# Replica Studies of the Surfaces of Teeth from Alaskan Eskimo, West Greenland Natives, and American Whites.

By

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The Eskimo dentition has been the subject of many investigations, both in archaeological skull collections and in present-day living natives of Greenland, Canada and Alaska. Most studies have been concerned with numerical variations in dentition, macroscopic dental anatomy, and caries prevalence. The histologic structure of Eskimo teeth has not been investigated. The present study, as originally planned, was directed at systematically describing, by means of optical microscopy of shadowed collodion replicas, the microstructural characteristics of the enamel surfaces of Eskimo teeth. The specimens used were obtained from the Alaskan Eskimo skull collections of the Division of Physical Anthropology, Department of Anthropology, Smithsonian Institution, Washington, D. C. Early in the course of the work it became evident that while the fundamental structures being observed were similar to those seen in previous studies of the surfaces of teeth from present-day American whites, there were marked variations in these structures which could only be measured and described by means of comparison of the two groups. For this reason the study was extended to include

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a reexamination of the material used in a previous study (11) of the surfaces of extracted teeth from present-day American whites. In addition, the surfaces of a third series of teeth, extracted from present-day West Greenland natives were studied. This sample was of interest because modern West Greenlanders ethnically and culturally are between Alaskan Eskimos of earlier times and modern American whites.

In this paper tooth surfaces from the three ethnic groups are compared in regard to their microscopic characteristics and the disappearance of structure with advancing age. The relation of occlusal attrition to smooth surface structure loss is described, and finally macroscopic surface defects in the three groups are compared. The latter section has been included because it appears probable that it has some bearing on the interpretation of the microscopic findings.

## Material.

The number of skulls and individuals from whom the teeth were obtained, the number of teeth, and the number of surfaces studied are shown by age groups in Table I.

**Table I.**

*Summary of Replicas Taken.*

| Age | Alaskan Eskimo | | | | | | West Greenlanders | | | | | | American Whites | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Skulls | No. of Teeth | No. of Surfaces | | | | No. of Individuals | No. of Teeth | No. of Surfaces | | | | No. of Individuals | No. of Teeth | No. of Surfaces | | | |
| | | | Facial | Lingual | Proximal | Total | | | Facial | Lingual | Proximal | Total | | | Facial | Lingual | Proximal | Total |
| unerupted[1] | | | | | | | | | | | | | 36 | 56 | 22 | 15 | 51 | 88 |
| 5— 9... | 5 | 17 | 13 | 12 | 25 | 50 | | | | | | | | | | | | |
| 10—14... | 13 | 49 | 43 | 40 | 60 | 143 | 8 | 9 | 9 | 9 | 14 | 32 | 32 | 81 | 57 | 50 | 54 | 161 |
| 15—19... | 22 | 83 | 83 | 77 | 114 | 274 | 21 | 26 | 21 | 24 | 37 | 82 | 29 | 52 | 42 | 26 | 46 | 114 |
| 20—29... | 23 | 95 | 88 | 86 | 107 | 281 | 60 | 78 | 66 | 73 | 112 | 251 | 38 | 91 | 59 | 55 | 66 | 180 |
| 30—39... | 19 | 58 | 55 | 51 | 66 | 172 | 31 | 38 | 35 | 35 | 51 | 121 | 52 | 100 | 64 | 55 | 49 | 168 |
| 40—49... | 13 | 37 | 34 | 29 | 32 | 95 | 14 | 17 | 13 | 15 | 20 | 48 | 30 | 105 | 79 | 51 | 67 | 197 |
| 50—59... | 5 | 14 | 12 | 8 | 8 | 28 | 18 | 21 | 18 | 19 | 29 | 66 | 23 | 80 | 70 | 45 | 52 | 167 |
| Total | 100 | 353 | 328 | 303 | 412 | 1043 | 152 | 189 | 162 | 175 | 263 | 600 | 240 | 565 | 393 | 297 | 385 | 1075 |

[1] Refers to unerupted molars from individuals of various ages.

**Table II.**

*Archaeological Data on Alaskan Eskimo Skulls.*

| Locality | Collector and year collected | Archaeological dating | Number of skulls | Number of permanent teeth used for replica study |
|---|---|---|---|---|
| Point Hope | COLLINS 1929 (3) | Several hundred years | 40 | 162 |
| Cape Kialegak, St. Lawrence Is. | COLLINS 1929 (3) | More than 200 years | 3 | 11 |
| Kowieruk* | COLLINS 1929 (3) | 100 years or more | 7 | 36 |
| Akeeveenuk Near Teller* | COLLINS 1929 (3) | About 100 years | 10 | 32 |
| Koyuk, Norton Bay* | COLLINS 1929 (3) | Probably 100 years | 5 | 14 |
| Atnik, Cape Darby* | COLLINS 1929 (3) | 100 years or less | 4 | 13 |
| Golovin Bay* | COLLINS 1929 (3) | Less than 100 years | 2 | 4 |
| Shishmaref* | COLLINS 1929 (3) | About 50 years | 5 | 20 |
| Metlatavik* | COLLINS 1928 (2) | Late 19th or early 20th century | 7 | 14 |
| Unalaklet on Norton Sound | FORD and CHAMBERS 1931 (5) | Less than 100 years | 13 | 37 |
| Nixerak at Point Barrow | FORD 1931 (5) | Maximum 100 years | 4 | 10 |

The Alaskan Eskimo skulls studied at the Smithsonian Institution are all of known origin and were dated archaeologically by their collectors (Table II). Most of them were excavated from gravel sites, those from Point Hope having been covered by about three feet of gravel, those from Kowieruk by about one foot. A few of the skulls (Metlatavik, Nixerak and some from Unalaklet) came from surface burials. The collection of skulls specified in Table II is remarkably well preserved. The number

* Seward Peninsula

of remaining teeth is high and, in contrast to conditions in many Eskimo skull collections, few anterior teeth have been lost post-mortem. In order to obtain the present sample of suitable teeth from 100 different skulls, however, it was necessary to examine 220 skulls, of which 20 had practically no teeth left (most of them having been lost antemortem), 50 had teeth with such advanced occlusal and incisal attrition that the crowns were essentitally absent, and 50 showed so much post-mortem damage of the teeth that they could not be used. None of the teeth in the skulls listed in Table II had been coated with preservative material of any sort. In the teeth studied the only significant surface change which appeared to have occurred as a result of interment and drying was the development of cracks. These were not present in sufficient numbers to interfere with the study of surface structure, and they were readily recognizable in most instances by their oblique, atypical courses across the surfaces.

The individual chronological ages of the skulls were estimated by the usual anthropological means, viz., from the degree of closure of the sphenobasilar synchondrosis and the sutures of the cranial vault. In young skulls the stage of eruption of the teeth was also taken into account, while occlusal attrition was not considered in any age determinations.

The teeth from the West Greenland natives were extracted at the hospital of Julianehaab, Southwest Greenland between 1942 and 1945. A few of the natives came from surrounding villages but the majority were inhabitants of Julianehaab. All natives in this territory are of mixed Eskimo-Danish descent, abundant white admixture to the original Eskimo population having taken place for at least two centuries. The ages of the individuals from whom the teeth were extracted were recorded and the teeth were kept dry in envelopes until the time of this study. The only obvious change which had occurred as a result of drying was the development of cracks, but these were present in very small numbers.

