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# The Priory of St Saviour, Bermondsey, Southwark

## The Human Bone

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this Report

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## THE HUMAN BONE

### Introduction

The monastery was founded in 1089 as the third house of the Cluniac order to be established in England and was a daughter house of La Charité-sur-Loire (Steele 1998). The earliest burials excavated in 1984 date probably from the second half of the twelfth century. During the vicissitudes of the fourteenth century the Priory was refounded as a Benedictine Abbey.

No other Cluniac burial ground of any size has been excavated but comparisons with human skeletal remains from monastic institutions of different religious orders in England clearly are justified. Published comparative sites, therefore, are numerous. Likewise some large monastic sites remain only part-published and further demographic and pathological information is available in the Greater London Archaeological Archive, for example 104 burials from the Cistercian Abbey of St Mary Graces (Waldron 1993a) and 334 burials from the cemetery of the hospital of St Mary Spital (White 1997). Furthermore, analysis of the extremely large groups of skeletons obtained from excavation of Merton Priory (Augustinian) and Stratford Langthorne Abbey (Cistercian) was being performed concurrently with that of Bermondsey Abbey and certain comparisons and provisional conclusions could be made advantageously with respect to life at these religious establishments.

### Materials and Methods

Composition of the Sample

Excavations between 1984 and 1988 had disclosed 202 articulated burials and a number of charnel deposits. Of the former 193 were available for inclusion in the analysis. There were in addition a large number of disarticulated skeletons, collected by the archaeologists as “bone samples”. The latter and the charnel material were to be scanned for pathology only.

Representativeness of Sample

Any sample that exceeds 100 individuals ought to provide valid information about the population buried in the cemetery (Waldron 1994, 10-27). 193 individuals should represent the monastic population reasonably well. However, the post-excavation assessment suggested that women were present among those buried and documentary evidence attests to the burial of women in the Lady Chapel of the Abbey. On the other hand there was considerable evidence for the disturbance of burials (the “bone samples”), including the collection of the disarticulated burials into charnel pits.

Preservation of bone

The physical condition of each skeleton was scored on a scale of 1 to 3. The categories were as follows:-

1. The surface of the bone was in good condition with no peeling or erosion and, although in many cases fragmented to some extent, most osteological information, both metric and non-metric, could be obtained from the remains.

2. The bone itself was in moderate to good condition but most of the long bone ends were missing, limiting the amount of metrical information available.

3. The bone was in poor condition often with the surface missing, the long bone ends absent and highly fragmented generally, which would limit the amount of retrievable information severely.

Using the above grading the majority of the remains, 127 (65.8%), fell into the first category and provided the bulk of the potential information extractable from a skeleton, including an estimate of the stature of the living individual. A further 39 (20.2%) of the remains were in class 2, yielding a reasonable amount of osteological information for a more detailed analysis. A mere 28 (14.5%) were assessed as poor and likely to provide little data.

29 (15.0%) of the burials had more than 80% of the skeleton present and a further 59 (30.6%) had more than 50% present (see Table 1). Although nearly half the burials (105) were not more than 50% complete these were usually represented by the lower part of the skeleton and since this often contained the pelvis the number that could not be aged or sexed therefore was smaller than is indicated by this proportion.

| Integrity (%) | ≤25% | 26-50% | 51-80% | >80% |
|---|---|---|---|---|
| n | 55 | 50 | 59 | 29 |
| **%** | **28.5** | **25.9** | **30.6** | **15.0** |

Table 1. Completeness of the skeleton

**Methods of analysis**

Bone data were recorded on the MoLAS Oracle 7 database. The condition of preservation of individual bones as a consequence of burial practices was noted and efficiency of recovery calculated by comparing the number of bones recovered with that expected from the total number of burials.

The age of any immature individuals was estimated using dental development and state of epiphyseal fusion (Bass 1995, 13-15, Brothwell 1981, 64-7) and diaphyseal lengths ( Ferembach, Schwidetzky and Stloukal 1980, Ubelaker 1984, 46-53, Powers 1988) and of adults: tooth wear stages (Brothwell 1981, 71-2), state of fusion of cranial sutures (Meindl and Lovejoy 1985) and morphology of the pubic symphysis (Brooks and Suchey 1990). Sex was estimated using skull and pelvic dimorphism (Phenice, 1967, Ferembach *et al* 1980, Brothwell 1981, 59-63) and tooth crown dimensions (Rösing 1983). Complementary data for sex estimation was sought metrically (Bass 1995, see below) but priority was given to the results of examination of the pelvis because this is regarded as the most reliable of the available techniques.

Conventional cranial and post-cranial measurements were taken (Bass 1995, 68-81, Brothwell 1981, 79-87) and long-bone lengths were employed in the estimation of stature using the regression equations established by Trotter and Gleser (1952, 1958). Non-metric traits were recorded (Berry and Berry 1967, Finnegan 1978) and where appropriate tested in the elucidation of family relationship.

The jaws were examined for non-metric traits, dental hygiene and pathology (Berry 1978, Hillson 1986). Information on general pathology was recorded (Ortner and Putschar 1985), as was the evidence for infectious disease (Rogers and Waldron 1989), joint disease (Rogers and Waldron 1995) and epidemiology (Waldron 1994).

**Human Variation**

Age

A single individual [2879] was immature, the remainder being adults. Of the adults 69 (35.9%) could not be aged with any degree of precision. 23 (12.0%) were aged between 17 and 25 years (18.7% of

ageable adults), 65 (33.9%) 25 to 45 (52.8% of ageable adults), and 35 (18.2%) over the age of 45 (28.5% of ageable adults); see Table 2.

Sex

The 192 adults comprised 137 (71.4%) males or possible males and 8 (4.2%) females or possible females (see Table 2). It is possible that the 47 (34.3%) adults of indeterminate sex included females but the evidence was lacking. Of the 145 skeletons that could be sexed 137 (94.5%) were male or possibly male and only 8 (5.5%) female or possibly female. this may be broken down further into male 118 (81.4%), possibly male 19 (13.1%), female 5 (3.4%) and possibly female 3 (2.1% ).

The overwhelming preponderance of males (and possible males) and the low proportion of females (and possible females) are in accordance with the character of a monastic house. The latter would include boarders and corrodians, whereas the former might embrace these privileged civilians as well as lay brothers and the monks themselves.

| Age group | male | ?male | unknown | ?female | female | Total |
|---|---|---|---|---|---|---|
| 13-16 years | 0 | 0 | 1 | 0 | 0 | **1** |
| 17-25 years | 19 | 2 | 1 | 0 | 1 | **23** |
| 26-45 years | 55 | 6 | 1 | 1 | 2 | **65** |
| 45+ years | 29 | 2 | 2 | 1 | 1 | **35** |
| unknown | 15 | 9 | 43 | 1 | 1 | **69** |
| **Total** | **118** | **19** | **48** | **3** | **5** | **193** |

Table 2. Demographic Profile of Bermondsey Burials

Stature

In accordance with current recommendations stature was calculated using measurements made on the bones of the lower limb exclusively, since these are regarded as giving a more accurate result than using the arm bones (Stroud and Kemp 1993, Buikstra and Ubelaker 1994, Conheeney 1997). Thus, the calculated height for 68 men from the site ranged from 1.57 to 1.85m, with a mean 1.72m (5'7¾"). This is only an inch or so shorter than the modern British average height 1.75m (anon 1998). Plainly it can no longer be contended that people in the Middle ages necessarily were very much shorter than their modern counterparts (Werner 1998). Stroud (1994, 436) cites twelve medieval cemetery sites with average male stature 1.70 to 1.74m. Meanwhile, average height for women at the same sites ranged from 1.57 to 1.61m. The data from other Cluniac establishments are sparse: 1.77m (5'9¾") at Thetford Priory, based on 5 high status men only (Wells 1957) and 1.72m (5'7½") for the 34 monks from Pontefract Priory (Hurst 1965).

