Teeth and Jaws of the Qilakitsoq Mummies

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In 1972, well-preserved mummies of six adult Eskimo women and two children (an infant of about six months and a boy of 3½–4½ years) were found at Qilakitsoq in the Uummannaq District, Northwest Greenland. Death occurred about 500 years ago.

A multidisciplinary study of these mummies included age estimation, dental anatomy, dental numerical variations, pathology of dental hard tissues and jaw bones, and evidence of temporo-mandibular joint disorders.

Recording of dental conditions, dental radiographic examination, roentgen diffraction analysis, scanning electron microscopy, and chemical analyses were limited to three adults and the oldest child, while the remaining four mummies could only be studied roentgenographically. The results may be summarized as follows.

One adult aged 18–21 had shovel-shaped maxillary incisors. The roots of the anterior teeth were short in mature individuals. One impacted maxillary supernumerary incisor was found, and three third molars were congenitally missing. The loss of teeth post mortem was insignificant but it is noteworthy that no less than eight incisors (and only one molar) were lost ante mortem. Pulp stones, some very large, were seen in many teeth, including those of the young woman. While all teeth were caries-free, traumatic injuries were common. Chipping of the enamel occurred universally and a complete intra-alveolar root fracture was diagnosed radiographically. The occlusal and incisal attrition was very pronounced in the mature women. Due to apposition of tertiary dentine, however, only one tooth displayed pulp exposure. The two mature skulls exhibited transversal grooves in the masticatory surfaces of their incisors, canines and premolars, produced by preparation of animal sinews for sewing. This procedure and other use of the anterior teeth for hide preparation probably accounts for the loss of incisors ante mortem. Fluoride analyses of surface enamel of deciduous and permanent teeth showed the same magnitude of concentration and distribution of this element as found in modern Northwest Greenlanders and in Danish mediaeval skull material.

In all adult dentitions considerable deposits of supragingival calculus were found, while subgingival calculus was only seen opposite two teeth with marginal periodontal bone involvement. The supragingival calculus either forms a rim at some distance from the alveolar margin indicating the course of the gum margin or extends over considerable parts of the facial crown surfaces, even those of anterior teeth. X-ray diffraction analysis of powdered calculus showed it to consist of hydroxyapatite, and samples of calculus examined by means of scanning electron microscopy disclosed a variety of morphological patterns dominated by crystalline structures and numerous mineralized micro-organisms. As was the case in mature East Greenland Eskimos examined by Pedersen in 1937, limbal alveolar bone loss was remarkably slight. However, pronounced bone destruction, probably traumatic in origin, was seen at two teeth. The findings of the dental study of the Qilakitsoq mummies are in agreement with those made in East Greenlanders in 1937 and in Danish collections of Greenland Eskimo skulls. They also offer many points of resemblance to those obtained in skulls of mesolithic hunter-gatherers unearthed at Vedbæk, Denmark, and dating about 7000 years back.

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The discovery in 1972 and the subsequent fate of eight fifteenth-century Eskimo mummies from Qilakitsoq, Uummannaq District, Northwest Greenland, have been described earlier by researchers participating in the multidisciplinary study to which the mummified bodies were eventually subjected. The general report (Hansen, Meldgaard & Nordqvist 1985) contains information on a wide range of findings as well as many aspects of Eskimo life. The present report is largely confined to the authors' studies of the teeth and jaws of the Qilakitsoq mummies though comparison with dental conditions previously found in arctic peoples will occasionally be made. Special attention is drawn to the radiological report by Eiken (1989) on the Qilakitsoq mummies

which contains valuable background information relating to our findings.

Material and methods

Dental conditions prevailing in Greenland in the old days were studied previously by Pedersen who in 1936 examined 526 skulls of pre-Danish Eskimos kept in the Laboratory of Biological Anthropology of the University of Copenhagen (Pedersen 1938 and 1947). In 1937 he surveyed dental conditions among 915 natives in Ammassalik/Angmagssalik and Ittoqqortoormiit/Scoresbysund. These Inuit lived traditionally and their lifestyle was little influenced by Europeans before World War II.

The background knowledge thus obtained was a major reason why examination of teeth and jaws proved to be an important step in the investigation of the mummies. The mummy material, however, was particularly suited for studies of the teeth and their surrounding bone because the dry skin had prevented loss of teeth after death and protected the fragile bone margins around their sockets. As a result, very few teeth were lost post mortem. Even teeth with only one short root remained in their proper positions or could be found beneath the dried skin. In contrast, numerous one-rooted teeth are missing from the museum collections of Eskimo skulls because these teeth were lost before or during removal of the skeletons from the graves, in transit or later (Pedersen 1949; Curzon 1976/77).

Dental conditions could be studied closely in only four (Nos. 2, 5, 7, and 8) out of the eight mummies. The mouths of the other mummies were either closed or covered by clothing. In order to preserve the exterior of these mummies and their clothing the dental examination had to be limited to the visible parts of their anterior teeth and to radiological findings.

Inspection of the masticatory apparatus was aided by a magnifying lens. X-ray examination using dental radiographic methods was made of all jaws. Additional examinations included scanning electron microscopy of calculus and worn tooth surfaces, X-ray diffraction analysis of calculus, and fluoride analysis of tooth enamel. Many photos were taken.

Results

Table 1 reviews the material under study, giving for each mummy sex, age at death, number of teeth lost before and after death, congenitally missing teeth and supernumerary teeth.

Some salient dental traits of each mummy are presented in the following individual notes.

Grave I, Mummy No. 1

Teeth and jaws could not be studied directly. The age at death of this infant was estimated to be about six months. The dentition shown in Fig. 1 corresponds to the stage of tooth formation recorded for Finnish children aged six months (Nyström *et al.* 1977; Nyström 1982). One deciduous mandibular central incisor had fallen out but was recovered. The stage of its root formation is that of an average white infant aged six months.

It has been suggested by v. Haven (1882), S. Hansen (1893) and others that primary teeth may erupt earlier in Greenlanders than in whites but no evidence to this effect is available.

Table 1. Sex, age and number of teeth of the Qilakitsoq mummies.

	Sex	Age years	Number of teeth: lost ante mortem	lost post mortem	congenitally missing	supernumerary
Mummy 1	M?	½	0	0	0	0
Mummy 2	M	3½–4½	0	1+	0	0
Mummy 3	F	c. 25	0	1	0	0
Mummy 4	F	c. 30	0	0	0	0
Mummy 5	F	c. 45	1	0	0	1++
Mummy 6	F	c. 50	5	0	2	0
Mummy 7	F	18–21	0	11	0	0
Mummy 8	F	c. 50	3	5	1	0

+ deciduous teeth
++ unerupted vestigial upper incisor.

Fig. 1. Mummy No. 1 is an infant aged about 6 months.

Grave I, Mummy No. 2

The radiological examination of the skeleton of this boy revealed symptoms of Down's syndrome (Eiken 1989) but no such symptoms were found in the development of his jaws, nor were any anomalous teeth encountered. The stage of formation and/or eruption of his teeth, however, may have been influenced, as delays in these processes are known to be associated with Down's syndrome (Roche & Barkla 1964, 1967; Orner 1971). Bearing this in mind we estimate his dental age at death to be within the rather wide range of 3½–4½ years. In any case it is remarkable that there is no sign of formation of second molars (Fig. 2). The more so as Boesen *et al.* (1976) found this tooth to erupt early in Greenlanders.

Fig. 2. The dentition of mummy No. 2, a boy aged 3½ – 4½. Lower first molar crowns tilted post mortem. No second molars visible.