The teeth from American whites were extracted in a dental office in Washington, D. C. Record was made of the ages of the individuals and the teeth were immediately placed in 5 % formalin. They were not allowed to dry except for the few minutes during which the replicas were made. Although these replicas were made in connection with an earlier study (11) most of the teeth were still on hand at the time of the present study and they

were examined for macroscopic surface defects together with the two other groups of teeth.

In the present study only permanent teeth were considered. Their distribution according to morphological types was: Alaskan Eskimo — 46 incisors, 44 canines, 101 premolars, 144 molars; West Greenland natives — 18 incisors, 13 canines, 34 premolars, 124 molars; American whites — 114 incisors, 53 canines, 173 premolars, 223 molars.

All of the Alaskan Eskimo teeth were non-carious. About 80 % of the teeth from the West Greenland natives, and 50 % of those from the American whites were carious. Since differences in structure between surfaces of non-carious and carious American white teeth have not been observed (11), and since surface differences between non-carious and carious teeth from West Greenland natives were not established, all surfaces have been considered together in the tabulations which follow.

## Methods.

The tooth surfaces were first cleaned with a revolving dental prophylaxis brush and a water suspension of a very fine abrasive (maximum particle size 0.3 $\mu$). It has been demonstrated (11) that this procedure does not cause appreciable alteration of structure.

The surfaces were then examined with a 2.5 power binocular loupe, and record was made of the presence or absence of caries and pronounced perikymata, scratches and cracks. In this first examination only a rough estimation of surface defects was made.

Metal-shadowed collodion replicas for optical microscopy were made of facial, lingual and proximal enamel surfaces.[1] The preparation of replicas has been described in detail previously (9). In brief, it consists of covering the surface with a collodion-amyl-acetate-ether mixture, allowing it to dry in air, and stripping off the thin film which is formed. The replica is next placed face up on a glass microscope slide and shadowed in a vacuum chamber. It is placed 3 cm below and 6 cm in front of a tungsten wire filament containing 65 mg of silver, which is heated until the metal evaporates. A thin layer of silver is thus deposited obliquely on the surface of the replica, and shadows are cast by the

[1] Due to the irregular topography of occlusal surfaces replica studies have thus far been limited to so-called "smooth" surfaces (facial, lingual, and proximal).

elevations which stand in its path. The angle of deposition is such that the shadows are roughly twice the length of the objects which cause them. By shadowing, the microscopic detail on the replica, which is otherwise difficult to observe with transmitted light is brought into pronounced tri-dimensional relief.

In examining the accompanying micrographs it is important to remember that the topographic detail on the surface is reproduced on the replica in reverse; depressions in the surface appear as elevations on the replica, and vice versa.

The replicas were studied with an optical microscope at magnifications of 35 ×, 100 × and 450 ×. Several hundred of the replicas from the Alaskan Eskimo were examined first, and as soon as it was determined that with regard to some structures comparison with the American white sample was necessary, the replicas from the latter group were re-examined, and the standards to be described subsequently were established. The replicas from all three groups were then studied and the necessary structural comparisons made on the basis of these standards. The replicas were not grouped according to sample, morphological type of tooth, tooth surface or age, but were examined at random. The findings were recorded and the various tabulations were made subsequent to the microscopy.

After completion of the replica study it proved necessary to examine the entire number of teeth from all three ethnic groups for macroscopic surface defects. The teeth were dried and inspected under a 1.5 power hand lens. Findings for each surface were recorded on the same punch cards on which the results of the replica study had been previously recorded.

## Microscopic Surface Structure.

The principal microscopic details on the replicas of facial, lingual and proximal surfaces from all three ethnic groups are perikymata, enamel rod ends, cracks, scratches, small depressions designated as micro-pits, and two hitherto undescribed configurations, designated as lamination and reticulation.

The appearance, course, and distribution of the perikymata on the surfaces of teeth from American whites have been described previously (9, 10, 11). These transverse waves, which are developmental in nature, are observed on all areas of the smooth surfaces except those from which they have been lost as a result of

wear. The concentration of perikymata decreases regularly from the cemento-enamel junction to the occlusal or incisal edge of a surface, there being an average of 30 per millimeter in the former region and 10 in the latter. The course of the perikymata is slightly undulate across a surface and they are generally parallel to each other and to the cemento-enamel junction.

The presence and distribution of perikymata on the surfaces of teeth from the Alaskan Eskimo and West Greenland natives closely resemble those from the American whites, but there are marked differences in their course. To determine these differences the perikymata were classified into three types, according to regularity of course. Perikymata designated as *regular* followed an even course across the surface (Fig. 1). Those designated as *irregular* (Figs. 2—5) showed great deviation from the regular course, the aberrances extending cervically for at least the distance between two perikymata. The third type, *medium*, included perikymata showing slight deviation from the regular course, which could not definitely be classified as irregular (Figs. 6—7).

Quite often the course of the perikymata is more irregular in some regions of a surface than in others. Irregular perikymata are most commonly found in the cervical half, but in some instances, the irregularity extends over the entire surface area. The distribution of surfaces by perikymata type is shown in Table III. In this tabulation the designations *medium* and *irregular*

**Table III.**

*Distribution of Surfaces by Perikymata Type.*

| Ethnic group | Number of surfaces with perikymata | Distribution of surfaces | | | Percent of surfaces with irregular perikymata by tooth type | | | | Percent of surfaces with irregular perikymata by surface type | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % with regular perikymata | % with medium perikymata | % with irregular perikymata | Incisors | Canines | Premolars | Molars | Facial | Lingual | Proximal |
| American white ..... | 902 | 72 | 22 | 6 | 4 | 0 | 2 | 12 | 6 | 4 | 7 |
| Alaskan Eskimo ..... | 931 | 19 | 39 | 42 | 33 | 43 | 29 | 54 | 51 | 31 | 42 |
| West Greenland ..... | 562 | 14 | 28 | 58 | x | x | 52 | 65 | 69 | 44 | 58 |

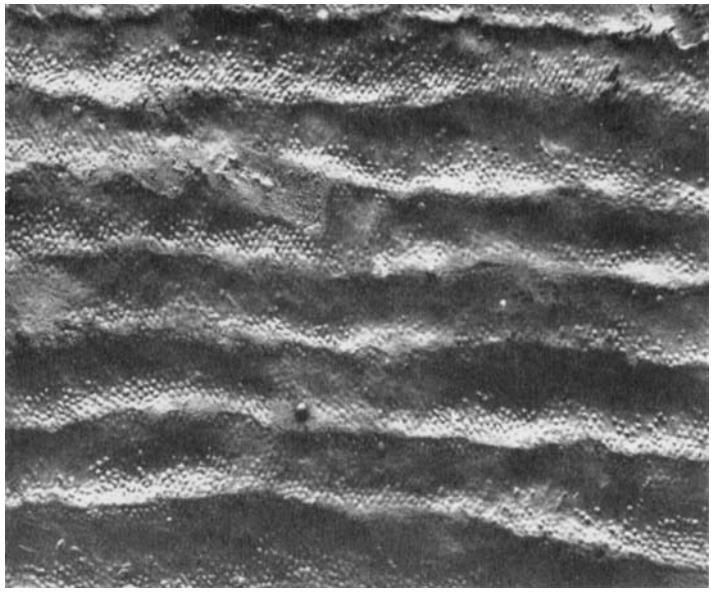


Fig. 1. *Regular* perikymata. (Premolar, mesial surface, Alaskan Eskimo, age group 30—39) × 120.