This is not to say that some groups (or sub-groups) at medieval sites were not appreciably shorter than in the present day. Different ethnic groups or a disadvantaged minority might be distinguishable in the cemetery, by being at the lower extreme of stature. Examples include the jews of York and Lincoln and the hospital inmates at St Mary Spital, London, for whom mean stature has been calculated as 1.67 and 1.69m, respectively (Stroud 1994, 435-6, Conheeney 1997, 223).

Only one of the women from Bermondsey Abbey had leg bones sufficiently intact for stature calculation. She proved to have been exceptionally tall for a medieval woman at 1.72m (5'7¾"). It is to be expected that women selected for the privilege of burial in the Abbey would have been of very high status, so that it need not be surprising that she should be taller than the commonality (Conheeney 1997, 223-4).

Handedness

In three of 18 pairs of upper limbs examined the length of the left arm bones exceeded that of the right limb by 2 to 6mm. If the observed upper limb assymetry is related to 'manual dominance' then these three (16.7%) were left-handed. In modern Britain about 10% of the population are left-handed so was the sinistrous proportion of the medieval population higher than today or is there something in the monastic life that selects for left-handed men? Further research on London's monastic sites may help to resolve this question

Cranial and Post-cranial indices

Meaurements made upon the skull, femur and tibia traditionally are used to produce indices which may appear to be of questionable significance but nonetheless remain of value for assessing variability within and between populations and for other comparative purposes (Stroud and Kemp 1993, 173-9, Stroud 1994, 437-9, Mays 1998, 96-100).

The calculated cranial index is a measure of the breadth of the cranium as a proportion of its length. Thus, the cranial index for 50 men ranged from 74.9 (borderline dolichocranic) to 94.2 (hyperbrachycranic), with a mean 83.1. The population therefore may be classified as brachycranic, in common with all English high medieval groups (Stroud 1994, 437). The people from the earlier London site of St Nicholas Shambles (eleventh-twelfth century) had mean index 77.5 and were therefore mesocranic (White 1988:30).

The shaft indices for the leg bones have a bearing upon the physique of the community, even if the implications of the degree of flattening of the shafts are unknown (Andermann 1976, Wells 1964, 132-4). The femur shaft index for a sample of 89 men ranged from 98.3 (eumeric) to 64.2 (platymeric), with a mean 83.6 for the right side and for 86 men from 99.3 to 66.5, mean 83.1, for the left side. The population therefore was slightly platymeric (Index $\leq$ 84.9). Similarly, 94 men ranged from 61.0 (platycnemic) to 92.3 (eurycnemic), mean 73.3, for the right side and for 91 men from 60.2 to 94.9 (mean 72.8) for the left side. The population was classed as eurycnemic, ie normal.

**Non-metric Variation**

Discontinuous or non-metric variation in the human skeleton has an heritable element and has been used in attempts to deduce the presence of family groupings in cemeteries. Such an approach, *a priori*, is unlikely to prove of great utility at a monastic site because of the nominal celibacy of the clergy and the unlikelihood of more than one son in any family entering the same monastic order. Thus, it would be futile to seek father-and-child or sibling groupings in the monks' burial ground and any clustering of non-metric characters in the cemetery hence would be fortuitous. Accordingly, non-metric variation is recorded here as overall frequencies of characteristics for compaison with other populations.

The skeletons were examined for 36 cranial and 34 post-cranial characters and of these 30 different traits were found. The prevalence of the various traits is summarised in Table 2. The only category of tooth missing congenitally other than third molars was the upper second premolar; this tooth was absent bilaterally in the upper jaw of one of the men [3400]. Similarly, Carabelli cusps occurred bilaterally in the lower first molars of one mandible [3905].

| CRANIAL TRAIT | n observed | n available | frequency (%) |
|---|---|---|---|
| Metopism | 12 | 97 | **12.4** |
| lambdoid ossicle | 4 | 97 | **4.1** |
| bregmatic ossicle | 1 | 97 | **1.0** |
| R asterionic ossicle | 6 | 97 | **6.1** |
| L asterionic ossicle | 5 | 97 | **5.3** |
| R epipteric ossicle | 2 | 97 | **2.1** |
| L epipteric ossicle | 1 | 97 | **1.0** |
| coronal ossicle | 2 | 97 | **2.1** |
| R lambdoid ossicle | 18 | 97 | **18.6** |

| | | | |
|---|---|---|---|
| L lambdoid ossicle | 17 | 97 | **17.5** |
| R squamo-parietal ossicle | 1 | 97 | **1.0** |
| L squamo-parietal ossicle | 1 | 97 | **1.0** |
| R torus maxillaris | 1 | 97 | **1.0** |
| L torus maxillaris | 2 | 97 | **2.1** |
| torus palatinus | 10 | 97 | **10.3** |
| R double occipital condyle | 3 | 97 | **3.1** |
| L double occipital condyle | 4 | 97 | **4.1** |
| R torus mandibularis | 7 | 94 | **7.4** |
| L torus mandibularis | 7 | 94 | **7.4** |
| R pterygoid spur | 18 | 94 | **19.1** |
| L pterygoid spur | 18 | 94 | **19.1** |
| third-molar absence | 47 | 391 | **12.0** |

Table 3. Frequencies of Cranial Non-metric Traits (unpaired and bilateral)

An indication of the appearance of the people of the community could be obtained by subjective classification of the skull features (Dawes and Magilton 1980, 27-8). Subjectively, skulls were usually oval in shape, as seen from above: 19 out of 33 possible cases (57.6%), "pear-shaped" skulls amounting to a mere 9 in number (27.3% of possible cases) the only other shape of consequence being "round" of which there were 5 (15.2% of possible cases). Faces tended to be long and narrow (6/14 or 42.9% of possible cases), the remainder being divided into "rectangular" or "oval" (each 21.4% of possible cases). Chin shape was as likely to be round (11/22 or 50% of possible cases) as "square". There was a single instance of a bathrocranic skull, [3905] (Brothwell 1981, 169).

The prevalence of metopic sutures (12.4%) and third-molar agenesis (12.0%) were broadly comparable to other medieval groups analysed. However, wormian bones (in every location on the cranial sutures) occurred at a lower frequency than at St Nicholas Shambles or any of the three sites in York (White 1988, 34, Dawes and Magilton 1980, 35, 41, Stroud and Kemp 1993, 185-8, Williamson 1994, 455). Similarly, auditory and palatine tori were present less commonly that at these other sites as was the maxillary torus (except at St Andrew, Fishergate) and the mandibular torus, except at St Nicholas Shambles (*ibid)*.

| POSTCRANIAL TRAIT | n observed | n available | frequency (%) |
|---|---|---|---|
| sternal foramen | 2 | 48 | **4.2** |
| R os acromiale | 2 | 38 | **5.3** |
| L os acromiale | 3 | 38 | **7.9** |
| R supra-scapular notch | 35 | 38 | **92.1** |
| R supra-scapular notch | 35 | 38 | **92.1** |
| L supra-scapular foramen | 2 | 38 | **5.3** |
| R supra-scapular foramen | 2 | 38 | **5.3** |
| R atlas posterior bridge | 2 | 78 | **2.6** |
| L atlas posterior bridge | 5 | 78 | **6.4** |
| R atlas lateral bridge | 2 | 78 | **2.6** |
| L atlas lateral bridge | 2 | 78 | **2.6** |
| R atlas double facet | 8 | 78 | **10.2** |
| L atlas double facet | 8 | 78 | **10.2** |
| R cervical rib | 1 | 78 | **1.3** |
| L cervical rib | 1 | 78 | **1.3** |
| R accessory sacral facets | 4 | 106 | **3.8** |
| L accessory sacral facets | 2 | 106 | **1.9** |
| lumbosacralisation | 3 | 71 | **4.2** |
| sacrolumbarisation | 2 | 71 | **2.8** |
| R acetabular crease | 5 | 108 | **4.6** |
| L acetabular crease | 3 | 106 | **2.8** |
| R septal aperture | 1 | 86 | **1.6** |
| L septal aperture | 2 | 101 | **1.9** |
| R supracondylar process | 1 | 86 | **1.6** |
| R 3rd trochanter | 12 | 98 | **12.2** |
| L 3rd trochanter | 12 | 90 | **13.3** |
| R Poirier's facet | 8 | 98 | **8.2** |
| L Poirier's facet | 6 | 90 | **6.3** |

| | | | |
|---|---|---|---|
| R Poirer's plaque | 2 | 98 | **2.0** |
| L Poirer's plaque | 1 | 90 | **1.1** |
| R squatting facet medial | 3 | 95 | **3.2** |
| L squatting facet medial | 2 | 72 | **2.8** |
| R squatting facet lateral | 7 | 95 | **7.4** |
| L squatting facet lateral | 7 | 72 | **9.8** |
| R calcaneal facet double | 15 | 94 | **16.0** |
| L calcaneal facet double | 15 | 95 | **15.8** |
| R talar facet double | 11 | 91 | **12.1** |
| L talar facet double | 11 | 89 | **12.4** |
| R talar squatting facet | 5 | 91 | **5.5** |
| L talar squatting facet | 3 | 89 | **3.4** |
| R os trigonium | 1 | 91 | **1.1** |
| L os trigonium | 1 | 89 | **1.2** |

Table 4. Frequencies of Postcranial Non-metric Traits (unpaired and bilateral).

