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A.D. 1070 - 1521

A paleopathological study

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# CANONS BURIED IN THE "STIFTSKAPEL" OF THE SAINT SERVAAS BASILICA AT MAASTRICHT, A.D. 1070 - 1521.

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### SUMMARY

To gain an insight into the life and health status of the Chapter Canons ("Stiftsheren") of the Saint Servaas Basilica at Maastricht a physical anthropological and paleopathological study was done of their skeletons. They had been interred in the Chapter Chapel ("Stiftskapel") of the same church from A.D. 1070 to 1521. All 27 skeletons were males. Their average age at death was 56 years.

All results confirmed the historical data that the Canons were socio-economically 'prosperous', even when compared to their already rather affluent civilian contemporaries in The Low Countries. Parameters used to reach this conclusion were age at death, stature and paleopathological changes. In every aspect the Canons did better. Of particular significance was the extremely high occurrence of DISH (100%), an affection already associated before with high social status and with an affluent (calorie-rich?, protein-rich?) diet, which corroborated our conclusion.

## 1. INTRODUCTION

### 1.1 GENERAL HISTORICAL INTRODUCTION

Around the turn of the 4th to the 5th century, Saint Servaas, the first bishop from within the present day Dutch borders, died at Maastricht. He was bishop in the territory inhabited by the tribe of the Tongres, the Roman government of which had moved to Maastricht for strategical reasons. In accordance with regulations, he was buried outside the Roman residential area, along the Roman road from Maastricht to Tongres (Thewissen, 1960). On this spot a simple wooden chapel was built which was replaced by a stone church during the second half of the 6th century. The remains of what was probably this building were discovered during excavations carried out from 1981 to 1989 (Panhuisen, 1981). Through the centuries the church had been radically rebuilt and enlarged several times and attained its approximate present day shape at the end of the 11th century (Dickhaut and Brouwers, 1991).

From the first years of its existence clergy were attached to Saint Servaas. They formed a monastery ('monasterium') under the direction of an Abbot. The earliest information about this community dates from the period A.D. 717 to 747. Historically it is not clear whether the members of the Saint Servaas community were ever monks. Yet it is a fact that they gave up

communal life around A.D. 1232 and took residence separately in private houses around the church. The name 'monasterium' went out of use and was replaced by 'Chapter' ("kapittel"), whilst the clergy called themselves 'Canons' ("kanunniken"). The name 'Abbot' changed to 'Provost' ("proost"). The spiritual head of the Chapter was the 'Dean' ("deken"; Dickhaut en Brouwers, 1991).

## STIFTSKAPEL

This former Double Chapel, situated at the east corridor of the cloister, was built during the second half of the 11th century (Dickhaut en Brouwers, 1991). At that time it already consisted of two storeys. On the ground floor, in the front part was the so-called 'Old Chapel' above the graves of deceased Canons; behind it was the 'lower treasure chamber', where the relics were kept. On the first floor was the 'Chapter Chapel', only for use by the Canons for prayer and meditation. In order to connect this old name with the former Chapter or "Stift", it was decided to refer to it as the "Stiftskapel" in the future. Therefore, since 1983 this name is in use for the Old Double Chapel as a whole, which at the moment is used as the 'Treasury of Saint Servaas' (Timmers, 1971).

## BURIALS IN THE STIFTSKAPEL (figs. 1, 2 and 3).

For a long time the soil under the Stiftskapel was intensively used for burials of Canons only. The hereafter examined graves/skeletons can be subdivided roughly into 3 (cultural) phases (Panhuysen, 1981):

- a) the youngest phase : covered by tombstones,
- b) the intermediate phase: marked by rectangular graves,
- c) the oldest phase : marked by trapezoid graves.

N.B.: In 1981 each grave/skeleton was assigned both a number (9 - 37) and a letter identifier (AA - Z), as well as a so-called findnumber. In order to prevent confusion this latter number will be used in the text. This findnumber actually consists of a so-called 'pitnumber' (1), an 'excavation-level-number' (1 - 3) and a 'findnumber s.s.' (0 - 106).

See catalogue (table 1).

ad a) The youngest phase was covered by tombstones dating from A.D. 1296 to 1521. From the inscriptions the name of the interred clerical dignitaries could be deduced (fig. 1) :

|                           |   |
|---------------------------|---|
| Tombstone III (A.D. 1521) | Gillis van Lymborgh, Canon of St. Servaas, died 14-3-1521. Findno. 1-1-7. |
|---------------------------|---|

|  |   |
|--|---|
| Tombstone IV (used twice, viz. A.D. 1296 and A.D. 1405): | Hendrik van Bijland, provost of St. Servaas, died 14-3-1405. Findno. 1-2-4. |
|--|---|

|                      |   |
|----------------------|---|
|                      | Reinoud van Oud Valkenburg, dean of St. Servaas, died 16-3-1296. Findno. 1-2-5. |
| Tombstone V (1329)   | Gerard van Schoonhoven, dean of St. Servaas, died 26-9-1329. Findno. 1-3-2.     |
| Tombstone VI (1313)  | NN. of St. Servaas, died 2-5-13. Findno. 1-3-12.                                |
| Tombstone VII (????) | (??) Findno. 1-1-56.  |

In addition to the above mentioned findnumbers, and with some reservation, also the Findnos. 1-1-48, 1-2-2 and 1-3-9 can be assigned to this youngest phase (Panhuysen, 1981).

Around A.D. 1850 two tombstones with inscriptions were moved to the northern corridor of the cloister. This concerned the tombstone of Robinus van Millen, dean of St. Servaas, who died 9-9-1315 and the twice used tombstone of Werner van Gressenich, cantor of St. Servaas, who died 16-7-1342 and Willem van St. Margraten, Canon and scholaster of St. Servaas, who died 25-11-1382 (van Nispen tot Sevenaer, 1936).

ad b) The intermediate phase was characterized by rectangular graves, to which Findnos. 1-1-50, 1-1-58, 1-1-102, 1-1-103 and 1-1-104 can be assigned. These skeletons were all found in situ.

ad c) The graves of the oldest phase had a characteristic trapezoid form (with tapering foot end) and were plastered. They were typical 'Frankish' sarcophagus, used into the 11th century. Originally they were covered by a bluestone slab and situated upto a depth of 120 cm. Altogether twelve of these graves were found, only four of which contained the original burial, viz.: Findnos. 1-1-9, 1-1-14, 1-1-56(?) and 1-1-101 (Panhuysen, 1981).

## 1.2 GENERAL PHYSICAL ANTHROPOLOGICAL INTRODUCTION

The Archaeological Department of the Municipality of Maastricht excavated 27 skeletons of Canons, under the direction of T. Panhuysen (1981). These so-called "Stiftsheren" were buried under the "Stiftskapel" of the Saint Servaas Basilica at Maastricht, between A.D. 1070 and 1521. Pending further investigation, the skeletons were reburied until 1992, when the following paleopathological study was started at the Barge's Anthropologica, Centre for Physical Anthropology, Medical Faculty, Leiden University.

After articulation and reconstruction of the bones of each skeleton, a standardized Physical Anthropological Report was completed (Maat, 1992). This included the:

1. inventarisation of the cranial- and postcranial status of each skeleton (forms 1, 2 and 3).
2. anthropometry of the skull (form 2).
3. description of the dental status (form 4).
4. morphological sex determination on pelvis and skull cranium, caput and mandibula (forms 5 and 6).
5. skeletal age determination (form 8).
6. anthropometry of the long bones and calculation of standing living height of adults (form 9).

## 2. MATERIAL and METHODS

### 2.1 MATERIAL

Twenty seven skeletons were examined. Figures 1, 2 and 3 give a general view of the position of the graves as they were found under the Stiftskapel.

The cranial and postcranial status showed that the skeletons were not complete. The conservation of the bones was generally good to moderately good. For a detailed description, see the Physical Anthropological Reports of each skeleton separately (Janssen, 1992).

### 2.2 METHODS

#### 2.2.1 MORPHOLOGICAL SEX- and AGE AT DEATH DETERMINATION

Sex and age at death were determined according to the directives of the 'Workshop of European Anthropologists' (WEA, 1980). The morphological sex determination of adults was expressed in the so-called 'degree of sexualization' of certain sexual characteristics (traits) on the pelvis and skull. The more of these can be determined, the more reliable the sex determination is. For the pelvis the maximum number of traits is 10, with a maximum weight of 19, whereas for the skull without mandibula the maximum number is 11, with a maximum weight of 24 (Maat, 1992).

For the skeletal age at death determination of adults, a procedure known as the 'Complex Method for Four or Less Age Indicators' was used (WEA, 1980). These anatomical indicators are subject to aging changes which are visible to the naked eye:

1. aspect of the facies symphysialis ossis pubis.
2. spongiosastructure of the proximal femur epiphysis.
3. spongiosastructure of the proximal humerus epiphysis.
4. endocranial suture obliteration.

The resulting ages at death based on three or four of the indicators were adequate to assign each individual to an age at death interval of 10 years. For example the skeletal age at death of 33 years corresponds with interval 3 (30-39 years). In cases where only one or two age indicators were available, the

age at death interval was settled by seriation according to molar attrition. By comparing molar attrition of skeletons with a too-wide age interval (e.g. 40-80 years) with so-called 'reference dentitions', this interval could be reduced to a 10-year-interval. 'Reference dentitions' are derived from skeletons with a more or less exact age at death determination in view of the presence of 3 or 4 age indicators (Maat and van der Velde, 1987).

#### 2.2.2 CRANIAL INDEX.

For a rough 'ethnic comparison' of the Canons with other population groups, a 'cranial index' was determined using the calculation-formula: maximum skull breadth x 100 : maximum skull length (Knussmann, 1988).

#### 2.2.3 DETERMINATION OF THE STANDING LIVING HEIGHT OF ADULTS.

The standing living height was calculated after Trotter and Gleser (1959) and after Breitingner (1937) from the length of the long bones. The physiological decrease of the living height with aging was calculated in case the formulas of Trotter and Gleser (1958) were used. According to the literature the actual living height of men during life, should be estimated by using the formula of Breitingner (1937) ('men born north of the Alps'; Wurm und Leimeister, 1986).

#### 2.2.4 DENTAL STATUS

Dental examination was possible on complete and incomplete jaws. The following features were noted:

1. Number of erupted teeth (N erupt.).
2. Number of not developed and not erupted teeth (N retar.).
3. Number of supernumerary teeth (N supern.).
4. Number of inspected teeth (N insp.): number of observed teeth.
5. Antemortem loss (N AM loss): number of resorbed- and resorbing teeth sockets.
6. Postmortem loss (N PM loss): number of inspected empty teeth sockets.
7. Postmortem alveolar loss (N PM alv.l.): number of lost sockets after death.
8. Number of carious teeth (N car.): number of inspected teeth with one or more carious lesions.
9. Number of teeth with abscess formation (N abscesses).
10. Number of fistulas.
11. Calculus formation.
12. Periodontitis.
13. Remarks.



### 2.2.5 PALAEOPATHOLOGY

Pathologic changes were macroscopically inspected, after which a (probability-)diagnosis was made. Where necessary, paleopathological textbooks- and journals were used (see References).

### 2.2.6 HARRIS' LINES

Harris' Lines are radiographically visible transverse lines in long bones as evidence of previous retardation of growth due to illness, from 2 months of age to completion of growth at 18 years in case of men. They are best seen on an X-ray of the distal part of the tibia and are subdivided into 3 types (Maat, 1984):

type I : lines only detectable by careful inspection,  
 type II : moderate lines located in the metaphyses,  
 type III : moderate lines located in the diaphyses plus well-marked (strong) lines in the metaphyses.