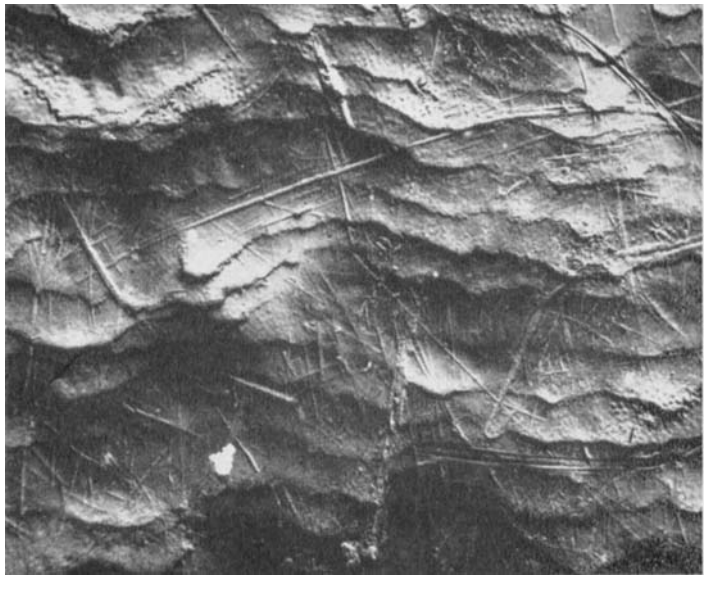


Fig. 2. *Irregular* perikymata (molar, lingual surface, Alaskan Eskimo, age group 30—39) × 120.



Fig. 3. *Irregular* perikymata (molar, distal surface, West Greenland, age 23) × 120.

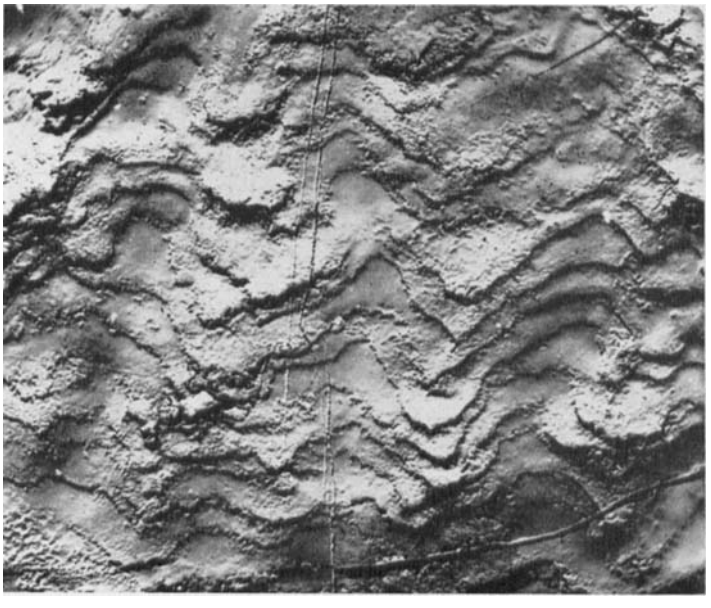


Fig. 4. *Irregular* perikymata in the gingival portion of a surface (molar, facial surface, Alaskan Eskimo, age group 15—19) × 120.

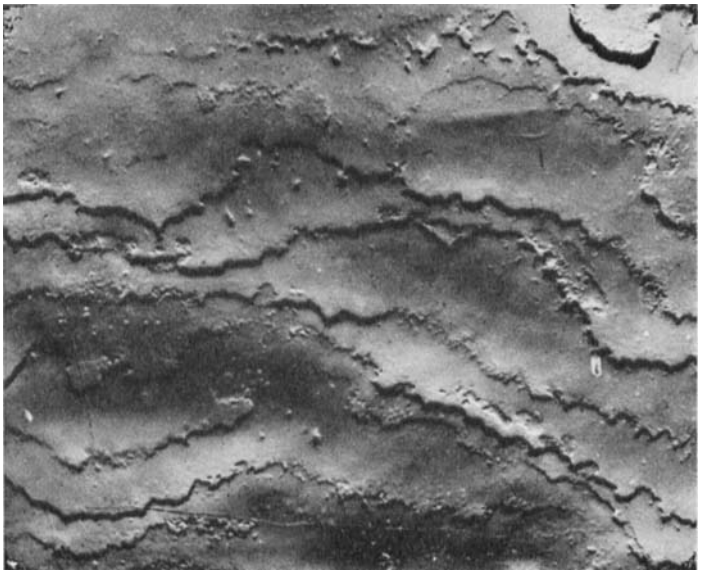


Fig. 5. *Irregular* perikymata in the gingival portion of a surface (molar, lingual surface, West Greenland, age 24), × 120.

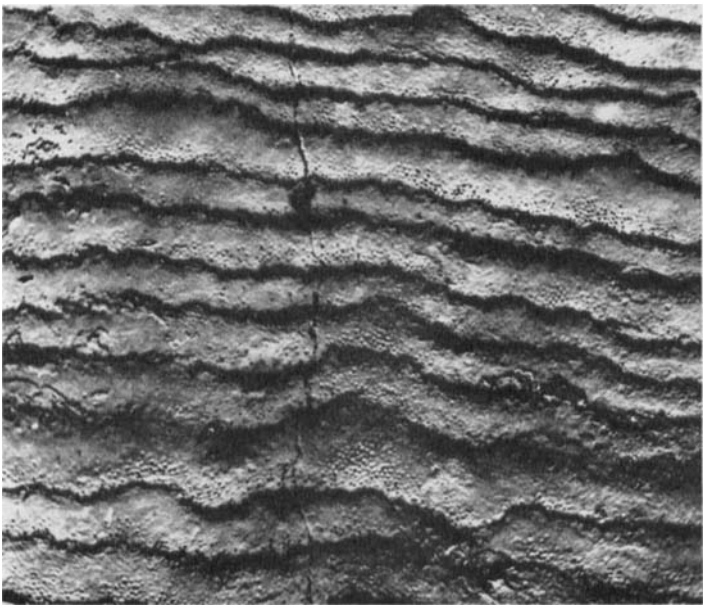


Fig. 6. *Medium* perikymata (molar, facial surface, Alaskan Eskimo, age group over 50) × 120.



Fig. 7. *Medium* perikymata (premolar, mesial surface, Alaskan Eskimo, age group 15—19) × 120.

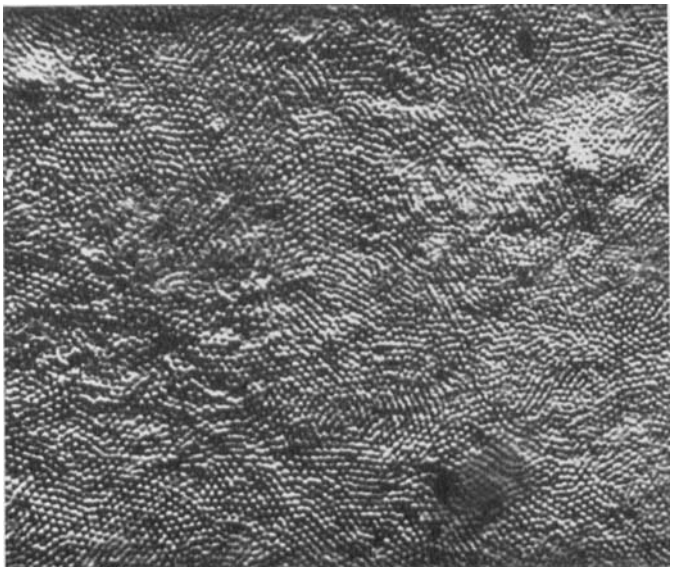


Fig. 8. Enamel rod ends (molar, facial surface, Alaskan Eskimo, age group 10—14) × 120.

refer to the maximum degree of perikymata irregularity observed on a surface, while *regular* refers to complete regularity of all the perikymata on a surface. It can be seen that surfaces with irregular perikymata are much more frequent in both the Alaskan and the West Greenland samples than in the American white. The surfaces of molars appear to have more irregular perikymata than do those of other morphological types of teeth, but it has been established that differences do not exist in the prevalence of perikymata irregularity in first, second, or third molars. In the Alaskan and Greenland samples facial surfaces show irregular perikymata more frequently than do lingual and proximal surfaces.

