

## ON CERTAIN ESKIMOID CHARACTERS IN ICELANDIC SKULLS

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The Peabody Museum of Harvard University possesses a collection of skeletal remains from Iceland consisting of 1 complete skeleton, 2 incomplete skeletons, 3 skulls with mandibles, 80 skulls without mandibles, including 60 in fairly good condition, 62 odd mandibles, and a large number of long bones and other skeletal parts.

These remains were collected in 1905 by John W. Hastings and Vilhjalmur Stefánsson. The Hastings collection (P. M. Cat. Nos. 57853-57885) came from Alftanes, Iceland, a small island off the coast near Reykjavik. The data in connection with the material are as follows:

These bones came from a church graveyard still in use. The church dates back to 1000 or so A.D. The bones were taken from what was said to be the oldest portion of the graveyard. They were taken out of a hole 6 x 12 and some 7 feet deep, out of which came the fragments of some 50 individuals. Owing to the Icelandic custom of burying the dead 6 feet deep and of using such small graveyards that in the course of years many interments have to be made in the same place, the oldest bones were found at a depth of from 2-5 feet. Six feet down were one or two burials that must have been made within the last 50 years. The tradition of the place was that part of the graveyard was so full on account of the Black Death which occurred in Iceland in 1402.

The remains collected by Stefánsson (P. M. Cat. Nos. 57886-57957) come from "Haffjorderey, Iceland (Hafrsfjarthar-ey, or Haffjartharey)."

These bones are from a church graveyard of considerable age. The oldest records of the church date from 1200 A.D. The church was removed in 1563. As far as is known there have been no subsequent burials.

Mr. Hastings began a study of this collection and also of a series of measurements and observations made by him upon living Icelanders, but the work was interrupted by his death. His incomplete notes were deposited in the Peabody Museum. I hope at a future date to publish a complete report on this collection, together with an elaboration of the anthropometric data secured by Mr. Hastings.

The present paper concerns itself with certain striking resemblances to Eskimo characters exhibited in this Icelandic collection, especially

by the skulls.<sup>1</sup> I have ventured to call these "Eskimoid characters," because they occur in association predominantly in Eskimo skeletons, although they are by no means wholly confined thereto, and are probably not racial characters but rather environmental adaptations which we may expect to find in some degree among all peoples living in Arctic or sub-Arctic regions and subsisting more or less exclusively on a diet of fish and flesh.

These characters are the mandibular torus, the palatine torus, the thickened tympanic plate, and the scaphoid skull vault. All of these seem to be mechanical adaptations due to excessive development of the masticatory apparatus. These characters will be discussed successively. Certain other resemblances between the long bones of Icelanders and Eskimo, especially in the femora, are possibly due to influences other than diet and have a more general distribution among primitive races. These will not be considered in this paper.

#### THE MANDIBULAR TORUS

The *Torus mandibularis* is a hyperostosis of the mandible so called by Fürst.<sup>2</sup> It had been previously observed by J. Danielli<sup>3</sup> in the mandibles of Ostiaks, Norwegians, and Lapps, and by Sören Hansen<sup>4</sup> as a feature of Eskimo lower jaws. It consists of a bony ridge or series of elevations on the lingual side of the alveolar process above the mylo-hyoid line, variable in its development and extension between the canines and the second or third molars. It is generally most prominent on the lingual side of the premolars and consists of compact bony tissue. According to Dr. Hrdlička<sup>5</sup> this physiological hyperostosis

<sup>1</sup> The author wishes to express his obligation to Prof. R. B. Dixon of Harvard University, and to Prof. Lawrence Baker of the Harvard Dental School, for valuable suggestions. He also wishes to thank Mr. S. J. Guernsey of the Peabody Museum for his assistance in preparing the illustrations which accompany this article.

<sup>2</sup> Carl M. Fürst, *Der Torus mandibularis bei den Eskimos und andern Rassen*, Verhandlungen der Anatomische Gesellschaft v. Berlin, 22, 1908, p. 295 sq.

<sup>3</sup> J. Danielli, *Archivio per l'Antrop. e l'Anat.* 1884, vol. 14, p. 333, 599.

<sup>4</sup> Sören Hansen, *Bitrag til Eskimoernes Kraniologi*, Medd. om Grönland, xvii, 1895, p. 356.

<sup>5</sup> Aleš Hrdlička, *Contribution to the Anthropology of Central and Smith Sound Eskimo*, *Anthropological Papers of the American Museum of Natural History*, Vol. V, Part II, 1910, p. 211.

Cf. also Ernest William Hawkes, *Skeletal Measurements and Observations of the Point Barrow Eskimo, etc.*, *American Anthropologist*, vol. 18, No. 2, 1916, p. 233.

“is undoubtedly of functional origin, the result of extraordinary pressure along the line of teeth most concerned in chewing, yet its occurrence in infant skulls indicates that at least to some extent the feature is already hereditary in these Eskimo [Southampton Island].”

Prof. Lawrence Baker has called my attention to the fact that even in modern civilized races all mastication tends to be directed toward the median line, and that the power cusps of the opposing molars, upon which the greatest amount of wear is to be observed, are the postero-external cusps of the lower molars and the antero-internal cusps of the upper molars. In primitive races, in which the lateral grinding movements are particularly marked, the effect is often seen on the crown of the lower molars which slope outward, and those of the upper molars which slope inward.<sup>6</sup>

The same pressure toward the median line necessitates the lingual reinforcement of the mandibular torus in cases where the natural strength of the alveolar processes and of the mandibular arch is not sufficient to withstand the strain directed medially in mastication. In many primitive races with massive masticatory apparatus which is subjected to hard usage, the mandibular torus is entirely lacking or very rare. This, I take it, is because the natural strength of the mandible is adequate without reinforcement.

The Eskimo, as has frequently been observed, makes an altogether abnormal demand upon his masticatory apparatus, not only by his diet, but also, in the case of the women, by chewing leather, and, in the case of the men, by using the teeth in tying knots, etc. Therefore, although the Eskimo jaw is naturally strong and massive, the additional reinforcement of the mandibular torus is required. This torus is doubly necessary in the case of the Icelander, who, belonging to the Nordic race, has the reduced jaws characteristic of civilized European peoples, and yet makes the demands on his masticatory apparatus that a fish and flesh diet in a sub-Arctic climate entails.

The usual concentration of this bony reinforcement between the canines and the first molars requires explanation. It would be natural to expect this concentration opposite the molars rather than the premolars, since the former are more particularly the grinding and crushing teeth. In grinding movements the fulcrum of the mandible tends to be at the condyles; the power is applied, for the most part, to the ascending rami; the weight is anterior to the power. Consequently

<sup>6</sup> Cf. F. H. Knowles, The Glenoid Fossa in the Skull of the Eskimo, Canadian Geological Survey, *Mus. Bull. No. 9, Anthr. Series, No. 4*, p. 10.

the strain is carried forward toward the symphysis, especially in the lateral grinding movements. Moreover, primitive people wear down their anterior teeth in comparison with the molars relatively more than do civilized races, both because they do not habitually substitute knife and fork for incisors and canines in cutting their food into pieces suitable for mastication, but bite or tear off mouthfuls, and also because they stuff their mouths with large quantities of food, a considerable portion of which must be chewed with the anterior teeth.