One area where clusters of non-metric traits might have proved informative was the Chapel (Building 2). Of seven burials recovered from the Chapel one ([3804]) was no longer available for analysis. Half the remainder were so incomplete that neither sex nor approximate adult age could be assigned ([2527], [3619], [3706]). The remaining three were male aged 26 to 45 years ([3798], 3817]) except for [3522]. a headless adult male of unknown age. None of them exhibited a pattern of non-metric traits such as could be used in the elucidation of possible family relationships.

**PATHOLOGY**

**Trauma**

One of the more frequently observed skeletal lesions in archaeological populations are those that are the result of injuries sustained during life. The knocks and tumbles or violent episodes of someone's life will often leave unmistakable traces in the skeleton in the form of broken bones.

Fractures in the Axial Skeleton

One individual , [3541], shows a small depressed fracture of the outer table of the left parietal. It is in the central area of the parietal and is quite small, measuring 10mm long by 4mm wide. It has not punctured the inner table which is perhaps fortunate for this individual as a perforating injury might have caused infection resulting in meningitis which was usually fatal. The fracture has rounded edges and there is no evidence of an inflammatory response although these changes might have remodelled out over time.

The most common fractures in this burial group were those of the rib cage. Five individuals ([3723], [3203], [2701], [2967] and [3599]) showed one or more broken ribs. Fractures to the ribs occurred on both left and right sides and were restricted to ribs in the upper and middle portions of the rib cage. All except two were well healed with no evidence of inflammation. Burial [3723] has a fracture of the left first rib in its neck portion which has not united despite considerable callus formation around both broken ends, forming a pseudarthrosis. Fractures of first ribs are associated with severe trauma to the shoulder and thorax region and are particularly dangerous because of the rib's close association with major vascular structures such as the subclavian artery or aorta. A pseudarthrosis at this location is, therefore, quite unusual. The left clavicle from this individual is poorly preserved and incomplete so it is difficult to determine whether or not the first rib fracture was associated with fracture of the clavicle (which lies just above). A second individual [3203] has two fractured ribs (right five and six) and both ribs have poor apposition and overlapping of the broken ends. The fractures are oblique and have resulted in slight angular deformity of about 5$^{o}$. Healing is complete, but remodelling callus is patchy and irregular. The overall prevalence of broken ribs is 9/1964 or 0.5%.

Fractures in the Appendicular Skeleton

Skeletons [2898] and [3236] have fractured right ulnae. In [2898] the fracture is at midshaft level and the healing is good with no angular or rotational deformity. The callus is dense lamellar bone

suggesting that the fracture occurred a considerable time before death. The second individual [3236] shows a fracture of the distal end, transversely across the shaft. The union of the broken ends is good with slight callus formation that has remodelled into dense lamellar bone. There is slight angular deformity with the distal segment medially deviated by approximately 20° from the long axis, reducing the length of the bone by 4mm when compared to the left ulna. Fractures of the shaft of the ulna are often referred to as "Parry fractures" as they are known to occur when an individual raises their arm to ward off a strike or blow - the subcutaneous edge of the ulna is exposed and takes the brunt of the force. This is a common interpretation, but equally ulnar fractures can be due to other causes. Prevalence of ulnar fractures is 2/160 or 1.3%.

Two other individuals ([2659] and [3798]) have fractured clavicles. These bones are quite often fractured by a fall on the shoulder or on an outstretched hand and are the most commonly broken bone in modern populations. High frequencies are also seen in archaeological populations (see for example Judd and Roberts 1998). Burial [2659] shows a fracture of the right clavicle which is well aligned with good healing, although despite the fact that the maximum lengths cannot be recorded it is clear that the right clavicle is shorter than the left. The frequency of broken clavicles is 2/167 or 1.2%. Skeleton 3493 (adult, not sexed) has a healed fracture of the left fibula 90mm inferior from the proximal end. The callus is rounded and dense and the ends are well united with no angular distortion.

Skeleton [3607] has a "Pott's" fracture; *three* breaks had occurred in the right ankle (talo-crural) joint (see Fig x). Pott's fractures are named after Sir Percival Pott of St. Bartholomew's hospital, London, who first described fracture of the distal fibula with displacement of the talus in 1769. In skeleton 3607 both malleoli plus the posterior margin of the tibia are fractured. The medial malleolus has broken at its junction with the main part of the tibia, and has been displaced by 8mm posteriorly where it has re-attached via callus formation. The lateral malleolus has broken at a point 60mm from the distal extremity of the fibula, i.e. *above* the inferior tibio-fibular joint. This suggests that the ligaments of the inferior tibio-fibular joint were ruptured, in turn leading to a widening of the joint allowing the talus to become unstable (a condition known as diastasis of the ankle). Apposition is good despite posterior displacement of the lateral malleolus at an angle of approximately 16° from the long axis. The third fracture is of the posterior margin of the tibia (or "posterior malleolus") and this has been displaced superiorly by 8mm and has re-attached via fracture callus, leaving a step like discontinuity on the articular surface of the distal tibia. The fracture of the posterior and lateral malleoli are well united by a moderate amount of callus that has remodelled into dense lamellar bone, the callus has united these two pieces resulting in the ankylosis of the distal fibula and tibia. The affect of these fractures has resulted in a posterior subluxation of the talus (and entire foot). Eburnation and subchondral pitting on the talus also indicate secondary osteoarthritis. Fractures such as this are characteristic of a rotational injury, i.e. the foot being forcefully twisted to one side or the other. Internal rotation (adduction) tends to result in the lateral malleolus fracturing *through* the inferior tibio-fibular joint. In bimalleolar adduction fractures the inferior tibio-fibular and collateral ligaments remain intact (Palastanga *et al* 1994, 514). By contrast, in external rotational (abduction) injuries the lateral surface of the talus pushes the lateral malleolus away from the tibia resulting in rupture of the inferior tibio-fibular joint and fracture of the fibula above this level, which is what is observed here. The fracture pattern seen in skeleton [3607] is consistent with an external rotation injury of severe violence. This was probably the result of an accident, perhaps a particularly awkward fall.

A total of 1023 long bones (humerus, radius, ulna, femur, tibia and fibula) were examined and a total of five had evidence of a fracture (0.5%). When ribs, crania and clavicles are considered also, the total number of individuals showing evidence of trauma in the form of fractures (healed and unhealed) is thirteen out of 193 adults (6.7%). Of these thirteen adults, twelve could be confidently sexed as male. The overall fracture frequency, therefore, for males in this group is 12/137 or 8.8%. Comparison of fracture prevalence between the sexes was not possible because the sample had lower numbers of females (8/193 or 4.2%), however it is noted that males in other comparable sites suffer up to twice the amount of fractures than females (Grauer and Roberts 1996, 537).

