent 203 of a total of 323. Saunders (1978:176) points out that the acetabular mark may be of value for studies of population differences. Certainly, the lack of sex and side differences would hold out some hope of this.

This is not true, of course, of the pre-auricular sulcus which Finnegan (1978) notes as a possible marker. He finds a marked sex difference in the trait. Saunders (1978:185) recorded a sulcus in some males and an absence of it in some females. I grouped the observation on the pre-auricular sulcus with observations on the ventral arc, subpubic concavity and medial ridge (Phenice 1969). In 66 individuals all four observations could be made, and all were consonant; 21 cases were classified as female and 45 as male. Some ambivalent cases remained:

1) female without a sulcus and often with one other "male" character:

- *a* in three cases the right innominate had no sulcus but the left did, including Fe 62/64 and Fe 62/23

- *b* Fe 62/O had sulci neither on the right nor on the left; the individual is discussed further in Chapter 7

- *c* individuals without pathology who had no sulci; Fe 1/48 had, however, post-cranials of female dimensions, the skull was female in character and the subpubic concavity and medial ridge of the innominates were female in form; Fe 17/1 had innominates with no female characteristics (as discussed elsewhere it is not possible to assign Fe 17/1 with certainty to one sex or the other);

2) males with sulcus: Fe 30/2 was the only instance and since the pubes were fragmentary, the sciatic notch wide and the age of the individual advanced, the case is an uncertain one.

There are a few examples of stray broken male pubes in association with ilia having sulci, but altogether the incidence 3/148 (2.0%) rests on uncertain foundations. One "male", Fe 62/X, had a sulcus but the other characters were mixed male/female. The dimensions of the leg bones put the individual firmly in the "female" category (no skull was associated).

Femora

The fossa of Allen was observed in terms of four "stages". In the first, normally associated with a fusing epiphysis capitis, a large porous depression with cancellous bone was present without a sharp edge. In the second, there was a smaller, better delineated depression with rounded edges. In the third, a thin veneer of compact bone encroached on the margins as it began to cover the depression. The fourth stage, the "true fossa of Allen", a fingertip depression, exhibited a blurred border. No side difference existed in adult bones whether all stages or only stages 2 and 4 are included in the test. Analysis of the fossa of Allen in terms of the interaction of the trait with age and sex gives a firm result: the presence of the trait as a whole is related to sex ($G = 7.2$; $P = .008$) but not to age ($G = 1.0$; $P = .306$). This is confirmed by a comparison of young and old adult males. No difference exists ($P = .172$), and this is true also for females (G with delta set at .5; $P = .08$). What can be seen is a progression from stage 1 to 4. Stages 1 and 2 make up 100% of the adolescent cases, 65% of the young adult cases and 16.7% of the old adult cases. The finding of changes with age is consonant with Anderson's description (1963:51) for the Fairty Ossuary, and the tendency of males to have a higher incidence of some mark on the femoral neck is well attested to (Saunders 1978:202).

A third trochanter was found only twice but differences in development of the gluteal ridge were noted. In general the ridge was not markedly developed and in most individuals it was absent altogether. This seems to be a very subjective trait and since two individuals (M.J., C.K.) made observations on the femora, the results cannot be regarded as reliable. They are included (Table 59), however, because they support the view that development of a gluteal ridge is not confined to males. The development of a fairly marked protuberance at the site of the attachment of the medial head of the gastrocnemius, on the other hand, does seem to be a male character (cf. Table 59).

Calcaneus, talus and patella

In Table 60 the form of the antero-medial calcaneal facet is recorded. No side differences can be noted. Two individuals seem to have had a bipartite calcaneus; in one case this was a bilateral occurrence. Fourteen other individuals with the more usual variants of the facet could be observed for bilateral symmetry. In 12/14 (85.7%) the trait variants were bilateral. In the two unilateral cases, the variants involved were a single facet on one side and an hourglass shaped facet on the other. Side differences were not seen for the medial protuberance of the calcaneus.

Some tali were observed, 34 right tali and 28 left. No case of an os trigonum was seen. The anterior calcaneal facet, without side difference, was equally single or hourglass in form. Only one case of two discrete facets was noted. In this report no information on facet extensions on the tibia and talus are recorded.

The vastus notch of the patella was observed to occur in 9 of 28 right, and 7 of 28 left patellae.□

Table 42: Morphological Variants of the Sternum, Clavicle and Scapula

	n
Sternum	
Sternal aperture	
1/26	
Clavicle	
Costal tuberosity medium development	
right	7/17
left	8/24
Sternocleidomastoideus attachment	
tuberosity	2/16
right	
ridge	1/16
tuberosity	3/15
left	
ridge	0/15
Subclavian ridge	
right	6/22
left	9/28
Conoid tubercle	
right	17/28
spur	3/28
left	15/29
spur	3/29
Deltoideus attachment	
ridge	13/27
right	
spur	1/27
ridge	16/32
left	
spur	1/32
Scapula	
Unfused acromial epiphysis	0/22
Humeral facet	8/22
Acromion shape	
sickle-shape	3/12
rectangular	6/12
triangular	2/12
irregular	2/12
Suprascapular notch	15/21
Glenoid fossa extension	26/34

Table 43: Distribution of Cribriform Fossae in Relation to Septal Apertures

Septal aperture	1 or more fossae cribriform	n	%
absent	absent	173	60.5
absent	present	23	8.0
present	absent	77	26.9
present	present	13	4.5
Total n		286	

Table 44: Distribution of Cribriform Olecranon and Coronoid Fossae in Relation to Septal Apertures

Septal aperture	1 or 2 fossae cribriform	n	%
absent	absent	75	60.0
absent	present	9	7.2
present	absent	39	31.2
present	present	2	1.6
Total n		125	

Table 45: Incidences of Morphological Traits in the Humerus, Radius and Ulna

Humerus	
Septal aperture	
12-18 year olds	9/17
18-35 year olds	36/10
males	18/51
females	16/45
35+ year olds	18/68
males	6/40
females	12/27
adults of unknown age	46/145
males	3/16
females	13/20
Supratrochlear spur in adults	2/270

	cribriform fossae coronoid	radial	olecranon
Cribriform coronoid fossa			
12-18 year olds	5/17	6/17	0/17
18-35 year olds	9/98	5/94	1/97
males	6/50	4/49	1/50
females	2/42	0/40	0/41
35+ year olds	1/60	3/60	3/63
males	1/36	3/35	2/36
females	0/24	0/24	0/26
unknown age adults	8/134	12/135	5/134
males	0/16	0/16	0/16
females	1/20	1/20	0/20

Radius

Distal facet shape	right	left
single	8/75	7/67
hourglass	67/75	60/67

Ulna

Trochlear notch form	Single	Double	Hourglass
Right			
males	1	13	14
females	2	5	14
Total	9	34	61
Left			
males	3	10	14
females	6	3	13
Total	16	32	58

Table 46: Morphological Variants of the Atlas

	%	n
Right transverse foramen		106
single	98.1	
double	0.0	
spur	0.0	
incomplete	0.0	
absent	1.9	
Left transverse foramen		106
single	100.0	
double	0.0	
spur	0.0	
incomplete	0.0	
absent	0.0	
Spina bifida		118
absent	99.2	
present	0.8	
Right condylar facet		118
single	77.1	
double	0.0	
constricted	22.9	
Left condylar facet		122
single	72.1	
double	0.0	
constricted	27.9	
Right posterior bridging		100
absent	88.0	
present	12.0	
Left posterior bridging		102
absent	96.1	
present	3.9	
Right lateral bridging		87
absent	93.1	
present	6.9	
Left lateral bridging		90
absent	93.3	
present	6.7	
Right arch foramen		110
absent	82.7	
notch	10.9	
foramen	6.4	
Left arch foramen		114
absent	79.8	
notch	14.1	
foramen	6.1	

Table 47: Morphological Variants of the Axis

	%	n
Right transverse foramen		115
single	95.7	
incomplete	0.9	
absent	3.4	
Left transverse foramen		116
single	95.7	
incomplete	0.9	
absent	3.4	
Spina bifida		122
absent	100.0	
present	0.0	
Spinous process		76
single	2.6	
parallel	34.2	
divergent	63.2	
Ossified apical ligament*		84
absent	65.5	
degree 1	26.2	
2	7.1	
3	1.2	
4	0.0	

* adults only: not ossification of the joint capsule

Table 48: Morphological Variants of C.3 to C.7

	C.3	C.4	C.5	C.6	C.7
Right transverse foramen					
single	98.2	92.8	72.9	47.4	75.6
double	1.8	1.8	23.7	49.1	13.3
spur	0.0	5.4	3.4	3.5	11.1
n	56	56	59	47	45
Left transverse foramen					
single	98.0	96.6	85.0	50.0	73.8
double	2.0	1.7	5.0	44.4	14.3
spur	0.0	1.7	8.3	5.5	11.9
absent	0.0	0.0	1.7	0.0	0.0
n	50	59	60	54	42
Spinous process					
single	11.9	4.2	15.6	82.1	100.0
parallel	16.7	8.3	17.8	10.7	0.0
diverges	64.3	87.5	66.7	7.1	0.0
n	42	48	45	56	70

Table 49: Transverse Foramina in C.3 to C.6

	Left n	Left %	Right n	Right %
Single	184	82.9	177	77.6
Double	29	13.1	44	19.3
Spur	9	4.0	7	3.1

Table 50: Unilateral/Bilateral Occurrence of the Foramen Transversarium in C.3 to C.7

		Left 1	Left 2	Left 3	Total	%
Right	1	182	10	8	201	79.4
	2	20	17	1	38	15.1
	3	9	1	4	14	5.5
Total		211	28	13	252	
%		83.7	11.1	5.2		

Key: 1 - single; 2 - double; 3 - spur

Table 51: Lower Thoracic Vertebrae Without Costal Facets

	T.9 n	T.9 %	T.10 n	T.10 %	T.11 n	T.11 %	T.12 n	T.12 %
Right	6/33	18.8	35/43	79.5	62/63	98.4	67/67	100.0
Left	4/34	11.8	35/41	85.4	62/62	100.0	67/67	100.0

Table 52: Inferior Facet Orientation in T.12

Form	n	%
Thoracic	10	17.5
Asymmetric	18	31.6
Intermediate	11	19.3
Lumbar	18	31.6

Table 53: Superior Facet Orientation in L.1

Form	n	%
Thoracic	15	18.5
Asymmetric	18	22.2
Intermediate	25	30.9
Lumbar	23	28.4

Table 54: L.5 Neural Arch Variations

Individual	Sex	Age	Spondylolysis Form
Fe 1/32	male	old adult	complete
Fe 9/V		adult	complete
Fe 18/1	male	adolescent	complete
Fe 20/2	male	old adult	complete
Fe 24	male	young adult	complete
Fe 62/-		adult?	complete
Fe 62/-		adult?	complete
Fe 62/Bundle H		adult?	complete
Fe 62/K	female	old adult	complete
Fe 62/58	male	old adult	complete
Fe 62/60	male	young adult	complete
Fe 62/75	female	old adult	complete
Fe 62/109	male	young adult	complete
Fe 62/110	female	old adult	complete
Fe 62/112	female	old adult	complete
Fe 9/J		adolescent?	right
Fe 62/-		adult	right
Fe 56/2	male	late adolescent	right
Fe 62/55	male	old adult	left

Table 55: Lumbo-Sacral Variations

Individual	Sex	Side	Variant
Fe 9/-	M	R,L	6 unit sacrum
Fe 62/G	M	R,L	semi-lumbarized S.1?
Surface	-	R,L	sacralized L.5
Fe 38/-	F	R,L	sacralized L.5
Fe 62/17(16)	M	R,L	sacralized L.5
Fe 62/63	F ?	R,L	semi-sacralized L.5
Fe 62/73	M	L	semi-sacralized L.5
Fe 62/-	M	R	semi-sacralized L.5
Fe 36/E	F	R,L	semi-sacralized L.5
Fe 36/10	F	R,L	semi-sacralized L.5
Fe 45/-	-	?L	semi-sacralized L.5

Table 56: Hiatus Level in the Sacra

Hiatus	All		Males		Females	
	n	%	n	%	n	%
to 5th centrum	21	20.0	6	15.8	5	17.8
to 4th foramen	24	22.9	6	15.8	9	32.1
to 4th centrum	38	36.2	17	44.7	9	32.1
to 3rd foramen	8	7.6	3	7.9	2	7.1
to 3rd centrum	9	8.6	4	10.5	3	10.7
to 2nd centrum	1	1.0	1	2.6	0	0.0
to 2nd foramen	1	1.0	0	0.0	0	0.0
to 1st foramen	1	1.0	1	2.6	0	0.0
to 1st body	1	1.0	0	0.0	0	0.0
open	1	1.0	0	0.0	0	0.0
n	105		38		28	

Table 57: S.1 Neural Arch Cleft

Individual	Sex	Hiatus Level
Fe 62/85	M	4th centrum
Fe 62/112	F	2nd foramen
Fe 62/77	M	4th centrum
Fe 62/96	F	4th foramen
Fe 62/10	M	3rd centrum
Fe 62/31	M	4th centrum
Fe 9/Q	F	5th centrum
Fe 9/F	-	4th centrum
Fe 3/1	M	4th centrum
Fe 3/2	M	-
Fe 36/M	-	4th centrum
Sample Size		105

Table 58: Mean Measure of Divergence for Left Side Incidences of Vertebral Traits

Trait	Kleinburg n	Kleinburg θ	Grimsby n	Grimsby θ
C.1				
Transverse foramen incomplete	6/358	1.301	0/106	1.469[a]
Posterior bridge	16/302	1.100	4/102	1.150
Transverse bridge	25/214	0.868	6/90	1.030
Posterior arch foramen	41/359	0.878	7/114	1.054
Condylar facet double	1/387	1.448[a]	0/112	1.472[a]
C.2				
Transverse foramen incomplete	10/375	1.235	1/116	1.347[a]
C.3-6				
Transverse foramen double	136/690	0.650	44/228	0.658
C.7				
Transverse foramen double	39/246	0.748	6/42	0.773
L.1				
Superior facet, lumbar form	249/418	-0.192	31/87	0.288
L.5				
Spondylolysis	19/220	0.968	16/109	0.775
Sacralized	16/300	1.100	9/145	1.055

Mean measure of divergence = .2243: Standard deviation = .0095
[a] Bartlett's adjustment (Sjøvold 1973:226) used.

Table 59: Morphological Variants in the Femur

Variant / Degree of expression		12-18	18-35 M	18-35 F	35+ M	35+ F
Fossa of Allen						
	0	2	20	40	22	19
	1	2	0	2	0	0
	2	3	7	3	1	0
	3	0	4	1	3	0
	4	0	1	1	2	0
Third trochanter						
	0	8	28	35	23	16
slight ridge	1	1	6	13	8	5
moderate ridge	2	0	1	2	2	3
marked ridge	3	0	1	1	0	0
trochanter	4	0	0	0	0	0
Medial gastrocnemius						
smooth	0	6	10	16	1	2
	1	1	16	25	16	17
	2	0	9	9	12	8
	3	0	5	0	3	0
protuberance	4	0	0	0	0	0

Table 60: Form of the Antero-medial Calcaneal Facet

	Right	Left	R+L	%
single	31	19	50	21.3
double	41	46	87	37.0
hourglass	44	44	88	37.4
anterior missing	6	4	10	4.2
Total	122	113	235	

CHAPTER 7

PATHOLOGY

Methods

Multiple, differential, diagnoses were considered during the examination of the many pathological specimens in the Grimsby cemetery. This approach to palaeopathological analysis is reflected in the way the material is presented in this chapter. No diagnosis was accepted on the basis of a first impression or preconception. Instead, the method of differential diagnosis was used to reduce the possibility of false diagnoses. Thus, as part of the discussion of each pathological condition, other possible causes for the condition are considered.

Each of the specific conditions identified (e.g. tuberculosis) is discussed separately, and those bones that provide the most abundant and/or reliable evidence for this condition (see Table 61) are considered. As far as is possible, pathological specimens in each burial feature are described together. Thus, within any one feature, all possible instances of a particular pathology are identified. This is necessary in order to try and reconstruct individuals since many of the pathological bones were removed from their context during excavation.

Syphilis

Feature 45 was a complex feature without individual burials. It yielded a number of pathological bones, some of which might well be associated with the dentition called Fe 45/12. On this dentition the maxillary attrition was unusual, no doubt because there was almost no tooth loss superiorly but a great deal on the mandible. On the right side of the maxilla, however, considerable deep abscessing had occurred and the M^3 and M^2 had already been lost. The dentition seemed to be that of a young adult female. The skull found associated with this dentition was fragmentary, no more than a skull cap (Pl. 7), and completely pathological, the only markedly pathological skull in the cemetery. The outer diploë of the parietals was thickened and irregular and medially, towards the coronoid suture, the outer diploë had eroded through. Radiographs revealed little, apart from 5 scattered centres of destruction and a more extensive area of anterior erosion. This pattern of apparent frontal involvement with a central area of coalescing pits and, beyond, scattered points of destruction, suggests syphilitic lesions. The osseous changes had reached only stages 2 and 3 of Hackett's classification (1978: 390).

If parietal or frontal syphilitic lesions are found, lesions of the tibia and the clavicle may be expected (see Steinbock 1976:112-113) in Feature 45. There was a fragment of a left clavicle with a lesion in the lateral portion. Three cases of tibial infections were found and it is likely that two of them belong to Fe 45/12 (Pl. 8). In these two there were discrete areas of pathological change on the mid-anterior surface, suggesting the beginnings of syphilitic gummatous destruction. The X-rays show that, in fact, the whole shaft was involved in bone changes.

The other infected tibia from Feature 45, a left tibia (Pl. 9), was markedly swollen in the medial third, but the X-ray shows that almost the whole shaft was involved. This is a case of periostitis, probably without general thickening of the cortex. The new bone growth was less dense than the compact bone of the shaft. The rather laminated new bone, which had not yet merged with the cortex (Pl. 9b), was thickest at the point of maximal swelling. This was on the medio-posterior edge at the attachment of flexor digitorum longus. It is unlikely that this tibia belonged to Fe 45/12.

Evidence from tibiae

Palaeopathological diagnosis is notoriously uncertain and this is especially so for the tibia which is often involved in both venereal and non-venereal syphilis. The tibia is also the bone most liable to non-specific infections: this is true of the Grimsby population as of other southern Ontario groups (see e.g. Stothers and Metress 1975: 8; Pfeiffer 1984: 184 and Jerkic 1975: 174; Katzenberg 1981) and perhaps all populations. As Sandison says (1968: 225), "the subcutaneous part of the tibia is particularly vulnerable to injury" and also "infections of the pretibial skin at this point may involve the closely adjacent periosteum."

Altogether, at least 16 individuals in the cemetery had some degree of tibial infection (Table 62, and Pl. 8 to 12), but those found in Feature 45 (Pl. 8 & 9) display the most marked pathological changes, together with a pair found on the surface (Pl. 10). The pair are rather suggestive of "sabre shin" tibiae but in fact the new bone growth is thicker not anteriorly, but posteriorly. The tibiae are thus not curved but appear abnormally straight, and "non-specific periostitis" or Paget's disease are much more likely diagnoses than syphilis. The left tibia from Fe 11 could be diagnosed as syphilitic but the paired tibiae from Feature 45 represent the most likely case of syphilis from the cemetery.

Also from Feature 45 came a sacrum with a spongey, non-arthritic build-up of bone on the left articular facet, an axis with the centrum displaying a large abscess, and a left navicular and right cuboid neither of which was more than a shell of bone surrounding a sinus at the proximal articular surface (Pl. 13).

Septic arthritis

The sacrum and axis from Feature 45 could represent some reaction to syphilis but it is not very likely that the tarsals referred to above are those of Fe 45/12. There is no indication that these tarsals are from the same individual: they may represent two separate cases of infection after injury to the foot. Puncture wounds or even surface wounds of the bottom of the foot could lead to osteomyelitis or septic arthritis.

Grimsby produced one specimen that is likely to be a good example of septic arthritis of the foot. This was a "stray" from Feature 62 (Pl. 14). The fifth metatarsal and the cuboid were fused and the cuboid had a sinus; the second metatarsal and the second cuneiform were fused; the third and fourth metatarsals were fused proximally; there was erosion of the proximal ends of the second to fourth metatarsals. The bone, despite the fusion, was rather porotic and there was no build up of new bone; probably a case of disuse osteoporosis. These factors suggest septic arthritis about a central puncture wound, with introduced infection. Tuberculosis should also be considered here, but one would perhaps expect more evidence of tubercular changes from Feature 62 and more sclerosis in the foot, which is not evident from the X-ray.

Tuberculosis

Vertebrae of two individuals (Pl. 15) showed abscessing of vertebral bodies: Fe 62/77, a male in his early thirties, had an L.2 with one abscess opening both on the superior end plate and on the ventral surface of the centrum. This individual had a right lumbar rib on L.1 but no other abnormality. Fe 62/90, a male of about 30, had abscessing of T.6 with three large sinuses in the superior end plate. No other pathological features were observed, but there was posterior inferior intervertebral disc rupturing on T.8 and T.9. Tubercular cold abscessing is a possible diagnosis for Fe 62/90.

From Feature 11 came the proximal element of a sacrum (but no other specimen) indicating a condition leading to bone destruction, abscessing and little bone regeneration (Pl. 16). This could be tuberculosis but metastasis of a carcinoma is also a possibility. The pathological changes could also be the result of infection of the contiguous soft tissues.

Feature 11 yielded two other pathological specimens. One was a left tibia (suggestive of syphilis) with anterior bowing, the swelling leading to much lateral vascular marking, and striated periostitis on the medial surface (Pl. 11c,d). The second was a juvenile humerus with unfused head and osteomyelitis of the proximal shaft (Pl. 16d,e): there were many draining sinuses but not much periosteal reaction. Haematogenous osteomyelitis seems the best diagnosis.

However, one specimen may be a certain case of tuberculosis of the spine. Fe 9/N consisted of T.3 to L.3 in which the lumbar, but not the thoracic, spinous process tips had just completed development. T.12 and L.1 were pathologically fused and it is probable that L.3 and L.4 were partly fused. The superior body of T.11 was eroded and it seems likely that ankylosis of T.10 and T.11 was beginning (Pl. 17). The X-ray shows clearly that this is a possible case of disc space tuberculosis with abscess formation, and end plate lesions with sclerosis.

The only other infectious condition from Feature 9 is that of an adult femur with swelling of the distal shaft, some periostitis and two large draining sinuses (Pl. 18). This seems to be a case of a medullary abscess as the result of haematogenous osteomyelitis. There is a certain amount of sclerosis distally which seems to have sealed off the area of pathology, but in the greater trochanter there is some radiolucency and at the neck/shaft juncture a possible sinus indicating pathology in the proximal femur.

The presence at Grimsby of only three instances of vertebral lesions suggestive of Pott's disease (less than 1% incidence), is surprising. Extensive skeletal evidence of tuberculosis could be expected in a late prehistoric or contact period southern Ontario population (cf. Hartney 1981: 142). At Glen Williams about 7% of the population was affected (Hartney 1981:146), while at Uxbridge the frequency was 6% (Pfeiffer 1984). The later Kleinburg ossuary contained only six cases of tuberculosis (based on lesions in the lower thoracic and lumbar regions of the vertebral column) but there were 35 other unassociated thoracic and lumbar centra with various forms of abscessing (12,000 vertebrae, comprising at least 520 columns, were examined: Jackes 1977). Pfeiffer (1984) has suggested that, by the contact period, an epidemic "wave" of tuberculosis had passed, leaving the Ontario population less susceptible. Another explanation might be that the Grimsby people were too weakened to survive to a stage of skeletal involvement, or that death from other causes supervened. Finally, since there is a chance that lesions resulting from blastomycosis (see Shadomy 1981: 28) are mistaken for tuberculous lesions in Ontario skeletons, it is possible that the Grimsby population is exhibiting a low frequency of fungal infections, as a result of reduced agricultural activity.

Smallpox

Fe 1/33 was excavated early but unfortunately stored and analyzed separately from the rest of Feature 1. The excavators thought the bones came from two levels, but clean breaks from both levels matched exactly. Fe 1/33 contained fragments of a child with the neuro-central synchondroses unfused, as well as fragments of two or three adults (e.g. three right patellae). The majority of the bones can be attributed to one adult (see Jackes 1983). The innominates appeared to be male and this seems confirmed by the S.1 body width (53 mm.) which was fairly large in comparison with total interalar width (112 mm.).

The age of Fe 1/33 is unknown. The S.1 and S.2 were fused and the manubrium was fused to the sternum. It is likely that the individual was over 30 when he died.

Fe 1/33 first attracted attention by abnormalities of the hip and femora (Pl. 20a): the acetabula seemed shallow. Only the right side could be measured and the width/depth ratio of 3.8 (width = 46 mm.; depth = 12 mm.) was more than two standard deviations outside the population mean (mean + 2σ = 3.734).

Unfortunately, both femora were broken. A reconstruction of the proximal portions appears in Fig. 20. The right femur was the more complete. Its neck was in valgus (neck/shaft angle = 138°) and the head flattened. The head extended well beyond the greater trochanter, which in fact was hypotrophied. The right shaft seemed slightly atrophied in comparison with the left, and this is confirmed by the platymeric indices which differed greatly (Table 63). The narrow neck of the right femur was well below the population mean of 29 mm.

Both elbows were abnormal but only the left was well enough preserved to be described (Fig. 21, Pl. 19). On the left ulna the whole area of the semilunar notch was grossly deformed with the coronoid process extended cranially. It appears certain that the right proximal ulna had a similar deformity. The deformity of the semilunar notch of the left ulna is related to the complete abnormality of the articular region of the left humerus. The interarticular area was nonexistent and it appears that the whole of the joint area had been transformed to articulate with the ulna. In other words, there was no apparent capitulum. The radial heads were broken but both the proximal radii must also have been markedly abnormal. The left radial neck was elongated and it seems certain, at least for the left arm, that there was disuse atrophy of all three bones.

Fe 1/33 was initially considered as a case of Perthès' disease. However, the features of the femora are not consistent with that diagnosis. Mild (Ribbing type) multiple epiphyseal dysplasia was also considered. This would be a very unusual case, however, since it is the elbows that were most markedly effected. Panner's disease (trauma to the elbow before epiphyseal union) is an inappropriate diagnosis. The more complete (left) elbow shows no sign of misalignment, and the abnormality is apparently bilateral. Such features could rarely be attributed to trauma. A search of the literature on elbow disorders led to references to the disruption of elbow joints following smallpox in infancy (Edeiken 1981:801-803; Resnick and Niwayama 1981: 2220-2223). The characteristics of Fe 1/33 fit very well with the descriptions of Cockshott and MacGregor (1958) and Nathan and Nguyen (1974) for skeletal changes resulting from smallpox. Typically, osteomyelitis following upon smallpox leads to bilateral disruption of the elbow joints, often accompanied by early cessation of growth in bones of the lower limb, leading to abnormal gaits.

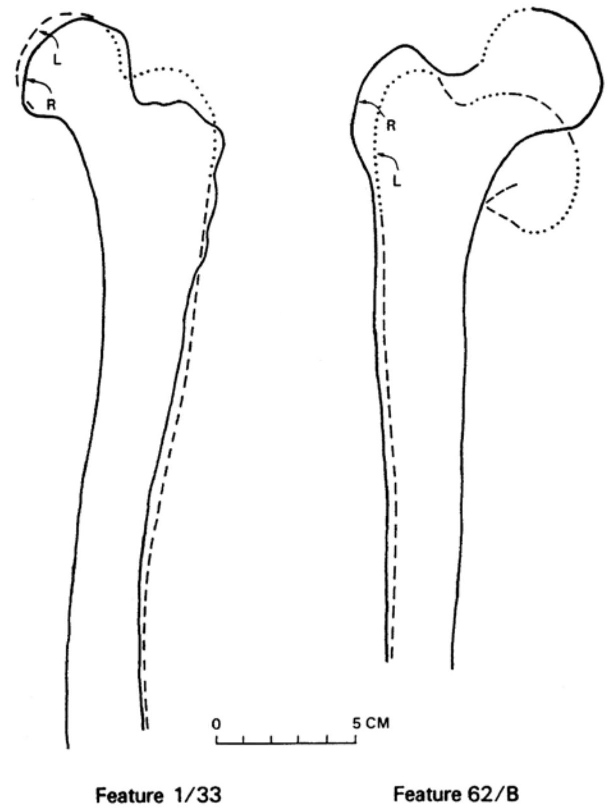


Figure 20: Femora of Fe 1/33 and Fe 62/B

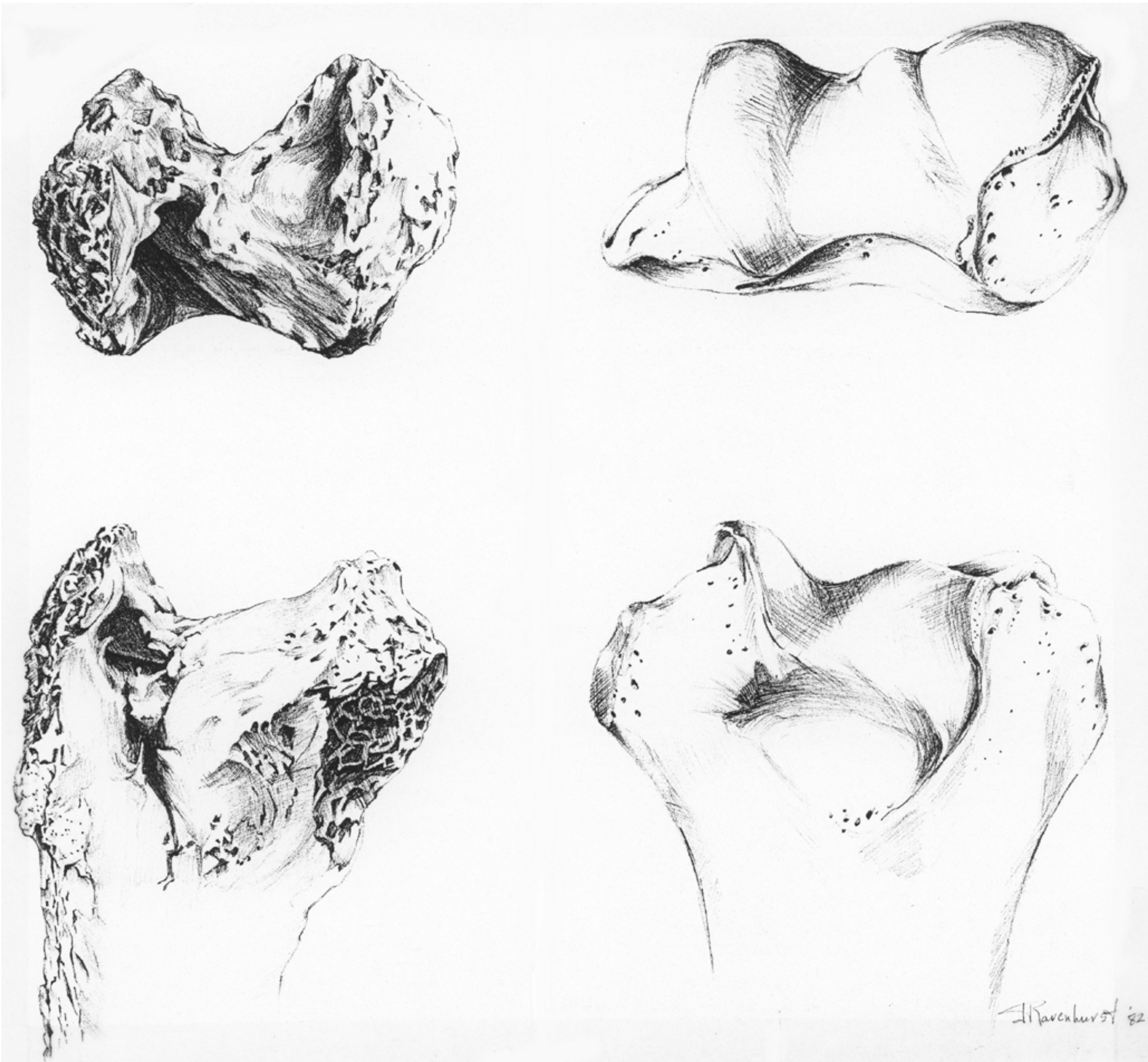


Figure 21: Fe 1/33 Distal humerus compared with a normal specimen

Feature 1 is likely to be one of the latest burials in the Grimsby cemetery (see Chapter 12; also Fox and Kenyon 1982 and Jackes 1983). Fe 1/33 probably died in 1649 or 1650 and is unlikely to have been born after 1620. While the age of onset of smallpox osteomyelitis is uncertain, an intensive review of the literature indicates that it is most likely to be under 10 years (over 100 cases are discussed in an extensive literature that goes back to the sixteenth century, much of it summarized in Cockshott and MacGregor 1958). Such marked deformity of the elbows suggests an age of onset well before fusion of the distal humeral articular epiphysis.

There is no record of smallpox

outbreaks near the Neutral before 1634, the year in which a well-documented epidemic spread from the English settlements in New England and reached the Mohawk (Duffy 1953:43; Jameson 1909:141; Cook 1973:492; contra Dobyns 1983:17). This epidemic may have reached the St. Lawrence Valley from New England, since contact is known to have occurred (see Trigger 1976:485-6), and there could also have been direct infection from England. A severe epidemic affected London in 1628 (Creighton 1965:435) and the English held Quebec from 1629 to 1633 (Trudel 1973:177). It is therefore surprising that the 1634 epidemic in Canada is generally considered to have been, not smallpox, but measles introduced from France (Trigger (1976:500; see also Jackes 1983 for further discussion), but the view that smallpox did not arrive among the Huron until 1639 cannot be refuted on the available evidence.

Dobyns (1983:15) is incorrect in stating that there was smallpox documented for New England and the Great Lakes in 1592 and 1593. However, there were epidemics of unknown type among the Algonkians in 1611 (Biggar 1922-26, 2:207) and one in New England from 1616 to 1619 (Williams 1909; Cook 1973:487 ff.), and these could have been smallpox. There was a smallpox pandemic beginning in 1614 (Hopkins 1983:34). In suggesting that plague is a more likely diagnosis than smallpox, Cook (1973:488) uses evidence on symptoms from as late as September, 1622 (the death of Squanto), and states incorrectly that nose bleed, head ache, lung congestion and skin lesions which remain visible on the survivors cannot be ascribed to smallpox, and that discolouration of the skin is symptomatic of plague (cf. e.g. Christie 1974:223,233). Furthermore, arguments based on seventeenth century knowledge of specific diseases and medical terminology (whether in French or English), are difficult to sustain. The Jesuits were not able to identify with certainty the cause of either the 1634 or 1639 epidemics (see Jackes 1983, and cf. Thwaites 16:53 and 101, see also Thwaites 16:217 and 18:23 with regard to the diagnosis and spread of the 1639 epidemic from New England, the Abenakis and Montagnais to the Huron). In sum, there is no sure evidence that plague, but not smallpox, was present in eastern North America by 1620 (Hopkins 1983).

The fact remains that there is no universally accepted record of a smallpox epidemic in Ontario until the late 1630s. However, measles is not a possible diagnosis for Fe 1/33: rubella is most likely to result in self-correcting changes at the knee joint and rubeola has never been known to cause bone changes. Although chicken pox can be mistaken for smallpox, there is no record of any virus, other than smallpox, having such an effect on bones. The evidence thus points to the existence of smallpox in Ontario before 1639 and perhaps even before 1634, for there is no likely alternative diagnosis for the symptoms presented by Fe 1/33.

Tumors

Feature 9 contained a juvenile pathological femur (Pl. 20b,c and d) with a distal shaft lesion marked by extraordinary laminae of new bone growth lying over the surface of the bone. This would seem to be a tumor, specifically a parosteal osteogenic sarcoma (Resnick and Niwayama 1981:2662).

Feature 9 also contained an adult femur (Pl. 21), again without associated bones, which had an abnormality totally different from that of the five cases to be discussed in the section on hip disorders. The angle of inclination was very low, about 109°, and the head lay slightly below the greater trochanter. There was no normal torsion, rather slight retroversion of -23°. The head was normal but the shaft appeared broad and flat, especially in the subtrochanteric region. Radiographs show a regular thickening of the cortex laterally with two main centres of thickening. The medial wall also appears to be thickened regularly from mid-shaft to neck. The major area of thickening exhibits a radiolucent area surrounded by a ring of sclerosis: the nidus of an osteoid osteoma.

Possible haematomas

The cemetery yielded several bones with swellings of the shaft which are difficult to interpret, besides the Feature 9 femur mentioned above. A humerus from Feature 45 (Pl. 22b,c,d) appeared to have a distal fracture. The X-ray, however, shows no fracture but rather an area of swelling beyond the cortex; within the swelling there are radiolucent areas. The best interpretation of this would be a subperiosteal haematoma, a diagnosis which could perhaps also be applied to the tibia from Feature 12 (Table 62, Pl. 12a). The radius of Fe 62/112 (Pl. 22a) in the absence of an X-ray, had been interpreted as evidence of an extraordinarily well-healed fracture, perhaps a greenstick fracture. But on the basis of a specimen illustrated by Steinbock (1976:259), the diagnosis may well be that of an ossified subperiosteal haematoma.

Hip disorders

Five individuals suffered from hip disorders, identified from femoral abnormalities (Tables 64 and 67). The most abnormal femora belonged to Fe 62/O (Pl. 23), a female judged to be 22 to 25 years old on the innominates. Hypertrophy of the greater trochanter of the left femur was so extreme, extending nearly 15 mm. beyond the head, that length measurements were taken to the greater trochanter rather than the head. The amount of hypertrophy was determined by extending lines at right angles from the long axis of the bone to meet the most craniad points of the greater trochanter and femoral head. The maximum head diameter of the left femur was a sagittal rather than transverse diameter. The left platymeric index (70.4) was slightly low but the right index (75) was normal. The ratio of physiological/maximum length (.984) was also normal (the population mean is .986).

Nevertheless, the left femur of Fe 62/O was completely abnormal. The virtual lack of a femoral neck is clear evidence of this. The condition was bilateral. The neck/shaft angle of the right femur was at least 140°; that is, at least 5 standard deviations above the mean established from the (admittedly small) Grimsby sample. Furthermore, the right femoral head was not only flattened but enlarged. Fig. 22, which plots the 95% confidence limit of the regression of maximum length on head width for the normal femora, shows that even the right femur was outside the normal limits of the population.

The width/depth ratio for the left acetabulum of Fe 62/O was 3.75 while the right was 3.1 (left: width = 45 mm., depth = 12 mm.; right: width = 43 mm., depth = 14 mm.). The left acetabulum was thus shallow but not outside the normal range: acetabular measurements do not allow one to define an abnormality of the femoral head.

The conclusion is that the left femur of Fe 62/O was highly abnormal and the right only slightly so, having no more than some degree of coxa valga (high neck/shaft angle) and a flattening of the head. The left femur had an extremely short neck and a flat, wide head (coxa plana and coxa magna).

The right femur of Fe 62/N was also abnormal (Pl. 23d,e). The left femur must have been classified as "stray" and thus was probably not noticeably abnormal. The head of the femur was flattened and expanded laterally so that the maximum head diameter lay in the sagittal plane. Nevertheless, the head extended well beyond the greater trochanter. The neck/shaft angle was about 141°, considerably above the mean for the population.

The platymeric index of 66.7 was low but within two standard deviations of the normal male right femoral mean. The ratio of physiological/maximum length (.985) was normal. The acetabular meaurements (width = 49 mm., depth = 16 mm.) gave a width/depth ratio of

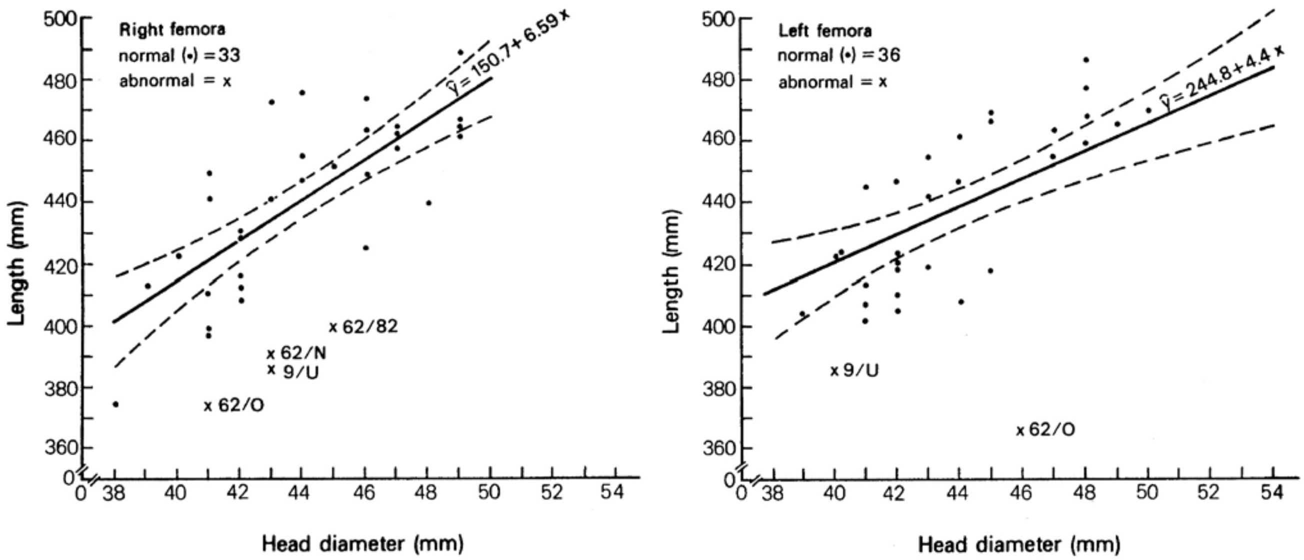


Figure 22: Abnormal femora plotted against the 95% confidence limits of normal femora on maximum length and head diameter

3.06, again perfectly normal for this population.

The Fe 62/N femur was short and broad-headed but not exceptionally abnormal and probably came from an individual with mild unilateral deformity of the femoral head. It is interesting, however, especially because it lay close to Fe 62/O.

During the analysis it became evident that at least one more individual in Feature 62 had a mild deformity of the femoral heads. Fe 62/82 comprised three individuals but only one set of innominates. These were of a young male about 20 years old and the best association of the femora were with those innominates (but all the post-cranial bones of Fe 62/82 fall within female limits: see Fig. 6 "G"). The right femoral head was complete, with the maximum diameter in the sagittal plane (see Fig. 22 where Fe 62/82 is shown to be outside the normal range). Its neck/shaft angle was about 139° and its angle of anteversion about 40°. The left femur unfortunately had damage to both the head and greater trochanter. It certainly had a lower angle of anteversion (around 30°) but the head, like that of the right femur, had areas of roughening and an extremely extensive fovea capitis. The ratio of physiological/maximum length was at the population mean for the right femur (.987) but below it for the left (.975). The population mean for right femora is .981 and for the left .991; the overall mean is .986. Using a small sample of 23 to obtain a standard deviation, I calculate a mean of .988 and standard deviation of .006, which puts the left femur of Fe 62/82 just below -2 standard deviations.

Feature 62/B was a male represented by broken right and left femora (Fig. 20, Pl. 24a). The right femur was normal, with a neck/shaft angle of about 128°. The left femur, however, had a neck/shaft angle of around 112°. In fact, the left femoral neck was markedly shortened and the articular surface of the head extended almost to the greater trochanter. The head appeared to have twisted forward and down and was extremely flattened. The head was broken but it is likely that there was arthritic reaction. The X-ray shows no fracture line and the best interpretation is of an early developmental abnormality of the metaphysis. The greater trochanter extended beyond the femoral head cranially.

Unfortunately, the left femur was not only broken but had postmortem erosion of its lateral wall.

Nevertheless, it seems possible that the shaft of the left femur was curved abnormally in an attempt to shift the distal condyles laterally.

The measurements on the right femur are limited to the subtrochanteric diameters (the anterior-posterior [27 mm.] and transverse [33 mm.] diameters giving the high but not abnormal platymeric index of 81.8) and the neck diameter was 30 mm. The left femoral neck had a width of 32 mm. The acetabular measurements given in Table 65 confirm the left-right asymmetry.

The femora of Fe 9/U, a female of about 30 with associated innominates, displayed marked asymmetry (Pl. 24b,c,d). In both right and left femora there was flattening of the head and in both the platymeric index was low, 63.3 on the right and 65.5 on the left (75.4 is the population mean). The right femur had unusual torsion with an extremely high angle of anteversion. The right angle was 52°, compared with 20° for the left. On the right femur the greater trochanter extended well beyond the head. On the left, the head and trochanter lay in the same plane. The neck/shaft angle on the left was low for this population (117°) while the right femoral head was in valgus (141°). The ratios of physiological to maximum lengths (right = .984, left = .979) were normal.

We have then a total of five adults, two females and three males, with some abnormality of the proximal femora. In two cases, Fe 62/O and Fe 62/B, there was marked abnormality of the left head which could have led to a shortening of one leg and a limp.

The most obvious diagnoses for abnormal proximal femora would be: congenital dislocation of the hips; congenital coxa vara; multiple epiphyseal dysplasia; slipped femoral capital epiphyses; Legg-Calvé-Perthès' disease (Table 66).

(a) Slipped femoral capital epiphyses

We may dismiss this immediately. This condition usually occurs in adolescents and leads to abnormalities of the head rather than of the femoral neck, although the neck does develop varus angulation (a low angle of inclination). The neck is not shortened and the head epiphysis normally slips up and back, not down and foreward. It occurs more often in males than in females and is bilateral in only 33% of cases, but there seems no reason to diagnose this condition here.

(b) Multiple epiphyseal dysplasia

This condition can also be dismissed, for it is most commonly bilateral and generally involves more than just the proximal femoral epiphyses. The population of the cemetery as a whole gave no indication of multiple epiphyseal dysplasia being present. As previously discussed, Fe 1/33 had some abnormality of the hips but the clue that this was not an example of mild (Ribbing type) multiple epiphyseal dysplasia lies in the very fact that the elbow joints were affected. Elbows are highly unlikely to be involved in multiple epiphyseal dysplasia.

(c) Congenital hip dislocation

This disorder is said to be common in North Amerian Indians (Salter, 1967). There is some evidence that holding the hips of infants in extension increases the incidence of hip dislocation (Lovell and Winter 1978: 722; Ogden and Moss 1978:41; Somerville 1962). While it is not known whether the Neutral used cradle boards, their use is attested to amongst the culturally similar Huron (Tooker 1967: 123).

Congenital hip dislocation is known to occur most often in the left hip of females (Lovell and Winter 1978; Walker 1980). In general the neck becomes anteverted and is in valgus or varus. The head is irregular and small, sometimes flat. The acetabulum is deformed (a pseudo-acetabulum may form). Extreme dislocation is clearly not present among the Grimsby femora.

One could, however, have a hip which is not dislocated but subluxated. The only sign would be increased anteversion (Alvak 1962) leading to a pigeon-toed gait, flat-footedness and eventual osteoarthritis (Somerville 1962). On the unaffected side there might, in fact, be an increase in the angles of inclination and anteversion (Shands and Steele 1958). Thus it seems possible that hip subluxation, though not hip dislocation, could be present in the Grimsby cemetery. However, although the less strongly affected femoral necks are in valgus, none of the heads suggest hip subluxation. Rather, the shortening of the necks argues more for a disruption at the metaphysis.

(d) Congenital coxa vara

Congenital coxa vara is a condition leading to shortening and broadening of the femoral neck. The neck is retroverted and in varus and there is hypertrophy of the greater trochanter. It affects males and females equally and is bilateral in 33% of cases. However, when bilateral, the changes are symmetrical. The acetabulum remains normal, but more importantly the head is normal.

(e) Legg-Calvé-Perthès' disease

We are left then with coxa plana, an condition which Langenskiold (1980) and Katz (1980) describe as leading to a shortening and broadening of the femoral neck. There is often a decrease of the neck/shaft angle on the affected side and possibly an increase on the unaffected side. There may be an overgrowth of the greater trochanter and a widening of the head, which does not increase in height (coxa plana). It is a condition which affects males much more often than females. It is said, however, to be extremely rare amongst American Indians (Goff 1962; Lovell and Winter 1978) though not amongst Asians, Eskimos and Central Europeans.

In 1909 and 1910, several people independently described a specific hip disease which was given the awkward name Legg-Calvé-Perthès' disease. It is most commonly referred to simply as Perthès' disease.

The disease is believed to occur more often in whites than in American Negroes (Broder 1953) and to occur about once per thousand live births. The incidence in males is higher than in females (1.35/1000 males, .27/1000 females: Molloy and MacMahon, 1966). The familial nature of the disease is confirmed in the literature (Lauritzen 1975) but has not been analyzed in detail.

In general terms the disease manifests itself most often between the ages of five and seven, most often in boys (80% of cases) and is unilateral in about 80-90% of cases with no side preference evident. The symptoms are often limited to a slight limp and slight pain with a reduction in abduction and internal rotation (Lauritzen 1975). Radiologically, an advanced case would show a condensed and flattened femoral head, and an epiphysis with a widened translucent epiphyseal line. The radiological appearance returns to normal except for the femoral head which may remain permanently flattened, in which case Lauritzen (1975: 36) suggests a prognosis of no more than moderate limitation of mobility and rarely any pain. He is discussing patients who have had some treatment, but it is worth noting that Fasting *et al.* (1980) feel that only very early treatment has any influence on the course of the disease.

The femoral head may also become irregularly shaped. This occurs in cases where the radiological changes are severe, i.e., where the whole of the epiphysis is involved (Fasting *et al.* 1980). Radiologically the femoral capital epiphysis appears to fragment. Nevelös *et al.* (1977) suggest that the fragmenting and non-fragmenting types are markedly different forms of the same disease and represent differing degrees of severity. The prognosis for the severe cases is not good. Mose *et al.* (1977) included in their study five females and 14 males of 54 to 79 years of age who had presumably received no treatment. All but one had joint degeneration. In 85% the degeneration was severe (defined as osteophytes, narrowed joint space, osteoporosis, hyperdensity, cysts). Of these cases, 73.7% had irregularly shaped femoral heads. In a group of thirty two 27-42 year olds, 31.2% had irregularly shaped femoral heads and 6% showed severe degenerative changes. Within a group of 20-32 year olds, 3% had severe changes and 24% had irregular femoral heads.

In summary, Perthès' disease may entail more or less significant changes in femoral head morphology irrespective of treatment. The changes appear to be permanent. It is possible (but not known) that without treatment the changes are more severe and that such changes result in marked degeneration of the joint.

In a few cases, Perthès' disease appears to be bilateral. The sex distribution is the same, but age of diagnosis is normally a year earlier (Lauritzen 1975: 119). Nevelös (1980) points out that Perthès' disease can manifest itself independently in hips, i.e., two unilateral occurrences, with time differences of six months to four years. Nevertheless, Nevelös' studies indicate that in nearly 50% of cases there is some degree of radiological change, symmetrical or asymmetrical, in both hips. Symptoms, however, seemed referable to only one hip.

Lauritzen (1975: 122) maintains that many patients with bilateral changes in fact show dysplasia epiphysialis capitis femoris (without actual condensation or collapse of the epiphysis), but he considers that this could progress into Perthès' disease (and see Meyer 1964:183-184. Dysplasia epiphysialis capitis femoris is seen in congenital dislocation of the hip to which Perthès' disease is believed to be related (see Meyer 1964:195).

The aetiology of Perthès' disease remains obscure (Nevelös 1980) but Lauritzen (1975) suggests that an abnormal course of the deep branch of the lateral epiphyseal artery would lead to periodic obstruction resulting in necrotization of the epiphysis. However, Ratliff (1978: 178) points out that Perthès' disease can not be ascribed simply to avascular necrosis.

We have then, five cases (Table 67) which seem best referred to as Perthès' disease rather than to congenital dislocation of the hip, although the latter is believed to be more common amongst American Indians. Some authorities see a relationship between congenital hip dislocation (perhaps in a mild form) and Perthès' disease. It is possible that less severe manifestations of Perthès' disease with reasonably good recovery, could well account for the five cases seen in this Neutral population. The more severe cases would certainly lead to limping, fatigue (and eventually osteoarthritis) with limited abduction and internal rotation. The less severe cases would be virtually symptomless. The variability in the manifestation of the condition is interesting in itself, Fe 9/U especially being an unusual case in that the angle of inclination is markedly higher on the right. This, together with the extreme right anteversion, makes it less than typical. Nevertheless, Fe 9/U can be grouped with Fe 62/82 (Pl. 24e) and Fe 62/N as cases in which the only symptoms would probably be mild aches and the early onset of arthritis.

Metabolic disorders

Fe 62/65 was judged to be a male on skull features. It is quite possible that the innominates of Fe 62/66 in fact belonged to Fe 62/65 in which case he was a male of around 24 years. There is every reason to think that Fe 62/66 was an older male whereas Fe 62/65 had no premortem tooth loss, no abscesses, just two caries and minimal wear on M^2 and M^3. Nevertheless, he had considerable and anomalous suture fusion. There was almost complete ectocranial as well as endocranial fusion of the major sutures. He was one of only nine individuals with external occipito-mastoid fusion, and one of only two skulls with zygomaxillary suture fusion (Table 68). His apparent abnormality was limited to an enlarged L.4 which showed anterior body wall bowing and biconcavity. The measurements (in millimetres) of this vertebra were: anterior height, 24.7; posterior height, 23.0; midcentrum height, 17.6; minimum central height, 12.8; superior width, 59.2; mid central width, 57.3; inferior width, 61.4; superior sagittal diameter, 44.4.

Two possible diagnoses suggest themselves: (1) Paget's disease, (2) a benign tumor. Paget's disease is equally common in males and females though perhaps slightly more frequent in males. It is especially common in the elderly but rather rare under age 40. The disease may be asymptomatic and may affect only one bone, at least initially. This is most likely to be a vertebra (see Resnick and Niwayama 1981: 1722). Schmorl and Junghanns (1971: 129,130,209) illustrate the classic features of coarsened trabeculae, condensation of bone at the end plates and enlarged vertebrae. These characteristics can be seen in Fe 62/65. Resnick and Niwayama (1981: 1729) mention also the biconcave deformity of "fish vertebrae".

Fe 62/65 (Pl. 25) does not exhibit a full "picture frame" vertebra although this seems to be partially present in several bones of the spine. Furthermore, the ballooning of the vertebra (the convexity of the anterior wall of the centrum) is more reminiscent of a benign tumor, an haemangioma (Schmorl and Junghanns 1971:326) which is often present in only one vertebra, frequently the L.4. Hemangiomas occur most often in females (Resnick and Niwayama 1981: 2671), more frequently in older than in younger adults. The trabeculae are enlarged and coarsened but the trabeculae are more often like complete vertical struts in vertebrae with an haemangioma.