## 3. RESULTS

### 3.1 SEX DETERMINATION

Due to bad preservation, sex determination was not possible on five (19%) of the 27 skeletons. All of the remaining 22 (82%) showed a male development. On 12 (55%) of the skeletons, the degree of sexualization could be determined from pelvis, caput, cranium and mandibula. All degrees of sexualization were positive (table 2). For example, the degree of sexualization of the pelvis varied from +0.5 to +1.44. Only with Findno. 1-1-104 the degree of sexualization of the mandibula was negative (-0.25). But in this case the sexualization degree of the pelvis was +1.0, of the caput +0.27 and of the cranium +0.45.

### 3.2 SKELETAL AGE DETERMINATION

Skeletal age determination was possible on 24 (89%) of the 27 skeletons (table 3). The youngest was 43 and the oldest 75 years of age. The ages at death based on four or three age indicators were adequate to assign 22 (82%) of 24 skeletons to an age at death interval of 10 years (table 4). For five skeletons, where only one or two age indicators were available, it was necessary to settle the age at death interval by seriation according to molar attrition (Maat and van der Velde, 1987). The highest percentage of death was in the 5th interval (50-59 years; 59%), the lowest number in the 7th interval (oldest: 70-79 years; 9%). See figure 4. The average age at death of the 24 Canons was  $55.7 = 56$  years.

### 3.3 CRANIAL INDEX

The average cranial index of the 11 measurable skulls was 83 (S.D. 3), viz. brachycephalic. Thus the skulls were relatively broad with regard to the length. Of two skulls the cranial index was resp. 84.2 and 84.5, viz. 'nearly' hyperbrachycephalic (extremely broad). See table 5.

### 3.4 STANDING LIVING HEIGHT

The standing living height could be determined for 23 (85%) of the 27 skeletons. The mean length of these males, calculated after Breitingner (1937) was 174 cm (S.D. 4 cm.) and after Trotter and Gleser (1958), not corrected- and corrected for loss of stature by aging after 30 years of age ('shrinkage'), was resp. 179 cm (S.D. 5.2 cm) and 176 cm (S.D. 5.4 cm). The smallest- and tallest standing heights, after Breitingner (1937), were resp. 167 and 180 cm (table 6). The average maximum femur length was 48.7 cm (N=17).

### 3.5 DENTAL STATUS

Dental examination was possible on 7 complete or partly complete upper and lower jaws. For 12 skeletons either the upper or the lower jaw was present. A dental examination was therefore performed on 19 (70%) of 27 skeletons. A total account of the dental status is given in table 7.

Of a total of 593 erupted teeth, 38 were lost antemortem and 117 postmortem. Of the 194 inspected teeth 32 (17%) were carious ('caries overall'). For the caries distribution per tooth see table 8 :

|     |    |       |                        |
|-----|----|-------|------------------------|
| --- | 5  | (16%) | 'occlusal caries'      |
| --- | 2  | ( 6%) | 'decayed broken'       |
| --- | 2  | ( 6%) | 'buccal neck caries'   |
| --- | 1  | ( 3%) | 'lingual neck caries'  |
| --- | 22 | (69%) | 'interproximal caries' |

On the 19 dentitions and/or parts of dentition were 20 abscesses, 4 of which with a fistula. Calculus formation was moderate/considerable, alveolar atrophy was light/moderate and periodontitis was moderate/considerable. Three persons had agenesis of resp.:  $M^{3,L+R}$  and  $M_{3,L+R}$  (Findno.1-1-16);  $M^{3,L+R}$ ,  $M_{3,L+R}$ ,  $I^{2,R}$  (Findno.1-1-48);  $M^{3,L+R}$ ,  $M_{3,L+R}$  (Findno.1-1-50).

From the above-mentioned data the following 'Indices' could be calculated:

Antemortem loss (%): percentage of inspected alveolar places with AM loss:

$$\frac{\Sigma \text{AM loss} \times 100}{\Sigma \text{N erup} - \Sigma \text{PM alv.1.}} = \frac{38 \times 100}{593 - 249} = 11.05 = 11\%$$

Postmortem loss (%): percentage of inspected alveoli with PM loss:

$$\frac{\Sigma \text{PM loss} \times 100}{\Sigma \text{N erup} - \Sigma \text{PM alv.1.} - \Sigma \text{AM l.}} = \frac{117 \times 100}{593 - 249 - 38} = 38.23 = 38\%$$

Caries frequency (%): percentage of inspected teeth with carious lesions.

$$\frac{\Sigma \text{N car} \times 100}{\Sigma \text{N insp}} = \frac{32 \times 100}{194} = 16.49 = 17\%$$

Abscess frequency (%): percentage of inspected alveoli with an abscess.

$$\frac{\Sigma \text{N absc} \times 100}{\Sigma \text{N erup} - \Sigma \text{PM alv l} - \Sigma \text{AM loss}} = \frac{20 \times 100}{593 - 249 - 38} = 6.5 = 7\%$$

DM(F) Index (%) : Decayed-Missing (Filled) Index: percentage of alveolar places with inspected or antemortem lost teeth, which show carious teeth or antemortem loss.

N.B. The DM(F) Index indicates the total damage caused by caries, assuming that 'antemortem lost teeth' are missing as a result of caries and not by trauma.

$$\frac{(\Sigma \text{N car} + \Sigma \text{AM loss}) \times 100}{\Sigma \text{N erup} - \Sigma \text{PM alv l} - \Sigma \text{PM loss}} = \frac{(32 + 38) \times 100}{593 - 249 - 117} = 30.83 = 31\%$$

### 3.6 PALAEOPATHOLOGY

The frequencies of main (paleo)pathological bone changes are listed in table 9.

#### 3.6.1 Fractures and injuries

Four skeletons showed healed fractures, resp. on the shaft of the left radius (Findno. 1-1-25); on the distal part of the right radius and ulna with secondary ankylosis ('fusing') of the radio-ulnar joint (Findno. 1-1-50); on the distal part of the left fibula (Findno. 1-1-54) and on the shaft of the left

humerus (Findno. 1-1-105). In all these cases the bone surface was smooth and without traces of callus formation. The healed fractures only showed a slight angular deviation.

The anterior side of the left femur in Findno. 1-1-58 showed an oblique/longitudinally healed 'chop wound'.

### 3.6.2 Spondylolysis

One skeleton (Findno. 1-1-7) had spondylolysis (neural arch separation from a vertebral body) of the 4th and 5th lumbar vertebra.

### 3.6.3 Infectious diseases

Indications for the existence of bone infections were only periostitic changes on a left fibula and a right tibia. However these scattered bones came from older graves, which were disturbed by more recent, late mediaeval burials.

### 3.6.4 Osteomalacia / Rickets

One skeleton (Findno. 1-1-48) showed a strong bending and flattening, laterally and forward, of the shaft of the left and the right radius and ulna. Other 'rachitic' bone-changes, for example of the skull, vertebral column and long bones of the legs were absent. The ribs of this skeleton were missing.

### 3.6.5 Osteomas

Two skeletons (Findnos. 1-1-104 and 1-1-105) had an osteoma on their cranial vault (15%). These osteomas were small.

### 3.6.6 Diffuse Idiopathic Skeletal Hyperostosis ('DISH', Forestier's Disease)

This disease, which causes connective tissue and cartilaginous structures to ossify, was in varying degrees of seriousness diagnosed on all inspectable skeletons (100%). The structures mostly affected were (tables 10-13; figs. 5-10): the ligaments of the spine (50-80%), the patellar ligament (100%), the calcaneal ligament (83%), the origin of the extensor muscles of the forearm (75%), the insertion of the musculus biceps (62%), the insertion of the musculus iliopsoas (80%), the insertion of the musculus vastus medialis (70%), and the thyroid cartilage (100%).

### 3.6.7 Degenerative joint diseases ('arthrosis')

The degenerative joint diseases were subdivided, according to their nature into three types:

'Vertebral osteophytosis' of vertebral bodies (VO; degenerative disc disease): 77% of the skeletons.

'Vertebral osteoarthritis' of vertebral arch facet joints (VOA): 29% of the skeletons).

'Peripheral osteoarthritis' of peripheral non-vertebral joints (pOA). See table 14.

### 3.6.8 Varia

#### Osteochondritis dissecans

This injury was diagnosed on the patellar surface of the right femur of Findno. 1-1-0.

#### Congenital anomalies

These were: a sutura metopica on 3 of the 23 (13%) skulls (Findnos. 1-1-25, 1-1-101, 1-3-12); one torus palatinus (Findno. 1-1-105) on a maxilla (upper jaw); one spina bifida occulta (Findno. 1-1-0) and two cases of so-called sacralization (i.e., the lowermost lumbar vertebra was incorporated in the sacrum; Findnos. 1-1-0 and 1-1-104).

### 3.7 'Harris Lines'

Forty-six Harris lines were found on 22 tibiae, i.e. 2.1 per tibia, of which 29 type III ('strong lines'; average 1.3 per tibia), 9 type II ('moderate lines'; average 0.4 per tibia) and 8 type I ('lines only detectable by careful inspection'; average 0.4 per tibia). Notable were Findnos. 1-1-9, 1-2-5 and 1-3-12 in which per tibia 3 type III Harris lines were found, while Findno. 1-1-16 even had 4 type III lines!! No Harris lines were found in 4 tibiae (Findnos. 1-1-27, 1-1-102, 1-1-104 and 1-1-105). Of the 29 type III lines, 16 (55%) were formed during the interval 0-6 years, 7 (24%) during the interval 6-12 years and 6 (20%) during the interval 12-18 years of age. See figure 11.

## 4 DISCUSSION

### 4.1 SEX

As was to be expected, all skeletons were male. After all, during the Middle Ages only Canons were interred under the Stiftskapel.

### 4.2 AGE

The overall mean age at death of the men was c. 56 years (55.7 years, N=24). This number corresponds with the finding that the highest death percentage (59%) was in the 5th interval (50-

59 years; table 4). This average age at death of 56 years is high for the time when the Canons lived (A.D. 1070-1521). Comparison with research into the age at death of citizens of Dordrecht (A.D. 1275-1572; Maat et al., 1998) and of Delft (A.D. 1265-1652; Onisto et al., 1998), i.e. from approximately the same time period, showed that these were ca. 44 and 45-46 years of age respectively.

It was not possible to verify to what extent the determined ages at death match the dates on the tombstones as these mention only the dates of death and not the dates of birth.

#### 4.3 CEPHALIC INDEX

No conclusions can be drawn from the calculated brachycephaly of the Canons with regard to their origin, as they did not belong to a particular genetic/homogeneous population group. Death records show that they came from different parts of Western Europe (Doppler, 1936, 1937, 1938, 1939).

In general however, this brachycephaly confirms the conclusions of Cross and Bruce (1983) and Stroud and Kemp (1993), that in mediaeval Western Europe a general but not understood tendency to brachycephaly existed.