Data given in Judd and Roberts (1998) and Grauer and Roberts (1996) demonstrate that fracture rates for males from five other comparable medieval urban sites ranged from 5.6-21.1% (St. Helen-on-the-Walls 7.3%, St. Nicholas Shambles 5.6%, Blackfriars 8.1%, Whithorn 5.7% and Chichester 21.1%).

The fracture frequency for Bermondsey Abbey males (8.8%) falls within this range. The figure of 21.1% at Chichester is high because the cemetery is associated with a leper hospital. Judd and Roberts (1998) suggest that the increased fracture frequency at this site is due to the sensory impairment in leprosy infection. If one ignores this biased group then, the frequencies range from 5.6-8.1%, and Bermondsey is broadly comparable with this range at 8.8%.

Soft Tissue Trauma

On some occasions, damage to soft tissues can result in tearing of ligaments and tendons, or a localised haematoma (blood clot). Under these circumstances a bone formative response is initiated, the proximity of blood clots to the periosteum can stimulate osteoblasts (Aufderheide and Rodriguez-Martin 1998). This results in a lesion known as myostitis ossificans. One possible case is seen in skeleton [2722] (a young adult male) which shows small exostoses of dense lamellar bone up to 9mm long on the infraglenoid tubercle of the left scapula. This formation of new bone might have been initiated by avulsion or partial avulsion of the long head of triceps.

Skeleton[ 2898] also has a dense nodule of bone on the posterior surface of the left lateral epicondyle of the humerus. It measures 21mm long and is 16mm at its widest point and is 7mm high. Inferiorly, the new bone extends as a flange and this might represent myostitis ossificans associated with the anconeus muscle. [2898] also has an ulnar fracture and spondylolysis (see above). Three skeletons ([2801], [2823] and [3217]) also have deposits of sclerotic bone on the metatarsal shafts. [2801] (mature adult male) has new bone deposits on the lateral surfaces of left and right metatarsals 2-4, with smaller circular deposits on the medial aspect of metatarsal 4. Skeletons [2823] and [3217] also exhibit these bone deposits on the lateral surfaces of metatarsal 3 and 4, [2823] also shows smaller deposits on the medial surface of left metatarsal 3. These bone deposits might represent myostitis ossificans due to repeated microtrauma to the dorsum of the foot.

**Joint Disease**

Another frequently observed pathological change is joint disease, and changes to the joints can show up in several ways. Osteophytic (lipping) development on the margins of joints are the most common; but these on their own cannot be considered as evidence of osteoarthritis because they are also a product of the ageing process. Other changes such as sub-chondral pitting, contour alteration and eburnation in particular are indicative of cartilage failure and enable osteoarthritis to be identified more securely. There was no evidence of any erosive arthropathies amongst this burial group. The distribution of joints with evidence of osteoarthritis are summarised in Table 5.

Table 5. Distribution of Degenerative Joint Changes.

| JOINT | male | female | unsexed | TOTAL | %individual |
|---|---|---|---|---|---|
| TMJ | 1 | 0 | 0 | 1 | **0.5** |
| shoulder | 18 | 1 | 0 | 19 | **9.8** |
| elbow | 6 | 0 | 0 | 6 | **3.1** |
| wrist | 11 | 0 | 0 | 11 | **5.7** |
| hand | 7 | 2 | 1 | 10 | **5.2** |
| hip | 2 | 0 | 0 | 2 | **1.0** |
| knee | 13 | 1 | 3 | 17 | **8.8** |
| ankle | 2 | 0 | 0 | 2 | **1.0** |
| foot | 3 | 0 | 1 | 4 | **0.5** |

The most frequently affected joints were the acromioclavicular joints in the shoulder. A total of 19 individuals (9.8%) showed degenerative changes in one or both shoulders. Another frequently affected joint was the knee where 8.8% of individuals showed osteoarthritic changes. Within the knee joint itself the most common area affected was the anterior compartment or patellofemoral joint. Eleven of the seventeen knee joints affected (65%) showed changes in this area, usually on one side only. Skeleton 3613, however, showed osteoarthritis in both of these joints. Of the eleven cases, eight could

be aged, and six of these were in the older adult category (i.e. 45+ yrs.). The same pattern of high prevalence of shoulder and knee changes was also seen in the males from Stratford Langthorne Abbey (Stuart-Macadam 1985).

**Infectious Disease**

Infectious disease can be broken into two broad groups: specific infection and non-specific infection. Specific infection is where the changes observed (in this case in bone tissue) are characteristic of one type of pathogenic organism. Specific infections in palaeopathological contexts usually refer to Treponemal disease (e.g. syphilis) or Mycobacterial disease (e.g. tuberculosis and leprosy). Non-specific infection refers to an infection where the bony changes observed are common to a wide range of pathogens (usually bacterial) and one particular species cannot be identified. At Bermondsey Abbey, evidence of both specific and non-specific infection was found.

Specific Infections - Tuberculosis

Tuberculosis is caused by infection by one of two strains of the tuberculosis bacillus, the human type (*Mycobacterium tuberculosis*) is usually transmitted by droplets in the air and is primarily a lung infection. The bovine form (*Mycobacterium bovis*) can be caught by ingesting contaminated meat or dairy products (e.g. milk or butter) and is primarily a gastrointestinal infection. Bone involvement in tuberculosis is, therefore, a metastatic phenomenon, that is bone becomes infected via spread from lesions in soft tissue. Areas in the skeleton such as the spine and long bones are predilicted sites of infection because of their rich vascular supply.

There is a probable case of tuberculosis in skeleton [3231], a young adult male [from the ? part of the Abbey complex]. The lumbar vertebrae show changes characteristic of tuberculosis infection (figure xx) and these are as follows : L3 shows two deep cavities on the anterior surface of the centrum that extend virtually the entire height of the vertebra. Both of these cavities have sharply demarcated margins and have walls composed of coarsely remodelled trabeculae. There is minimal bone formation except towards the inferior end-plate where the trabeculae have become smoothed to form thin sheets of lamellar bone. The end-plates are intact and unaffected. L4 shows a central lytic focus within the body of the vertebra (approx. 17mm wide and 5mm high). The bone around this lytic focus consists of sclerotic trabeculae. A lytic lesion (scalloping) also exists on the anterior body of L4. The destruction caused by the central lytic focus has resulted in a crush fracture of L4 (the superior surface is inclined at an angle of approximately 10$^{o}$ transversely and 25$^{o}$ antero-posteriorly), and this would have caused the spine to have become abnormally curved (kyphotic). Angular kyphosis (Pott's disease) has been described as the "classic hallmark" of tuberculosis of the spine (Rogers and Waldron 1989, 614). L5 also has scalloped lytic lesions that extend across the whole anterior surface. This lesion is not as clearly demarcated as those seen in L3 and L4, and has less distinct margins. The walls are composed of coarse trabecular tissue and the end-plates are intact. The right L4/5 zygapophyseal joint is ankylosed, although this may have occurred as a result of the fracture rather than the infective process itself. The anterior surface of the sacrum is also affected by lytic lesions, S2 clearly shows the scalloping effect.

The key features of all these lesions are that there is no apparent sinus formation, reactive bone formation is minimal (i.e. the lesions are primarily lytic in nature), the crush fracture at L4 and the scalloped anterior surfaces. The anterolateral scalloped lesions of the lumbar vertebral bodies, due to spread of infection beneath the anterior longitudinal ligament, are diagnostic of spinal tuberculosis (Rogers and Waldron 1989, 614, Stirland and Waldron 1990,224).

In considering a differential diagnosis, other disease processes such as brucellosis, pyogenic osteomyelitis and mycotic (fungal) infection must be borne in mind. Brucellosis tends to present destructive and bone formative responses at the same time (Zimmerman and Kelley 1982, 92, Stirland and Waldron 1990, 225) and another common finding is that the inter-vertebral discs are affected (ref), whereas in [3231] they are normal. Osteomyelitis provokes marked proliferation of new bone (Stirland and Waldron 1990, 225) whereas in tuberculosis there is very little proliferation of new bone, sequestra

are rare and no cloacae are formed (Rogers and Waldron 1989). Involvement of posterior elements is common in fungal infections affecting the spine (Aufderheide and Rodriguez-Martin 1998, 140).