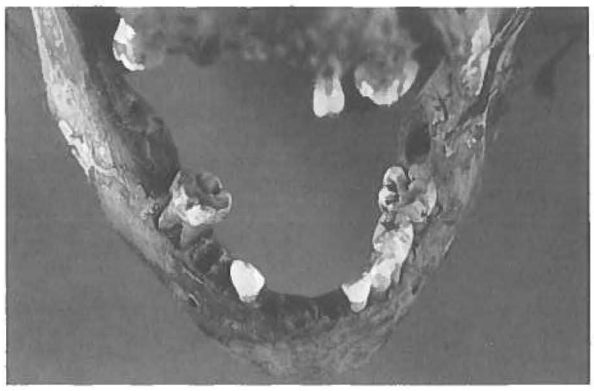

Fig. 3. After removal of the skin the teeth of mummy No. 2 could be examined. Nine loose deciduous teeth are shown in Fig. 4.

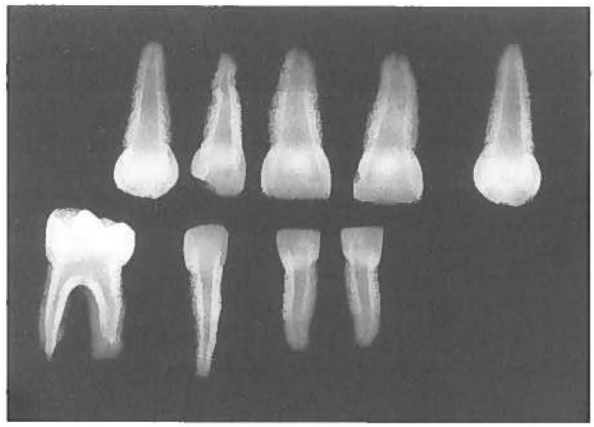

Fig. 4. Nine aberrant deciduous teeth of mummy No. 2. Seven were found in the thorax. The two upper central incisors were located under the skin of the head.

All deciduous teeth except the upper right first molar were found.Some were located under the skin far away from their natural positions (Fig. 4). When recovered, however, even the remotest ones proved to fit into their proper sockets after removal of the covering dry skin.

The teeth showed slight to moderate occlusal and incisal attrition comparable to that found in 4–5 year old East Greenland Eskimo children in 1937 by Davies and Pedersen (1955). No dental hypoplasia, caries or tooth fractures were present.

Fig. 5. Mummy No. 3 (20-25-year-old woman). Wide pulp cavities. Two large pulp stones in left central incisor.

Grave I, Mummy No. 3

This is a 20–25 year old woman with a full complement of teeth except for the upper right lateral incisor, which had fallen out after death and was not recovered. The roots of her third molars were fully formed but their crowns were almost unworn and had remarkably wide pulp cavities. Two sizable pulp stones were found in one of the upper central incisors. Moderate chipping of the molar enamel was seen, as were small incisal fractures and multiple facial enamel infractions of the upper incisors. Neither enamel hypoplasia nor caries were found. Dental calculus was abundant but there was practically no marginal periodontal bone loss. Pronounced bilateral mandibular tori were present.

Grave I, Mummy No. 4

Dental examination of this body of a woman aged 25–30 was hampered by technical difficulties and no special dental X-ray examination could be carried out. After recovery of the mandibular third molars, the dental arches were found to be complete and all four third molars had completed their root formation. Attrition of all teeth was slight to moderate. The left lower central incisor had an incisal perforation to the pulp cavity, and the left upper central incisor an incisal fracture. Both are likely to have been caused by trauma. There was a minor irregularity of position of the left upper incisors. Mummy No. 4 had no torus mandibularis.

Grave I, Mummy No. 5

This mummy is that of a woman aged 40–50. All teeth except I_1 sup. dxt. were found *in situ* or were picked up in the pharynx. The missing upper incisor was lost some time before death, as evidenced by its healed socket. The X-ray examination disclosed a vestigial supernumerary tooth in the premaxilla above I_1 sup. sin., a phenomenon previously recorded in Greenland Eskimos by Pedersen (1949), Balslev Jørgensen (1953), and Larsen *et al.* (1978). As appears from Figs. 7 and 8 the attrition of the teeth was heavy both occlusally and interproximally. The lower incisors were worn down to their necks and were rounded facio-incisally after loss of all facial enamel while the upper incisors had retained some of theirs. This type of wear distribution is likely to have been caused by pulling hides (predominantly of seal) forward and downward between closed anterior dental arches. The strain on both lower central incisors – or an accident – has caused necrosis of their pulps resulting in periapical osteitis (Fig. 9). In addition to these demands upon the anterior teeth the latter have been subjected to the frequent traumata effected by preparation of sinews for sewing. This activity (described for example by Holm (1888), Steensby (1910), and de Poncins (1942)) resulted in production of transversal grooves in the incisors, as observed in 1937 by Pedersen (1947 and 1952) in East Greenland Eskimo women above the age of 40. When the incisors were lost or extreme wear made then unsuited for sinew preparation the canines (or even premolars) were resorted

Fig. 6. Supernumerary tooth in the premaxilla of mummy No. 5.

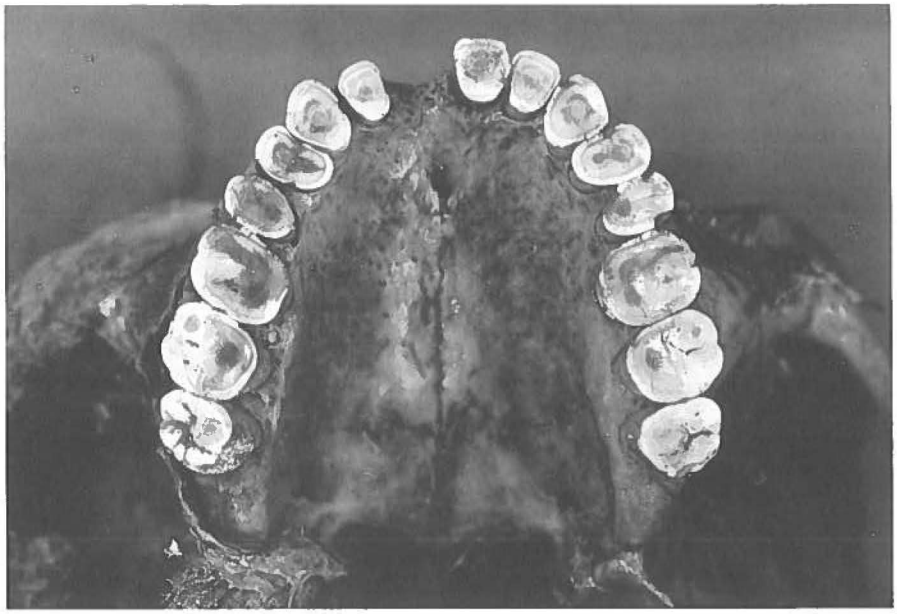

Fig. 7. The maxillary dental arch of mummy No. 5.

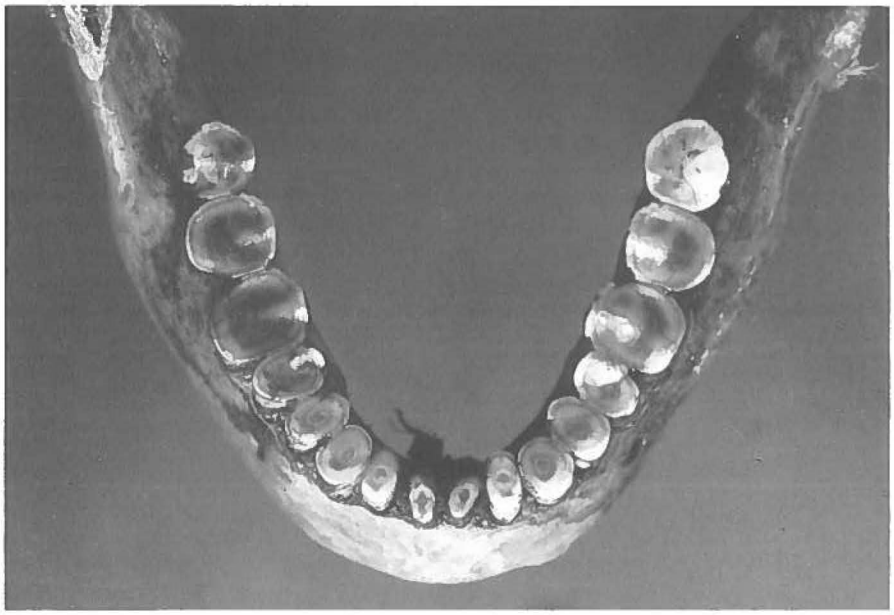

Fig. 8. The mandibular dental arch of mummy No. 5.