There is then, some possibility of an haemangioma but Fe 62/65 is most likely to have had Paget's disease. Examination of the bone showed that the end plates of T.12 were abnormal. The X-ray confirms this and shows that there is sclerosis of the end plates in L.3 and L.5 as well as in T.12 and L.4. L.1 and L.2 were X-rayed at a slight angle so that their condition is uncertain, but since a number of vertebrae are involved, a diagnosis of an haemangioma is unlikely to be correct. The only other possible specimens from the cemetery indicating the existence of Paget's disease are two tibiae from the surface (Pl. 10).

Conditions of unknown aetiology

The timing of cranial suture fusion is variable and uncertain but several individuals may have had anomalous fusion (Table 68).

Ten individuals have occipito-mastoid fusion and in most of these the status of the major cranial sutures or of the teeth indicate that the individuals were fairly old (e.g. Fe 62/9, Pl. 26a). In two cases the tooth wear is not advanced (Fe 62/27, also discussed in Chapter 8) and Fe 62/65, but suture fusion is well established. Fe 62/10 had no external fusion but was associated with innominates giving an age of 41 years. In three individuals, however, there were no indications of advanced age: Fe 62/4, Fe 62/85 and Fe 9/22 all had little tooth wear, little or no tooth loss, and no external fusion of the major sutures. Fe 9/22 was a skull without associated post-cranials, and had a dental arcade that was particularly U-shaped and had a strong overbite. Fe 9/22 had the most marked degree of enamel hypoplasia (linear) in the site.

Fe 62/85 and Fe 62/4 are interesting because, besides the occipito-mastoid fusion, they share vertebral anomalies and possibly a hyperostotic condition. Both were males in their late twenties.

Fe 62/85 was aged at 29 years on the basis of his pubic symphysis. He had unusual cranial features, an exceptionally broad nose and a large and heavy occipital protuberance.

Pl. 26b,c serves to illustrate the nature of his skull. It is obvious from the few cranial measurements available (Table 69) that the great length of his skull was as striking as the breadth of his interorbital region. And yet his post-cranial skeleton was of normal size. His humeri and tibiae were both extremely close to the male mean for the population on the characters used for sex differentiation (see Chapter 2). However, the humerus/femur length ratio was slightly unusual (the highest point above the line in Fig. 5), in that his humeri were long in relation to his femora.

Fe 62/85 also had several anomalies of the vertebral column. Pl. 27a shows the asymmetry of the superior atlas facets and the presence of the paracondylar facet(s). The skull showed a large and faceted paracondylar process on the right and one was probably also present on the left. There was agenesis of the right inferior facet of L.5 and right superior facet of the sacrum. An interesting feature of the sacrum was the great lipping of the sacro-iliac joints which was bilateral but asymmetric, there being some fusion on the right but not on the left. Furthermore, the costal cartilages were ossified and fused to the sternum.

The signs of sacroiliitis and the further evidence of a hyperostotic condition in the form of ossified costal cartilages could suggest ankylosing spondylitis. In some American Indian populations there is a high incidence of ankylosing spondylitis (Gofton *et al*. 1966, 1971). It is most likely to occur in men around 25 to 30 years (the average age of onset) and has some degree of familial occurrence. Nevertheless, the ossifications in Fe 62/85 could also be explained in terms of reaction to the congenital anomalies.

Most of the vertebral indices could be calculated for the thoracic and lumbar spine of Fe 62/85. The pattern presented is not extraordinary, although the L.5 value is certainly extremely low and the T.8 value is surprisingly high (Table 70); but there is no evidence of completely abnormal posture. However, there is every possibility that the posture of his head was unusual. The atlanto-occipital joint would certainly have had reduced mobility. Perhaps this alone is sufficient to explain the ossified costal cartilages, the spurring of the occipital protuberance and a certain degree of cervical arthritis which was especially marked at the C.5/C.6 and C.6/C.7 joints. There was marked laminal spurring in the thoracic spine superiorly, especially at T.3 and T.4, and inferiorly, especially from T.8 to T.10. This is a perfectly normal pattern of spurring. There was also some central noding and rupturing inferiorly on T.8 and T.9. With the lumbar region again, we have some evidence of abnormal posture. Firstly, there was a great deal of arthritis, up to 4 degrees in the lower lumbar region. There was also rather a lot of laminal spurring including degree 4 spurring inferiorly on L.3: this is unusual. The evidence points to an instability at the lumbo-sacral joint which might well have resulted in sacro-iliac joint changes.

Fe 62/4 was 27 to 30 on the pubic symphysis. He had a 6 unit sacrum which did not, it seems, have much lipping of the sacro-iliac joint but did have ossification of the left sacroiliac (or iliolumbar ?) ligament (Pl. 28b). T.4 and T.5 were fused at the centra, the laminal spurs, the articular facets and the interspinous ligaments (Pl. 28a). There was also a build up of bone along the popliteal lines.

There was no arthritis in the lumbar spine, but a great deal (up to 3 degrees) in the thoracic region. There was noding and rupturing of all centra from T.5 to T.9, central noding cranially and sagittal noding caudally.

Each of these two cases is a little equivocal. Both had a variety of anomalies. It might be said that in Fe 62/85 the facet agenesis at the lumbo-sacral juncture has led to the ilio-sacral fusion. That would not, however, explain the costal cartilage ossification. It might also be argued that ossification of the ligaments, before lipping of the sacro-iliac joint, is not the usual pattern and that it is related to the 6 unit sacrum (or sacralized sixth lumbar ?) of Fe 62/4. The total pattern is suggestive of a hyperostotic condition for which one possible diagnosis is ankylosing spondylitis. Nevertheless, for individuals with conjoint anomalies, it is necessary to take the congenital characters into account when considering the unusual ossifications.

Cribra orbitalia

Cribra orbitalia (Pl. 28c), but not widespread porotic hyperostosis, was found in the Grimsby cemetery. It is assumed that in the New World iron deficiency anaemia is the cause of lesions fairly commonly seen in the orbits of both juveniles and adults (El Najjar *et al*. 1976:477). It is further assumed here that the lesions result from anaemia in infancy and also perhaps in adolescent females and that they are self-healing. This assumption is made on the basis of Akabori's (1933) data in which 81.8% of children under 10 exhibit cribra orbitalia, while 11.8% of 60 to 70 year olds show the lesions and then but "faintly". Akabori did not find the condition to be sex related. Other studies also suggest that cribra orbitalia is most common in younger age groups but the association with sex varies among populations studied (see e.g. Cybulski 1977; Hengen 1971; El Najjar *et al*. 1976). Table 71 records the ages and sexes of the 7 individuals who showed cribra orbitalia.

Pseudo-pathology

An interesting case of pseudo-pathology in Feature 9 was diagnosed only after long consideration of possible causes of multiple lytic defects in infants (e.g. Letterer-Siwe manifestation of histiocytosis X). Fe 9/H appeared to be composed of two individuals, the younger about 1.5 years judging from bone lengths. A few bones from each, especially radii and ribs, showed multiple "lesions", neat, small holes in what was otherwise healthy bone. The skulls of two individuals, Fe 9/19 and Fe 9/20, judged to be 15 months and 2.5 years respectively, each showed similar round holes over the vaults but not in the orbits. The infants 19, 20 and H were found together (K. Mills, personal communication, 1982) and I therefore assume there to have been two individuals showing the effects of some postmortem agent.□

Table 61: Summary of Pathological Specimens and Alternative Diagnoses

Provenance	Plate	Bone	Most likely diagnosis	Other possibilities considered
Surface	10	R/L tibiae	Paget's	periostitis, syphilis
Fe 1/33	19,20	L/R humerus, ulnae, radii, femora	smallpox	Perthès', epiphyseal dysplasia, Panner's, specific trauma
Fe 9/-	18	femur	haematogenous osteomyelitis	tuberculosis
Fe 9/-	20	juvenile femur	parosteal osteogenic sarcoma	none
Fe 9/-	21	adult femur	osteoid osteoma	congenital hip disorders
Fe 9/N	17	T.3-L.3	tuberculosis	none
Fe 9/U	24	femora	Perthès'	5 other hip disorders (see Table 66)
Fe 11/-	11	L tibia	syphilis	periostitis
Fe 11/-	16	S.1	metastasis of carcinoma	tuberculosis, contiguous soft tissue infection
Fe 11/-	16	juvenile humerus	haematogenous osteomyelitis	tuberculosis
Fe 12/1	12	R tibia	subperiosteal haematoma	fracture
Fe 45/-	--	clavicle	syphilis	none
Fe 45/-	8	R/L tibiae	syphilis	none
Fe 45/-	9	L tibia	periostitis	syphilis
Fe 45/-	--	sacrum	syphilis ?	-
Fe 45/-	--	axis	syphilis ?	-
Fe 45/-	13	L navicular	septic arthritis	syphilis, osteomyelitis
Fe 45/-	13	R cuboid	septic arthritis	syphilis, osteomyelitis
Fe 45/-	22	humerus	subperiosteal haematoma	fracture
Fe 45/12	7	skull	syphilis	none
Fe 62/-	14	L tarsals & metatarsals	septic arthritis	tuberculosis
Fe 62/4	28	sacrum/vertebrae	ankylosing spondylitis	conjoint congenital anomalies
Fe 62/65	25	T.12-L.5	Paget's	haemangioma
Fe 62/77	15	L.2	tuberculosis	none
Fe 62/82	--	femora	Perthès'	5 other hip disorders (see Table 66)
Fe 62/85	26,27	sacrum/vertebrae	ankylosing spondylitis	conjoint congenital anomalies
Fe 62/90	15	T.6	tuberculosis	none
Fe 62/112	22	radius	subperiosteal haematoma	fracture
Fe 62/B	24	femora	Perthès'	5 other hip disorders (see Table 66)
Fe 62/N	23	R femur	Perthès'	5 other hip disorders (see Table 66)
Fe 62/O	23	femora	Perthès'	5 other hip disorders (see Table 66)

Table 62: Tibial Infections

Indiv.	Sex	Age	Side	Comments
62/86	M?	35+	R	proximal half with irregular posterior swelling (Plate 12b).
			L	more infected: swelling as on R but also on anterior mid-shaft and lateral distal shaft.
17/1	F	20-22	R	mid- and distal shaft swelling, minimal periosteal change but some cortical thickening and fibula very swollen on distal half.
			L	shaft swollen slightly throughout its length, some involvement of fibula (Plate 11a).
1/37	F	30	R	slight periostitis mid-anterior shaft.
			L	no infection.
1/38	F	25-30	R	medial portion of lower third had swelling and slight periosteal change.
62/14	M	25-30	R	medio-distal spongey exostosis (osteocartilagenous exostoses?)
			L	swelling on popliteal line (left medio-lateral humerus also had exostosis) (Plate 12c).
45/-	?	?	L	swelling over whole shaft with new bone growth.
45/12?	F?	25-35	R	both tibiae had mid-anterior shaft gummatous areas (syphilis?): changes actually extend along cortex with apposition both internally and externally leading to narrowing of canal (Plate 8).
12/1	M	25	R	thickening of cortex at one point on distal shaft antero-medially with marked swelling but not much periosteal change (Plate 12a).
			L	no infection?
62/77	M	30-35	R	medial protuberance.
			L	no infection? (abcessing of lumbar vertebrae)
62/27	M	18-35	R	no infection.
			L	anterior and medial swelling in proximal half, minimal periosteal change.
62/11	F?	40+?	R	lateral proximal shaft infection.
			L	medial proximal shaft infection.
11/-	?	?	L	mid one third swollen anteriorly (syphilis?) (Plate 11c, d).
9/U	F	30	R	no infection (Perthès Disease?) (Plate 24).
			L	slight periostitis.
Surface	F?	adult	R	overall swelling, cortical thickening and coarsening of trabeculae (Paget's Disease?).
			L	the medullary canal is wide and there are 2 cortical layers (Plate 10).
Surface	?	adult	R	slight anterior infection mid-shaft.
Surface	?	child	L	slight postero-medial swelling in lower one third.

Table 63: Metrical Characteristics of the Femora of Fe 1/33

	PAP	TD	I	ND	NSA
Right	24.0	30.0	80.0	23.0	138°
Left	22.0	33.0	66.7	-	±140°
Normal male					
Right	24.6	32.2	76.4	29.1	127.3°
Left	24.6	32.3	77.3	28.9	

Table 65: Fe 62/B Acetabular Measurements

	Right	Left
Width (mm)	50.0	47.0
Depth (mm)	18.0	12.0
Width/depth ratio	2.8	3.9

Key for Tables 63 and 64:
PAP proximal A/P diameter
TD transverse diameter
I index
ND neck diameter
NSA neck/shaft angle

Table 64: Metrical Characteristics of the Abnormal Femora

Individual	Sex	Age	Side	Maximum Length	Physiol. Length	PAP	TD	Head Width	Neck Width
62/0	F	22-25	R	374	368	21	28	41	
			L	365*	355*	19	27	46*	
62/N	M	22-25	R	390	384	20	30	43*	
62/82	M	20	R	399	394	20	27	45	30
			L	403	393	20	27		28
62/B	M		R			27	33		30
			L						32
9/U	F	30	R	386	380	19	30	43	
			L	385	377	19	29	40	

* estimated measurements

Table 66: Summary of Signs of Hip Abnormalities

	congenital hip dislocation	congenital coxa vara	Perthes' disease (coxa plana)	slipped capital epiphyses	Meyer's fem. capital dysplasia	mild multiple epiphyseal dysplasia
neck	anteverted broad	retroverted short,broad	torsion normal short,broad	anteverted short,broad	outcome normal	torsion normal short
neck/shaft angle	high (on both affected and unaffected sides)	low (in varus) side)	low (high on unaffected	low	outcome normal	low
head	may be flat after subluxation; irregular, small after dislocation	normal	flat and broad posteriorly	displaced	outcome normal	flat
greater trochanter	normal	hypertrophied	hypertrophied	normal	outcome normal	?
acetabulum	margin everted (subluxation) deformed (dislocation)	normal	?	?	outcome normal	?
stature	normal	short	short	normal	normal	short
occurrence	familial ??	not familial	familial?	familial	familial	familial
sex	females (6:1)	1:1	males (5:1)	males (3:1)	males	1:1
side	left 60% right 20% bilateral 20% usually bilateral	? 33.3%	no side preference 12-20%	L more common (in M) 20-30%	40-50%	?
symmetry	none	present sometimes	none	none	present	present
age of onset or recognition	by screening at six weeks	2-3 years	5-7 years	10-20 years	2-5 years	5+ years

Table 67: Characteristics of Abnormal Femora

individual	sex	side	ante-version angle	greater trochanter	head	neck	neck/shaft angle*	platy-meric index	stature (cm)
Fe 62/0	F	R	32°	below head	flat	short	140+°	75.0	153.6
		L	25°	above head	flat	none	-	70.4	
Fe 62/82	M	R	40°	normal	flattish	normal	139°	74.1	163.2
		L	30°	normal	flattish	normal	140°	74.1	
Fe 62/B	M	R	-	normal?	normal?	normal?	128°	82.0	
		L	-	above head	flat	short	112°		
Fe 62/N	M	R	26°	below head	flat	short	141°	66.7	162.0
Fe 9/U	F	R	52°	above head	flat	short	141°	63.3	155.4
		L	20°	same plane as head	flat	short	117°	65.5	
Normal		R	31°	below head	round		127°	76.6 (M) 73.9 (F)	169.7 (M) 159.7 (F)
		L	24°	below head	round		127°	79.7 (M) 74.3 (F)	

* In the abnormal bones the measurement of the angle was made on projected slides with the neck axis running from the superior border of the fovea capitas and bisecting the neck.

Table 68: Individuals with Anomalous Suture Fusion

		SUTURES											TEETH		
Indiv.	sex	Z-M		C	S	L	O-M		C-S		P-S		A	W	PTL
		R	L				R	L	R	L	R	L			
9/22	M	0	0	0	0	0	2	0	0	0	0	0	0	1.4	0
20/B	M	0	0	0	2	0	2	2	0	0	0	0	4	3.4	4
62/4	M	-	-	0	0	0	2	2	0	0	0	0	0	2.4	0
62/9	M	0	0	0	2	0	2	2	0	0	0	0	extensive		
62/10b	M	0	0	0	0	0	2	0	0	0	0	0	extensive		
62/27	M	0	0	1	2	1	1	2	0	0	0	0	0	2.1	0
62/55	M	0	0	2	2	2	0	0	0	0	0	0	2	2.8	5
62/58	M	0	2	1	2	1	0	0	0	0	0	0	3	2.6	3
62/65	M	2	0	1	2	1	2	0	0	0	0	0	0	2.1	0
62/82c	F	0	0	0	0	0	0	0	-	2	0	0	0	2.1	0
62/83	M	0	0	2	2	2	2	-	0	0	0	0	2	-	2 (frag.)
62/85	M	-	-	0	0	0	2	2	0	0	0	0	1	2.2	1
62/111	M	0	0	0	0	0	3	0	2	0	2	0	3	4.0	4

<u>Key</u>

Sutures: Z-M = zygomaxillary
C = coronal
S = sagittal
L = lambdoidal
O-M = occipito-mastoid
C-S = central squamosal
P-S = posterior half of squamosal.
0 - not fused externally
1 - partly fused externally
2 - fused externally
3 - occipito-mastoid internally fused.

Dentition: A = number of abscesses observed
W = sum of degree of wear (0-4)/number of teeth observed
PTL = number of teeth lost premortem.

Table 69: Cranial Measurements of Fe 62/85 (mm)

glabello-occipital length	199
biasterionic breadth	108
minimum nasal breadth	13
nasion-bregma chord	123
bregma-lambda chord	112
lambda-opisthion chord	103
frontal arc	142
parietal arc	123
occipital arc	125

Table 70: Vertebral Indices of Fe 62/85

Vertebra	Fe 62/85	Male Mean
T.1	109.5	102.3
T.2	105.1	101.5
T.3	103.2	102.0
T.4	99.0	108.3
T.5	-	109.1
T.6	-	108.4
T.7	-	105.2
T.8	112.0	105.0
T.9	105.0	102.3
T.10	103.6	104.0
T.11	114.2	114.2
T.12	116.7	115.0*
L.1	-	114.6*
L.2	110.9	108.9
L.3	100.3	105.8
L.4	-	98.0
L.5	76.0	87.1

* Fe 62/85 T.12 has thoracic type lower facets; the mean for T.12 of the same morphology is given here, together with the mean for the corresponding L.1.

Table 71: Cribra Orbitalia

Individual	Sex	Age
Fe 1/32	M	45-50
Surface	F?	18-35?
Fe 46	F?	16-18
Fe 9/31	?	13
Fe 9/10	?	13
Fe 52	M?	13-14
Fe 13	?	6

CHAPTER 8

TRAUMATIC CHANGES

This chapter will describe the cases of major trauma, including osteoporotic fractures and trauma presumed to have been caused by weapons. Also included will be features that result from minor trauma; spurring at points of tendon and ligament attachment, and vertebral end plate fractures caused by intervertebral disc compression. Such skeletal changes are best discussed as trauma, rather than as degenerative change, because in some cases healing is possible, and in others incidences do not increase with age.

Major trauma

Fe 62/82a was represented by a partial skull and mandible judged to be a male of just over 30. A possible trauma to the symphysis menti involving a blow to the right side of the jaw was well healed, leaving no more than a slight deformity of the chin. A perforation into the left frontal sinus represented an unhealed wound which could have been the cause of death (Pl. 29a).

Pl. 29c shows the curious case of an isolated right orbit, with a hole in the roof of the orbit nearly a centimetre long. No pathological bone is evident, merely a neat oval with a small amount of healing at the margins. Presumably death prevented complete healing of an injury caused by a sharp weapon.

The elderly male in Feature 10 had a healed fracture of the left clavicle. There was one example in Feature 9 of a simple well-healed fracture of the lower mid shaft of the humerus. The excavation plots indicate that this bone could have been associated with Fe 9/23, a female of 30-35. A fractured femur found close by was thought by the excavators to be from the same individual (Pl. 30) (K. Mills, personal communication, 1979).

The humerus of Fe 26/5, a male of 35-40, is puzzling. The only abnormality was a prominent medial proximal spur (Pl. 30d), probably the result of trauma leading to muscle damage rather than to direct injury to the bone. Abnormalities of the elbow joint were present in two individuals. Fe 62/59, a female of 35-40, had had an injury to the olecranon process of the right ulna (Pl. 31a) which led to arthritic destruction, especially of the coronoid process. Fe 23/1, was an edentulous female of at least 40 years, with arthritic knee joints. There may have been a fracture of the left elbow because the olecranon process appeared distorted; but the bone was osteoporotic and broken, making observations difficult. There was, however, a healed Colles' fracture on the right distal radius.

Three other individuals had forearm injuries. Fe 62/2, a young male of about 25, had an ulna fracture (Pl. 31c,d) as well as several ruptured intervertebral discs. The left ulna had healed in misalignment causing shortening, and the radius was bowed to accomodate this. A similar case in Feature 62 is suggested by a stray left ulna which was strongly curved (Pl. 31b). Ulnar bowing can, however, result from a dislocation of the radial head as well as from a radial fracture (Resnick and Niwayama 1981:2257). The third example of forearm injury is a well-healed lower mid-shaft fracture of the right radius in Fe 62/112, a female of around 40 (Pl. 22a). Without a radiograph it is impossible to exclude the alternative diagnosis of a subperiosteal haematoma (see Chapt. 7). Only two femora showed fracturing, the femur from Feature 9 mentioned above, markedly misaligned, and an interesting juvenile specimen. The juvenile, also from Feature 9, had a well-healed spiral fracture (Pl. 32a,b). The healing had, however, been accompanied by marked thickening of the shaft (when compared with a normal specimen of the same age), a reduced neck/shaft angle, an enlarged lesser trochanter and a spur marking the cranial limit of the fracture line. A distal epiphysis, probably from the same individual, had an extraordinary flattening of the lateral condyle, demonstrating that the gait must have been quite abnormal (Pl. 32c).

The only tibia with a fracture was a left distal fragment from the surface which showed extensive fracturing of the distal and articular portion. This had resulted in infection and a large draining sinus was present.

A sacrum from Feature 46, presumed to be of a male of 30-35, had an unusual fracture in which the coccyx and distal sacral body were deflected to one side (Pl. 32d).

The lateral surface of the right innominate of Fe 30/3, a male of at least 35-40, displayed an extraordinary feature (Pl. 33). A pleat of bone ran from above the acetabulum and angled ventrally. An X-ray demonstrates clearly that no fracture was present. The best interpretation seems to be that an object, perhaps the point of a weapon, lay against the surface of the bone for long enough to bring about a change in the morphology of the iliac blade. The form of the acetabulum must also have been markedly altered for the femoral head was unilaterally flattened and the fovea capitis had become a longitudinal fissure.

There were a number of individuals with vertebral fractures, and in each case it must be determined whether the fractures were the result of major trauma, or whether the individuals were sufficiently osteoporotic to warrant categorizing the vertebral fractures as 'collapse' fractures, requiring no more than the most minor trauma.

A T.12 from the surface provides a classic case of osteoporotic collapse (see Saville 1970:45-46; Urist *et al*. 1970:33). The superior surface had been forced well below the level of the anterior centrum and was marked by a deep left side disruption of the end plate. The inferior surface had a straight sagittal node with a rupturing into the neural canal.

A similar case is that of Fe 36/E represented by T.7-L.5. Feature 36 was unfortunately vandalized so extensively that the association of this vertebral column is unknown. It had a bilaterally semi-sacralized L.5, a wedged L.3 (with an index of 149.5) and a fractured T.12. Apart from some superior osteophytosis at L.1 and L.4 there was almost no degenerative change. The T.12 superior body had a deep sagittal node, but the indication that this is a case of major trauma, rather than osteoporotic collapse, is the rift of the superior surface running across the left lateral and anterior margins (Pl. 33c,d).

The chance that Fe 62/27 was a mixed individual is high. The skull seemed to be that of an old male, whereas the innominates were given an age of around 25, and the post-cranials numbered Fe 62/27 have been analyzed as those of a young male. There was fracturing and/or noding of T.4 and T.6-T.9. The fractures were marginal, on the superior surfaces, and in general on the left side with extensions along the ventral margins. T.6-T.8 had marked fracturing anteriorly. In T.4 the fracture was lateral but the high index of 117.2 suggests that there was wedging. The spine did not appear osteoporotic but mid-thoracic fractures are very uncommon except as the first sign of osteoporosis of the spine which is frequently marked by wedging of T.3-T.6 (Urist *et al*. 1970:30).

Fe 62/10 was an interesting individual most unfortunately not examined until the last day in the field laboratory. A male of 40 or more, he had a possible fracture of T.12, with right lateral fracturing, superiorly and inferiorly, of L.1. There was wedging of L.1 and possible wedging of L.2; L.3 and especially L.2 were osteophytic. Apart from the vertebral fracturing, there was osteomyelitis of both calcanei and the left talus. Fe 62/10 lived long enough for extensive lipping to build up on the right talus and for a great deal of new bone growth to occur. The distal portion of the left tibia was infected (the surface was eroded which made it impossible to see its form but revealed at least three cloacae), and it is fairly certain that the right calcaneus and left talus were also acutely infected, displaying irregular sinuses (Pl. 34). The evidence of trauma in the vertebral column, together with the apparent restriction of the infection to the ankles (the left tibia seemed to have no infection in the diaphysis) makes the diagnosis of infection after trauma the best one. Although improbable, a straight fall down the escarpment or lake cliffs, with a landing on the feet would best explain the calcaneus/vertebrae fractures. In view of the apparent restriction of the zone of infection, the marked bone deformity and the bilateral (though asymmetric) bone changes, "acute pyogenic osteomyelitis by direct infection" (Steinbock, 1976: 73) subsequent to compound fracturing resulting from a straight fall onto the feet ('falling elevator fracture') is the best diagnosis.

Fe 62/75 was clearly not one individual. The skull was that of a young person but the post-cranials were those of an old female with osteoporotic collapse of the vertebrae, separated neural arch of L.5 and probably spondylolisthesis and a healed fracture of the sternum. The L.3 was completely collapsed and L.2 was slightly wedged, as was L.5 (Pl. 33e). In each case it was the superior surface that was fractured.

Fe 23/3 was judged to be a male of over 40. His L.1 was collapsed and his L.2 had a large anterior node associated with superior collapse. There was osteophytic reaction on L.3 and L.4 but, in general, the vertebrae looked healthy and not osteoporotic. There is every chance that this was a case of major trauma.

Fe 62/108a vertebrae were assumed to be those of an old male. T.11-T.12 were present and highly arthritic with marked ventral osteophytosis of the inferior bodies. The lumbar vertebrae made up a 'kissing spine'. L.1 was wedged and fused to the centrum of L.2, while L.3 and L.4 had considerable osteophytosis. It is impossible to say whether this is a case of fusion after a fracture of L.1, but a compression fracture with ostephytic reaction (rather than an osteoporotic collapse fracture) is the best diagnosis. Osteophytes would not be expected to accompany osteoporosis (Siegelman 1970:69).

Feature 61 contained only one skeleton, an elderly male. His first, second and third lumbar vertebrae had collapsed and then completely fused at centra and zygapophyses, as well as through the laminal spurring. L.4 and L.5 appeared quite normal despite some arthritis and osteophytosis. Unfortunately, the bones were not well preserved and one can only say that such wholesale fusion of vertebrae with no signs of pathology, apparently after fracturing, suggests fairly major trauma.

Fe 9/V, an adult vertebral column with C.1 arthritis and an L.5 separated neural arch, had also an L.1 lacking lateral processes. There was rupturing of the intervertebral disc into the neural canal on both the superior and inferior surfaces of the L.1 centrum. It is fairly certain that L.1 was wedged. Its vertebral index was very high (see Table 72). Both surfaces of the T.12 had nodes and there was a superior rupturing into the neural canal on the T.12 and an inferior rupturing on the T.11. All vertebrae from T.5 to L.2, except T.10, had nodes and T.7 also had an inferior rupture into the neural canal. Fe 9/V was not osteoporotic. Rather, the lack of transverse processes on L.1 and the separated neural arch seem to have predisposed the spine for problems. The trauma required to cause the T.12 and L.1 wedging may not have been severe.

There appear to have been eight or

nine vertebral columns in the cemetery which had sustained some injury. The majority of cases cannot really be thought of as examples of osteoporotic collapse. Collapse can be claimed only for Fe 62/75 with any certainty, but the morphology of that spine surely predisposed it to problems, as perhaps with Fe 9/V and Fe 36/E.

Vertebral fractures are confined to T.12-L.3 in general (Table 73). Fe 62/27 is the exception, for in that case the lumbar vertebrae were absolutely free of noding, arthritis and osteophytes. The small marginal fractures and the noding in the mid-thoracic region argue for some specific and unusual trauma or else an early sign of osteoporosis.

The incidence of vertebral fractures which are not ascribed to osteoporosis seems high but Schmorl and Junghanns (1971:262-3) stress that vertebral fractures are fairly common, especially among men, and that they can occur after slight trauma, frequently over several vertebrae. Our Grimsby findings, while initially surprising since one expects vertebral fracturing to be rare except in elderly females, need not be questioned. Merbs (1969) presents much the same picture for his Sadlermiut skeletons. What is of especial interest here is the apparent relationship between fracturing and spinal column anomalies.

Postcranial spurring

Table 74 gives the incidences by side of a variety of spurs that occur at specific points on the infracranial bones. To the information contained in the table, it may be added that in the few scapulae examined no acromial spurring was seen (0/13). The distal spur on the humerus, on the eminence between the radial and coronoid fossae was much more common. It was observed to occur with equal frequency in males (16/85 or 18.8%) and females (13/60 or 21.7%). Saunders (1978:290) shows the trait to be age progressive although the Grimsby data indicate this possibility only for females (but P = .5).

Bicipital spurring on the radius had a low incidence. It seemed to occur equally in males and females and no differences were observed between the two adult age groups (right 6/101; left 7/102).

The proximal spur on the ulna (olecranon spurring) may occur a little more often in males but this is not certain. It does occur much more often on the right side than on the left (X^2 = 6.38, P = .01: right 11/104; left 2/101), confirming that such spurring should not be regarded as a genetically determined morphological trait (see Burke *et al.* 1977: pneumatic drill operators have a 25% incidence of olecranon spurring). Ulnar distal spurring is rarer and though it may occur more often in females this cannot be proved.

On the femur 'osteophytes' in the trochanteric fossa were observed. There is no difference in incidence between sides or sexes. However, the incidence in the older adult age category (35/54) is nearly twice that of young adults (28/78). Saunders (1978:291) similarly finds trochanteric fossa "spicules" to be more common in older adults. The largest exostosis occurs in the left femur (the only one associated) of an old male, Fe 62/66. His femur was noteworthy for having neither anteversion nor retroversion. The neck/shaft angle at 125° was low but not extremely so. The femur was short (450 mm.) for its head diameter (53 mm.) and the neck was very thick (36 mm.). Nevertheless, the platymeric index (81.25) and the ratio of physiological/maximum length (.996) were not extraordinary. One other left femur from Feature 62 had a very large head diameter and was relatively short and it also had extremely marked spurring in the trochanteric fossa. One assumes then that although there was no marked sex difference (P = .12), trochanteric fossae exostoses are more likely to be found on the femorae of short, heavy males perhaps in the presence of low angles of anteversion.

Spurring on the tibial tuberosity was not common and displayed no side differences. It may be more common in males, but the incidences were too low for certainty. In an attempt to discover whether spurring has any association with particular stresses on the bone, the association of tuberosity spurring with medial proximal arthritis of the tibia was checked. No relationship whatsoever was found.

Spurring along the popliteal line was fairly common and had a marked association with sex (P = .03) and especially with age (P = .000). One individual, Fe 62/4, had a popliteal crest. The care that should be taken if such phenomena are analyzed as morphological variants is emphasized by the fact that Fe 62/4 had possible early fusion of cranial sutures, fusion of thoracic vertebrae, a six unit sacrum and sacroiliac (or iliolumbar) ligament ossification (Pl. 28b). Fe 62/4 was discussed in Chapter 7.

Posterior spurring of the calcaneus was fairly common and had no association whatsoever with arthritis. However, in the few patellae observed it is quite clear that whenever there was *marked* spurring there was arthritis.

The exact nature of the forms of infracranial spurring remains unclear, but obviously they are related in varying degrees to sex, age, general robustness, and perhaps to use and gait variations caused by morphological anomalies or abnormalities. Clearly they are the result of 'the functioning of the structure' and only incidentally are they inherently structural. There is no doubt that they are upon occasion the result of enthesopathy, that is, pathological reactions at the attachment sites of ligaments or tendons and this may apply to patellar, olecranon and posterior calcaneal spurs (Table 75 and see Resnick and Niwayama 1981).

Laminal spurring (ossification into the ligamentum flavum) is a characteristic which does not increase in incidence with age after adulthood (Table 76 and Fig. 24).

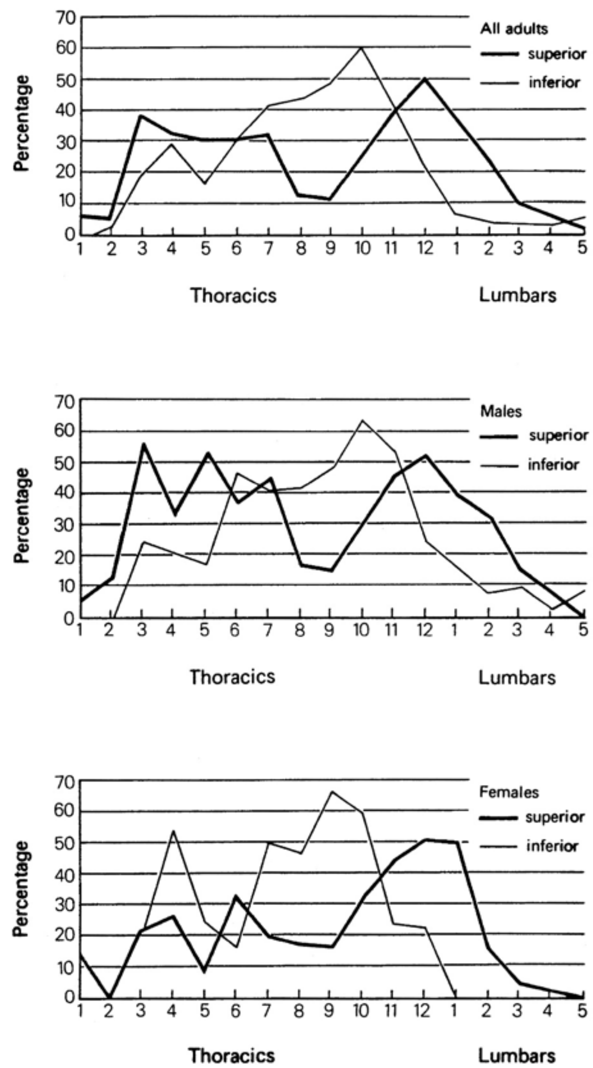


Figure 23: Laminal spurring of two degrees and more in adults

It does not appear to be correlated with facet arthritis. For these reasons it is not considered in the section on degeneration.

Sex differences in superior spurring show up at T.3, T.5 and T.7 (Table 77). There appears to be a startling difference between males and females at T.5 (Fig. 23). The difference, however, disappears if all degrees of spurring are included in the counts. The differences between sexes for T.4 inferior spurring is the reverse of what one would expect from the T.5 data. Nevertheless, with all degrees of spurring included the difference is

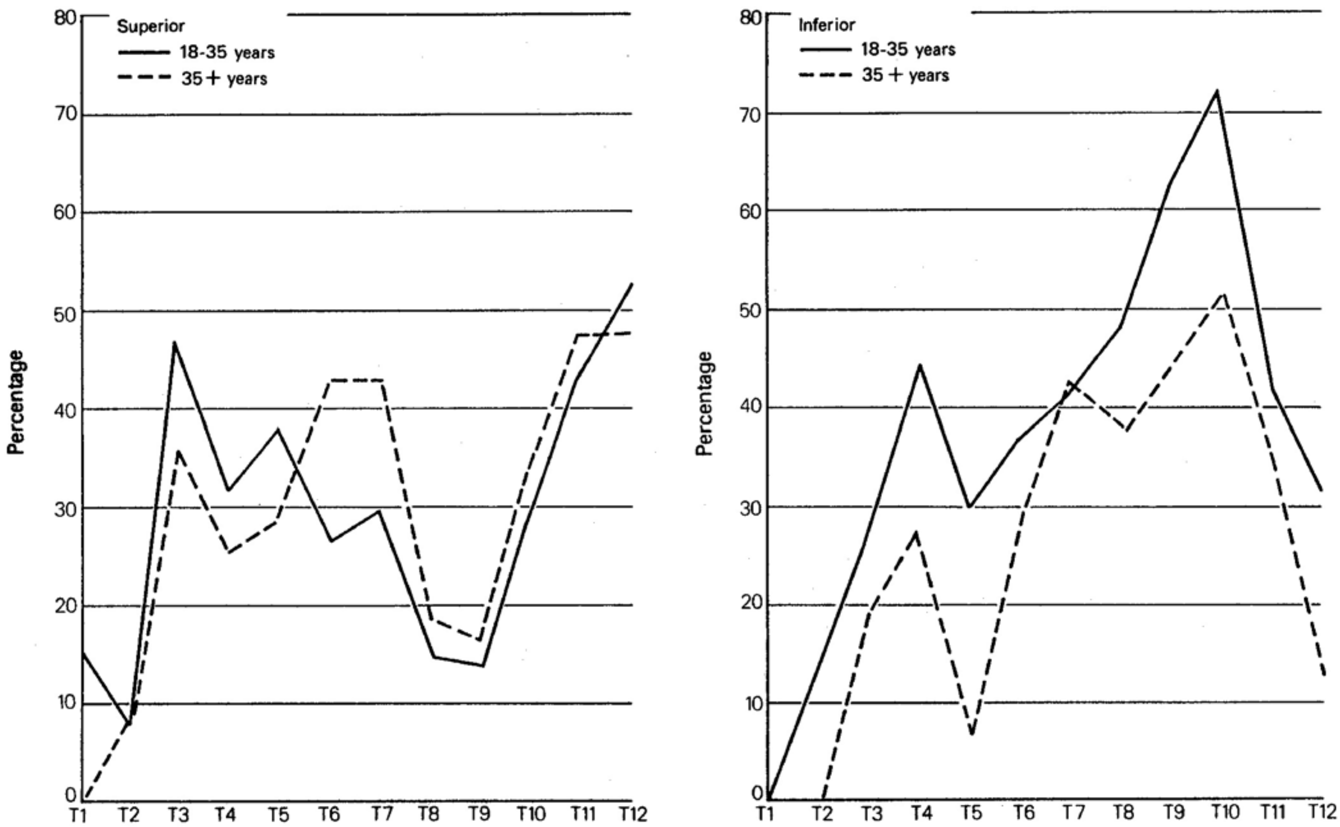


Figure 24: Laminal spurring in the thoracic spine by adult age

maintained (males 39%, females 82%). Superior spurring of T.3 is also divergent between males and females; again the difference is maintained when spurring of all degrees is considered (males 87.5%, females 44.4%).

Laminal spurring must bear some relationship, as Shore (1931) suggested, to the curves of the spine. This is not a simple relationship, but it is worth pointing out that the male and female vertebral indices ([posterior height/anterior height] x 100) show sex differences at the upper thoracic level (Table 20 in Chapter 2). There is a discontinuity between T.4 and T.5 in the index for males (from 102.2 to 108.0), whereas the discontinuity lies between T.5 and T.6 in females (from 103.2 to 109.9). If there is in fact a difference in the point of dorsal flexure in the spine between males and females, it might help to explain the lack of concordance between males and females in upper thoracic spurring.

Lumbar laminal spurring is comparatively rare in females (see Fig. 23). Although spurring is not usually thought of as occurring in the lumbar spine (Nathan 1959), it is found among American Indians. I have argued elsewhere (Jackes 1977) that lumbar spurring may be more common in spines with greater lumbar lordosis. The lumbar index

$$(\sum PBH \times 100/\sum ABH)$$

for Grimsby is 101.3, a figure which fits well with that for other American Indians (Dorsey 1895). The difference in index between males (102.3) and females (99.8) is noteworthy. The females thus have straight spines with a tendency to more lordosis than the males who are in fact kyphotic, so there is no direct relationship between lordosis and spurring. The lower incidence of laminal spurring in females remains unexplained.

Schmorl's nodes

The final set of observations to be

made under the general heading of "microtrauma" is on Schmorl's nodes. Nodes are caused by pressure from the nucleus pulposus resulting in small fractures of the vertebral end plates. They can occur in adolescents engaged in heavy work and are not age related, for they do not appear to increase in frequency with age. The overall frequency of nodes on the superior bodies of T.1 to T.12 is 9.9% (52/527). In young adults the frequency is 10.9% (28/256) and in older adults it is 7.5% (12/160). Similarly, the overall lumbar frequency is 14.7% (66/449) for the younger and 7.5% (15/202) for older adults. The lower incidence in the latter can be explained by the reduced elasticity of the intervertebral disc in older people and the masking of healed end plate fractures in old individuals.

There may be differences in patterning for noding between age categories (Fig. 24). For example, superior lumbar noding occurs in 18.9% (42/222) of young and 5.1% (5/98) of old adults, whereas the incidence of inferior lumbar noding for young adults is 10.6% (24/227) and 9.6% (10/104) for old adults.

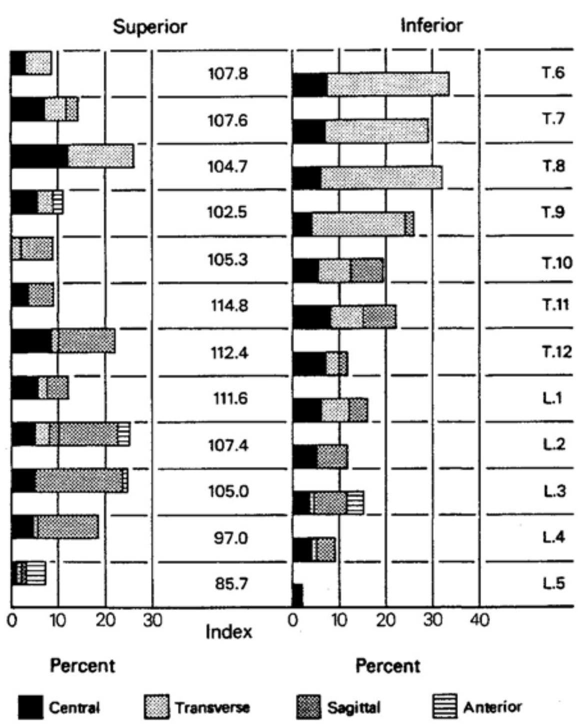


Figure 25: Incidences of noding in T.5 to L.5 of adults

Noding on the superior body of the sacrum is in 4.1% (2/49) of young adults and in none of 24 older adults sacra.

Noding occurs more often in males than in females (Table 78), although only on the superior lumbar surfaces are sex differences in noding significant (P = .05).

Tables 78, 79 and 80 concentrate only on noding in T.6 to L.5. There is little noding in the upper thoracic: the male (9.0%, 22/243) and female (5.8%, 9/154) incidence of noding for T.1 to T.12 in comparison with the figures in Table 79 show this clearly.

The data summarized in Tables 80 and 81 and in Fig. 25 give information on different types of nodes; central, transverse and sagittal. Nodes at the ventral borders of vertebrae (anterior nodes) occur *only* in old people: in 3.1% of old superior bodies and 1.0% of inferior bodies. No nodes associated with osteoporosis were found except for anterior nodes. Columns in a very bad condition of preservation were not coded and some of these are likely to have been osteoporotic. Nevertheless, I know this to be true only for Fe 26/9 and Feature 50. In all other cases for which arthritis and/or osteoporosis were recorded in the notes, the vertebrae were coded for analysis.

The causes of noding are clearly very diverse and noding is mentioned in this report in connection with spinal columns which have anomalies, pathologies, and major traumatic changes. Nodes can occur in association with such conditions as osteomalacia, Paget's disease, infection, neoplasms, degenerative disc disease, juvenile kyphosis, ankylosing spondylitis, rheumatoid arthritis and trauma. Nevertheless, it can be assumed that in the majority of cases nodes represent responses to the pressures placed upon the normal vertebral column by normal activity. Incidences of noding will be referred to again in summarizing evidence derived from osteoarthritis for activity patterns.□

Table 72: Vertebral Indices Normal Contrasted with Fe 9/V

Vertebra	Males	Females	Fe 9/V
T.11	114.8	115.4	114.4
T.12	112.4	110.8	125.7
L.1	111.6	111.7	131.6
L.2	107.4	108.9	110.0
L.3	105.0	105.8	100.4

Table 74: Infracranial Spurring

	Spur	Right	Left
Humerus	supratrochlear	1/145	1/139
	distal	37/156	36/150
Radius	bicipital	6/101	7/102
	proximal	11/104	2/101
	distal	4/67	4/61
Femur	trochanteric	49/126	47/120
Tibia	tuberosity	5/106	4/108
	popliteal	14/130	16/143
Calcaneus	posterior	10/19	5/12
Patella	anterior	6/26	4/28

Table 73: Vertebral Fractures

Vertebra	Major Trauma						Osteoporotic Fractures
T.4	62/27						
T.5							
T.6	62/27						
T.7	62/27						
T.8	62/27						
T.9							
T.10							
T.11							
T.12	9/V		36/E		62/10		Surface
L.1	9/V	23/3		61	62/10	62/108a	
L.2		23/3		61	62/10		62/75
L.3			36/E	61			62/75
L.4							
L.5							62/75

Table 75: Sites of Pathological Spurring in the Post-cranial Skeleton

Disease	Tendon	Bone
ankylosing spondylitis	quadriceps	patella
acromegaly	quadriceps	patella
degenerative osteoarthritis	quadriceps	patella
	triceps	ulna
gout	triceps	ulna
diffuse idiopathic	quadriceps	patella
skeletal hyperostosis	triceps	ulna
	achilles	calcaneus

Table 76: Thoracic Laminal Spurring of Two Degrees and More

	Superior				Inferior			
	18-35		35+		18-35		35+	
	n	%	n	%	n	%	n	%
T.1	2/13	15.4	0/11	0.0	0/13	0.0	0/11	0.0
T.2	1/13	7.7	1/11	9.1	0/13	0.0	0/11	0.0
T.3	7/15	46.7	4/11	36.4	4/15	26.7	2/11	18.2
T.4	5/16	31.2	3/12	25.0	7/16	43.8	3/11	27.2
T.5	6/16	37.5	4/14	28.6	5/17	29.4	1/14	7.1
T.6	5/19	26.3	6/14	42.8	7/19	36.8	4/14	28.6
T.7	7/24	29.2	6/14	42.8	10/24	41.7	6/14	42.8
T.8	4/27	14.8	3/16	18.8	14/29	48.3	6/16	37.5
T.9	4/29	13.8	3/18	16.7	18/29	62.1	8/18	44.4
T.10	8/28	28.6	6/18	33.3	20/28	71.4	10/20	50.0
T.11	12/28	42.8	8/17	47.0	12/29	41.4	6/18	33.3
T.12	16/31	51.6	8/17	47.0	9/30	30.0	2/18	11.1

18-35 years: females 41% to 48% of sample; 35+ years: females 31% to 36%.

Table 77: Laminal Spurring of Degrees and More

	All				Males				Females			
	superior		inferior		superior		inferior		superior		inferior	
	n	%	n	%	n	%	n	%	n	%	n	%
T.1	2/30	6.7	0/30	0.0	1/16	6.25	0/16	0.0	1/7	14.3	0/7	0.0
T.2	2/31	6.4	1/31	3.2	2/16	12.5	0/16	0.0	0/7	0.0	0/7	0.0
T.3	13/33	39.4	7/33	21.2	9/16	56.25	4/16	25.0	2/9	22.2	2/9	22.2
T.4	12/36	33.3	11/35	31.4	5/16	33.3	3/14	21.4	3/11	27.3	6/11	54.5
T.5	12/39	30.8	7/40	17.5	9/17	52.9	3/17	17.6	1/11	9.1	3/12	25.0
T.6	13/42	31.0	13/42	31.0	7/19	36.8	9/19	47.4	4/12	33.3	2/12	16.7
T.7	15/45	33.3	19/45	42.2	10/22	45.4	9/22	40.9	3/14	21.4	7/14	50.0
T.8	7/52	13.5	24/54	44.4	4/24	16.7	11/26	42.3	3/17	17.6	8/17	47.0
T.9	7/57	12.3	28/57	49.1	4/27	14.8	13/27	48.1	3/18	16.7	12/18	66.7
T.10	15/60	25.0	37/61	60.6	8/27	29.6	18/28	64.3	6/18	33.3	11/18	61.1
T.11	23/59	39.0	27/62	43.5	11/24	45.8	14/26	53.8	9/20	45.0	5/20	25.0
T.12	31/61	50.8	14/60	23.3	13/25	52.0	6/24	25.0	11/21	52.4	5/21	23.8
L.1	41/107	38.3	8/106	7.5	16/40	40.0	6/38	15.8	18/35	51.4	0/35	0.0
L.2	26/99	26.3	5/101	5.0	13/39	33.3	3/39	7.7	5/30	16.7	0/30	0.0
L.3	12/107	11.2	4/106	3.8	6/40	15.0	4/39	10.2	2/32	6.25	0/32	0.0
L.4	7/106	6.6	4/109	3.7	3/39	7.7	1/39	2.6	1/32	3.1	0/33	0.0
L.5	3/107	2.8	6/106	5.7	0/40	0.0	3/39	7.7	0/25	0.0	1/26	3.8

Table 78: Sex Differences in Incidences of Noding

	Males				Females			
	Superior		Inferior		Superior		Inferior	
	n	%	n	%	n	%	n	%
T.6-12	21/165	12.7	31/171	21.6	9/113	8.0	23/115	20.0
L.1-5	30/175	17.1	19/177	10.7	12/128	9.4	10/129	7.8

Table 79: Vertebral noding in adults

	Superior						Inferior					
	All		Males		Females		All		Males		Females	
	n	%	n	%	n	%	n	%	n	%	n	%
T.6	3/38	7.9	1/16	6.25	1/12	8.3	14/42	33.3	6/19	31.6	3/12	25 .0
T.7	6/44	13.6	1/21	4.8	2/13	15.4	13/45	28.9	6/22	27.3	4/14	28 .5
T.8	13/51	25.5	7/23	30.4	3/17	17.6	17/53	32.1	7/26	26.9	5/16	31 .2
T.9	6/54	11.1	3/25	12.0	0/17	0.0	14/54	25.9	7/26	26.9	4/12	33 .3
T.10	5/56	8.9	2/27	7.4	0/16	0.0	11/56	19.6	2/26	7.7	4/17	23 .5
T.11	5/61	8.2	2/27	7.4	0/18	0.0	13/61	21.3	6/27	22.2	2/18	11 .1
T.12	13/60	21.7	5/26	19.2	3/20	8.8	8/63	12.7	3/25	12.0	1/22	4.5
L.1	11/93	11.8	3/36	8.3	1/26	3.8	16/100	16.0	3/36	8.3	3/28	10 .7
L.2	24/97	24.7	8/36	22.2	3/26	11.5	11/96	11.4	5/34	14.7	0/27	0.0
L.3	24/98	24.5	10/34	29.4	4/26	15.4	13/87	14.9	6/36	16.7	3/26	11 .5
L.4	13/95	13.7	7/33	21.2	2/26	7.8	9/99	9.1	4/34	11.8	2/27	7.4
L.5	7/101	6.9	2/36	5.5	2/24	8.3	2/97	2.1	1/37	2.7	1/21	4.8
S.1	2/115	1.7	0/39	0.0	0/31	0.0	-	-	-	-	-	-

Table 80: Distribution of Types of Noding in the Lower Thoracic and Lumbar spine

	Central				Anterior/Posterior				Transverse				Anterior			
	superior		inferior		superior		inferior		superior		inferior		superior		inferior	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
T.6	1/38	2.6	3/42	7.1	2/38	5.3	11/42	26.2								
T.7	3/44	6.8	3/45	6.7	2/44	4.5	10/45	22.2	1/44	2.3						
T.8	6/51	11.8	3/53	5.7	7/51	13.7	14/53	26.4								
T.9	3/54	5.6	2/54	3.7	2/54	3.7	11/54	20.4			1/54	1.8	1/54	1.8		
T.10			5/56	5.4	1/56	1.8	4/56	7.1	4/56	7.1	4/56	7.1				
T.11	2/60	3.3	5/61	8.2			4/61	6.6	3/60	5.0	4/61	6.6				
T.12	5/60	8.3	5/68	7.2	1/60	1.7	2/68	2.9	7/60	11.7	1/68	1.5				
L.1	5/93	5.4	6/100	6.0	2/93	2.2	6/100	6.0	4/93	4.3	4/100	4.0				
L.2	8/97	8.2	5/96	5.2	2/97	2.1			12/97	12.4	6/96	6.2	2/97	2.1		
L.3	5/98	5.1	3/87	3.4			1/87	1.1	18/98	18.4	6/87	6.9	1/98	1.0	3/87	3.4
L.4	4/95	4.2	4/99	4.0	1/95	1.0	1/99	1.0	6/95	6.3	4/99	4.0	2/95	2.1		
L.5	1/101	1.0	2/99	2.0	1/101	1.0			1/101	1.0			4/101	4.0		
S.1	1/115	0.9											1/115	0.9		

Table 81: Incidence of Transverse Nodes in the Lower Thoracic and Lumbar Spine among All Types of Noding

	Males				Females			
	Superior		Inferior		Superior		Inferior	
	n	%	n	%	n	%	n	%
T.10	2/2	100.0	2/2	100.0	0/0	0.0	1/4	25.0
T.11	1/2	50.0	2/6	33.3	0/0	0.0	0/2	0.0
T.12	3/5	60.0	1/3	33.3	1/2	50.0	0/1	0.0
L.1	3/3	100.0	3/3	100.0	0/1	0.0	0/3	0.0
L.2	5/8	62.5	2/5	40.0	1/3	33.3	0/0	0.0
L.3	9/10	90.0	4/6	66.7	3/4	75.0	0/3	0.0
L.4	4/7	57.1	1/4	25.0	0/2	0.0	1/2	50.0
L.5	1/2	50.0	0/1	0.0	0/2	0.0	0/1	0.0

CHAPTER 9

DEGENERATIVE CHANGES

The interpretation of degenerative changes is difficult and, in general, little is done in osteological reports beyond noting the frequency of the occurrence of arthritis on joint surfaces of the skeleton.

Arthritis was coded in degrees of severity from 1 to 5: 1 denoting a slight build-up of bone at the margins of a joint surface; 2 more extensive build-up at the margins; 3 the beginning of eburnation on a joint with its surface pitted; 4 extensive destruction of the joint with pitting overridden by a ridged eburnated surface; 5 fusion of the joint surfaces.

Joint surface differences

The summary diagram (Fig. 26) provides percentage incidences of all degrees of arthritis in all adults. It is not surprising if there are very different incidences for the two surfaces of the same joint. More pressures may be exerted on one part of a joint capsule than on another: but, more importantly, the observation of slight degrees of arthritis is subjective, liable not only to inter- and intra-observer error, but difficult because some joint surfaces show slight changes more clearly than others. Moreover, sample sizes will be very variable because some joint surfaces are more liable than others to the slight damage that makes observation of arthritic changes impossible.