#### 4.4 STANDING LIVING HEIGHT

The calculated mean length after Breitingner (1937) of 174 cm (maximum femur length 48,6 cm) is rather tall in comparison with the mean length of the male population of Dordrecht and Delft from the same period, viz. 168.9-170.6 cm (maximum femur length 45.5-46,2 cm, Maat et al., 1998; Onisto et al., 1998). According to Roede (1985), the standing living height would be a good parameter for socio-economic growth conditions. This would mean that these conditions were far better for the Canons than for the average citizens of Dordrecht and Delft. Indeed, the historical literature suggests that the Canons were of 'prosperous descent' (van Rensch, 1986; Doppler, 1936; 1937, 1938 and 1939).

#### 4.5 DENTAL STATUS

Table 7 shows that of the 593 erupted teeth 117 (38%) were postmortally lost, that is to say that the loss of elements, which at the original burial were still present, was very high.

Of the 194 inspected teeth 32 (17%) were carious ('caries overall'), 22 (69%) of which were 'interproximal', meaning that the caries was localized between the teeth (see table 8).

The general caries percentage, 'caries overall' (17%), was very high compared to that of Dutch citizens at that time (12% Dordrecht, Maat et al., 1998; 8-13% Delft, Onisto et al., 1998). This is possibly the result of a diet with a relatively

high starch content, as starch is converted into sugars which are responsible for the development of caries. The same phenomenon is reflected in the high DMF-index of 31% (26% Dordrecht, 23-30% Delft), as this index incorporates the 'antemortem loss' that likewise mostly is caused by carious destruction.

The location of the lesions corresponds with the finding of Moore and Corbett (1973) that caries, until the end of the Middle Ages, was usually interproximal neck caries. For 2000 years, from the beginning of the Iron Age (c. 550 B.C.) until the end of the Middle Ages (c. A.D. 1500) there would have been no marked change in the location pattern of caries. In these population groups caries would be associated with the occurrence of alveolar atrophy which in itself would be a result of serious attrition due to eating coarse food (Moore and Corbett, 1971). Moreover, it is known that high attrition prevents the appearance of occlusal caries (Maat and van der Velde, 1987).

#### 4.6 PALAEOPATHOLOGY

##### 4.6.1 Traumata / Fractures

The described fractures of humerus, radii and fibula were all well-healed, old fractures, thus caused years before death.

The ankylosis ('stiffening' of a joint) on skeleton 1-1-50 is probably the result of callous formation after a simultaneous fracture of the distal part of the right radius and ulna. A possible complication with these 'wrist fractures' is a lesion of the nervus ulnaris, radialis and/or medianus with its attendant neurological manifest deviation of the position of the hand.

With a fracture of the distal part of the fibula (a so-called Pott's fracture of the ankle) in Findno. 1-1-105, the ankle gets unstable.

The healed wound on the anterior side of the left femur of Findno. 1-1-58 was possibly caused by a cut or blow from a sharp weapon (for example a sword, sabre or axe).

##### 4.6.2 Spondylolysis / Spondylolisthesis

Spondylolysis refers to a separation in a vertebral arch between the body and the spinous process of one or more vertebrae. At first, a congenital anomaly, possibly on a genetic basis, was thought to be the cause. Recently it has been proved that spondylolysis is due to stress (fatigue) fracturing as a result of chronic mechanical stress (Merbs, 1983, 1996). According to Roberts and Manchester (1995) a congenital 'weak spot' in a vertebral arch would be a predisposing factor. Examples of ways of life with a high risk of chronic stress are: Eskimos (Merbs, 1983; 50%) and prehistoric South American fishermen (Arriaza, 1995; 18% of the male population). The

single case of the Canons does not exactly point to heavy physical work! In general the lesion gives no or few complaints. Pain appears when there is a slow forward migration of one vertebra over another (spondylolisthesis) as a result of which nerves get trapped.

#### 4.6.3 Infectious diseases

Periostitis is an infection of the fibrous covering of a bone, the periosteum. In serious cases the compact bone and the bone marrow become also affected (osteomyelitis). From the two scattered bones found we can conclude that, in general, the chance of contracting an infection was low for the Canons. The periostitis in case of the one tibia can just as well be the result of a perforating skinwound, instead of a general, bloodborn (hematogenous) infection.

#### 4.6.4 Osteomalacia / Rickets

Osteomalacia and rickets are caused by a deficiency of vitamin D in food. Vitamin D occurs naturally in animal fat of certain food products and is also synthesized in the skin by sunlight (ultraviolet rays). A lack of this vitamin results in a deficient bone mineralization which manifests itself in a bending of the long bones of the legs under pressure of the bodyweight. Osteomalacia is the adult counterpart of childhood rickets. In case of osteomalacia especially the muscle tension causes the thin long bones, such as for instance the bones of the forearm to bend. Findno. 1-1-48 was evidently one such rare case. As a whole however, there was no question of a general vitamin D deficiency with the Canons.

#### 4.6.5 Osteomas

Osteomas are not uncommon benign bone tumors. They are usually found solitary or multiple on the bones of the cranium as so-called 'button osteomas' (Steinbock, 1976). In view of the small sample size (N=13), the two osteomas found on the cranial vault are not remarkable (3% Onisto et al. 1998; 8% Maat et al., 1998).

#### 4.6.6 Diffuse Idiopathic Skeletal Hyperostosis ('DISH')

In this skeletal affection, there is a strong tendency to develop enthesopathies with increasing age, i.e., ossified entheses (ligaments, membranes, muscle insertions, joint capsules) and ossified cartilaginous structures. According to Forestier and Rotès-Querol (1950), who described this disease for the first time, the ossification of the anterior longitudinal ligament of the spine would be pathognomonic. Resnick et al. (1995) stated that, apart from this enthesial ossification of the spine, there also occur ossifications on extraspinal sites. Examples of this are: ligament- and muscle insertions, joint capsules



and rib cartilages.

DISH was already found in Neanderthal men and is also at the present time a rather widespread disease. It is twice as common in males as in females and its prevalence increases with age (Crubézy, 1989). Maat et al. (1995) showed that it can start at an early age (20-30 years). Waldron (1985) and Rogers and Waldron (1995) found a high incidence of DISH (20-30%) at Wells Cathedral and at Merton Priory, in other words, a notably high prevalence of DISH in monastic and high status burial grounds of people who had enjoyed a plentiful diet. The results of our study (100% DISH) also point in this direction, since the Canons were socially of high status and were known for their abundant diet (Dickhaut and Brouwers, 1991). Tables 10-13 give a good insight in the places of predilection. It is very important to know these places for making a diagnosis, especially when samples are incomplete.

#### 4.6.7 Degenerative joint diseases ('arthrosis')

These are the most frequently occurring joint diseases with elderly people. The most important causes are repeated minor trauma ('wear and tear') and constitution. Especially the latter seems to be the decisive factor (Maat et al., 1995).

As with the citizens of late mediaeval Delft (Onisto et al., 1998) and Dordrecht (Maat et al., 1995), 'Vertebral Osteophytosis' (77%; degeneration of the fibro-cartilaginous intervertebral discs) was found twice as often as 'Vertebral Osteoarthritis' (29%; degeneration of the cartilage of the synovial joints between vertebral arches, the so called 'facet joints. Also in absolute sense our percentages are comparable with those of Dordrecht (resp. 71% and 37%). Why the frequencies of Delft are about one half is not clear however (resp. 44% and 15%). Also with respect to the distribution of 'Peripheral Osteoarthritis', such as the higher frequency of arthrosis of the hip than arthrosis of the knee, the percentages of Maastricht agree with those of Dordrecht. This is remarkable, especially in the light of a reversal of the ratio in the 20th century (Baetsen et al., 1997; 18th-19th century Alkmaar). See table 14.

#### 4.6.8 Varia

##### Osteochondritis dissecans

This disease (avascular necrosis) is probably the result of a (genetic) disturbance in the blood supply of a joint, in combination with a trauma. As a result, a small piece of joint cartilage and its underlying bone becomes necrotic. As in our case (1-1-0), this defect is usually located in the large joints. Males between the ages of 15 and 25 years are most affected (Aegerter and Kirkpatrick, 1968).

## Congenital anomalies:

### Sutura metopica (sutura frontalis)

At birth the frontal bone consists of two halves which may remain separate during life. Normally this sutura metopica closes (ossifies) before the end of the 2nd year. The frequency of appearance of this suture (13%) is not extremely high for the mediaeval Low Countries (12%, Dordrecht; 6%, Delft).

### Torus palatinus

This is a bony protrusion along the median line of the hard palate. Formerly it was thought that a 'post-natal hyperostosis', as a result of 'mechanical stress' through a certain diet or disease, would be the cause. Nowadays the opinion is that the torus palatinus is an epigenetic variant (Brothwell, 1981).

### Spina bifida occulta

Spina bifida occulta is a congenital defect of the spine, by which the arches of one or more vertebrae are absent. Most cases of spina bifida occulta occur in the lumbosacral region, are covered by skin and therefore invisible from the outside, hence its name. The frequency of this disorder in the Canons (13%) does not differ remarkably from their contemporaries (13% Dordrecht, Maat et al., 1998; 5-9% Delft, Onisto et al., 1998).

### Sacralization

The conclusion of no remarkable difference from contemporaries, in particular given the small sample, also holds for the sacralizations found: 15% of the 5th lumbar vertebrae (Dordrecht 10%, Maat et al., 1998; Delft 2-8%, Onisto et al., 1998).

## 4.7 Harris' Lines

The number of Harris lines per tibia, corresponds in individuals to the number of growth delays per individual up to the age of 18, by illnesses and/or alimentary disorders. For comparison: in the Canons an average of 1.3 type III ('serious') growth arrest lines was found. In their English civilian contemporaries from St. Helen-on the Walls, Altwark (A.D. 900-1500), there was also an average of 1.3 (1.25; Dawes and Magilton, 1980). Their state of health was characterized as 'moderate' and with a reasonable life expectancy. It is notable that more than half of the 'serious' growth arrests' (type III) were sustained by the Canons in their early youth (0-6 years), thus well before they entered the Church.