Fig. 9. Mandibular central incisors of mummy No. 5 have rounded facio-incisal contours and both exhibit periapical sequelae of pulp necrosis (osteitis).

Fig. 10. Sinew groove in the right mandibular canine of mummy No. 5.

Fig. 12. The coronal part of fractured mandibular premolar of mummy No. 5. Resorption and repair apically (cf. Fig. 11).

to, as is the case with mummy no. 5 (Figs. 10 and 38). Further consequences of the heavy demands on the dentition of this "elderly" woman are the widespread chipping of the enamel margins and the remarkable intra-alveolar fracture of the root of P_1 inf. dxt. close to the apex of a tooth without defects of its crown (Fig. 11). This root fracture is of long standing as evidenced by resorption and subsequent cementoid repair (Fig. 12). Finally, sequelae of trauma are found in the marginal periodontal bone. Mesially to I_1 sup. sin. there is a rather deep bony pocket, and buccally to M_1 sup. dxt. the entire wall of the socket is lost, exposing the buccal roots now covered with islands of calculus (Fig. 13). Figs. 14, 15 and 16 show that abundant supragingival calculus was present on the crowns of all teeth in the form of a rim or wall indicating the course of the free margin of the gum tissue at about two millimetres distance from the alveolar margin. The marginal bone loss is slight to moderate along and between all teeth.

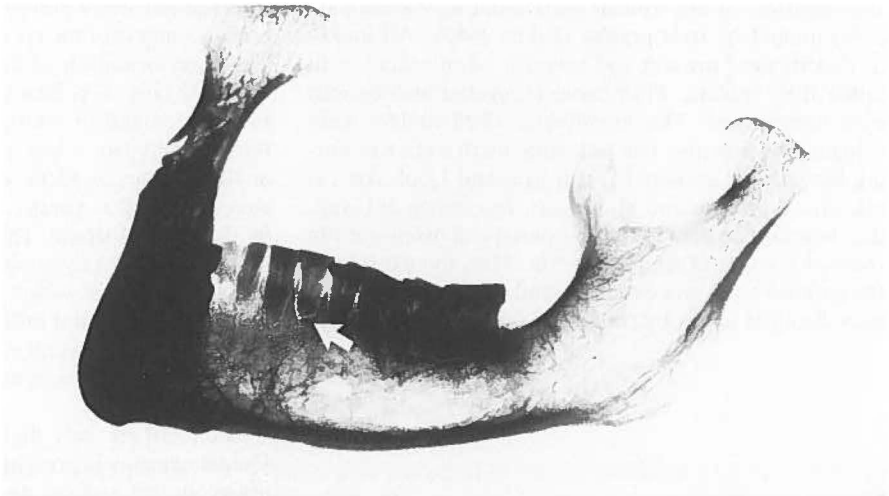

Fig. 11. Inveterate intra-alveolar root fracture of otherwise intact P_1 inf. dxt. in mummy no. 5.

Fig. 13. Breakdown of buccal alveolar wall at M_1 sup. dxt. of mummy No. 5. Supragingival calculus on all teeth. Subgingival calculus on M_1.

Fig. 15. Abundant lingual calculus in mummy No. 5.

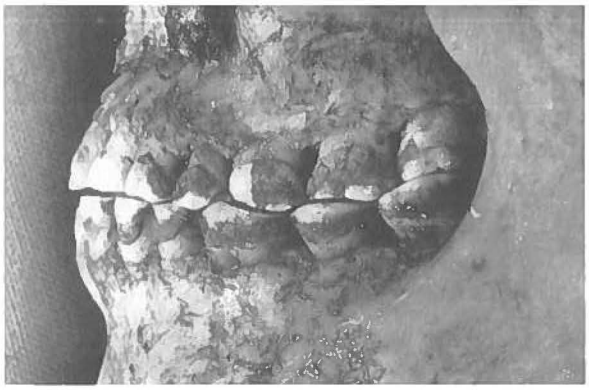

Fig. 14. Abundant buccal calculus in mummy No. 5. Normal occlusion.

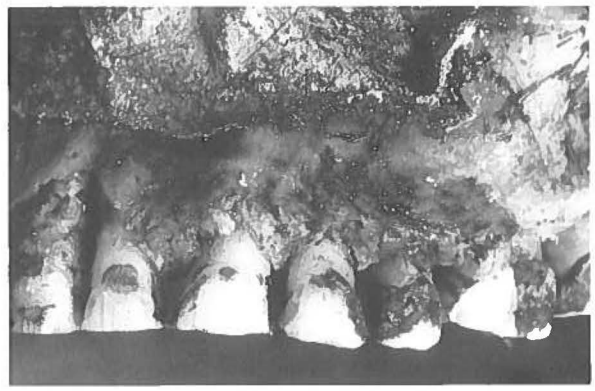

Fig. 16. Supragingival calculus on upper anterior teeth of mummy No. 5.

Grave II, Mummy No. 6

The dentition of this woman aged about fifty could only be examined by tomography (Eiken 1989). All maxillary teeth were present and severely worn except both upper third molars, which were elongated and showed hypercementoses. The mandibular third molars were congenitally missing. The following teeth were lost during life (healed sockets): I_2 sup. sin. and I_1 inf. dxt., I_1 inf. sin., I_2 inf. sin. and M_2 inf. sin. The crown of I_2 sup. dxt. was broken off. There was periapical osteitis at the roots of I_2 sup. dxt. and I_1 sup. sin. Thus the damage to the anterior teeth was extensive and would seem to have been brought about by traumata. Caries was absent.

Grave II, Mummy No. 7

This woman died when she was 18–21 years old and thus is the youngest of the six adult women from Qilakitsoq. The root formation of her third molars was not quite complete (Fig. 17). Dental radiographs taken in 1937 in East Greenland of young Eskimo women corroborate that mummy No. 7 was about 18 years or slightly older at death. Eleven teeth were lost post mortem. None were lost intra vitam. The upper incisors showed marked shovel-shape. The enamel was of perfect structure except for a hypoplastic depression in the parts of the upper incisors which were mineralized at age four (Fig. 18). The dental radiographs revealed a number of pulp stones and several sclerotic areas in the jaw bones which are as yet unexplained. Fig. 19 shows this phenomenon.

The teeth are only slightly worn and caries is absent. Dental calculus is present on the buccal surfaces of the upper molars and on most teeth in the form of a rim

Fig. 17. Left mandibular molars of mummy No. 7 – aged 18–21 – showing incomplete closure of apical foramen af M_3 and large pulp stones in M_1 and M_2.