The enamel rod ends on the surfaces of teeth from the Alaskan Eskimo and West Greenlanders do not differ in appearance from those in the American whites (Fig. 8). They are concave, about 6 $\mu$ in diameter, and show the same variations in depth, ordinarily being shallowest in the cervical regions and deepest near the incisal or occlusal edges of the surfaces.

The prevalence of micro-pits, laminated areas, and reticulated areas among individuals, teeth, and surfaces in the three samples is shown in Table IV. The occurrence and appearance of micro-

**Table IV.**

*Occurrence of Some Specific Structures on Tooth Surfaces.*

| Ethnic group | Micro-pits | | | Laminated areas | | | Reticulated areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | % of individuals | % of teeth | % of surfaces | % of individuals | % of teeth | % of surfaces | % of individuals | % of teeth | % of surfaces |
| American white ..... | 36 | 23 | 15 | 24 | 13 | 9 | 10 | 7 | 4 |
| Alaskan Eskimo ..... | 53 | 29 | 19 | 63 | 31 | 15 | 46 | 20 | 11 |
| West Greenland ..... | 15 | 13 | 5 | 75 | 70 | 41 | 43 | 42 | 20 |

pits, or small depressions, on the surfaces of teeth from American whites have been described and illustrated in a previous publication (11). These pits are shallow, circular or irregular in shape, from 20 to 50 $\mu$ in diameter, and are generally localized in the cervical region of a surface. From their appearance, as well as their occurrence on unerupted teeth, they seem to be develop-

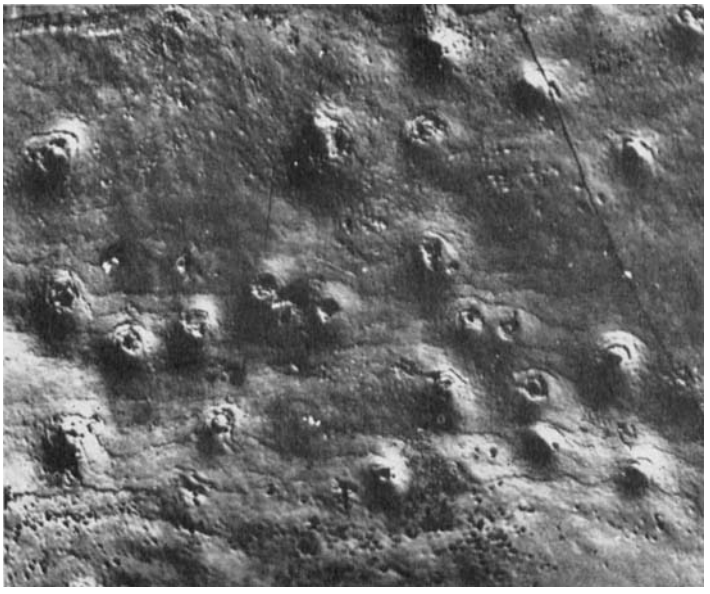


Fig. 9. Micro-pits in the cervical region of a surface (canine, mesial surface, Alaskan Eskimo, age group 5—9) × 120.



Fig. 10. Micro-pits in the mid-region of a surface (molar, lingual surface, Alaskan Eskimo, age group 15—19) × 120.

mental in origin. In the present study they were found in a slightly higher proportion of the individuals, teeth, and surfaces in the Alaskan Eskimo than in the American whites, and in a considerably lower proportion in the West Greenlanders. In all three groups the percents of molar teeth and molar surfaces showing micro-pits are higher than the corresponding percents for incisors, canines and premolars, but the breakdown according to facial, lingual, and proximal surfaces does not demonstrate appreciable differences. In the Alaskan Eskimo group the micro-pits are not restricted to the cervical regions of the surfaces as in the other groups but also occur in the midregions (Figs. 9—10).

On many of the surfaces in all three samples localized shelf-like, or laminated areas were observed. They are considerably more prevalent in the West Greenland and Alaskan Eskimo samples than in the American white. Their typical appearance resembles grotesquely aberrant perikymata (Figs. 11—13). In most instances they occur in small patches less than a millimeter square. They are seldom seen on the occlusal thirds of the surfaces and they are also rare on surfaces exhibiting total loss of perikymata and rod ends due to wear. In all three samples they were seen more frequently in molars than in incisors, canines, and premolars and on facial surfaces more frequently than on the other surfaces. The origin and significance of these laminated areas are not known.

Reticulated, or net-like configurations were observed on many of the surfaces in all three samples. These shallow, narrow grooves were almost always found on the incisal or occlusal thirds of the surfaces. Their general pattern was that of an irregular network, in most cases discontinuous (Fig. 14). In all three ethnic groups they were more prevalent on the surfaces of premolars and molars than of incisors and canines, but no one particular type of tooth surface was involved more frequently than the others. The only clue thus far to the correct interpretation of this structure is that, unlike micro-pits and laminations, it occurs slightly more often on surfaces which show signs of initial wear. This might mean that the pattern represents an early stage in the loss of perikymata.

Due to the cracking of some surfaces resulting from the post-mortem drying of the teeth in the Alaskan and Greenland samples it was not possible to determine accurately the relative types and numbers of naturally occurring cracks on these surfaces. However,



Fig. 11. Laminated area and large oblique crack which most likely developed after extraction (molar, facial surface, West Greenland, age 54) × 120.

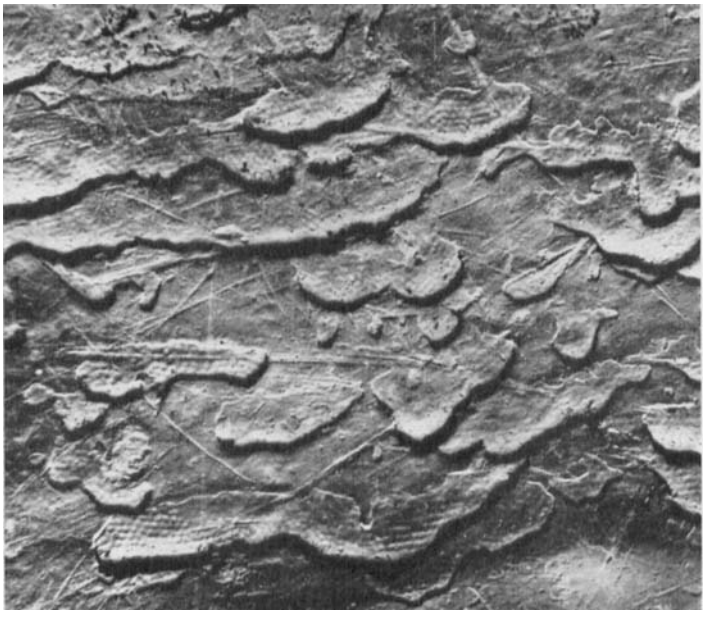


Fig. 12. Laminated area (premolar, mesial surface, West Greenland, age 32) × 120.