In the Icelanders the mandibular torus is often situated so far forward that it strengthens the symphyseal region, as may be observed in Plate 5 figure 2. A most unusual hyperostosis is to be seen on the mandible of one male Icelander (P. M. Cat. No. 57885) (Pl. 5, fig. 3). This affects the inferior border of the symphysis on its internal aspect and makes the genial tubercles assume the appearance of a tuberosity. No doubt the same mechanical causes have operated here, but the vertebræ associated with this skeleton show marked marginal exostoses due to arthritis, and this hyperostosis of the genial tubercles may be partly pathological in origin.

The Icelandic collection contains 56 adult mandibles, of which only 5 are associated with skulls. In observing the mandibular torus I have not attempted to distinguish the sex in these odd mandibles. As the character does not lend itself to measurement, I have made the following classes: Absent, slight, medium, pronounced, very pronounced. The "slight" class includes mandibles which exhibit small and isolated but easily perceptible additions of compact tissue along the lingual borders of the alveolar processes; the "medium" class includes those in which the hyperostoses are larger and more extensive; in the "pronounced" and "very pronounced" classes they assume the character of large tuberosities and continuous or intermittent ridges. Repetition of these morphological observations on the same series shows an occasional variation in the degree of development of the characters ascribed to an individual, but these variations are infrequent, occurring almost exclusively in the last two classes, and by no means invalidate the results.

The torus was not observed in the mandibles of infants or in those of very young children. Plate 5 illustrates mandibles of the "very pronounced" class only.

Table I indicates the distribution of the character with comparative data from other races.

TABLE I. MANDIBULAR TORUS

RACE		ABSENT	SLIGHT	MEDIUM	PRO- NOUNCED	VERY PRO- NOUNCED	TOTAL
Icelanders.....	Cases.....	18	16	9	8	5	56
	Per cent....	32.1	28.6	16.1	14.3	8.9	67.9
Eskimo.....	Cases.....	4	8	7	7	5	31
	Per cent....	12.9	25.8	22.6	22.6	16.1	87.1
Southern California In- dians.....	Cases.....	44	2	0	0	0	46
	Per cent....	95.7	4.3	0.0	0.0	0.0	4.3
Italians.....	Cases.....	29	1	0	0	0	30
	Per cent....	96.7	3.3	0.0	0.0	0.0	3.3
Chukchi.....	Cases.....	1	1	0	0	0	1
	Per cent....	100.0	100.0	0.0	0.0	0.0	100.0

It will be observed in the above table that of 31 Eskimo mandibles 27, or 87.1 per cent, exhibited the *Torus mandibularis* in some degree. This result agrees with that of Fürst<sup>7</sup> who in a large collection of Eskimo crania found about 80 per cent with the mandibular torus. A comparison of the Icelandic material with the Eskimo material examined by the author shows the appearance of the character in 67.8 per cent of the former as against 87.1 per cent of the latter. As would be expected, the more pronounced development of the character is relatively more frequent in Eskimo than in Icelanders. In the Icelandic mandibles the torus is more often composed of isolated ridges and knobs than in the Eskimo, with whom it is usually continuous. Danielli<sup>8</sup> found 5 of 17, or 29.4 per cent, of Lapp mandibles exhibiting the mandibular torus, 11 of 32 Ostiak mandibles, or 31.4 per cent. Fürst found it in 17 per cent of Swedish mandibles.<sup>9</sup>

For comparison with the Icelandic and Eskimo material in regard to the functional adaptations with which this paper is concerned there were selected series of crania from prehistoric graves in the Santa Catalina Islands, off the coast of southern California, medieval and modern Italian crania, and crania of Libyans from the Siwah Oasis.

The Santa Catalina crania are dolichocephalic and mesocephalic skulls, decidedly scaphoid, and with large jaws. They are especially suitable for comparison with Eskimo because they probably represent

<sup>7</sup> Loc. cit.

<sup>8</sup> Loc. cit.

<sup>9</sup> Loc. cit.

the earlier dolichocephalic branch of the American race. In spite of the large development of their masticatory apparatus only 2 of 44 mandibles examined, or 4.3 per cent, showed any trace of the mandibular torus.

The Italian crania were selected because the inhabitants of Iceland are of Nordic stock and it was desired to compare with them skulls of Europeans of approximately the same period living in more temperate climates. The Italian skulls are of mixed Mediterranean and Alpine stock and come, for the most part, from medieval churchyards. A comparison with Nordic crania would have been preferable, but an adequate series was not available. One of 30 Italian mandibles, or 3.3 per cent, showed a very slight trace of the bony reinforcement under consideration.

The Libyan crania are those of a dolichocephalic people of the Mediterranean race and may reasonably be compared with the dolichocephalic Icelanders of Nordic stock, in view of the unquestionable resemblance that exists between the crania of these two races. The Libyans represent long heads in a subtropical environment; the Icelanders long heads in a sub-Arctic environment. Only 12 of the Libyan crania examined had mandibles associated with them and none of these showed any signs of the mandibular torus.

It seems apparent from these comparisons that the mandibular torus is essentially a functional adaptation rather than a racial character and that it occurs especially among peoples living in northern latitudes and existing principally on animal food. We may call it an Eskimoid character because it is predominantly present in the crania of the only Arctic people whose anthropology is reasonably well known. But it also occurs in a large proportion of the mandibles of Lapps, Ostiaks, and Icelanders, to a lesser extent in Swedish mandibles, and probably elsewhere among northern peoples.

#### THE PALATINE TORUS

In contrast with the mandibular torus the palatine torus is a variation that appears with comparative frequency in most races. It consists in general of a thickening of the bony roof of the palate along the median line, variable in form and extent. It seems to be primarily a hyperostosis of the bone bordering the median suture and is usually a postnatal development.<sup>10</sup> Some writers consider it due to the dispo-

<sup>10</sup> Rudolf Martin, *Lehrbuch der Anthropologie*, Jena, 1914, p. 831.

sition of the glands along the alveolar margins of the palatal roof, asserting that in palates characterized by the longitudinal torus the glands are confined to the lateral parts of the palatal vault, while in those without the torus they extend to the median suture or are entirely absent.<sup>11</sup>

In the view of the author the frequent presence of the palatine torus in the crania of Eskimos, Icelanders, Lapps, and other people of northern habitat who live principally upon a fish and flesh diet is due to precisely the same physiological factors which were held to account for the presence of the mandibular torus among the same groups. These people make unusual demands upon their masticatory apparatus and chew toward the median line. In the case of the upper jaw the strain medially directed is carried up to the summit of the palatine vault and the thickening of the palatal roof along the median suture forms a buttress to resist this pressure. In this case the hyperostosis does not occur on the alveolar processes because of the vaulted structure of the palate.