Tuberculosis is often described as a population density dependent disease, and as Larsen (1997, 103) points out the biocultural model and general pattern of skeletal involvement in the context of increasing population density and sedentism is well illustrated. The increase in population density in London during the medieval period [ref - migration] would have presented ideal conditions for increased prevalence of this disease. Tuberculosis in urban populations is usually the pulmonary type, however, Boylston and Roberts (1997) have found evidence of probable gastro-intestinal tuberculosis in the medieval population from the city of Lincoln [dating secure ?]. Other possible cases of tuberculosis from medieval London include a 12 year old child from St. Mary Spital [date] (Conheeney 1992), and an adult male with Pott's disease of the spine from Stratford-Langthorne Abbey, dated 1135-1538 A.D. (Stuart-Macadam 1985). This, therefore, suggests that monks were also to this disease. As bone involvement in tuberculosis is associated with advanced soft tissue disease it must have been apparent to other individuals that he ([3231]) was very sick.

Non-specific Infection

A common form of non-specific infection is periostitis. A low grade inflammation of the periosteum causes its osteogenic layer to lay down new bone on the cortex underneath. This usually results in striations of new bone being deposited, woven at first, coalescing into small areas of plaque-like new bone that will eventually be incorporated into the cortex. Periostitis is frequently seen in archaeological populations, particularly on tibiae and fibulae, especially tibiae. Periostitis may be the result of infection by common bacteria (e.g. *Staphylococcus* or *Streptococcus* sp.) systemic disease or minor trauma. In the right leg 27 out of 98 tibiae (27.6%) showed a periosteal bone formation on one or more surfaces. In four of these cases periostitis had also occurred on the fibula. The left leg showed a slightly higher prevalence with 26 out of 75 (34.6%) with periostitis on one or more surfaces. In eight of these cases periostitis had also occurred on the fibula. Overall, fibulae showed a lower prevalence with 11 out of 78 fibulae (14.1%) on both left and right sides.

Skeleton [3555], a young adult male, showed new bone formation on the anterior surface of the sacrum (S1-3). On S1 the new bone consists of a lamellar plaque and on S2 there is a larger area of new bone, mostly on the left side consisting of spicules of lamellar bone. A trace of this new bone can also be seen on S3. This might have been caused by direct spread of bacteria from the colon or rectum.

Two mature adult males ([2692] and [3515]) have periosteal bone formative responses on the visceral surfaces of ribs. [2692] has fine woven bone deposits in the neck region of left ribs four and five. [3515] has three right ribs (right first and ?second and ?third) plus two left mid-section (5-8) ribs with new bone deposits in the neck region of the visceral surface. The aetiology of periosteal rib lesions still remains uncertain, Pfeiffer (1991:197) for example, suggests that rib lesions of this type are best interpreted as forms of non-specific inflammatory periostitis. However, Roberts *et al* (1994) found a strong association with these lesions in people who had died from tuberculosis. As this burial group already demonstrates clear evidence of tuberculosis (burial [3231]), the rib periostitis seen in [2692] and [3515] might represent further evidence for the presence of a chronic pulmonary stressor, such as tuberculosis.

Sinusitis

Sinusitis (or inflammation of the maxillary sinus) was found in four adult males ([3490], [3897], [3223] and [3914]). The cause can be attributed to air pollution; Lewis *et al* (1995) noted other causes. In burials [3490] and [3897] the inflammation was associated with dental abscesses of the first molar that had perforated the sinus. Skeleton [3223] has bilateral sinusitis, the floors and antero-medial walls have spicules of new bone on their surfaces and skeleton [3914] has new bone formation (spicules of lamellar bone) on the floor of the sinus. These four cases of sinusitis are based on skulls with fragmentary maxillae and as such is a gross underestimation of the true prevalence because the sinus itself cannot be examined in intact skulls.

**Circulatory Disorders**

Skeleton [3458] is an incomplete adult consisting only of the right femur, tibiae, fibulae and feet. The tibiae and fibulae show near perfect bilateral and symmetrical distribution of periosteal lesions (see Figure x.). The tibiae and fibulae had new bone deposits at mid-shaft level consisting of well remodelled striations of lamellar bone. The distal ends of the bones also have extensive new bone deposits consisting of coarse and porous new bone, suggesting a more recent formative process (fig. x) The right femur of this individual also showed periostitis, there are plaques of lamellar bone on the shaft and porous new bone on the medial and anterior surfaces of the distal end. Although the skeleton is incomplete, the bilateral and symmetrical distribution of the lesions would suggest a systemic cause rather than trauma or infection. The distribution of periostitis in the legs is possibly the early stages of hypertrophic osteoarthropathy, which consists of a strictly symmetrical periosteal bone deposition on the shafts of the long bones of the extremities (Ortner and Putschar 1985, 246, Fennell and Trinkaus 199, :992) the incompleteness of this skeleton, however, limits the certainty of this. The bones most frequently involved are the forearms and lower legs, ankles (tibia and fibula) and the knee (Ortner and Putschar 1985, 246, Aufderheide and Rodriguez-Martin 1998, 91). Hypertrophic osteoarthropathy is a disease of considerable antiquity, Fennell and Trinkaus (1997) described a case dating from the Palaeolithic !

**Diffuse Idiopathic Skeletal Hyperostosis (DISH)**

DISH is a condition that has only become recognised relatively recently, both clinically and in palaeopathological contexts. The main manifestations of DISH are bony proliferations on the margins of the vertebral bodies that fuse together causing the spine to become rigid. Ossifications also occur elsewhere in the skeleton at sites of ligament and muscle attachment. DISH occurs in older individuals, usually over 50 years, and it far more common in males than in females (Resnick and Niwayama 1988). It is the vertebral changes that are most characteristic of DISH, blocks of ankylosed (fused) vertebrae have the appearance of melted candlewax dripped down the bodies. The exact cause is unknown, but it has an association with obesity and late-onset diabetes (Julkunen *et al* 1971, Waldron 1985).

There were fifteen cases of DISH at Bermondsey, all were mature adult or older adult males and this is not surprising given that modern clinical findings suggest that this group are most often affected. The prevalence of DISH at Bermondsey is 15/193 (7.8%) when vertebrae and extra-spinal enthesopathies are considered together. This prevalence is relatively high compared to modern populations where it is usually about 2.8%. It is, however, comparable with the 8.6% seen at Merton Priory (Waldron 1985), and the prevalence of 8.2% in the burials from St. Mary Graces, London (Waldron 1992) where monks, clergy or high status individuals were found within the church. Similarly, at St. Mary Spital, London, the prevalence was 20%, where three burials were found grouped together in an area that contained clerical and wealthy burials (Conheeney 1997). The high prevalences of DISH at monastic sites is thought to be related to a calorie rich diet and obesity (with attendant late-onset diabetes), indeed, Waldron (1985) suggests that it might have been an "occupational hazard" of monastic life. At the cemetery of St. Andrew, Fishergate, a total of fifteen individuals had evidence of DISH (or probable DISH) out of 312 adults (4.8%). [see Alan Pipe for comment on animal bones, does it support Waldron's hypothesis ?] [need burial plan to see if DISH cases are clustered !!].

**Metabolic Disease**

Metabolic disease results from disturbances to the normal metabolic processes that occur during the growth and development of the body and can result from dietary insufficiencies or hormone imbalances. Bone changes of this type are often considered as "stress indicators". There is evidence of two types of metabolic disease or stressor in this population; cribra orbitalia and osteoporosis.

Cribra orbitalia can be recognised by porous bone lesions in the roof of the orbit (eye-socket). These lesions are considered to be suggestive of iron deficiency anaemia, however, they could also represent an adaptive response to pathogen loads (Larsen 1997, 62) as a potential synergism with infection has also been suggested (Goodman *et al* 1988). Five skulls show evidence of cribra orbitalia (Table 6), the prevalence of this condition is 5/97 skulls with one or both orbits (5.2%).

| BURIAL | SEX | AGE | LATERALITY | TYPE* |
|---|---|---|---|---|
| 3487 | male | mature adult | bilateral | type 3 |
| 3015 | not sexed | older adult | left | type 4 |
| 3220 | male | mature adult | bilateral | type 3 |
| 3558 | male | older adult | bilateral | type 3 |
| 3223 | male | young adult | bilateral | type 3 |

Table 6. Skulls with cribra orbitalia (*following Stuart-Macadam (1991, Figure 9.3a).