The ilio-femoral joint, however, provides an example of the differences between the two surfaces of the same joint, taking into account only more marked expressions of arthritis, that is, "2" to "4", to reduce observer error. The frequencies for the acetabulum [right (12/111) 10.8%; left (15/111) 15.8%] contrast sharply with those for the femoral head [right (0/67); left (1/72) 1.4%]. The acetabulum then shows more arthritic changes than the femoral head, whether one looks at all or only at more severe expressions of arthritis.

In other joints, sample sizes are smaller and arthritic changes in some cases are less severe. It thus seems best, as well as justifiable, to use all degrees of arthritis in the following analysis.

Side differences

There is probably no side difference at the shoulder: the humeral head shows none and the glenoid fossa difference is not real, it is based on small sample size and statistically is quite insignificant (X^2 adjusted P = .3).

Similarly, at the elbow, right and left sides are equivalent except for the radial heads for which the probability is about .15. In the wrists the radius again appears to show right/left differences but the probability is actually only .4.

It seems that arthritis is more marked in the left hip. However, for the acetabulum the probability using 2+ degrees of arthritis is .5, the difference between sides being quite insignificant, and little more significant (P = .2) when all degrees of arthritis are used. It is at the femoral head that the side difference shows up, but, with a probability of .057, it is only approaching significance.

As with the scapula, the fibula data are derived from a small sample so that one cannot put too much emphasis on the side differences indicated there. We are left with the possibility that the right knee shows considerably more degeneration than the left. This is worth examining in more detail.

There is no difference in marked expressions of arthritis on the medial condyle of adult femora between left (4/85: 4.7%) and right (4/82: 4.9%) incidences. The lateral condyles also have statistically equivalent incidences (right - 7/91: 7.7%; left - 4/76: 5.3%), the probability being .53.

The tibia lateral condylar surfaces (right - 2/55: 3.6%; left - 2/54: 3.7%) show no difference between sides on more marked expressions of arthritis and the medial surfaces (right - 4/63: 6.3%; left - 3/73: 4.1%) display little more difference. No real side differences exist, even if all degrees of expression are taken into account: the probabilities are only .5 for the medial, and a not quite significant .06 for the lateral surface.

In the vertebral column significant differences between arthritis incidences of the right and left superior facets exist for T.5 (X^2 = 8.2, P at 1df = .004) and T.12 (X^2 = 5.07, P at 1df = .02). These differences are expressed only by the slightest degree of arthritis and disappear when '0' and '1' are lumped (T.5 right, 3/79: left, 6/40; T.12 right, 1/61: left 1/64).

T.5 is interesting not only in having some left/right differences but in having the highest incidence (41% on the right) of arthritic breakdown of the vertebral articular facets (Figs.28,29). The particular stresses laid on this vertebrae result from its position in the Grimsby population at the height of the dorsal curve (see the vertebral index, Table 82).

The asymmetry of arthritis in T.12 is confirmed in the analysis, summarized in Table 83, which deals with those T.12 vertebrae in which both superior facets are observable. The incidence of arthritis present unilaterally on the right is particularly high (18/37: 48.6%). This pattern of arthritis seems to be a characteristic of the Grimsby population, rather than a result of the various possible morphologies of T.12 (Table 84). T.12 does not always display asymmetry in facet arthritis (Jackes 1977).

The above discussion on side differences in the incidence of arthritis has shown that, except in the case of several vertebrae, any apparent right/left frequency differences are not significant.

Age differences

Though side may have no effect on arthritis, age of course does. It is important to know the proportion of the population over 35 or 40 in any analysis of arthritis. Table 85, which provides information on cervical arthritis and osteophytosis, is the clearest example of age differences. Osteophytosis of the superior body of C.7, with incidences of 69.2% in older and 5.3% in younger adults, is the most extreme case of age disparities.

While the cervical vertebrae present the most dramatic differences in bone degeneration between younger and older adults, the possibility of a large difference of incidence must be kept in mind for all bones. Thus, Table 86 is presented with age breakdown whenever the sample sizes are large enough. Although it is true that there may have been some mixing of individuals during burial and/or excavation and that adult age assessment techniques may be lead to errors, whatever indication of age there is must be included in the analysis since age is basic to arthritis incidences.

Sex differences

While age is basic to a discussion of arthritis incidences, sex differences in degenerative changes are ambivalent.

For the humerus, there seems to be little difference between sides at the four locations where arthritis was observed and, at the head, there was no difference at all between males and females. Distally, however, male and female differences are indicated (Table 87).

For the trochlear surface the sample consisted of 22 young and 13 older males and 11 young and 8 older females (13/15: 37.1%; 8/19: 42.1%);

age category inequalities in the sample do not enter into the question. Males do have more arthritis than females at the elbow joint. However, this does not show up on the radial head where males have 13.3% arthritis (4/30) and females 14.8% (4/27), with 44% (7/16) of males and 38.4% (5/13) of females in the older category. At the radial articulation surface on the ulna, males do have more arthritis (19/48: 39.6%) than females (10/44: 22.7%) or a difference of 16.9% (P = .08). An equivalent difference between males (19/42: 45.2%) and females (10/35: 28.6%) is seen on the olecranon surface, again non-significant (P = .13). The difference between males and females is doubled for coronoid notch arthritis: males have 46.5% (20/43) and females 12.3% (12/39), nevertheless the difference is not significant (P = .14) whatever test is used.

There is then no significant difference between the sexes at the shoulder. There is some indication (from the trochlea of the humerus) that males have more arthritis at the elbow than females. This difference is based entirely on mild arthritic changes. If more severe changes alone are considered, differences vanish.

At the wrist, males and females appear to have the same amount of arthritis: distal radius, males - 14/46: 30.4%; females - 9/32: 28.1%).

For the innominates there is again no indication of sex differences (Table 88). In fact, the auricular surface incidences are 23/138 (16.7%) for males and 18/107 (16.8%) for females. The acetabulum similarly gives no indication of sex differences: males - 45/137: 32.8%; females - 23/90: 25.6% (P = .24).

The femoral head, with a male frequency of 3/35 (8.6%) and a female frequency of 2/35 (5.7%), supports the contention that there is no difference at the hip between sexes (although spurring around the fovea capitis is 22.2% in males (12/54) and nonexistent in females (0/58)).

Table 89, however, points to clear sex differences at the knee in the frequencies of arthritis. Analysis of the femora has been done twice, and the second results are reported here after a complete reassessment of the ages and sexes of individuals and the possibility of mixing. The two sets of results do not differ substantially but confirm that sex assignments for the femora are reasonably reliable.

Table 90 shows that the male and female sample sizes for age categories are comparable. However, because the older adult femora represent around 50% of the male femora, but only 36% of the female femoral sample, only the 18-35 year age group will be examined (Table 91). The males have well over twice as much arthritis at the knee as females.

Little is known of the Neutral Indians' activity patterns: inferences must be drawn from what is recorded for the Huron. Though Champlain considered Huron men good for nothing but hunting, fighting, dancing and sleeping (Biggar 1929: 136-137) while the women did the hard work, it seems likely that felling trees, bringing in timber for village building, and carrying great loads when portaging on hunting and trading expeditions, exerted pressures on the knees of men more damaging than the agricultural and other activities of the women. In this connection, we can cite Merbs (1969:33) for evidence that lifting of heavy objects causes arthritis of the knees.

The vertebral column is especially sensitive to degenerative changes (see Tables 92 to 99), although these changes may be dependent upon the sex of the individual. Unfortunately, sex attribution cannot be as certain for spines as for innominates and associated femora.

To a certain extent the pattern of incidence of osteophytosis and the pattern for facet arthritis echo

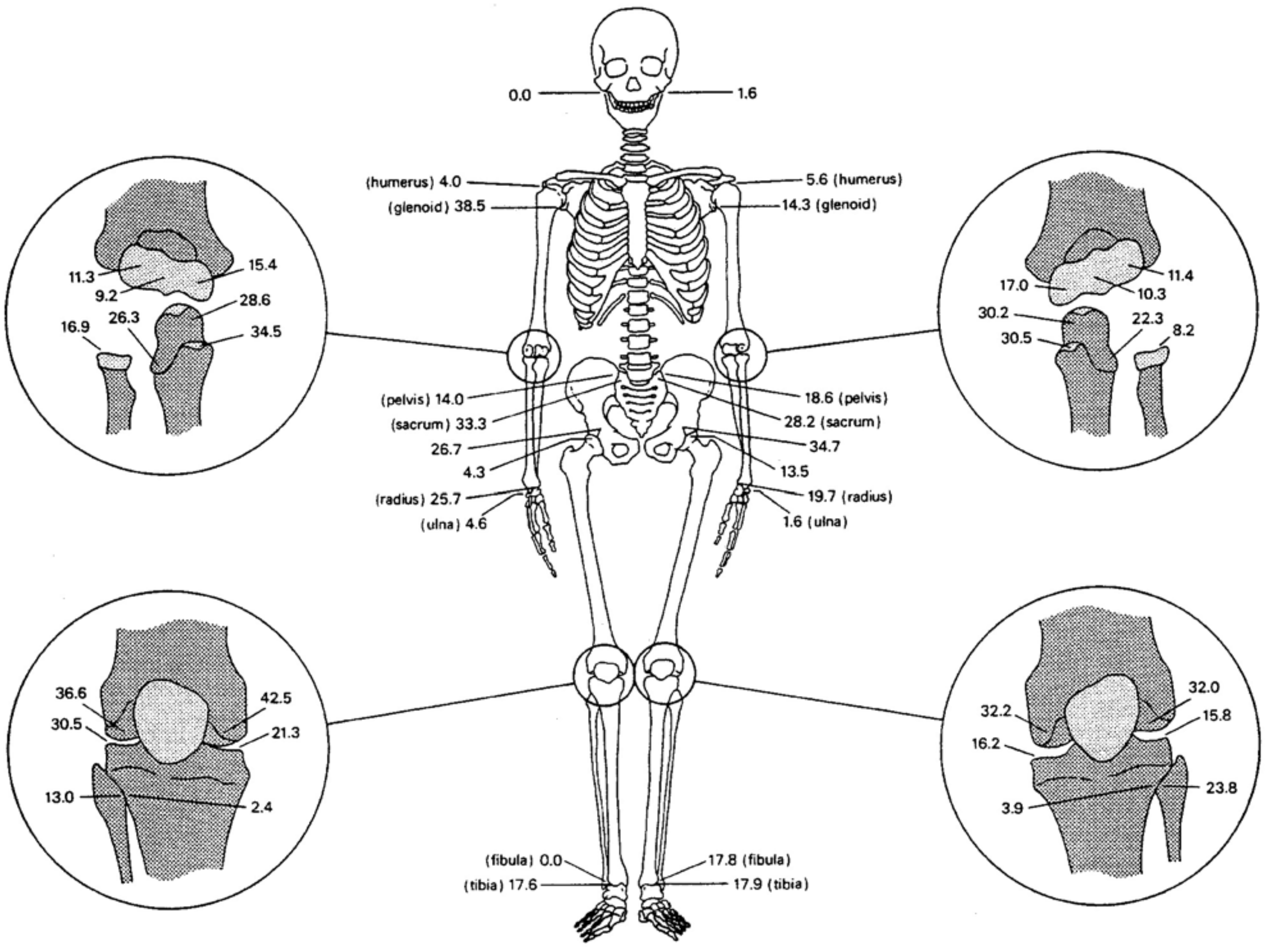


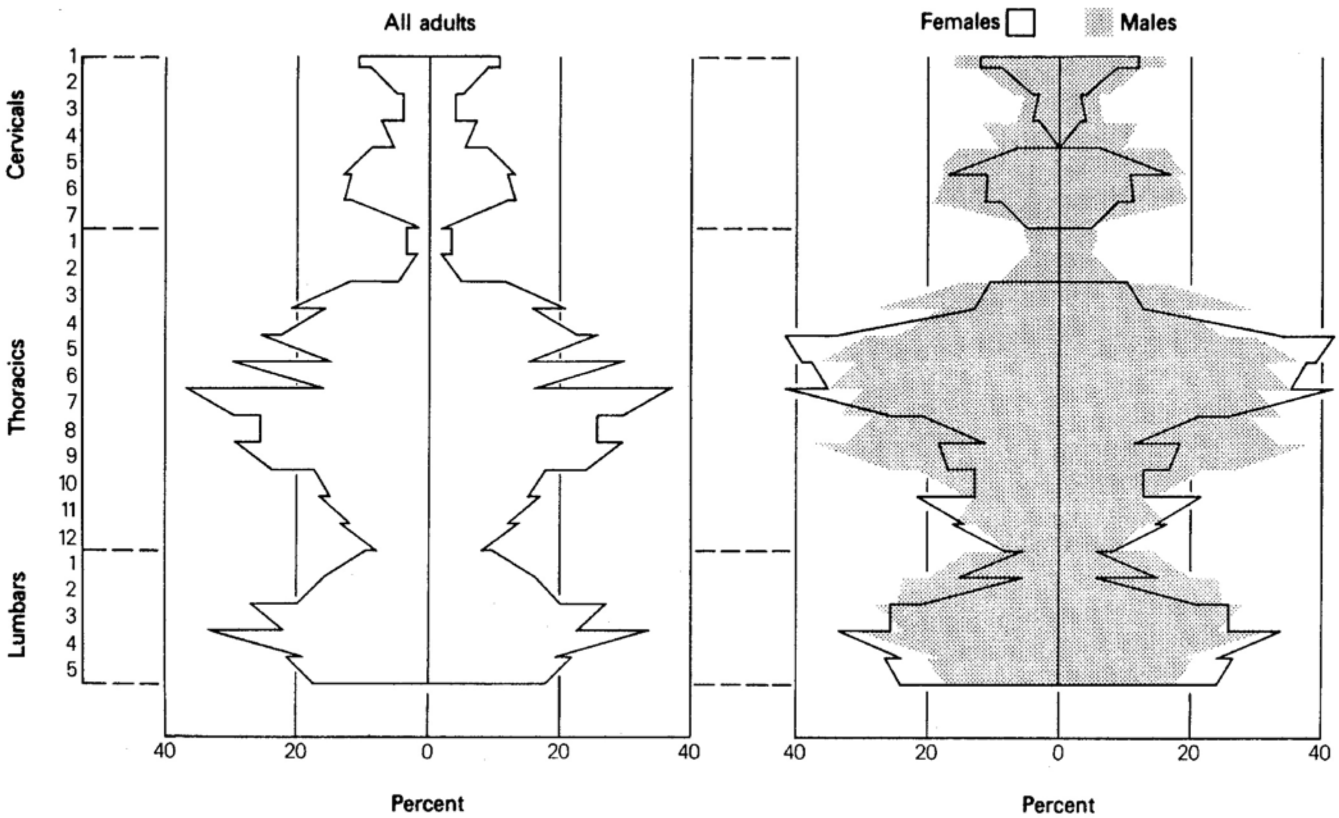
Figure 26: Frequency of all degrees of arthritis in adults

each other. This is especially true for females, who have both less osteophytosis (Table 92 and Fig. 27) and less facet arthritis in the cervical region (Table 93) than males. Overall, the frequency of male cervical facet arthritis is 19.6% while for females it is 6.7% (Table 94).

While there is a difference between males and females for thoracic osteophytosis (Table 97 and Fig. 27), there is considerable concordance between male and female patterns of facet arthritis (Fig. 28). Males have a little more arthritis in the right upper thoracic and less in the left upper thoracic region, but in both sexes the right peaks of incidence at T.5 and T.10 are well marked, with reduced incidence at T.7. In both sexes the left incidence is lower but more evenly distributed with some peaks at T.4 and T.10.

In males, lumbar osteophytosis is more marked in the upper lumbar region and less marked in the lower, the reverse of the female pattern (Table 97). There are some slight differences in the patterning of facet arthritis between males and females for the lumbar region and, overall, females have slightly more lumbar superior facet arthritis (27.3%) than do males (17.9%) (Table 94). The difference for lumbar superior facet arthritis is especially marked in young adults, most significantly on the left, where the probability of the male/female difference is .013

Figure 27: Lipping of centra in adults (see data in Table 95).



The data are difficult to interpret; male and female osteophyte patterns are rather different, especially in the mid and lower thoracic and lumbar regions. The pattern of facet arthritis incidence is, however, basically the same in both sexes except for the cervical region. In this population, males are more likely to suffer osteophytosis and cervical arthritis than females.

There is some evidence from the literature that males always have more osteophytosis than females, in human beings (Nigerians, Davis 1960; Eskimos, Merbs 1963; American whites and blacks, Nathan 1962; Europeans, Schmorl and Junghanns 1959) and in other animals (Harris 1977). However, male/female differences may depend on the age structure of the sample being studied (Merbs 1969:36; Roche 1957).

There is little material dealing with arthritis of the vertebral articular facets, but it seems likely that males are more often affected than females (see e.g. Merbs 1969), especially as there is some correlation, more markedly in the cervical region (Inglemark *et al*. 1959), between osteophytosis and arthritis in the vertebral column.

Summary on trauma and degeneration

The general impression is of a population which is not seriously affected by bone degeneration or trauma. It is possible that, at least for arthritis, this is a result of an early age at death. As is perhaps to be expected, major trauma was probably more common in males.

Of changes in the skeleton caused by factors other than major trauma, only arthritis of the knee, cervical arthritis and osteophytosis, and superior lumbar noding consistently differ in incidence between male and females. In each case the males have higher incidences. Cervical degeneration could be a result of something other than activity (e.g. directly sex dependent, dependent on the age structure of the sample), but the evidence indicates that males were doing heavier work than females.

The data presented in Table 96 indicate that special strains were placed on the male lower spine in the Grimsby population (P = .024, comparing male and female, 35+, inferior facet arthritis, pooled sides). This conclusion is supported by the information given in the previous chapter. Noding is no doubt a result of compression loading (Farfan *et al.* 1972) and transverse nodes may be caused by lateral bending together with compression loading. Transverse nodes are most common among males (significance of male/female difference, pooled surfaces P = .008; see Table 81 in Chapter 8). Such evidence of sexual differentiation is best explained by differences in activity patterns. While the females were constantly active, the males were more likely to have episodes of sudden, stressful activity after periods of relaxation: specifically, the males heaved, lifted and carried heavy objects more often than did the women.☐

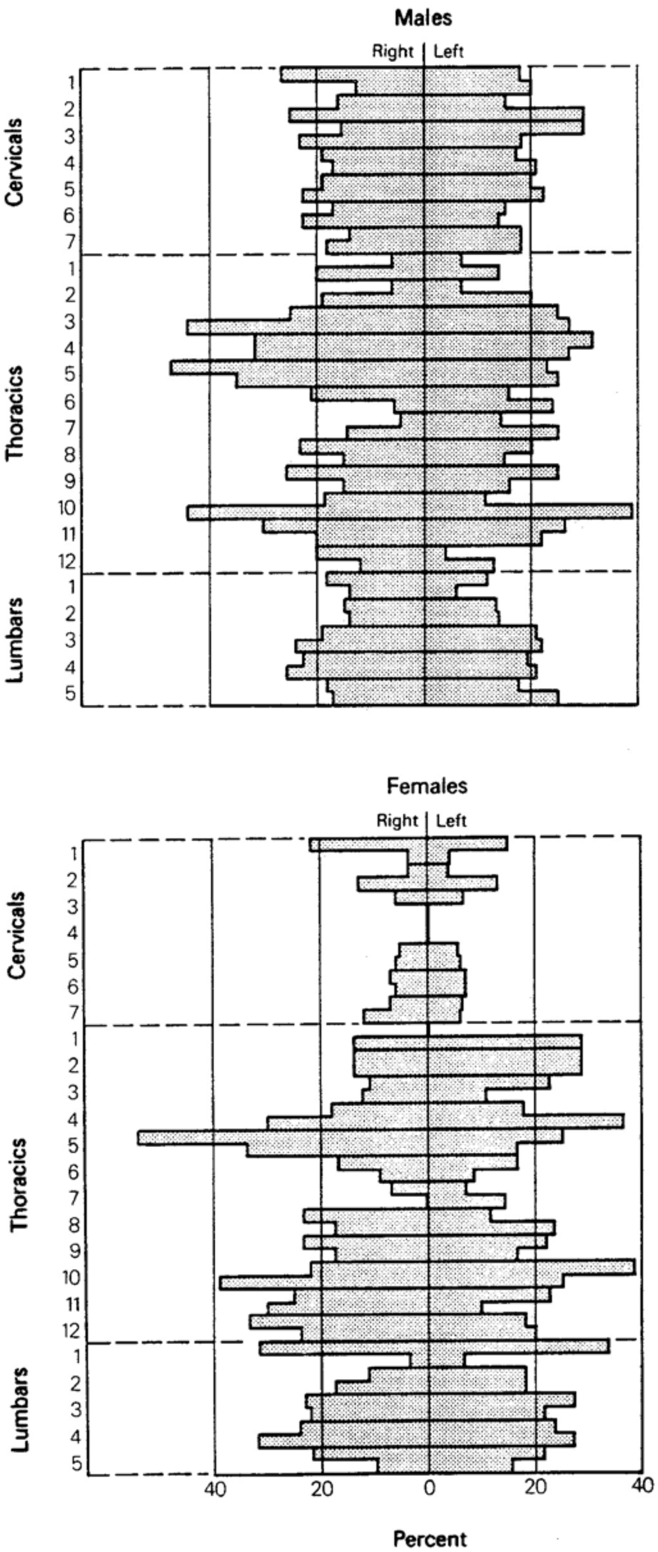


Figure 28: Incidence of arthritis of the superior and inferior facets of vertebrae

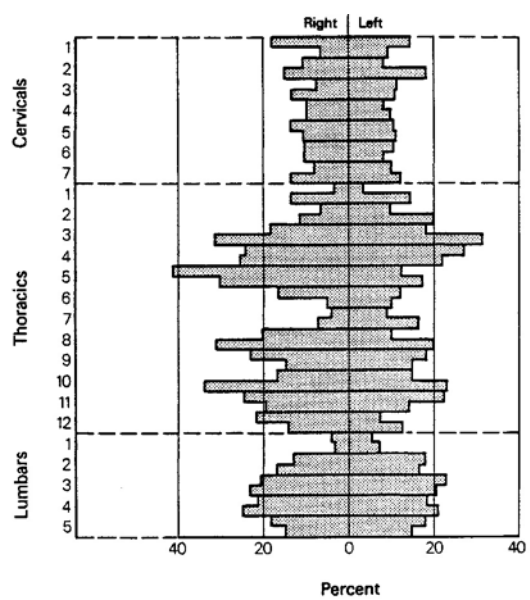


Figure 29: All degrees of arthritis of the articular facets of adult vertebrae

Table 82: Thoracic Indices

Vertebra	Index
T.1	104.4
T.2	101.1
T.3	102.3
T.4	105.3
T.5	110.5
T.6	107.8
T.7	107.6
T.8	104.7
T.9	102.5
T.10	105.3
T.11	114.8
T.12	112.8

Table 83: T.12 Superior Facet Arthritis

	n	%
Symmetrically present	14/37	37.4
Present only on or more marked on the right	19/37	51.4
Present only on or more marked on the left	4/37	10.8

Table 84: T.12 Superior Facet Arthritis More Marked on the Right

Inferior facet orientation normal in 3/4 (75.0%)
Inferior facet orientation intermediate in 3/5 (60.0%)
Inferior facet orientation indicates lengthened thoracic region in 2/5 (40.0%)
Inferior facet orientation asymmetrical in 3/7 (42.8%)

Table 85: Incidences of Cervical Arthritis and Osteophytosis

	C.1		C.2		C.3		C.4		C.5		C.6		C.7	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Superior facets														
Right														
18-35	5/40	12.5	2/41	4.9	0/24	-	0/25	-	1/28	3.6	1/29	3.4	1/26	3.8
35+	10/24	41.7	5/21	23.8	4/17	23.5	6/21	28.6	6/20	30.0	6/17	35.3	4/17	23.5
Total	18/101	17.8	11/104	10.6	4/54	7.4	6/63	9.5	9/68	13.2	7/66	10.6	5/61	8.2
Left														
18-35	3/37	8.1	2/40	5.0	1/23	4.3	0/26	-	0/29	-	1/30	3.3	1/27	3.7
35+	7/22	31.8	4/23	17.4	5/16	31.2	5/21	23.8	7/20	35.0	5/17	29.4	5/17	29.4
Total	14/101	13.9	8/101	7.9	6/51	11.7	5/63	7.9	7/67	10.4	7/67	10.4	6/60	10.0
Inferior facets														
Right														
18-35	1/38	2.6	3/36	8.3	0/24	-	0/27	-	1/28	3.6	1/29	3.4	2/26	7.7
35+	4/21	19.0	7/20	35.0	6/17	35.3	6/20	30.0	6/17	35.3	7/18	38.9	5/20	25.0
Total	6/98	6.1	13/93	14.0	7/54	13.0	6/63	9.5	7/64	10.9	7/67	10.4	9/66	13.6
Left														
18-35	1/38	2.6	2/36	5.5	0/26	-	0/26	-	1/26	3.8	1/29	3.4	1/27	3.7
35+	8/25	32.0	8/20	40.0	5/17	29.4	6/20	30.0	6/19	31.6	4/14	28.6	6/19	31.6
Total	10/108	9.2	13/88	14.8	6/54	11.1	6/61	9.8	7/63	11.1	5/60	8.3	8/66	12.1
Superior body														
18-35	8/44	18.2	6/40	15.0	0/22	-	0/23	-	1/23	4.3	3/24	12.5	1/19	5.3
35+	12/27	44.4	8/23	34.8	3/18	16.7	7/18	38.9	9/20	45.0	9/15	60.0	9/13	69.2
Total	25/115	21.7	19/104	18.3	3/52	5.8	8/56	14.3	11/62	17.7	14/56	25.0	10/42	23.8
Inferior body														
18-35			1/7	14.3	0/23	-	0/24	-	3/23	13.0	2/23	8.7	1/20	5.0
35+			5/22	22.7	4/16	25.0	5/17	29.4	13/21	61.9	11/17	64.7	1/11	9.1
Total			7/88	7.9	4/51	7.8	6/56	10.7	17/64	26.6	15/56	26.8	2/44	4.5

Table 86: All Degrees of Arthritis in the Adult Post-cranial Skeleton

	All		18-35		35+	
	Right	Left	Right	Left	Right	Left
Tempero-mandibular joint						
mandibular condyle	0/55	1/61	0/29	0/30	0/15	1/18
Scapula						
glenoid fossa	5/13	2/14				
Humerus						
head	3/75	4/72	0/25	1/24	3/13	2/15
trochlea	17/110	17/100	2/33	2/34	6/19	9/21
capitulum	11/97	10/88	1/30	2/31	8/20	4/15
interarticular surface	11/119	11/107	0/35	0/34	7/22	3/18
Radius						
ulnar notch (distal)	6/66	4/74	3/27	2/28	1/11	1/12
radial head	10/59	5/61	2/19	0/17	4/12	2/13
distal radius	18/70	15/76	8/29	7/28	6/14	2/12
Ulna						
radial articulation	25/95	23/103	7/27	4/30	10/15	8/18
olecranon process	26/91	26/86	7/25	7/24	9/13	6/14
coronoid process	30/87	29/95	8/23	9/28	9/14	5/14
distal ulna	3/65	1/62	1/22	0/23	2/12	1/9
Pelvis						
acetabulum	31/116	41/118	6/56	8/54	14/27	16/26
auricular surface	17/121	24/129	6/59	6/57	6/27	10/30
Sacrum						
superior facet	14/115	16/113	3/53	2/50	8/24	8/24
auricular surface	24/72	22/78	6/33	6/33	8/17	8/16
superior body osteophytes	28/85		7/37		14/20	
Femur						
head	3/69	10/74	1/23	2/20	1/16	4/17
medial condyle	37/87	29/90	13/36	9/31	9/16	6/19
lateral condyle	34/93	25/78	10/37	8/30	9/17	5/14
fovea capitis	12/111	17/105	1/37	2/32	7/25	4/25
Patella						
medial	5/14	7/19				
lateral	7/19	4/19				
Tibia						
medial condyle	13/64	12/74	4/17	2/22	5/15	6/16
lateral condyle	18/58	9/56	3/14	1/14	6/13	7/17
distal facet	17/101	19/105	5/30	8/33	6/20	4/22
superior fibular facet	2/83	3/76	0/27	0/25	2/19	3/19
Fibula						
proximal facet	3/23	5/21				
distal facet	0/28	5/28				
Calcaneus						
cuboid facet	2/17	0/10				
anterior facet	7/23	0/15				
medial facet	11/32	4/20				
posterior facet	3/23	2/15				
Talus						
superior facet	1/18	1/18				
navicular facet	0/17	1/12				
anterior calcaneal facet	3/18	1/14				
posterior calcaneal facet	6/21	3/19				

Table 87: Sex Differences in Arthritis of the Humerus

	Right n	Left n	Right & Left n	Right & Left %	All reassessed* n	All reassessed* %
Head						
Males	2/24	1/24	3/48	6.2	3/44	6.8
Females	0/16	2/16	2/32	6.2	2/30	6.7
Trochlea						
Males	7/31	9/35	16/66	24.2	16/62	25.8
Females	1/22	2/19	3/41	7.3	3/39	7.8
Capitulum						
Males	7/29	5/28	12/57	21.0	12/54	22.2
Females	2/21	1/16	3/37	8.1	3/36	8.3
Interarticular						
Males	6/36	3/36	9/72	12.5	9/65	13.8
Females	1/23	0/16	1/39	2.6	1/39	2.6

*the results after a complete reassessment and the removal of uncertain individuals.

Table 88: Arthritis of All Degrees in the Innominates

	Right 18-35	Right 35+	Right Total	Left 18-35	Left 35+	Left Total
Acetabulum						
Males	4/32	9/16	19/64	5/36	10/15	26/73
Females	2/24	5/11	11/50	3/18	6/11	12/40
Auricular surfaces						
Males	6/36	1/13	9/65	3/36	5/15	14/73
Females	0/23	5/14	8/54	3/21	5/15	10/53

Table 89: Arthritis at the Knee Joint

	Male n	Male %	Female n	Female %	P
Femur					
medial condyle	20/37	54.0	9/47	19.1	.001
lateral condyle	19/38	50.0	8/48	16.7	.001
Tibia					
medial condyle	15/46	32.6	3/29	10.3	.030
lateral condyle	14/37	37.8	3/25	12.0	.025

Table 90: Arthritis in the Femur

	18-35	35+
Fovea capitis		
Males	3/27	9/27
Females	0/37	0/21
Medial Condyle		
Males	14/24	6/17
Females	6/35	3/12
Lateral condyle		
Males	12/23	7/15
Female	3/21	3/12

Table 91: Young Adult Femoral Arthritis

	Medial condyle		Lateral condyle	
	n	%	n	%
Males	14/24	58.3	12/23	52.2
Females	6/35	17.1	5/36	13.9
		P = .001		P = .002

Table 92: Freguency of Osteophytosis of All Degrees in the Cervical Centra

	Dens facet		Superior body		Inferior body	
	n	%	n	%	n	%
All						
C.1	25/115	21.7				
C.2	19/105	18.1			9/99	9.1
C.3			4/53	7.5	4/51	7.8
C.4			8/55	14.5	6/54	11.1
C.5			11/61	18.0	17/63	27.0
C.6			14/56	25.0	15/56	26.8
C.7			10/42	23.8	2/43	4.6
Males						
C.1	12/38	31.6				
C.2	9/36	25.0			5/33	15.2
C.3			3/26	11.5	3/24	12.5
C.4			6/25	24.0	5/25	20.0
C.5			8/25	32.0	10/26	38.5
C.6			9/25	36.0	10/26	38.5
C.7			8/20	40.0	1/19	5.3
Females						
C.1	8/32	25.0				
C.2	5/26	19.2			2/25	8.0
C.3			1/15	6.7	1/15	6.7
C.4			1/16	6.2	0/15	0.0
C.5			2/18	11.1	6/18	33.3
C.6			3/14	21.4	3/14	21.4
C.7			2/12	16.7	1/11	9.1

Table 93: Frequency of Arthritis of All Degrees on the Cervical Articular Facets

	Superior				Inferior			
	Right		Left		Right		Left	
	n	%	n	%	n	%	n	%
All								
C.1	18/101	17.8	14/101	13.9	6/98	6.1	10/111	9.0
C.2	11/104	10.6	8/101	7.9	14/94	14.9	14/89	18.7
C.3	4/54	7.4	6/51	11.7	7/54	13.0	6/54	11.1
C.4	6/63	9.5	5/63	7.9	6/63	9.5	6/61	9.8
C.5	9/68	13.2	7/67	10.4	7/64	10.9	7/63	11.1
C.6	7/66	10.6	7/67	10.4	7/67	10.4	5/60	8.3
C.7	5/61	8.2	6/60	10.0	9/66	13.6	8/66	12 1
Males								
C.1	9/34	26.5	6/32	17.6	4/31	12.9	7/35	20.0
C.2	6/34	17.6	5/33	15.2	8/32	25.0	8/32	25.0
C.3	4/26	15.4	6/24	25.0	6/26	23.1	5/27	18.5
C.4	6/29	20.7	5/29	17.2	6/30	20.1	6/29	20.7
C.5	6/29	20.7	6/30	20.0	6/27	22.2	6/27	22.2
C.6	6/31	19.4	5/32	15.6	7/31	22.6	4/28	14.3
C.7	4/28	14.3	5/27	18.5	5/28	17.8	5/27	18.5
Females								
C.1	6/28	21.4	4/27	14.8	1/26	3.8	1/29	3.4
C.2	1/26	3.8	1/28	3.6	3/23	13.0	3/23	13.0
C.3	1/15	6.7	1/15	6.7	0/14	0.0	0/15	0.0
C.4	0/16	0.0	0/16	0.0	0/15	0.0	0/14	0.0
C.5	1/18	5.6	1/18	5.6	1/17	5.9	1/17	5.9
C.6	1/14	7.1	1/14	7.1	1/15	6.7	1/14	7.1
C.7	1/14	7.1	1/15	6.7	2/17	11.8	1/17	5.9

Table 94: Overall Incidence by Region of Small Joint Arthritis in the Vertebral Column

	Males			Females			
	Right	Left	Total	Right	Left	Total	P
	n	n	%	n	n	%	
Cervical							
superior	41/211	38/207	18.9	11/131	9/133	7.6	.000
inferior	42/205	41/205	20.2	8/127	7/129	5.8	.000
Thoracic							
superior	55/243	43/248	20.0	37/164	33/164	21.3	n.s.
inferior	57/245	53/233	23.0	35/162	31/163	20.3	n.s.
Lumbar							
superior	33/177	31/181	17.9	32/140	36/145	27.3	.060
inferior	35/176	27/169	18.0	23/134	24/139	17.2	n.s.

Table 95: Frequency of Arthritis of All Degrees on the Superior Articular Facets

	Right				Left			
	Males		Females		Males		Females	
	18-35	35+	18-35	35+	18-35	35+	18-35	35+
C.3	0/15	4/11	1/9	0/6	1/14	5/10	1/9	0/6
C.4	0/15	6/14	0/9	0/7	0/15	5/14	0/9	0/7
C.5	0/15	6/14	1/12	0/6	0/16	6/14	0/12	1/6
C.6	0/19	6/12	1/9	0/5	0/19	5/13	1/10	0/4
C.7	0/16	4/12	1/9	0/5	0/16	5/11	1/9	0/6
T.1	0/8	1/8	0/4	0/3	0/7	1/7	0/4	0/2
T.2	0/8	1/8	1/4	0/3	1/8	0/8	1/4	1/3
T.3	1/8	3/8	1/6	0/3	1/8	3/8	2/6	0/3
T.4	2/8	3/8	0/6	2/5	2/8	3/8	0/6	2/5
T.5	3/8	5/9	4/6	2/5	2/8	2/9	2/7	1/5
T.6	2/10	2/9	0/7	2/5	1/10	2/9	0/7	2/5
T.7	1/13	0/9	1/9	0/5	1/12	2/9	0/9	1/5
T.8	1/15	5/11	2/12	2/5	2/14	3/11	0/12	2/5
T.9	3/15	4/12	2/12	2/5	2/13	4/11	2/12	2/6
T.10	2/15	3/12	1/12	3/6	1/15	2/12	2/12	5/6
T.11	4/14	4/12	4/14	1/6	1/14	6/13	1/12	3/6
T.12	3/15	2/10	4/14	3/7	0/15	1/11	3/14	1/8
L.1	1/23	5/10	3/22	7/10	0/24	4/9	3/23	8/10
L.2	2/24	3/10	2/20	1/6	1/25	4/11	2/21	3/7
L.3	0/24	7/12	2/20	4/6	1/25	7/13	4/21	3/5
L.4	1/23	7/12	1/19	6/10	1/24	6/12	1/21	6/9
L.5	0/25	7/14	2/17	4/10	1/26	6/12	2/18	4/10

Table 96: Frequency of Arthritis of All Degrees on the Inferior Articular Facets

	Right				Left			
	Males		Females		Males		Females	
	18-35	35+	18-35	35+	18-35	35+	18-35	35+
C.3	0/14	6/12	0/9	0/5	0/15	5/12	0/10	0/5
C.4	0/16	6/14	0/9	0/6	0/15	6/14	0/9	0/6
C.5	0/15	6/12	1/12	0/5	0/14	6/13	1/11	0/6
C.6	0/18	7/13	1/10	0/5	0/18	4/10	1/10	0/4
C.7	1/16	4/12	1/9	1/8	0/15	5/12	1/10	1/7
T.1	1/8	2/7	1/4	0/3	1/7	1/7	1/4	1/3
T.2	1/8	2/8	1/4	0/3	2/7	1/8	2/4	0/3
T.3	2/8	5/8	0/5	1/3	2/7	2/8	0/6	1/3
T.4	2/8	3/8	1/5	2/5	2/7	2/8	2/6	2/5
T.5	1/8	5/9	2/7	2/5	1/7	3/9	1/7	1/5
T.6	0/10	1/8	0/7	1/4	1/8	3/9	0/7	1/5
T.7	2/12	1/9	0/9	0/5	3/11	2/9	0/9	2/5
T.8	2/14	3/10	1/12	2/5	2/13	3/10	2/12	2/5
T.9	1/15	3/11	1/11	2/6	1/14	3/12	2/12	1/6
T.10	4/15	8/12	4/12	3/6	4/13	6/13	2/10	2/6
T.11	1/14	4/11	4/14	2/6	2/13	3/10	1/14	1/6
T.12	0/13	3/11	2/14	3/7	1/13	2/10	2/14	2/6
L.1	0/25	5/11	1/24	0/6	0/24	2/10	0/23	2/9
L.2	1/24	4/12	2/21	3/7	0/23	5/12	3/21	2/7
L.3	1/22	7/11	3/21	3/6	1/21	6/11	3/23	3/5
L.4	1/22	8/13	4/19	5/9	1/23	6/11	3/20	5/10
L.5	0/23	6/13	2/16	0/5	1/23	5/11	1/14	2/7

Table 97: All Degrees of Osteophytosis of Adult Thoracic and Lumbar Centra

	Superior				Inferior			
	18-35	35+	T	%	18-35	35+	T	%
MALES								
T.1	0/4	1/5	1/9	11.1	0/5	1/5	1/10	10.0
T.2	0/6	1/3	1/9	11.1	1/6	1/4	2/10	20.0
T.3	1/4	1/2	2/6	33.3	2/4	2/3	4/7	57.1
T.4	1/5	2/3	3/8	37.5	1/4	4/6	5/10	50.0
T.5	2/5	5/7	7/12	58.3	3/5	5/6	8/11	72.7
T.6	1/3	4/5	5/8	62.5	3/5	4/5	7/10	70.0
T.7	4/10	6/7	10/17	58.8	5/11	7/7	12/18	66.7
T.8	4/11	6/6	10/17	58.8	6/12	6/6	12/18	66.7
T.9	4/8	8/8	12/16	75.0	3/11	7/8	10/19	52.6
T.10	2/11	6/7	8/18	44.4	1/10	4/7	5/17	29.4
T.11	1/12	4/7	5/19	26.3	0/12	7/10	7/22	31.8
T.12	0/11	5/8	5/19	26.3	0/11	3/7	3/18	16.7
FEMALES								
T.1	0/2	0/0	0/2	0.0	0/1	0/0	0/1	0.0
T.2	0/3	0/0	0/3	0.0	0/3	0/0	0/3	0.0
T.3	1/4	0/1	1/5	20.0	1/4	0/0	1/4	25.0
T.4	1/3	0/1	1/4	25.0	2/4	2/2	4/6	66.7
T.5	3/4	2/2	5/6	83.3	4/6	3/3	7/9	77.8
T.6	3/5	3/3	6/8	75.0	3/5	2/2	5/7	71.4
T.7	4/8	3/3	5/6	83.3	3/7	1/1	4/8	50.0
T.8	3/8	1/2	4/10	40.0	1/7	1/2	2/9	22.2
T.9	2/8	2/3	4/11	36.4	1/6	2/3	3/9	33.3
T.10	1/9	2/3	3/12	25.0	1/9	2/3	3/12	25.0
T.11	3/10	3/4	6/14	42.9	3/10	1/4	4/14	28.6
T.12	1/9	3/4	4/13	30.8	0/9	2/4	2/13	15.4
MALES								
L.1	0/14	7/9	7/23	30.4	1/15	10/12	11/27	40.7
L.2	2/13	10/12	12/25	48.0	4/16	10/12	14/28	50.0
L.3	4/13	10/12	14/25	56.0	2/13	10/12	12/25	48.0
L.4	4/13	11/11	15/24	62.5	2/15	7/9	9/24	37.5
L.5	3/17	8/10	11/27	40.7	2/18	9/11	11/29	37.9
FEMALES								
L.1	1/16	1/2	2/18	11.1	2/15	4/6	6/21	28.6
L.2	2/12	0/7	2/19	10.5	3/15	6/7	9/22	40.9
L.3	5/15	6/7	11/22	50.0	6/17	6/7	12/24	50.0
L.4	11/17	9/10	20/27	74.1	5/14	6/9	11/23	47.8
L.5	5/12	5/7	10/19	52.6	4/11	4/6	8/17	47.0

Table 98: All Degrees of Osteophytosis of Adult Thoracic and Lumbar Centra

	Superior		Inferior	
	n	%	n	%
T.1	1/17	5.9	1/17	5.9
T.2	1/18	5.6	2/19	10.5
T.3	4/17	23.5	7/17	41.2
T.4	7/22	31.8	12/26	46.2
T.5	14/27	51.8	19/30	30.0
T.6	14/24	58.3	19/28	32.1
T.7	21/28	75.0	20/34	58.8
T.8	19/37	51.4	19/37	51.4
T.9	20/34	58.8	17/36	47.2
T.10	13/37	35.1	12/39	30.8
T.11	15/45	33.3	13/51	25.5
T.12	12/45	26.7	7/44	15.9
L.1	12/66	18.2	25/74	33.8
L.2	22/66	33.3	30/73	41.1
L.3	40/74	54.0	34/74	45.9
L.4	53/80	66.2	29/73	39.7
L.5	33/76	43.4	27/77	35.1

Table 99: Frequency of Arthritis of All Degrees in Adult Thoracic and Lumbar Articular Facets

	Superior Facets				Inferior Facets			
	Right		Left		Right		Left	
	n	%	n	%	n	%	n	%
T.1	1/30	3.3	1/27	3.7	4/29	13.8	4/28	14.3
T.2	2/31	6.4	3/31	9.7	5/31	16.1	6/30	20.0
T.3	6/33	18.2	6/33	18.2	10/32	31.2	7/32	30.4
T.4	9/37	24.3	10/37	27.0	9/36	25.0	8/36	22.2
T.5	16/39	41.0	5/40	12.5	12/40	30.0	7/39	17.9
T.6	7/42	16.7	5/42	11.9	2/40	5.0	4/40	10.0
T.7	2/45	4.4	4/44	9.1	3/44	6.8	7/43	16.3
T.8	11/54	20.4	8/53	15.1	16/52	30.8	10/51	19.6
T.9	13/57	22.8	10/54	18.5	8/55	14.5	8/56	14.3
T.10	10/60	16.7	11/60	18.3	20/60	33.3	13/56	23.2
T.11	15/62	24.2	13/60	21.7	12/61	19.7	8/59	13.6
T.12	13/61	21.3	5/67	7.5	8/58	13.8	7/57	12.3
L.1	4/95	4.2	5/94	5.3	3/100	3.0	7/96	7.3
L.2	12/90	13.3	16/89	18.0	16/95	16.8	15/90	16.7
L.3	19/93	20.4	22/96	22.9	20/90	22.2	18/88	20.4
L.4	20/97	20.6	18/97	18.6	24/97	24.7	20/95	21.0
L.5	19/105	8.1	18/102	17.6	13/91	14.3	13/89	14.6

CHAPTER 10

DENTAL ATTRITION AND PATHOLOGY

Diet

The diet of the Neutral must, to some extent, have resembled that of the Huron, their fellow agriculturalists to the north. The importance of corn to the Huron is stressed in the literature, as well as the famines that resulted if the maize crop was ruined. Gathered food (berries and acorns) become important only during famine times. Fishing seems to have provided more food than game hunting and the general impression is that meat was not of great importance (Tooker 1964:60-71; Heidenreich 1971: 200-212; Trigger 1976: 31,36,37, 41,415,416). Several factors may, however, have resulted in differences between Huron and Neutral nutrition during the historic period. Before the epidemics that began in 1634, the Huron in historical Huronia may have suffered from population pressure leading, perhaps, to less abundunt game locally. Seventeenth century Huron hunting was largely directed towards trapping beaver for pelts, and beavers had been killed off in Huronia quite soon after the establishment of direct fur trade with the French. Both these factors would have increased the importance of maize agriculture, the province of the women.

A further important consideration for the precontact and contact periods, when drawing inferences about the Neutral from the Huron, is that the Neutral lived in an area further south with a milder climate. The French missionaries noted the woods of the Neutral country and the abundance of game and fruit. It would seem obvious that the Neutral had a better and more varied diet than the Huron, were it not for one piece of evidence. The drought of 1638 was extremely severe. The Neutral did not hunt and gather to overcome the shortage of corn. They sold their children in order to get corn (Thwaites 1898 15:157) and fled (Thwaites 1898 20:49).

The Neutral country was described as very rich with many deer, moose and other animals in the forests and fish in the rivers. The crops were abundant in 1626 according to Daillon (Sagard 1939) and included squash, corn, beans and "other vegetables" as well as tobacco (quoted in Wright 1963:15). Daillon was offered venison, squash, roast corn and cakes made of boiled sunflower seed meal (Anon. 1913:9). Lalemant in 1641 (Thwaites 1898 21:197), in describing Neutral country, writes of chestnuts and wild apples. The Jesuits (Thwaites 1898 21:195-7) did not notice great differences in available foodstuffs between the Huron and Neutral but Daillon certainly considered that Neutral country was richer than historic Huronia.

Huronia was covered by mixed forest, while Neutralia was an area of deciduous forest. The country around Grimsby was originally covered by forests of oak, pine, beech, maple, elm, black ash and chestnut (Wicklund and Matthews 1963:17). Grimsby has a mean annual temperature of 47°F (8°C) compared with 42° to 44°F (6°-7°C) for Simcoe County (i.e. historic Huronia) (cf. Presant *et al*. 1965:21 and Hoffman *et al*. 1962:17), coupled with equivalent precipitation. The area of Grimsby (that between Hamilton and St. Catherines) has 169-170 frost free days a year on average, while Simcoe County averages 126-154 frost free days. Not only is the climate more equable than in Simcoe County, but the soil around Grimsby is very rich, now used for peach orchards and vinyards. The lakeshore soils are the rich Grimsby and Vineland Sandy loams, and above, beyond the escarpment, lie the Haldiman Plain loams which are good for corn growing. In contrast, Simcoe County soils are generally not even good for corn (Hoffman *et al*. 1962:84).

Lalemant, however, stresses that the Neutral diet was not only rich in plant foods, but also in meat. He writes that Brébeuf and Chaumonot had some difficulty because they were fasting for Lent while living in the house of a woman who constantly prepared meat for meals. She prepared special fish meals for the Jesuits (Thwaites 1898 21:225). Thus one visualizes a diet more interesting than that of the Huron with their corn soup and corn bread. The Jesuits seem to have thought that the Neutrals were the better nourished, for they were struck by the fact that the Neutral were "taller, stronger and better proportioned" than the Huron (Thwaites 1898 21:199). Evidence from the Maurice Ossuary (Jerkic 1975) indicates, however, that at that period the Huron were not smaller than the Neutral.

Archaeological evidence confirms the impression that the Neutral ate a good deal of meat. Wright (1981:122ff) provides information on the faunal remains at the Walker site based on over 10,000 bone fragments. The great majority of remains were of white-tailed deer. It is suggested that deer drives (as described by Daillon [Sagard 1939]) resulted in large bags and that whole animals were brought back to the village to be butchered. It would seem that fish, birds, molluscs and turtles also provided food. Lennox (1981:341 ff.) presents comparable information on over 20,000 bone fragments from the Hamilton site. Mammals are slightly less important and deer make up a lower proportion of the mammal fragments but the two sites are remarkably consistent.

The plant remains from the Walker site consist of almost equal quantities of raspberry seeds, corn and hawthorn remains (Wright 1981:113) with a mixture of other cultigens and wild fruits and nuts. Lennox (1981:340) also reports wild fruit and nuts from the Hamilton site.

The osteological evidence offers no signs of dietary deficiencies. But there seems to be some reason to suspect that the women ate less well than the men. The men probably hunted, fished and gathered on their war and trading trips. The women, besides making baskets, spinning twine, preparing skins, sewing and cooking, did all the agricultural work. Though the women no doubt did some gathering (Trigger 1976:36) there is some reason to believe that their diet was not particularly broad: women seem to have had more dental pathology than men.

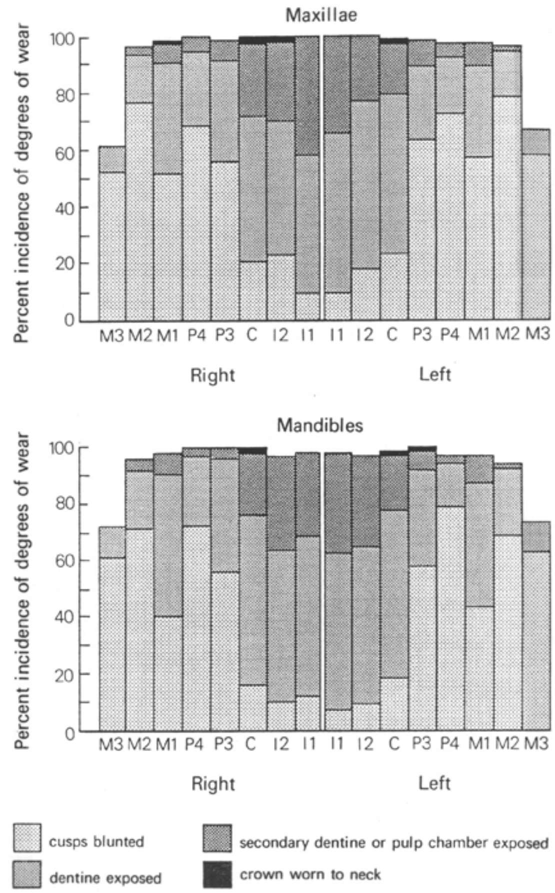


Figure 30: Attrition in young adults

Method

The dentition was coded by Peter Hall following the standardized coding of the University of Toronto Skeletal Data Bank system. On each specimen the presence or absence of individual teeth was recorded. If

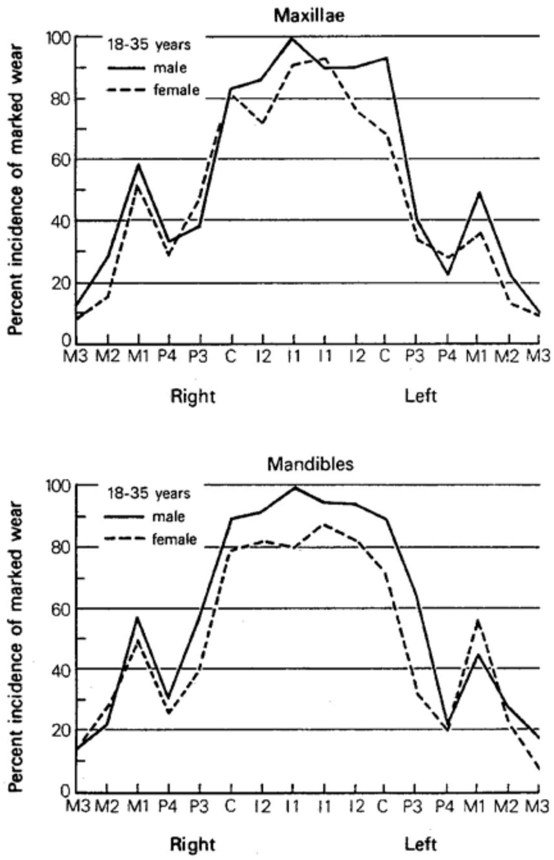


Figure 31: Attrition of 2+ in young adult males and females

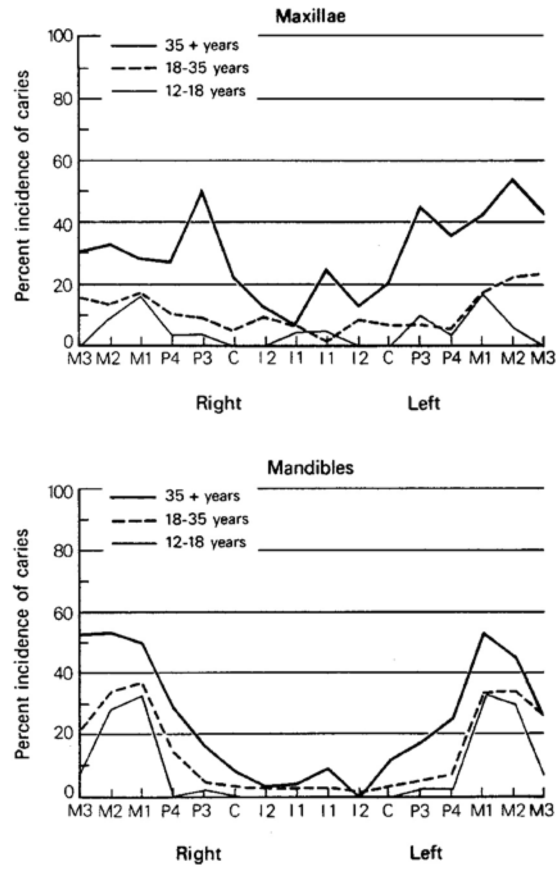


Figure 32: Caries frequencies by age

absent, the loss was recorded as premortem (from pathology) or postmortem, congenital absence or indeterminate. The latter category was necessary because no X-ray facilities were available. Wear was recorded in the following degrees: (1) cusps blunted; (2) dentine exposed; (3) secondary dentine or pulp chamber exposed; (4) crown worn to neck.