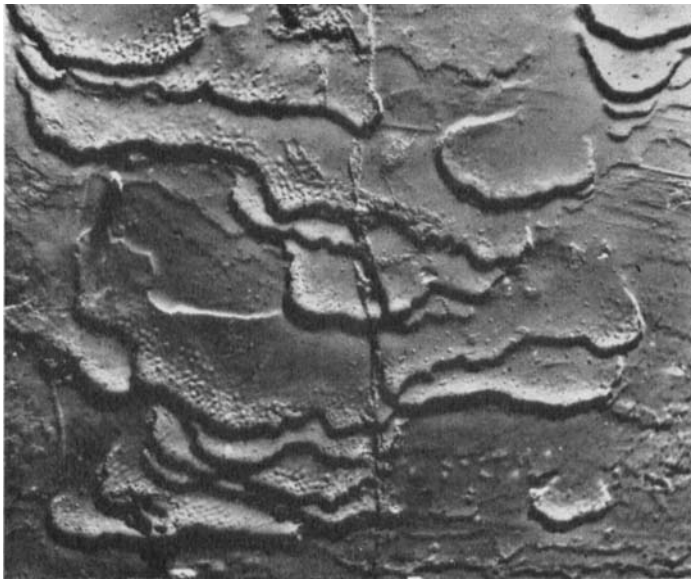


Fig. 13. Laminated area (molar, facial surface, Alaskan Eskimo, age group 40—49) × 120.



Fig. 14. Reticulation on the occlusal third of a molar surface (molar, facial surface, Alaskan Eskimo, age group 5—9) × 120.



Fig. 15. Irregular cemento-enamel junction (molar, mesial surface, West Greenland, age 37) × 120.



Fig. 16. Irregular perikymata on the surface of an enamel extension (molar, facial surface, Alaskan Eskimo, age group 10—14) × 120.

those cracks which were not visibly complicated by post-mortem cracks appeared similar in all respects to those previously observed on teeth of American whites. Large numbers of short, narrow cracks were noted in the cervical regions, perpendicular to and originating from the cemento-enamel junction. Few cracks extended more than halfway and an even smaller number all the way to the occlusal or incisal edges of the surfaces. The coincidence of cracks and the outer edges of lamellae on the surfaces of American white teeth has been described in a previous publication (12), and it is thought that in the case of the Arctic samples in this study the same interpretation holds true.

The surfaces of the Alaskan and Greenland teeth showed scratches which were only slightly greater in prevalence and depth than those on the surfaces of the teeth from American whites. This was surprising in the case of the Alaskan Eskimo sample, considering the in vivo and post mortem environment to which the teeth had been exposed.

Another structural feature of interest is the commonly observed irregularity of the cemento-enamel junction in the teeth from West Greenland and Alaska. Although the course of the cemento-enamel junction in the teeth from American whites is ordinarily somewhat uneven, much more marked deviations are exhibited by the teeth in the Alaskan and Greenland samples (Fig. 15). On molar teeth of whites, particularly on the buccal surfaces, the enamel often extends apically opposite root bifurcations and grooves in the form of a short triangular process. The frequent occurrence in Eskimo of so-called "enamel extensions" *i. e.*, much longer continuations of the enamel toward, or in many cases into, the root bifurcations has been reported and their macroscopic appearance described (4, 6, 8). Examination of replicas of enamel extensions in Alaskan Eskimo and West Greenland native teeth has revealed that such regions of the enamel are characterized by perikymata and rod end patterns similar to those in the normal plane of the cemento-enamel junction of the particular surfaces from which they extend. Generally speaking they show a high concentration of very irregular perikymata (Fig. 16).

The conclusions which can be drawn from the study of the microscopic characteristics of the Alaskan Eskimo and West Greenland native tooth surfaces examined are that in many respects the two resemble each other quite closely, but that they differ

strikingly from those of the teeth from the American whites. The significance of the high proportion of surfaces in the Alaskan and Greenland groups which show irregular perikymata, as well as micro-pits, lamination and reticulation (none of which seem to be interrelated) is not known. Two explanations which might be ventured are that these structural differences have been brought about by influences acting during the time of tooth development, or, less likely, that they could conceivably represent genetic or racial characteristics.

## Changes in Surface Structure with Advancing Age.

In a previous study of the smooth surfaces of teeth from American whites (11) it was found that the amount of structural detail present is related to the ages of the teeth. The data showed that with advancing age there is a progressive and gradual wearing away of the perikymata and enamel rod ends. The rate at which these structures are lost depends upon both the location of the surface on the tooth and the location of the tooth in the dental arch. The perikymata and rod ends were found to disappear more quickly from facial surfaces than from lingual or proximal surfaces, and in the case of all types of surfaces they were lost more rapidly in incisors and canines than in premolars and molars.

For the present comparsion of the changes with age of surface structure in the three ethnic groups the replicas were evaluated according to the same standards as those previously used (11). Record was made of the presence or absence of perikymata and rod ends, of their relative prominence, and of the approximate amount of surface area showing these details. Tabulations according to age groupings were made as before of the percents of surfaces (specific for surface type and morphological type of tooth) showing *pronounced*, *medium*, *faint*, or *absent* perikymata and rod end patterns. It was found that the amount of structural detail on the surfaces of Alaskan Eskimo and West Greenland native teeth decreased with advancing age and that this loss of structure followed a pattern closely similar to that in the American whites. The general trend of the data is shown in Figure 17. The only noteworthy differences between the three ethnic groups were that in the Alaskan and Greenland samples lingual surfaces appeared to have lost their structure more quickly than did those in the American white sample, and that a smaller number of the surfaces

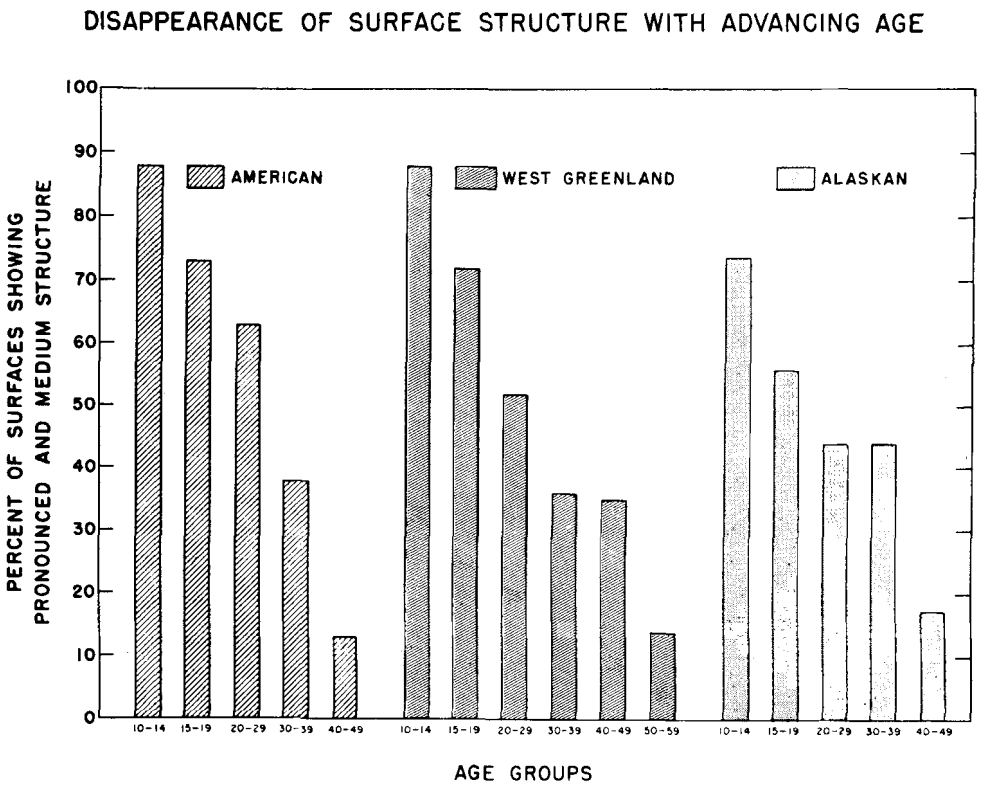



Fig. 17.

in the former two groups fell in the *absent* category. For example, in a comparison of molar surfaces in the three samples, for ages 40—49, it was found that only 7 % of the surfaces in the Alaskan Eskimo group and 4 % in the West Greenland group did not show visible structure as compared to 20 % in the American whites.