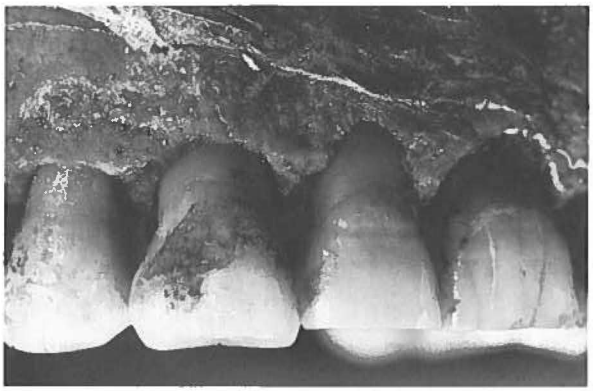

Fig. 18. Maxillary anterior teeth of mummy No. 7 showing facial calculus on C sup. dxt., enamel hypoplasia in I_2 and cracks in I_1.

Fig. 19. Sclerotic bone around P_2 sup. dxt. and large pulp stones in M_1 and M_2. Mummy No. 7 aged 18–21.

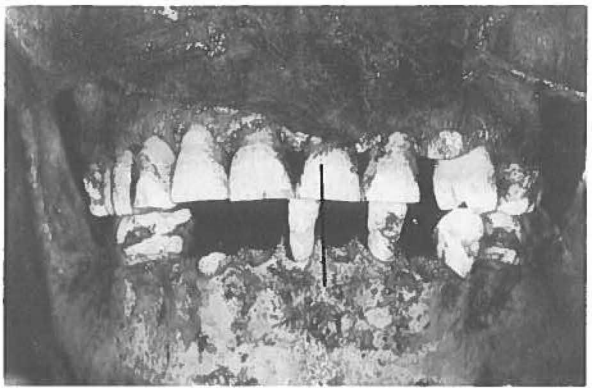

Fig. 20. Deviation of mandibular arch midline towards the left in mummy No. 7..

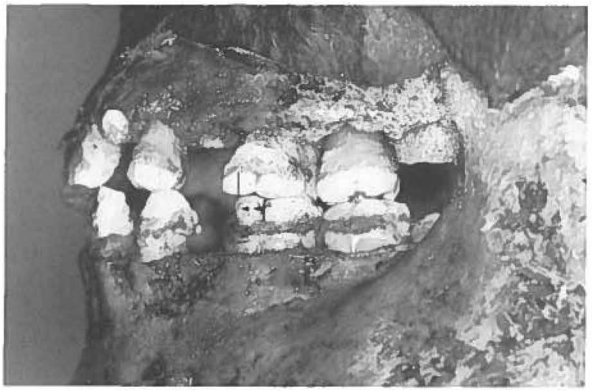

Fig. 21. Distal occlusion of left molars in mummy No. 7, cf. Fig. 20.

Fig. 22. Abnormal shape of right mandibular condyle in mummy No. 7.

along the alveolar margin. Fig. 18 shows a facial "cake" of porous calculus which was present on all upper anterior teeth until it was removed from some of them in order to disclose any enamel defects. This type of facial calculus was seen on upper anterior teeth in many East Greenlanders in 1937.

This woman differs from the others by having an abnormal bite with a skew to the left and backwards

Fig. 23. Right mandibular condyle shows abnormal shape with median projection. Mummy No. 7.

(Figs. 20 and 21). She had marked pathological changes in her right mandibular condyle, and the articular disk was thickened. These changes are probably due to an earlier injury such as a fall or a blow. The shape of the condyle shows that a certain amount of rebuilding of the temporo-mandibular joint had taken place (Figs. 22 and 23). This might have been the consequence of some slight damage to the joint occurring between the ages of six and ten. At that stage, pains in the joint can alter the normal movement to such an extent that abnormal occlusion develops, as has been described by Collin Rasmussen (1984). This would cause later pathological changes such as those evident in the right TM-joint of mummy no. 7.

Grave II, Mummy No. 8

When she died this woman was about fifty years of age. She had lost three incisors ante mortem, viz. I_1 inf. dxt., I_1 inf. sin., and I_2 sup. sin. M_3 inf. sin. was congenitally absent. The upper central incisors have had very short roots, as evidenced by their empty, shallow sockets. They may have been resorbed, cf. Pedersen (1949, plates 26–28). Except for M_3 sup. dxt. (no opposing tooth) the 23 remaining teeth were strongly worn and exhibited a great deal of chipping of the enamel (Fig. 26). The occlusal plane is helicoidal (Fig. 27). Abundant supragingival calculus was present on the palatal and buccal surfaces of the upper molars and on the occlusal surface of M_3 sup. sin. (no antagonist) (Fig. 28). A rim of supragingival calculus was also seen on the buccal surfaces of the mandibular teeth while there was almost none on their lingual surfaces. Considering the age at death the marginal alveolar bone loss was moderate though interproximally it was somewhat more pronounced between the molars (Fig. 29).

Pulp stones were found in several teeth. Tori mandibulares of moderate size were present.

Discussion

Estimation of individual age

To estimate the age at death of the mummies, studies of dental conditions, X-ray examination of the skeletons and histomorphological studies of bone, as well as gen-

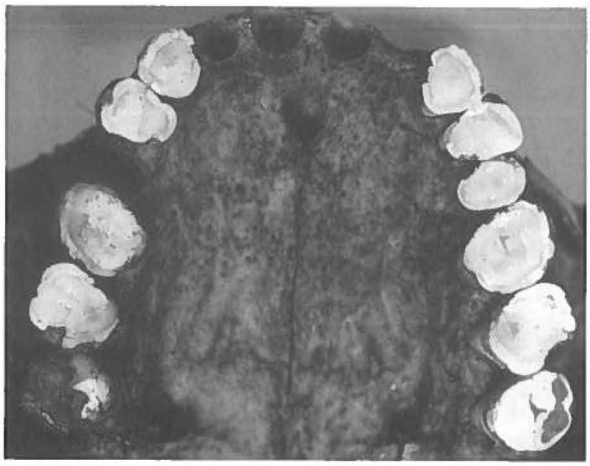

Fig. 24. Maxillary dental arch of mummy No. 8. One incisor lost ante mortem. Extensive chipping of enamel.

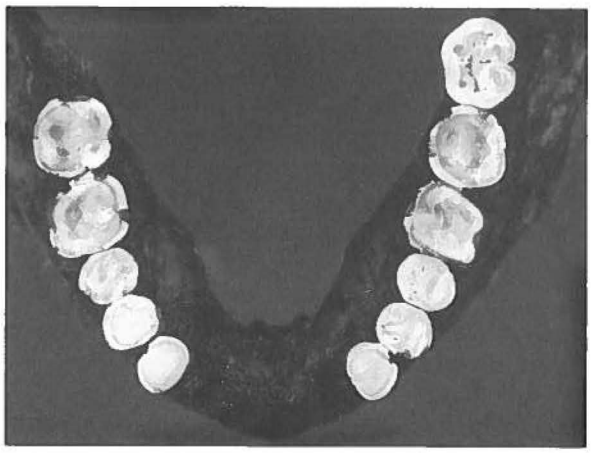

Fig. 25. Mandibular dental arch of mummy No. 8. Both central incisors lost ante mortem. Chipping of enamel. Tori mandibulares.