## TABLES

TABLE 1 CATALOGUE

| Findno. | Grave/Nr. |                 |              |
|---------|-----------|-----------------|--------------|
| 1-1- ?  | P1        |                 |              |
| 1-1- 0  | P2        |                 |              |
| 1-1- 7  | C         | 34              |              |
| 1-1- 9  | E         | 11              |              |
| 1-1- 14 | H         | 9               |              |
| 1-1- 16 | G         | 10              |              |
| 1-1- 18 | F         | 12              | no skeleton  |
| 1-1- 20 | I         | 13b             |              |
| 1-1- 22 | J         | 14              | no skeleton  |
| 1-1- 25 | M         | 17 <sup>1</sup> |              |
| 1-1- 27 | N         | 23              |              |
| 1-1- 30 |           |                 | no skeleton  |
| 1-1- 33 | K         | 37              | no skeleton  |
| 1-1- 35 |           |                 | no skeleton  |
| 1-1- 47 |           |                 | no skeleton  |
| 1-1- 48 | T         | 24              |              |
| 1-1- 50 | P         | 29              | no skeleton  |
| 1-1- 50 | AG        | 36 <sup>4</sup> |              |
| 1-1- 51 | D         | 21              |              |
| 1-1- 54 | W         | 30              |              |
| 1-1- 56 | Q         | 27              |              |
| 1-1- 58 | L         | 20              |              |
| 1-1-101 | R         | 26              |              |
| 1-1-102 | S         | 25              |              |
| 1-1-103 | U         | 32              |              |
| 1-1-104 | V         | 33              |              |
| 1-1-105 | X         | 31              |              |
| 1-1-106 |           |                 | no skeleton  |
| 1-2- 1  | Y         | 17 <sup>2</sup> |              |
| 1-2- 2  | Z         | 19              |              |
| 1-2- 3  | AA        | .. <sup>3</sup> |              |
| 1-2- 4  | AB        | 35              |              |
| 1-2- 5  | AC        | 13a             |              |
| 1-2- 7  |           | .. <sup>3</sup> | three skulls |
| 1-3- 2  | AD        | 15              |              |
| 1-3- 9  | AF        | 16              |              |
| 1-3- 12 | AE        | 18              |              |

<sup>1</sup> same as 1-2-1<sup>2</sup> same as 1-1-25<sup>3</sup> west of 1-3-12<sup>4</sup> under 1-1-48

TABLE 2

## SEX DETERMINATION

| Findno. | Grave/Nr. | Sex.dgr.<br>pelvis | W  | Sex.dgr.<br>caput | W  | Sex.dgr.<br>cranium | W  | Sex.dgr.<br>mandib. | W | Sex<br>M / F |
|---------|-----------|--------------------|----|-------------------|----|---------------------|----|---------------------|---|--------------|
| 1-1- ?  | P1        |                    |    |                   |    | +0.6                | 10 |                     |   | M            |
| 1-1- 0  | P2        | +0.95              | 19 |                   |    |                     |    | +1.17               | 6 | M            |
| 1-1- 7  | C         | 34                 | 19 | +0.56             | 27 | +0.37               | 19 | +1.0                | 8 | M            |
| 1-1- 9  | E         | 11                 | 19 | +0.95             |    |                     |    |                     |   | M            |
| 1-1- 14 | H         | 9                  | 7  | +0.57             | 32 | +1.63               | 24 | +2.0                | 8 | M            |
| 1-1- 16 | G         | 10                 | 19 | +1.21             | 32 | +1.17               | 24 | +1.75               | 8 | M            |
| 1-1- 18 | F         | 12                 |    | no skeleton       |    |                     |    |                     |   |              |
| 1-1- 20 | I         | 13b                |    |                   |    |                     |    |                     |   |              |
| 1-1- 22 | J         | 14                 |    | no skeleton       |    |                     |    |                     |   |              |
| 1-1- 25 | M         | 17 <sup>1</sup>    | 9  | +0.78             |    | +0.24               | 21 |                     |   | M            |
| 1-1- 27 | N         | 23                 | 19 | +0.68             | 24 | +1.63               | 16 | +1.25               | 8 | M            |
| 1-1- 30 |           |                    |    | no skeleton       |    |                     |    |                     |   |              |
| 1-1- 33 | K         | 37                 |    | no skeleton       |    |                     |    |                     |   |              |
| 1-1- 35 |           |                    |    | no skeleton       |    |                     |    |                     |   |              |
| 1-1- 47 |           |                    |    | no skeleton       |    |                     |    |                     |   |              |
| 1-1- 48 | T         | 24                 | 19 | +1.0              | 29 | +1.76               | 21 | +2.0                | 8 | M            |
| 1-1- 50 | P         | 29                 |    | no skeleton       |    |                     |    |                     |   |              |
| 1-1- 50 | AG        | 36 <sup>4</sup>    | 19 | +0.78             | 29 | +0.75               | 24 | +1.0                | 5 | M            |
| 1-1- 51 | D         | 21                 |    | +0.6              | 10 | +0.0                | 2  | +0.75               | 8 | M            |
| 1-1- 54 | W         | 30                 | 16 | +1.44             |    |                     |    |                     |   | M            |
| 1-1- 56 | Q         | 27                 | 2  | +0.50             | 28 | +1.0                | 22 | +0.83               | 6 | M            |
| 1-1- 58 | L         | 20                 |    |                   |    |                     |    |                     |   |              |
| 1-1-101 | R         | 26                 | 2  | +1.0              | 30 | +1.19               | 21 | +1.5                | 6 | M            |
| 1-1-102 | S         | 25                 | 19 | +1.16             |    |                     |    |                     |   |              |
| 1-1-103 | U         | 32                 | 7  | +1.29             | 27 | +1.10               | 21 | +1.17               | 6 | M            |
| 1-1-104 | V         | 33                 | 19 | +1.0              | 30 | +0.45               | 22 | -0.25               | 8 | M            |
| 1-1-105 | X         | 31                 |    |                   |    | +1.14               | 21 |                     |   | M            |
| 1-1-106 |           |                    |    | no skeleton       |    |                     |    |                     |   |              |

TABLE 2, continued

## SEX DETERMINATION

| Findno. | Grave/Nr. | Sex.dgr.<br>pelvis | W            | Sex.dgr.<br>caput | W     | Sex.dgr.<br>cranium | W    | Sex.dgr.<br>mandib. | W     | Sex<br>M / F |   |
|---------|-----------|--------------------|--------------|-------------------|-------|---------------------|------|---------------------|-------|--------------|---|
| 1-2- 1  | Y         | 17 <sup>2</sup>    | +1.38        | 8                 | +0.92 | 25                  | +1.0 | 19                  | +0.5  | 6            | M |
| 1-2- 2  | Z         | 19                 | +1.2         | 5                 |       |                     |      |                     | +0.33 | 6            | M |
| 1-2- 3  | AA        | .. <sup>3</sup>    |              |                   |       |                     |      |                     |       |              |   |
| 1-2- 4  | AB        | 35                 | +0.63        | 19                |       |                     |      |                     |       |              |   |
| 1-2- 5  | AC        | 13a                |              |                   |       |                     |      |                     | +2.0  | 8            | M |
| 1-2- 7  |           | .. <sup>3</sup>    | three skulls |                   |       |                     |      |                     |       |              |   |
| 1-3- 2  | AD        | 15                 |              |                   |       |                     |      |                     |       |              |   |
| 1-3- 9  | AF        | 16                 | +0.63        | 19                |       |                     |      |                     |       |              | M |
| 1-3- 12 | AE        | 18                 | +0.95        | 19                | +0.3  | 30                  | +2.0 | 4                   | +1.0  | 1            | M |

Sex.dgr.= degree of sexualization (+/-= masculine/feminine development); W= weight; mand.= mandibular; M= male; F= female.

<sup>1</sup> same as 1-2-1

<sup>2</sup> same as 1-1-25

<sup>3</sup> west of 1-3-12

<sup>4</sup> under 1-1-48

TABLE 3

AGE AT DEATH (years)

| Findno. | Grave/Nr.          | Sym.        | Fem. | Hum. | Sut. | Skel.age | Attr.M1 | Attr.M2 | Attr.M3 | Interv.* |
|---------|--------------------|-------------|------|------|------|----------|---------|---------|---------|----------|
| 1-1- ?  | P1                 |             | 3    | 2    | 4    | 51-57    |         |         |         | 5        |
| 1-1- 0  | P2                 | 4           | 3    | 2    |      | 60-66    |         |         |         | 6        |
| 1-1- 7  | C 34               | 3           | 2    | 2    | 4    | 49-54    | 4.00    |         |         | 5        |
| 1-1- 9  | E 11               |             | 4    | 4    |      | 62-71    |         |         |         |          |
| 1-1- 14 | H 9                |             | 2    | 2    | 4    | 40-46    | 4.33    |         |         | 4        |
| 1-1- 16 | G 10               | 4           | 6    | 6    | 4    | 68-73    | 4.00    | 2.66    |         | 7        |
| 1-1- 18 | F 12               | no skeleton |      |      |      |          |         |         |         |          |
| 1-1- 20 | I 13b              |             |      |      |      |          |         |         |         |          |
| 1-1- 22 | J 14               | no skeleton |      |      |      |          |         |         |         |          |
| 1-1- 25 | M 17 <sup>1</sup>  |             | 3    | 3    | 4    | 53-59    |         |         |         | 5        |
| 1-1- 27 | N 23               |             |      |      | 2    | 30-60    | 3.00    | 2.33    | 2.00    | 4        |
| 1-1- 30 |                    | no skeleton |      |      |      |          |         |         |         |          |
| 1-1- 33 | K 37               | no skeleton |      |      |      |          |         |         |         |          |
| 1-1- 35 |                    | no skeleton |      |      |      |          |         |         |         |          |
| 1-1- 47 |                    | no skeleton |      |      |      |          |         |         |         |          |
| 1-1- 48 | T 24               | 4           | 2    | 2    | 4    | 60-66    | 4.00    | 3.00    |         | 6        |
| 1-1- 50 | P 29               | no skeleton |      |      |      |          |         |         |         |          |
| 1-1- 50 | AG 36 <sup>4</sup> | 4           | 2    | 2    | 5    | 61-66    | 4.33    | 2.66    |         | 6        |
| 1-1- 51 | D 21               |             |      |      | 4    | 40-80    | 4.00    | 2.66    |         | 5        |
| 1-1- 54 | W 30               | 2           | 2    |      |      | 40-48    |         |         |         | 4        |
| 1-1- 56 | Q 27               |             |      | 4    | 4    | 52-66    | 3.33    | 3.00    | 2.66    | 5        |
| 1-1- 58 | L 20               |             |      |      |      |          | 4.00    |         |         |          |
| 1-1-101 | R 26               |             |      |      | 4    | 40-80    | 5.66    | 5.33    | 5.33    | 7        |
| 1-1-102 | S 25               | 3           | 3    | 4    |      | 51-57    |         |         |         | 5        |
| 1-1-103 | U 32               |             |      | 3    | 4    | 50-65    |         |         |         |          |
| 1-1-104 | V 33               | 3           | 2    | 3    | 5    | 52-57    |         |         |         | 5        |
| 1-1-105 | X 31               | 3           | 2    | 2    | 4    | 49-54    | 3.00    | 3.00    |         | 5        |
| 1-1-106 |                    | no skeleton |      |      |      |          |         |         |         |          |

TABLE 3, continued

AGE AT DEATH (years)

| Findno. | Grave/Nr. | Sym.            | Fem.         | Hum. | Sut. | Skel.age | Attr.M1 | Attr.M2 | Attr.M3 | Interv.* |
|---------|-----------|-----------------|--------------|------|------|----------|---------|---------|---------|----------|
| 1-2- 1  | Y         | 17 <sup>2</sup> |              |      | 4    | 40-80    |         | 2.66    | 2.00    | 4        |
| 1-2- 2  | Z         | 19              | 3            | 4    |      | 51-60    |         |         |         | 5        |
| 1-2- 3  | AA        | .. <sup>3</sup> |              |      |      |          |         |         |         |          |
| 1-2- 4  | AB        | 35              | 3            | 3    |      | 50-59    |         |         |         | 5        |
| 1-2- 5  | AC        | 13a             | 3            |      |      | 40-60    | 4.00    | 2.66    | 2.33    | 5        |
| 1-2- 7  |           | .. <sup>3</sup> | three skulls |      |      |          |         |         |         |          |
| 1-3- 2  | AD        | 15              |              |      |      |          |         | 5.33    |         |          |
| 1-3- 9  | AF        | 16              | 3            | 2    | 3    | 48-54    |         |         |         | 5        |
| 1-3- 12 | AE        | 18              | 3            | 3    | 2    | 48-54    |         | 2.33    |         | 5        |

Sym.= pubic symphysis; Fem./Hum.= spongiosa in proximal femoral/humeral epiphysis; Sut.= suture obliteration; Skel.= skeletal; Attr.= attrition; M= molar.