It will be argued that this hyperostosis occurs frequently on the palatal roofs of individuals belonging to civilized races in whom the masticatory apparatus is much reduced. It is possible that the hypothesis of structural reinforcement may not be applicable to all such cases. But in the majority of the European skulls exhibiting the torus that I have examined there is evidence of hard usage of the teeth and good development of the masticatory muscles. I was informed by a friend who has such a marked palatine torus as to cause a slight impediment in his speech, that from his childhood he has been fond of masticating tough meat.

The palate is notoriously susceptible to physiological conditions during the period of childhood and adolescence. Abundant evidence of this is found in the great frequency of malformed palates among the children of our city populations. Where the palatine torus occurs in constricted, high-roofed palates the hyperostosis along the edges of the median suture may be due to a general disturbance of growth resulting in a thickening along the median line instead of the normal broadening of the lamellæ forming the roof of the hard palate and the nasal floor. Pathological conditions often create an effect upon the conformation of bony parts which is superficially identical with the normal response of

<sup>11</sup> Alberto Cocchi, *Ricerche antropologiche sul Torus palatinus*, *Archivio per l'Antropologia e la Etnologia*, 22, 1892, p. 289, sq.

Cf. also L. Stieda, *Der Gaumenwulst*, *Internationale Beiträge zur Wissenschaftlichen Medicin*, Bd. I, 1891, p. 145 sqq.

the organism to functional requirements. The scaphoid skull vault and extensive temporal planes of the Eskimo are due to physiological adaptation, whereas the same features in the skull of a microcephalic idiot are the result of pathological causes. In the opinion of the author the palatine torus may be due either to acquired modification or to arrest of growth.

Among the Icelanders the palatine torus was found to be well developed in crania of young children (3 cases), and Duckworth<sup>12</sup> records its existence in the crania of Eskimo children. As a structural reinforcement it would naturally begin to manifest itself at this time, the

TABLE II. PALATINE TORUS

RACE		ABSENT	SLIGHT	MEDIUM	PRO- NOUNCED	VERY PRO- NOUNCED	TOTAL
Icelanders.....	Cases.....	17	16	11	11	4	59
	Per cent...	28.8	27.1	18.6	18.6	6.8	71.2
Eskimo.....	Cases.....	14	26	10	6	4	60
	Per cent...	23.3	43.3	16.7	10.0	6.7	76.7
Southern California In- dians.....	Cases.....	24	29	4	3	0	60
	Per cent...	40.0	48.3	6.7	5.0	0	60.0
Italians.....	Cases.....	27	9	4	0	0	40
	Per cent...	67.5	22.5	10.0	0	0	32.5
Stwans.....	Cases.....	47	7	1	0	0	55
	Per cent...	85.5	12.7	1.8	0	0	14.5

pressure toward the median line tending to stimulate the growth of the bone and to cause the thickening of the edges along the suture.

Stieda<sup>13</sup> distinguishes a broad, flat torus and a narrow, highly arched, spindle-shaped torus, between which are transitional forms. The broad, flat variety appears almost exclusively in the Eskimo and both types occur among the Icelanders, although the narrow type is infrequent.

As the form of the palatine torus does not permit the taking of satisfactory measurements I have classified it according to the degree of its development, taking into consideration elevation and extension longitudinally and transversely.

In addition to the above, the character was observed in 3 Chukchi

<sup>12</sup> W. L. H. Duckworth and B. H. Pain, *A Contribution to Eskimo Craniology*, *Journ. Anthr. Inst.*, 1900, XXX, p. 135.

<sup>13</sup> *Op. cit.*

skulls, two of which had very marked palatine tori and the third a slight development; one Lapp skull, which also exhibited the torus in a very marked degree, and one Siberian skull which showed a small torus. Cocchi<sup>14</sup> found the torus in all of 16 Fuegian skulls, or 100 per cent; in 21 of 30 Ostiak skulls, or 70 per cent; in 10 of 15 Samoyed skulls, or 66.6 per cent; in 18 of 25 Australian skulls, or 72 per cent; in 85 of 242 Papuan skulls, or 35.2 per cent; and in 52 per cent of 2,741 Italian skulls. Martin<sup>15</sup> gives 60 per cent as the occurrence of the palatine torus among Eskimos and 88 per cent among the Lapps, but does not state the number of crania examined. The range of the character among Europeans, exclusive of Italians, is from 13.8 per cent (Bavarians) to 46 per cent (Poles). In a collection of 304 Guanche skulls I found the torus in 8.5 per cent but I did not note the varying degrees of development in the individual cases.

It will be apparent from the above figures that the palatine torus occurs most frequently in peoples of extreme northern or southern habitat with the exception, possibly, of the big-jawed Australians and Tasmanians, and the Polynesians (among the last named of whom Cocchi gives the occurrence as 73.3 per cent of 30 cases). It seems to me quite probable that a larger number of observations would reduce the percentages of occurrence in these groups, as neither of the two Australian skulls in the Peabody Museum exhibit the character, and an adequate number of Papuan skulls (242) examined by Cocchi shows only 35.2 per cent.

Table II shows that the very marked development of the character is found particularly among the Icelanders and Eskimo.

It is instructive to note that Cocchi found the palatine torus particularly remarkable for size in his Fuegian crania, all of which exhibited the character. The length varied from 40 to 50 mm. and the breadth from 10 to 15 mm. Here again the torus shows a notable development in the crania of a people who subsist principally upon fish and animal food and who live in an extreme southern climate. It should be remarked, however, that the one Fuegian skull in the Peabody Museum collection is devoid alike of mandibular torus, palatine torus, and thickened tympanum.

The table shows that whereas 60 per cent of the ancient southern California Indians have the palatine torus, the development is pro-

<sup>14</sup> Op. cit., p. 286 sq.

<sup>15</sup> Op. cit., p. 832.

nounced in 5 per cent only, as against 25.4 per cent in the Icelanders and 16.7 per cent in the Eskimo. In the Italians and Siwans only a slight or medium development of the torus occurs.

Of 30 Eskimo skulls with jaws, 17, or 56.6 per cent, exhibited both the mandibular torus and the palatine torus. Eight skulls showed the mandibular torus without the palatine torus and four skulls the palatine torus without the mandibular torus. There seems to be some correlation in the degrees of development of the two characters in the same skull, and when one is but slightly developed the other shows a correspondingly small development or is absent in the most of cases.

Of 5 Icelandic skulls with which mandibles were associated 4 exhibited neither the palatine torus nor the mandibular torus, and the fifth had both characters well developed. It may be worthy of mention that the skulls associated with mandibles in the Icelandic collection are probably from the most recent burials represented. The custom in Icelandic churchyards was to clear out the earlier skeletal remains and throw them together into a pit, and it is probable that only the recent undisturbed interments yielded whole skeletons or skulls with mandibles.