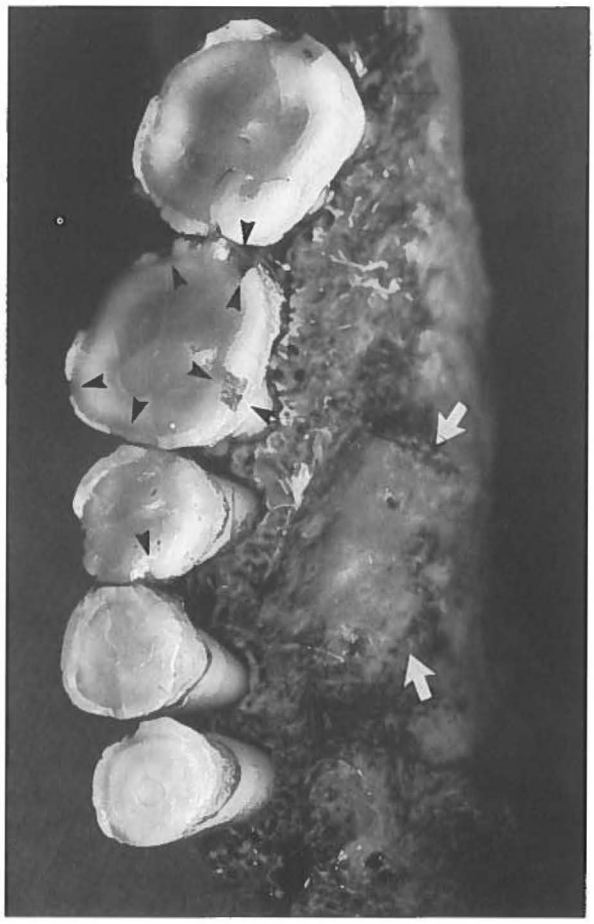

Fig. 26. Attrition and chipping (arrows) in mandible of mummy No. 8. Torus mandibularis (arrows).

eral anthropological criteria were employed. Dental age estimation is optimal in the case of the three youngest individuals, namely the two children (Nos. 1 and 2) and

Fig. 27. Left mandibular teeth of mummy No. 8. Helicoidal shape of occlusal plane. Sinew furrow on masticatory surface of P_1. Calsulus rim and moderate marginal bone loss around molars.

Fig. 28. Abundant palatal and occlusal calculus formation on right upper molars of mummy No. 8. M_3 had no opposing molar.

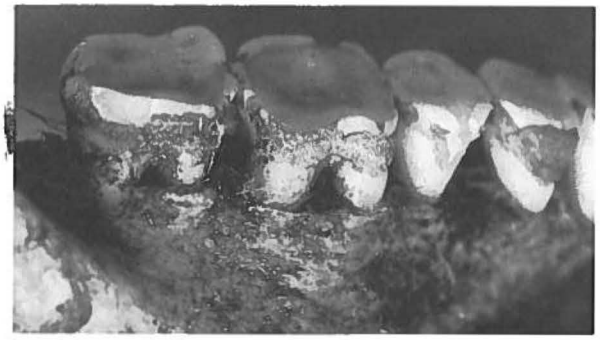

Fig. 29. Right mandibular molars and premolars of mummy No. 8. Alveolar bone loss though moderate includes furcation involvement.

No. 7 whose wisdom teeth were not completely formed (Fig. 17).

Loss of teeth

The radiological examination of the mummies led to the recovery of several teeth located far away from their proper positions. Many of mummy 2's deciduous teeth lay firmly enclosed in the mummified tissues of the back underneath the clothing, which had partly disintegrated. Obviously these teeth had fallen out post mortem.

When all teeth which had fallen out of the jaws after death were repositioned, tooth loss post mortem amounted to eighteen, limiting the loss of teeth ante

mortem to nine. These nine teeth were lost by the three oldest women, viz. Nos. 5, 6, and 8. Eight of them were incisors indicating the heavy demands on women's front teeth to be discussed later.

In 1940 Hrdlička, the renowned anthropologist, published an essay on ritual ablation of front teeth in Siberia and America in which he maintained that many anterior teeth were intentionally removed. Merbs (1968 and 1983) questions Hrdlička's interpretations and submits evidence of traumatic causation of (Sadlermiut) Inuit ante mortem loss of anterior teeth. The present authors share Merbs' views as does Costa (1980b). The female Eskimo dentition is a precious tool, crucial to her social and matrimonial success in life. That she – or her community – would permit her to be deprived of this asset voluntarily would seem absurd.

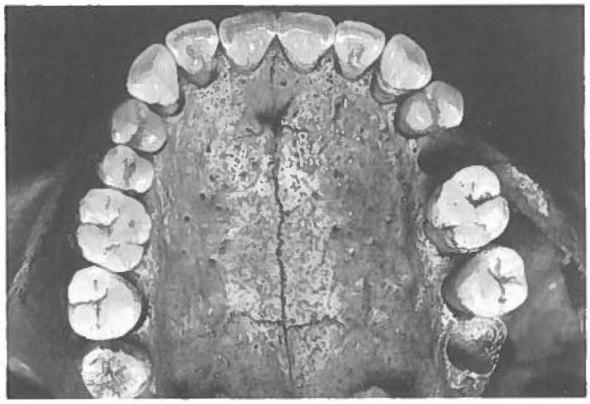

Fig. 30. Shovel-shape of upper incisors of mummy No. 7.

Congenitally missing and supernumerary teeth

The occurrence of congenital absence of teeth was examined and discussed in great detail previously by one of the present authors (Pedersen 1949: 38–59). The most striking feature was shown to be widespread absence of third molars in Greenland Eskimos. In the mummies, however, only three third molars did not develop.

A vestigial supernumerary tooth was found in the premaxilla of mummy No. 5 (Fig. 6). This is a fairly common phenomenon among Greenland Eskimos (Pedersen 1949; Balslev Jørgensen 1953; Larsen *et al.* 1978).

Tooth morphology

Because of heavy attrition, few of the typical dental anatomical features which characterize the Eskimo and indicate his origins among the Mongolian peoples could be identified in the mummies. However, the younger adults, especially mummy No. 7, showed pronounced shovel-shape of the upper incisors (Fig. 30), a typical feature among Greenland Eskimos (Pedersen 1949; Aas 1983). A further difference between Greenland Eskimos and Caucasians is that the Eskimo mandibular first molar frequently has three roots as opposed to the usual two roots in Danish molars (Pedersen 1949). There is, however, no example of three-rooted lower first molars among the six adult mummies. Eskimo teeth have strong and short roots, while the teeth of whites are longer and thinner (Pedersen 1949). In this respect the teeth of the mummies are typical eskimoid as are the gingival enamel margins (see Pedersen and Thyssen 1942) observed in the mummies.

Enamel hypoplasia

Irregular structure and faulty mineralization of the hard tissues of the permanent teeth may be caused by disease, malnutrition or famine during infancy while the teeth develop and calcify, but before they erupt. After eruption of the teeth, the visible result may be enamel hypoplasia, i.e. enamel surface irregularity, a phenomenon seen in mummy No. 7. This young woman exhibited enamel hypoplasia in the parts of the crowns of her front teeth closest to their necks (Fig. 18). This enamel mineralizes between the ages of two and four, viz. the period when breast feeding usually terminated among Greenlanders. Similar depressed areas in the dental enamel have been found in many skull collections in recent years by dental and anthropological workers (*vide* Pindborg 1982 and Goodmann & Armelagos 1985). They occur for instance in Danish mesolithic hunter-gatherers (living about 7000 years ago) excavated at Vedbæk in Denmark during the late 1970s (Albrethsen *et al.* 1976).

Attrition

The most impressive feature of the mummy dentitions is their pronounced to extreme occlusal and interproximal attrition. When the occlusal and incisal wear reaches down below the largest circumference of the crowns the completely worn-down teeth look like pegs at gum level, at some distance from the neighbouring teeth (Fig. 8). The illustrations accompanying this report demonstrate that all degrees of occlusal and interproximal attrition are represented in the adult Qilakitsoq dentitions, largely depending on the age at death of the woman concerned.

For centuries the heavy wear of Eskimo teeth has been noted by arctic travellers, and has been discussed

Fig. 31. Ammassalik woman (1937) scraping blubber off a sealskin with her *ulo*.

Fig. 32. Girl cleaning boot sole sealskin with her *ulo* at East Greenland village 1937.