<sup>1</sup> same as 1-2-1

<sup>2</sup> same as 1-1-25

<sup>3</sup> west of 1-3-12

<sup>4</sup> under 1-1-48

\* after seriation with respect to molar attrition.

TABLE 4 AGE AT DEATH DISTRIBUTION

| Age interval (years) | Number | %   |
|----------------------|--------|-----|
| 0 - 9                | 0      | 0   |
| 10 - 19              | 0      | 0   |
| 20 - 29              | 0      | 0   |
| 30 - 39              | 0      | 0   |
| 40 - 49              | 4      | 18  |
| 50 - 59              | 13     | 59  |
| 60 - 69              | 3      | 14  |
| 70 - 79              | 2      | 9   |
|                      | 22     | 100 |

TABLE 5 CRANIAL INDEX (breadth / length x 100)

| Findno. | Grave/Nr.          | Index        |
|---------|--------------------|--------------|
| 1-1- ?  | P1                 | NA           |
| 1-1- 0  | P2                 | NA           |
| 1-1- 7  | C 34               | 80.2         |
| 1-1- 9  | E 11               | NA           |
| 1-1- 14 | H 9                | 79.6         |
| 1-1- 16 | G 10               | 82.3         |
| 1-1- 18 | F 12               | no skeleton  |
| 1-1- 20 | I 13b              | NA           |
| 1-1- 22 | J 14               | no skeleton  |
| 1-1- 25 | M 17 <sup>1</sup>  | 86.3         |
| 1-1- 27 | N 23               | NA           |
| 1-1- 30 |                    | no skeleton  |
| 1-1- 33 | K 37               | no skeleton  |
| 1-1- 35 |                    | no skeleton  |
| 1-1- 47 |                    | no skeleton  |
| 1-1- 48 | T 24               | 83.1         |
| 1-1- 50 | P 29               | no skeleton  |
| 1-1- 50 | AG 36 <sup>4</sup> | 83.1         |
| 1-1- 51 | D 21               | NA           |
| 1-1- 54 | W 30               | NA           |
| 1-1- 56 | Q 27               | 86.9         |
| 1-1- 58 | L 20               | NA           |
| 1-1-101 | R 26               | 84.2         |
| 1-1-102 | S 25               | NA           |
| 1-1-103 | U 32               | 74.9         |
| 1-1-104 | V 33               | 82.6         |
| 1-1-105 | X 31               | NA           |
| 1-1-106 |                    | no skeleton  |
| 1-2- 1  | Y 17 <sup>2</sup>  | 84.5         |
| 1-2- 2  | Z 19               | NA           |
| 1-2- 3  | AA .. <sup>3</sup> | NA           |
| 1-2- 4  | AB 35              | NA           |
| 1-2- 5  | AC 13a             | NA           |
| 1-2- 7  | .. <sup>3</sup>    | three skulls |
| 1-3- 2  | AD 15              | NA           |
| 1-3- 9  | AF 16              | NA           |
| 1-3- 12 | AE 18              | NA           |

<sup>1</sup> same as 1-2-1<sup>2</sup> same as 1-1-25<sup>3</sup> west of 1-3-12<sup>4</sup> under 1-1-48



TABLE 6  
CALCULATED STATURE

| Findno.            | Grave/Nr. |                 | Trotter<br>& Gleser<br>'52 (cm) | Trotter<br>& Gleser<br>corr. (cm) | Brei-<br>tinger<br>'37 (cm) |
|--------------------|-----------|-----------------|---------------------------------|-----------------------------------|-----------------------------|
| 1-1- ?             | P1        |                 | 176.2                           | 174.8                             | 172.6                       |
| 1-1- 0             | P2        |                 | 171.4                           | 169.5                             | 169.8                       |
| 1-1- 7             | C         | 34              | 174.6                           | 173.3                             | 172.6                       |
| 1-1- 9             | E         | 11              | 176.3                           | 174.1                             | 172.7                       |
| 1-1- 14            | H         | 9               | 181.4                           | 180.9                             | 176.6                       |
| 1-1- 16            | G         | 10              | 179.2                           | 176.8                             | 173.9                       |
| 1-1- 18            | F         | 12              | no skeleton                     |                                   |                             |
| 1-1- 20            | I         | 13b             | 172.7                           | 173.9                             | 169.5                       |
| 1-1- 22            | J         | 14              | no skeleton                     |                                   |                             |
| 1-1- 25            | M         | 17 <sup>1</sup> | 177.0                           | 175.4                             | 172.5                       |
| 1-1- 27            | N         | 23              | 179.7                           | 178.8                             | 174.4                       |
| 1-1- 30            |           |                 | no skeleton                     |                                   |                             |
| 1-1- 33            | K         | 37              | no skeleton                     |                                   |                             |
| 1-1- 35            |           |                 | no skeleton                     |                                   |                             |
| 1-1- 47            |           |                 | no skeleton                     |                                   |                             |
| 1-1- 48            | T         | 24              | 172.6                           | 170.6                             | 170.2                       |
| 1-1- 50            | P         | 29              | no skeleton                     |                                   |                             |
| 1-1- 50            | AG        | 36 <sup>4</sup> | 168.3                           | 166.4                             | 168.2                       |
| 1-1- 51            | D         | 21              |                                 |                                   |                             |
| 1-1- 54            | W         | 30              | 179.9                           | 179.1                             | 176.6                       |
| 1-1- 56            | Q         | 27              | 167.8                           | 166.1                             | 167.4                       |
| 1-1- 58            | L         | 20              |                                 |                                   |                             |
| 1-1-101            | R         | 26              | 180.6                           | 178.7                             | 174.3                       |
| 1-1-102            | S         | 25              | 183.3                           | 181.9                             | 180.1                       |
| 1-1-103            | U         | 32              | 177.2                           | 175.5                             | 173.1                       |
| 1-1-104            | V         | 33              | 173.2                           | 171.7                             | 171.7                       |
| 1-1-105            | X         | 31              | 176.3                           | 175.0                             | 173.3                       |
| 1-1-106            |           |                 | no skeleton                     |                                   |                             |
| 1-2- 1             | Y         | 17 <sup>2</sup> |                                 |                                   |                             |
| 1-2- 2             | Z         | 19              | 177.1                           | 175.6                             | 172.5                       |
| 1-2- 3             | AA        | .. <sup>3</sup> |                                 |                                   |                             |
| 1-2- 4             | AB        | 35              | 188.6                           | 187.2                             | 182.5                       |
| 1-2- 5             | AC        | 13a             | 187.6                           | 186.4                             | 181.9                       |
| 1-2- 7             |           | .. <sup>3</sup> | three skulls                    |                                   |                             |
| 1-3- 2             | AD        | 15              |                                 |                                   |                             |
| 1-3- 9             | AF        | 16              | 183.5                           | 182.2                             | 178.5                       |
| 1-3- 12            | AE        | 18              | 179.4                           | 178.2                             | 175.1                       |
| Mean               |           |                 | 177.6                           | 176.2                             | 173.9                       |
| standard deviation |           |                 | 5.24                            | 5.35                              | 3.91                        |

corr.= corrected for age over 30 years

<sup>1</sup> same as 1-2-1<sup>2</sup> same as 1-1-25<sup>3</sup> west of 1-3-12<sup>4</sup> under 1-1-48

TABLE 7 DENTAL STATUS

| Feature          | Number / Rate   |
|------------------|-----------------|
| N erupted        | 593             |
| N supernumerary  | 0               |
| AM loss          | 38              |
| PM loss          | 117             |
| N inspected      | 194             |
| PM alveolar loss | 249             |
| N caries         | 32              |
| N abscesses      | 20              |
| N fistulas       | 4               |
| Alveolar atrophy | slight/moderate |
| Calculus         | moderate/severe |
| Periodontitis    | moderate/severe |

N= number; AM= antemortem; PM= postmortem

TABLE 8 CARIES DISTRIBUTION

| Tooth     | Number |       |     | Number                                     |   |   |   |    |  |    |
|-----------|--------|-------|-----|--|---|---|---|----|--|----|
|           | aff.   | insp. | %   | occ./dc.br./b.neck/l.neck/interpr./abscess |   |   |   |    |  |    |
| Maxilla:  |        |       |     |  |   |   |   |    |  |    |
| I1        |        |       |     |  |   |   |   |    |  | 2  |
| I2        |        |       |     |  |   |   |   |    |  |    |
| C         | 1      | 11    | 9%  |  |   |   |   | 1  |  | 1  |
| P1        | 1      | 12    | 8%  |  |   |   |   | 1  |  | 4  |
| P2        | 2      | 9     | 22% | 1  | 1 |   |   | 1  |  | 2  |
| M1        | 4      | 9     | 44% |  |   |   | 1 | 4  |  | 1  |
| M2        | 3      | 9     | 33% | 1  |   |   |   | 2  |  |    |
| M3        |        |       |     |  |   |   |   |    |  |    |
| Mandible: |        |       |     |  |   |   |   |    |  |    |
| I1        | 2      | 16    | 13% |  |   |   |   | 2  |  |    |
| I2        | 4      | 16    | 25% |  |   |   |   | 4  |  |    |
| C         | 2      | 21    | 10% |  | 1 |   |   | 2  |  |    |
| P1        | 3      | 18    | 17% | 2  |   |   |   | 1  |  |    |
| P2        | 1      | 14    | 7%  |  |   |   |   | 1  |  | 2  |
| M1        | 2      | 14    | 14% | 1  |   |   |   | 1  |  | 3  |
| M2        | 3      | 18    | 17% |  |   | 2 |   | 1  |  | 4  |
| M3        | 1      | 12    | 8%  |  |   |   |   | 1  |  | 1  |
| Total:    | 32     | 194   | 17% | 5  | 2 | 2 | 1 | 22 |  | 20 |

aff.=affected; insp.=inspected; occ.=occlusal; dc.br.=decayed broken;  
b.=buccal; l.=lingual; interpr.=interproximal;

TABLE 9 FREQUENCY OF MAIN PATHOLOGIC CHANGES IN ADULTS

| Pathologic change         | Number of individuals affected |        | Number of individuals inspected |
|---------------------------|--------------------------------|--------|---------------------------------|
| Healed fractures          | 4                              |        | NA                              |
| Healed femur wound        | 1                              | ( 1%)  | 50                              |
| Spondylolysis L4,5        | 1                              | ( 7%)  | 15                              |
| Infections                | 0                              | ( 0%)  | NA                              |
| Rickets, healed           | 1                              | ( 4%)  | 23                              |
| Osteoma: cranial          | 2                              | (15%)  | 13                              |
| DISH                      | 17                             | (100%) | 17                              |
| Vertebral Osteophytosis   | 13                             | (77%)  | 17                              |
| Vertebral Osteoarthritis  | 5                              | (29%)  | 17                              |
| Peripheral Osteoarthritis | 15                             |        | NA                              |
| Osteochondritis diss.     | 1                              | ( 5%)  | 20                              |
| Sutura metopica           | 3                              | (23%)  | 23                              |
| Torus pallatinus          | 1                              | (14%)  | 7                               |
| Spina bifida occulta      | 1                              | ( 9%)  | 11                              |
| Sacralization L5          | 2                              | (15%)  | 14                              |

NA= non-applicable; DISH= diffuse idiopathic skeletal hyperostosis; diss.=dissecans; L5= 5th lumbar vertebra.