Investigators studying the mandibular torus and the palatine torus separately have found both characters remarkably frequent and well developed in the Lapps and Ostiaks. It is therefore probable that they occur in association in the same individuals of these peoples. One Italian skull of 29 with mandibles had a slight development of the mandibular torus which was associated with a small palatine torus.

As a result of this investigation of the palatine torus it may be stated that this feature seems to be a structural reinforcement due to physiological adaptation, appearing most frequently in peoples with strongly developed masticatory apparatus who subsist mainly on animal food. Its occurrence in modern civilized peoples of mixed diet is probably due to the same factors in the majority of cases, but may in some instances be caused by abnormal conditions of growth and development. The difference in the distribution of the glands lying between the mucous membrane and the hard palate observed by Stieda and Cocchi is probably an effect of the presence or absence of the palatine torus rather than a cause.

#### THE TYMPANIC PLATE AND THE POSTGLENOID PROCESS

The shallowness of the glenoid fossa in the Eskimo skull is well known to anthropologists and has been made the subject of study by Knowles,<sup>16</sup>

<sup>16</sup> Op. cit.

who associates it with the lateral grinding movements carried to an extreme by that people in their mastication of unusually tough substances. While this feature is unquestionably very common, according to my observations it is not always present in the Eskimo. It does not seem to be specially prevalent in the crania of Icelanders.

On the other hand I have been impressed in observing Eskimo crania, with the almost invariable thickness of the tympanic plate which constitutes, in part, the posterior wall of the glenoid fossa. I am not aware that this feature in Eskimo skulls has been made the subject of comment, although it is hardly probable that anthropologists have overlooked it.

Boule<sup>17</sup> remarks that in the chimpanzee the tympanic plate does not contribute to the formation of the glenoid fossa except in a very small measure, being separated from it by the postglenoid process. The same condition exists in the skulls of the gorilla, orang-utan, chimpanzee, and many of the lower Primates. The tympanic plate is roughly cylindrical or tubular and its inferior surface is regularly convex, especially toward the auditory meatus. In most of the crania of modern men the tympanic plate is relatively shorter and more compressed between the mastoid and zygomatic portions of the temporal bone. The inferior surface is not cylindrical, and properly speaking there is no inferior surface; it is reduced to a more or less sharp edge separating two very unequal slopes. The anterior plane, which is almost vertical forms the greater part of the free surface of the tympanic bone, and at the same time almost all of the posterior wall of glenoid fossa, for, according to Boule, the postglenoid process in recent man is practically absent. In his view the formation of the tympanic bone in Neanderthal man is intermediate between the type found in the anthropoid apes and that prevalent in recent man, and he also finds a tendency toward a well-developed postglenoid process in the Mousterian race. He considers that of all recent men the Eskimo approaches most closely to the Neanderthaloid type in these features.

In regard to the postglenoid process in modern man Boule<sup>18</sup> says:

Chez l'Homme actuel, sauf de rares exceptions, l'apophyse post-glénoïde est rudimentaire ou nulle. On ne distingue bien qu'en regardant le crâne de profil; on voit alors une légère saillie terminée par un bord aminci qui s'accole,

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<sup>17</sup> M. Boule, *L'Homme fossile de la Chapelle-aux-Saints*, *Annales de Paleontologie*, 1911, p. 56.

<sup>18</sup> *Op. cit.*, p. 67.

en avant du méat auditif, contre l'os tympanique dont elle est séparée par la fissure de Glaser.

He also seems to consider that a well-developed postglenoid process should have its summit detached from the tympanic plate.

The so-called postglenoid process is dependent for its existence upon the position and form of the glenoid cavity. It is simply the root of the zygomatic process thrown into relief by the anterior excavation of the glenoid fossa. When the glenoid fossa is deep and situated well forward from the tympanic plate, the process is well marked; when the glenoid cavity is shallow or situated farther back and close to the tympanic plate the postglenoid process is absent or rudimentary. Whether or not the postglenoid process covers a large part of the tympanic plate depends not only upon these factors but also upon the situation of the auditory meatus and the tympanic bone relative to the zygomatic process. In the adult gorilla the auditory meatus is situated much higher than it is in modern man, so that the posterior part of the glenoid fossa is formed entirely by the zygomatic root or postglenoid process. In the skull of a young gorilla in which the permanent dentition had not erupted the position of the auditory meatus was found to be relatively lower and the postglenoid process was not more markedly developed than it is in many modern human crania. The summit of the process was not detached from the tympanic plate which projected below it, whereas in the adult gorilla the tympanic plate is completely masked by this tubercle. Similarly in the illustration of the temporal region of the La Chapelle-aux-Saints skull, given by Boule, the large area of the anterior portion of the tympanic plate covered by the postglenoid process seems to be dependent upon the high anthropoid position of the auditory meatus and the tympanic bone, rather than upon an excessive projection of the zygomatic root.

In modern man, contrary to Boule's assertion, the postglenoid process is often well developed but it does not cover a large area of the tympanic plate because of the relatively lower position of the auditory meatus. I have found a well-developed postglenoid process to occur with considerable frequency in the skulls of most modern races, and especially in certain peoples belonging to the North African branch of the Mediterranean race—the Guanches and the Libyans from the Siwah Oasis. On the other hand, it is very rare among the Eskimo, who have shallow glenoid fossæ, for the most part. It occurred to me that the unusual thickness of the tympanic plate in the Eskimo, mentioned

above, might be due in part to the absence of the postglenoid tubercle in association with the shallow glenoid fossa, and to the consequent strain exerted by the condyles on the tympanic plate in the process of mastication.

Textbooks in anatomy state that a lobe of the parotid gland intervenes between the mandibular condyle and the tympanic plate. This is no doubt true in the case of many modern men with deep glenoid fossæ placed well forward, but in many Eskimo and other peoples with massive mandibular condyles these parts abut directly against the tympanic wall when the jaw is closed. In the movements of elevation and retraction considerable strain must be exerted against the tympanic plate.

In order to make clear the relations of these parts and the approximation to the Eskimoid type which Icelandic crania exhibit, it is necessary to describe certain variations which occur in the form of the lateral part of the tympanic plate.

Angelotti<sup>19</sup> describes four types of the tympanic plate in man: (1) In which the internal and external margins of the tympanic plate diverge below so that the inferior portion forms a rugous, almost triangular area below the meatus. (2) In which the external and internal margins are approximately parallel and delimit a rugous semicircular band which follows the contour of the auditory meatus. (3) In which the posterior portion of the tympanic plate is developed at the expense of the anterior, and the rugous portion belongs almost exclusively to the posterior part. (4) In which the rugous surface is absent.