## Occlusal Attrition and Smooth Surface Structure.

In view of the fact that occlusal and incisal attrition of the teeth was so much more marked in both the Alaskan Eskimo skulls and the present-day West Greenland natives than in the present-day American whites, it was unexpected not to find a proportionately more rapid loss of structural detail from the smooth surfaces of

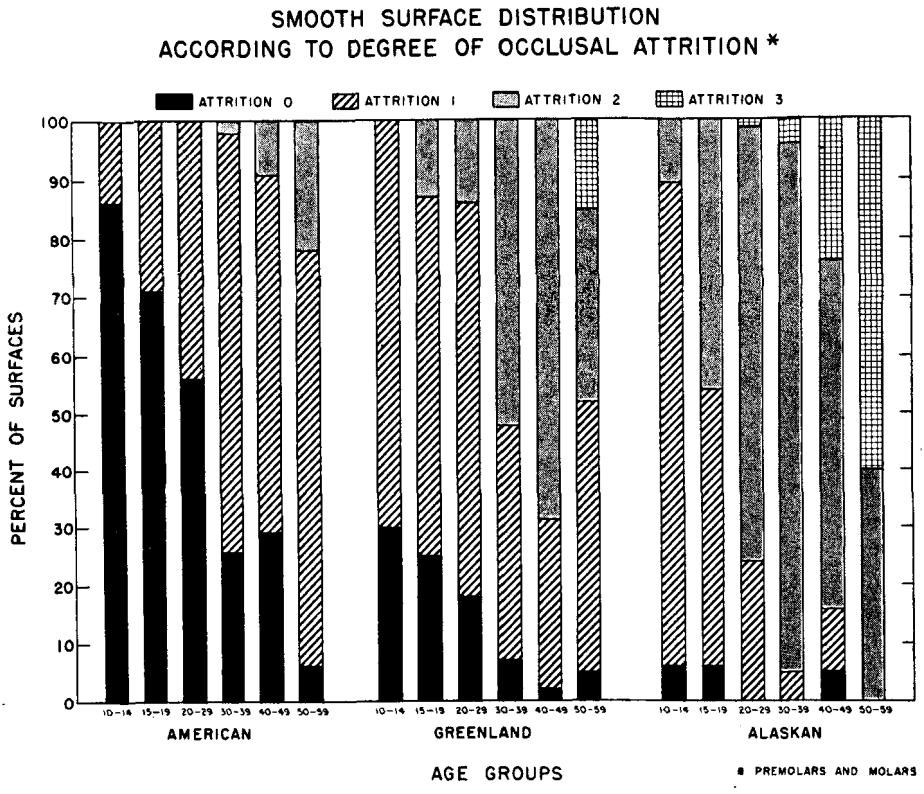



Fig. 18.

the former two groups. In order to determine the relation between occlusal attrition and smooth surface structure loss, the degree of occlusal attrition of all premolars and molars was estimated according to the standards established by BROCA (1). In BROCA's classification, degree 1 designates attrition not exposing the dentin, degree 2, partial exposure of the dentin, degree 3, total exposure of the dentin, and degree 4, total loss of the crown.

The facial, lingual, and proximal surfaces which had been studied microscopically were then separated according to the degree of occlusal attrition of the teeth on which they were located, and grouped by age (Fig. 18). In this graph it can be seen that in each age group a large proportion of the surfaces were located on teeth showing no occlusal attrition in the American white sample, attrition 1 in the West Greenland sample, and attri-

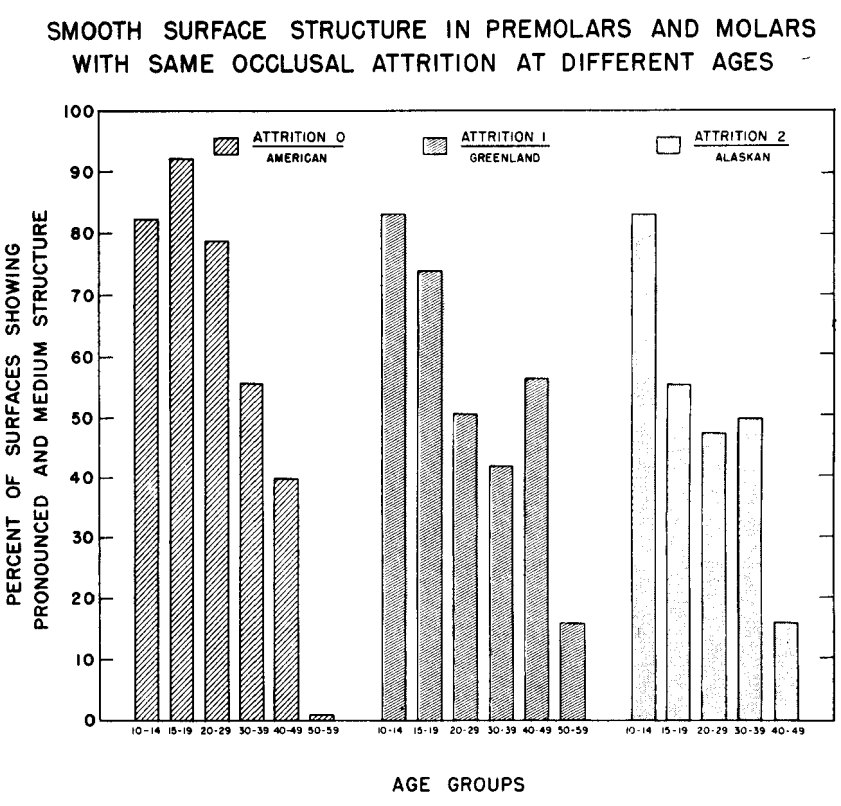



Fig. 19.

tion 2 in the Alaskan sample. An opportunity was thus afforded of comparing the quantities of structure on the smooth surfaces of teeth showing the same degree of occlusal attrition at different age levels. It would be expected that if the factors causing occlusal attrition influence the disappearance of structural detail from the smooth surfaces either all the surfaces in a particular attrition category should resemble each other, regardless of age, or the rate of loss, considered by advancing age groups, should be enhanced by the attrition. That the former is not the case is evident, as shown in Figure 19, and it is also apparent that only a slight acceleration in structure loss occurred, noticeable mainly in the younger age groups.