TABLE 10 ENTHESEPATHIES

| Ligament-attachment          | Number of individuals affected (%) |     | Number of individuals inspected |
|------------------------------|------------------------------------|-----|---------------------------------|
| apical and alar of dens      | 4                                  | 80  | 5                               |
| anterior longitudinal        | 8                                  | 73  | 11                              |
| flavum                       | 6                                  | 50  | 12                              |
| costo-vertebral              | 1                                  | 13  | 8                               |
| coraco-clavicular            | 6                                  | 55  | 11                              |
| costo-clavicular             | 4                                  | 36  | 11                              |
| coraco-acromial              | 6                                  | 75  | 8                               |
| sup. transverse scapular     | 3                                  | 33  | 9                               |
| glenoid lip                  | 3                                  | 33  | 9                               |
| annular of radius            | 1                                  | 8   | 12                              |
| inteross.membr.(radius/ulna) | 8                                  | 62  | 13                              |
| artic. disc (ulna/carpus)    | 1                                  | 8   | 13                              |
| sacral (ventr. and dors.)    | 5                                  | 46  | 11                              |
| supraspinale (sacrum)        | 2                                  | 33  | 6                               |
| interosseous sacro-iliacal   | 3                                  | 27  | 11                              |
| iliolumbar                   | 5                                  | 63  | 8                               |
| sacrotuberal                 | 5                                  | 71  | 7                               |
| acetabular lip               | 2                                  | 22  | 9                               |
| femoral head                 | 3                                  | 27  | 11                              |
| iliotibial tract             | 3                                  | 23  | 13                              |
| patellar ('tufting')         | 5                                  | 100 | 5                               |
| cruciate (tibial)            | 3                                  | 23  | 13                              |
| dist.ant. and post.tibiofib. | 5                                  | 39  | 13                              |
| deltoid                      | 1                                  | 8   | 13                              |
| calcaneal ('spurring')       | 10                                 | 83  | 12                              |
| long plantar                 | 2                                  | 17  | 12                              |

sup.= superior; artic.= articular; ventr./dors= ventral/dorsal; dist.= distal; ant.= anterior; tibiofib.= tibiofibular.

TABLE 11 ENTHESTOPATHIES

| Joint capsule attachment             | Number of<br>individuals<br>affected | (%) | Number of<br>individuals<br>inspected |
|--------------------------------------|--------------------------------------|-----|---------------------------------------|
| vertebral arch facets                | 2                                    | 18  | 18                                    |
| sternoclavicular and<br>sternocostal | 1                                    | 9   | 11                                    |
| shoulder (scapular)                  | 2                                    | 15  | 13                                    |
| elbow (ulnar)                        | 3                                    | 27  | 11                                    |
| hip (acetabular, femoral)            | 2                                    | 15  | 13                                    |
| 1st metatarsophalangeal              | 1                                    | 25  | 4                                     |
| 1st metatarsal                       | 1                                    | 25  | 4                                     |

TABLE 12 ENTHESTOPATHIES

| Origin of<br>muscle attachment                           | Number of<br>individuals<br>affected | (%) | Number of<br>individuals<br>inspected |
|--|--------------------------------------|-----|---------------------------------------|
| biceps m. of arm:  |                                      |     |                                       |
| coracoid process   | 3                                    | 38  | 8                                     |
| supraglen. tuberc.                                       | 1                                    | 11  | 9                                     |
| coracobrach. m.:   |                                      |     |                                       |
| coracoid process   | 3                                    | 38  | 8                                     |
| triceps m. of arm:                                       |                                      |     |                                       |
| infraglen. tuberc.                                       | 5                                    | 56  | 9                                     |
| deltoid m.:  |                                      |     |                                       |
| scap. sp.; acr.; clav.                                   | 4                                    | 57  | 7                                     |
| teres minor m.   |                                      |     |                                       |
| margo infraglen.   | 1                                    | 14  | 7                                     |
| extensor mm. of forearm                                  |                                      |     |                                       |
| lat. epicondylus   | 6                                    | 75  | 8                                     |
| flexor mm. of forearm                                    |                                      |     |                                       |
| med. epicondylus   | 4                                    | 50  | 8                                     |
| fascia lata  |                                      |     |                                       |
| iliac crest<br>('whiskering')                            | 7                                    | 58  | 12                                    |
| greatest gluteal muscle                                  |                                      |     |                                       |
| ala of ilium   | 2                                    | 25  | 8                                     |
| sartorius muscle   |                                      |     |                                       |
| ant. sup. iliac sp.                                      | 5                                    | 56  | 9                                     |
| tensor muscle of fascia lata                             |                                      |     |                                       |
| ant. sup. iliac sp.                                      | 5                                    | 56  | 9                                     |
| straight muscle of thigh                                 |                                      |     |                                       |
| ant. inf. iliac sp.<br>and upper margin<br>of acetabulum | 6                                    | 67  | 9                                     |
| obturator mm. and obt. membr.                            |                                      |     |                                       |
| obturator foramen  | 2                                    | 29  | 7                                     |
| 'hamstring' muscles                                      |                                      |     |                                       |
| ischial tuberosity                                       | 3                                    | 38  | 8                                     |
| adductor muscles   |                                      |     |                                       |
| ramus of ischium and<br>ant. side of pubis               | 6                                    | 86  | 7                                     |
| pectineal muscle   |                                      |     |                                       |
| pecten of pubis  | 4                                    | 57  | 7                                     |
| soleus muscle  |                                      |     |                                       |
| soleal line  | 6                                    | 46  | 13                                    |
| tibialis anterior muscle                                 |                                      |     |                                       |
| upper half of lat.<br>surface of tibia                   | 1                                    | 8   | 13                                    |

m(m). = muscle(s); supra/infraglen. = supra/infra glenoidal; tuberc. = tuberculum; scap. = scapular spine; sp. = spine; acr. = acromion; clav. = clavicle; lat. = lateral; med. = medial; ant. = anterior; obt. = obturator.

TABLE 12, continued

## ENTHESOPATHIES

| Insertion of<br>muscle attachment | Number of<br>individuals<br>affected | (%) | Number of<br>individuals<br>inspected |
|-----------------------------------|--------------------------------------|-----|---------------------------------------|
| deltoid muscle                    |                                      |     |                                       |
| deltoid tubercle                  | 3                                    | 23  | 13                                    |
| supraspinous muscle               |                                      |     |                                       |
| greater tubercle                  | 1                                    | 8   | 12                                    |
| teres minor m.                    |                                      |     |                                       |
| greater tubercle                  | 1                                    | 8   | 12                                    |
| greater pectoral muscle           |                                      |     |                                       |
| crest of gr.tuberc.               | 4                                    | 31  | 13                                    |
| subscapular muscle                |                                      |     |                                       |
| lesser tubercle                   | 6                                    | 50  | 12                                    |
| teres maj. and latis. d. mm.      |                                      |     |                                       |
| crest of lr.tuberc.               | 3                                    | 23  | 13                                    |
| triceps muscle of arm             |                                      |     |                                       |
| olecranon                         | 2                                    | 18  | 11                                    |
| brachial muscle                   |                                      |     |                                       |
| tuberosity of ulna                | 4                                    | 36  | 11                                    |
| biceps muscle of arm              |                                      |     |                                       |
| radial tuberosity                 | 8                                    | 62  | 13                                    |
| gemellus mm. and int. obt. m.     |                                      |     |                                       |
| trochanteric fossa                | 4                                    | 50  | 8                                     |
| greatest gluteal muscle           |                                      |     |                                       |
| gluteal tuberosity                | 5                                    | 46  | 11                                    |
| adductor muscle of leg            |                                      |     |                                       |
| linea aspera                      | 6                                    | 46  | 13                                    |
| mid. gluteal and pirif. mm.       |                                      |     |                                       |
| greater trochanter                | 1                                    | 14  | 7                                     |
| iliopsoas muscle                  |                                      |     |                                       |
| lesser trochanter                 | 8                                    | 80  | 10                                    |
| medial great muscle               |                                      |     |                                       |
| intertrochant. line               | 7                                    | 70  | 10                                    |
| pectineal muscle                  |                                      |     |                                       |
| pectineal line                    | 4                                    | 36  | 11                                    |
| great adductor muscle             |                                      |     |                                       |
| medial epicondyle                 | 4                                    | 31  | 13                                    |
| quadriceps muscle of thigh        |                                      |     |                                       |
| tuberosity of tibia               | 4                                    | 31  | 13                                    |

m(m). = muscle(s); gr. = greater; maj. = major; latis. d. = latissimus dorsi; lr. = lesser; int. = internal; pirif. = piriformis; tuberc. = tubercle; intertrochant. = intertrochanteric; obt. = obturator.

TABLE 13

## OSSIFIED CARTILAGES

| Cartilage       | Number of<br>individuals<br>affected (%) |     | Number of<br>individuals<br>inspected |
|-----------------|--|-----|---------------------------------------|
| thyroid         | 3  | 100 | 3                                     |
| ribcartilages   | 6  | 75  | 8                                     |
| xiphoid process | 2  | 33  | 6                                     |

TABLE 14

## PERIPHERAL OSTEOARTHRITIS

| Joint       | Number of<br>individuals<br>affected (%) |     | Number of<br>individuals<br>inspected |
|-------------|--|-----|---------------------------------------|
| Temp.-mand. | 1  | 11% | 9                                     |
| Shoulder    | 3  | 19% | 16                                    |
| Elbow       | 5  | 46% | 11                                    |
| Hip         | 3  | 25% | 12                                    |
| Knee        | 3  | 19% | 16                                    |

Temp.-mand.= temporomandibular joint.

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# LEGENDS

- Afb./Fig. 1: Plan of the Double Chapel ("Stiftskapel"). Floor level. From: Panhuysen (1981).
- Afb./Fig. 2: Plan of the burial place with graves under the floor of the 'Old Chapel' (ca. A.D. 1070-1550). From: Panhuysen (1981).
- Afb./Fig. 3: Example of one of the transverse sections through the burial place (see Fig. 2).
- Afb./Fig. 4: Age at death distribution of 22 Canons.
- Afb./Fig. 5: DISH. Ossification of the anterior longitudinal ligament (male, 62 years old; Findno. 1-1-48).
- Afb./Fig. 6: DISH. Ossification of the patellar ligament on the tibial tuberosity (male, 51 years old; Findno. 1-3-12).
- Afb./Fig. 7: DISH. Ossification of the transverse ligament of the scapula (male, 54 years old; Findno. 1-1-104).
- Afb./Fig. 8: DISH. Ossification of the insertions of the capsule of the shoulder joint, the tendon of the triceps muscle at the lower border of the same joint surface and of the short head of the biceps muscle on the coracoid process of the scapula (male, 51 years old; Findno. 1-3-12).
- Afb./Fig. 9: DISH. Ossification of the Achilles tendon on the calcaneus ('calcaneal spurring'; male, 50-65 years old; Findno. 1-1-103).
- Afb./Fig.10: DISH. Ossification of the costal cartilages on the sternum (male, 64 years old; Findno. 1-1-50).
- Afb./Fig.11: Distribution of the age of formation of type III Harris' lines.