Osteoporosis is a condition where bone is qualitatively normal but *quantitatively* deficient and quite common in post-menopausal females. The loss of bone mass predisposes areas of the skeleton to fracture, such as the wrist, femoral neck or a crush fracture in the spine. One possible case of osteoporosis was seen in an older adult male , [3897], which has a compression fracture of the first lumbar vertebra. Broken articular ends of long bones also show some degree of ante-mortem trabecular loss.

**Congenital and Developmental Disorders**

Congenital defects cover a range of abnormalities that are present at birth or manifest themselves later in life due to faulty development. Amongst the more common defects seen in the skelton are minor variations in the number of form of vertebrae, particularly at the lumbosacral level.

Spondylolysis is a condition usually seen in lumbar vertebrae where the posterior section of the neural arch is separate at the junction with the pedicles at the *pars interarticularis*, either unilaterally or bilaterally. Spondylolysis is seen in up to 5% of modern populations (Dandy 1994), and it is usually twice as frequent in males than in females (Waldron 1992). The exact aetiology of this condition is still a matter of debate (Arriaza 1997, Aufderheide and Rodriguez-Martin 1998), some authors suggest a congenital weakness (e.g. Roberts and Manchester 1995, 78) while some argue that spondylolysis can be caused by other than congenital factors (Pecina and Bojanic 1993). Three cases of spondylolyis were seen in the Bermondsey population, two in mature adult males ([3817] and [3200]) and one in an older adult male ([2898]). Skeleton [3817] has bilateral spondylolysis at L5, but the other two cases ([3200] and [2898]) are slightly unusual because they are associated with other lumbo-sacral congenital defects. In skeleton [2898] there is bilateral spondylolysis of L4 in association with sacralisation of L5. L4 has weakly developed transverse processes when compared to L3 or L5 that are inclined superiorly rather than perpendicular to the sagittal axis as in L1-3. The detached segment of neural arch has come into direct contact with the left superior articular facet and both surfaces are eburnated at this point suggesting that the detached ossicle was capable of limited movement. Waldron (1992) also noted two cases of spondylolysis from St. Mary Graces, London, where the detached segment became osteoarthitic.

Skeleton [3200] shows bilateral spondylolysis at L5 associated with spina bifida occulta. Clinical studies have demonstrated that the proportion of individuals with spondylolysis in whom spina bifida occulta also occurs is usually 20-40%, although frequencies of up to 70% have been reported (Waldron 1993, 55). An Anglo-Saxon example from Castle Mall, Norwich, has also been described (Anderson 1996, 15) but the spina bifida occulta only affected S1 and S2. In skeleton 3200, the non-union in the midline seen between S1-5 also affects the separate posterior segment of L5 neural arch, i.e. it was in two halves not united in the mid-line (see Figure x), although one half of the ossicle has been lost post-mortem. The dysraphic defect extending to the L5 spondylolytic segment does appear, however, to be quite unusual. [Does this lend support to the condition being of congenital origin ?].

Two individuals ([3558] and [3200]) have spina bifida occulta, where the posterior arches of the sacrum are open from S1 to S5. In [3200], this was associated with spondylolysis (described above). Several other individuals had partial spina bifida occulta. Three sacra ([2929], [3099] and [3251]) had a non-union at S1 only, in [3251] this was associated with a supernumary 6th lumbar vertebra, in [2633] non-union of S2-S5 was associated with a sixth lumbar vertebra. Five individuals also have the first coccygeal vertebra fused to the sacrum, three cases ([3654], [2643] and [3294]) were not associated with

other lumbo-sacral congenital abnormality. Two other cases ([3279] and [3914]) were associated with lumbo-sacral congenital abnormality. There is one case of lumbarisation [3607] where S1 was separate from the sacrum and had a lumbar form. Burial [2898] had the reverse of this, where L5 had sacralised, i.e. had become incorporated into the sacrum. This was also associated with spondylolysis (see above). Changes in rib segmentation had also occured. Burial 2812 for example showed a cranial shift in rib segmentation, C7 has cervical ribs and T12 has no ribs facets and rudimentary transverse processes. Burial [3613] has no rib facets at T12.

Four burials [(2633], [3268], [3251] and [3279]) had supernumary lumbar vertebrae. The normal number of lumbar vertebrae is five, but these individuals had six. In two cases ([2633] and [3279]) the sixth vertebra was sacralised. Burial [3251] was associated with dysraphism of S1. Chapman (1998, 47) describes four cases of sixth lumbar vertebrae dating from the medieval period, all of which were sacralised. In burial [3501] the posterior arch of the atlas is congenitally missing. Unfortunately the skull is missing, so whether it was a separate bone or fused to the occipital must remain open to question. The embryological development of this area is complex and gives rise to a high incidence of congenital and acquired abnormalities (Black and Scheuer 1996, 189).

Five individuals had an absent third metacarpal styloid process. In two skeletons this was bilateral ([3197] and [3015]) but in the other three it was present in the right third metacarpal but the left was missing so it is impossible to tell if it was bilateral. In all five cases the styloid process was considerably reduced or absent and not present as a separate ossicle. In burial [3200] the hook of the right hamate is hypoplastic.

It can be seen that with many of the spinal congenital defects, one defect is found in association with another. Larger sample sizes will be needed to examine possible correlations in the prevalences of these defects.

**Neoplastic Disease**

Neoplastic disease is an abnormal mass of tissue, commonly known as a tumor. It represents one of the rarer forms of disease seen in the archaeological record. However there are some benign neoplasms that are seen more commonly. One example is dense outgrowths of bone from the outer table of the skull, often referred to as a “button” or “ivory” osteoma, they have no symptoms and are of little clinical significance. Two males ([2640] and [3541]) have solitary button osteomata on the right parietal bone, approximately 5mm in diameter. A third male (3220] had multiple osteomata, a total of nine were distributed all over the skull (four on the frontal, ranging from 4-10mm in diameter, two on each parietal (10-20mm), one on the occipital (10mm) plus one on the lateral surface of the mandible below the right first molar (7mm). All were shallow protrusions not more than 2mm in height. Osteomata are usually solitary lesions, so the presence of one skull with nine is a little unusual, however, Stroud (1993, 223) describes a skull with over twenty from a medieval cemetery in York !

In addition to, and possibly related to, the multiple osteomata seen in skeleton [3220], is a solitary exostosis of bone (figure xx) in the same individual. The exostosis extends from the head of the fibula onto the posterior surface of the shaft approximately 35mm in length, terminating in a small spike. This might represent an osteochondroma [please confirm this with x-ray]. The presence of both a benign osteogenic and chondrogenic neoplasm in the same individual might suggest that there is a relationship between the two, i.e that they share the same aetiological factor. Alternatively, as both neoplasms are commonly occuring, their occurrence in the same individual could be due to chance.

**Dental Disease**

Of the 193 individuals in this sample only 104 had the dentition present, either complete or incomplete. Of these 104 individuals, five could not be sexed and only three were female. As the number of females in this group is so low, this discussion relates to the presence of dental disease in the 94 males. Summaries of recorded dental pathology are given in Tables 7 and 8. A total of 94 dentitions were assessed by tooth position for ante-mortem loss, non-eruption and abcesses, and by individual tooth for caries. Recovery of dentitions was good, out of a total of 3008 teeth (94 x 32 adult teeth) 2566 (85.3%)

of the tooth positions were available for study. The amount of post-mortem tooth loss was low with only 8% lost altogether; single rooted teeth can drop out during the decay process and undoubtedly some will be lost during excavation.