Fig. 33. Polar Eskimo woman preparing sealskin to be used for boot (*kamik*) soles.

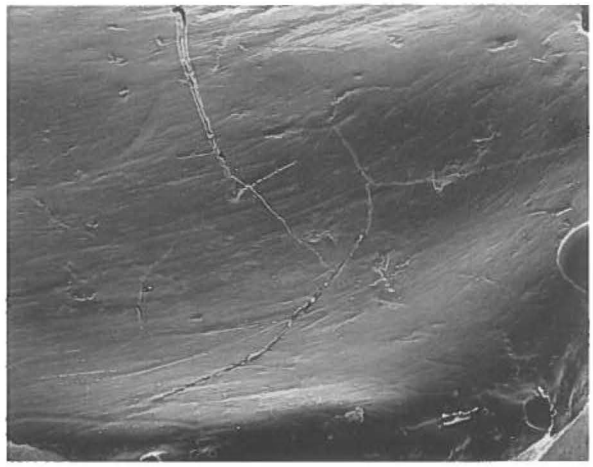

Fig. 34. Cracks and parallel scratches in exposed dentine of M_1 inf. dxt. of mummy No. 5. Direction of scratches is largely lingual-buccal (right-left on fig.). SEM X 20.

intensely by anthropological and odontological workers. Mention of this phenomenon was made as early as 1724 by J. B. Winslow (1724) and 1784 by James Cook (1784). A comprehensive survey of dental attrition in Greenland was published by Davies & Pedersen (1955). They quote a number of early reports and discuss the etiology of the heavy wear of Greenland Eskimo teeth, which seems to be caused both by the chewing of tough food, bruxism, and by the use of the teeth as implements. The latter is especially the case among Eskimo women, who prepare hides with their teeth. Although Eskimo men also had extreme dental attrition (e.g. Steensby 1910), the women ranked first in the use and abuse of their teeth. The women would hold the skin, usually sealskin, with their front teeth as they scraped the blubber off the inner side of the skin (Figs. 31, 32). Skin used, for example, for the soles of *kamiks* (boots) was "rubbed", with the mouth partly closed, down over the lower front teeth (Fig. 33), which were worn and gradually became rounded (Fig. 8). The women also softened the skin before sewing by actually chewing its edges with their front teeth.

Examples of microscopic traces left by chewing activities on exposed molar dentine in the form of numerous fine, parallel scratches are seen in Figs. 34 and 35. This course is similar to that described by Murphy (1964b) in Australians. A closer study of such patterns using a larger material might pay considerable dividends and is on our list of desiderata for future research.

Sinew grooves

The considerable effort involved in preparing threads from sinews for sewing is described by Holm (1888: 65)

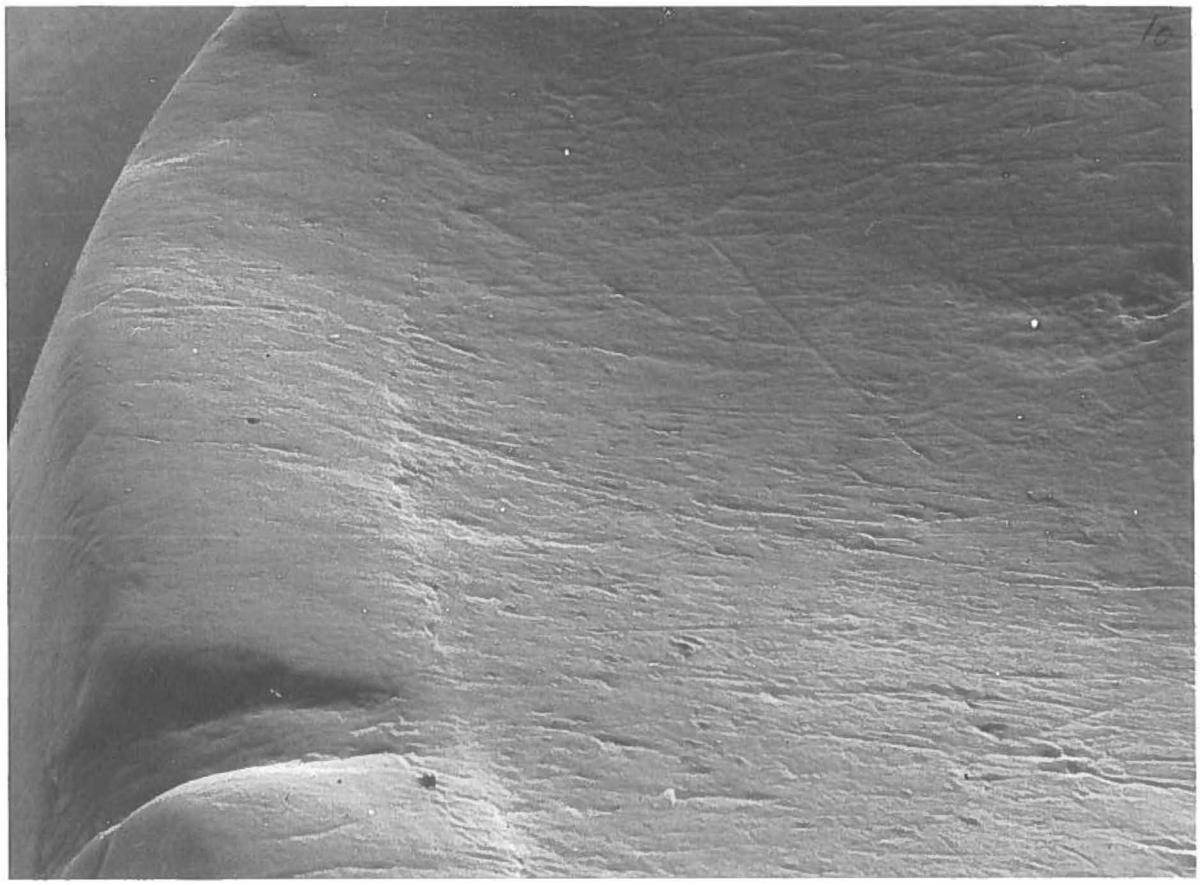

Fig. 35. Occlusal surface of C inf. dxt. of mummy No. 5. Dentine (right) and enamel (left) show parallel scratches. SEM X 250.

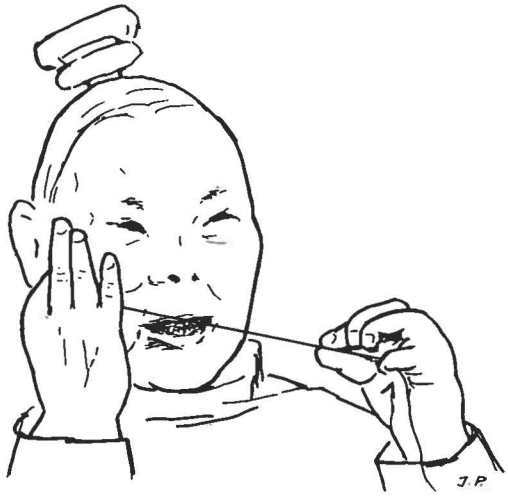

Fig. 36. Sinew thread being rolled against the cheek. Ammassalik 1937.

Fig. 37. Sinew thread being pulled across closed anterior dental arches. Ammassalik 1937.

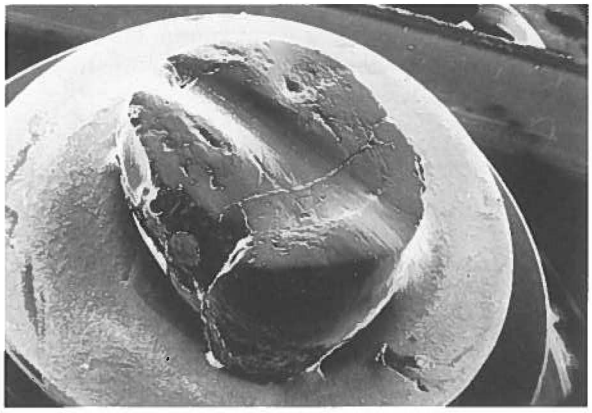

Fig. 38. SEM of sinew groove in C inf. dxt. (same as Fig. 10) of mummy No. 5.