He finds these varieties occurring in almost every race at every age among the 2,000 crania examined by him, but he does not state the distribution. For the purposes of the present investigation I have found it more convenient to distinguish the following types: (1) In which the floor of the auditory meatus is relatively horizontal; the upper and lower borders of the inferior part of the tympanic plate are well-defined, continuous, and approximately in the same vertical plane; the summit of the vaginal process is above or on a level with the inferior edge of the tympanic plate. (2) The floor of the auditory meatus slopes abruptly downward and outward; the upper edge of the posterior portion of the tympanic plate is ill-defined and situated mesialward from the lower edge; the summit of the vaginal process is above or on a level with the

<sup>19</sup> Guido Angelotti, *Variazioni e lacune nella "pars tympanica" del temporali*, *Atti della Societa Romana di Antropologia*, Vol. XV, 1909-1910, p. 36.

lower edge. (3) The floor of the meatus slopes abruptly downward and outward; the posterior portion of the tympanic plate is beveled outward and both borders are ill-defined; the summit of the vaginal process is below the inferior edge of the tympanic plate.

The anterior and posterior portions of the tympanic plate vary in thickness within each type, but are generally thicker and more massive in the first type, whereas in the third type they are usually thin. The first type corresponds roughly with Angelotti's first type and is predominantly found in Eskimo crania. The second type prevails among Icelanders and the crania of most races seem to exhibit principally the second and third types. In the Eskimo the anterior portion of the tympanic plate is notably thick and the posterior portion is generally

TABLE III. THICKNESS OF TYMPANIC PLATE

RACE	CASES	ANTERIOR PART			CASES	POSTERIOR PART		
		Min.	Max.	Mean		Min.	Max.	Mean
Eskimo.....	61	1.5	6.0	4.12	61	4.5	12.0	8.42
Icelanders.....	58	1.5	5.0	3.26	52	3.0	11.0	6.47
Southern California In- dians.....	60	1.0	4.0	2.55	39	3.0	11.0	5.66
Italians.....	41	1.0	4.5	1.98	21	3.5	7.0	5.35
Siwans.....	56	0.5	4.5	1.98	28	3.5	9.0	5.53

extremely massive. To a lesser degree the same thickening is observed in the case of the Icelandic crania.

It seemed advantageous to measure the thickness of the anterior and posterior parts of the tympanic plate, and the following method was adopted: The thickness of the anterior portion was measured at a point on the lateral border on a level with the center of the auditory meatus; the thickness of the posterior portion was measured from the central point on the upper border to the lowest point on the inferior border. The first measurement can be taken on all modern human skulls, but the second measurement can be taken only where the lower portion of the tympanic plate is not beveled, but has distinct borders.

Table III indicates the means and ranges of the measurements in the various series of crania examined.

It is apparent from the above that the Eskimo have unusually thick tympanic bones and that the Icelanders approach them in this character, surpassing the big-jawed California Indians. Figure 1 shows graphically the distribution of thickness of the anterior portion of

the tympanic plate in four of these groups. It will be noticed that in all of the groups except the Eskimo the number of measurements of the thickness of the posterior portion of the tympanic plate is less than the

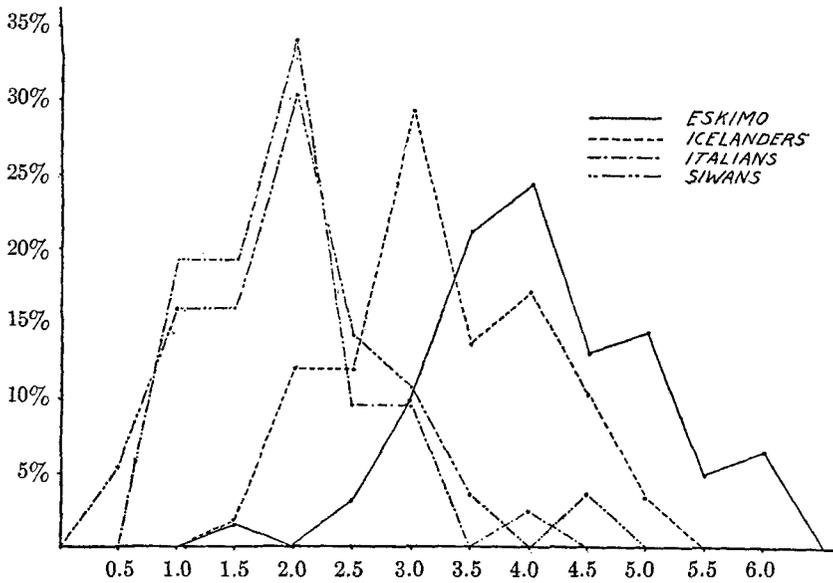


FIG. 1.—Anterior thickness of tympanic plate

number of measurements of the anterior portion. This is due to the larger numbers of the third type of tympanic plate in which the lower portion is thin and beveled, with indistinct edges, and may be incomplete.

TABLE IV. POSTGLENOID PROCESS

RACE		ABSENT	SLIGHT	MEDIUM	PRO- NOUNCED	VERY PRO- NOUNCED	TOTAL
Eskimo.....	Cases.....	34	16	5	6	0	61
	Per cent...	55.7	26.2	8.2	9.8	0	44.3
Icelanders.....	Cases.....	16	17	16	12	0	61
	Per cent...	26.2	27.9	26.2	19.7	0	73.8
Southern California In- dians.....	Cases.....	21	29	9	1	0	60
	Per cent...	35.0	48.3	15.0	1.7	0	65.0
Italians.....	Cases.....	14	14	11	2	0	41
	Per cent...	34.1	34.1	26.8	4.9	0	65.9
Siwans.....	Cases.....	12	15	16	10	2	55
	Per cent...	21.8	27.3	29.1	18.2	3.6	78.2

It seemed possible that there might be some relation between the thickness of the tympanic plate and the development of the postglenoid process. For the latter, when prominent, resists the posteriorly directed strain incident to the elevation and retraction of the mandible. Further, general observations seemed to point toward a prevailing absence of the postglenoid process in the Eskimo, whose tympanic walls are thick, and a frequent development of this feature in European skulls with generally thin tympanic plates.

Table IV gives the results of these observations.

TABLE V. CORRELATION OF POSTGLENOID PROCESS WITH THICKNESS OF ANTERIOR PART OF TYMPANIC PLATE

RACE		POSTGLENOID PROCESS					Total
		Absent	Slight	Medium	Pro-nounced	Very pro-nounced	
Eskimo.....	Cases.....	34	16	5	6	0	61
	Mean thick-ness.....	4.14	4.0	4.2	4.25	0	4.12
Icelanders.....	Cases.....	16	17	16	12	0	61
	Mean thick-ness.....	3.0	3.4	3.3	9	0	3.26
Southern California Indians.....	Cases.....	21	29	9	1	0	60
	Mean thick-ness.....	2.55	2.5	2.6	4.0	0	2.51
Italians.....	Cases.....	15	13	11	2	0	41
	Mean thick-ness.....	1.78	2.14	2.04	2.0	0	1.98
Siwans.....	Cases.....	12	15	16	10	2	55
	Mean thick-ness.....	2.3	1.6	2.06	2.05	2.75	1.98

It is clear from the above table that a well-developed postglenoid process is relatively rare in the Eskimo, less so in the Italians and in the southern California Indians, but comparatively common in the Icelandic and Siwan crania.