Ante-Mortem Tooth Loss

Severely diseased teeth such as those that have been partially destroyed by caries, or inflammation of the gums, will result in the disruption of the tooth socket and the tooth will drop out. The tooth socket (alveolus) will then remodel over with new bone. In this group, the highest frequencies of ante-mortem tooth loss was seen in first and second molars. In the maxilla, the mean molar frequencies ranged from 15.3-19.6% compared to 2.6-3.7% in the anterior teeth. In the mandible, the mean frequency of ante-mortem molar loss ranged from 12.5-24.8% compared to 3-4% in the anterior teeth.

Abcesses

A dental abcess usually occurs when oral bacteria gain access to the tooth pulp cavity and the resulting infection then tracks down the root canal and causes a focal infection at the tip of the root in the surrounding bone. Accumulated quantities of pus with then extrude through the bone, leaving a hole in the alveolar bone. Abcesses in the maxilla can sometimes drain into the maxillary sinus creating an inflammation in the sinus (see section on sinusitis). Of a total of 1234 maxillary tooth positions, 41 (3.3%) showed an abcess. Similarly, in the mandible, of 1332 positions, 34 (2.6%) showed an abcess. This frequency is similar to that seen at St. Andrew, Fishergate, where 1.6-4.1%.

Caries

Oral bacteria ferment sugars found in the diet. A byproduct of this is the production of acid, which in turn demineralises the surface of the tooth. This causes a cavity to develop on the tooth enamel which progressively gets larger and penetrates through dentine into the pulp cavity of the tooth. The entire crown can be destroyed by such a process.

The caries frequency was calculated from the number of teeth rather than tooth positions. In the maxilla, 8.7% of teeth had at least one carious lesion (Table 3). Caries was more common in the molar teeth with frequencies between 10.0-20.3%. In the mndible there was a lower frequency of caries (4.7%). The overall caries frequency at Bermondsey is 6.5% (138 lesions seen in 2104 teeth). This is similar to other medieval frequencies, for example the frequency at St. Nicholas Shambles, London, was 5.5%.

**Paget's Disease**

Paget's disease is a chronic disorder resulting from defective bone remodelling. The exact cause is not known, but it has a possible viral aetiology. Paget's disease usually affects people over 40 years and is more common in males than in females. The defective bone turnover usually involves a single bone or small groups of bones, but it rarely affects all bones in the body. Bones become thicker and more dense, in the early stages the bone becomes porotic followed by areas of sclerosis. In later stages there is thickening of the outer table of the skull, with loss of distinction between the inner and outer tables.

An isolated cranium [1579] is noticeably heavier than is usual and the temporal bones are thickened. The frontal bone also has a thickened ridge in the sagittal plane. X-radiography shows enlarged cranial tables, up to 17mm thick, with obliteration of the diploic space. The grooves for the middle meningeal artery are also very clearly marked. These changes suggest that this individual suffered from Paget's disease.

Reported cases of Paget's disease in the palaeopathological record are rare (Roberts and Manchester 1996, 184, Stirland 1991). This might be due to the fact that it can only be recognised (macroscopically) in the later stages of the disease, Pagetic changes might be detected in earlier stages if bones are routinely x-rayed. For example, Waldron (1993a) found four medieval cases of Paget's disease at St. Mary Graces, London, based on morphological features and confirmed by radiography. A

further ten cases were found when radiography was carried out on bones x-rayed for other reasons. Waldron found that the crude prevalence was 3.0% for males and 4.1% for males and that this was consistent with the prevalence found in modern populations, although here the women were more affected than the men.

**Osteochondroses**

In skeleton [3220], there are defects in the thoracic vertebrae. These defects consist of a failure of ossification on the anterior parts of the apophyseal rings on the inferior aspects of T4-9. The T6-8 section also displays a kyphotic defect (anterior slant of the spine). These changes might represent a possible case of Scheuermann's disease. Scheuermann's disease can be recognised by anterior wedging of thoracic vertebrae associated with localised bone destruction of the anterior margins of the vertebral end plates. The effect in the living individual produces a smooth rounded kyphosis, i.e. a slight "hunch-back" appearance. Scheuermann's disease usually affects adolescent males. The aetiology is not known (Lowe 1990), although Ortner and Putschar (1985) suggest the underlying cause is extrusion of nucleus pulposus (Schmorl's nodes) followed by anterior narrowing of the disc space and subsequent growth disturbance. Familial patterns, suggestive of a genetic aetiology, have been described although mechanical factors are gradually gaining credibility (Lowe 1990, Aufderheide and Rodriguez-Martin 1998).

Anderson and Carter (1994) note that Scheuermann's disease is rarely reported in the palaeopathological literature. One reason for this might be its confusion with intervertebral disc disease. Plus, Scheuermann's defects might be masked by later age-related changes such as vertebral osteophytosis, although anterior wedging should indicate its presence. Clinical and radiological diagnostic criteria such as the presence of one or more vertebrae wedged for $5^{o}$ or more and an increase in thoracic kyphosis of more than $40^{o}$ have been suggested (Pecina and Bojanic 1993, 111-112) and this might be useful for archaeological material also.

## SUMMARY AND CONCLUSIONS

Bermondsey Abbey appeared typical of monastic sites in demonstrating a sex bias among the articulated burials. When the individuals of indeterminate sex were omitted there were 137 men but only eight female burials, giving a male: female ratio of 17.1 :1. This is of the same order of magnitude as at Guildford Friary (6.3:1), the Dominican Friary, Oxford (8.5:1), the Gilbertine Priory, York, eastern cemetery (15.7:1) and the Greyfriars Oxford (>16.0:1), even larger ratios being obtained for the Augustinian Merton Priory and the 1983 excavations at the Cistercian Stratford Langthorne Abbey (Stroud and Kemp 1993: 254).

The largest group of ageable men among the burials was that in the age-range 26 to 45, i.e. mature but not elderly, (54.0% of ageable adults). The next most populous category was those demonstrably over the age of 45 (27.4% of ageable adults). The occurrence of a skull[1579] showing Paget's disease, a disease of ageing, showed that the prolific disarticulated bone also included very old individuals. The high proportion of older men at Bermondsey Abbey probably accounts for the variety and richness of the pathology observed, whereas the larger number of individuals from Stratford Langthorne Abbey (1994), concurrently under analysis, appear to have died rather younger on average so possibly accounting for the lower disease prevalence evident so far at that site. Should this be borne out when the analysis is complete it will be necessary to account for the difference.

The low proportion of women buried in the abbey was as was to be expected and therefore not problematical but it is unfortunate that most of the female skeletons were too damaged for much else to be revealed about them. The single female skeleton that was sufficiently complete for stature estimation proved to be that of a very tall woman but this would be consistent for the class of person being buried under privileged circumstances.

The absence of children from the site has implications for palaeopathology in addition to demography. Thus, there were no indications of the common diseases of childhood or of developmental deficiency in

the skeleton (such as rickets or scurvy), with the sole exception of cribra orbitalia. This was present in 5.2% of possible cases, indicating that there were problems of metabolism, possibly iron-deficiency anaemia but almost certainly aggravated by internal parasites. On the other hand, the high proportion of DISH, (consistent with what has been shown for the higher clergy at other sites) suggested that certain of the monastic community or the nobility choosing burial in the Abbey were enjoying a diet far richer than was available to the lay poor.

Tuberculosis, present in [3231] and possibly two other men, now is considered to be a disease of poverty. Although the Cluniac monks on admission to the order swore a vow of poverty it is obvious that their standard of living (as measured by diet, hygiene, shelter, sanitation and medical care) was better than that of the majority of the population so the conditions for transmission instead probably depended on the close proximity in which the community lived, prayed and worked. Sinusitis, present in a minimum of four men, was neither a disease of rich or poor but of air pollution and obviously difficult to escape in a monastery.

It is known that Benedictine novices in the fifteenth century had to submit to a medical examination before admission to the order and to swear that they were free of infection (Hatcher 1986). Cluniac houses may have had a different procedure but the three potential TB sufferers presumably developed their symptoms only after their late teens, although there is always the possibility that the infection itself had been contracted earlier in life.