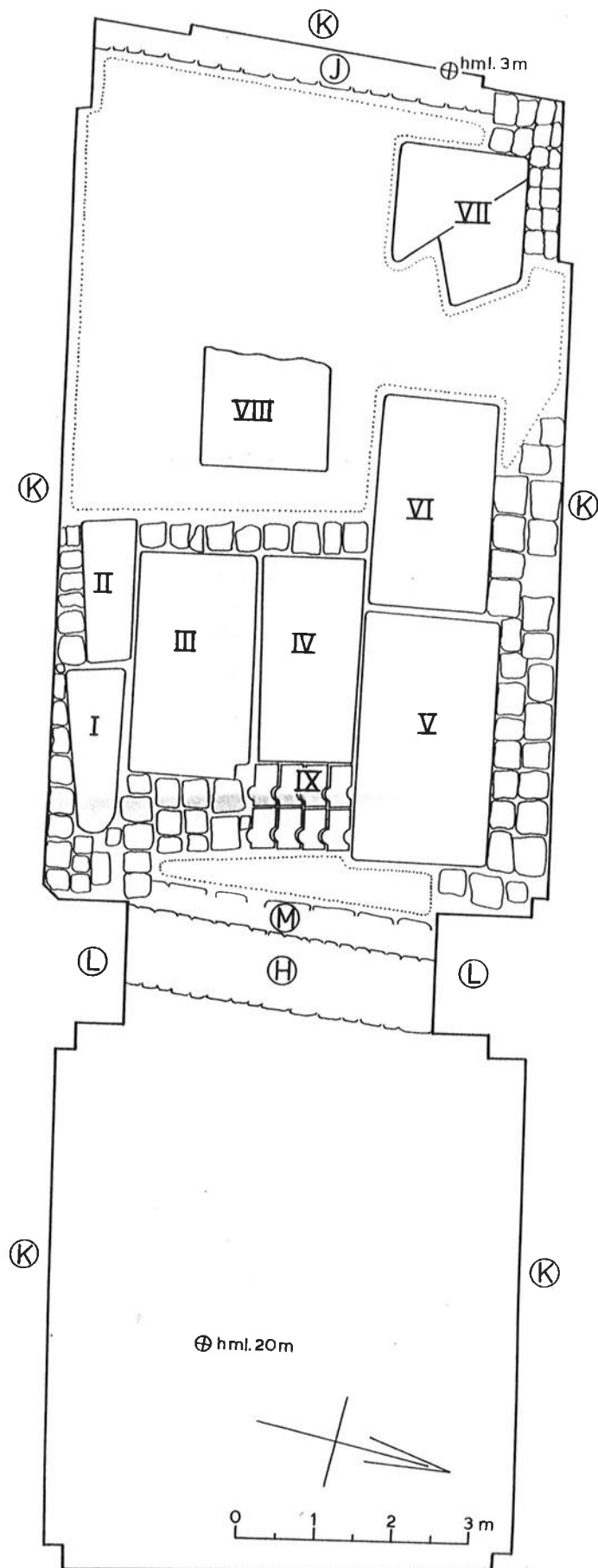


fig.1

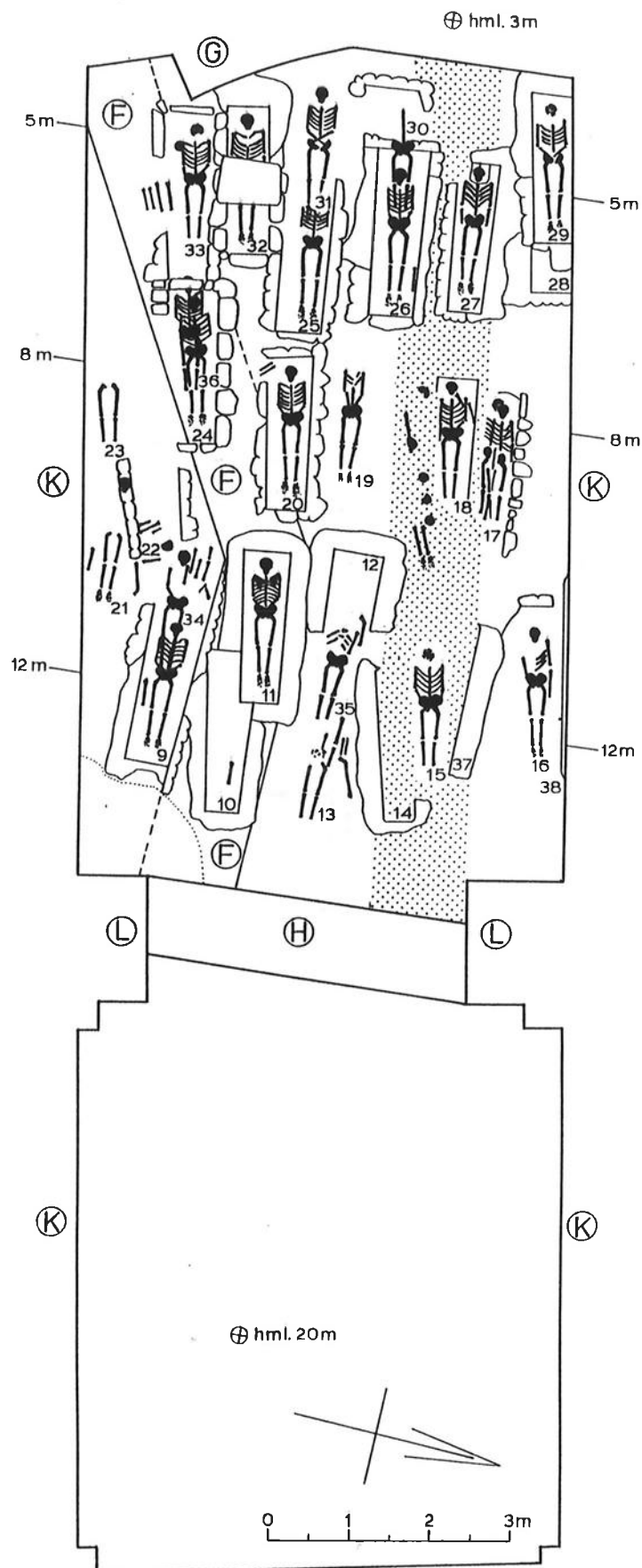


fig.2

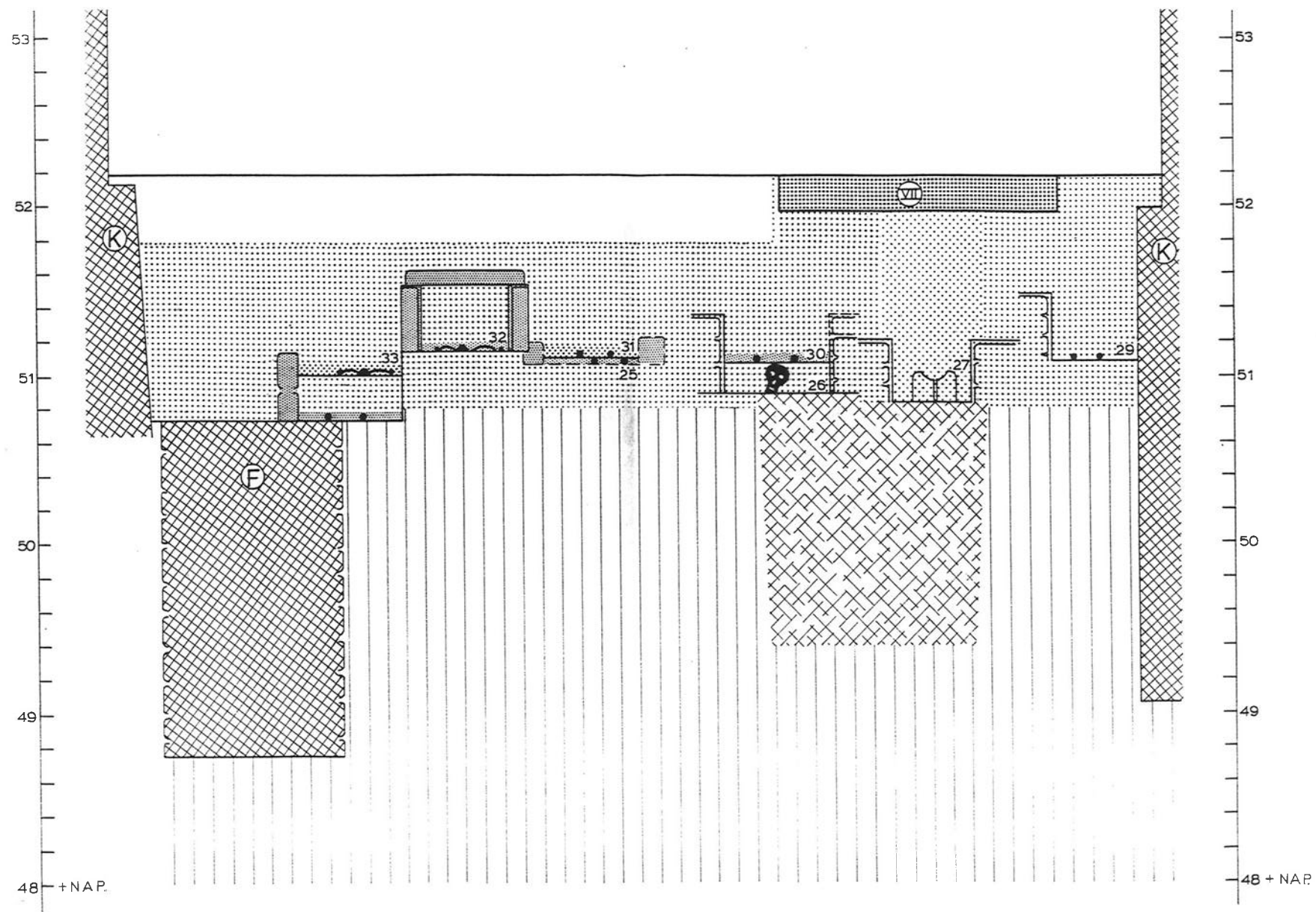


fig.3

# MAASTRICHT, CANONS BURIED IN THE “STIFTSKAPEL”

AGE AT DEATH DISTRIBUTION; 1070-1521 AD

N=22; Age estimated according to WEA, 1980; Janssen and Maat, 1998

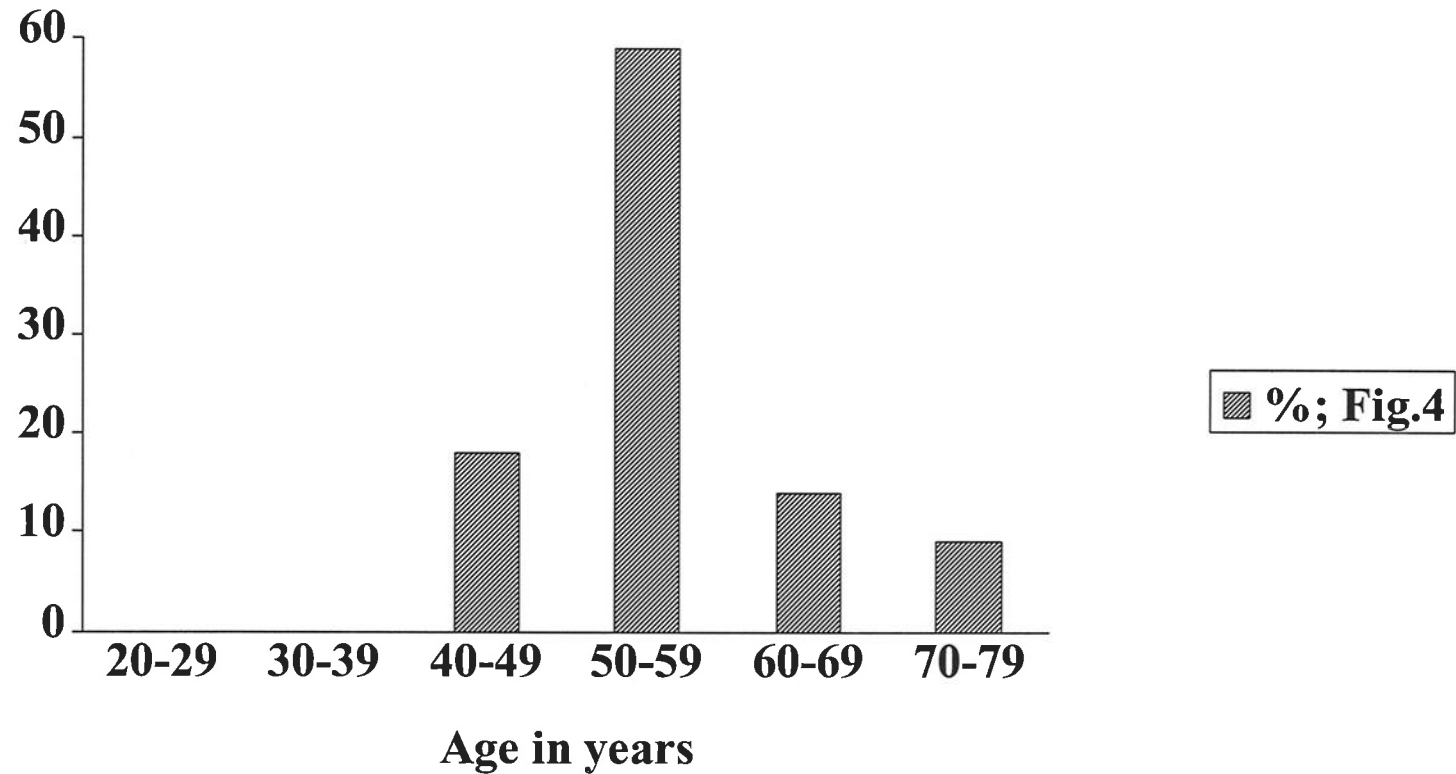




fig. 5



fig. 6