The above result makes it very improbable that there is any close correlation individually between absence of a postglenoid process and thickened anterior walls of the tympanic plate, although taking the groups as units the Eskimo with thick tympanic plates infrequently have well developed postglenoid processes, and the Siwans with well-developed postglenoid processes usually have very thin tympanic plates.

Nevertheless, in glenoid fossæ with well-developed postglenoid processes the anterior wall of the tympanic plate is usually very thin behind the process where it is shielded from the thrust of the condyle, although it often becomes abruptly thicker below the process at the point where the measurement is taken.

In general the investigation of this feature seems to confirm the view that the thickening of the tympanic plate in the Eskimo is yet another instance of structural reinforcement through physiological adaptation, and that the same condition in a lesser degree obtains in the crania of Icelanders. There is no clear relation in individuals between the development of the postglenoid process and the thickness of the anterior tympanic wall.

#### THE SCAPHOID SKULL VAULT

The effect of the temporal muscles upon the form of the skull vault has been demonstrated in a classical article by Prof. Arthur Thomson.<sup>20</sup> Dr. Hrdlička<sup>21</sup> ascribes the sagittal elevation, which is predominantly a feature of Eskimo crania, to the exceptional development of the temporal muscles:

Morphologically, it consists in part of a strengthening of the bone along the median line, and in part of a more acute arching of the skull along this line, and its length corresponds nearly to the extent of those parts of the temporal muscles which exercise the greatest action. It arises in the opinion of the writer on the one hand, and in the main, by the forced expansion of the cranial cavity upward, in the direction of the least resistance, . . . and is due to the interference with the lateral growth by the extraordinarily developed temporal muscles, and on the other hand by an accumulation of bone along the median line, due to the increased tension along this line, where the growth of bone is more rapid (at least so along the sagittal suture), due to the pressure of the temporal muscles while active.

It is apparent in the light of this explanation, which is unquestionably correct, that the sagittal elevation is due in part to causes identical with those invoked by the author of the present paper to explain the palatine torus and the mandibular torus, namely, pressure directed mesially in the process of mastication. The sagittal elevation also serves as a structural reinforcement.

<sup>20</sup> Arthur Thomson, A consideration of some of the more important factors in the production of man's cranial form, *Journ. Anthr. Inst.*, vol. 33, 1903. p. 135 sqq.

<sup>21</sup> Op. cit., p. 195.

TABLE VI. SAGITTAL ELEVATION

RACE		ABSENT	SLIGHT	MEDIUM	PRO- NOUNCED	VERY PRO- NOUNCED	TOTAL
Eskimo.....	Cases.....	2	10	17	24	8	61
	Per cent....	3.3	16.4	27.9	39.3	13.1	96.7
Icelanders.....	Cases.....	12	24	10	14	1	61
	Per cent....	19.7	39.3	16.4	22.9	1.6	80.3
Southern California In- dians.....	Cases.....	7	7	8	31	7	60
	Per cent....	11.7	11.7	13.3	56.6	11.7	88.3
Italians.....	Cases.....	31	9	1	0	0	41
	Per cent....	75.6	22.0	2.4	0	0	24.4
Stwans.....	Cases.....	51	5	0	0	0	56
	Per cent....	91.1	8.9	0	0	0	8.9

The presence of the sagittal elevation in the Icelandic skulls, as may be observed from the preceding table, is remarkable. This character is usually lacking in modern crania of the Nordic type but is to be found in varying degrees in a large proportion of neolithic crania from northern Europe in which the masticatory apparatus is well developed. Except in a few instances the sagittal elevation in the Icelanders is not associated with a diminution in width of the cranial vault and a great increase in the height, as in the Eskimo. When compared with the California Indians the Icelandic crania exhibit a lesser frequency of the sagittal elevation and the higher grades of development are not as common. But these California crania show as pronounced a development of the character as the author has ever observed in any group except the Eskimo. They have very large jaws and well-developed temporal muscles, but, as in the case of the Icelanders, the sagittal elevation is not usually associated with an extremely narrow, high skull vault.

#### CORRELATION OF CHARACTERS IN INDIVIDUALS

Having observed that the Icelandic and Eskimo crania resemble each other as groups in the frequent manifestation of the mandibular torus, the palatine torus, the thick tympanic plate, and the scaphoid skull vault, it remains for us to determine to what extent these characters are found in association in individuals of the two groups and in the other comparative material.

Reference has already been made to the association of the mandib-

ular torus with the palatine torus in the Eskimo crania. Of 30 skulls with jaws, 17, or 56.6 per cent, exhibited both characters. In the other series the number of skulls with which mandibles were associated was so small that no conclusions could be drawn.

Of the 30 Eskimo skulls with jaws, 17, or 56.6 per cent, exhibited mandibular torus, palatine torus, thick tympanic plate, and sagittal elevation. For purposes of this correlation, the thickening of the tympanic bone was divided into the usual degrees of absent, slight, medium, pronounced, and very pronounced. There seemed to be some correlation between the degrees of development of the different characters in the same skull but it was not very pronounced.

Table VII shows the association of palatine torus, thickened tympanic plate, and sagittal elevation in the various groups for individuals.

TABLE VII. PALATINE TORUS, THICKENED TYMPANIC PLATE AND SAGITTAL ELEVATION

RACE	CASES	PER CENT	TOTAL NUMBER OF SKULLS
Eskimo.....	44	72.1	61
Icelanders.....	21	34.4	61
Southern California Indians.....	7	11.7	60
Italians.....	0	0.0	41
Stwans.....	0	0.0	56

OTHER CRANIAL FEATURES

Eskimo crania generally show very prominent malars with somewhat protruding antero-inferior angles. Many of the Icelandic crania have also prominent malars but the protrusion of the antero-inferior angle is absent in spite of very strongly marked attachments of the masseter muscles. The prominent malars of the Eskimo are probably due only in part to physiological adaptation, as well-developed and large malars are a characteristic of the American race in general. The malars in the Icelandic crania are generally somewhat larger than those of most Nordic crania, but they do not approach the Eskimoid development.

Prevailing shallow suborbital (canine) fossæ are found in Eskimo, although this feature is variable. An individual survey of this character in the Icelandic series was not made, but general observations indicate that shallow suborbital fossæ are more common in these than in most European crania. A very deep suborbital fossa is associated

with a deflation of the maxillary sinus which weakens the structure of the face and is not commonly found in the crania of people with well-developed masticatory apparatus.