Types of caries were recorded as follows: (1) pit and fissure; (2) approximal; (3) pit and fissure and approximal together; (4) crown destroyed by decay.

The data on attrition and pathology are summarized in a series of tables and figures as follows:

attrition: Tables 100, 101; Fig. 30, 31;
caries: Tables 102 to 105; Fig. 32 to 36;
premortem tooth loss: Tables 106 to 109; Fig. 37 to 39;
decay of adult posterior dentition: Table 110;
agenesis and loss of third molars: Table 111;
tests of significance on lost and carious second molars: Table 112;
abscessing: Tables 113 and 114.

Caries and tooth loss

Brothwell (1963:277) states that first molars are "most liable to caries". This is true in the Grimsby population for younger age groups only. In older individuals only the LM_1, which remains most affected by caries, follows the pattern defined by Brothwell. Any pattern is obscured by differences due to age, sex, side and jaw,

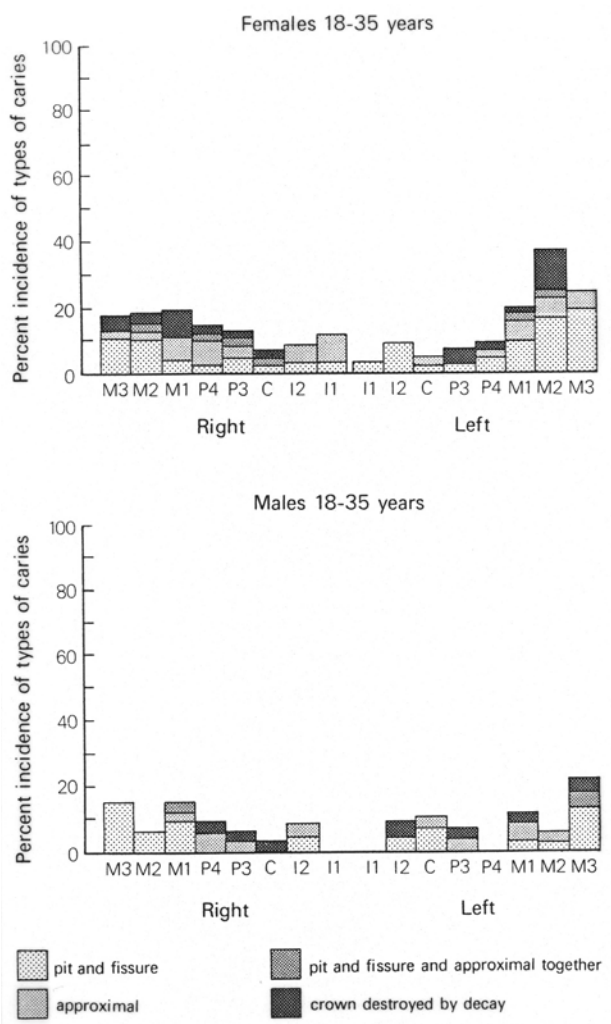


Figure 33: Caries in young adult maxillae

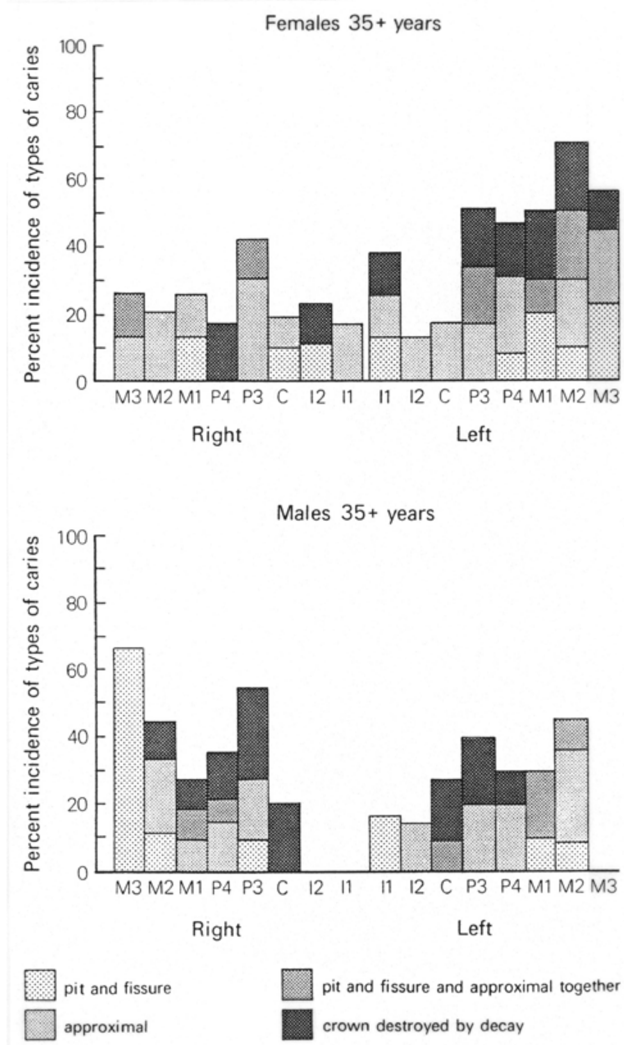


Figure 34: Caries in older adult maxillae

factors which introduce great variation (see Figs. 32 to 36). Phenice (1969:62) similarly finds that the first molar is not invariably the one most often carious, while Pfeiffer (1979:36) demonstrated that the LM_2 are most liable to caries in mandibles, and linked this with the presence of buccal pits. Her study was made on the Kleinburg population, proto-historic Huron.

Identification of the tooth most at risk must also include consideration of teeth lost through pathology. In this population loss of cheek teeth, if not anterior teeth, is due primarily to caries rather than to excessive attrition, trauma or periodontal disease unassociated with carious teeth. Support for this contention lies in a comparison of the data from mandibles illustrated in Figs. 32 and 37, demonstrating that teeth which were carious in 12-18 year olds are likely to be lost in young adult life. Table 110 provides information on tooth decay in all individuals over 18 years. The table excludes those third molars in which the cause of tooth loss is indeterminate. It also excludes those determined to be congenitally absent. The number of cases of M3 hypodontia is 5 and 6 for the right and left M^3, 8 and 4 for the corresponding M_3. Table 111 explores the question of tooth loss of indeterminate cause in more detail. The maximum values may be

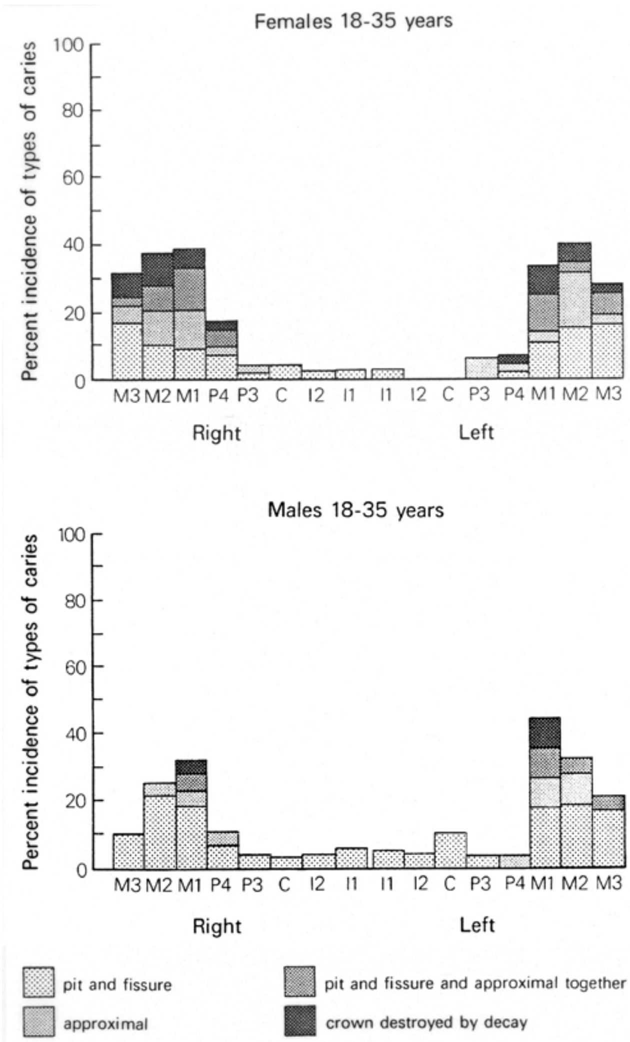


Figure 35: Caries in young adult mandibles

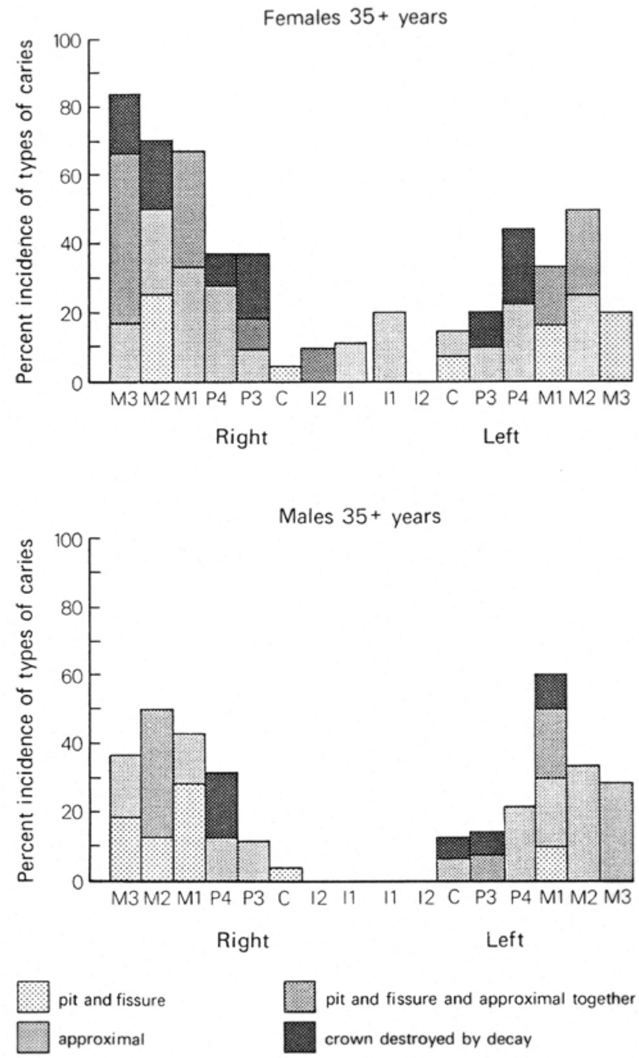


Figure 36: Caries in older adult mandibles

closer to reality since fairly high third molar agenesis values can be expected for American Indians (Brothwell *et al*. 1963; Dahlberg 1963).

The data presented in Table 110 suggest that people generally chewed more on the right and that the mechanical action of chewing cleaned the teeth to some extent, leaving the left teeth much more liable to decay. While the mandibular teeth may be more likely to decay because the lower dentition is bathed in liquids with food particles in the saliva, Dr. J. Mayhall (*in litt*., 1982) has pointed out that a better explanation may lie in the more complex groove pattern of lower molars. The tooth at greatest risk is LM_2 followed by RM_1 and then LM_1. Lower cheek teeth are always at more risk than the uppers except for P^3. In the sexable adults the tooth with the highest frequency of abscessing is LM_1 followed by LM^1 and then by LP^4 and RM^2, an interesting observation implying that the causes of abscessing relate to something in addition to a high incidence of caries and the position in the mouth, i.e. to crown and root structure.

The people of Grimsby suffered severely from dental problems: nearly 36% of all adult cheek teeth were carious or lost. But more than this, abscesses were present at the sites of 3.5% (137/3871) of all sexable adult teeth. In the males

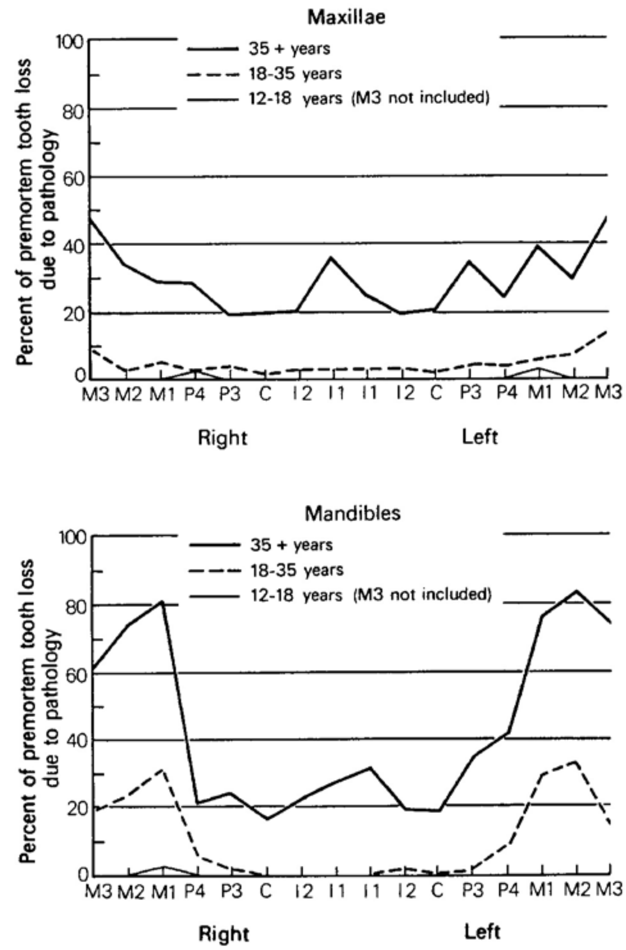


Figure 37: Premortem tooth loss by age

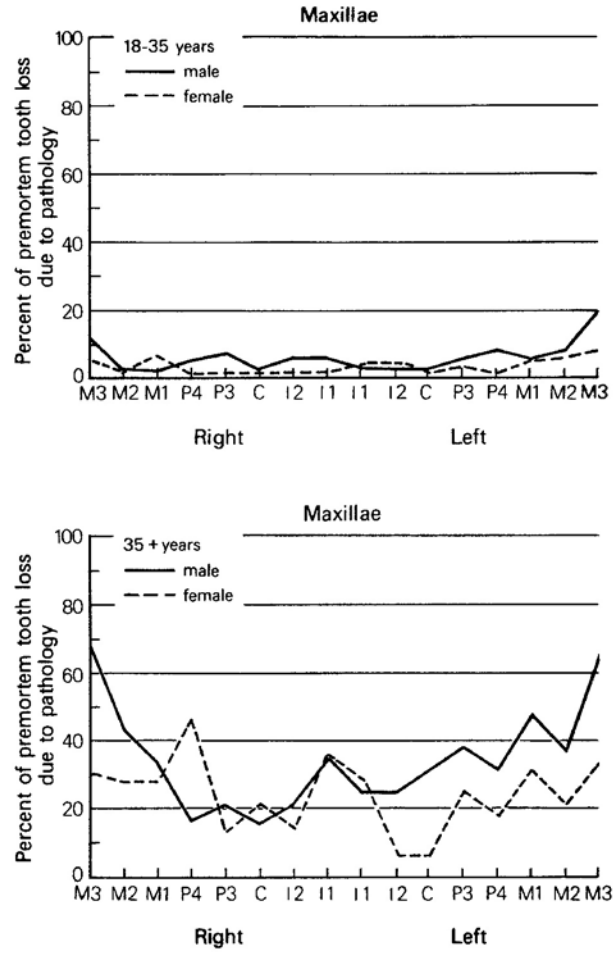


Figure 38: Maxillary premortem tooth loss by age and sex

of the old age category 10% of mandibular tooth sites showed abscessing. Thus, added to the discomfort of decaying teeth there was often the pain and continuing infection of an abscess.

The problems began early. Of 16 dm^1 aged 2 to 6 years, 3 (19%) were carious. Of 20 dm_1 of the same age 5 (25%) were decaying.

The pathology of the second molar

A full study of the dentition is not possible in this report, but the major trends may be summarized by an analysis of the second molars.

First a comparison of carious and lost right and left second molars: whether grouping carious and lost teeth (1 df) or separating them (2 df) the result is the same. The left/right maxillary difference is significant (P @ 1 df = .016, P @ 2 df = .047), but the side difference in mandibles is much greater (P @ 1 df = .000, P @ 2 df = .000). The difference between the maxillary and mandibular second molars is highly significant on both sides but more so on the left (left, G @ 2 df = 57.016; right, G @ 2 df = 21.832).

The greatest differences are thus between upper and lower dentitions, then between sides on the mandible, and much less so between sides on the maxilla.

The interaction of the variables can be examined with the first test including side, carious and lost teeth and age on maxillae. Partitioning the G, we find that the interaction of pathology and age contributes 86.4% of the G value, while side contributes 11.4%. The total G value is 39.718. Thus age is of overwhelming importance, yet the probability of side by pathology *is* significant (P = .03).

The same test on the mandible gives an even higher G value (56.095) which, when partitioned, shows almost total (95.4%) explanation in terms of age x pathology. Side accounts for 4.5% of the G value and the probability does not reach significance.

The next step is to include sex in the variables being considered. First a number of two-way G tests were done to examine the need to do multiway tests (Table 112). The surprising result was that only in the RM^2 of 18-35 year olds does the difference between males and females reach significance. In all other tests, though the female incidence of lost and carious teeth was higher (e.g. 19.6% against 8.3% for LM^2 of 18-35 years), the difference was not significant. Furthermore, it is clear that in the older adult category the male/female difference in dental pathology for upper and lower second molars is much reduced. Multiway tests would simply confirm what we already know; that age differences override sex differences.

One final question: are the right/left and upper/lower differences of the same order for males and females? Tests were done on 18-35 year olds (Table 112). The side difference is significant only for female maxillae. The mandible/maxilla difference is highly significant on the left for both males and females but only on the right for males.

Sex differences

The result with regard to sex was not totally expected, since preliminary work in the field laboratory gave the impression of greater female dental pathology. Overall, in the 18-35 age group males and females have the same amount of premortem loss and carious teeth. The percentage is 12.1% and 14.9% (P = .13) for the maxilla and

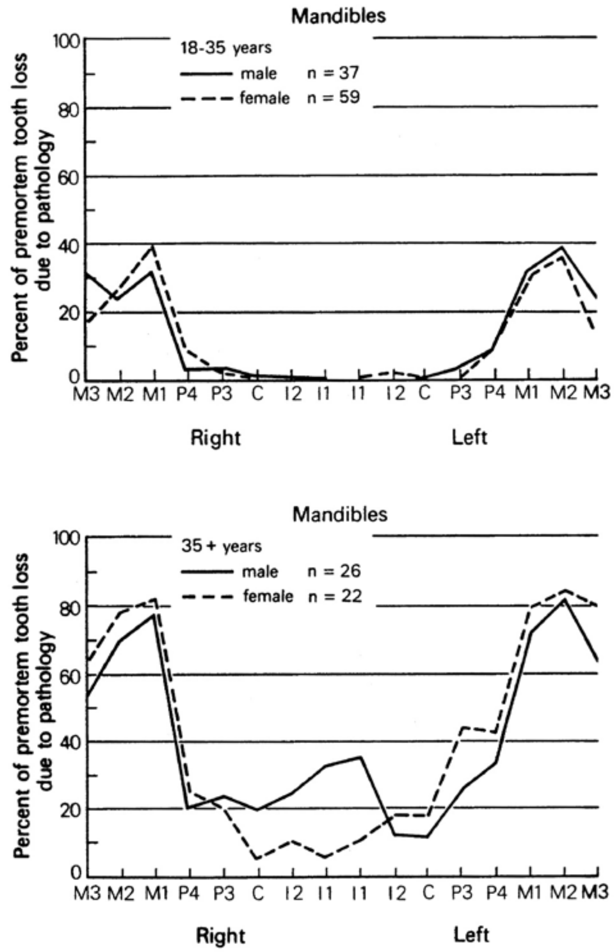


Figure 39: Premortem tooth loss in mandibles by age and sex

22% and 22.4% for the mandibles. Similarly, abscessing is the same for males and females (2.4% and 2.9%) in the mandible, but the similarity breaks down in the maxilla (1.5% and 3.4%; P = .04). The difference is even more dramatic if one looks at carious teeth. In the mandible there is no sex difference (P = .330) but in the maxilla the sex difference is extremely significant (P = .001). For tooth loss the mandible again reveals no sex difference (P =.330) but in the maxilla males have significantly more antemortem tooth loss (P = .020). Thus, males and females have equivalent pathology in the mandibles. In the maxilla, females have more abscessing, markedly more caries but *less* tooth loss.

The tooth loss discrepancy is not to be explained by the addition of more indeterminate M^3. Table 111 shows that the maximum M^3 hypodontia value is equivalent for males (9%) and females (8.2%). In the seven recorded cases of cusp chipping or tooth fracturing for which sex could be determined, four are females and three are males, so there is no indication that trauma caused excess male tooth loss. Furthermore, if one excludes the anterior dentition, maxillary cheek teeth loss is still more frequent in males (P = .026). The sex assignment of adolescent skeletons is uncertain; but 12-18 year old males do not seem to show a greater caries frequency than females of the same age (males 11/113; females 9/175: P = .134 or P for G adjusted = .210).

Females thus seem to have had more dental pathology than males but the evidence for this is confined to the maxillae and is based only on caries and abscessing rates. Nevertheless, Figs. 33 and 34 show that caries so large that the crown is destroyed by decay are much more common in females. For the cheek teeth, such caries occur in under 2% of adult males (maxillae 5/309: mandibles 3/245). In females over 4% of cheek teeth are nothing but roots with perhaps a small shell of enamel wall left (maxillae 21/483: mandibles 17/411). The male/female difference is very significant (P = .003).

Associations amongst pathological features

On all adult M2s a number of tests were carried out to examine associations amongst tooth loss, abscessing, caries and attrition. There must be a negative relationship between caries and attrition which would be difficult to test. In this population caries rates are greater than attrition rates. The only association tested in detail was the hypothesis that as attrition reached degree 2, there would be more approximal than pit and fissure caries recorded. This is true for all M2 except RM^2 showing, (a) that types of caries *recorded* do not simply depend on the degree of attrition, and (b) that types of caries present and degree of attrition do not have a simple relationship.

It seems obvious that caries and abscessing are related, and indeed there is no doubt that, in the maxilla, abscesses are more likely to occur below teeth with type 4 caries (G adjusted, P = .004 on the left and .02 on the right) than teeth with no caries or less severe forms of caries. The relationship is not significant for the mandibular M2s, though it approaches significance on the right. In fact, over half the M_2 abscesses are associated with teeth lost antemortem (12/22, of which 7/12 occur on the left). In the maxilla M^2 abscesses are also often associated with teeth lost due to pathology (5/13, of which 2/5 occur on the right). The conclusion must be that abscesses occur most commonly below teeth with severe caries or in association with premortem tooth loss.

Anterior dentition

As is to be expected, there are few carious incisors; the structure of the teeth would contribute to this (though teeth with shovelling may be more susceptible). The biting function of the incisors and the mechanical action of the tongue against them may also contribute to reduced pathology. The incisor caries frequencies are lower in males than in females (Fig. 33). This is especially true for the right incisors of old males (Fig. 34), in spite of the fact that there is great anterior tooth loss in the mandibles of old males in comparison with old females (Fig. 39). Males may have decreased incisor caries because they have more incisor wear than females (see Fig. 31).

The right upper and lower central incisors are heavily worn in males, and they are usually non-carious (Figs. 33,34,36). Yet in the maxillae and mandibles the central incisors are commonly lost, especially in males (see Figs. 37,38,39). It would appear that the male incisors are worn down quite fast and often asymmetrically, which suggests not only cultural practices, but specifically pipe smoking. This wear would inhibit caries formation but it does not stop incisor tooth loss which, in the maxillae, is equivalent in males and females. Old males have quite a high abscess incidence for the RI^1 and for both lower central incisors (Tables 113, 114), probably as a result of wear down to the gingiva.

Trauma might also lead to anterior tooth loss. None was noted (apart from one fractured canine in Fe 9/7, a male in his early 30s), but that is not surprising. The mandible of Fe 62/108, a male assessed at 40? years, well illustrates the state of the anterior dentition of an older male in this population (Plate 35a).

The jaw pictured in Plate 35a also explains the extraordinary peak in P^3 caries in old people (Fig. 32) since that is likely to be the only cheek tooth left in occlusion with any topography. The P_4 may well have drifted and dropped out of occlusion.

Tooth malpositioning

Malpositioned teeth are present in 14 individuals (Table 115 and Plates 35 and 36). In six cases the malpositioning resulted from drift and tilting following tooth loss. Molar teeth have tilted so that their lingual or distal surfaces have come into occlusion in four cases, three of them mandibular. In two cases, left canines have rotated following the loss of adjacent teeth. In eight cases, all young individuals, malpositioning is not the result of tooth loss. Two of these involve impaction of M_3. Five involve rotation or crowding of premolars, and one crowding of both upper and lower incisors.

Comparisons

Comparisons of dental pathology across populations are problematic. While the aim is often to find evidence of dietary differences, the frequencies of caries may be influenced by a number of other factors, including: (1) the age structure of the population; (2) attrition, itself determined by methods of preparing food and soil types in the area, as well as diet; (3) genetic factors; (4) trace minerals in soil and ground water (Powell 1985: 315); and (5) the number of intact teeth which may also be a function of the techniques of coping with carious teeth. Clean alveolar healing, which is common in the Grimsby sample, suggests that dental extraction was practised (G.H. Sperber, personal communication).

Patterson's (1984) dental data from a number of Huron and Neutral burials, appear to demonstrate that precontact Huron groups had high rates of dental pathology, probably indicating a largely corn-based diet. Precontact Neutral and historic Huron had lower rates of pathology. In Table 116 Grimsby data are presented in a form comparable with that provided by Patterson. For Grimsby only dentitions over age 12 are examined, since it is difficult to present tooth loss by percentage values for individuals under 12. The percentage values for permanent molars when those under 12 years are included are 23.4% (383/1636) for molar caries and estimated as 23.8% (546/2290) for molar loss antemortem. The data suggest that twice as many intact permanent molars were carious at Kleinburg as at Grimsby. The varied diet postulated here for the Neutral suggests that nutritional factors led to some reduction in the incidence of dental pathology at Grimsby. Factors unrelated to carbohydrate intake, primarily the age structure of the population, might also be important. The final column of Table 116 attempts to indicate the differing age structures of the dead; those assessed at age 25 and over are expressed as a percentage of all those over age nine.

Stable isotope analysis provides a method of estimating the percentage of the diet contributed by maize. Schwarcz *et al*. (1985:201) have established that the maize contribution in the diet of the Huron buried at Ball, Kleinburg and Ossossané averaged 51%. A fragment of skull, probably from Feature 62, which was inadvertently retained when the Grimsby bones were prepared for reburial, has been analyzed. Since the provenance and sex are uncertain, and the sample size inadequate, the results are not definitive.

H.P. Schwarcz (pers. comm., 26/07/85), reports stable isotope values for the Grimsby fragment as follows: $\delta^{13}C = -12.3‰$ and $\delta^{15}N = 11.7‰$. This translates to a diet containing about 52% maize, equivalent to that for Kleinburg (Schwarcz *et al.* 1985:199). In light of this, and despite the inadequate sample, it could be suggested that earlier age at death, rather than a more varied diet, led to the lower incidence of dental pathology at Grimsby.

Confirmation comes from the analysis by K.N. Schneider, Wichita State University, Wichita, Kansas, of several tooth fragments from Feature 1 which also remained unburied. Her report, written in 1988, is included as Appendix III and suggests a strong dependence on maize.□

Table 100: Two and More Degrees of Wear in the Dentitions of Young Adults

	Maxillae	Mandibles
Right		
M3	5/55	8/70
M2	18/88	16/64
M1	44/93	38/66
P4	27/86	20/72
P3	35/82	36/82
C	61/77	67/80
I2	44/57	60/69
I1	50/55	49/57
Left		
I1	48/53	51/56
I2	46/56	62/71
C	61/82	72/90
P3	27/77	37/88
P4	21/84	14/75
M1	38/94	34/64
M2	16/89	17/67
M3	5/58	8/75

Table 101: Wear of Two Degrees and More in the Mandibles and Maxillae of Young Adults

	Males		Females	
	Upper	Lower	Upper	Lower
Right				
M3	2/16	3/21	3/37	5/37
M2	9/32	5/22	8/51	9/33
M1	20/34	12/21	20/51	15/30
P4	10/30	9/29	14/48	10/38
P3	12/31	15/26	20/42	18/45
C	24/29	27/30	35/43	35/44
I2	19/22	23/25	24/33	32/39
I1	20/20	17/17	30/33	29/36
Left				
I1	18/20	18/19	30/32	29/33
I2	19/21	22/23	26/34	34/41
C	27/29	25/28	30/44	35/49
P3	11/27	18/28	14/40	16/49
P4	7/31	6/27	13/45	8/40
M1	17/35	10/22	18/50	17/30
M2	8/35	6/21	6/45	8/35
M3	2/20	4/22	3/35	3/37

Table 102: Caries Frequencies in the Maxillae

	12-18	18-35	35+
Right			
M3	0/14	10/62	4/13
M2	3/33	13/93	7/21
M1	6/37	17/100	6/21
P4	1/27	10/93	6/22
P3	1/25	9/92	12/24
C	0/24	4/80	5/22
12	0/19	6/62	2/16
I1	1/21	4/58	1/15
Left			
I1	1/20	1/57	4/16
I2	0/17	5/58	2/15
C	0/27	6/84	5/24
P3	3/30	6/84	10/22
P4	1/29	5/87	9/25
M1	6/35	17/98	9/21
M2	2/32	21/94	12/22
M3	0/11	15/64	6/14

Table 103: Caries Freguencies in the Mandibles

	12-18	18-35	35+
Right			
M3	1/15	16/74	9/17
M2	11/38	25/74	7/13
M1	12/36	27/73	5/10
P4	0/34	11/77	9/31
P3	1/34	4/83	5/29
C	0/34	3/81	3/36
I2	0/30	2/68	1/29
I1	0/20	2/57	1/23
Left			
I1	0/22	2/57	2/22
I2	0/28	1/71	0/23
C	0/32	3/92	4/33
P3	1/32	5/88	5/27
P4	1/34	6/79	7/27
M1	13/38	24/71	9/17
M2	11/36	25/73	5/11
M3	1/15	22/83	3/12

Table 104: Caries Frequencies in the Maxillae

	Males		Females	
	18-35	35+	18-35	35+
Right				
M3	3/20	2/3	7/40	2/8
M2	2/32	4/9	10/55	2/10
M1	5/34	3/11	11/57	2/8
P4	3/34	5/14	7/52	1/6
P3	2/33	6/11	6/49	5/12
C	1/31	2/10	3/44	2/11
I2	2/23	0/7	3/36	2/9
I1	0/22	0/8	4/34	1/6
Left				
I1	0/21	1/6	1/35	3/8
I2	2/22	1/7	3/34	1/8
C	3/30	3/11	2/45	2/12
P3	2/30	4/10	3/44	6/12
P4	0/32	3/10	4/47	6/13
M1	4/36	3/10	10/52	5/10
M2	2/35	5/11	18/50	7/10
M3	5/23	0/3	9/37	5/8

Tooth loss due to indeterminate cause included

Table 105: Caries Freguencies in the Mandibles

	Males		Females	
	18-35	35+	18-35	35+
Right				
M3	2/20	4/11	13/42	5/6
M2	6/23	4/8	15/40	3/4
M1	7/22	3/7	13/34	2/3
P4	3/29	5/16	7/41	4/11
P3	1/26	1/15	2/46	4/11
C	1/30	0/17	2/45	3/15
I2	1/25	0/15	1/38	1/11
I1	1/17	0/13	1/36	1/9
Left				
I1	1/20	0/11	1/33	2/10
I2	1/23	0/13	0/42	0/7
C	3/30	2/16	0/50	2/14
P3	1/28	2/14	3/49	2/10
P4	1/28	3/14	3/42	4/9
M1	10/23	6/10	12/36	2/6
M2	7/22	2/6	15/38	2/4
M3	5/24	2/7	12/43	1/5

Table 106: Premortem Tooth Loss in Maxillae

	12-18	18-35	35+
Right			
M3	1/32	7/90	15/31
M2	0/35	2/101	11/32
M1	0/37	6/111	10/34
P4	1/35	3/112	10/35
P3	0/34	4/109	7/36
C	0/33	2/109	7/35
I2	0/33	3/101	7/35
I1	0/31	3/100	13/36
Left			
I1	0/31	3/100	9/36
I2	0/31	3/103	7/36
C	0/35	2/104	8/39
P3	0/35	4/102	13/38
P4	0/35	4/103	9/38
M1	1/36	6/104	14/36
M2	0/34	7/102	10/34
M3	0/29	13/96	16/34

Tooth loss due to indeterminate cause included.

Table 107: Premortem Tooth Loss in Mandibles

	12-18	18-35	35+
Right			
M3	0/38	21/110	32/52
M2	0/40	26/109	40/54
M1	1/40	35/113	45/55
P4	0/37	6/111	11/52
P3	0/36	2/107	13/53
C	0/39	0/105	9/54
I2	0/38	0/101	12/53
I1	0/35	0/95	14/51
Left			
Il	0/38	0/98	16/50
I2	0/37	1/100	11/56
C	0/40	0/108	11/58
P3	0/40	1/113	20/57
P4	0/39	8/113	24/61
M1	0/40	33/113	46/60
M2	0/39	37/111	50/60
M3	1/38	16/111	44/59

Tooth loss due to indeterminate cause included.

Table 108: Premortem Tooth Loss in Adult Maxillae

	Males		Females	
	18-35	35+	18-35	35+
Right				
M3	4/32	11/16	3/54	4/13
M2	1/36	7/16	1/56	4/14
M1	1/39	6/18	4/60	4/14
P4	2/38	3/18	1/61	7/15
P3	3/39	4/19	1/58	2/15
C	1/38	3/19	1/59	3/14
I2	2/36	4/19	1/54	2/14
I1	2/35	7/20	1/54	5/14
Left				
I1	1/36	5/20	2/54	4/14
I2	1/38	5/20	2/54	1/15
C	1/38	7/22	1/53	1/16
P3	2/38	8/21	2/53	4/16
P4	3/38	6/19	1/54	3/17
M1	2/38	9/19	3/55	5/16
M2	3/39	7/19	3/53	3/13
M3	7/35	11/17	4/52	5/15

Tooth loss due to indeterminate cause included.

Table 109: Premortem Tooth Loss in Adult Mandibles

	Males		Females	
	18-35	35+	18-35	35+
Right				
M3	11/35	13/25	9/59	13/21
M2	8/34	18/26	15/59	17/22
M1	11/35	20/26	23/59	18/22
P4	1/37	5/25	5/58	5/20
P3	1/34	6/26	1/56	4/20
C	0/34	5/26	0/56	1/20
I2	0/33	6/25	0/53	2/20
I1	0/29	8/25	0/53	1/18
Left				
I1	0/30	8/23	0/54	2/19
I2	0/29	3/25	1/56	4/23
C	0/34	3/27	0/57	4/23
P3	1/35	7/27	0/60	10/23
P4	3/36	9/27	5/59	11/26
M1	11/35	20/28	18/59	19/24
M2	13/34	22/27	21/59	21/25
M3	8/35	17/27	7/57	19/24

Tooth loss due to indeteminate cause included.

Table 110: Dental Pathology in Adults (18 Years and Over)

	Maxillae Lost	Maxillae Caries	Maxillae Total	Maxillae %	Mandibles Lost	Mandibles Caries	Mandibles Total	Mandibles %
Right								
M3	18	14	32/122	26.2	56	26	82/175	46.8
M2	15	20	35/140	25.0	53	32	85/177	48.0
M1	17	24	41/153	26.8	90	32	122/183	66.7
P4	15	16	31/154	20.1	20	21	41/176	23.3
P3	12	21	33/153	21.6	18	9	27/173	15.6
Left								
P3	19	17	36/153	23.5	21	10	31/184	16.8
P4	15	14	29/154	18.8	32	15	47/187	25.1
M1	24	26	50/151	33.1	87	36	123/188	65.4
M2	20	35	55/144	38.2	97	32	129/186	69.4
M3	26	21	47/131	35.9	65	26	91/182	50.0

Table 111: Minimum and Maximum Hypodontia Values in Sexable Adults

	Left Males	Left Females	Right Males	Right Females	Total	%
M^3						
Minimum	1/52	2/67	1/48	2/67	6/234	2.6
Maximum	6/52	5/67	3/48	6/67	20/234	8.5
M_3						
Minimum	1/62	2/81	0/60	3/80	6/283	2.1
Maximum	3/62	4/81	3/60	4/80	14/283	4.9

The maximum values include those cases in which cause of tooth loss was indeterminate.

Table 112: Probability Values from G Tests on Lost or Carious versus Intact Noncarious Second Molars

Teeth	P	Comparison
LM^2 x RM^2	.016	Sides
LM_2 x RM_2	.000	Sides
LM^2 x LM_2	.000	Jaws
RM^2 x RM_2	.000	Jaws
RM^2 x RM^2	.000	18-35 vs 35+ years
LM^2 x LM^2	.000	18-35 vs 35+ years
RM_2 x RM_2	.000	18-35 vs 35+ years
LM_2 x LM_2	.000	18-35 vs 35+ years
RM^2 x RM^2	.004	18-35 Males vs females
RM^2 x RM^2	.617	35+ Males vs females
RM_2 x RM_2	.367	18-35 Males vs females
RM_2 x RM_2	.506	35+ Males vs females
LM^2 x LM^2	.127	18-35 Males vs females
LM^2 x LM^2	.151	35+ Males vs females
RM_2 x RM_2	.835	18-35 Males vs females
RM_2 x RM_2	.703	35+ Males vs females
RM^2 x LM^2	.527	18-35 Males
RM_2 x LM_2	.146	18-35 Males
RM^2 x RM_2	.005	18-35 Males
LM^2 x LM_2	.000	18-35 Males
RM^2 x LM^2	.021	18-35 Females
RM_2 x LM_2	.265	18-35 Females
RM^2 x RM_2	.233	18-35 Females
LM^2 x LM_2	.000	18-35 Females

Table 113: Abscessing in Adult Maxillae

	18-35				35+			
	Males		Females		Males		Females	
	n	%	n	%	n	%	n	%
Right								
M1	1/26	3.8	2/49	4.1	0/10	0.0	0/9	0.0
M2	1/31	3.2	3/54	5.6	3/11	27.3	1/11	9.1
M3	0/34	0.0	6/58	10.3	1/13	7.7	1/10	10.0
P4	1/33	3.0	2/59	3.4	2/15	13.4	3/11	27.3
P3	1/34	2.9	3/56	5.4	3/13	23.1	1/13	7.7
C	0/34	0.0	1/55	1.8	2/15	13.3	0/13	0.0
I2	0/32	0.0	0/52	0.0	0/15	0.0	0/12	0.0
I1	0/33	0.0	0/51	0.0	1/16	6.3	0/12	0.0
Left								
I1	0/31	0.0	0/50	0.0	0/18	0.0	0/14	0.0
I2	0/34	0.0	1/49	2.0	0/18	0.0	0/16	0.0
C	1/36	2.8	0/50	0.0	1/19	5.3	0/16	0.0
P3	1/36	2.8	1/50	6.0	3/16	18.8	1/15	6.7
P4	1/34	2.9	2/53	3.8	4/16	25.0	2/15	13.3
M1	1/35	2.9	4/50	8.0	1/13	7.7	3/13	23.1
M2	0/32	0.0	2/49	4.1	1/13	7.7	2/12	16.7
M3	0/30	0.0	1/44	2.3	1/11	9.1	1/10	10.0

Table 114: Abscessing in Adult Mandibles

	18-35				35+			
	Males		Females		Males		Females	
	n	%	n	%	n	%	n	%
Right								
M3	0/29	0.0	3/55	5.5	1/24	4.2	1/19	5.3
M2	1/32	3.1	4/58	6.9	1/23	4.3	2/19	9.5
M1	2/31	6.5	4/56	7.1	0/23	0.0	1/21	4.8
P4	0/31	0.0	0/55	0.0	2/24	8.3	0/19	0.0
P3	0/32	0.0	0/54	0.0	0/24	0.0	2/19	10.5
C	0/31	0.0	0/54	0.0	0/24	0.0	1/19	5.3
I1	0/32	0.0	0/52	0.0	1/22	4.5	0/19	0.0
I2	0/28	0.0	0/52	0.0	2/23	8.7	0/19	0.0
Left								
I1	1/29	3.4	0/53	0.0	2/21	9.5	0/19	0.0
I2	0/29	0.0	0/55	0.0	1/22	4.5	0/19	0.0
C	0/32	0.0	0/56	0.0	0/23	0.0	1/21	4.8
P3	0/33	0.0	1/56	1.8	0/24	0.0	1/22	4.5
P4	1/33	3.0	3/57	5.3	0/24	0.0	1/25	4.0
M1	4/32	12.5	7/57	12.3	3/23	13.0	1/24	4.2
M2	2/32	6.3	3/57	5.3	2/23	8.7	2/25	8.0
M3	1/33	3.0	1/56	1.8	0/21	0.0	0/24	0.0

Table 115: Individuals with Tooth Malpositioning

Individual	Sex	Age	Tooth	Comment
Fe 9/42	?	13-15	RP_3 RC	Rotated 90°. Mandible. Rotated 45°.
Fe 11/-	Young Adult		LP_3	Rotated.
Fe 11/-	Young Adult		LP_4	Rotated 90°.
Fe 11/4	F	18-20	LP^3	Crowded bucally by C & P^4.
Fe 17/2	M	17-20	RM_3	Impacted. (Plate 36c)
Fe 18/4	M	26	RM^2	Lingual tilt of about 60°, buccal wear. Status of M^3 unknown: other R maxillary teeth intact. RM_3 and RM_1 lost.
Fe 20/2	M	45-50	RM_3	Labial and mesial drift with distal wear: RM_2, RM_1 lost premortem.
Fe 27/3	M	25-30	RM_2	Labial tilt and buccal wear following drift. (Plates 3c, 36a)
Fe 36/18	?	?	RC RM_2	Rotated following loss of adjacent teeth on mandible. Mesial lean following loss of adjacent teeth.
Fe 42/1	F	36+	LC	Rotated: is only tooth remaining on L mandible.
Fe 54/2	?	11-12	LP_3	Rotated.
Fe 62/20	F	20-23	RI^2, $I_{1,2}$	Crowded. (Plate 35c,d)
Fe 62/T	M	16-17	R,LM_3	Impacted. (Plate 36d)
Fe 62/ Bundle F	?	?	LC	Drift following mandibular tooth loss. (Plate 36b)

Table 116: Percentage frequencies of dental pathologies in cheek teeth for some Ontario sites together with the number of adults 25 years and over expressed as a percentage of those 10 years of age and over.

Site		Caries	Antemortem tooth loss	Adults (25+/10+) years
Kleinburg	molars	52.9	29.1	83
	premolars	25.9	14.9	
Glen Williams	molars	35.7	37.1	74
	premolars	20.5	21.5	
Milton	molars	42.8	35.1	?
	premolars	12.3	15.4	
Maurice	molars	40.0	35.1	84
	premolars	27.2	16.9	
Grimsby	molars	25.5	24.3	43
	premolars	11.3	9.1	

Data from Patterson (1984); see also Hartney (1981b). Grimsby individuals included in the calculations for this table are all over age 12. Details on age structures of the site populations will be found in Jackes (1986).

CHAPTER 11

DEMOGRAPHY

Introduction

The possibility of doing useful analyses of the demography of cemetery populations has been questioned by Howell (1973, 1982) and Bocquet-Appel and Masset (1982). Some anthropologists are strongly convinced of the value of conventional demographic studies using life tables in anthropology (e.g. Van Gerven and Armelagos 1983; Buikstra and Konigsberg 1985). I find it impossible to accept this point of view without question (Jackes and Lubell n.d.; Jackes 1985, 1986), but it is necessary to present the data on the Grimsby population for evaluation and interpretation by others.

The techniques used to assign sex and age to individuals have been described in Chapter 1. As stated there, because of the size and complexity of Feature 62 only those adult skeletons that could be sexed and aged using the innominates are included in Tables 2 and 117: as with Features 9, 11 and 45, Feature 62 was treated as an ossuary for the demographic study. Consequently, 20 individuals could not be assigned an age within a five year age category. Together with the 6 unknown age adults from the other features within the site, they are excluded from the first life table (Table 117). The exclusion of unknown adults, however, has a strong effect on the life table and it is preferable to include them in some form. The method used here is to calculate the percentage of individuals in each 5-year age category from age 20, then distribute the unknown individuals proportionately over all adult age categories.

Life tables (see Appendix II for formulae)

Once the age and sex distribution of the individuals in the cemetery has been determined, life tables are constructed. In the life tables individuals are grouped in 5 year age classes, D_x being the number of individuals within each age group. The first year of life is dealt with separately for two reasons: (1) mortality is highest within the first year of life in most populations (see e.g. Shryock *et al*. 1971: 398); (2) the bones of the very young are not well represented in archaeological sites because of their fragility and probably because they are rarely given normal burial. The related Iroquoian group, the Huron, is known to have buried infants separately (Thwaites 1898 10:273) and perhaps older children also (Kapches 1976; see also Fitzgerald 1979). Brothwell (1971) has suggested that the ratio of infants under one year to those under 20 years should be between 4:1 and 4:3. Following Melbye (1977), I have used the ratio 4:2. The total number of individuals under one year in the Grimsby site was 13 and the figure 147 for infants under one year old is arrived at by the formula

$$D_{0-1} = D_{0-20} - 2(D_{0-1}).$$

The original 13 is added here, so the 0-1/0-20 ratio becomes .500 in Tables 119 and 122.

In the life tables the values under q_x, give the probability of dying within a certain age range. Examination of these values or the curve which they describe can serve as a check on the accuracy of age distribution. It is very probable that there is an underrepresentation of individuals in the 1-5 age category, which is not unexpected. Thereafter, the least probability of death is at the age of ten. This is in perfect accord with published life tables (Acsádi and Nemeskéri 1970:49). It is possible that the age assignments in the 30 to 40 year categories are incorrect because of the convention of placing "young adults" in an 18 to 35 year category. Individuals who appear "middle aged" might thus be placed in a age category which is too high. It is very tempting to estimate an individual to be, say, 36 years instead of 34 years when he has a great deal of tooth loss and a certain amount of cranial suture closure. The q_x values reveal that too many people were placed in the 35 to 40 year range at the expense of the adjacent categories. There can be no explanations other than bias, or the particular effects of age assessment based on the innominate. In a paper discussing pubic symphysis age assessment (Jackes 1985) I have shown that a peak in mortality at age 35 may result from using the McKern and Stewart (1957) method of aging adult males.

Smoothing of suspect age classes may be done by "running averaging" (Weiss 1973:15). Table 120 presents the life table calculated on the basis of smoothed numbers for the age classes of 25 years and over.

Fertility

While the Huron desired many children (Tooker 1964:122), prolonged breast-feeding and sexual abstinence limited births to one every three years (Thwaites 1898 8:127). It is entirely possible that many Indian populations in southern Ontario had very low birth rates at the beginning of the historic period (Sagard 1939: 127; Heidenreich 1971:168). The Neutral at Grimsby did not perhaps suffer the full effects of the stresses which may have lowered birth rates amongst their neighbours, the Huron: population pressure, disease, disruption of the economy and the society by the fur trade, the arrival of the Jesuits and the incursions of the Iroquois. Nevertheless, the Neutral could not have remained completely unaffected by these happenings: Lalemant in 1640, reported three years of "wars, famine and sickness" for the Neutral (Trigger 1976:595, 602). They suffered equally with the Huron from the famines of the 1630's and 1640's (Heidenreich 1971:58) which may have lowered birth rates considerably. Moreover, while we have no ethnohistorical evidence that introduced disease was as important a factor as it was for the Huron, smallpox had struck the Neutral (Jackes 1983) and the evidence suggests that the population of Grimsby had a high death rate (Jackes 1986).

Life tables are drawn up on the basis of the assumption of a stable population, an assumption which cannot be made for the Neutral at Grimsby, since the ethnohistorical record suggests that Ontario populations were in decline during the seventeenth century and had low birth rates. Further tables are therefore presented here employing a method sometimes used by anthropologists for non-stable populations. In Tables 121 and 122, the Carrier (1958) method allows the recalculation of demographic parameters in a population with a .01% rate of decline.

Even with recalculated life tables, we cannot estimate the birth rate with any confidence. Table 123 gives various values derived from life table analyses of the Grimsby population for "life expectancy at birth" or average age at death. The value $1/e_0$ should give an estimate for the birth rate, both in stable and declining populations. That, and all the other values relating to fertility which could be derived from the Grimsby life tables (Table 123) are excessively high and not consonant with expected values (compare the values for West Mortality Level 1 Model Table). Crude birth rates of between 45 and 61 per thousand would equal or exceed the highest recorded rates (Shryock *et al*. 1971:469; Pressat 1972:175).

The estimates of fertility derived from life tables are partly affected by the number of infants dying, but also, and more strongly, by the proportion of the population assumed to have died between 15 and 45 (Jackes and Lubell n.d.). The degree to which life table values relating to fertility are affected by possible adult age estimation errors can be assessed by further comparison with Coale and Demeny (1966) model tables. Although these are themselves estimates, they provide the best source for predictions of demographic parameters. If Grimsby life table fertility rates are calculated without an infant adjustment, the total fertility rate is 6.2. These figures are coupled with an infant mortality rate of 3.5% (see Table 118). Such an extremely low infant mortality rate would suggest a total fertility rate of around 2.1 (Coale and Demeny 1966:22,66, 162 West mortality level 21) and an average age at death of around 68 (not 22 as here). If one now increases the infant mortality rate to 29% (see Table 119), a comparison is possible with Coale and Demeny (1966:4, 32, 128) West mortality level 4 where the life expectancy at birth is about 26 and the total fertility rate is still only about 4.0. At West 4 level of mortality, it would be necessary to postulate a birth rate of over 60 and a growth rate of between .020% and .025% to reach the total fertility rate of 7.4, required by the life table calculated for Grimsby.

Population size and death rates

Following Acsádi and Nemeskéri (1970) further statements, deriving from life tables, may be made about the population. If the population is stationary the total population size can be calculated from the sum of Dx values and the life expectancy at birth divided by the length of time (t) the cemetery was in use:

$$(P = 10\% \text{ of } t + (De_0/t)).$$

If (t) is assumed to be 10 years (Kenyon, 1982), the size of the group which the Grimsby cemetery represents is calculated as between 826 and 832 (see Tables 118 and 119 without and with infant adjustment). Were the cemetery representative of all the deaths in one group over a period of 30 years (cf. Fox and Kenyon 1982) the population size would be 278 or 280.

If we accept that the Grimsby life table must be calculated as for a population in quite sharp decline (r = -.01), the life table death rate can be estimated (from $1/e_0$, since the correction for decline has been applied) as somewhere between 67 per thousand and 47 per thousand depending on whether the infancy adjustment is used. Comparative palaeodemographic studies (Jackes 1986) have indicated that the mortality level at Grimsby was extremely high, on a level with that at the Arikara site of Larson. An extremely high crude death rate is to be expected.

From the formula

$$((1/e_0) * \sum D_x) \quad \text{or} \quad \sum D'_x/1000$$

(see Table 122), we would expect 29 or 34 people to die at Grimsby in any one year. Since Feature 62 is composed of 103 individuals including only two infants under one year, some factor must be introduced in explanation. Feature 62 may represent the dead of more than one year, for, even though the Neutral Indians probably did not practice secondary interment (Tooker 1964:15), delayed burial as described by the Jesuits, must have been common.