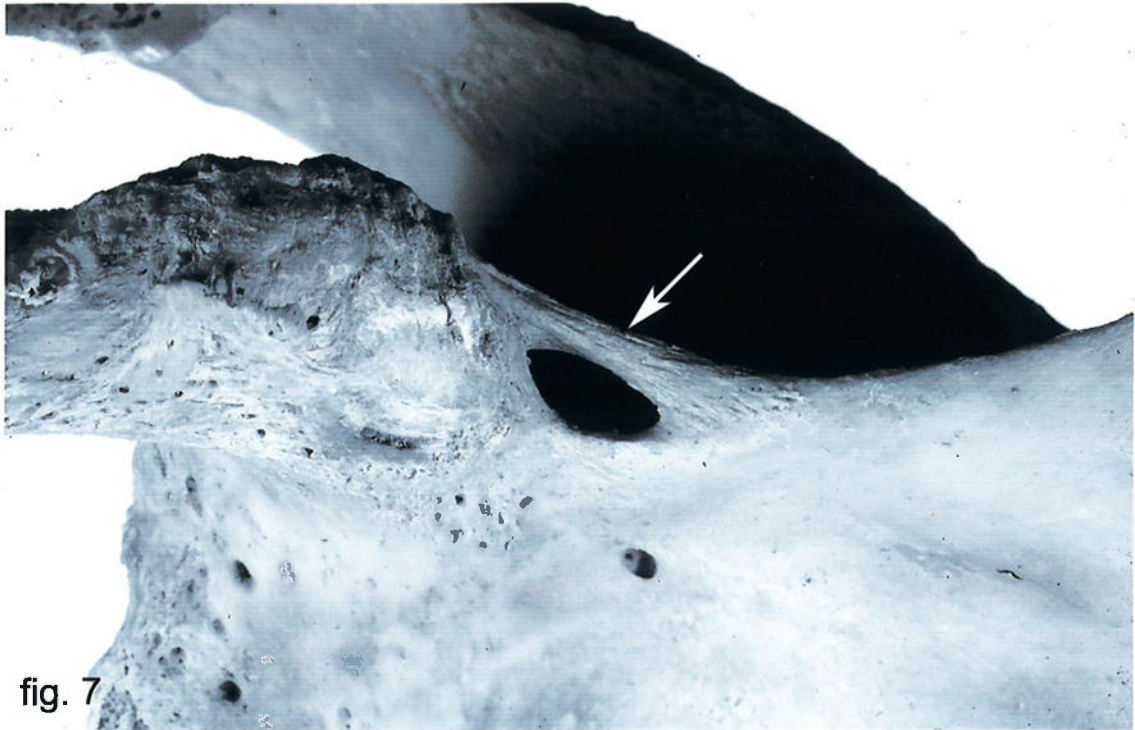


fig. 7

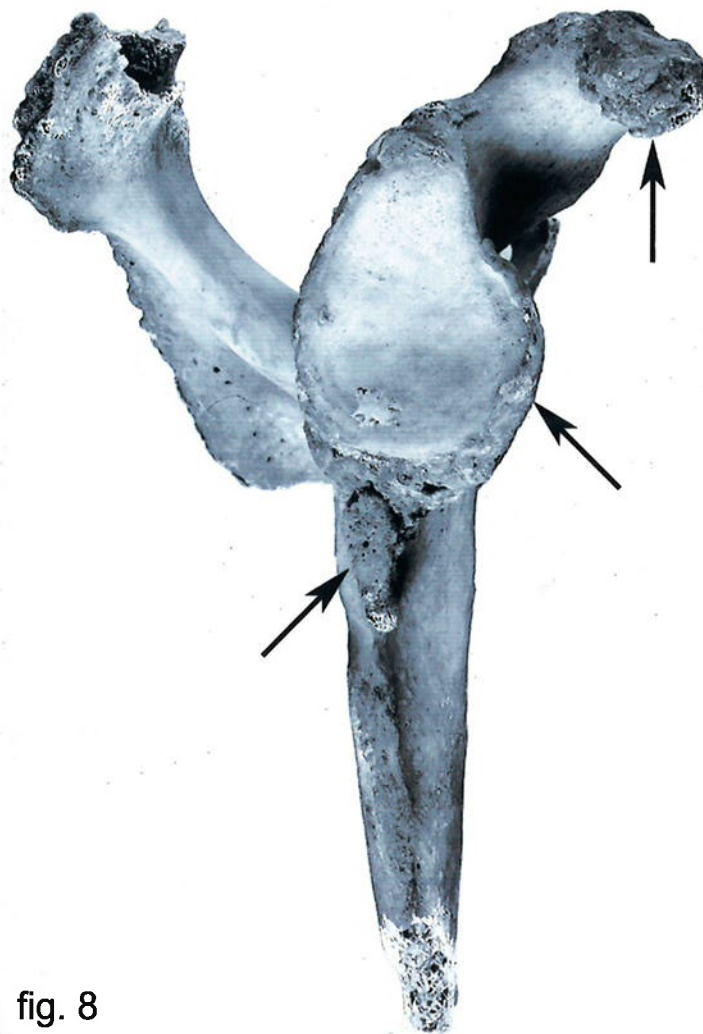


fig. 8



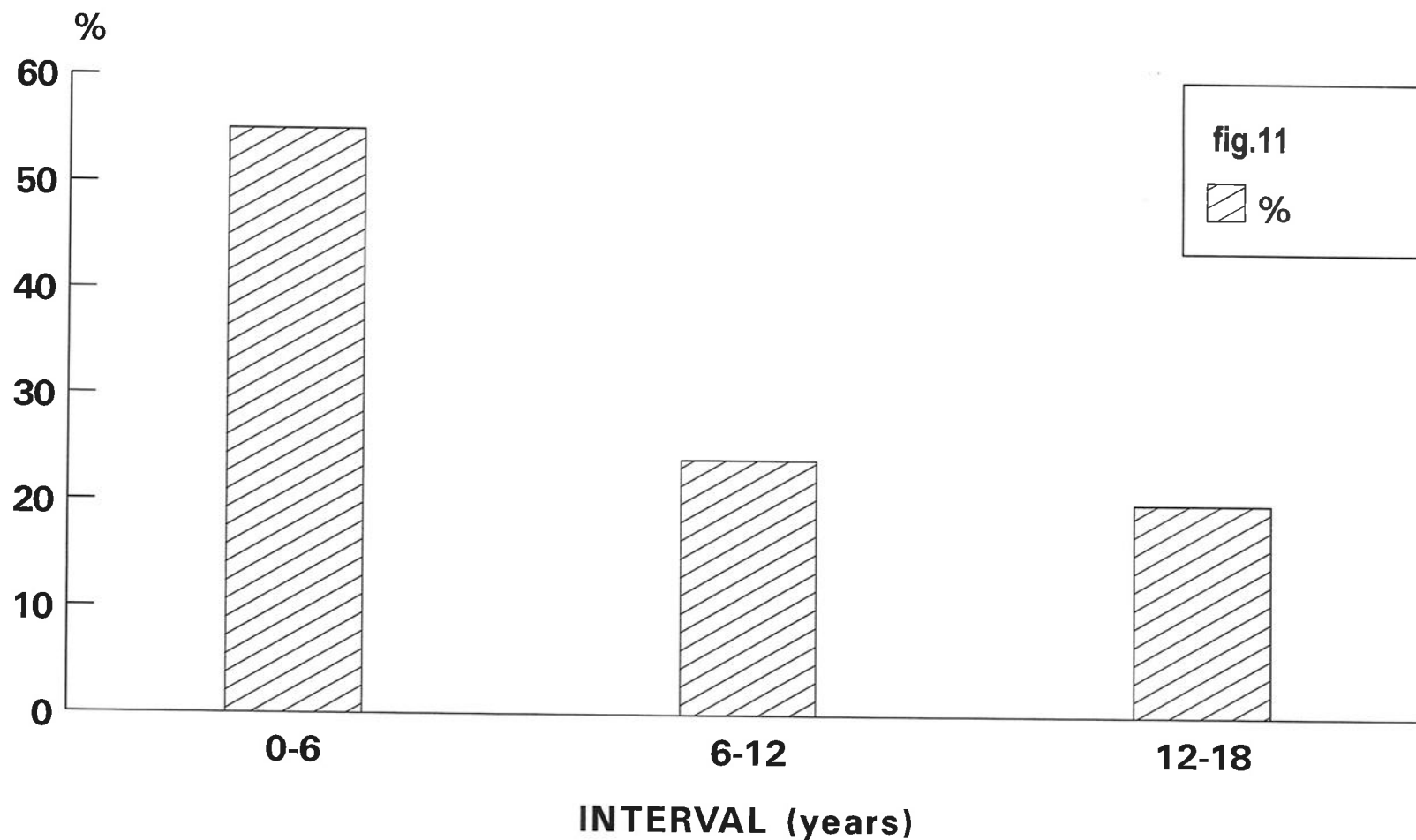


fig. 9



fig. 10

**MAASTRICHT, CANONS BURIED IN THE "STIFTSKAPEL"**  
**AGE OF FORMATION OF TYPE III HARRIS' LINES (N = 29)**  
**1070-1521 AD**



Janssen and Maat, 1998  
Age of formation calculated after Maat, 1984  
22 tibias/individuals