## Macroscopic Surface Defects.

In an attempt to determine the significance of the pronounced structural differences between the surfaces of the Alaskan Eskimo and West Greenland teeth and those of the teeth from the American whites, the question arose whether or not similar differences existed in the proportions of surfaces showing macroscopic defects. The surfaces of all teeth from the three ethnic groups were reexamined under a hand lens, and it was found that almost all of the visible defects appeared either as small pits or as shallow, transverse grooves. These pits and grooves resembled what are commonly designated as mild hypoplastic defects. In order to approximate the relative depth and number of pits the surfaces were classified according to a set of standards made available by Lady MELLANBY in connection with studies in Greenland. These standards consist of a series of permanent molar teeth showing progressively increased degrees of surface pitting, designated as Hy 1, Hy 2, and Hy 3. A molar with no pitting (Hy 0) is also included, as well as a molar (Hy 3 gross) showing the extremely distorted surfaces of a "grossly" hypoplastic tooth. It was found that in each of the three samples under study more than 90 % of the teeth and surfaces were distributed in classes Hy 0 to Hy 2, about 5 % in class Hy 3, and less than 1 % in class Hy 3 gross. The typical microscopic appearance of pits on the replicas of surfaces classified as Hy 1, 2, and 3 is shown in Figures 20—22. Pits on the first type of surface are irregular in shape, shallow, and usually not over 150 $\mu$ in diameter. Pits on the Hy 2 type of surface are similar in shape, slightly deeper, and in the range of 250 $\mu$ in diameter, while those on the Hy 3 type of surface are considerably deeper, much more sharply outlined, and often 500 $\mu$ or more in diameter.

The percents of teeth showing macroscopically pitted surfaces, and the percents of surfaces, according to type of surface and morphological type of tooth, which show pits macroscopically are presented in Tables V and VI. It can be seen that considerably higher proportions of teeth and surfaces are affected in the Alaskan and West Greenland samples than in the sample from the American whites. Of interest is the observation that the prevalence of pitted surfaces is considerably higher in molars and canines than in incisors and premolars (Table V). It was also established that facial surfaces are more often pitted than are



Fig. 20. Pits on a surface classified macroscopically as Hy 1 (Mellanby) × 120.



Fig. 21. Pits on a surface classified macroscopically as Hy 2 (Mellanby) × 120.

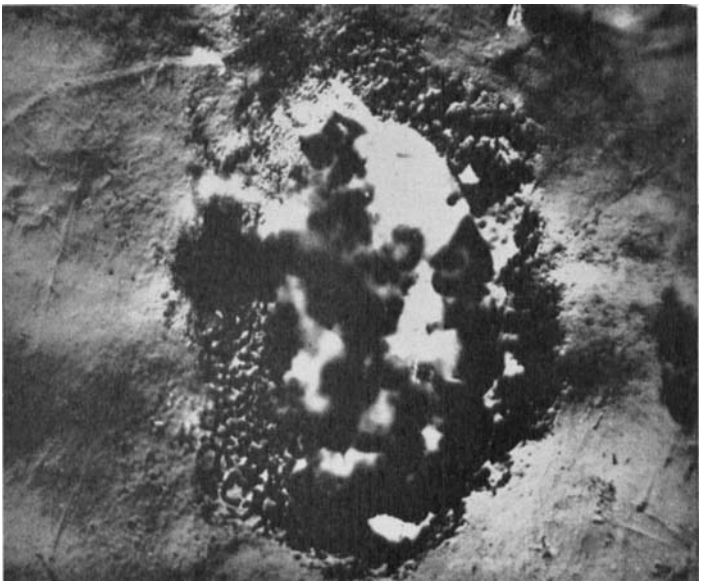


Fig. 22. Pit on a surface classified macroscopically as Hy 3 (Mellanby) × 120.

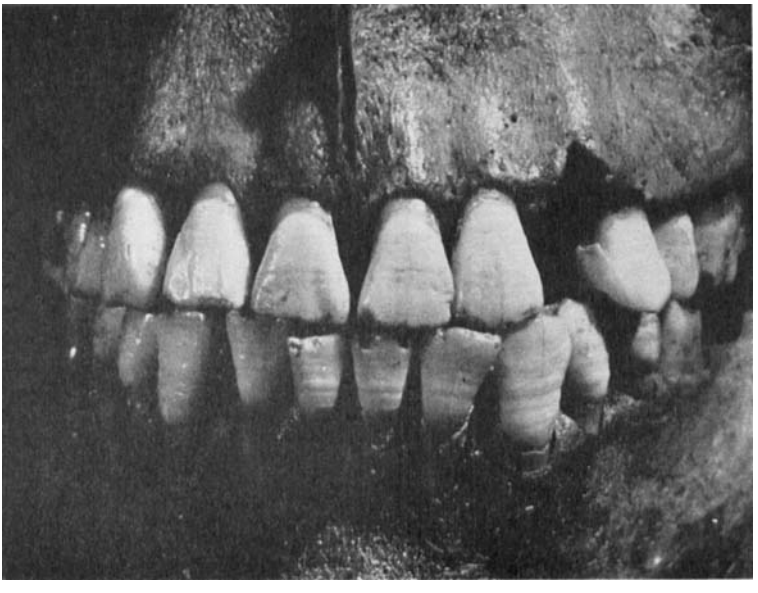


Fig. 23. Transverse grooves on the facial surfaces of the anterior teeth in an Alaskan Eskimo skull.

**Table V.**

*Percent of Teeth Showing Macroscopic Surface Defects.*

| Ethnic group | Type of defects | Morphological types of teeth | | | | |
|---|---|---|---|---|---|---|
| | | Incisors | Canines | Pre-molars | Molars | Total |
| American white | Pits | 7 | 30 | 17 | 35 | 22 |
| | Grooves | 18 | 23 | 6 | 7 | 11 |
| | Total | 23 | 56 | 21 | 39 | 32 |
| Alaskan Eskimo | Pits | 13 | 48 | 19 | 43 | 31 |
| | Grooves | 50 | 43 | 37 | 15 | 31 |
| | Total | 59 | 82 | 50 | 53 | 57 |
| West Greenland | Pits | (33)[1] | (53)[1] | 26 | 55 | 48 |
| | Grooves | (22)[1] | (38)[1] | 3 | 6 | 9 |
| | Total | (61)[1] | (77)[1] | 29 | 60 | 55 |

lingual and proximal surfaces (Table VI). Finally, in the sample of American white teeth, it was found that approximately the same percents of surfaces on non-carious teeth (17 %) showed pits as on carious teeth (13 %). In the West Greenland teeth the proportions were the same; however, the number of non-carious teeth studies was small.

The transverse grooves were much more prevalent in the Alaskan Eskimo sample than in the other two ethnic groups (Tables V and VI). They were more commonly found on incisors and canines than on posterior teeth and were more common on facial than on lingual and proximal surfaces. Usually there were only one or two of these grooves on a tooth surface in the American white sample, while in the other two ethnic groups, especially the Alaskan Eskimo, the number per surface was often greater (Fig. 23). The grooves here described do not stand out microscopically, since they appear as gently rolling elevations on the

[1] Small sample.