The interpretation of the Grimsby burial features is not a problem in demography but requires an understanding of Neutral burial practices as discussed in the next chapter.□

Table 117: Unadjusted and Unsmoothed Life Table (26 unknown adults excluded)

x	D_x	d_x	l_x	q_x	L_x	T_x	e_x	C_x
O-1	13	37.4	1000.0	0.037	981.3	21361.5	21.3	45.9
1-5	33	95.0	962.6	0.099	3660.3	20380.3	21.1	171.4
5-10	46	132.4	867.6	0.153	4006.9	16719.9	19.2	187.6
10-15	30	86.4	735.2	0.118	3460.0	12713.0	17.2	162.0
15-20	38	109.4	648.8	0.169	2970.6	9253.0	14.2	139.1
20-25	53	152.6	539.4	0.283	2315.8	6282.4	11.6	108.4
25-30	53	152.6	386.9	0.396	1553.0	3966.6	10.2	72.7
30-35	23	66.2	234.3	0.284	1006.0	2413.6	10.2	47.1
35-40	25	72.0	168.1	0.431	660.6	1407.6	8.3	30.9
40-45	11	31.7	96.1	0.333	401.6	747.0	7.7	18.8
45-50	13	37.4	64.5	0.591	228.8	345.4	5.2	10.7
50-55	6	17.3	27.1	0.667	92.1	116.6	4.2	4.3
55-60	3	9.8	9.8	1.000	24.5	24.5	2.5	1.1
	347							

population given 10 years	743.100	
population given 30 years	250.367	
general fertility	221	assuming 1:1 sex ratio
total fertility	6.628	assuming 1:1 sex ratio
crude birth rate	46.813	
child/woman ratio	1044.931	

Table 118: Unadjusted Life Table (unknown adults distributed proportionately)

x	D_x	d_x	l_x	q_x	L_x	T_x	e_x	C_x
O-1	13	34.8	1000.0	0.035	982.6	22096.9	22.1	44.5
1-5	33	88.4	965.2	0.092	3684.0	21114.4	21.8	166.7
5-10	46	123.2	876.8	0.141	4076.1	17430.4	19.8	184.5
10-15	30	80.3	753.6	0.107	3567.2	13354.3	17.7	161.4
15-20	38	101.8	673.3	0.151	3111.9	9787.1	14.5	140.8
20-25	60	160.7	571.5	0.282	2455.8	6675.1	11.6	111.1
25-30	60	160.7	410.8	0.392	1652.4	4219.3	10.2	74.8
30-35	26	69.6	250.1	0.280	1076.6	2567.0	10.2	48.7
35-40	29	77.7	180.5	0.433	708.4	1490.4	8.2	32.1
40-45	13	34.8	102.8	0.342	427.2	782.0	7.5	19.3
45-50	15	40.2	68.0	0.600	239.7	354.8	5.1	10.8
50-55	7	18.7	27.9	0.700	92.4	115.2	4.0	4.2
55-60	3	9.1	9.1	1.000	22.8	22.8	2.5	1.0
	373							

population given 10 years	826.100	
population given 30 years	278.033	
general fertility	209	assuming 1:1 sex ratio
total fertility	6.265	assuming 1:1 sex ratio
crude birth rate	45.255	
child/woman ratio	991.738	

Table 119: Life Table with Infant Adjustment (unknown adults distributed proportionately)

x	D_x	d_x	l_x	q_x	L_x	T_x	e_x	C_x
O-1	147	289.7	1000.0	0.290	855.1	16393.4	16.4	52.2
1-5	33	65.0	710.3	0.092	2711.1	15538.2	21.8	165.4
5-10	46	90.7	645.3	0.141	2999.6	12827.2	19.8	183.0
10-15	30	59.1	554.6	0.107	2625.1	9827.6	17.7	160.1
15-20	38	74.9	495.5	0.151	2290.1	7202.4	14.5	139.7
20-25	60	118.2	420.6	0.282	1807.3	4912.3	11.6	110.2
25-30	60	118.2	302.3	0.392	1216.0	3105.0	10.2	74.2
30-35	26	51.2	184.1	0.280	792.3	1889.0	10.2	48.3
35-40	29	57.2	132.8	0.433	521.3	1096.8	8.2	31.8
40-45	13	25.6	75.7	0.342	314.3	575.5	7.5	19.2
45-50	15	29.6	50.1	0.600	176.4	261.1	5.1	10.8
50-55	7	13.8	20.5	0.700	68.0	84.7	4.0	4.1
55-60	3	6.7	6.7	1.000	16.8	16.8	2.5	1.0
Total	507							

population given 10 years	832.800	
population given 30 years	280.267	
general fertility	247	assuming 1:1 sex ratio
total fertility	7.410	assuming 1:1 sex ratio
crude birth rate	61.000	
child/woman ratio	1029.915	

Table 120: Life Table with Infant Adjustment (unknown adults distributed proportionately, smoothed from age 20)

x	D_x	d_x	l_x	q_x	L_x	T_x	e_x	C_x
0-5	180.0	355.0	1000.0	0.355	4112.4	17103.6	17.1	240.4
5-10	46.0	90.7	645.0	0.141	2998.0	12991.1	20.1	175.3
10-15	30.0	59.2	554.2	0.107	2623.3	9993.1	18.0	153.4
15-20	38.0	75.0	495.1	0.151	2288.0	7369.8	14.9	133.8
20-25	60.0	118.3	420.1	0.282	1804.7	5081.9	12.1	105.5
25-30	48.7	96.1	301.8	0.318	1268.7	3277.1	10.9	74.2
30-35	38.3	75.5	205.7	0.367	839.7	2008.4	9.8	49.1
35-40	22.7	44.8	130.2	0.344	539.0	1168.6	9.0	31.5
40-45	19.0	37.5	85.4	0.439	333.3	629.7	7.4	19.5
45-50	11.7	23.1	47.9	0.481	182.0	296.4	6.2	10.6
50-55	8.3	16.4	24.9	0.659	83.3	114.4	4.6	4.9
55-60	3.3	6.5	8.5	0.767	26.1	31.1	3.7	1.5
60-65	1.0	2.0	2.0	1.000	4.9	4.9	2.5	0.3
Total	507.0							

Table 121: Life Table Calculated at r = -.01 (unknown adults included, unsmoothed)

x	D_x	-0.01	D'_x	d_x	l_x	q_x	L_x	T_x	e_x	C_x
0-1	13	1.00	13.06	27.46	1000	0.03	986.27	25380.1	25.38	38.86
1-4	33	1.03	34.00	71.47	972.54	0.07	3737.86	24393.8	25.08	147.28
5-9	46	1.08	49.58	104.21	901.07	0.12	4236.36	20656.0	22.92	166.92
10-14	30	1.13	33.99	71.45	796.87	0.09	3798.11	16419.6	20.61	149.65
15-19	38	1.19	45.27	95.14	725.42	0.13	3382.49	12621.5	17.40	133.27
20-24	60	1.25	75.14	157.92	630.29	0.25	2751.12	9239.0	14.66	108.40
25-44	128	1.42	181.63	381.75	472.37	0.81	5627.04	6487.9	13.73	221.71
45-64	25	1.72	43.12	90.62	90.62	1.00	860.88	860.8	9.50	33.92
Total	373		475.79							

the Carrier (1958) formula was erroneous: Table 121 had +0.01 values in earlier printings
general fertility rate 167.72 assuming 1:1 sex ratio
total fertility 5.03 assuming 1:1 sex ratio
crude birth rate (1/e0) 39.40

Table 122: Life Table Calculated at r = -.01 (with infant adjustment, unknown adults included, unsmoothed)

x	D_x	-0.01	D'_x	d_x	l_x	q_x	L_x	T_x	e_x	C_x
0-1	147	1.00	147.73	242.00	1000	0.24	879.00	19891.6	19.89	44.19
1-4	33	1.03	34.00	55.70	758.00	0.07	2913.30	19012.6	25.08	146.46
5-9	46	1.08	49.58	81.22	702.30	0.12	3301.83	16099.3	22.92	165.99
10-14	30	1.13	33.99	55.68	621.08	0.09	2960.26	12797.5	20.61	148.82
15-19	38	1.19	45.27	74.15	565.40	0.13	2636.32	9837.2	17.40	132.53
20-24	60	1.25	75.14	123.08	491.25	0.25	2144.23	7200.9	14.66	107.80
25-44	128	1.42	181.63	297.54	368.16	0.81	4385.73	5056.7	13.73	220.48
45-64	25	1.72	43.12	70.63	70.63	1.00	670.97	671.0	9.50	33.73
Total	507		610.45							

the Carrier (1958) formula was erroneous: Table 122 had +0.01 values in earlier printings
general fertility rate 191.79 assuming 1:1 sex ratio
total fertility 5.75 assuming 1:1 sex ratio
crude birth rate (1/e0) 50.27

Table 123: Grimsby Fertility Rates Calculated from C_x on the Assumption of a Sex Ratio of 1:1 (compared with Coale and Demeny [1966] West Mortality Level 1[a])

Table Numbers	118	119	121	122	West 1
${}_1q_0$	.035	.290	.027	.242	.365
r	0	0	-.01	-.01	0
e_0	22.1	16.4	25.4	19.9	20.2
$1/e_0$	45.2	61.0	39.4	50.3	49.5
General fertility	208	246	168	192	176
Total fertility	6.2	7.4	5.0	5.8	5.3

[a] Values recalculated by method used for Grimsby life tables.

CHAPTER 12

INTERPRETATION OF AGE AND SEX DISTRIBUTION WITHIN THE BURIAL FEATURES

The features - burial patterns

It seems unlikely that the burial features (burial pits or graves) in the Grimsby cemetery are random accumulations of bones. The evidence indicates that in its ideal form, Neutral burial practice involved the very careful arrangement of the bundled remains of the dead. Feature 62 shows this best, since it provides a sample large enough for the pattern to be quite clear.

Feature 62

Feature 62 contained a series of bundles arranged in an oval with the skulls forming the centre of the oval (Fig. 40 and frontispiece). The exceptions are the skulls of Fe 62/9 (an old male) and Fe 62/95 (a young female) both to the north, and Fe 62/58 (an old male) whose skeleton was laid extended over the eastern end of the oval. To the southwest a number of juveniles were buried together, with their skulls out of alignment. The oldest individuals in this group were two adolescent males, Fe 62/1 who was around 15 and Fe 62/38, not yet 20 years old. Near the juveniles lay the skull numbered Fe 62/47, probably a female in her twenties. This is possibly the skull of Fe 62/O. The skull is the only one within this area of the oval, which contained, however, the pelves of 3 or 4 adults.

The distribution of skulls in Feature 62 (Fig. 40) reflects the bases for the arrangement of the bundled bones. Most males were buried in the eastern portion of the grave: the exceptions were Fe 62/4 and Fe 62/2. The former (discussed in Chapter 7) is likely to have suffered from a certain amount of disabling back pain. Fe 62/2 also had a disabilities, a fractured left arm and ruptured intervertebral discs. Other males were buried in the western portion of the feature (Fig. 40 y,z), but they lacked skulls. These males were Fe 62/N and Fe 62/B, both buried in the same location as Fe 62/O. Thus, three of the four individuals from the site diagnosed as having severe Perthès' disease, an old male (Fe 62/B), a young male (Fe 62/N) and a young female (Fe 62/O) were buried together. They shared the same disease which is familial in occurrence. Therefore, the arrangement of bodies may reflect family relationships.

Other evidence suggests family groupings in burials. Fe 62/103 and Fe 62/104, children who shared an unusual eruption sequence for the permanent dentition, were buried together (Fig. 40 x). Four cases of spondylolysis were buried together slightly to the east of the Fe 62/O group (Fig. 40 b). There was also another concentration of separated neural arches at the north-eastern end of Feature 62 (Fig. 40 b) which included Fe 62/58, an extended burial. Furthermore, at least two of the "stray" separated neural arches from Feature 62 came from that area (the eastern "point" of the oval) of the feature. Altogether 12 of the 19 L.5 neural arch anomalies were from Feature 62 (around 11.6% incidence in Feature 62 as compared with a 2.6% incidence for the rest of the cemetery). The probability of this occurring by chance is .000.

The two extremely tall females with inca bones came from the east end of Feature 62, buried close together (Fig. 40 c). They represent 50% of the inca bones in the entire site. Suppression of M_3 is present in two individuals buried together (Fe 62/26 and Fe 62/27) (Fig. 40 d).

From all the evidence presented here the conclusion is that close relatives were buried together (an interpretation that has also been

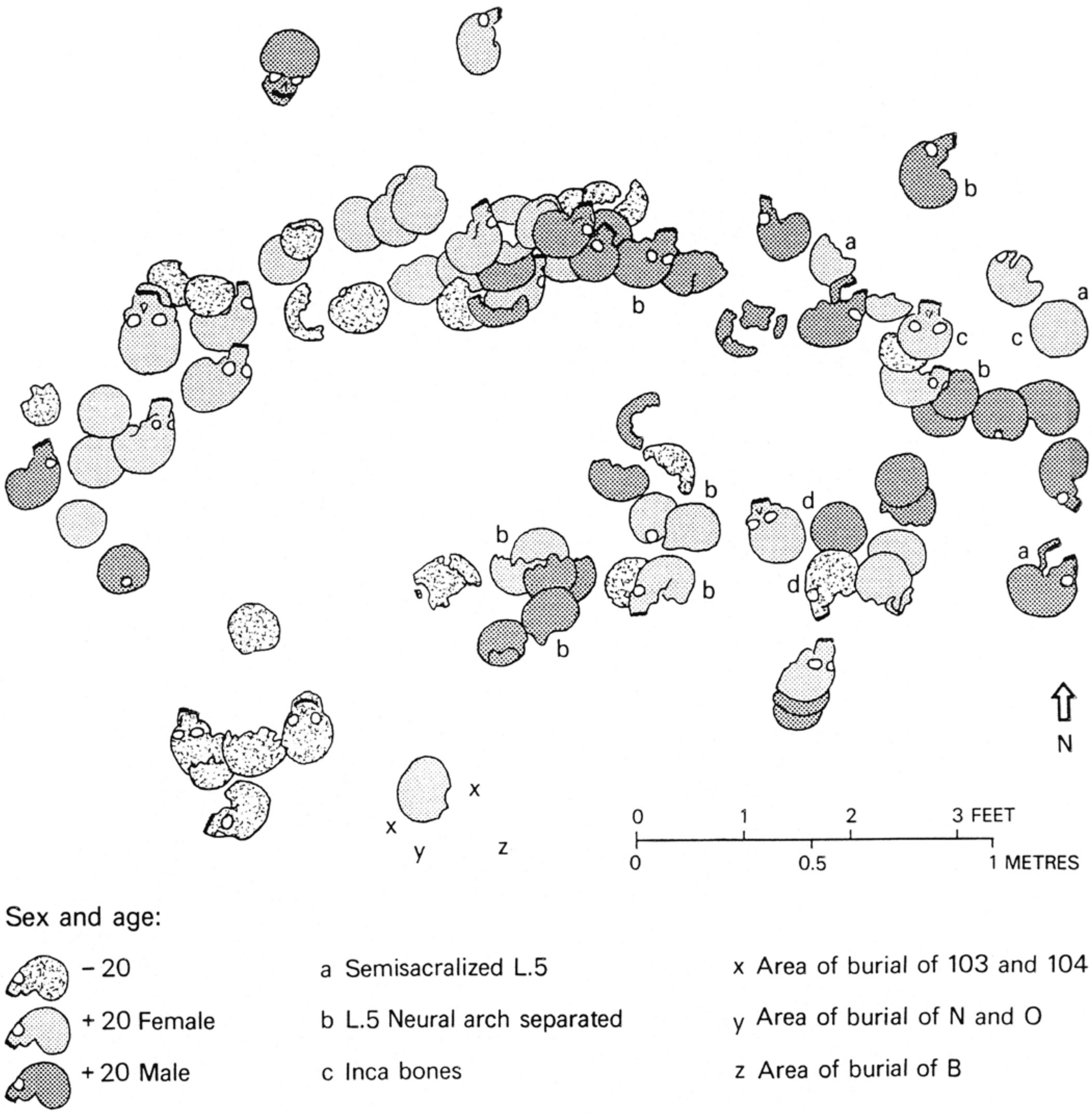


Figure 40: Distribution of skulls in Feature 62

drawn from analysis of an undisturbed portion of the Walker site; Crerar, 1983). Since, however, there is a tendency to bury males at the east end of Feature 62 and juveniles and people with disabilities at the west end, relationships may be overridden by certain status considerations. An indication of this is the grouping of old males together at the east end (Fe 62/58, 66, 65, 56, 55, 73, 24). One old female (Fe 62/57) is included here, and two young females (Fe 62/21 and Fe 62/63).

Feature 1

In contrast with the pattern discernible in Feature 62, Feature 1 shows no such neat arrangement. Rather there seems to be a mixed-up and incomplete set of bundles. Perhaps this indicates the hurried burial of people left awaiting the final ceremonies rather longer than usual. There are a minimum of 17 individuals in Feature 1 on the basis of the innominates. But there were two peripheral skulls and at least two sets of innominates not associated with skulls. Many of the bundles, although described by the excavators as discrete, consisted of parts of several individuals. For example, Fe 1/39 was a "discrete bundle on top of the feature" and yet it had 1 right and 2 left humeri, 2 left radii, ulnae, and tibiae. There were 2 right, but no left, femora and calcanei.

Features 26 and 36

Feature 26 which also had a great deal of disarticulation, had many old people; six individuals (40%) were 35 years or more and there was considerable degenerative disease. Fe 26/1 had a left femur whose head was severely affected by osteoarthritis. Fe 26/9 had arthritic acetabula and the vertebrae were so arthritic that there was some fusion. Fe 26/3 also had a very arthritic spine.

This characteristic of having many old people was shared with Feature 36 in which at least 58% of the individuals were over 30 and there were at least 3 spines which were arthritic and porotic. Feature 36 contained semi-bundles and had been vandalized.

Features with contrasting demographic characteristics

Features 62, 26 and 36 all share an important trait: they all have an excess of males. In this they can be contrasted with Features 9 and 11 and, to some extent, Feature 45. The latter three features had an underrepresentation of males. Feature 45 was, it seems, disturbed to such an extent (Kenyon 1982) that it is permissible to exclude it from consideration. Feature 28 also suffered considerable disturbance.

The majority of features contain few individuals (Table 5) and in fact 26 features contain one person each. Of the single burials 50.0% contain children, commonly very young; 26.9% contain an adult male and 23.1% an adult female (occasionally single burials may have part of another individual included). The small features might be the burial places of people dying during the summer. Larger features might be interpreted as spring burials of those who had died in the winter. However, the majority of the large features have no relationship to an expected demographic breakdown. Nevertheless, the age and sex distributions are not random, but group in distinct patterns. It appears that the features do not result from unusual and varying mortality patterns but from cultural practices. This is certainly true of Feature 62.

Feature 62 does not suggest a normal pattern of deaths for Grimsby or for any other population. There is an overrepresentation of adult males and an underrepresentation of subadults. The overall Grimsby adult/subadult ratio is .74 (373 individuals with 214 over 20 years and 159 under 20 years). Feature 28 and Feature 1 agree most closely with the overall pattern. Features 9 and 11 (ratios .38 and .6) are closest to what could have been the general pattern of deaths and burials over one year, with many subadults and slightly fewer adult males than females. In contrast, Feature 62 has an adult/subadult ratio of 2.4. The Feature 62 distribution differs significantly from the pattern presented by Feature 9 (P = .000) and Feature 11 (P = .004).

Feature 9 has an extremely high percentage of individuals under 20. It is only to be expected that there is a higher child than adult mortality rate in a pre-industrial population. However, a closer examination of the age-structure of Feature 9 shows that it is unusual. Most child deaths occur under 5 years and indeed under 12 months, but Feature 9 has only one individual under one year (1.7% of the feature). In all populations late childhood and early adolescence is the period of least risk. In the Grimsby population, those who died between 5 and 15 constituted 20.4% (based on the raw data) of the total deaths. In Feature 9, however, 46.6% of the dead were between 5 and 15 years. The smallpox that is most prevalent in that age group is the least lethal type of smallpox (cf. Dixon 1962:325) and that age group is the least likely to succumb to the after-effects of epidemic disease. No disease, and certainly not famine, can be adduced as the cause for the age pattern of Feature 9. This grouping together in a single grave of so many children can only be explained by cultural factors.

The variety of age and sex compositions for the larger features at Grimsby can be reduced to four types (Figs. 41 and 42). Features 9, 26, 1 and 45 all of them with extensive disarticulation, represent the extreme forms of feature type as shown in Fig. 41. The A group of features (Features 1 and 28) exhibits the same general sex and age breakdown as the population as a whole: it could represent the normal pattern of deaths over any particular period. Groups B and C when combined would give age and sex breakdowns similar to those of group A. Feature 45 could well be an aberrant form of group B, perhaps a result of the disturbance of the burials. The overall pattern of burial by feature may reflect the remnant of a cultural practice in which males were buried separately from the females and children (who were buried together). Such a practice would have fitted well with a matrilineal system in which the male dead are not returned to be buried with the rest of their matriclan, or are returned to their natal villages all together at the time of some form of Feast of the Dead.

Cultural factors

Burial of the old

As in Feature 62 where most adults are buried in the eastern end of the grave, and especially most of the older men, so in the Grimsby burials in general there is an overall tendency to separate adults and children and especially old people and children. In the Grimsby cemetery a distinct pattern emerges. Several features (20, 26, 30, 36, 62) have few females, many males and some children. Furthermore, the males are often in the 35+ age category. In the entire site, 31 males were recognized as being over 35 years (this includes 10 in Feature 62, but in fact there were 12 skulls with complete internal suture fusion which were judged to be male in Feature 62). Six of the 31 came from Feature 30, two from Feature 36 and one from Feature 20. So nearly three quarters of the older males were accounted for by five of the 55 features. As we know from Feature 62, the older males were often grouped in burial. Either the older men were specifically buried together or most of the old men died at once but at different times from the older women. The difference in the distribution of older males and females is highly significant (P = .008).

The older females were dispersed throughout the cemetery. Five of the female skulls in Feature 62 had complete internal suture fusion, but on the basis of the innominates at least 11 females in Feature 62 were over 35 years of age. Apart from the older women in Feature 62, there

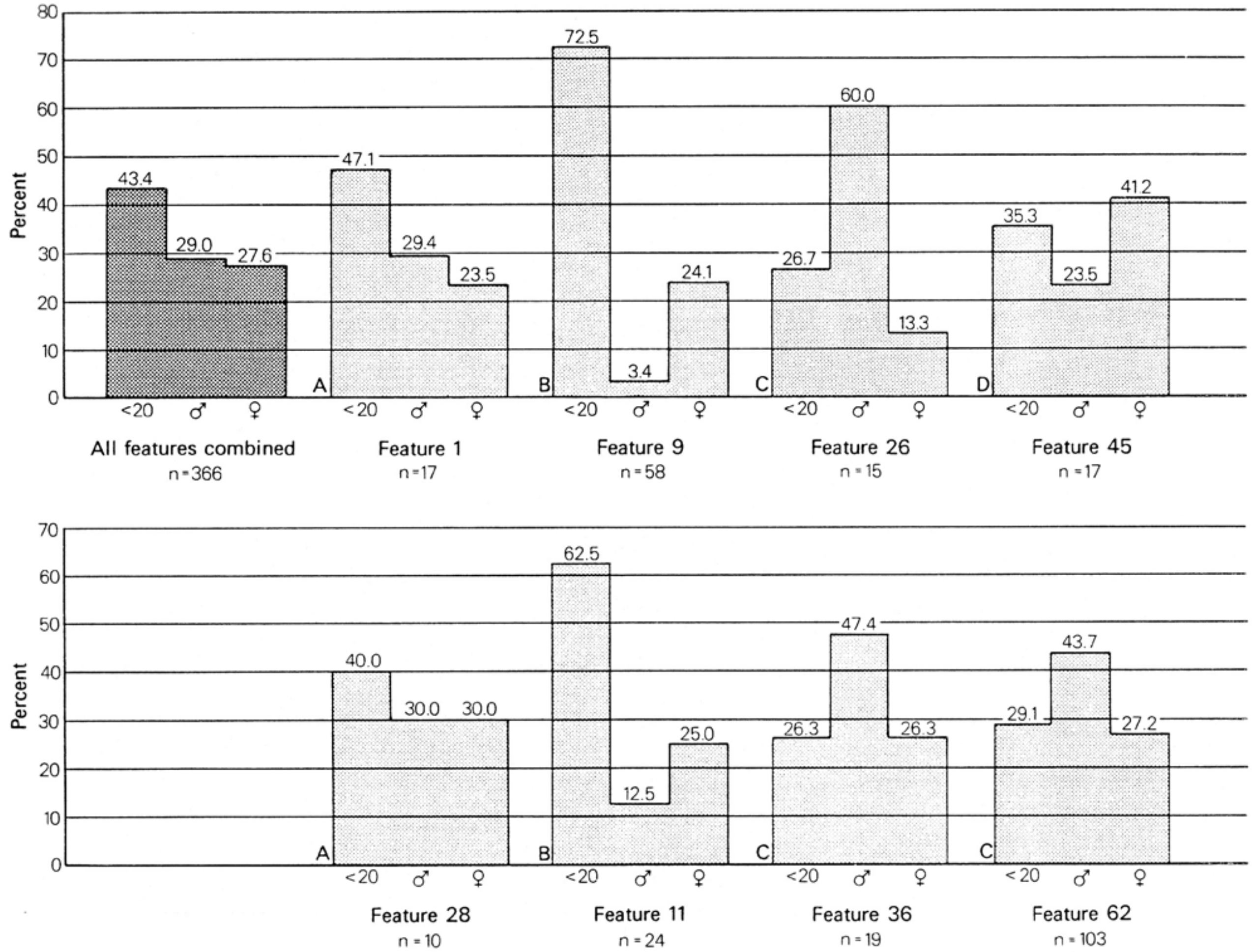


Figure 41: Death rates for subadults and adult males and females by burial feature

were 16 other females recognised as being over 35 years throughout the site. They were present in 15 features (two in Feature 17) so that there is no grouping of older females at burial comparable with that for men. In fact, older females are most likely to be buried with children under 5 years (G = 0.262, lowest result of all tests made amongst age and sex categories to test burial associations). This indicates that the grouping of older males does indeed relate to cultural practices rather than to any "demographic crises" which hit older people particularly hard.

Burial of infants

Cultural factors decided on who was buried in the cemetery in the sense that only thirteen of the 373 individuals counted in the cemetery were under one year. In no pre-industrial society would infant mortality account for only 3% of the deaths. It is thus clear that infants were not normally buried in the cemetery. There is a chance that not all infant burials were found by the excavators (because of disturbance or outlying position) for small children were probably often buried in individual graves. Of the 26 or 27 individual burials (Feature 14 is equivocal since several of the bone lengths gave ages very much younger than the dental stage), 4 were under 12 months, and a further 3 were 12 to 18 months. Two more burials were of children 4 to 5 years old. In all, 50% of individual burials were of people under 15 years. Furthermore, nearly one third of infants under 12 months were in individual graves and nearly one third of individual graves are of those 12 months or less.

The chances are high that some infants were not buried in the cemetery. Kapches (1976) has pointed out that Huron Indians usually buried infants and sometimes children in longhouses or, if not within houses, at least within the village area. When such burials are of adolescents or adults they were possibly either torture victims or victims of other forms of violent death. All other Huron Indians seem to have been buried in discrete ossuary pits, generally in total disarticulation. Archaeological evidence demonstrates that the Neutral also buried infants within longhouses (Fitzgerald 1979), a practice which must have been followed at Grimsby in view of the underrepresentation of infants.

Neutral burial practices

The Neutral burial pattern is not well understood. The Jesuits were not able to describe the Neutral rituals in detail, as they did the Huron Feast of the Dead of 1636. Lalemant wrote, on the basis of the reports of Brébeuf and Chaumonot after their visit during the winter of 1640-1641 (following the 1639 smallpox epidemic):

> Those of the Neutral Nation carry the bodies to the burying ground only at the latest moment possible when decomposition has rendered them insupportable: for this reason, the dead bodies often remain during the entire winter in their cabins: and, having once put them outside upon a scaffold that they may decay, they take away the bones as soon as is possible, and expose them to view, arranged here and there in their cabins until the Feast of the Dead (Thwaites 1898 21:199).

This does not tell us about the timing or the nature of the Feast of the Dead but all the evidence points to something rather different from the great communal feasts of the Huron.

One of the clearest proofs of the difference between Huron and Neutral burial practices lies in the almost complete absence of cut marks at Grimsby. In a Huron ossuary like that at Kleinburg there are numerous cut marks attesting to the practice of defleshing and disarticulating bodies. As an example, at Kleinburg at least 25 vertebrae bore cut marks, those in the cervical region being often extremely deep (Jackes 1977) and the numerous cuts around the proximal femora were noteworthy. In contrast, only two cut marks were found in the entire Grimsby site. One was a slash, rather than a cut, on the head of a male(?) left femur from Feature 11. The other was a single cut on the anterior surface of the superior shaft of a left femur from Feature 46. The implication is that the dead were buried, not at specific times, but when they had reached a stage of complete disarticulation, just as the Jesuit account implies. Other Neutral sites in the northern portion of Neutral territory show the Grimsby pattern. Shaver Hill, dated 1600-1620 (Stothers 1972), contained 195 individuals within 10 features. One feature had 163 people with skulls and long bones aligned, and mature and immature postcranials separated. Another feature had 18 individuals and 11 other people were in the eight "peripheral" burials.

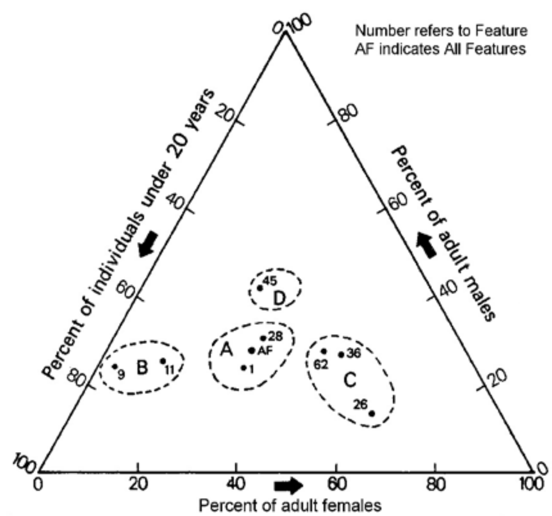


Figure 42: Composition of the larger burial features by age and sex

Wright (1981:121) has suggested that the similar pattern at the Walker site (at least 16 features, with up to 70 individuals in a feature) resulted from the smallpox epidemic of 1639. In the light of evidence from the Grimsby site, and from Shaver Hill, it would seem reasonable to say that, when Neutral burials diverge from what is basically an ossuary pattern and display the more complex Grimsby type of pattern, it cannot be assumed that this is due to cultural disruption.

Evidence for disruption and increased death rate

There is ethnohistorical evidence of famine, disease and war among the Neutral from the 1630s onwards. If the Grimsby cemetery represents the last 10 or even 30 years of the existence of the Neutral Nation, we should find evidence of the crises by comparing the Grimsby demographic parameters with those from other Ontario populations known archaeologically.

One Ontario site may serve as an example of post contact death rates: Ossossané (Katzenberg and White 1979), a Huron ossuary probably dated 1636, several years after the epidemic of 1634 described by the Jesuits as one in which many died (Thwaites 1898 8:89). Furthermore, in 1634 the Huron lost 300 men in war (100 as prisoners, Thwaites 1898 7:213,215), so many that only 10 or 11 canoes (Thwaites 1898 7:215,221; 8:69) were sent to trade at Trois Rivières that year. It is thus surprising that so many young males seem to be represented among the deaths at Ossossané in the 10 or 12 years prior to 1636.

Even if the bodies or bones of some of the 200 dead were brought back by the 200 fleeing survivors, war dead were not buried in an ossuary [Tooker 1961:132]). Even more doubtful is the alternative explanation that it was the young men who died in the 1634 epidemic. The disease that struck the Huron that year might have been smallpox or it might have been measles (Jackes 1983). The characteristic U-shaped curve of measles mortality in 'virgin soil populations' is well attested to (Black *et al*. 1977) and a clear demonstration of this lies in the Faroe Island epidemic of 1846, with an overall attack rate of 77.6%, but a minimal case fatality rate between 1 and 29 years (less than 1%; Fox et al. 1970:74). There is no evidence that young males are particularly susceptible to smallpox (Steffensen 1977). The 1918 influenza epidemic is the only recorded epidemic in which many young adults died (Beveridge 1978:31). The Ossossané data are thus problematic in some respects.

In order to make comparisons amongst sites, whether in terms of life expectancy at 10, number of survivors at 15, or mortality rates, we must be able to trust archaeological demographic data. An example of the difficulty of trusting such data is that life expectancy at 10 for Ossossané is published as something over 20 (Katzenberg and White 1979), slightly higher than that calculated for Kleinberg (Pfeiffer 1974). Under no circumstances could we have expected this result, since mortality at the pre-contact Kleinburg site is unlikely to have been higher than at the contact period Ossossané site.

The reasons for questioning such data, and partial solutions to the problems which they raise, have been discussed in detail elsewhere (Jackes 1985, 1986). I have concluded that the mortality levels at Grimsby are indeed higher than those at Ossossané, and may be among the highest of any North American archaeological site.

Direct evidence of epidemic diseases and of famine would be most clearly provided by mass burials of infants, young children and the elderly. Crises, directly and indirectly, most affect the very young and the very old, but we have no unbiased archaeological record in Ontario of the infant mortality and, as we have seen, cultural factors apparently determined that at Grimsby children and old males would be separated in death (e.g. cf. Features 9 and 62).

Feature 62, with its extremely careful arrangement of bundles, does not suggest the disruption which I deduce from Feature 1.

The pattern of old males buried together would imply some disruption, if the causes of death were such as to remove a number of old people from the population at the same time. The C values of the life tables suggest that a low proportion of the population was over 35 years (6.6%) and yet at least 18 skulls from Feature 62 (17.5% of the feature) were probably 35 and over. If Feature 62 represents the dead of one year or less then it must record a catastrophic event since it is obvious that the simultaneous death of many leaders of the society (in this population, the old) would lead to social breakdown.

In the previous chapter it was suggested that explanations must be sought for those features having more individuals than could be expected to die in one year at Grimsby. That means that Feature 9, and especially Feature 62, have to be explained, for one has 58 individuals in it and the other has 103.

Since Shaver Hill, an earlier site, also has at least one very large feature, it supports the view that Feature 62 does not represent the dead of one period of crisis. There were no cut marks in Feature 62, and yet everyone except Fe 62/58 was in generally the same state of disarticulation. Although there was disarticulation, there did not seem to be evidence of haste, mixing, people left unburied and then hurriedly bundled pell mell. Feature 62 seems rather to represent some grand ceremonial, the final expression of the great feeling for the dead which the Jesuits noted as the chief characteristic of the Neutral. The Jesuit descriptions of the aftermath of great epidemics when the dead went unburied and eaten by dogs (Thwaites 1898 16:219), may be appropriate for Feature 1 at Grimsby, but not for Feature 62.

We can only assume that Neutral burial practices were flexible. On some occasions individuals were buried at any time when the ground was not frozen; for example, infants and perhaps those dead by violent means who did not partake of the afterlife in the usual way (cf. Tooker 1964: 132). Group burials after the spring thaw or just before the winter freeze, perhaps members of the same nuclear or extended family, are a possibility suggested by, for example, Feature 17. There must also have been burial delayed over several seasons to have allowed the grouping of individuals, the groupings being determined by sex, age, status, disability, family relationship.

There is, then, some evidence for crisis and increased levels of mortality, but there is no basis for saying that the Grimsby cemetery overall is a response to smallpox epidemics.

Evidence of social structure and its relationship to burial practices

Size of social units

The evidence of social structure that we can deduce from the cemetery at Grimsby is slight. Most importantly, it points to an emphasis on smaller social units than in Huron society. There is some doubt as to exactly who was buried together in a Huron ossuary, but the net was cast wide. People came from distant villages with their dead (see e.g. Tooker 1964:135). Relationships were cemented with gift giving of almost potlatch intensity. The community of the dead was underlined by the deliberate mixing of the bones (Tooker 1964:139-140). This served to emphasize the importance of ties in the world of the living, since the life of the dead mirrored that of the living.

Amongst the Neutral by contrast there can have been no regularly recurring great communal Feasts of the Dead. Smaller corporate units must be represented in the Grimsby cemetery.

Neutral burial practices are a rather problematic affair. The Neutral are considered to have had ossuary burial, only distinguished from that of the Huron by a smaller number of individuals, false floors in the ossuaries and peripheral burials (cf. Noble 1978). On the basis of the Grimsby data and that provided by the Walker (Wright 1981) and Shaver Hill (Stothers 1972) sites, I would suggest that, while this interpretation could relate to one time period or to one section of the Neutral nation, it is likely that emphasis on Huron ossuaries has led to a misinterpretation of Neutral practices.

In 1966, Marian White, working in the Niagara Frontier area, in a pioneer attempt to define ossuary burial and to understand the complexity of the burial practices in the area supposed to have been occupied by the Neutral, was almost defeated by the lack of reliable information and the multiplicity of burial types (White 1966, 1972).

It is quite possible to see the Grimsby pattern as one of a number of individual and group burials (extended or bundled) with, rarely, some ossuary pits. But at Grimsby, the evidence for ossuary burial (which might be defined as one in which, say, 75% of the individuals are disarticulated and not buried as bundles) rests on Feature 45, itself disturbed and probably incomplete. The distinction between ossuary burial and multiple bundle burial is one implicitly supported by White (1966:16).

An 'ossuary' is no more than a repository for bones, but usage in North American anthropology has given the word a specific meaning. Ossuary burial implies disarticulation of defleshed bones and the mixing of individuals (see Ubelaker 1978:19, and Tooker 1961:134 who says that ossuary burial is specific to the Huron and Neutral). There is no doubt that the mixing of individuals was important to the Huron. It is equally clear from the Grimsby evidence that, although mixing might occur, retention of individual identity in burial was the ideal. In general, skulls and long bones seem to have been kept together: in the four recognized cases in which skulls are not associated with long bones (Fe 1/33 and Fe 62/O,N and B) there were marked disabilities. It could well be that this was an effort to separate an unsatisfactory body from a soul in the afterlife or at rebirth (an emphasis on resurrection was recorded for the Neutral, see Wright 1963:20). Whatever the merit of this suggestion, the evidence in general points to the retention in death of individual identity. That more evidence is not available is most probably a reflection of the disturbed state of other Neutral burial sites and the inexperience of many excavators over the last 100 years in dealing with complex multiple burials. If further large undisturbed seventeenth century cemeteries are discovered and excavation is possible, no doubt a complicated pattern of single and multiple burial will be discerned and the patterning of burial will be understood in terms of sex and age and familial relationships and status.

Sex

In Features 20, 26, 30, 36 and 62, from over 40% to over 80% of the individuals are adult males. Those features constitute group C in Figs. 41 and 42. Features 28 and 45 were markedly disturbed and should be excluded from the discussion. Feature 1 is also not typical of Neutral practice. Features 9 and 11 constitute group B, which thus represents the only other category of burial that we need consider. To group B we may add Features 17, 18, 51, 56 and 59, all having more females and children than adult males.

Apart from Feature 1, we are thus able to group all undisturbed larger burial features in the cemetery: the tendency to bury males separately from women and children seems to be born out whenever there are multiple burials of any size.

Age

There are several indications of age patterning in the burial practices. Infants were generally buried separately but Features 9 and 11 serve to support the idea that children were buried together. As has been pointed out, Feature 9, with its excess of 5 to 15 year olds, is a clear indication of cultural practices.

Among adults, age was also a determinant of burial place to some extent. Almost all the features in group C had old males whereas, of the males buried in the B group of features, there was only one possible male over 30 (in Feature 11).

Familial relationship

Within larger features close genetic relationships seem to be represented by burial in near proximity (as discussed for Feature 62) of individual bundles, and the burials of just a few people together might represent family groupings.

Status

Most of those who had high status seemed to have been males, though there are several indications of high status females (those at the eastern end of Feature 62, for example, and Fe 9/1). A possible explanation for the presence of so many males together (catastrophe being unlikely) in several features lies in a matrilocal pattern of residence. It is possible that men did not live in their natal village and that after death they were returned for burial to their birthplace. On the other hand, when males are buried together, they are very often old, which would imply that status is the important factor, not, for example, the burial of war dead. Because of the burial of older males together I would suggest the possibility that the men who governed the matrilineage or matriclan were buried at one ceremony.

Summary

We have no comparative or ethnohistorical evidence by which to interpret the Grimsby cemetery. We can only say that features like 62 and 9 suggest some type of communal Feasts of the Dead occurring at intervals of several years. These seem not to have included complete social groupings but rather categories of people determined by age, sex or status. Nevertheless, age, sex and status were not the sole determinants of burial place, for Feature 62 and to a lesser extent Feature 9, suggest the grouping of closely related people. It is possible that males were returned to their natal villages but the bewildering mix of single and multiple burials defies attempts at all embracing explanations.

The Neutral burial practices seem to have been extremely complex and in the absence of ethnohistorical sources we can only hope that archaeology will one day provide some basis for understanding the nature of the single and multiple burials with their varying numbers and demographic characteristics. Until we have a better idea of the length of time Neutral cemeteries were in use, and the extent of the area from which the dead were brought to be buried in any particular cemetery, and the social groupings represented, demographic studies based on Neutral skeletal materials are problematic. Fox and Kenyon (1982) have made a start on such a study and their conclusions are discussed from the viewpoint of palaeodemography in more detail elsewhere (Jackes 1986). The groupings of features identified here have no concordance with the groupings Fox and Kenyon deduced from bead types. Four of the features in Type C have been identified by Fox as to period: two each as IIIa and IIIb. The identifications for Type B are the same: two each as IIIa and IIIb (Fox *in litt.* 21/1/83). Just such a pattern of burial types cross-cutting period of burial would be predicted by the hypothesis of a cultural selection of individuals for burial in specific groupings as an element in the burial practices of the people who interred their dead at Grimsby over an extended period of time.□

CHAPTER 13

SUMMARY

The cemetery at Grimsby, Lincoln County, Ontario was excavated as a salvage project by Dr. W. Kenyon of the Royal Ontario Museum in the winter of 1976-1977. The human remains were analyzed within the town limits of Grimsby in the spring of 1977 and were reburied close to the original site in the summer of 1977. While the analysis and this report were completed early in 1982, some effort has been made to incorporate relevant studies published up until June 1985.

Fifty-five of the 58 separate burial features identified by the excavators contained bone, and the burial features included from one (in the case of 26 graves or features) to 103 individuals. Altogether 373 individuals were counted amongst those excavated from the burial features. Bones were found on the surface of the site, perhaps as a result of the disturbance of Feature 45, but these were not included during the analysis of age and sex distributions. Because of the time constraints, certain limits were placed on the analysis. During field analysis, detailed attention was not paid to ribs, scapulae, clavicles, tarsals and carpals, metatarsals and metacarpals and digits, patellae and fibulae.

Sex was assigned mainly on the basis of innominate form, but extensive metrical analyses of long bones and skulls, as well as stepwise discriminant analysis of the more complete skulls, contributed to the accuracy of sex determination. Because most adult individuals were buried as bundles or in flexed or extended postures, it was often possible to check sex assignment using a number of skeletal elements. This is in contrast to Huron ossuaries, the best known of the Ontario burial forms, in which the majority of the individuals are disarticulated and their bones commingled in burial. The Grimsby cemetery thus provides an opportunity to gain more accurate data on sexually dimorphic characters than is general in Ontario. Full data on metrical characters, including diagnostic bivariate plots, for each sex are thus given for the major long bones. Two individuals buried together in Feature 17 showed a confusing mixture of male and female characteristics and proportions.

The ages of children were assessed by comparisons with the Schour and Massler chart of dental eruption sequence. When possible, the ages were checked by examination of the diaphyseal lengths of long bones and the measurements of some other bones. Growth curves for the major long bones are provided, and comparison with diaphyseal lengths associated with Schour and Massler ages for the Arikara site of Mobridge (39WW1, Merchant and Ubelaker 1977) indicates slower growth rates among the Neutral. Discussion of recent data on late precontact juveniles from Simcoe County, Ontario (Melbye 1983), indicates that the ages predicted from Grimsby diaphyseal lengths can be used in analyses of other Ontario skeletal samples. The figures on proportional bone growth and estimated ages can be used with confidence in research on disarticulated or incomplete subadult material in southern Ontario.

Adult ages were assessed initially by reference to pubic symphyses, using the McKern and Stewart (1957) method for males (checked against the Todd method of 1920, with no discrepancies found) and the Gilbert and McKern (1973) method for females. Other factors were taken into consideration when assessing age and/or the possibility of mixing of individuals during excavation. These were observations on dental attrition and premortem tooth loss, arthritic changes, osteoporosis and suture closure.

Post-cranial measurements are not used for a full analysis of interpopulation comparison in this report. Such a study might show significant differences in skeletal robusticity between those populations living before and after contact. Judging from the data on Kleinburg (Pfeiffer 1979b) and Maurice (Jerkic 1975), the Jesuits' impression that the Neutral were taller than the Huron may have been incorrect. It is possible that the Jesuit opinion resulted from a comparison with Huron who had been exposed to the disruption resulting from European contact longer than had the Neutral. Mean Grimsby male stature is estimated at 170 cm. and mean female stature at 160 cm. (Neumann and Waldman, 1967 formulae).

Metrical characters of the skull are summarized. They were not used for regional population comparison (since this is the object of a full scale study now under way at McMaster University) but attention was paid to them, firstly, with regard to sex assignment; secondly, in the discussion of an individual who appeared to have multiple anomalies; and thirdly, in most detail, with regard to the possibility that French-Neutral miscegenation occurred at the time of earliest contact. The skull of Fe 9/1 differs markedly from those of other Neutral females. The skull is compared with those of seventeenth century Londoners (Hooke 1926) and it is shown that, especially in the chord and arc measurements over the skull length, Fe 9/1 diverges from the Neutral towards the pattern presented by a mixed Norman/Saxon/Celtic seventeenth century population. Frenchmen were living amongst the Huron from 1610.

Twenty five cranial morphological characters (non-metrical traits) are analyzed with close attention to differences attributable to age and sex. The data are presented so that comparative analyses can utilize unilateral and bilateral information by age and sex. Male-female differences are strongly indicated only for the Foramen of Huschke. Age changes are discussed for this trait, and for supraorbital foramina. In neither case is there evidence of age dependency. Eighteen traits are used for an initial comparison with four other Ontario sites, based on data presented by Molto (1979). The method of comparison used is the Mean Measure of Divergence (MMD) using the Freeman-Tukey transformation. The results show Grimsby to be significantly different from Serpent Mounds, Fairty, Tabor Hill and Kleinburg (Table 37).

Three recent theses on Ontario cranial and dental traits permit more detailed distance studies. Molto (1980) provides reassessed cranial data on a wide range of sites, and 16 traits are used here to compare incidences amongst nine Ontario sites. Dental data (see Appendix I) derived from a sample of casts made at Grimsby by Peter Hall and analyzed by G.S. Tait, provide the basis for comparisons amongst five Ontario sites. The degree of isolation (DI) amongst the sites has been calculated as

$$(MMD + 2) - 2\sigma$$

(negative MMD values with the sign changed are added to DI to assess significance). Summing of the ranked DI values allows a rapid estimate of the extent to which each site is genetically disparate.

A homogeneous "Huron" grouping of Kleinburg, Garland, Ossossané, Uxbridge and Maurice is evident (Table 39), covering perhaps 150 years and several Ontario counties (Fig. 1 and Table 1). We confirm Molto (1980) in his view that Kleinburg is related to other Huron samples (*contra* Wright 1977; but Kleinburg is markedly divergent from the Huron Sopher site, as well as from Neutral sites, in dental trait frequencies). Carton is closely related to this group, but also to some Neutral samples (it does not diverge from Shaver Hill on dental traits), suggesting gene flow at the northern edge of Neutralia in the protohistoric period. Carton may represent a general Ontario Iroquois type. The other Neutral sites of Shaver Hill, Glen Williams and Grimsby, especially the latter two, represent populations that were not only separate from the Huron gene pool, but from each other. Postulated Huron population movements during the protohistoric period in contrast with the stability of the Neutral Nation may explain these differences in MMD patterns, between the tightly clustered Huron and dispersed Neutral. There seems good evidence that Neutral subgroups maintained their separate identities over considerable periods of time, and that those buried in such Neutral cemeteries as Grimsby represent distinct population sub-groups.

Post-cranial morphological traits are considered in some detail for the axial skeleton and long bones, except with regard to facet extensions on the tibia and the corresponding talus facet extensions. Particular attention is paid to the distribution of apparently sex-dependent characters on the innominate and confusion arose only in a few specific cases. Vertebrae exhibit many morphological traits potentially useful in population comparisons and these were examined and the data presented in such a way as to allow comparison with both cemetery and ossuary samples. A distance study based on 11 vertebral traits confirms the significant difference between Kleinburg and Grimsby. The lengthening of the functional thoracic spine described for the Huron (Jackes 1977) is confirmed also for the Neutral.

The discussion of pathological specimens is complicated by the fact that many of the pathological specimens did not arrive in the field laboratory with full details of their context. Furthermore, there was no opportunity for detailed examination of the specimens or discussion and consultation with colleagues because the bones had to be kept within Grimsby.

In analyzing each pathological specimen, close attention was paid to all other pathological bones from the same feature. This was done in an attempt to sharpen the diagnosis and was especially helpful with the various isolated bones from Feature 45, most of which could be attributed to one individual with syphilitic changes, each bone serving to strengthen the diagnosis. Besides the one clear possibility of syphilis, there is one good case of juvenile tuberculosis and two possible adult cases, both from Feature 62. While more tuberculosis might have been expected, totally unexpected was the presence of four or five cases of Perthès disease, not known to be common among American Indians but previously recognized at Fairty (Anderson 1964). Ankylosing spondylitis, on the other hand, is common among American Indians. Kidd (1954) recognized its presence by two cases at Ossossané, there were two possible cases at Kleinburg (though psoriatic spondylo-arthropathy may be a better diagnosis (J.S. Percy *in litt*. 16/4/84), and Grimsby provides a further two possible cases.

If the diagnosis of Fe 1/33 as smallpox osteomyelitis is correct (see Jackes 1983), and no other condition seems possible after an extensive search of the literature on smallpox complications back to the eighteenth century, then we have the first confirmation that European diseases ran ahead of direct contact. From characteristics of the burial and dating on trade beads (Fox and Kenyon 1982), it is likely that Fe 1/33 died close to 1650. Since he was probably well over 30 when he died, and must have contracted smallpox before age 15, the chances are quite high that the unknown epidemic of 1616-1619 on the east coast of North America was indeed smallpox (see Hopkins 1983) and reached Ontario.

Trauma, both major and minor, and degenerative changes are dealt with in detail. The majority of cases of major trauma were found in the vertebrae, very few cases of vertebral fracture being attributable to osteoporotic collapse. In three cases spines with fractures had anomalies (separated fifth lumbar neural arches, semi-sacralized L.5). Postcranial osseous spurring is dealt with, not under the heading of morphology, but as minor trauma, and associations with pathological conditions are also noted. The relationship of various forms of spurring with age, side, sex and bone anomalies is discussed whenever possible.

While spurring may be related to side, arthritic changes in the post-cranial skeleton are not side dependent. There is one very specific sex difference in the incidence of arthritis and that is at the knee, where males have arthritic changes more than twice as often as females, even when age is controlled for. The difference is interpreted as due to the lifting of heavy loads during portaging, clearing land and building villages. Cervical arthritis is also more common in males than in females and while this is not direct evidence that men did heavier work than the women, when combined with the evidence of arthritis at the knee and the incidences of Schmorl's nodes in the vertebrae, it is quite convincing. Transverse noding in the T.12 - L.5 spine section is exactly twice as common in males as females ($X^2 = 5.4$ @ df 1, $P = .02$). Sporadic lateral bending and compression loading was probably important in the work performed by the adult males buried at Grimsby.

The Grimsby dentition is analyzed with particular attention to attrition and pathology (caries, antemortem tooth loss and abscessing). General patterns of pathology broken down by age and sex are determined. Full analysis of the second molars allows assessment of the significance of jaw, side, sex and age factors in dental pathology. The mandibular dentition is more liable to pathology than the maxillary and the left side of the mouth more than the right. The major difference between the sexes appears in the incisors which are heavily worn (especially on the right) in males which leads to abscessing and tooth loss. Pipe smoking is the obvious explanation. Females had more maxillary dental pathology than males (more abscessing, more caries and more very large caries). However, they had less tooth loss and it is possible that a study of sex differences in dental pathology is complicated by dental extraction, which was perhaps more common for males. While the evidence is equivocal, it suggests a female diet that was less varied and more carbohydrate-based than the male diet.

It is possible that the Grimsby population relied less heavily on a corn-based diet than did the Huron. This could be explained by geographical factors. Population comparisons are complicated by a variety of factors which could influence attrition, caries and tooth loss rates (not only diet but age structure of the population, soil type, method of grinding, genetic factors). Nevertheless, the data provided by Patterson (1981) indicate less dependence upon corn among the precontact Neutral than among the precontact Huron. Within limits, relating especially to the age structures of the populations, Grimsby dental pathology rates are very low for Ontario, suggesting a diet less restricted to corn. On the basis of stable isotope studies, Schwarcz *et al*. (1985) demonstrate less dependence on corn at the late Neutral site of Cooper, in comparison with Kleinburg, Ball and Ossossané. However, stable isotope analysis of an isolated skull fragment from Grimsby indicates a diet with a maize component equal to that of Kleinburg. Trace element analysis of Feature 1 dental enamel by K.N. Schneider (Appendix III) confirms that the last inhabitants of Grimsby had a maize-based diet with some associated dietary deficiencies.

While not definitive, this suggests that the average Grimsby adult age was lower than that at Kleinburg.

The demography of the Grimsby population is presented here "for the record"; both full data on age and sex distribution by feature, and life tables with and without the infant and old age adjustments common in studies of Ontario sites (e.g. Katzenberg and White 1979; Melbye 1981) are included. Adults of indeterminate age are initially excluded from the analysis, and then distributed proportionately over adult age categories. There are strong reasons to doubt the accuracy of adult age assessments and the possibility of accurately estimating demographic parameters when the sample may be biased and the population in decline (Jackes and Lubell n.d.; Jackes 1985; 1986). Comparison with other sites in Ontario and in South Dakota (Jackes 1986) suggests that the Grimsby population was in decline and had suffered something like a doubling of mortality rates over the period of contact. Fox and Kenyon (1982) have suggested that the people in the cemetery at Grimsby represent the whole of the 30 years of decline of the population. Final life tables are presented using the Carrier (1958) method of adjusting for a population with a .01% rate of decline.

The problems of the demographic analyses of skeletal populations such as that from the Grimsby cemetery are multiple. The first and simplest relates to age assessment. This problem was illustrated by examples which showed that quite extraordinarily high fertility rates would be predicted for the Neutral from the life tables. The literature, however, suggests that the Huron had a low birth rate in the historic period, and it seems reasonable to accept this for the Neutral. The high life table rates probably derive from errors in age assessment which lead to an overestimation of the numbers in the 15-45 year age group.

Further problems in demography arise from the possibility that the sample available to us is biased, whether in terms of age or sex. Cultural factors may intervene to an unknown extent so that we cannot determine the true patterns of death. Huron ossuaries such as Kleinburg are thought to have very few biases: all individuals within a limited number of villages, dead within a limited time period, were buried together except perhaps for infants and those dead by drowning or violence.

It seems clear that Grimsby and a number of other Neutral burial grounds had a pattern of burial quite different from that of the Huron. This, together with the possibility that the Grimsby burial ground is to be ascribed on bead type to three different periods within the 30 year span (further discussed in Jackes 1986) covering the decline and destruction of the Neutral Nation, should warn us against making categorical statements about its demography.

The burial features at Grimsby can be differentiated into three main types. In Type A features there is a balance of males and females, adults and subadults, and these may represent the unceremonious last burials at Grimsby during the final destruction of Neutral society. Type B are features with many children and Type C are those with many adult males.

Late adolescents are nearly always buried in large features and their burial pattern is different from that of infants and other children. Young children are the most likely of all age groups to be buried in single graves, otherwise they are likely to be buried with old females. Old females are distributed over 29% of the 55 features containing recognizable skeletons, whereas the old males are all contained within 9% of the features: the difference is highly significant. But the clearest cultural pattern is the tendency to group old males together and to separate them from the young.

I suggest that Grimsby is neither wholly unique amongst Neutral sites, nor is its general burial pattern a response to smallpox epidemics. Neutral burial of the seventeenth century is nothing like that of the Huron who intermingled the dead in stressing wider corporate relationships, perhaps even trading relationships. The Neutral were probably concerned to emphasize relationships within the smaller corporate units important to them, with much stress upon the categorization of individuals by age and sex and, ultimately, by social status. Individuality was important, perhaps because of the emphasis upon resurrection recorded for the Neutral by the French (Wright 1963:20). This being so, ossuary burial of the mingled remains of all the dead at specific times is not consonant with Neutral beliefs. Grimsby cemetery, at least, had a complex mixture of single and multiple burials, the latter having careful arrangements of placed bundled bones of the long-dead and also extended burials of the more recently dead. Those who were buried during the final period of the Neutral Nation, perhaps A.D. 1649 to 1650, did not, however, receive ceremonious burial. Knowledge of whether this holds true at sites other than Grimsby must await the analysis of fully excavated late sites such as Cooper.□

APPENDIX I

ANALYSIS OF DENTAL CASTS

G. Stewart Tait and Mary Jackes

A. Morphological Aspects of the Grimsby dentition.

The sample analyzed consists of 133 dental stone casts (67 maxillae, 66 mandibles), representing 63 adults and 7 individuals with mixed dentition. The morphological features examined were basically those considered by Scott *et al.* (1983). Traits were recorded by side (see Table 124) and by individual. The observations discussed here are reported according to the individual count procedure, and the sample size (n) always refers to numbers of individuals, not teeth. When lateral asymmetry occurred, the higher value of a graded character scale is used, or, in the case of occlusal surface patterns, a separate category created.