The extraordinarily narrow nasal aperture characteristic of the Eskimo, which is possibly due to climatic influence, does not occur in the Icelandic crania, in which the form of the nasal aperture, the nasal bridge, and the frontal processes of the superior maxilla are those normally observed in the skulls of northern Europeans.

The zygomæ of the Icelanders are more massive than those of most Europeans and the temporal crests are more strongly marked.

The mandibles are often massive but do not exhibit the very low, broad ascending rami and the everted angles often observed in those of the Eskimo.

#### CAUSES OF ESKIMOID CHARACTERS IN ICELANDIC SKULLS

It remains to be considered whether the Eskimoid characters observed in Icelandic crania are due to convergence by physiological adaptation through environmental causes or whether they may be assigned to the inheritance through race mixture.

Greenland was colonized by Icelanders under Eric the Red in 985. Stefánsson calculates that some 700 Icelanders went to Greenland the first summer.<sup>22</sup> In the twelfth century there were two colonies in Iceland which were said by the medieval historian Björn Jónsson to consist of 190 dwellings and 90 dwellings, respectively. On the basis of this statement Stefánsson estimates the population to have been not far short of 3,000. In the fourteenth century the colonists were involved in trouble with the Eskimo and about the middle of the century the western settlement was completely destroyed and no one escaped to tell the tale. In the fifteenth century there are other records of destructive raids by "the heathen." The last mention of the colony is a Bull early in the pontificate of Alexander VI which confirms the appointment (ca. 1493) of the Benedictine monk Mathias to the colony of Greenland, and says that no ships have come away from there for 80 years, that the people have mostly fallen away from the true faith, and that this monk will endeavor to bring them back to the church. Stefánsson thinks that the colony was destroyed by the Eskimo rather than assimilated by them. The Eskimo tradition is that they destroyed their enemies by burning them to death in their houses.

<sup>22</sup> Vilhjalmur Stefánsson, *The Icelandic Colony in Greenland*, *American Anthropologist*, n. s., vol. 8, No. 2, 1906, pp. 262-270.

Prof. R. B. Dixon has suggested to me that the Greenland colonists may have intermarried to some extent with the Eskimo, and individuals or families returning to Iceland from time to time might thus have introduced an Eskimo strain of blood into the Icelandic population. If this were the case we might regard the Eskimoid characters in Icelandic skulls as an instance of the hereditary transmission of an acquired modification. We are convinced that the characters discussed in this paper are acquired modifications in the case of the Eskimo, and, as has been mentioned, there is some evidence of the hereditary transmission of these characters in the Eskimo crania.<sup>23</sup>

In this connection it is interesting to note that some travelers have considered that traces of Eskimo mixture exist in the Icelandic population. Says Burton:<sup>24</sup>

The modern Icelander is a quasi-Norwegian, justly proud of his old home. His race is completely free from any taint of Skraelling, Innuvit, or Mongoloid blood, as some travellers have represented, and as the vulgar of Europe seem to believe. Here and there but rarely, a flat dark face, oblique eyes, and long black horsehair, show that a wife has been taken from the land

Where the short-legged Esquimaux  
Waddle in the ice and snow.

But in another passage the same author says:<sup>25</sup>

The hair . . . seldom shows the darker shades of brown; and in the very rare cases where it is black, there is generally a suspicion of Eskimo or Mongoloid blood.

On the other hand, Nelson Annandale believes that the Icelanders exhibit traces of intermixture with the Lapps.<sup>26</sup> I have not been able to find any systematic treatise on the physical anthropology of the Icelanders and am not disposed to place complete confidence in the observations of Burton<sup>27</sup> who states that "the cranium is distinctly brachycephalic," inasmuch as all but three or four of our collection of some 85 skulls are either distinctly dolichocephalic or mesocephalic.

Burton also says in the same passage that "the face is round or square rather than oval; the forehead often rises high, and the malar bones stand out strongly, while the cheeks fall in."—"The jawl is strong and

<sup>23</sup> Vide supra, p. 3.

<sup>24</sup> Richard F. Burton, *Ultima Thule, or, A Summer in Iceland*, London, 1875, Vol. I, p. 130.

<sup>25</sup> *Op. cit.*, p. 133.

<sup>26</sup> Nelson Annandale, *The Faroes and Iceland*, Oxford, 1905, p. 163 sq.

<sup>27</sup> *Op. cit.*, p. 131.

square, and the chin is heavy, the weak 'vanishing' form being uncommon." Annandale also remarks that the face of the Icelandic type is "short, broad, square, and flat, often with prominent cheek-bones, with small, deepset eyes, a short, broad, nose, and a very large mouth; the complexion is pale, lacking the ruddy coloring of the typical Scandinavian skin."<sup>28</sup> Both writers also agree that the beard is scanty and does not appear until late.

Travelers in Iceland describe the natives as of a stout "square figure." Burton says, "They have the thick, unwieldy trunks of mountaineers, too long for the lower limbs . . . . The legs are uncommonly sturdy; the knees are thick, and rounded."<sup>29</sup> The femora of our Icelandic collection are extraordinarily like those of the Eskimo in their very marked curvature, massive heads and inferior condyles, and highly developed pilasters.

It is apparent from the above descriptions that the Icelanders exhibit many physical characters which are reminiscent of the Eskimo. The writer hopes to make a complete investigation of all of the skeletal remains of Icelanders in the Peabody Museum collection in comparison with an ample Eskimo series, which should determine whether these apparent resemblances are significant or merely superficial.

The history of the Icelandic colonies in Greenland, summarized above, would seem to indicate that the contact of the colonists with the Greenland Eskimo resulted in hostilities rather than intermarriage, but it is possible that the lost colonies were assimilated by the Eskimo. Since European communications with Greenland ceased about the beginning of the fifteenth century and no permanent European colony was established until 1721 it seems apparent that any strain of Eskimo blood in the Icelanders represented by our skeletal material would have to result from the return of the early colonists to Iceland, since most of the remains probably antedate the sixteenth century. On the whole there seems little probability that any of the Eskimoid characters exhibited in the skeletal remains of these medieval Icelanders represent the result of a race mixture.

On the other hand it seems possible to explain these Eskimoid characters in Icelandic crania which have been demonstrated above as physiological adaptations due to dietary and general environmental conditions approximating those to which the Eskimo have been subjected since their occupation of the Arctic regions of North America.

<sup>28</sup> *Op. cit.*, *loc. cit.*

<sup>29</sup> *Op. cit.*, Vol. I, p. 134.