Monasteries are usually regarded as the repositories of medical knowledge and this was important at a time when there were few physicians and these tended to live and work in towns. The expertise accumulated in the Infirmary over the centuries would be invaluable in treating simple disorders and in dealing with trauma, notably the splinting, setting and reduction of limb and other fractures (Greene 1992). This appears to have been the case where Bermondsey Abbey was concerned, except for the extreme complications of the Pott's fracture described above and in contradistinction to the large number of badly-healed fractures observed in the 1994 sample of skeletons from Stratford Langthorne Abbey.

There were no injuries suggestive of inter-personal violence. This is in contrast to other monastic sites, where lesions on the skull, principally, but also elsewhere in the skeleton, were indicative of assault: St Andrews, Fishergate, Halton Abbey, Stratford Langthorne (Stroud and Kemp 1993: 232-9, 259-60) and St Mary Graces (Waldron 1993a). The absence of evidence for deliberately inflicted injury may be surprising in view of documented instances at Bermondsey Abbey, such as the various incidents involving Adam de Stratton or the monk Arnulf, during the thirteenth century.

An extremely interesting finding about the monastic population lay in biological distance. Several characteristics of the skeleton pointed to the population being congenitally distinctive. On the basis of craniometry, platymeria and handedness the population was different from that of St Nicholas Shambles, albeit of an earlier date. Craniometry apart, the population appeared different from all English medieval samples and when a suite of non-metric characters was considered the differences were more obvious still (in particular the frequencies of wormian bones and the tori, *vide supra).* Furthermore, the frequency of dental disease (in particular dental caries infection) was higher in the maxilla than in the mandible. This is a rare finding because the jaws are usually affected in equal measure, although there may be exceptions in different ethnic groups. Thus, in the Jews of York and Lincoln caries was more prevalent in the lower jaw than in the upper (Williamson 1994).

Bermondsey Abbey from its inception was an alien house, with its affairs directed from Lewes (the premier Cluniac Priory in England) or from La Charité. The first English Prior , Richard Dunton, was not appointed until nearly 300 years after the foundation. Was there likewise a turnover in monks of the lower orders migrating from France itself? French and indigenous monks mingled in the Cluniac Priory of Lewes (Kenward 1997: 156-7). Further research is required in order to confirm that the different skeletal characteristics of the Bermondsey Abbey monks have their origin in France.

The Bermondsey Abbey publication follows volumes in the MoLAS monastic series: St Mary Spital, St John Clerkenwell and St Mary Clerkenwell and will be succeeded by the definitive reports on Stratford Langthorne Abbey and Merton Priory. As recently as 1997 it was possible to bemoan the dearth of publications concerning large medieval cemeteries (Daniell 1997:143-4).

| MAXILLARY | RIGHT | | | | | | | | LEFT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DENTITION** | **M3** | **M2** | **M1** | **P4** | **P3** | **C** | **I2** | **I1** | **I1** | **I2** | **C** | **P3** | **P4** | **M1** | **M2** | **M3** | **total** |
| tooth positions available | 70 | 71 | 74 | 78 | 81 | 81 | 81 | 82 | 74 | 76 | 81 | 78 | 79 | 78 | 77 | 73 | 1234 |
| lost post-mortem | 3 | 2 | 1 | 1 | 3 | 5 | 18 | 22 | 28 | 20 | 7 | 4 | 2 | 0 | 2 | 2 | 120 |
| **% lost post-mortem** | **4.3** | **2.8** | **1.4** | **1.3** | **3.7** | **6.2** | **22.2** | **26.8** | **37.8** | **26.3** | **8.6** | **5.1** | **2.5** | | **2.6** | **2.7** | **9.7** |
| lost ante-mortem | 9 | 10 | 14 | 3 | 5 | 1 | 2 | 4 | 2 | 2 | 1 | 2 | 3 | 19 | 17 | 9 | 103 |
| **% lost ante-mortem** | **12.9** | **14.1** | **18.9** | **3.8** | **6.2** | **1.2** | **2.5** | **4.9** | **2.7** | **2.6** | **1.2** | **2.6** | **3.8** | **24.4** | **22.1** | **12.3** | **8.3** |
| tooth unerupted | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 10 | 19 |
| **% unerupted** | **11.4** | | | | | | | | | | | | **1.3** | | | **13.7** | **1.5** |
| positions with abcess cavity | 1 | 5 | 6 | 2 | 2 | 3 | 1 | 0 | 1 | 1 | 2 | 3 | 3 | 6 | 4 | 1 | 41 |
| **% abcess cavities** | **1.4** | **7.0** | **8.1** | **2.6** | **2.5** | **3.7** | **1.2** | | **1.4** | **1.3** | **2.5** | **3.8** | **3.8** | **7.7** | **5.2** | **1.4** | **3.3** |
| TEETH | 50 | 59 | 59 | 74 | 73 | 75 | 61 | 56 | 44 | 54 | 73 | 72 | 73 | 59 | 58 | 52 | 992 |
| caries cavity | 5 | 6 | 12 | 11 | 7 | 3 | 2 | 1 | 1 | 2 | 2 | 5 | 2 | 10 | 9 | 8 | 86 |
| **% caries** | **10.0** | **10.2** | **20.3** | **14.9** | **9.6** | **4.0** | **3.3** | **1.8** | **2.3** | **3.7** | **2.7** | **6.9** | **2.7** | **16.9** | **15.5** | **15.4** | **8.7** |

Table 7. Summary of Dental Pathology in maxilla (males only)

| MANDIBULAR | RIGHT | | | | | | | | LEFT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DENTITION** | **M3** | **M2** | **M1** | **P4** | **P3** | **C** | **I2** | **I1** | **I1** | **I2** | **C** | **P3** | **P4** | **M1** | **M2** | **M3** | **total** |
| tooth positions available | 83 | 83 | 81 | 81 | 82 | 84 | 84 | 84 | 83 | 83 | 83 | 84 | 82 | 85 | 85 | 85 | 1332 |
| lost post-mortem | 1 | 1 | 1 | 4 | 5 | 7 | 10 | 14 | 14 | 10 | 6 | 4 | 3 | 1 | 3 | 1 | 85 |
| **% lost post-mortem** | **1.2** | **1.2** | **1.2** | **4.9** | **6.1** | **8.3** | **11.9** | **16.7** | **16.9** | **12.0** | **7.2** | **4.8** | **3.7** | **1.2** | **3.5** | **1.2** | **6.4** |
| lost ante-mortem | 11 | 17 | 28 | 5 | 1 | 0 | 1 | 3 | 3 | 1 | 0 | 2 | 5 | 15 | 10 | 3 | 105 |
| **% lost ante-mortem** | **13.3** | **20.5** | **34.6** | **6.2** | **1.2** | | **1.2** | **3.6** | **3.6** | **1.2** | | **2.4** | **6.1** | **17.6** | **11.8** | **3.5** | **7.9** |
| unerupted | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 17 | 30 |
| **% unerupted** | **14.5** | | | | | | | | | | | | | | | **20.0** | **2.3** |
| positions with abcess cavity | 0 | 3 | 8 | 1 | 1 | 1 | 2 | 3 | 3 | 0 | 1 | 2 | 0 | 8 | 0 | 1 | 34 |
| **% abcess cavities** | | **3.6** | **9.9** | **1.2** | **1.2** | **1.2** | **2.4** | **3.6** | **3.6** | | **1.2** | **2.4** | | **9.4** | | **1.2** | **2.6** |
| TEETH | 59 | 65 | 52 | 72 | 76 | 77 | 73 | 67 | 66 | 72 | 77 | 78 | 73 | 69 | 72 | 64 | 1112 |
| caries (one or more) | 4 | 10 | 6 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | 4 | 6 | 5 | 8 | 52 |
| **% caries** | **6.8** | **15.4** | **11.5** | **5.6** | | | **1.4** | | | | | **5.1** | **5.5** | **8.7** | **6.9** | **12.5** | **4.7** |

Table 8. Summary of Dental Pathology in mandible (males only)

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