Incisors and canines

Shovel-shaped maxillary incisors are a characteristic feature of Amerindian dentition. This was rated according to Hrdlička's (1920) 4-grade scale: full shovel, semi-shovel, trace and absence. The Grimsby maxillary incisors usually displayed the full shovel grade, the frequencies being greater for I^1 (26/32 - 81.3%) than for I^2 (15/40 - 37.5%). The difference between the incidences for the central and lateral incisors is highly significant with a X^2 probability of .000. The I^2 incidence does not include 3 individuals (7.5%) who had fully shovelled I^2s on one side and barrelled antimeres on the other. Barrel-shaped incisors were seen only amongst the left upper lateral incisors. Semi-shovelling occurred in 12.5% of I^1s and 25.0% of I^2s, while ridge traces were found in 6.3% and 25.0%, respectively, of these teeth.

Males had full shovelling on 86.7% of I^1 (n = 15) and 44.4% of I^2 (n = 18). The incidences for females were not significantly different (83.3%, n = 12; 38.9%, n = 18).

Shovelling was much less robust in the mandibular incisors: semi-shovelling of I_1 occurred in 11.4% of the Grimsby individuals (n = 35), and the incidence was equivalent in I_2 (11.9%, n = 42). The incisors of the remaining individuals were classified as trace (I_1, 34.3%; I_2, 45.2%) or absent (I_1, 54.3%; I_2, 42.9%).

The incidences of semi-shovelling in the mandibular incisors of males and females were very similar. Sex differences were, however, evident in the frequencies of the trace and ab-sent categories, but as the distinction between these two classes is rather subtle, the recorded proportions are unlikely to be of significance.

Lateral grade asymmetry for shovel-shape was absent in the maxillary central incisors, but present in 7.5% of the upper lateral incisors (n = 40). The pattern was similar for the mandibular incisors, with asymmetry present in 2.9% of 35 central incisors and 9.5% of 42 lateral incisors.

Pronounced labial ridging was noted as a separate trait on the maxillary incisors in 8 of 33 individuals. There were six cases of mesial ridging (18.2%) and three cases of distal ridging (9.1%) observed for I^1. Central upper incisor distal ridging occurred only on the right side. One individual, Fe 9/26, had incisors that were double-shovelled on the RI^1. Labial ridging was much weaker on the lateral incisors. It was observed in 6 individuals, with 6 cases (15.0%, n = 40) of mesial ridging and 1 case of distal ridging (unilaterally on the right: 2.2%, n = 42). Only very slight facial ridging occurred on the mandibular incisors.

Another important feature of

Amerindian dentition is the labio-mesial rotation or "winging" of the central incisors (Dahlberg 1963). Unilateral winging occurred more frequently in the mandibular incisors (19.2%, n = 52) than in the maxillary incisors (15.4%, n = 52), as did bilateral winging (15.4% and 1.9%). There were also two cases (3.9%) of unilaterally "counterwinged" or disto-lingually rotated lower incisors.

Rotation, and especially disto-lingual rotation of mandibular incisors seems to be related to crowding of the teeth. Twenty mandibles had some form of incisor winging and in 15 of these, the anterior dentition was crowded. This led to the rotation of either the lateral incisors or the canines in 9 (60%) of these 15 individuals. On the other hand, only 22.2% of individuals with winged maxillary incisors (n = 9) showed signs of significant crowding of the anterior dentition. Maxillary incisor rotation could therefore be a diagnostic morphological trait for Amerindian populations, as Dahlberg (1963) has proposed, while mandibular rotation is simply a consequence of crowding.

Lingual tubercles on the anterior maxillary teeth have been used as diagnostic features for comparing Amerindian and Mongolian populations (Scott *et al*. 1983; Turner 1983). This is particularly true for the lateral incisors and canines (the feature rarely occurs on the central incisors). There was only one case of a tuberculated central incisor in the Grimsby sample (2.3%, n = 43), and the eminence resembled an enlarged, prominent enamel ridge rather than a typical tubercle. A tubercle is defined as a rounded protuberance separated from the rest of the basal cingulum by a distinct groove. Tubercles were manifested much more frequently on the lateral incisors (13% n = 46), but were most commonly observed on the canines (30.6%, n = 36). However, their occurrence was often unilateral in the former (at least 50.0% of 6 recorded cases) and usually bilateral in the latter (at least 54.5% of 11 recorded cases, with only one definite unilateral case).

The incidence of canine tubercles seems to be sex-dependent (males 9/18; females 1/15: X^2 P = .007).

The distal accessory ridge was found on both maxillary and mandibular canines, but was recorded only for the lower cuspids, as these may be more significant for inter-populational comparisons (Scott 1977) and the ridge is also less subject to obliteration by wear. The accessory ridge was expressed bilaterally in all determinable cases, but was only weakly manifested by the Grimsby population, which displayed grades 1 or 2 (Scott 1977: Fig. 2), except for one probable male which approached a class 3 level. The ridge has been shown to be sexually dimorphic in Amerindian populations (Scott 1977) and this is reflected in the Grimsby sample by the difference in trait incidence between males (55.6%, n = 9) and females (12.5%, n = 16) (X^2 P = .021). However, the population frequency (29.0%, n = 31) is much lower than that recorded for southwestern Amerindians (54.0%) and little greater than that recorded for American Whites (22.0%) and Asiatic Indians (23.0%) (Scott 1977).

Premolars

Tratman (1950) and others (see Mayhall 1979) have suggested that Mongoloid premolars are characterized by the occasional occurrence of the "premolar occlusal tubercle" but this feature was not observed on either the upper or lower premolars of the Grimsby population. The maxillary premolars were strongly bicuspid and all were similar in shape, except for a "barrel" RP^4 in Fe 62/61. The mandibular P_3s were weakly bicuspid and rather variable in occlusal form. In a number of mandibles (9.8% n = 51), the buccal cusp of P_3 was bilaterally conical in shape and strongly elevated above the tubercle-sized lingual element (see Kraus *et al*. 1969: 71, Fig. I - 113c). Sexual dimorphism and lateral asymmetry were not significant factors for cusp number observations in the mandibular P_3s.

The occlusal surface patterns

displayed by the P_4s were usually variations of the ideal H2, U2 and Y3 cusp and groove configurations (Zeisz and Nuckolls 1949:175, Figs. 155 to 157). A fourth category was added here to accommodate unusual or irregular patterns and the male and female frequencies for each class are pooled, there being no significant differences. The bicuspid types were dominant, with the H2 group the largest (33.3%, n = 48), followed by the irregular and U2 categories (25.0% and 20.8% respectively). The tri-cuspid Y3 frequency was relatively low (12.5%). Additionally, there were four individuals (8.3%) with lateral asymmetry, displaying Y3/U2 or H2/U2 combinations of patterns.

Molars

Maxillary molars: occlusal features

The occlusal surface patterns of the upper molars were classified according to Dahlberg's (1963) 4-grade scale of hypocone (disto-lingual cusp) reduction (4, 4-, 3+, 3), but additional classes were introduced to accommodate the variation found in the M^3s. The general trend of hypocone reduction from M^1 to M^3 was supported by the results obtained from the Grimsby sample. The M^1s fell within the 4 or 4- categories (56.7% and 41.7%, n = 60) with a single exception. The M^2s usually displayed the 4- pattern (70.9%, n = 55), but 18.2% were of the 3+ type.

The assessment of the degree of hypocone reduction in M^1 and M^2 was complicated by the presence of the metaconule or fifth cusp, on the distal aspect of the metacone (disto-buccal cusp). When this took the form of a small tubercle of grade 1 or 2 size (Harris and Bailit 1980: Fig.1), it was simply ignored in scoring for the hypocone reduction trait. However, the molars in which the metaconule was a moderate or large element (grades 3-5) were placed in a separate 5-cusped category (and excluded from the sample used for population distance analysis). The fifth cusp was expressed bilaterally and manifested on 7.8% of M^1 (n = 51) and 13.0% of M^2 (n = 46), usually to a minor degree.

Also occurring in the 5-cusped category for M^2 were a few specimens displaying the seventh or medio-buccal cusp, located between the paracone and metacone (Turner 1967: 97, Fig.10). This element occurred in low frequencies in both M^2 (3.6%, n = 55) and M^3 ((2.4%, n = 41). It was always much smaller than the two largest cusps, the protocone (mesio-lingual element) and paracone (mesio-buccal element).

The M^3s had the most diverse occlusal morphology and ranged from a 4- pattern (in two individuals) to a bicuspid 2/2+ state (12.2%, n = 41). The largest categories were the 3+ and 3 classes, comprising 34.1% and 26.8% of the determinable M_3 sample. There were also 3 peg elements (7.3%) and a number of 4-cusped or 5-cusped teeth of irregular or unusual form (14.6). Various degrees of metacone reduction were observed among the M^3s, including 2 cases (3+ pattern) where the cusp was manifested as a mere tubercle, equivalent in size to the adjacent and greatly diminished hypocone.

Male and female frequencies were similar for the maxillary molars. The genetic instability of the M^3 is reflected in the percentages for lateral pattern asymmetry (6.7%, n = 60 in M^1, 7.3%, n = 55 in M^2 and 14.6%, n = 41 for M^3), but the probability value for the difference between the second and third upper molars is not significant.

Paramolar and entomolar cusps

Several accessory cusps were found on the buccal and lingual surfaces of the maxillary molars, the best known being the Carabelli feature. The variations of this trait were grouped into three general categories, following Dahlberg (1963): (1) trait absence, (2) presence of pits, grooves or ridges and (3) the occurrence of cusp outlines or eminences on the lingual surface of the proto-cone. The M^1 characteristically showed a high frequency of the trait, with 9.1%

coded as 3 and 60.0% coded as 2 (n = 55). The second and third upper molars rarely displayed the Carabelli feature, and only in the form of class 2 manifestations (7.5%, n = 53 for M^2; 5.1%, n = 39 for M^3).

Paramolar cusps were found on both upper and lower molars. On the maxillary teeth, three unilateral (left) parastyles were observed on the buccal surface of the paracone, one (1.8%, n = 55) on M^2 and two on M^3 (5.1%, n = 39). These were small to medium sized tubercles; they may be useful for interpopulation discrimination (Kustaloglu 1962; Turner 1983).

Accessory cusp features tended to be bilateral in the mandibular teeth. One paramolar cusp was observed on the disto-buccal (hypoconid) M_3 surface (3.8%, n = 26) and two (separate individuals) on the disto-lingual M_3 surface (6.7%, n = 30). The expression of this character was always stronger on one side (small to medium sized tubercles) than on the other (ridges or furrows). Without side preference, an individual with a tubercle on one side, always had a ridge or furrow on the other. There is a suggestion here of a lower accessory cusp complex similar to the paramolar complex described by Kostaloglu (1962) for the upper teeth.

The various manifestations of the protostylid feature (Bölk's paramolar complex), found on the buccal surface of the protoconid (mesio-buccal cusp) of the lower molars were classified according to a slightly modified version of the 7-grade scale used by Dahlberg (1963). The grade 1 category was restricted to the presence of very large, circular, deep buccal-groove pits, 1-2 mm in diameter. The grade 2 class was expanded to include pits, grooves and wrinkles occurring on the mesio-buccal surface. The protostylid trait was most strongly expressed on the M_1s with 2.6% (n = 38) displaying a cusplike eminence, 2.6% a groove or vertical wrinkle and 10.5% a large pit. The M_2s manifested only grade 1 and 2 characters (19.5% and 4.9%, n = 41), as did the M_3s (4.0% and 20.0%, n = 25).

Mandibular molars: occlusal features

Supernumerary cusps or tubercles were also observed in the occlusal portion of the molar crown. These included the sixth and seventh cusps, the tuberculum sextum and tuberculum intermedium. The sixth cusp is coupled (lingually) with the distal "fifth" cusp or hypoconulid and is associated with the standard cusp and groove patterns considered below (Kraus *et al*. 1969: 110-111, Fig. I-182). The sixth cusp was usually less than half the size of the protoconid or metaconid (mesio-lingual element).

The seventh cusp produces a very distinctive pattern when it takes the form of a prominent, wedge-like element between the two lingual lobes, the metaconid and entoconid (Kraus *et al*. 1969: 110-111, Fig. I-183). This manifestation is rather rare among Amerindian populations (Scott *et al*. 1983) and it was not observed in the Grimsby sample. Only the weakest degree of expression was displayed; a triangular eminence or ridge located in the distal portion of the metaconid, with a vertical groove lying mesial and parallel to the lingual groove (Kraus *et al*. 1969: 110; Scott *et al*. 1983). This feature occurred most commonly on M_1 (10.0%, n = 40), rarely on M_2 (2.6%, n = 39) and was not found on M_3 (n = 31). The frequency of the seventh cusp has been used as a diagnostic trait in the comparison of different Amerindian populations (Scott *et al*. 1983; Turner 1983).

First molars

The traditional cusp and groove patterns defined by Gregory (1934: 69) and Jørgensen (1955) were used to describe the occlusal morphology of the lower molars. The Y5 configuration was dominant in the M_1s (76.3%, n = 38) but absent in the M_2s and M_3s. The X5 pattern was present in only 7.9% of M_1s, while the Y6 class was the second largest (13.2%). The M_1s were usually

5-cusped teeth (86.4%, n = 44), but 13.6% were 6-cusped (Y6 and +6). The interpretation of Y5 and Y6 dominance on the M_1s may be complicated by the presence (on the metaconid) of the "deflecting wrinkle", which deflects the lingual groove distally to create a "spurious" Y-pattern (Morris 1970). This character occurs very frequently amongst some Amerindian populations (Turner 1983; Morris 1970; Scott *et al*. 1983). In the Grimsby sample it was found in a relatively low proportion of the Y5 teeth (31%, n = 29) but was recorded on half the Y6 specimens (3/6, including one M_2). Therefore, the percentage of valid Y5 specimens would still be high for the Grimsby people (52.6%, n = 38) and the Y-pattern dominant on the M_1s (60.5%).

Second molars

The X5 and X4 classes were the largest M_2 groups (30.8% and 20.5%, n = 39), and the +4 category was also important (15.4%). Various miscellaneous patterns (Y6, Y4, +5, X6) comprised 15.4% of the specimens, and there was also a large proportion (17.9%) of antimeres displaying lateral asymmetry by X5/+5, X4/+4 and Y4/+4 combinations. The M_2s were commonly 4-cusped teeth (47.6%, n = 42); the frequency of 6-cusped molars (14.3%) was comparable to that of the M_1s, while the remainder (38.1%) were 5-cusped elements. As with the M_1s and M_3s, large discrepancies between male and female frequencies for the different patterns were not observed on the M_2s.

Third molars

The M_3s displayed the greatest variety of occlusal patterns. The most common of the standard classes was the X4 category (32.3%, n = 31), while the X5 (9.7%), X6 and X4/+4 configurations (6.5% combined) were also observed. Most M_3s (51.6%) were irregular and did not fit any traditional cusp pattern. However, within this group, one type occurred with some frequency (19.4%, n = 31). In this type there was an extra medio-buccal cusp between the protoconid and the hypoconid, in a pattern otherwise resembling a X4 or X5 configuration. The extra element varied in size from a tubercle to a full-sized cusp, and could be referred to as a "tenth cusp" (see Turner 1967:97, Fig. 10).

Distance studies

Third molars are not used for inter-population comparisons because of their genetic instability. The first two maxillary and mandibular molars display a number of diagnostic characters that can be used for this type of analysis, and some of the features of the anterior teeth are also believed to be useful for this purpose. Twenty traits were selected for a biological distance comparison of five southern Ontario Iroquoian samples, using data from P.J. Wright (1974) and K. Wright (1977), together with the Grimsby data (see Tables 125 and 126). The results are discussed in the Summary (Chapter 13) in conjunction with a similar study using cranial traits.

B. Metrical Analysis of the Grimsby Cast Sample.

Measurements of cheek teeth and alveolar arch were taken by G.S. Tait: six separate measurements of each dimension were taken on three separate occasions between July 1983 and February 1984. Buccolingual diameters were taken on permanent premolars and molars. During each of the three series of measurements, two maximum measurements were recorded after a series of trials to find the maximum diameter of the tooth.

Cidália Duarte took three series of maximum mesio-distal and bucco-lingual measurements, as defined by Bass (1971), on the anterior dentition.

Tait's arch measurements comprised the following:

1. The maxillary labial segment from LC^1 to RC^1 (LSL): from the most distal point of the canine crowns at the cemento-enamel

junction. The socket margin was substituted when the canine was absent.

2. The maxillary buccal segment lengths from LP^3 to LM^2 and RP^3 to RM^2 (BSL): from the anterior point of the premolar mesial contact facet to the distal crown at the cemento-enamel junction. When right and left sides differed, the larger value was recorded; otherwise the more complete side was used. Estimates derived from the alveolar sockets were used for missing data.

3. The maxillary alveolar breadth, from LM^2 to RM^2 (SAB). The widest points of the teeth just above the cemento-enamel junction were used. Estimates derived from alveolar sockets substituted for missing values.

4. The maxillary alveolar length, from LI^1/RI^1 to LM^2/RM^2 (SAL). The fixed jaw of the calliper was laid against the distal second molar and the sliding jaw was brought to rest on the central incisors. Distal socket margins substituted in estimating missing data.

5. The mandibular labial segment length, from LC_1 to RC_1 (LSL). Techniques followed those discussed for 1. above.

6. The mandibular buccal segment lengths, from LP_3 to LM_2 and from RP_3 to RM_2 (BSL). Techniques followed those recorded for 2. above.

7. The mandibular alveolar breadth, from LM_2 to RM_2 (IAB). Techniques followed those recorded for 3. above.

8. The mandibular alveolar length, from LI_1/RI_1 to LM_2/RM_2 (IAL). Techniques were identical with those recorded for 4. above.

Discriminant function analyses of the tooth and arch measurements did not provide clear separation of males and females: it was not possible to determine the sex of the 11 unknown dentitions or to confirm the sex of an uncertain individual like Fe 62/63. Univariate analysis of the measurements provides data in Tables 127, 128 and 129, showing the variables for which significant sex differences have been demonstrated.□

Table 124: Observations of dental morphology (left side)

I. INCISORS

Lingual shovelling

		absent	full	semi	trace	barrel	n
I^1	Male	0	13	0	1	0	14
	Female	0	5	2	0	0	7
	All	0	20	4	1	0	25
I^2	Male	1	7	3	2	2	15
	Female	1	7	4	4	1	17
	All	2	14	9	8	3	36
I_1	Male	9	0	1	2	0	12
	Female	4	0	1	8	0	13
	All	17	0	4	12	0	33
I_2	Male	7	0	1	4	0	12
	Female	8	0	2	9	0	19
	All	17	0	4	16	0	37

Labial shovelling

		mesial	n	distal	n
I^1	Male	2	13	0	14
	Female	1	10	0	10
	All	4	28	0	29
I^2	Male	2	14	0	16
	Female	1	16	0	19
	All	5	34	0	39

Winging

		absent	present	counter	n
I^1	Male	19	2	0	21
	Female	20	2	0	22
	All	43	4	0	47
I_1	Male	16	4	0	20
	Female	13	6	0	19
	All	33	15	0	48

Lingual tubercles

		absent	present	n
I^2	Male	17	1	18
	Female	17	2	19
	All	37	4	41

II. Canines

Lingual tubercles

	absent	present	n
Maxilla			
Male	9	5	14
Female	13	1	14
All	24	7	31

Distal accessory ridge

	absent	present	n
Mandible			
Male	2	5	7
Female	10	2	12

III. Premolars

Occlusal surface pattern

	H2	U2	Y3	other	n
P_4					
Male	7	6	1	3	17
Female	7	3	4	6	20
All	16	9	6	10	41

IV. Molars

Hypocone reduction

		4	4-	3+	3	other	n
M^1	Male	13	12	0	0	0	25
	Female	12	8	0	0	1	21
	All	30	24	0	0	1	55
M^2	Male	0	17	5	0	1	23
	Female	0	9	7	0	3	19
	All	0	30	13	0	4	47
M^3	Male	0	2	4	5	4	15
	Female	0	0	8	5	2	15
	All	0	2	12	10	7	31

Carabelli's trait

		absent	pit/groove	cuspule	n
M^1	Male	6	12	1	19
	Female	7	9	0	16
	All	14	26	4	44
M^2	Male	22	1	0	23
	Female	17	1	0	18
	All	42	3	0	45
M^3	Male	9	0	0	9
	Female	13	1	0	14
	All	23	1	0	24

Protostylid trait

		0	1	2	3	n
M_1	Male	8	1	0	1	10
	Female	14	0	0	0	14
	All	29	2	1	1	33
M_2	Male	9	2	0	0	11
	Female	13	4	1	0	18
	All	24	7	2	0	33
M_3	Male	5	0	2	0	7
	Female	9	0	2	0	11
	All	14	0	4	0	18

Tuberculum intermedium (C7)

		absent	present	n
M_1	Male	11	2	13
	Female	11	0	11
	All	28	4	32
M_2	Male	11	0	11
	Female	16	0	16
	All	31	0	31
M_3	Male	13	0	13
	Female	13	0	13
	All	26	0	26

Cusp and groove pattern

	Y5	Y6	Y4	+4	+5	+6	X5	X4	X6	other	n
M_1											
Male	8	3	0	0	0	1	0	0	0	0	12
Female	1	2	0	0	0	0	0	0	0	0	13
All	24	5	0	0	0	1	3	0	0	0	33
M_2											
Male	0	0	0	3	1	0	6	2	1	0	13
Female	0	0	1	5	0	0	4	4	1	0	15
All	0	0	1	10	2	0	10	7	2	0	32
M_3											
Male	0	0	0	0	0	0	1	3	1	7	12
Female	0	0	0	0	0	0	1	6	0	6	13
All	0	0	0	0	0	0	2	9	1	13	25

In order to increase sample sizes, individuals whose sex assignment was uncertain have been included within the sexed sample. The individuals are Fe 36/6003 (maxilla, male?); Fe 36/7001 (mandible, male?); Fe 62/63 (maxilla and mandible, female?).

Table 125: Data for calculation of mean measure of divergence for five southern Ontario sites

	Grimsby				Shaver Hill				Carton				Sopher				Kleinburg			
Traits	right	left	n	θ	right	left	n	θ	right	left	n	θ	right	left	n	θ	right	left	n	θ
Maxillary																				
I^1 shovel absent	0/30	0/25	55	1.427	0/12	0/15	27	1.362	0/7	0/3	10	1.213	0/15	0/12	27	1.362	7/174	6/180	354	1.178
I^1 labial ridge	7/27	4/28	55	0.630	3/13	3/13	26	0.546	3/7	0/3	10	0.374	3/15	2/13	28	0.670	26/212	23/251	463	0.905
I^2 shovel absent	1/33	2/36	69	1.121	1/11	1/10	21	0.886	0/14	0/12	26	1.357	0/7	0/9	16	1.294	8/163	10/161	324	1.089
I^2 labial ridge	4/34	5/34	68	0.811	0/7	2/9	16	0.787	2/12	1/11	23	0.789	3/8	2/8	16	0.362	13/196	11/182	378	1.057
I^2 lingual	4/38	4/41	79	0.907	2/11	3/11	22	0.550	2/13	1/12	25	0.821	1/8	2/10	18	0.686	13/207	21/193	400	0.975
C lingual	10/27	7/31	58	0.419	5/17	0/15	32	0.730	6/29	10/3	61	0.487	5/18	2/10	28	0.504	11/254	9/295	549	1.182
M^1 hypocone not	27/54	30/5	10	-0.05	38/44	26/3	77	-0.71	59/67	45/5	12	-0.73	29/36	25/3	69	-0.59	225/34	234/35	698	-0.32
M^1 Carabelli	33/50	30/4	94	-0.34	22/42	13/3	74	0.053	33/64	26/5	11	0	27/36	14/3	68	-0.20	136/20	154/21	419	-0.39
M^2 hypocone not	1/49	0/43	92	1.320	0/22	2/25	47	1.112	0/38	1/27	65	1.273	1/17	2/21	38	0.964	52/320	21/303	623	0.870
M^2 Carabelli	3/49	3/45	94	1.024	0/21	3/24	45	1.013	0/39	1/32	71	1.286	3/17	1/20	37	0.869	40/240	38/209	449	0.709
Mandibular																				
P_4 2 or 3 lingual	6/40	6/41	81	0.769	7/19	1/13	32	0.506	4/27	6/25	52	0.648	4/14	1/18	32	0.730	23/226	25/232	458	0.909
M_1 + pattern	1/31	1/33	64	1.178	3/32	1/30	62	1.030	4/52	5/45	97	0.938	1/18	1/33	51	1.131	18/215	16/221	436	1.001
M_1 protostylid[b]	2/30	2/33	63	1.035	2/33	0/26	59	1.162	3/57	2/51	10	1.118	1/18	5/34	52	0.856	12/157	11/171	328	1.030
M_1 cusp #6	4/38	6/38	76	0.814	8/26	8/22	48	0.333	11/22	9/20	42	0.046	6/16	12/3	49	0.263	91/146	87/142	288	-0.23
M_1 cusp #7	2/32	4/32	64	0.928	8/32	6/27	59	0.543	15/48	8/42	90	0.505	4/18	7/34	52	0.602	34/235	29/225	460	0.810
M_2 Y pattern	4/30	1/32	62	0.972	0/21	1/14	35	1.166	0/40	4/46	86	1.113	12/25	9/21	46	0.085	13/192	28/193	385	0.903
M_2 protostylid[b]	1/30	2/33	63	1.100	1/24	2/26	50	1.042	4/39	2/46	85	1.014	0/26	1/21	47	1.221	22/151	26/149	300	0.745
M_2 cusp #5	17/33	17/3	68	0	14/16	17/2	39	-0.61	26/31	32/3	69	-0.73	21/26	18/2	47	-0.70	174/19	184/19	389	-0.99
M_2 cusp #6	3/33	5/35	68	0.854	4/11	3/15	26	0.461	7/22	7/23	45	0.379	7/20	4/18	38	0.423	58/133	67/127	260	0.038
M_2 cusp #7	1/31	0/31	62	1.266	2/22	2/24	46	0.942	2/35	1/42	77	1.145	5/25	5/21	46	0.586	10/205	22/176	381	0.979

NB: Bartlett's adjustment (Sjøvold 1973:226) used for all traits with incidence of 0 or 1.
[a] Full-sized hypocone; 5-cusped molars excluded from samples.
[b] Large pits excluded from incidences.

Table 126: Mean Measure of Divergence using twenty dental traits (pooled sides)[a]

	Grimsby	Shaver Hill	Carton	Sopher	Kleinburg
Grimsby	-	1.232	1.673	2.257	3.817
Shaver Hill	.014	-	-0.409	0.893	1.607
Carton	.016	.021	-	1.105	1.756
Sopher	.015	.020	.021	-	2.312
Kleinburg	.005	.011	.012	.011	_
Grimsby	-	3.203	3.642	4.228	5.806
Shaver Hill	7	-	1.549	2.853	3.586
Carton	4	10	-	3.063	3.731
Sopher	3	9	8	-	4.290
Kleinburg	1	6	5	2	-
Total rank	15	32	27	22	14

[a] The first matrix presents the MMD (above) and δ (below); the second matrix presents the degree of isolation (DI = (MMD + 2) - 2δ) (above) and the rank order (below): the method is discussed in Chapter 5. Thus, Kleinburg and Grimsby are most different and Carton and Shaver Hill, least different. All differences are significant apart from the Carton-Shaver Hill MMD.

Table 127: Measurements of anterior dentition with comparison between male and female means

MAXILLAE	n	mean	δ	*t*	P
Right canine length					
All	22	8.285	.474	1.87	.079
Males	10	8.513	.505		
Females	9	8.133	.358		
Right canine breadth					
All	26	7.737	2.345	-.95	.362*
Males	12	7.203	3.378		
Females	12	8.144	.663		
Right I^2 length					
All	20	7.598	.604	.66	.521
Males	8	7.675	.446		
Females	8	7.488	.671		
Right I^2 breadth					
All	29	6.733	.453	-.30	.768
Males	13	6.703	.410		
Females	14	6.757	.530		
Right I^1 length					
All	12	8.708	.475	.12	.907
Males	5	8.733	.591		
Females	5	8.693	.444		
Right I^1 breadth					
All	28	7.223	.460	.24	.813
Males	13	7.236	.413		
Females	12	7.192	.509		
Left I^1 length					
All	12	8.720	.548	1.12	.306
Males	4	8.908	.692		
Females	4	8.467	.380		
Left I^1 breadth					
All	25	7.337	.465	1.84	.081
Males	12	7.533	.438		
Females	11	7.206	.415		
Left I^2 length					
All	16	7.496	.521	1.39	.195
Males	8	7.575	.401		
Females	4	7.175	.600		
Left I^2 breadth					
All	26	6.745	.477	-.92	.367
Males	10	6.637	.490		
Females	15	6.820	.486		
Left canine length					
All	18	8.296	.488	.82	.430
Males	10	8.357	.463		
Females	4	8.117	.585		
Left canine breadth					
All	23	8.107	1.834	-.38	.713*
Males	12	8.000	2.536		
Females	9	8.285	.576		

* Probabilities of *t* given by separate variance estimates.

MANDIBLES	n	mean	δ	*t*	P
Right canine length					
All	24	7.226	.485	2.37	.029
Males	10	7.447	.495		
Females	11	7.003	.360		
Right canine breadth					
All	26	7.414	.483	1.91	.070
Males	9	7.656	.494		
Females	14	7.271	.458		
Right I_2 length					
All	13	6.307	.503	1.77	.120
Males	4	6.492	.347		
Females	5	6.113	.298		
Right I_2 breadth					
All	27	6.067	.341	1.45	.161
Males	9	6.204	.367		
Females	13	6.023	.216		
Right I_1 length					
All	11	5.467	.415	-2.40	.054
Males	4	5.342	.279		
Females	4	5.867	.338		
Right I_1 breadth					
All	20	5.712	.378	-.15	.881
Males	9	5.733	.379		
Females	8	5.758	.287		
Left I_1 length					
All	14	5.302	.345	-2.97	.021
Males	4	5.033	.234		
Females	5	5.473	.210		
Left I_1 breadth					
All	25	5.595	.346	.87	.393
Males	8	5.742	.381		
Females	13	5.623	.244		
Left I_2 length					
All	14	6.188	.328	1.47	.181*
Males	3	6.333	.058		
Females	8	6.121	.398		
Left I_2 breadth					
All	33	6.016	.343	.23	.817
Males	9	6.082	.320		
Females	18	6.050	.335		
Left canine length					
All	25	7.233	.473	1.21	.239
Males	10	7.397	.461		
Females	11	7.152	.463		
Left canine breadth					
All	28	7.618	.513	3.58	.002
Males	12	7.947	.465		
Females	12	7.320	.392		

Table 128: Bucco-Lingual Breadths with comparison between male and female means

MAXILLAE	Mean	δ	n	*t*	P
Right M^3					
All	10.621	.838	28	1.13	.268
Males	10.835	.651	11		
Females	10.458	.958	16		
Right M^2					
All	11.582	.67886	54	2.88	.006
Males	11.879	.64166	24		
Females	11.342	.66040	25		
Right M^1					
All	11.745	.52719	54	2.32	.025
Males	11.949	.50532	23		
Females	11.611	.47164	22		
Right P^4					
All	9.417	.687	51	2.14	.038
Males	9.644	.65980	23		
Females	9.213	.707	23		
Right P^3					
All	9.716	.53920	54	1.01	.318
Males	9.807	.58602	22		
Females	9.646	.53163	27		
Left P^3					
All	9.669	.61098	52	1.23	.224
Males	9.808	.67534	22		
Females	9.590	.55302	26		
Left P^4					
All	9.451	.60696	55	1.01	.318
Males	9.553	.69437	25		
Females	9.374	.55015	25		
Left M^1					
All	11.760	.51090	56	2.56	.014
Males	11.970	.44024	23		
Females	11.610	.51070	23		
Left M^2					
All	11.604	.67349	50	2.60	.013
Males	11.856	.68968	25		
Females	11.346	.60182	20		
Left M^3					
All	10.635	.81667	27	1.13	.271
Males	10.821	.81489	13		
Females	10.455	.84138	13		

MANDIBLES	Mean	δ	n	*t*	P
Right M_3					
All	10.46889	.6.5599	27	1.44	.166*
Males	10.63714	.8.1361	14		
Females	10.28333	.3.9962	12		
Right M_2					
All	10.53771	.62455	35	1.56	.130
Males	10.77750	.70502	16		
Females	10.43000	.47560	14		
Right M_1					
All	10.93825	.52930	40	2.36	.025
Males	11.24615	.41438	13		
Females	10.87000	.44518	17		
Right P_4					
All	8.26156	.50233	45	.60	.553
Males	8.33421	.52027	19		
Females	8.23429	.53265	21		
Right P_3					
All	7.74978	.53742	45	1.34	.190
Males	7.87250	.57521	20		
Females	7.64150	.51680	20		
Left P_3					
All	7.8769	.5575	48	1.61	.115
Males	8.00583	.58231	24		
Females	7.72895	.52838	19		
Left P_4					
All	8.30435	.49303	46	2.0	.052
Males	8.45409	.48522	22		
Females	8.15105	.48084	19		
Left M_1					
All	10.94421	.45827	38	.95	.352
Males	11.11467	.44971	15		
Females	10.96994	.3699	14		
Left M_2					
All	10.56500	.60586	34	2.07	.048
Males	10.89583	.67391	12		
Females	10.44765	.49306	17		
Left M_3					
All	10.37840	.77202	25	1.09	.296*
Males	10.55917	1.04639	12		
Females	10.21083	.37002	12		

* Probabilities of *t* given by separate variance estimates.

Table 129: Measurements of Alveolar Arches with comparison between male and female means

MAXILLAE	Mean	δ	n	*t*	P
LSL					
All	40.175	2.542	54	2.05	.046
Males	40.956	2.504	27		
Females	39.510	2.4571	23		
BSL					
All	32.221	1.738	53	2.46	.018
Males	32.807	1.637	25		
Females	31.656	1.635	24		
AB					
All	63.595	3.094	39	2.19	.036*
Males	64.597	3.546	21		
Females	62.579	1.938	15		
AL					
All	46.064	3.189	37	1.60	.119
Males	46.938	2.710	20		
Females	45.169	3.737	14		
MANDIBLES					
LSL					
All	31.750	1.549	52	.61	.543
Males	31.995	1.523	24		
Females	31.722	1.556	24		
BSL					
All	35.499	2.102	38	1.04	.306
Males	35.797	2.192	18		
Females	35.061	1.894	16		
AB					
All	59.478	2.721	25	1.24	.229
Males	60.405	2.082	10		
Females	58.921	3.262	12		
AL					
All	43.020	3.122	24	.40	.696
Males	42.995	2.950	10		
Females	42.430	3.517	11		

* Probabilities of *t* given by separate variance estimates.

APPENDIX II

LIFE TABLE CALCULATION

x - age class groupings

D_x - numbers of individuals in each age class

d_x - proportion of individuals dying in each age class

$$d_x = \frac{(D_x)}{\sum D_x} 1000$$

l_x - number of individuals surviving in an age class of an original cohort of 1000

$${}_5l_5 = l_0 - d_0 \text{ etc.}$$

q_x - probability that an individual in an age class will die before attaining the next age class

$$q_x = \frac{d_x}{l_x} \quad \text{or} \quad q_x = \frac{l_x - (l_{x+1})}{l_x}$$

L_x - total number of years lived in an age class of all surviving people per 1000 individuals born

$${}_1L_0 = \frac{l_1 + d_0}{2}; \quad {}_4L_1 = \frac{4(l_1 + l_5)}{2}; \quad {}_5L_5 = \frac{5(l_5 + l_{10})}{2} \text{ etc.}$$

T_x - total number of years lived by the population from age x

$$T_0 = \quad L_x; \quad {}_5T_5 = T_0 - L_0 \text{ etc.}$$

e_x - life expectancy

$$e_x = \frac{T_x}{l_x}$$

C_x - the age distribution of the population is given by the relative numbers of the population to a certain age

$$C_x = \frac{L_x}{e_0}$$

M_x - age specific mortality can be calculated by

$$M_x = \frac{d_x}{L_x}$$

$$\text{General Fertility Rate} = \frac{{}_1C_0}{({}_5C_{15} \text{ to } {}_5C_{40}/2)} \times 1000$$

$$\text{Total Fertility Rate} = \frac{{}_1C_0}{({}_5C_{15} \text{ to } {}_5C_{40}/2)} \times 30$$

APPENDIX III

DENTAL ENAMEL COMPOSITION AT THE GRIMSBY SITE: A PRELIMINARY REPORT

Kim N. Schneider

Introduction

Dental enamel is a lasting biological tissue which reflects the developmental, dietary, and disease processes in operation during the whole lifetime of an individual, not only during the period of enamel formation. The elemental composition of enamel is affected directly by the quality and quantity of the diet, the efficiency of uptake, and disturbances which alter the incorporation of a wide variety of ions. Study of this structure, therefore, provides a number of avenues for palaeoepidemiological and palaeo-nutritional research.

During the enamel maturation period of amelogenesis, a massive influx of inorganic ions occurs complimented by qualitative and quantitative changes to the organic fraction of the matrix. As amelogenesis proceeds and a full thickness of enamel has been deposited in a particular region, the maturation process continues until the final high mineral content (96%) is achieved (Eisenmann 1980:183). Mature enamel is classified as carbonate hydroxyapatite:

$$Ca_{10-x}(O_{2+x}H_{2+3x-y})(PO_4)_{6-3x-y}(CO_{3)4x}(O_4H_4)_y$$

where x never exceeds unity and y never exceeds 2 (McConnell 1960). Principally because of this chemical structure, dental enamel is an accommodating compound which allows a wide variety of atomic substitutions while maintaining its crystallographic integrity.

Although dental enamel is composed in large part of calcium and phosphorous, various elements are known to substitute for these primary components. Losee et al. (1974) reported that at least 41 elements of the periodic table are incorporated into dental enamel, most with atomic numbers less than 34. These "substitution" elements can be incorporated during enamel maturation or they may accumulate during the post-eruptive period. Diagenetic alteration can occur in sound enamel, but some elements will accumulate only if the surface or sub-surface of the enamel is hypomineralized or demineralized (Little and Steadman 1966).

The incorporation of a particular element during enamel formation depends both on its availability and on its particular chemical properties. The substitution of chloride and fluoride ions for the OH ion in apatite is well documented (White 1975; Derise and Ritchey 1974). These ions, along with divalent cations such as strontium and lead have been shown to change the unit cell size proportional to the mole percent substitution (Trautz 1967). Such substitutions alter the structure, causing modifications which may render the enamel susceptible to dissolution (and subsequent caries) as compared to non-altered enamel.

The quantification of both macro- and micro-constituents of sound enamel provides the basis for evaluations of cariostatic and cariogenic properties of these elements. The composition of enamel also provides an indirect measure by which populations may be evaluated regarding subsistence strategies. Because particular elements are found more commonly in particular foods, dietary inclusion of these foodstuffs will provide the opportunity for their structural inclusion in enamel. Finally, compositional studies may help elucidate patterns of biological stress. While enamel defects such as hypoplasias may be the result of metabolic factors such as hypoparathyroidism of infections such as congenital syphilis which are manifested by differential retention of the organic portion of a developing tooth, enamel may also be defective if chronic elemental deficiencies are operant during the tooth's formation.

Materials and methods

During the packing of the Grimsby skeletons for reburial, thirty-three teeth from Feature 1 were overlooked. These teeth had been excavated by F.J. Melbye at the beginning of the salvage operation and transported in film canisters to the Royal Ontario Museum in Toronto prior to the establishment of the osteological field laboratory on the outskirts of Grimsby. The canisters were not reopened for several years. Feature 1 as the final burial place of the Neutral Nation before its destruction by the Iroquois (Jackes 1983) is of great interest, so the inadvertent retention of these teeth was very fortunate. Because of signs of disturbance to the enamel micro-structure, it was decided to examine the teeth further for evidence of alteration to the diet caused by famine.

Of the 33 available teeth, representing at least nine individuals, the 13 least friable were selected for analysis. These share the following characteristics: no caries or signs of abscessing; intact crowns; low wear (< wear score 3, Molnar 1971); absence of linear enamel hypoplasia; normal crown shape and form; no apparent intrinsic or extrinsic stain.

The teeth were cleaned gently with a toothbrush and dental explorer, using distilled water to remove adhering dirt. Each tooth was polished with a series of silicon grit papers and diamond paste on a Struers DP-U2 polishing device to produce a planar surface. Specimens were cut at the cemento-enamel junction to remove roots, and each was mounted with Electrodag on aluminium stubs for carbon coating.

An S410 Cambridge Scanning Electron Microscope equipped with a Tracor Northern Energy Dispersive X-ray Analyser was used for characterization of enamel composition. Ten elements were chosen for quantification, including major essential elements (Ca, P), trace essential elements (Mg, Cu, Mn, Se, Fe,), trace non-essential elements (Sr, Al) and trace non-essential (toxic) elements (Pb). These elements were chosen because each is present in dental enamel (Curzon and Cutress 1983), each plays a role in nutrition, and each has been shown to be useful for the discrimination of populations utilizing different subsistence bases and the corresponding different dental caries expres-sions (Schneider 1986).

Elemental peak, associated back-ground and non-associated background were collected at three separate locations on each tooth. The working distance to the detector was 11 mm., with the polished planar surfaces oriented at a 38-40 degree inclination to the detector. A 20kV accelerating voltage and a 40-sec real time counting interval were used.

Tracor Northern SSQ standardless semi-quantitative analysis was performed, yielding the elemental concentration of each element chosen. All data require 2-3 iterations. Mean weight percents for each ele-ment per tooth were calculated and converted to parts per million (ppm) using SAS software (SAS Institute 1982). These data were entered as a matrix for correspondence analysis using the CORAN program (Lebart, Morineau and Warwick 1984). The analysis follows the methods outlined in Greenacre (1984) using the eigendecomposition method. This provides a method for displays of both columns and rows of a matrix in low dimensional space allowing similarities between rows (teeth) and columns (elements) to be determined. Such clustering along principal axes in the joint display permits simultaneous interpretation of effects.

Results

As in the case of a previous study (Schneider 1984), Al was eliminated from this investigation because it is associated with increasing distance from the surface of the tooth, and the element fluctuated widely among subsequent aliquots.

Data were analyzed using correspondence analysis in two groups composed of succedaneous or permanent (n = 9) and deciduous (n =

4) teeth. Both groups were subjected to a correspondence analysis including all elements (i.e. Ca and P plus all trace elements except Al) and an additional analysis using only trace elements.

Fig. 43 displays each permanent tooth (as a square) and each element examined. The first two principal axes explain 93.47% of the variance within the data matrix (1 = 78.30%; 2 = 15.17%). The dispersion along the first principal axis appears to generally discriminate within the sample by tooth type. The second axis seems to differentiate among the sample members on the basis of typical elemental concentration range. Elements with negative values on the second axis tend to be found at concentrations at or below 10 ppm, whereas the elements with positive second axis coordinates tend to be detected at higher concentrations (>10-100 ppm). The exception to this tendency is Se which is usually found at concentrations of 0.1-0.9 ppm (Curzon 1983) and is positioned in the display with elements generally recorded at between 100-1000 ppm.

Fig. 44 displays all succedaneous teeth examined using only trace element values. The first two principal axes of inertia explain 90.11% and 4.42% of the variance respectively. Ca and P do not appear to contribute to a large degree to the pattern of variation present as this analysis is able to explain more of the variance than when these two elements are included. Again, the first axis separates teeth by tooth type and the second axis by relative ppm concentrations. The inconsistent positions of Se and Pb (in the latter case, positioned in the display largely due to excessive concentration in one tooth) are noteworthy.

Four deciduous teeth are included in the Grimsby Feature 1 sample analyzed. These teeth were analyzed separately due to the likelihood that they were subjected to a very different set of developmental parameters compared to the permanent teeth in the sample.

Correspondence analysis is executed twice; once including Ca and P, and again, with these two elements excluded. Copper is excluded from both analyses as this element was not detected in any of the deciduous teeth. Fig. 45 displays the analysis with macroconstituents included. The first axis explains 76.08% and the second axis 23.01% of the variance. Fe and Mn, elements of similar atomic weight, cluster away from the centre of the display. The remaining elements are found at relatively high concentration: as with the permanent tooth sample, Se shares a prominent position with other elements generally found at comparatively higher concentrations.

Fig. 46 explains 72.74% and 22.12% of the variance on the first two axes respectively, using only trace element values. This display is difficult to interpret as the dispersion along the first axis does not appear to correspond to tooth type, developmental age or any observable trend among the elements. Little dispersion is observed along the second axis and this underlines the overall homogeneity of the deciduous tooth sample.

Finally, the Grimsby samples were entered along with samples from Ohio (Schneider 1984) for a correspondence analysis. The Ohio populations represent disparate groups, geographically, culturally, and temporally and correspondence analysis using enamel composition data had efficiently discriminated these groups by subsistence strategy and corresponding caries experience.

Fig. 47 shows that this trace element comparison clearly places the Grimsby samples with the horticultural peoples represented at the Turpin and Pearson Village sites. As in the original study, the hunting-gathering-fishing population represented at Williams Cemetery remains separated from the other samples examined.

The Ca:P ratios of the sampled teeth are of interest. Ca and P are critical to the formation of carbonate hydroxyapatite crystals. The theoretical ratio of Ca:P in dental enamel as derived from pure, synthetic hydroxyapatite is 2.15 (Brudevold and Soremark 1967). Human dental enamel generally has a

Ca:P ratio lower than that of pure hydroxyapatite, but values greater than 2.15 have been reported (Pyke 1973). Grimsby teeth Ca:P ratios range from a low of 1.60 (upper M3) to a high of 2.38 (deciduous upper third premolar). The average Ca:P ratio for all teeth samples is 1.78.

Discussion

While the analyses presented here are limited by small sample size, we believe the results reflect important evidence regarding the individuals buried in the Grimsby Cemetery Feature 1. Permanent teeth had relatively low Ca:P ratios. In each tooth with a low value for Ca there is a relatively high concentration of Mg, consistent with the hypothesis that Mg substitutes for Ca, with Mg maintaining the interprismatic spacing when present in sufficient quantity.

The most noteworthy trace elements in the permanent dentition are Se, Zn and Fe. Selenium is at its highest concentration in meats (especially organ meats) and cereals, but the element is affected by its presence in local soils and by heat and it may be lost during milling or cooking (Guthrie 1983). The high concentrations of Se reported here (range 12-87 ppm) are significantly higher than is generally reported in the literature. Shearer (1983) tentatively supports a cariogenic role for the element, and the levels observed at Grimsby would predict a high associated caries risk. Since maize is an excellent source of Se, a dependence on this foodstuff would be consistent with the results of our analyses. As Se is associated with matrix proteins in the organic fraction of human enamel, its abundance in the Grimsby teeth may be reflected in the impaired or irregular amelogenesis during the enamel maturation process noted during SEM examination of the teeth.

Both Zn and Fe are present at very low concentrations in the permanent and deciduous dentitions. Zinc levels are reduced in the presence of phytic acid (as in maize), and in cases of intestinal infection such as hookworm (Guthrie 1983). Dietary sources of Zn include nuts, meat and fish and our evidence does not suggest that these were central items in the Grimsby Feature 1 diet. Zinc deficiency in animal studies appear to confirm an increased caries incidence (Al-Hayali et al. 1981), while high concentrations of Zn are associated with low caries rates (Schneider 1984, 1986).

Iron-rich foods include red meats, legumes, fruits and vegetables, but the quantity and quality of Fe is affected by its absorbability and techniques of food processing. A clear cariostatic or cariogenic role for Fe has yet to be established. Fiber and bulk in the diet interfere with Fe absorption, and vegetable- and grain-based diets characteristically produce marginal Fe status. This is particularly relevant in a maize-focused diet because phytic acid in corn combines with Fe to produce an insoluble Fe complex that cannot by utilized (Underwood 1977).

The absence of Cu in the deciduous dentition examined may result from chronic prenatal deficiency. As Cu is essential in the oxidation of ferrous to ferric Fe, deficiency can produce anaemia, decreased collagen formation and skeletal demineralization (Underwood 1977). Cu deficiency could be an important factor in prenatal development and failure to thrive during early postnatal growth.

The compositional profile represented by the Grimsby sample when compared with other populations would suggest a resemblance to other maize-dependent horticultural groups. Based on these comparative populations, a caries frequency of 12-20% would be predicted for the Grimsby population independent of any knowledge of other analyses of Grimsby dental pathology.

There is a variability of all elements within one tooth and among the whole Grimsby tooth sample and this variability may be ascribed to:

1. the Grimsby sample is composed of a variety of teeth representing various tooth classes. Inconsistencies among tooth types might be expected because enamel will be laid down at different ages. As diet shifts with age, especially when an infant is weaned to an adult diet, the developing enamel will vary in composition. Clustering by tooth type in our analyses of

the permanent dentition probably reflects this phenomenon;

2. periodic, systemic stress, nutritional or infectious, is know to impair ameloblast function and it is reasonable to suggest that such factors affected normal dental development at Grimsby.