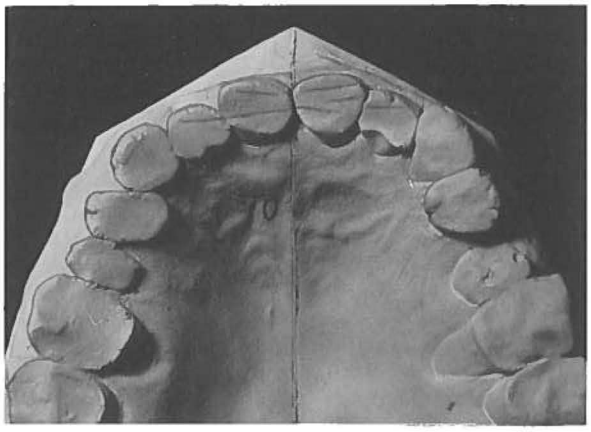

Fig. 39. Sinew grooves in the anterior teeth of 57-year-old East Greenland Eskimo woman examined in 1937. Chipping of enamel of most teeth.

and Steensby (1910: 344) in Greenland natives and by de Poncins (1942: 24) in Canadian Inuit. This activity caused transverse furrows in the "chewing surfaces" of the front teeth. First, thick bunches of tendinous material from animals were split into thin cords with the *ulo* (woman's knife). Next, these cords were alternately rolled against the cheek and drawn across the clenched front teeth (Figs. 36, 37), on which they produced one or more grooves (Figs. 10, 38). The purpose of this latter manoeuvre was to moisten and soften the sinew. Sinew grooves were seen in 1937 in half a dozen women in East Greenland (Fig. 39). They occurred only among "the old ones", meaning women over 40 years of age (Pedersen 1949). The Qilakitsoq women are the first West Greenlanders in whom these furrows have been found. When a woman lost her front teeth, usually as a result of having used them as a third hand for years, the sinew thread had to be prepared with her canines and/or her premolars. One such example occurs in mummy No. 8, who had lost her front teeth long before death. Instead she had used her right lower canine to make the threads. Mummy No. 5 displays furrows in two front teeth – one in the upper jaw, one in the lower. However, furrowing can be most clearly seen on her right lower canine (Figs. 10, 38).

Fractures

Cracks in the enamel of the teeth are also frequently caused by stress factors. The front teeth of several of the mummies show cracks running all the way down the facial surfaces of their crowns. These cracks are particularly numerous in mummy No. 3. The deciduous teeth of mummy No. 2 and the teeth of the mature adults show pronounced chipping of their masticatory surfaces caused by chewing hard foods, by bone fragments and by using the teeth as tools. Chipping of Eskimo dental enamel has been described before by Pedersen (1944, 1949) and has been dealt with by Turner & Cadien (1970), who are widely quoted in the anthropological literature. Effects of trauma are also found in the mesolithic hunters of Vedbæk in Denmark, whose teeth showed many fractures.

In mummy No. 6 the whole crown was broken off from an upper front tooth, and radiographs showed that in mummy No. 5 there was a transversal root fracture of a worn but otherwise intact lower premolar. SEM examination of the fractured root surfaces showed deposits of cementoid repair tissue, indicating that the heavy trauma causing the fracture had occurred quite some time before death.

Resorption

Among the consequences of the extensive use and abuse of the incisors are the shortening of their roots as a result of resorption. This is most evident in the considerably resorbed roots of the anterior teeth of the oldest Qilakitsoq women. Similar observations were made in elderly people in East Greenland in 1937 (Pedersen 1949). Orthodontists have shown that roots can be resorbed by using extensive force during treatment. If too much force is used, the roots may be resorbed and this may remain unnoticed until much later.

Caries

No carious lesions were found in any of the eight people from Qilakitsoq. Similarly there are almost no carious lesions in the large Copenhagen collections from precolonial Greenland, Canada, and Alaska. Less than one

percent of these skulls displayed cavities, and then only in very few teeth. Curzon (1976/77) reported identical findings in Eskimo skulls kept in British museums. During the twentieth century, caries has become rampant and widespread among Eskimo populations, and virtually all modern Greenlanders have caries and/or tooth loss from caries. Nowadays, many people over forty are edentulous in Greenland. Despite intensive efforts by Danish health authorities to prevent and treat dental caries, it has been on the increase until recently (Pedersen 1971; Jacobsen & Hansen 1974; Jakobsen 1979; Senderovitz 1981, 1986), the reason being the change from the traditional hunters' diet to a diet of imported food with a high sugar content (Pedersen 1938; Baarregaard 1949; Møller *et al.* 1972). A certain amount of fluorine in food and drinking water protects teeth from caries. However, overconsumption of fluorine is harmful to tooth development giving rise to the condition known as dental fluorosis. The drinking water is low in fluorine almost everywhere in Greenland except for the town of Narssaq in the southern part of West Greenland, and today the prevalence of dental decay is much lower there than elsewhere in Greenland (Jakobsen 1979).

Surface enamel of both deciduous and permanent teeth of the Qilakitsoq mummies has been analysed for fluorine content. It seems to have about the same concentration and distribution as was found among modern Greenlanders in the area.

Pulp calcifications

It is well-known that secondary dentine is deposited on the walls of the pulp cavity during life and that tertiary dentine develops on these walls opposite areas subjected to peripheral damage or irritation. Usually, the heavy occlusal attrition of the teeth does not lead to pulp exposure, because deposition of tertiary dentine keeps pace with the occlusal loss of dentine. In cases with extreme occlusal attrition areas of exposed tertiary dentine appear on the occlusal surface as darker islands because the different structure of tertiary dentine facilitates staining (Figs. 7, 8).

A striking discovery made during the 1937 survey of East Greenlanders was the frequent occurrence of large pulp stones seen in dental radiographs, even those taken of young adult dentitions. Comparative radiographical studies by Andersen & Østergaard (1984) of mandibles of ancient Greenland Eskimos and other ethnic groups established that the Greenlanders had a considerably higher prevalence of pulp stones than had mediaeval Norsemen from Greenland and Danish neolithic people. As a matter of fact, the prevalence in Greenland Eskimo jaws is the highest on record so far. In keeping with this, the radiographs of the mummy dentitions exhibited several sizable pulp stones. The reason why Greenland Eskimos have the highest prevalence of pulp calcifications is not known, but studies in progress of other ethnic groups may contribute to the understanding of this problem.

Calculus

Calculus (tartar) was found on the crowns of all the adults' teeth and on the buccal aspect of the roots of one upper molar exposed by gingival pocket formation. The sharp demarcation of the supragingival calculus deposits at a short distance from the alveolar margins of the jaws indicates the level of the gingival margin when the subject was alive. As calculus formation is slight in museum specimens of Greenlandic skulls, it was surprising to find such widespread and abundant amounts of calculus among the Qilakitsoq women. The skulls in museums probably lost some calculus post mortem as the 1937 survey of the living East Greenlanders revealed widespread calculus, though its location and structure seemed to be somewhat different from those of Danes. This is also the case when closer studies of the calculus of the mummies are made (cf. Figs. 17 and 18). The reason for these differences is not known at the present time.

Samples of supragingival calculus originating from mummy No. 8 were pulverized and subjected to X-ray diffraction analysis. The X-rays showed the presence of hydroxyapatite. No other calcium phosphates and no calcium carbonates were found.