**Table VI.**

*Percent of Surfaces Showing Macroscopic Defects.*

| Ethnic group | Morphological types of teeth | Facial surfaces % showing: | | Lingual surfaces % showing: | | Proximal surfaces % showing: | |
|---|---|---|---|---|---|---|---|
| | | Pits | Grooves | Pits | Grooves | Pits | Grooves |
| American white | Incisors.... | 5 | 19 | 0 | 5 | 2 | 10 |
| | Canines.... | 32 | 25 | 14 | 0 | 0 | 0 |
| | Premolars.. | 13 | 6 | 10 | 4 | 5 | 3 |
| | Molars..... | 37 | 9 | 19 | 2 | 16 | 0 |
| Alaskan Eskimo | Incisors.... | 14 | 53 | 2 | 17 | 3 | 23 |
| | Canines.... | 52 | 50 | 11 | 16 | 15 | 35 |
| | Premolars.. | 18 | 39 | 7 | 27 | 9 | 29 |
| | Molars..... | 45 | 14 | 19 | 7 | 17 | 7 |
| West Greenland | Incisors.... | (33)[1] | (28)[1] | (29)[1] | (6)[1] | (21)[1] | (14)[1] |
| | Canines.... | (42)[1] | (25)[1] | (8)[1] | (23)[1] | (19)[1] | (19)[1] |
| | Premolars.. | 18 | 4 | 10 | 0 | 5 | 0 |
| | Molars..... | 54 | 4 | 27 | 2 | 16 | 2 |

replicas and their surface structure is not different from that of the areas between them.

The results of the macroscopic examination showed that, as in the case of the microscopic findings, the surfaces of the Alaskan Eskimo and West Greenland native teeth were markedly more irregular than those of teeth from the American white sample. Since the types of surface defects which were observed macroscopically are generally thought to result from systemic disturbances occurring during tooth formation, the gross evidence of much more imperfect tooth development in the Alaskan Eskimo and West Greenland natives lends support to the contention that the microscopic irregularities may be similar in origin.

[1] Small sample.

## Summary.

Metal shadowed collodion replicas for optical microscopy were made of: (1) 1,043 surfaces of 353 permanent teeth from 100 Alaskan Eskimo skulls in the Smithsonian Institution of Washington; (2) 600 surfaces of 189 permanent teeth extracted from 152 modern West Greenland natives; and (3) 1,075 surfaces of 565 permanent teeth from 240 Washington, D. C. dental office white patients.

The microscopic structures observed on the tooth surfaces from the three ethnic groups were: perikymata, enamel rod ends, micro-pits, lamination, reticulation, scratches, and cracks. It was found that the course of the perikymata is markedly more irregular on the surfaces of the Alaskan Eskimo and West Greenland teeth than on the teeth from the American whites. In addition, the prevalence of lamination and reticulation is much greater in the former two groups than in the latter.

The disappearance of surface structure (enamel rod ends and perikymata) with advancing age was studied in the three samples. Similar rates of progression of structure loss with age were found. Grouping of surface replicas by age of individuals and degree of occlusal attrition of teeth showed that factors causing occlusal wear do not seem to contribute appreciably to smooth surface structure loss.

Inspection of all teeth involved showed higher incidence of macroscopic surface irregularity (pits and grooves) in the Alaskan Eskimo and West Greenlanders than in the whites.

It is thought that the high proportion of microscopic and macroscopic surface irregularity in the Arctic groups resulted from influences of a non-genetic nature during tooth formation.



## Résumé.

Des répliques au collodion ombrées au métal pour la microscopie optique furent faites des objets suivants:

1°. 1043 surfaces de 353 dents permanentes de 100 crânes d'Esquimaux d'Alaska à la Smithsonian Institution of Washington;

2°. 600 surfaces de 189 dents permanentes extraites de 152 indigènes vivants du Groenland occidental;

3°. 1075 surfaces de 565 dents permanentes de 240 clients (Américains blancs) d'une clinique dentaire à Washington, D. C.

Sur les surfaces coronaires des dents de ces trois groupes ethniques on a pu constaté des différentes structures microscopiques. Ces structures ont été: périkymaties, extrémités de prismes d'émail, micro-dépressions, lamination, réticulation, égratignures, craquelures. On a trouvé le cours des périkymaties décidément plus irrégulier sur les surfaces d'émail des dents provenant d'Esquimaux d'Alaska et d'indigènes du Groenland occidental que sur les surfaces des dents d'Américains blancs. En outre, on a trouvé la lamination et la réticulation beaucoup plus fréquentes chez les deux premiers groupes que chez le dernier.

La disparition graduelle du relief de surface (extrémités de prismes d'émail et périkymaties) avec l'âge avançant fut étudiée dans les trois groupes de dents. Il fut constaté que la perte des reliefs avec l'âge avançant se fait sur à peu près le même rythme dans les trois groupes. Le classement des répliques de surface par âge des personnes et par degré de l'usure des faces triturantes a révélé que les facteurs causant de l'usure des faces triturantes ne semblent pas contribuer beaucoup à la perte de structure des surfaces lisses.

L'examen de toutes les dents faisant l'objet de l'étude a montré que les irrégularités de surface macroscopiques (petites dépressions circulaires et linéaires) sont plus fréquentes chez les Esquimaux d'Alaska et les indigènes du Groenland occidental que chez les Américains blancs.

Il est supposé que le fait que les irrégularités de surface microscopiques et macroscopiques sont tellement fréquentes chez les groupes arctiques est dû à l'influence d'une nature non-héréditaire pendant la formation des dents.

## Zusammenfassung.

Zum Zwecke optisch-mikroskopischer Studien wurden durch Metall beschattete Kollodiumabdrücke an folgendem Untersuchungsmaterial hergestellt:

1) 1043 Zahnflächen an 353 bleibenden Zähnen von 100 Eskimoschädeln aus The Smithsonian Institution of Washington,

2) 600 Flächen an 189 bleibenden Zähnen, die bei 152 heutigen Westgrönländern extrahiert waren,

3) 1075 Flächen an 565 bleibenden Zähnen weisser Amerikaner (aus einer zahnärztlichen Privatpraxis in Washington, D. C.).

Die mikroskopischen Gebilde, die an den untersuchten Zahnflächen der drei ethnischen Gruppen zur näheren Beobachtung kamen, waren: Perikymatien, Schmelzprismen-Enden, Mikrogrübchen, Plättchenbildungen, Netzbildungen, Schrammen und Spalten. Es zeigte sich, dass der Verlauf der Perikymatien auf den Schmelzoberflächen der Zähne ausgesprochen stärkere Unregelmässigkeiten bei den Alaskaeskimos und den Eingeborenen Westgrönlands aufweist als bei den weissen Amerikanern. Ausserdem war Plättchen- und Netzbildung bei den beiden ersten Gruppen viel häufiger als bei der letztgenannten.

Das allmähliche Verschwinden des Oberflächenreliefs (Enden der Schmelzprismen und Perikymatien) mit zunehmenden Lebensalter wurde ebenfalls studiert, wobei ungefähr das gleiche Tempo im Verlust des Reliefs bei allen drei Gruppen festgestellt wurde. Eine Einteilung der Oberflächenabdrücke nach dem Alter der Personen und dem Grad der Kauflächenabnutzung der Zähne zeigte, dass die Faktoren, die die Kauflächenabnutzung bewirken, nicht wesentlich zum Verschwinden der Oberflächenstruktur an den glatten Flächen der Zahnkronen beizutragen scheinen.

Makroskopische Unregelmässigkeiten der Schmelzoberflächen (Grübchen und Furchen) wären häufiger bei den Alaska-Eskimos und den Westgrönländern festzustellen als bei den weissen Amerikanern.

Es wird angenommen, dass das stark gehäufte Vorkommen mikroskopischer und makroskopischer Oberflächenunregelmässigkeiten bei den arktischen Gruppen einem nicht erblichen Einfluss während der Zahnentwicklung zuzuschreiben ist.

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