In summary, the Grimsby Feature 1 trace element analysis suggests a dependence on maize agriculture with a diet high in selenium and low in zinc, iron and copper content. Nutritional deficiencies combined with periods of real nutritional stress are indicated, especially for the children buried in Feature 1.☐

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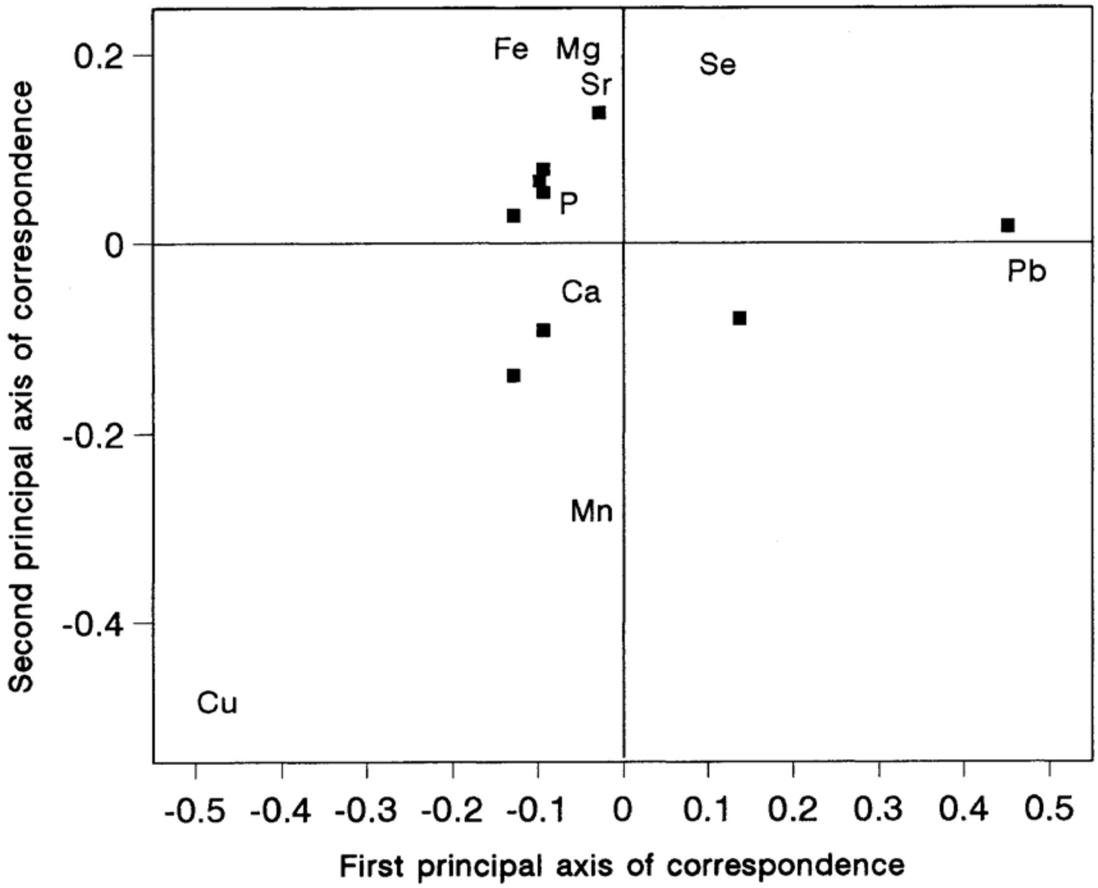


Fig. 43: First (x) and second (y) principal axes of correspondence analysis including all succedaneous teeth and all elements examined (except Al)

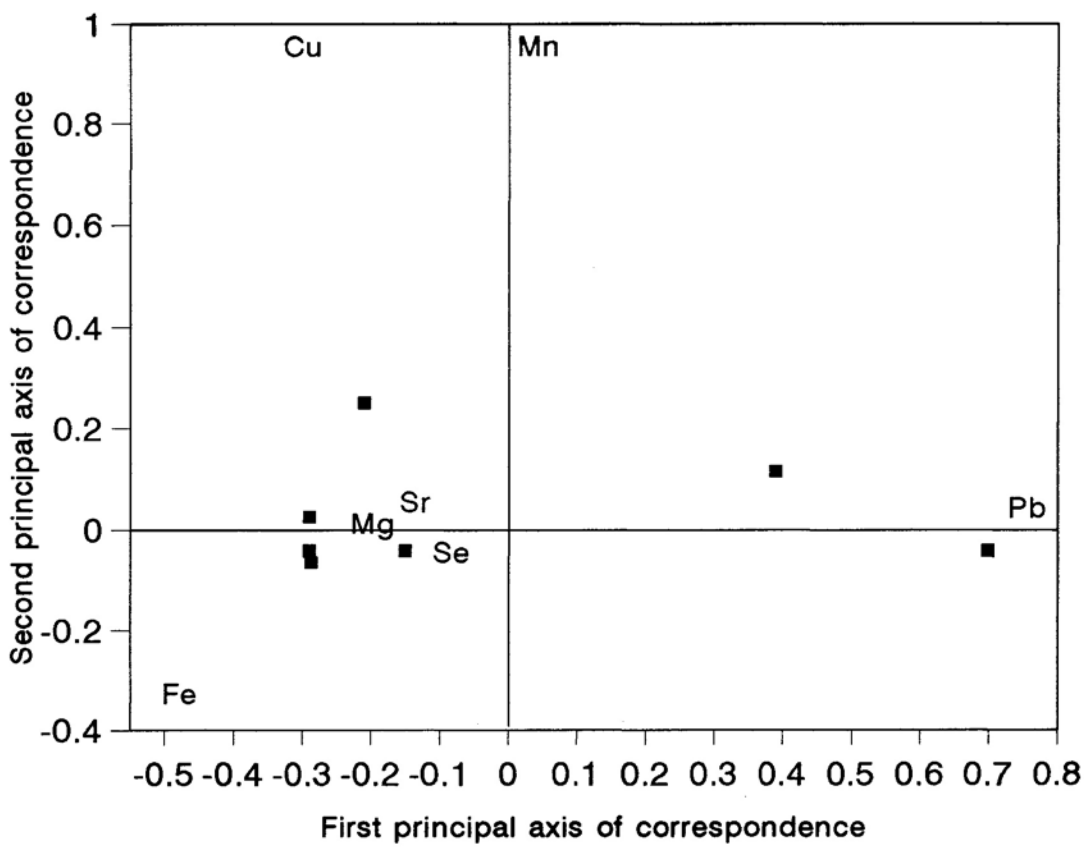


Fig. 44: First (x) and second (y) principal axes of correspondence analysis of succedaneous teeth (trace elements only)

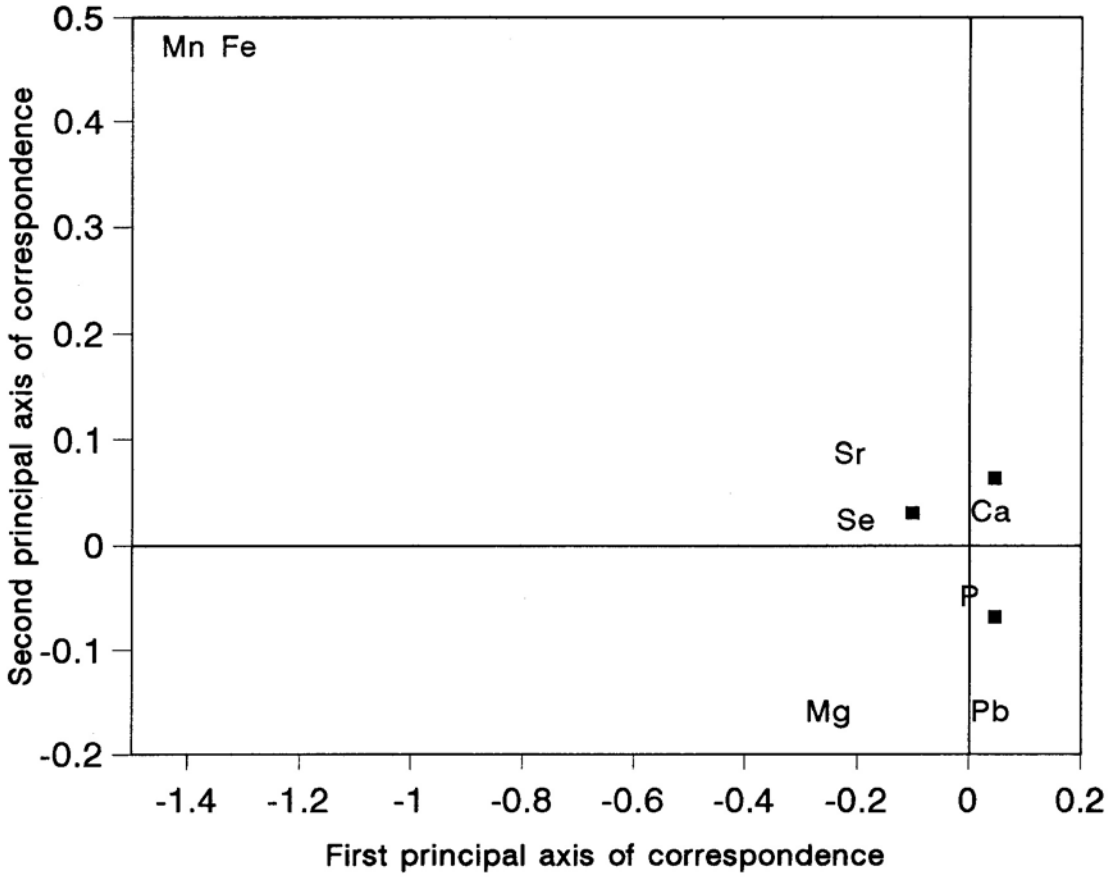


Fig. 45: First (x) and second (y) principal axes of correspondence analysis of deciduous teeth and all elements (except Al and Cu)

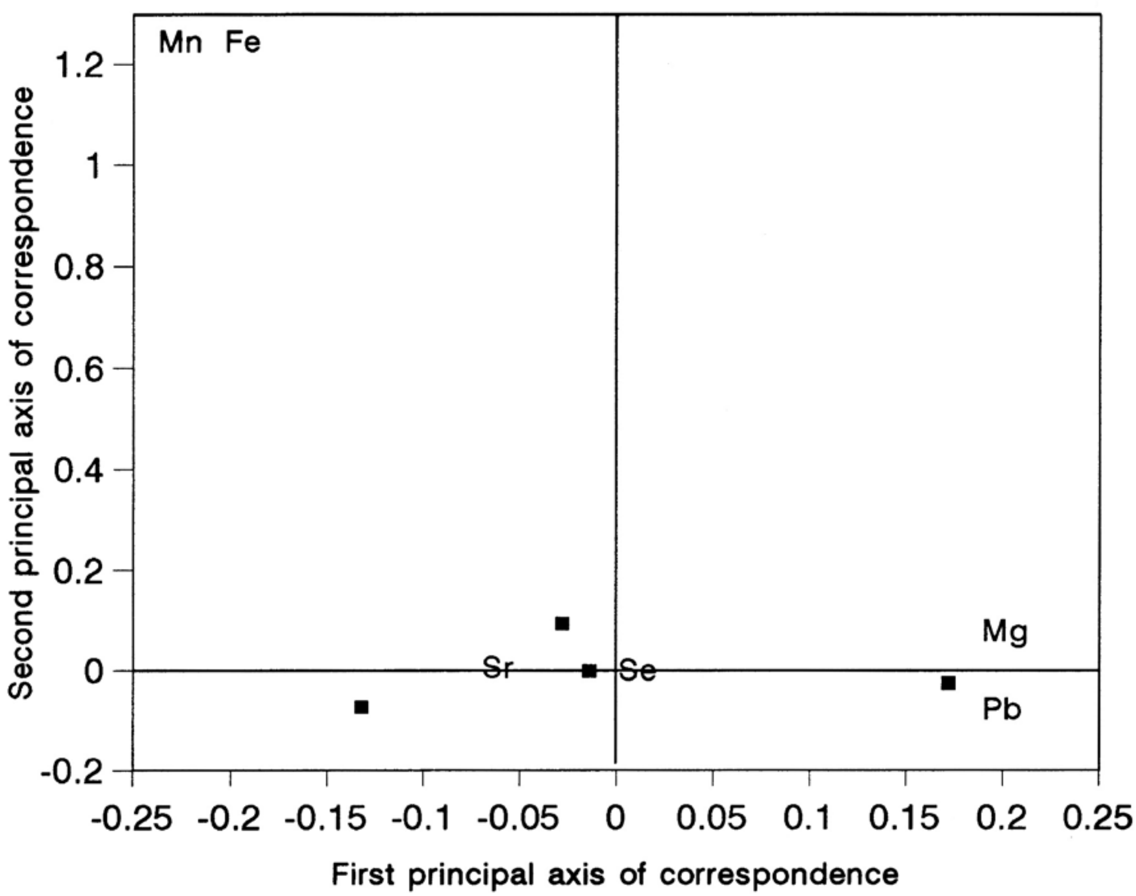
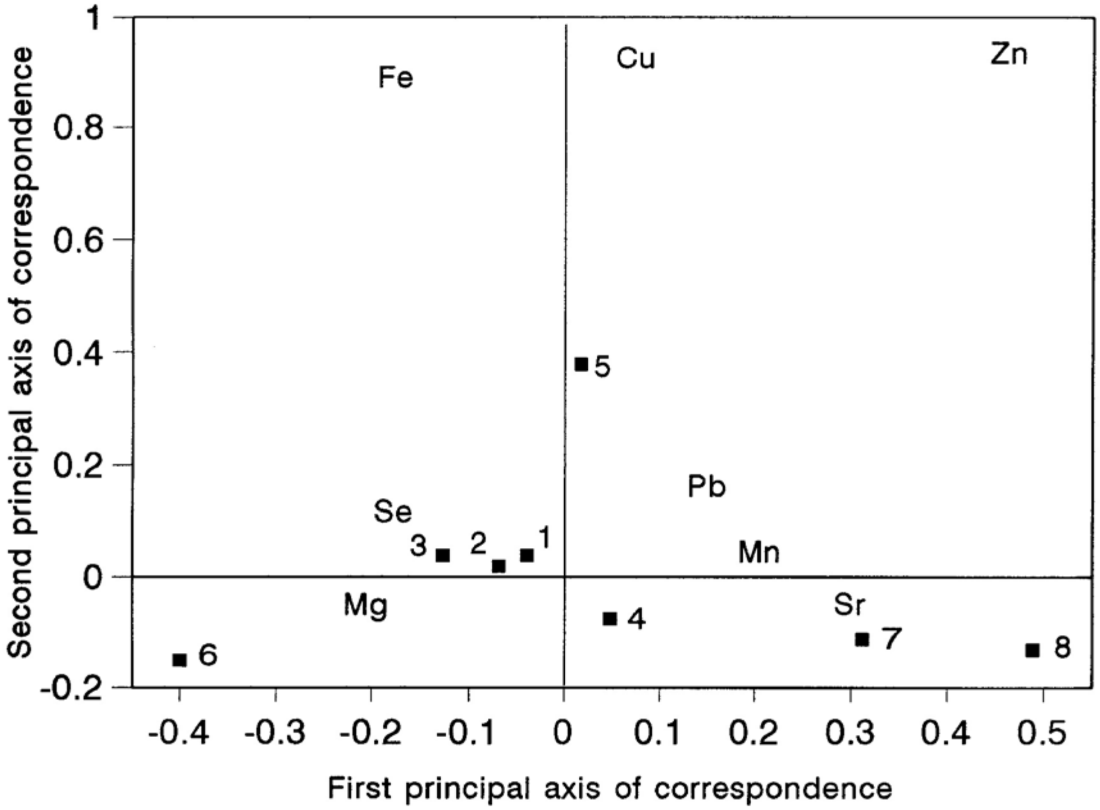


Fig. 46: First (x) and second (y) principal axes of correspondence analysis of deciduous teeth (trace elements only)



1 - Grimsby adult; 2 - Grimsby deciduous; 3 - Pearson Village (33Sa9);
4 - Indian Hills (33Wo4); 5 - Williams Red Ochre Cemetery (33Wo7a);
6 - Turpin (33Ha19); 7 - State Line (33Ha58); 8 - Anderson Village (33Wa4).

Fig. 47 First (x) and second (y) principal axes of correspondence analysis comparing Grimsby samples to Ohio samples.

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PAGE, FIGURE and PLATE INDEX OF INDIVIDUALS

(DC = dental cast made)

PLATE 1: Four Views of the Skull of Fe 9/1

a Norma frontalis
b Norma basilaris
c Norma lateralis
d Norma verticalis

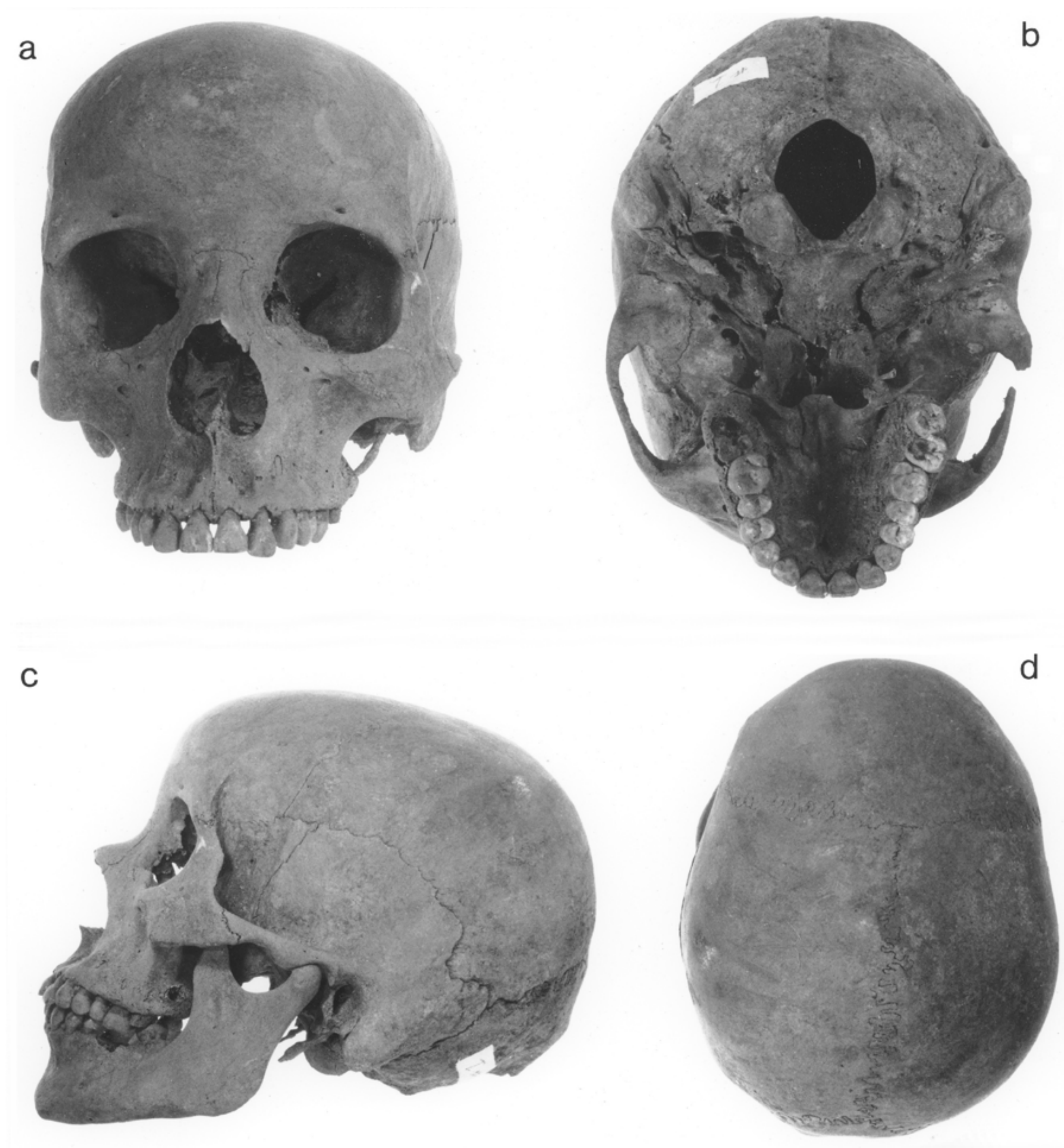


PLATE 2: Cranial Variations

a Fe 62/111: fusion of the posterior portion of the squamosal suture
b Fe 62/63: inca bone

a

b

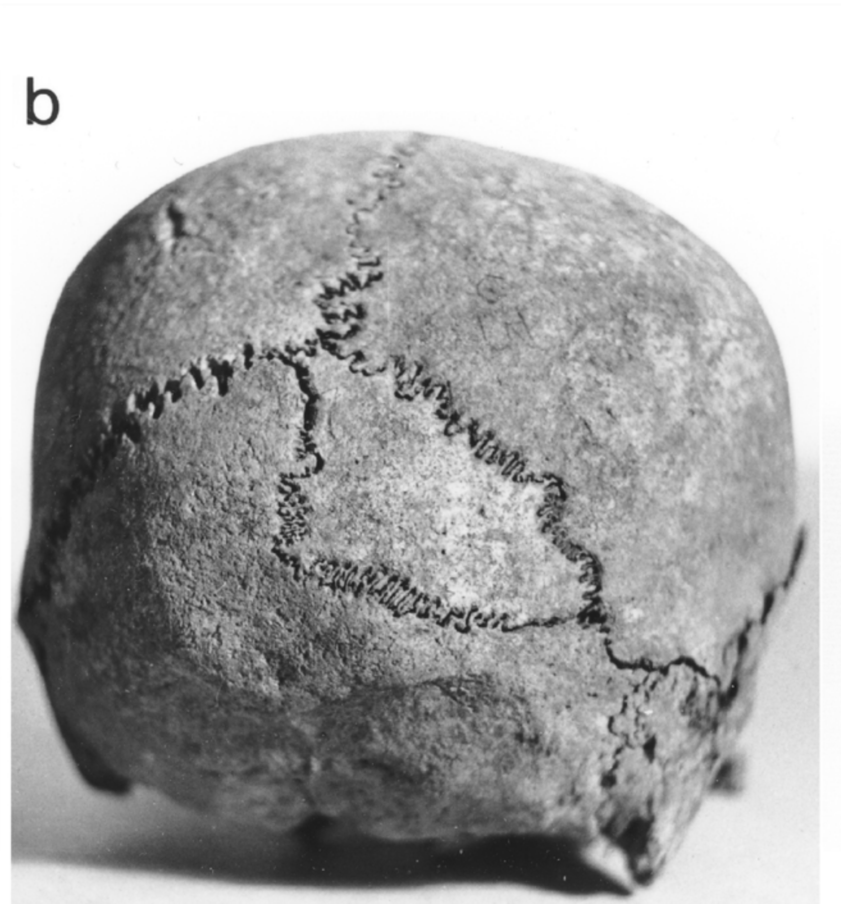
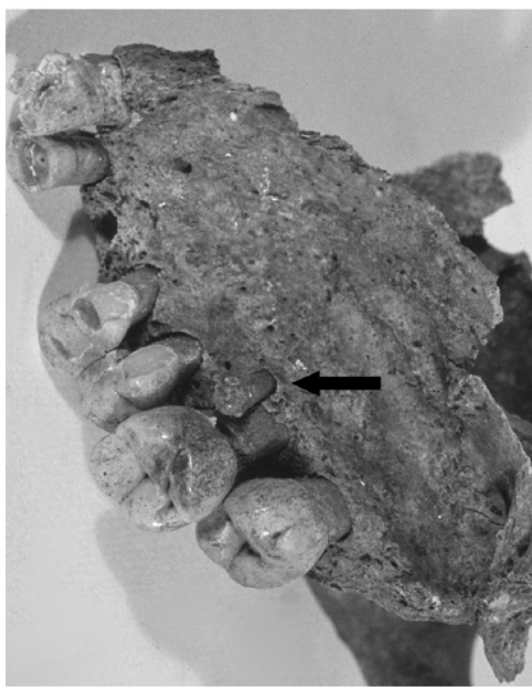


PLATE 3: Dental Variations

a Fe 62/43: lateral deciduous incisor agenesis
b Fe 9/8: supernumerary peg tooth in the right maxilla
c Fe 27/3: peg right upper third molar

a

b



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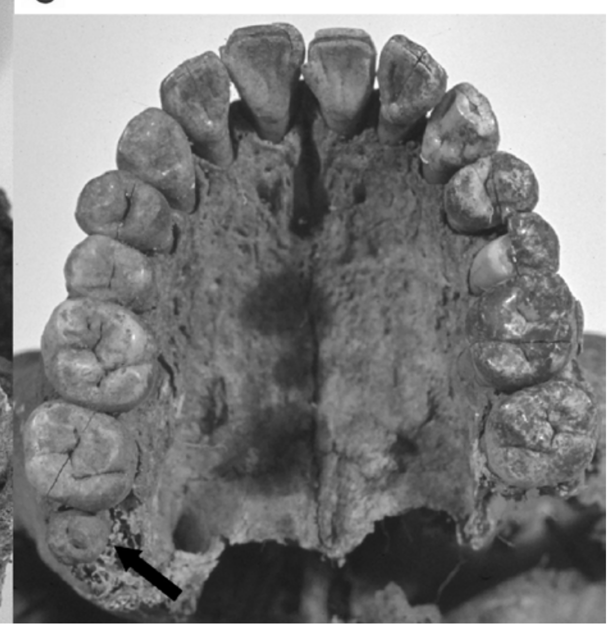

PLATE 4: Cervical Morphology

a Fe 62/111: atlas and axis with posterior bridging, paracondylar facet, ossified apical ligament and dens facet arthritis
b Fe 9/A-5: C.5 (above) and C.6(below) articulate at the right transverse process
c Fe 9/F: Fusion of C.7 and T.1

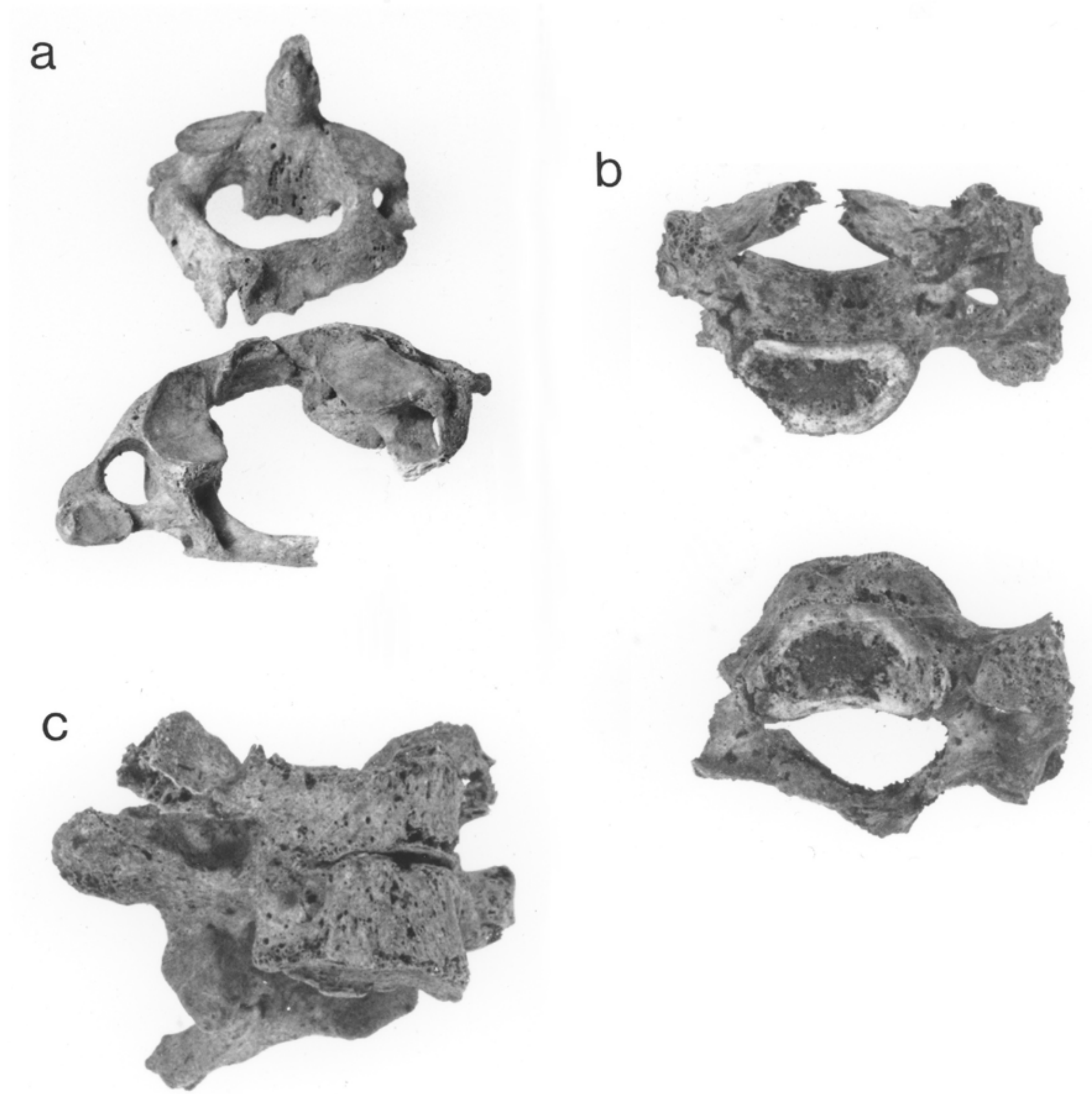

PLATE 5: Thoracic and Lumbar Morphology

a Fe 62/82: secondarily closed bifid neural arch in T.2
b Fe 62/24: L.1 lateral process on right articulates through a costal facet
c Fe 18/1: complete separation of the L.5 neural arch
d Congenital fusion of T.11 and T.12 in "stray" vertebrae from Feature 45
e Fe 9/J: right side neural arch separation
f Fe 62/58: secondary fusion on the left side of L.5 separated neural arch

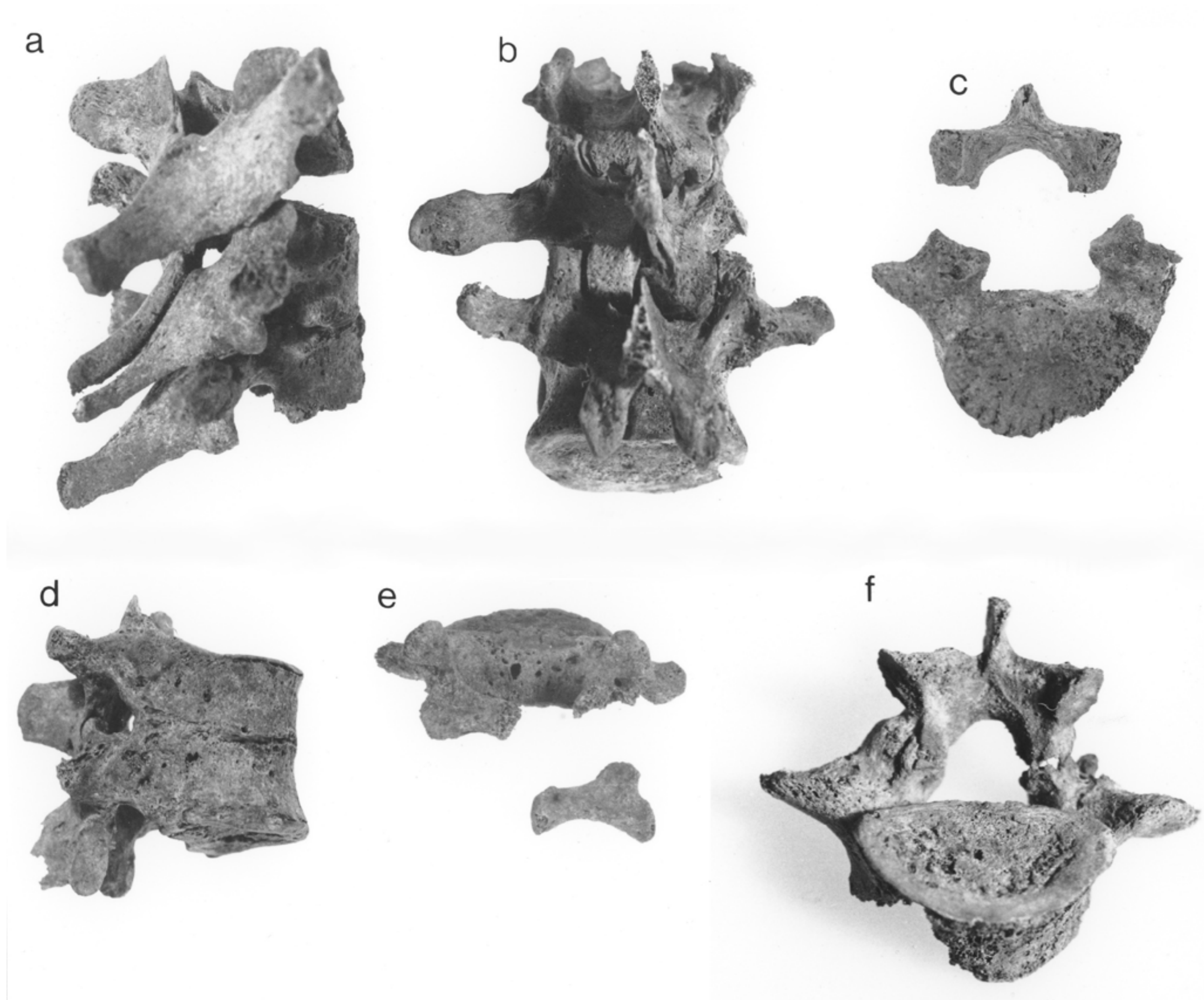

PLATE 6: Sacral Variations

a Sacralized L.5 from surface
b Hiatus to first foramen in Fe 59/1

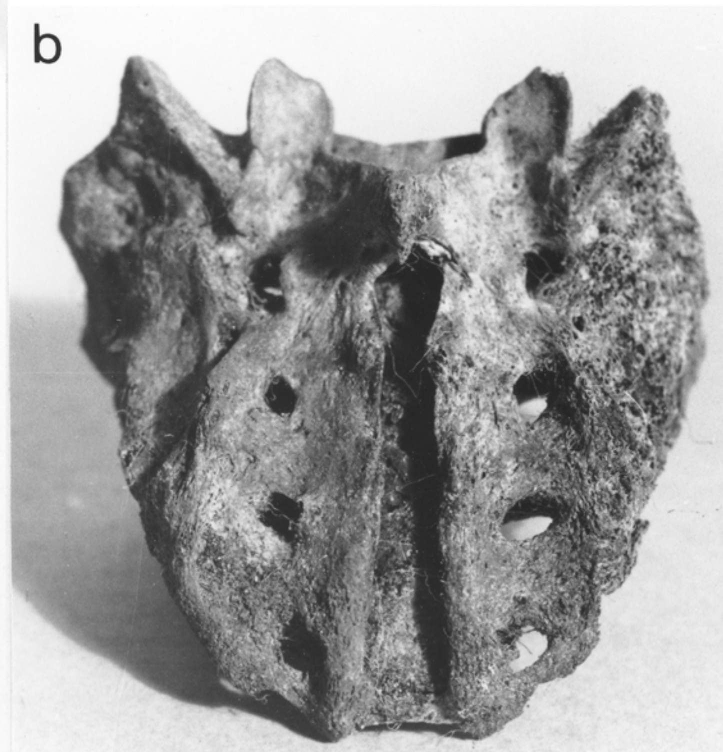

PLATE 7: Skull of Fe 45/12: Possible Case of Syphilis

a Outer diploë erosion (frontal to the right)
b Detail of area just behind bregma

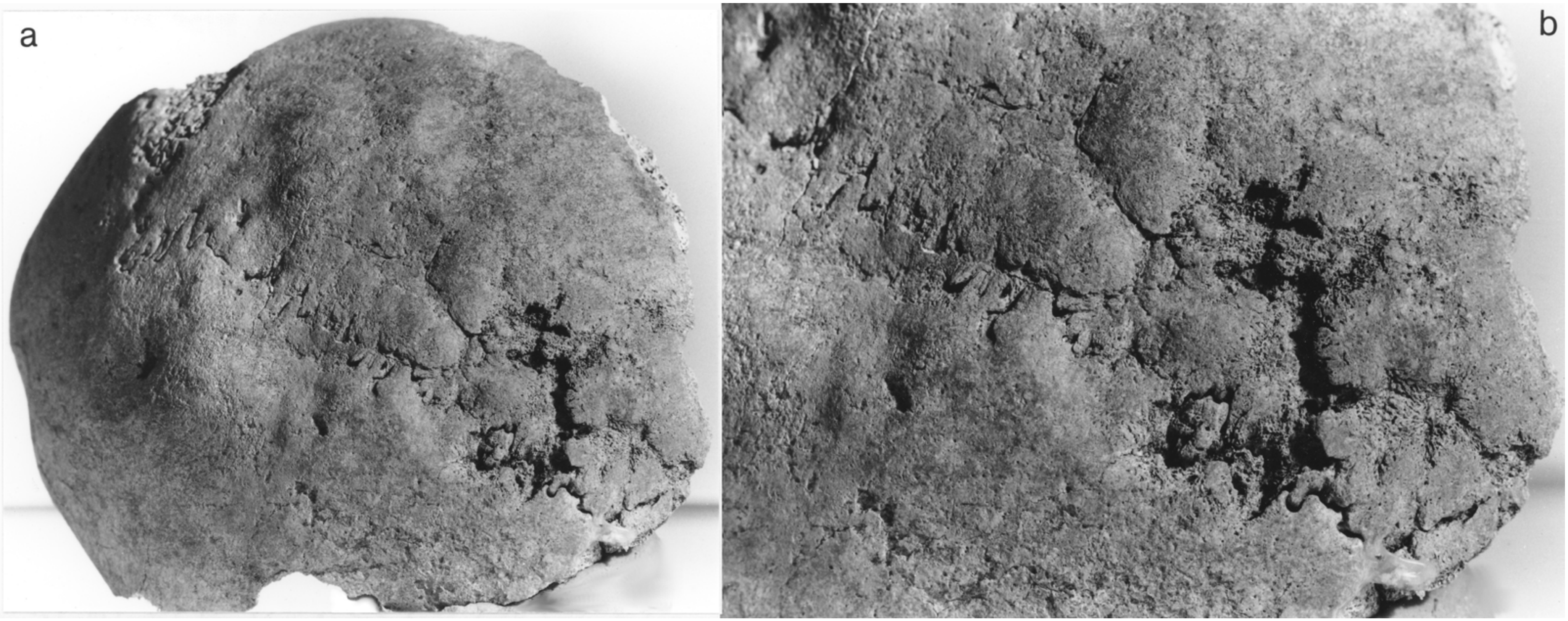

PLATE 8: Left and Right Tibiae from Feature 45/12

a Mid shafts: left on left
b Radiographs of tibiae: left on left
c Detail of left tibia, lateral surface

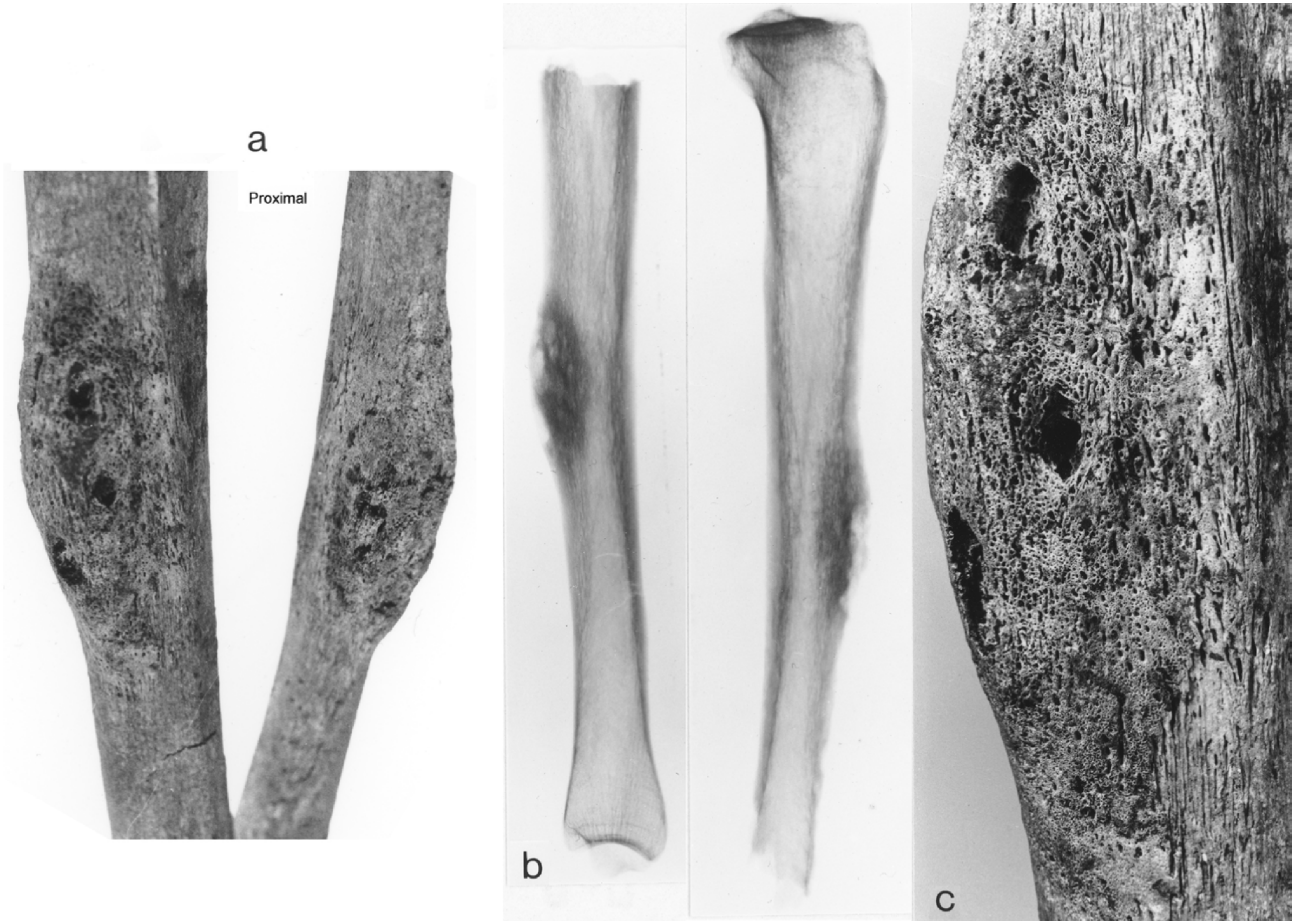

PLATE 9: Left Tibia from Feature 45

a Postero-lateral surface
b Anterior-posterior X-ray
c Detail of postero-lateral surface at the level of the nutrient foramen

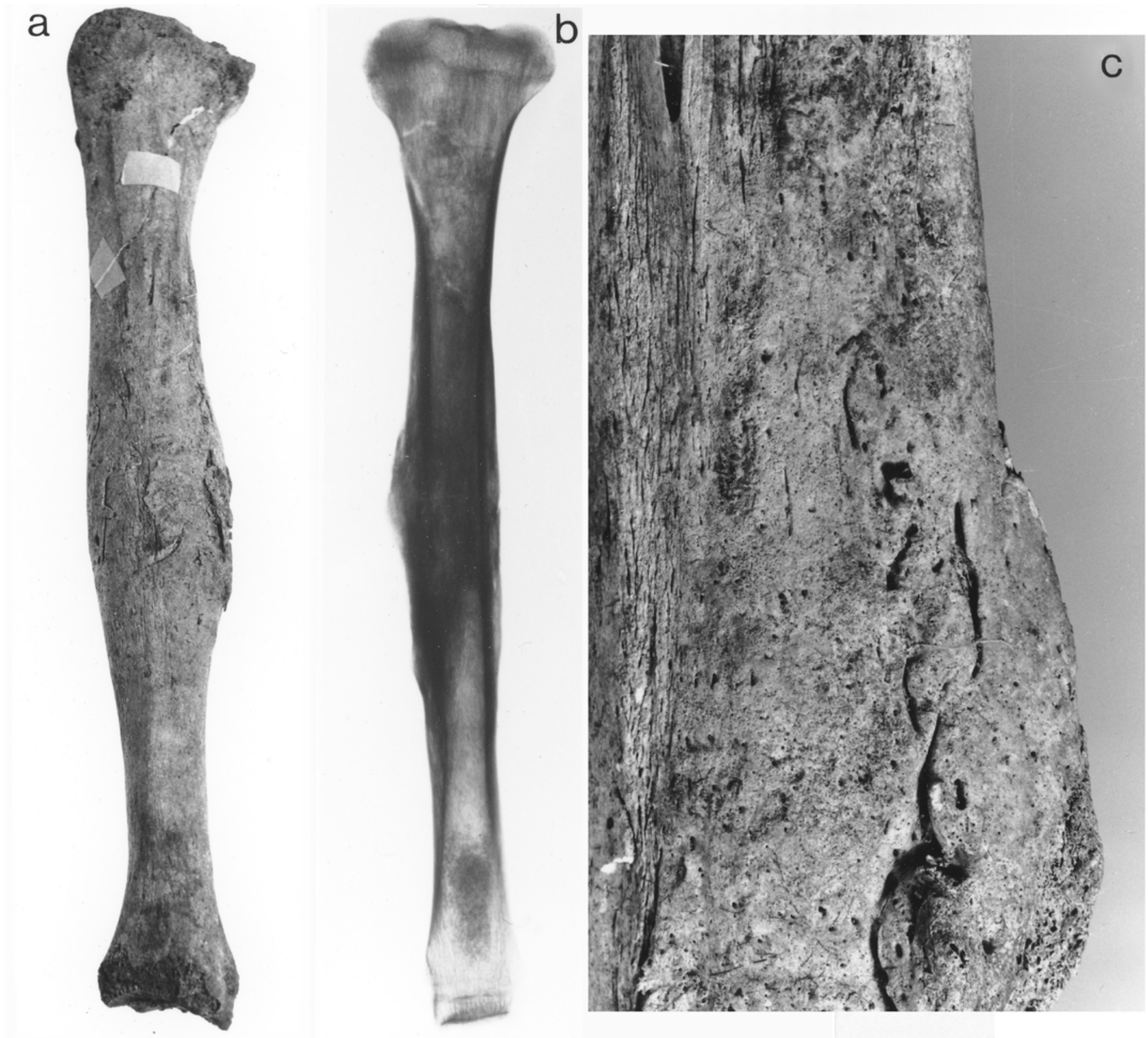

PLATE 10: Paired Tibiae and Fibulae from the Surface

a Left tibia, medial surface
b Radiograph of left tibia, lateral-medial view
c Left tibia, lateral shaft surface
d Mid shaft portions of both fibulae

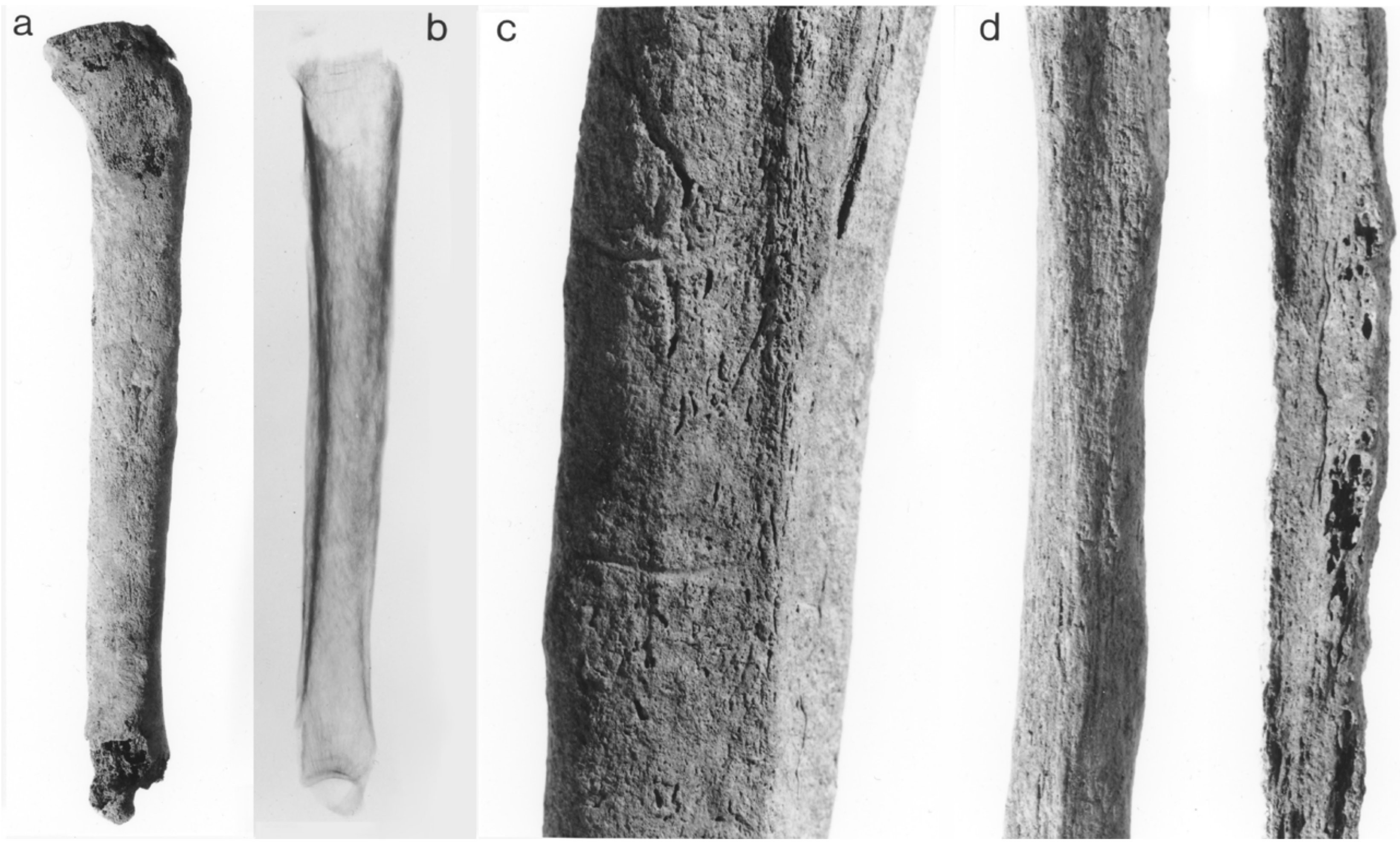

PLATE 11: Pathological Tibiae

a Fe 17/1: Tibiae and fibulae
b Fe 17/1: Radiograph (A/P) of right tibia and fibula and left tibia (M/L)
c Lateral view of left tibia: a possible case of syphilis from Feature 11
d Medial view of left tibia from Feature 11

PLATE 12: Variations in Tibial Conditions

a Tibia from Feature 12 with typical swelling and periostitis
b Medial view of tibiae of Fe 62/86 with marked swelling
c Tibia and humerus of Fe 62/14 showing exostoses

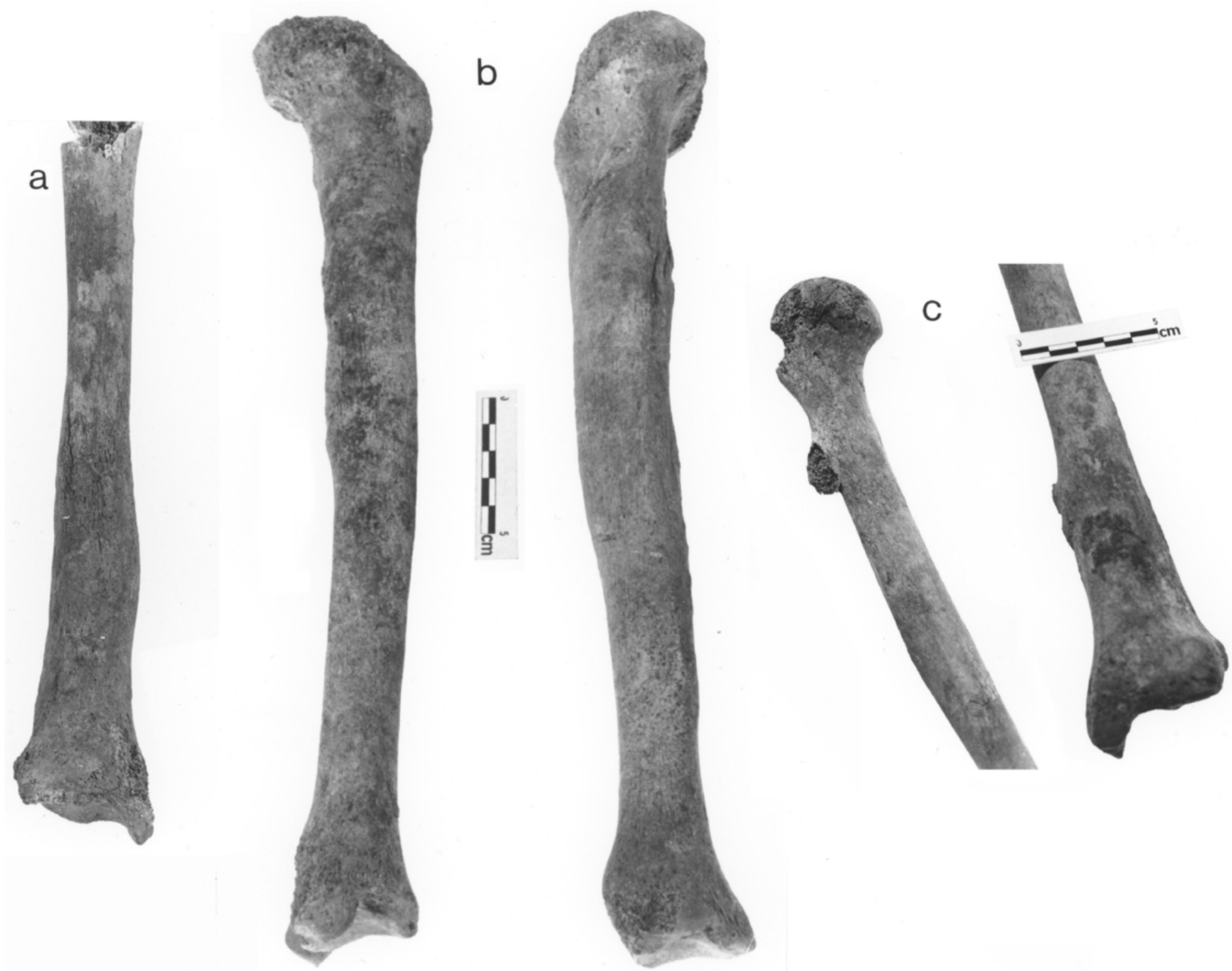

PLATE 13: Pathological Tarsals

a Fe 45: right cuboid
b Fe 45: distal view of left navicular

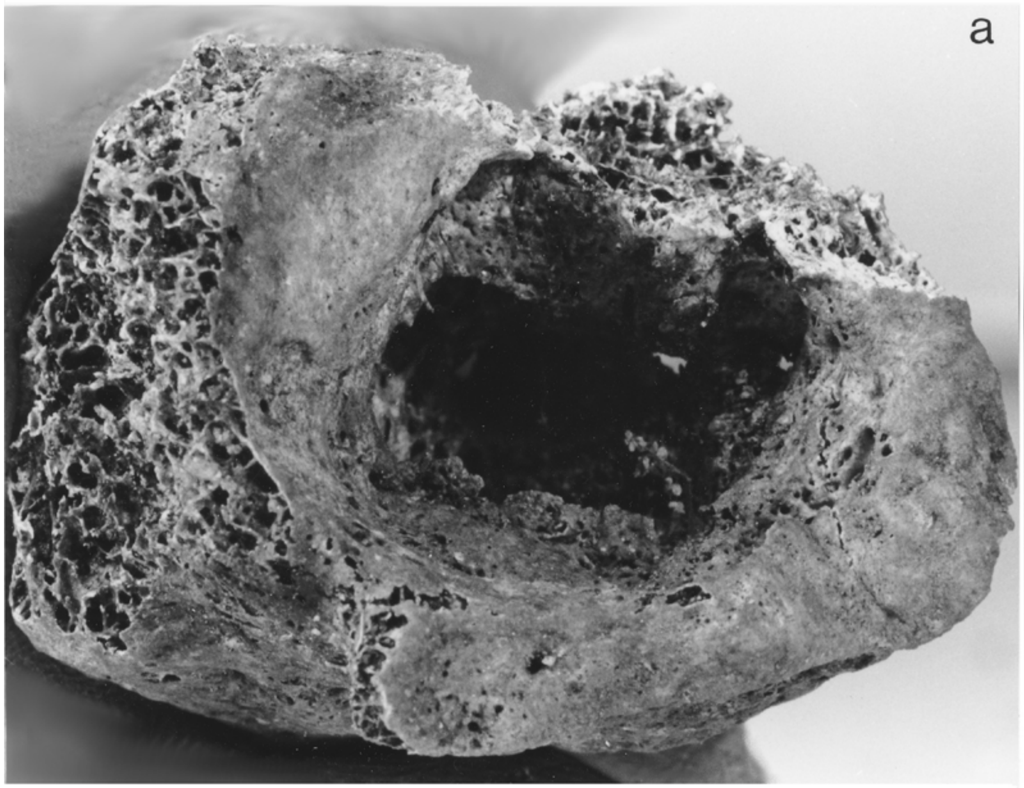

PLATE 14: Feature 62: "Stray" Pathological Foot

a Overall view **b** Fifth metatarsal and cuboid **c** Detail of plantar surface **d** Radiograph of calcaneus and fifth metatarsal and cuboid

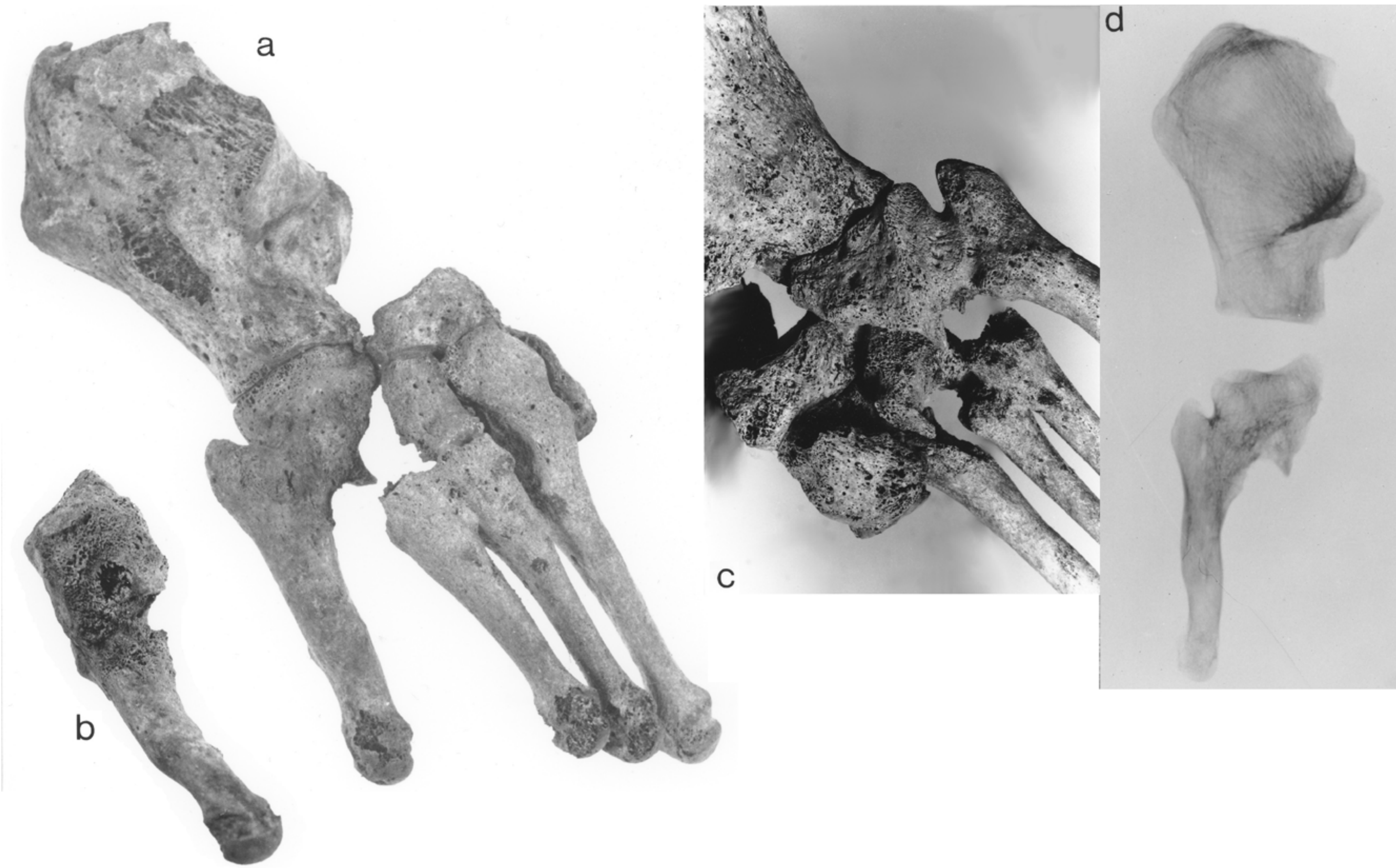

PLATE 15: Vertebral Pathology

a Fe 62/77: L.1
b Fe 62/77: T.12 and L.1
c Fe 62/90: T.5 and T.6 left lateral view
d Fe 62/90: T.5 (above) and T.6 (below) with abscess of centrum