Owing to the difficulty of raising cereals in the inhospitable climate of Iceland the people live principally upon a milk and fish diet. De Kerguelen, writing in 1767, says: "In summer food was of cods' heads, boiled like all other provisions: in winter the peasants ate sheeps' heads kept in fermented vinegar of sour milk (Syra), or in juice of sorrel (Súra), and other plants, the mutton being sold. Bread was not the staff of life, being eaten only on high days and holidays, that is, at births, marriages, and deaths: the richer sort baked cakes, broad and thin, like sea biscuits, of black rye flour from Copenhagen."<sup>30</sup> "The children were weaned after the first week and were fed on the flesh of the foul mollie or fulmar-petrel."<sup>31</sup> "For home consumption the cod is split and hung up unsalted in the 'wind-house.' It is known by its shriveled appearance, and, like the refuse heads, it is eaten uncooked."<sup>32</sup> They also eat whale belly (Rengi) and the flesh of the dog shark. The latter is buried for two or three weeks, then washed, cut up into strips, which are hung for a year in the drying house before being considered fit for food. Burton declares that "the dried skate is the bread of this ichthyophagous race."<sup>33</sup> The flesh of sea fowl is also a staple article of diet and the Icelander particularly appreciates the flavor of the oil.<sup>34</sup> Horseflesh is also eaten in some parts of the island. Mutton is hung up to dry in the smoke of the peat reek and is eaten raw, "having acquired much the appearance and consistency of horn."<sup>35</sup>

Cattle are raised and the milk, butter, and cheese are important articles of diet, but the flesh is too expensive to be eaten by the peasantry. The soil yields a few hardy vegetables, such as potatoes and turnips.

So far as I have been able to learn the Icelanders do not prepare leather by chewing the skins, but their dependence upon tough dried fish as the staple article of diet seems to account satisfactorily for the morphological characters in which they so closely resemble the Eskimo.

#### CONCLUSION

The results of this investigation may be summarized as follows:

(a) The crania of Icelanders show a striking similarity to those of

<sup>30</sup> M. de Kerguelen Tremarec, *Relation d'un Voyage dans la Mer du Nord*, 1772, quoted by Burton, *op. cit.*, Vol. I, p. 147.

<sup>31</sup> Burton, *op. cit.*, Vol. I, p. 154.

<sup>32</sup> *Ibid.*, Vol. I, p. 194.

<sup>33</sup> *Ibid.*, Vol. II, p. 239.

<sup>34</sup> Annandale, *op. cit.*, p. 127, sq.

<sup>35</sup> *Ibid.*, p. 192.

the Eskimo in the prevalence of the mandibular torus, the palatine torus, the thickened tympanic plate, and the sagittal elevation of the skull vault.

(b) Whereas there is a possibility of an Eskimo strain in the Icelandic population, it is altogether probable that these similarities are due in both peoples to an unusual development of the masticatory apparatus consequent upon an almost exclusively fish and flesh diet and the habitual chewing of very tough food.

(c) It may reasonably be expected that the same physiological adaptations will appear in the crania of any peoples living in far northern or southern lands, who are forced by their environment to subsist mainly upon animal food.



FIG. 1.—Eskimo mandible with mandibular torus

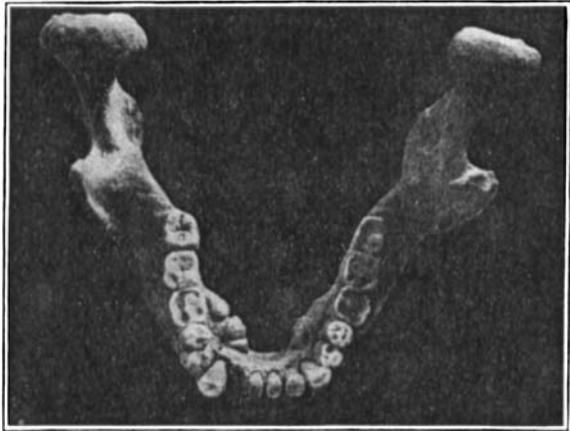


FIG. 2.—Icelandic mandible with mandibular torus

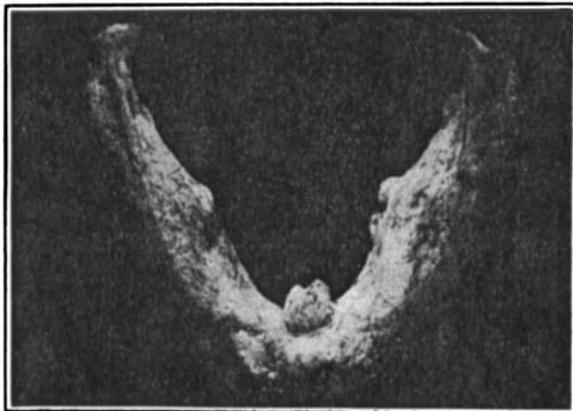


FIG. 3.—Icelandic mandible with hyperostosis of genial tubercles

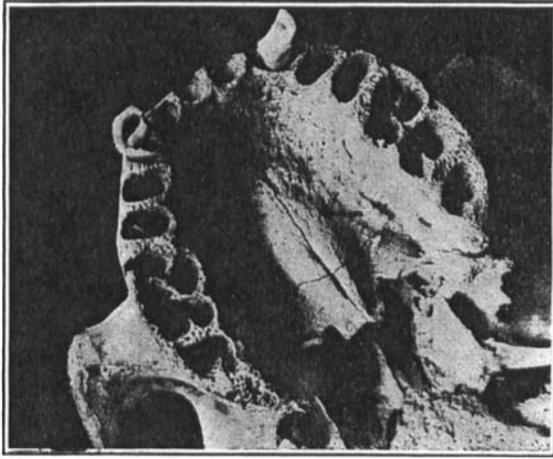


FIG. 1.—Eskimo with palatine torus

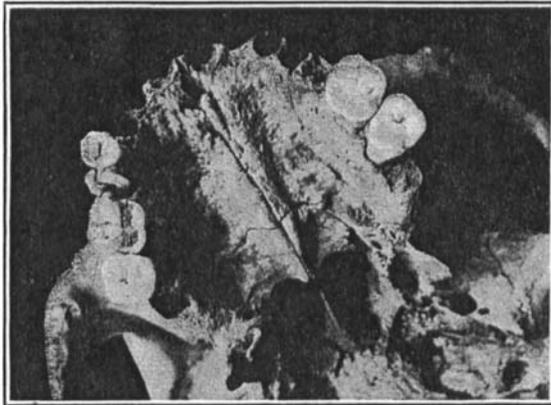


FIG. 2.—Icelander with palatine torus

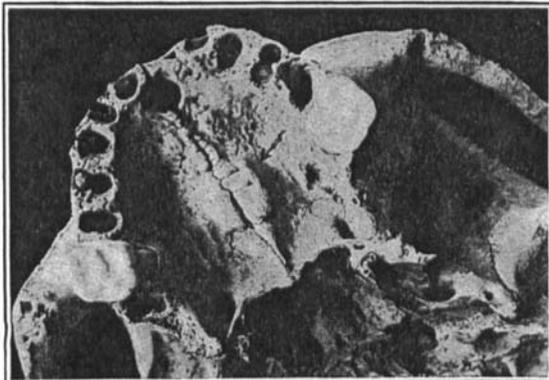


FIG. 3.—Icelander with palatine torus