In a further attempt to describe the nature of dental calculus as found in the mummies, scanning electron microscopic studies were carried out. Two of the SEM photos are presented in Figs. 40 and 41. The final interpretation of our results in this area is not yet available. SEM studies of dental calculus have previously been published by American (Baunhammers *et al.* 1973; Lustman *et al.* 1976), Japanese (Shirato *et al.* 1981; Kodaka & Ishida 1984) and Swedish (Friskopp 1984) researchers, and are at present being performed in several laboratories.

Periodontal disease

It is probable that all the older and possibly also the younger adults had chronic inflammation of the gums (gingivitis) at least corresponding to the calculus deposits. However, the loss of alveolar bone material along and between the teeth is horizontal and slight in depth. Deeper disintegration of alveolar bone is seen only in limited areas, for example in mummy No. 5, who had a total loss of bone tissue opposite the buccal aspects of the right upper first molar (Fig. 13). Similar changes are seen approximally at the remaining upper central in-

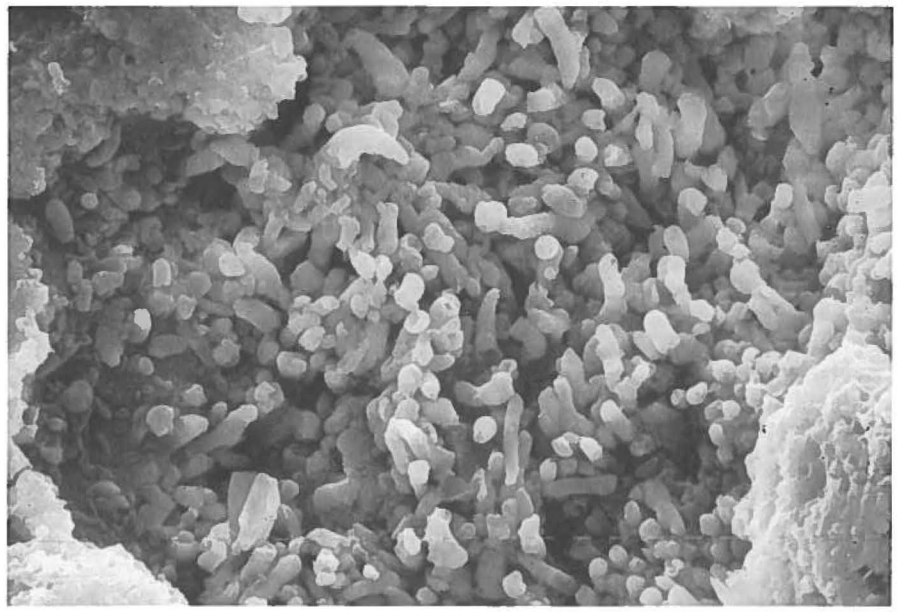

Fig. 40. SEM of supragingival calculus from the innermost layers of deposits on molars of mummy No. 8. Numerous mineralized micro-organisms. X 4,600.

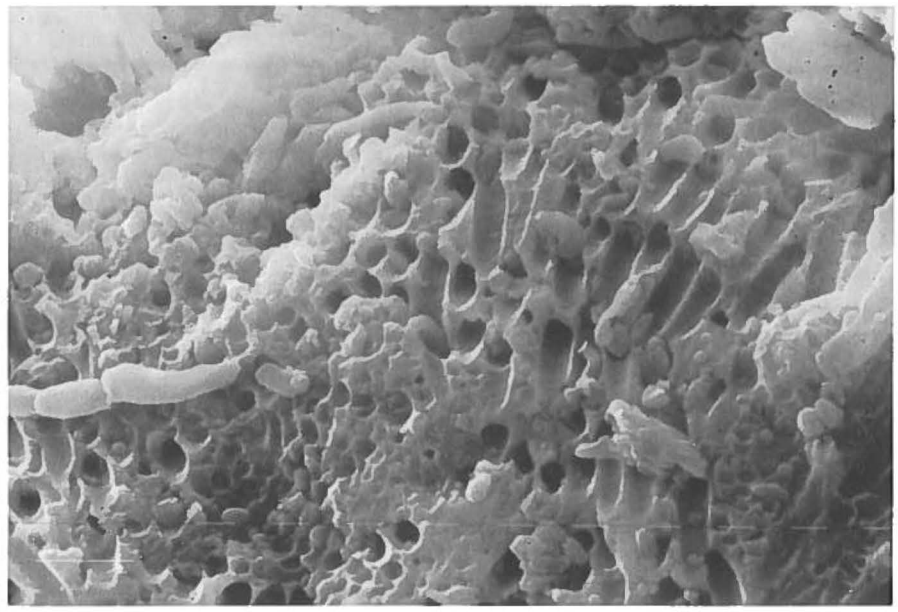

Fig. 41. SEM of surface layer of supragingival calculus shown in Fig. 40. Many lost unmineralized micro-organisms have left impressions in inorganic stroma. X 8,000.

cisor in Fig. 7. In both sites there must have been deep gingival pockets, possibly with pus formation and tenderness. Most probably these changes were initiated by bone splinters or other hard material invading the gingival sulcus.

Occlusion and Temporomandibular Joint

With one exception (mummy No. 4) all the adult mummies exhibited completely regular tooth positions. Their front teeth meet edge-to-edge and the molars show "normal" occlusion (Angle class I). The only exception is mummy No. 7 who had an abnormal bite with a deviation to the left and back of the mandibular teeth (distal occlusion of the left teeth) as shown in Figs. 20 and 21. She had marked changes in the right condyle of her mandible and the articular disc was thickened on that side. These changes are probably due to an earlier injury such as a fall or blow. The shape of the right condyle demonstrated that a certain rebuilding of the temporo-mandibular joint had occurred (Figs. 22, 23). This might have been the consequence of some slight

damage to the joint between the age of six and ten. At that stage, pain in the joint can alter the normal movements to such an extent that abnormal bite conditions develop (cf. Collin Rasmussen 1984). This, in turn, would cause later changes such as those found in the right temporo-mandibular joint of mummy No. 7.

Opportunities for close studies of the mummy temporo-mandibular joints were limited. Our findings, however, are in agreement with those published by Knowles (1915) and Ritchie (1923) who studied Canadian Eskimos and reported that their glenoid fossae were remarkably shallow. The mandibular condyles of the mature women at our disposal exhibit considerable amounts of wear and porosities but are too few in number to permit interpretations regarding joint changes as related to dental activities (cf. Merbs 1983).

Jaws

The dental radiographs of mummy No. 7 showed several sclerotic areas in her jaw bones (Fig. 19) for which we can offer no explanation.

Two of the women had bilateral overgrowths on the inner sides of their mandibles opposite the molars, so-called tori mandibulares. Those of mummy No. 8. were moderately developed, while those of mummy No. 3 were larger. A bone projection (torus palatinus) is seen in the midline of the palate in mummy No. 5. Tori mandibulares are notably frequent among Eskimos (Fürst & Hansen 1915; Leigh 1925; Hrdlička 1940; Mayhall & Mayhall 1971). They are probably caused by the special conditions of life in the Arctic, and may have arisen in connection with strongly developed masticatory musculature. Their etiology is, however, still open to discussion and is a favourite subject in arctic anthropological literature (e.g. Sellevold 1980).

In summary, the dental studies of the Qilakitsoq mummies confirmed the importance of the dentition in age estimation. They also demonstrated that the teeth of Eskimo women in the old days were overworked and damaged and in the end might be lost due to lifelong use as tools. The present studies confirm that in ancient Eskimos, calculus can occur without serious damage to the alveolar bone supporting the teeth. They also confirm that Eskimos of the past did not suffer from dental caries.

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