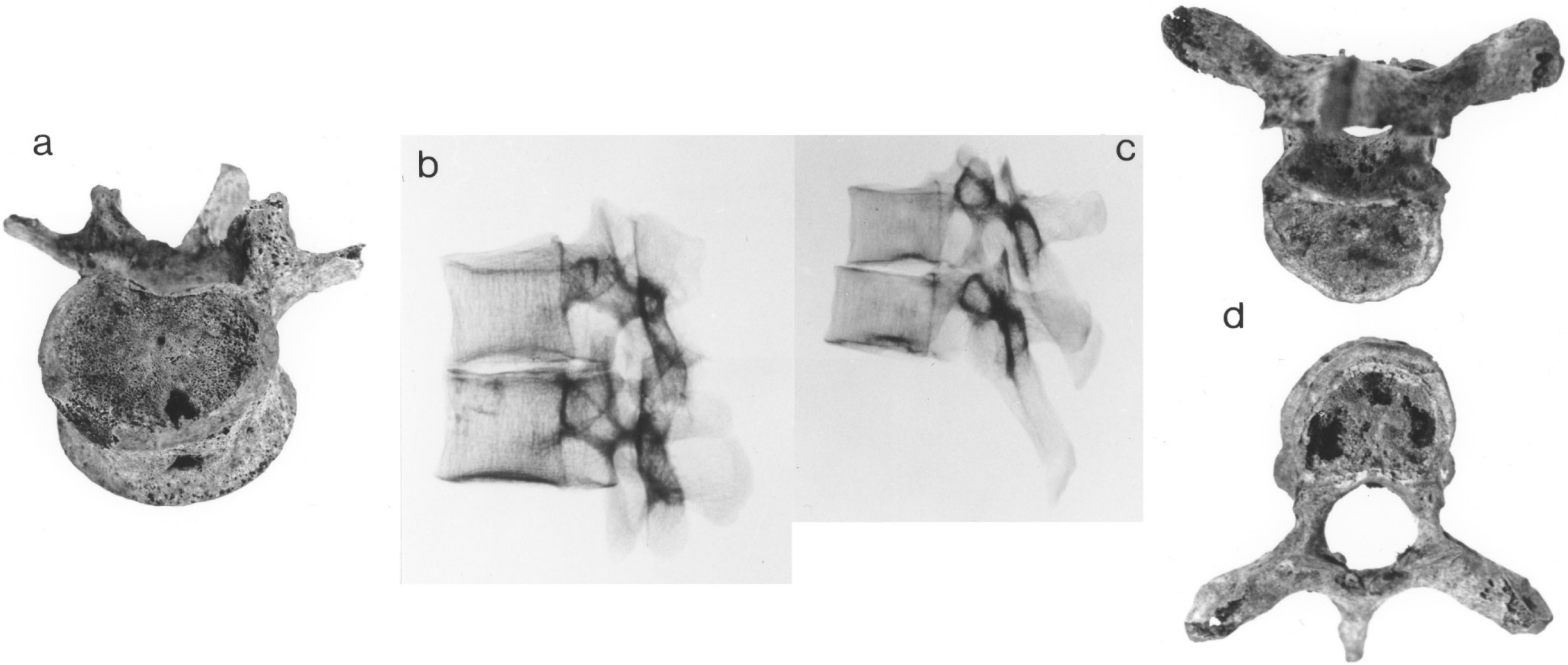

PLATE 16: Two Pathological Specimens from Feature 11

a Dorsal surface of S.1 centrum
b Radiograph of sacrum
c Ventral surface of S.1 centrum
d Subadult humerus
e Radiograph of subadult humerus

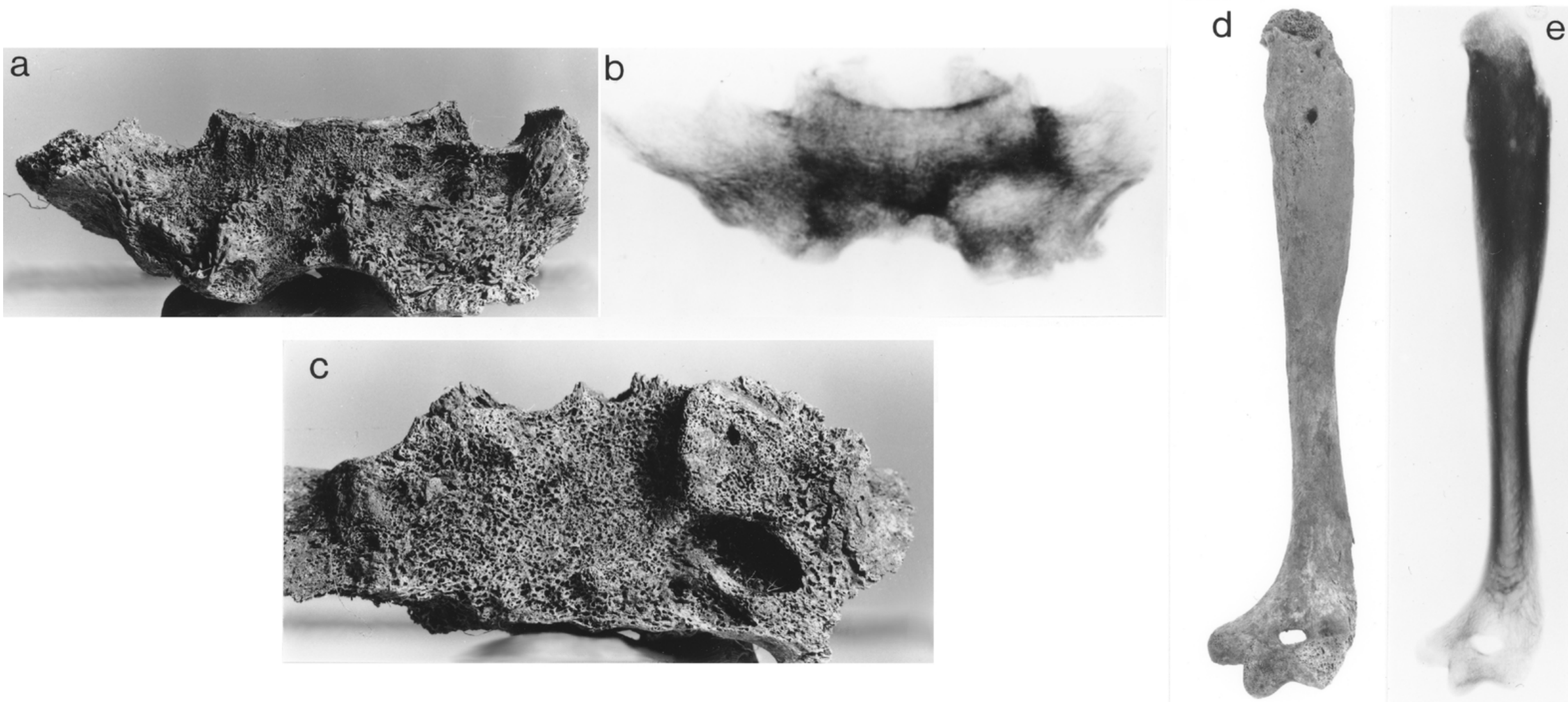

PLATE 17: Possible Tuberculosis of the Spine in Fe 9/N

a T.9 to L.3
b Radiograph of T.11 to L.3
c T.12, L.1

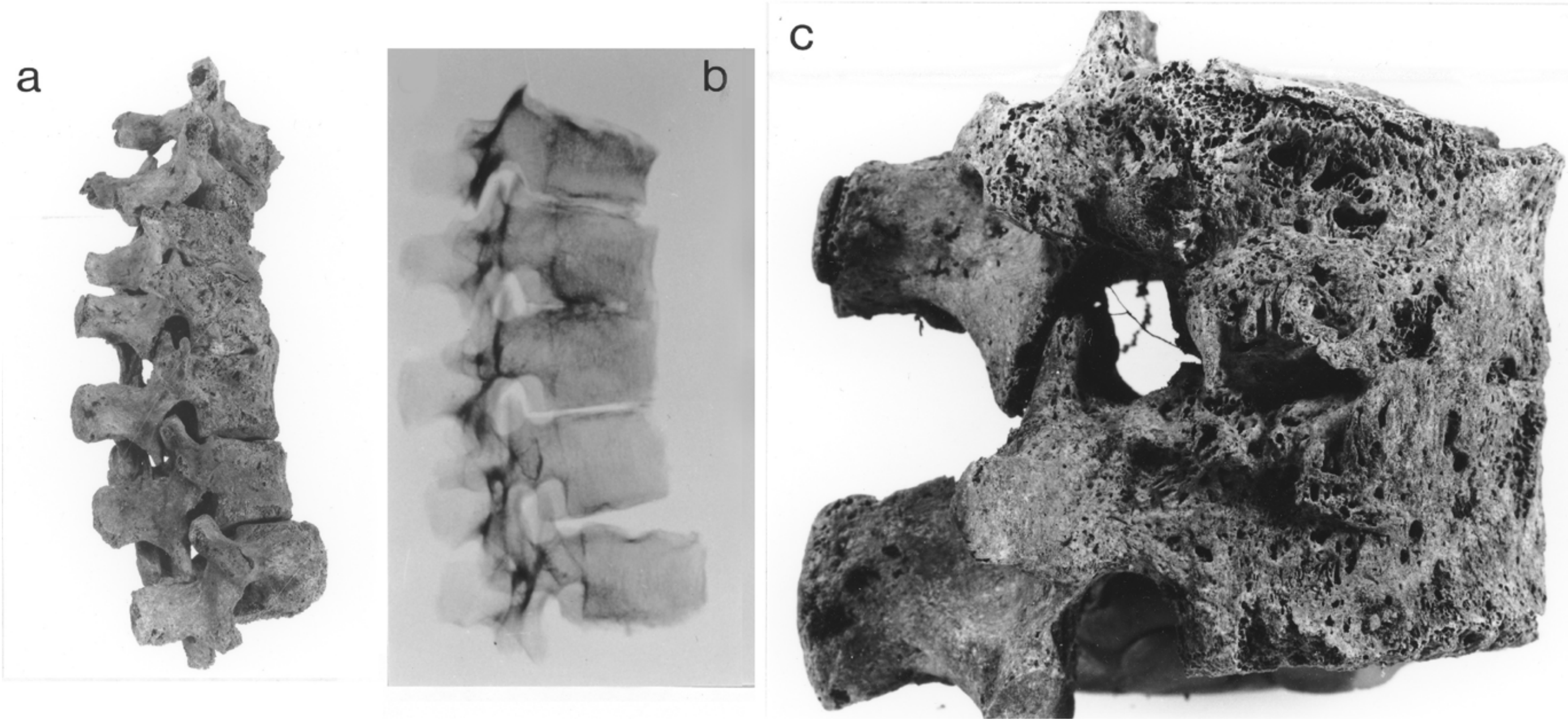

PLATE 18: A Possible Case of Haematogenous Osteomyelitis from Feature 9

a Anterior view of left femur
b Radiograph of femur
c Detail of lower shaft

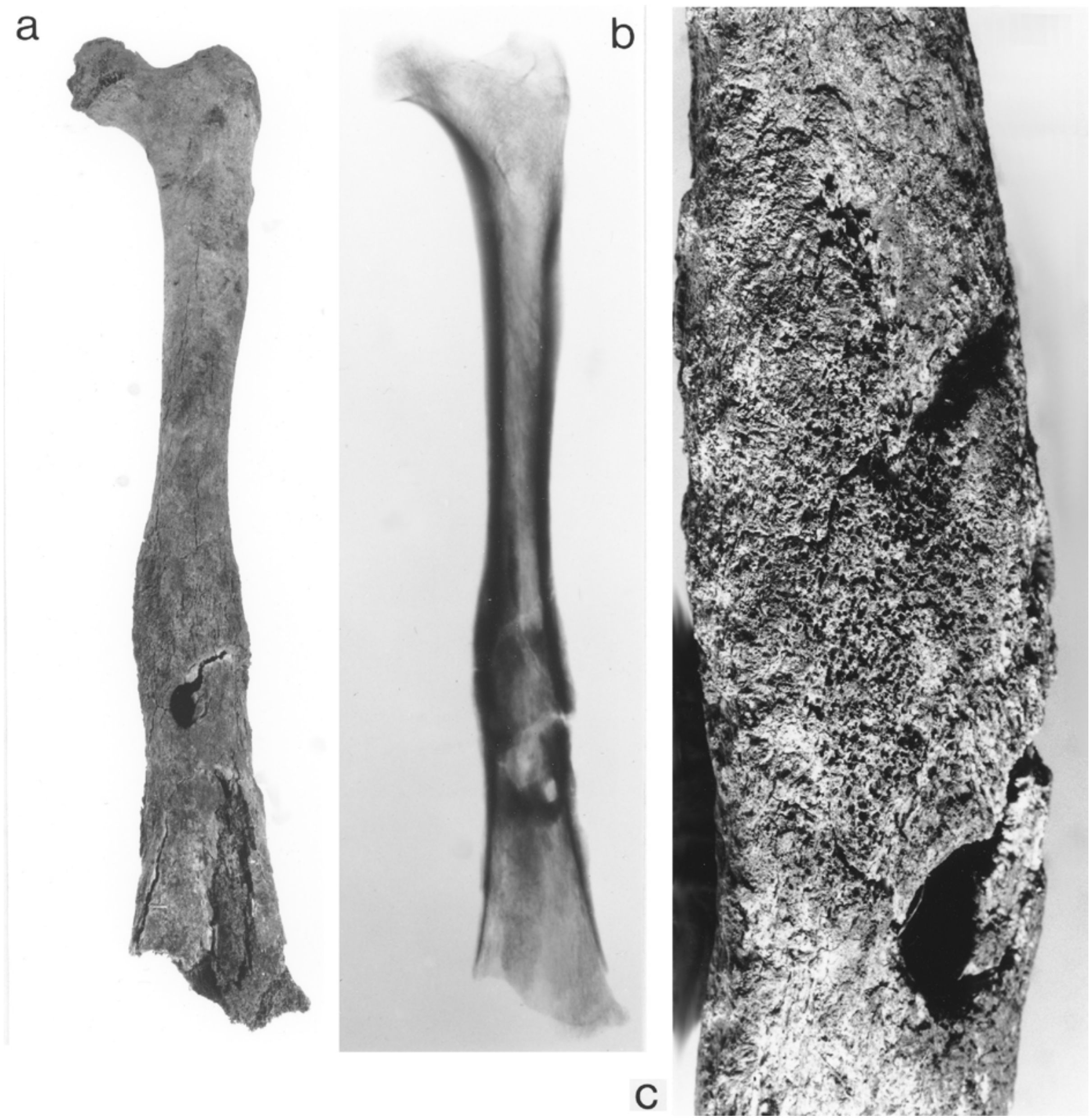

PLATE 19: Fe 1/33: a possible Case of Osteomyelitis Variolosa

a The elbow joints
b The left elbow
c Distal aspect of left humerus
d Posterior surface of left distal humerus

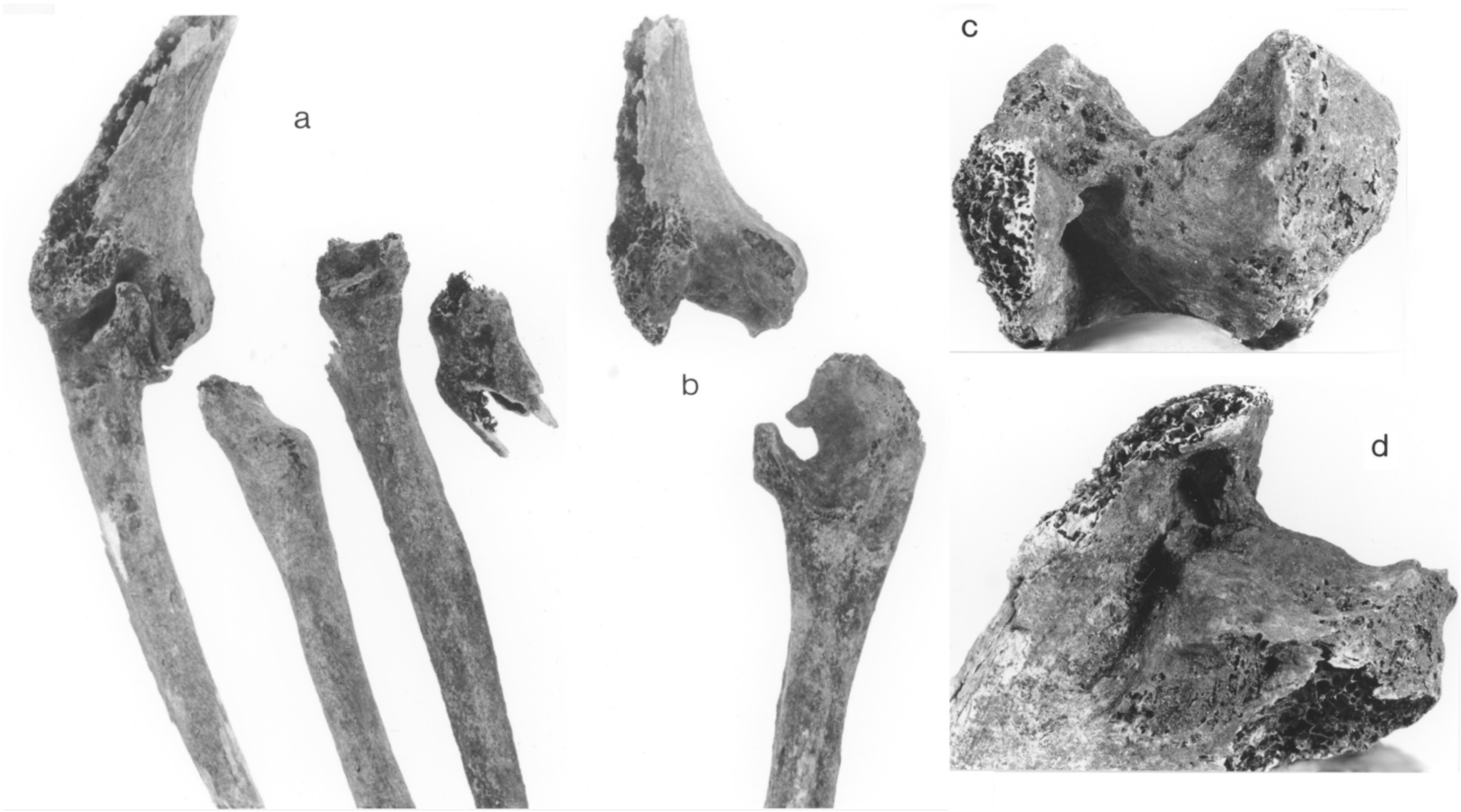

PLATE 20: The Hip Joint of Fe 1/33 and a Juvenile Left Femur from Feature 9

a Fe 1/33: right femur and acetabulum
b Fe 9: radiograph of juvenile left femur (A/P)
c Fe 9: juvenile left femur, detail of pathological bone proliferation
d Fe 9: juvenile left femur

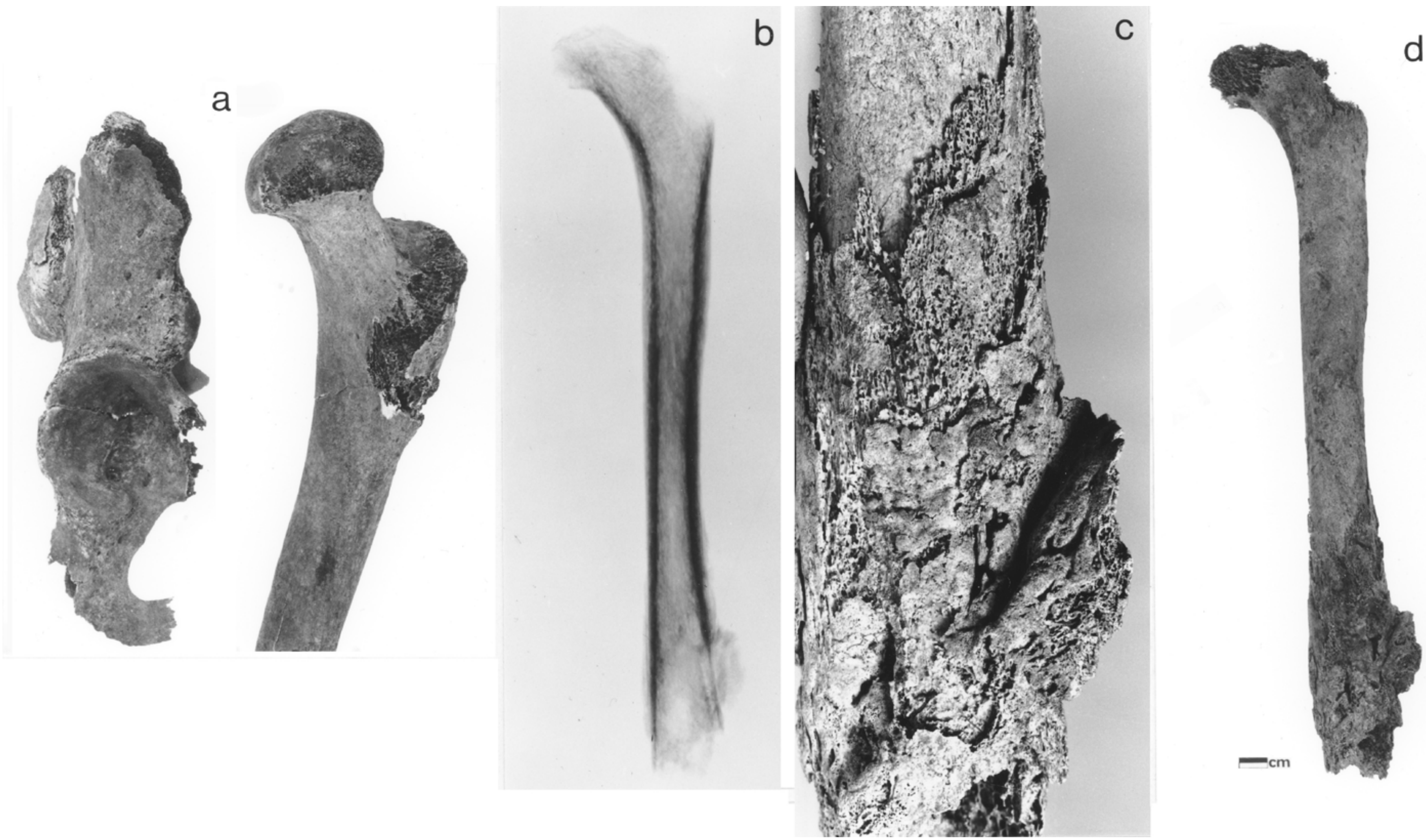

PLATE 21: A Possible Case of Osteoid Osteoma from Feature 9

a Right femur
b Radiograph of femur (A/P)
c Craniad view of femur showing retroversion

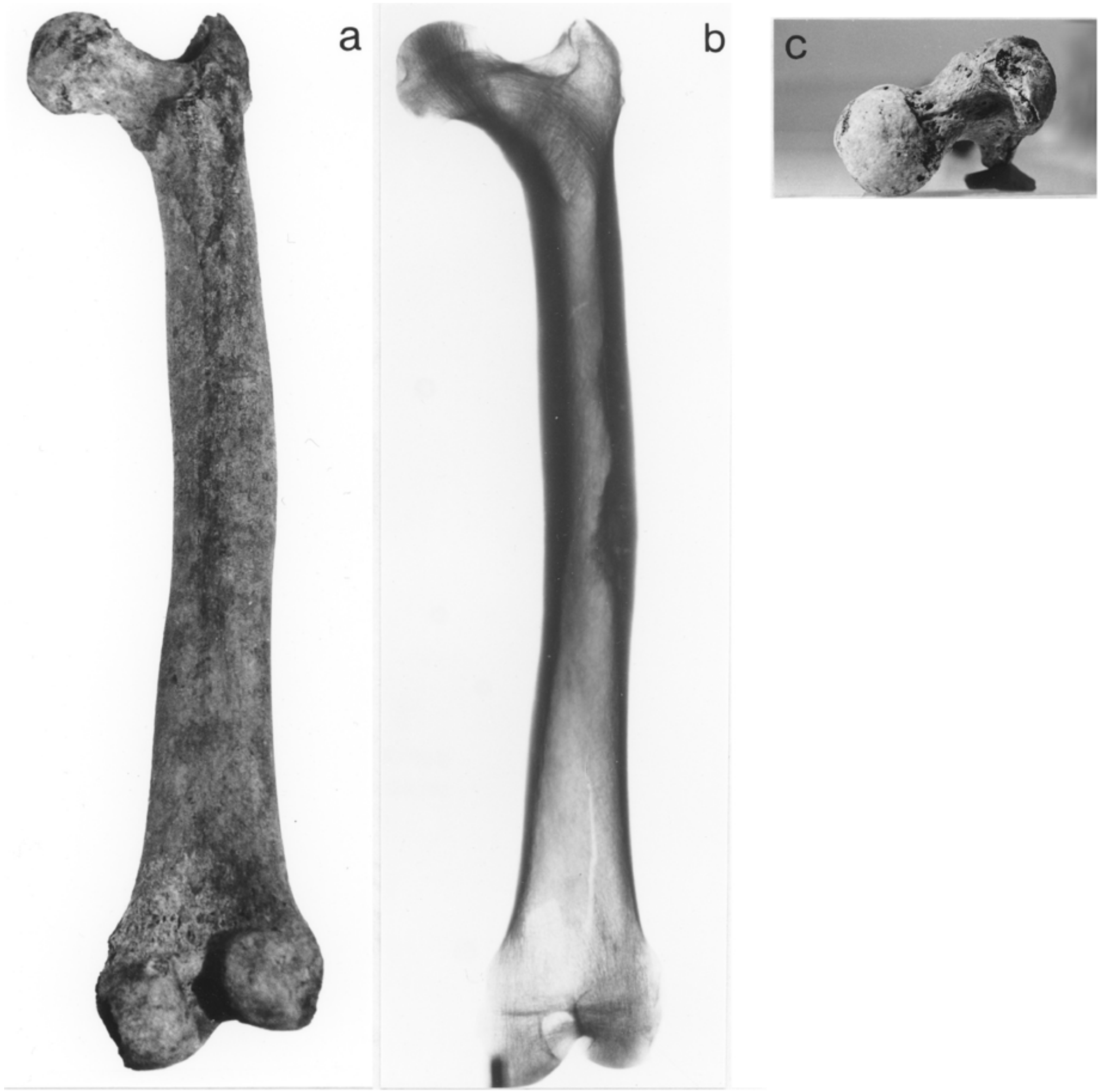

PLATE 22: Possible Subperiosteal Haematomas

a Fe 62/112: right radius
b Fe 45: posterior aspect of left humerus
c Fe 45: radiograph of left humerus
d Fe 45: cross-sectional view of distal shaft of left humerus offered by a postmortem break

PLATE 23: Perthès' Disease

a Fe 62/O: proximal femora
b Fe 62/O: radiograph of femora
c Fe 62/O: craniad view of femora
d Fe 62/N: right femur
e Fe 62/N: radiograph of right femur

PLATE 24: Perthès' Disease

a Fe 62/B: left femur and innominate
b Fe 9/U: femora
c Fe 9/U: craniad view of femora
d Fe 9/U: radiograph of femora
e Fe 62/82: proximal right femur

PLATE 25: Fe 62/65

a T.12 to L.5
b Radiograph of T.12 to L.5
c L.4: superior surface of centrum

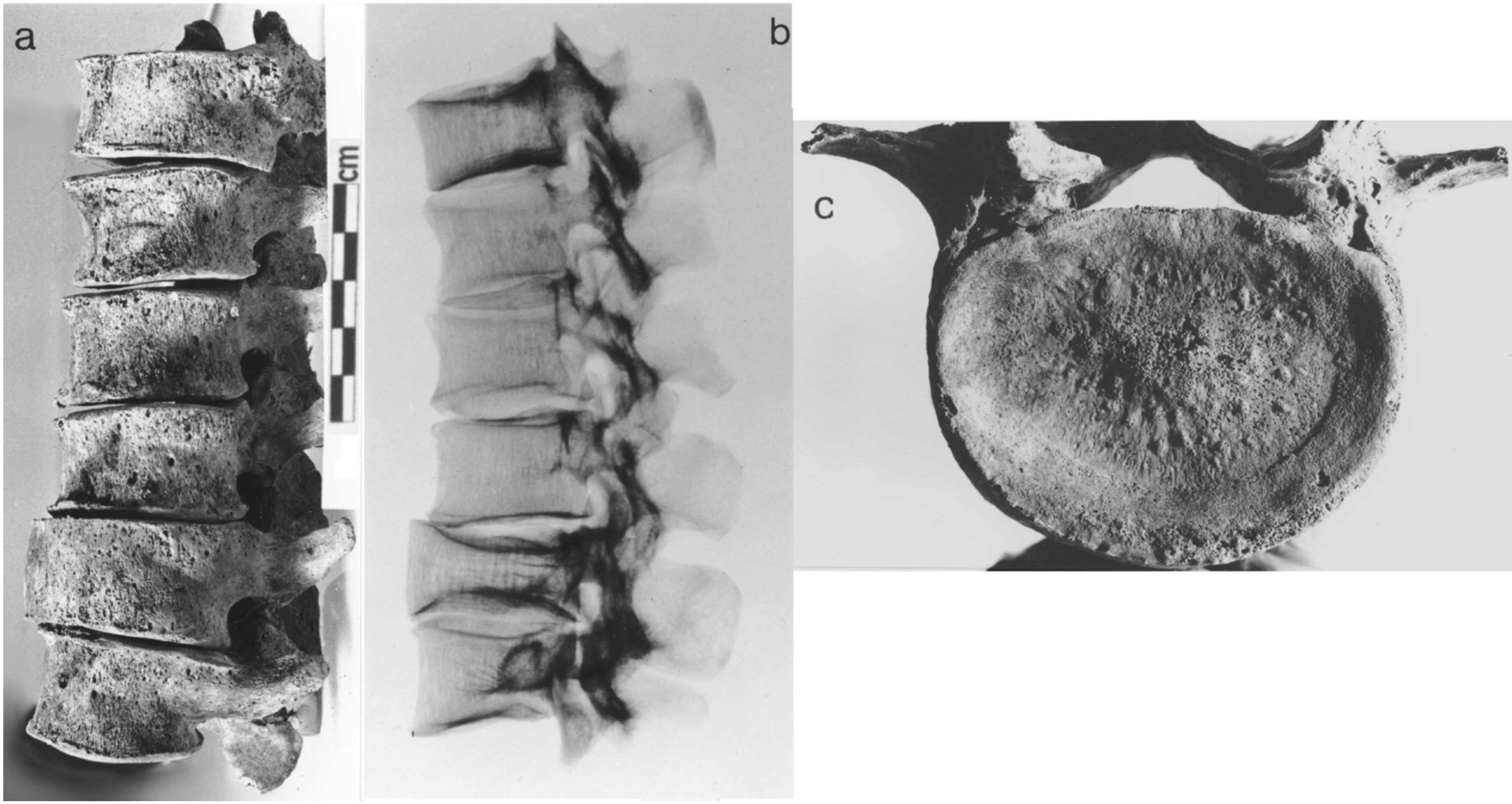

PLATE 26: Suture Fusion and the Skull of Fe 62/85

a Normal occipito-mastoid fusion in an old individual (Fe 62/9)
b Fe 62/85: norma frontalis
c Fe 62/85: norma lateralis

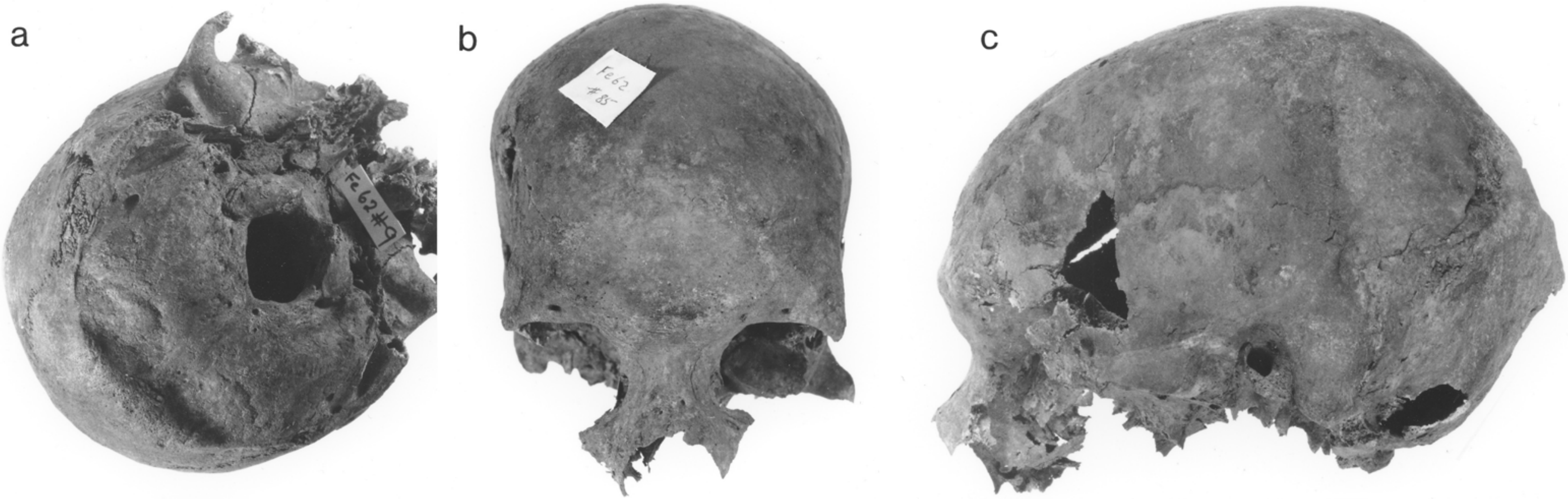

PLATE 27: Fe 62/85

a Atlas and axis
b L.5: malformation of the right inferior facet
c Sacrum: malformation of the right superior facet and arthritic changes to left superior facet
d Sacrum showing sacro-iliac lipping

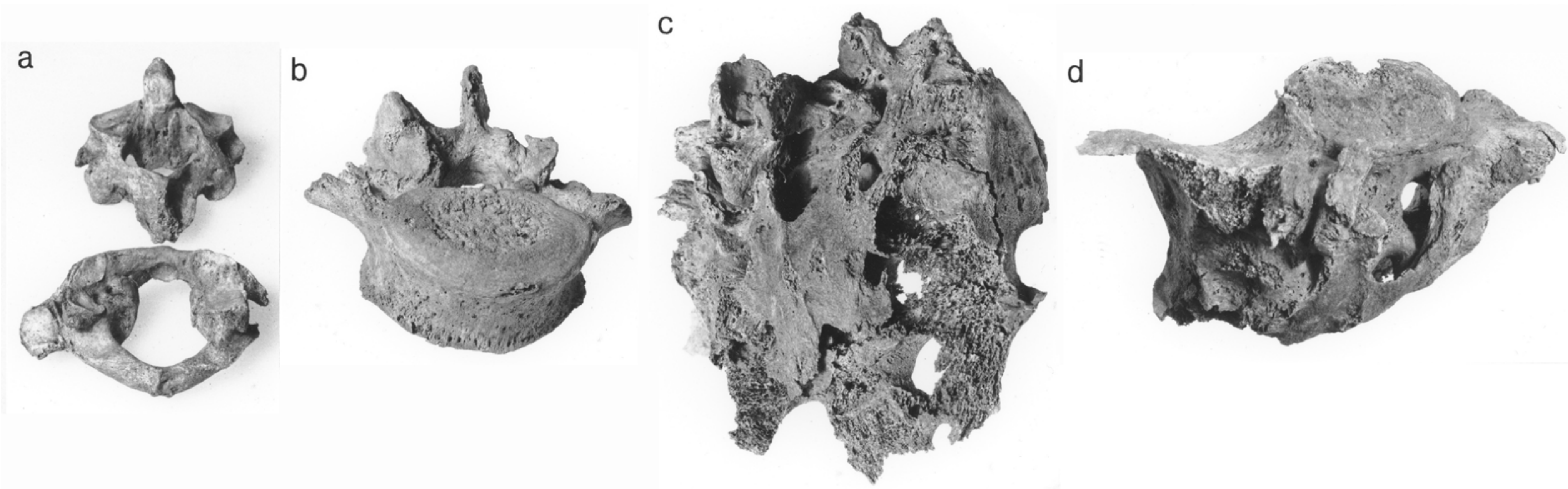

PLATE 28: Conditions of Unknown Aetiology

a Fe 62/4: fused upper thoracic vertebrae (T.4 and T.5)
b Fe 62/4: sacrum showing ossified ligaments
c Fe 9/31: right orbit showing cribra orbitalia

PLATE 29: Trauma to the Skull

a Fe 62/82a: trauma to the left frontal and orbit
b Fe 62/82a: trauma to the jaw
c Surface: possible trauma to right orbit


a


b

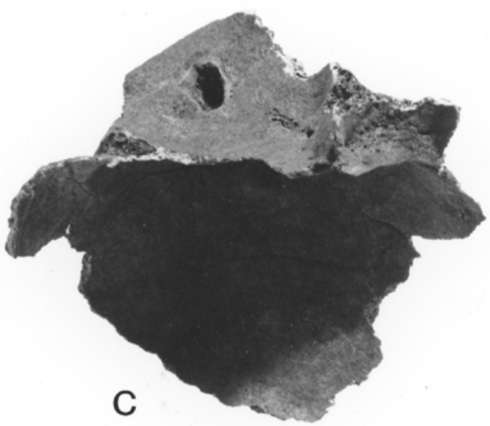
c

PLATE 30: Trauma to the Long Bones

a Fe 9: right humerus of ?Fe 9/23
b Fe 9: right femur of ?Fe 9/23
c Fe 9: radiograph of femur of ?Fe 9/23
d Fe 26/5: right humerus

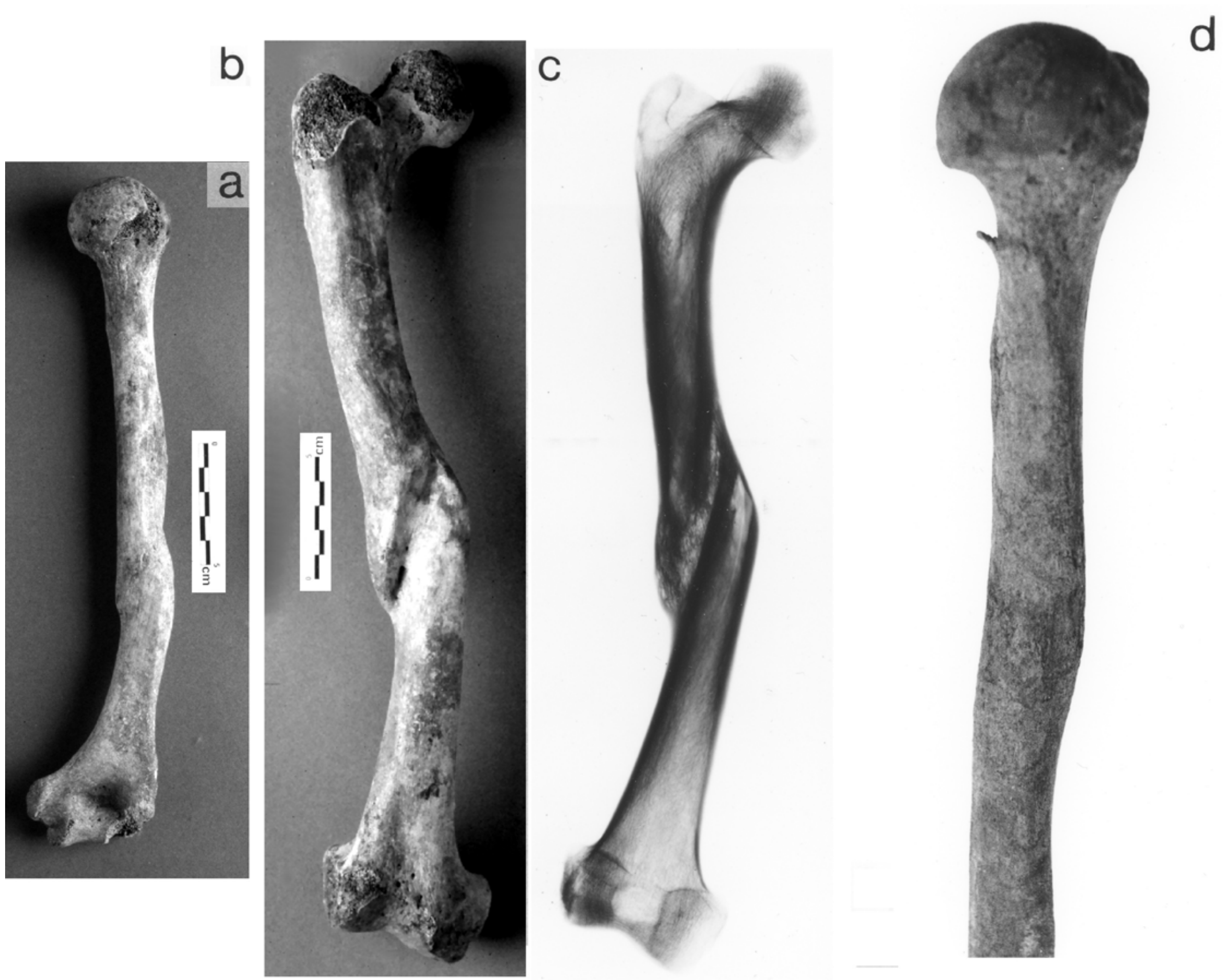

PLATE 31: Fractures of the Upper Limb

a The elbow of Fe 62/59
b "Stray" left ulna from Feature 62 compared with a normal specimen
c Fe 62/2: fracture of left ulna
d Fe 62/2: radiograph of left radius and ulna

LATE 32: Fractures of the Lower Limb and Pelvic Basin

a Fe 9: on the right, fractured juvenile left femur compared with normal femur of the same age (on the left)
b Fe 9: radiograph of juvenile left femur
c Fe 9: distal epiphysis of juvenile left femur
Fe 46: sacrum

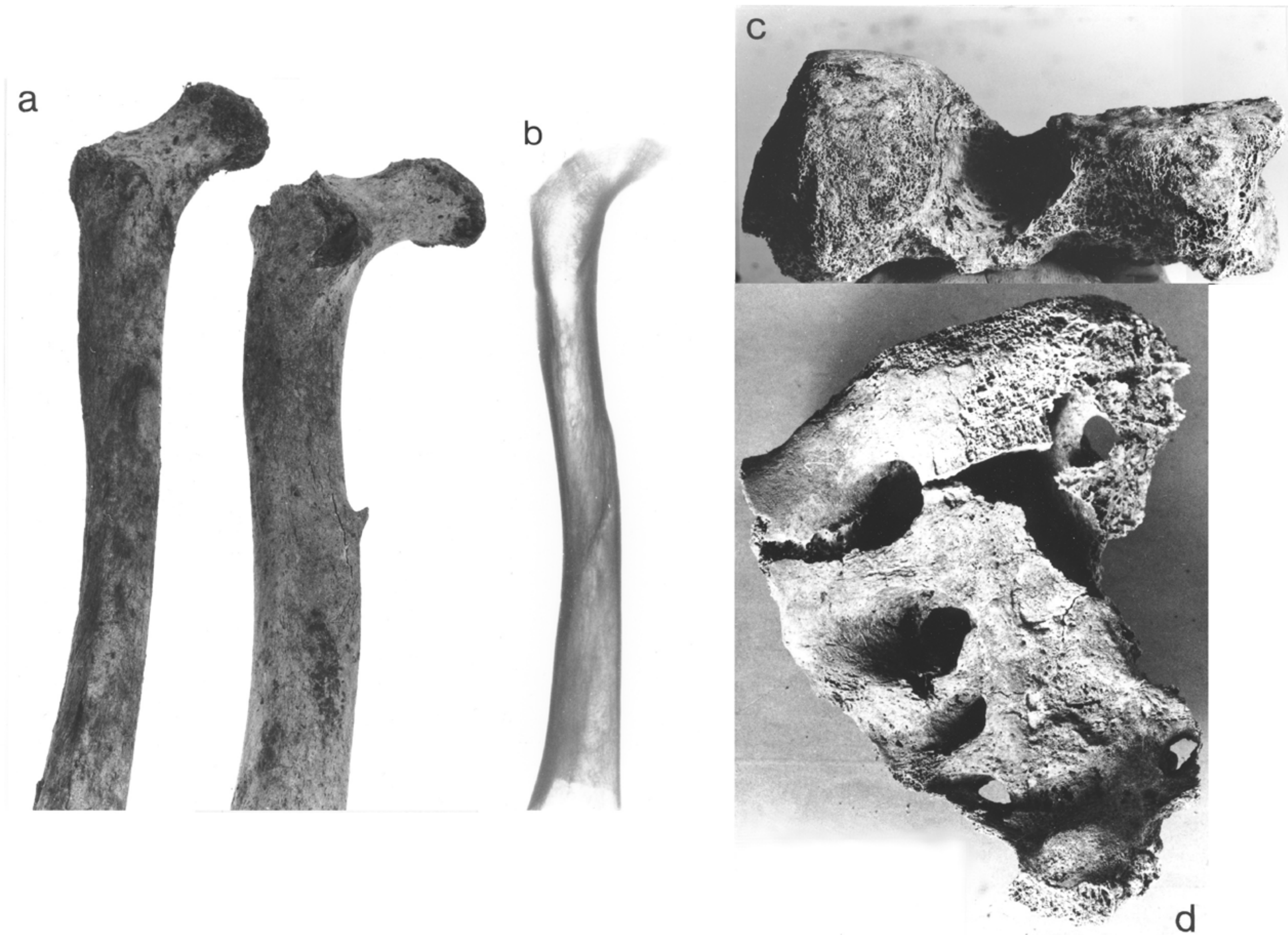

PLATE 33: Trauma to the Pelvis and Lower Limb

a Fe 30/3: right innominate
b Fe 30/3: radiograph of right innominate
c Fe 36/E: sacrum and semi-sacralized L.5
d Fe 36/E: T.10 to L.5; T.12 is fractured
e Fe 62/75: T.12 to L.5; fracture of L.3

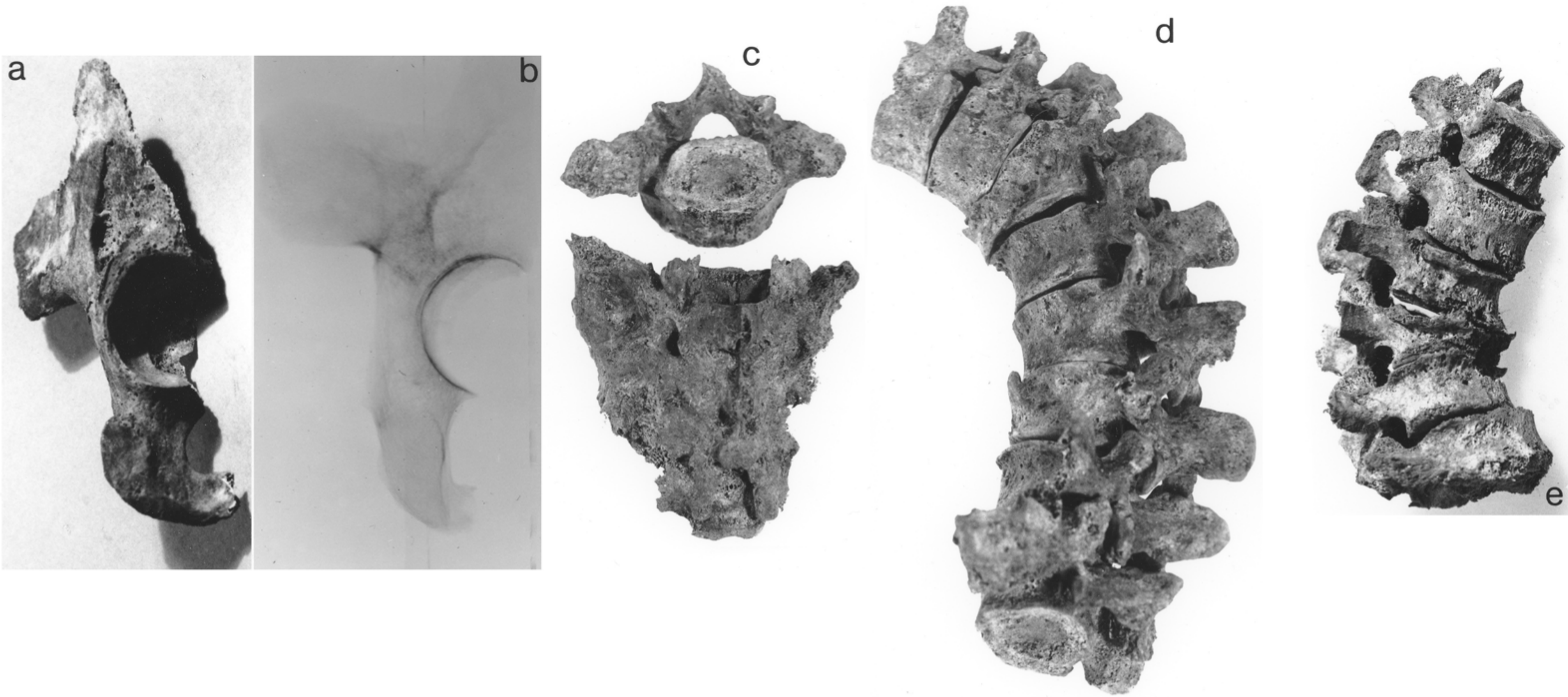

PLATE 34: Fe 62/10: Osteomyelitis following Trauma?

a Anterior surface of distal tibia
b Left talus (posterior superior) and calcaneus (inferior)
c Right calcaneus (lateral superior)
d Right calcaneus (inferior)

PLATE 35: Dental Loss and Crowding

a Fe 62/108: anterior attrition and tooth loss
b Fe 62/4: extreme tooth loss in the maxilla
c Fe 62/20: maxilla with crowded right lateral incisor
d Fe 62/20: crowding or rotation of lower incisors

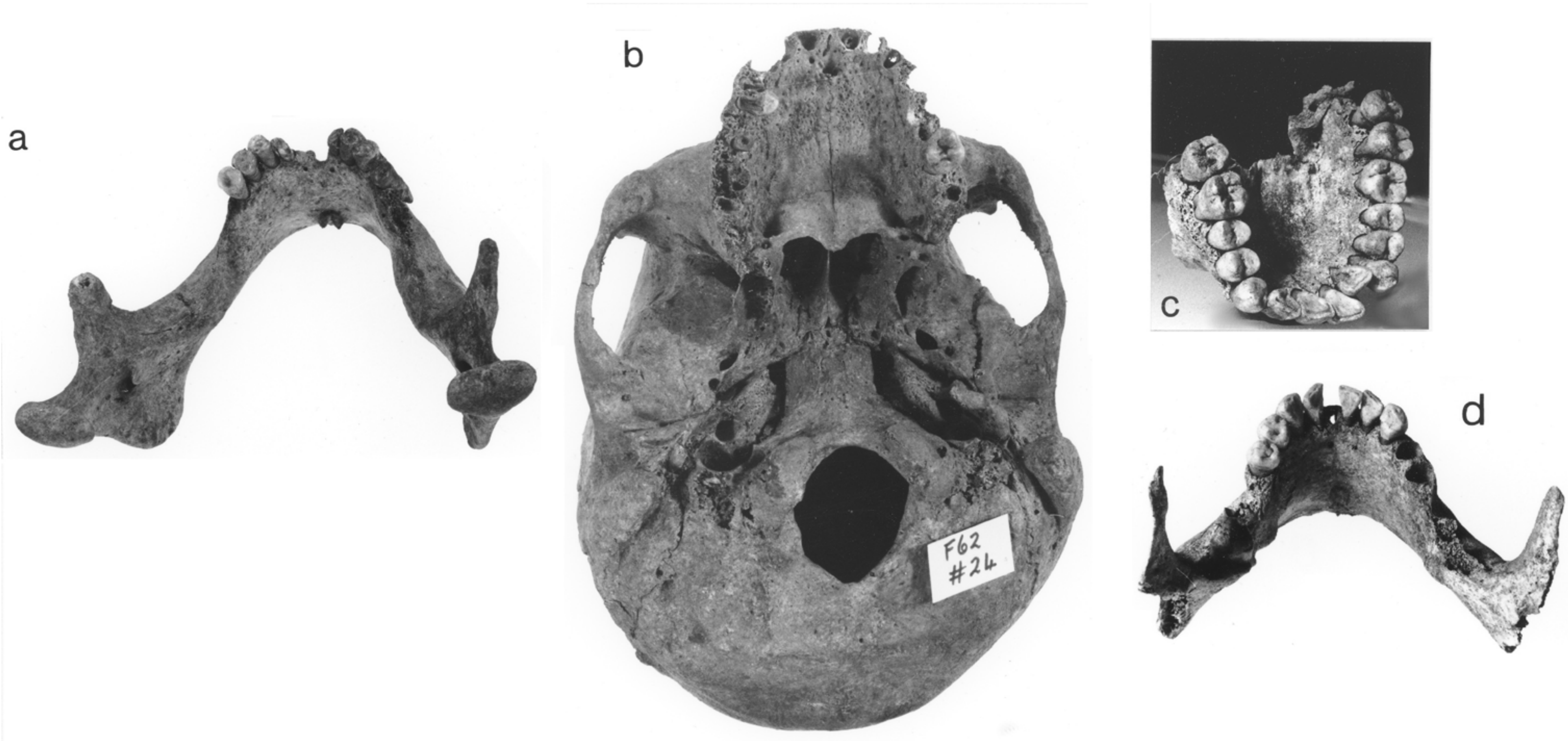

PLATE 36: Tooth malpositioning

a Fe 27/3: the right second lower molar has drifted lingually and mesially and shows labial wear
b Fe 62/Bundle F: tooth loss has caused tooth malpositioning (the left third molar has a large enamel pearl)
c Fe 17/2: impacted left third molar
d Fe 62/T: impacted third lower molars