

the ages of fourteen and fifteen in four individuals, between sixteen and seventeen in three, and not until twenty in two cases. The average age thus amounts to about sixteen years. According to MacDiarmid, who accompanied the arctic expedition under John Ross as its doctor, menstruation among the Eskimos often first begins at the age of twenty-three and even then occurs only during the summer months. Again it is stated that Eskimo girls have their first menstruation when between the ages of thirteen and fifteen years. Turner gives thirteen years for the approximate age in Labrador; Kelly's estimate of the age of maturity in Eskimo girls is likewise thirteen years; and according to Dr. Thompson, who has practiced for a number of years among the Eskimos of Alaska, the probable average age, not based upon statistics, is about fourteen years. Stenfansson's attention was directed to the early age of maturity among Eskimo girls by Dr. H. R. Marsh, a medical missionary at Point Barrow, and he estimated the age among western Eskimo girls at from ten to fourteen years."

Speculation as to the causes of the rather early puberty in the so far observed western Eskimo young women, would be premature. The facts can only be determined by careful studies on the heredity, personal environment, nourishment and metabolism in these subjects.

¹ The means, 13.3 for the full-blood and 13.2 for the mixed-blood, should perhaps be augmented a little because in most of the subjects the age was probably something over the year given.

² Weyer, E. F., *The Eskimos, Their Environment and Folkways*, 80, New Haven (Yale Univ. Press), 46-49 (1932).

ESKIMO CHRONOLOGY

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Communicated May 7, 1936

An analysis of the archaeological collections from an extensive Eskimo village site at Kukulik, St. Lawrence Island, Alaska, has shown that six cultural horizons, marked by changes in material culture, are represented in a single stratified midden deposit. A "test cut" excavated through the midden exposed a deposit of refuse with a maximum depth of 14 feet, and in the walls of the trench strata of sod were apparent marking periods in the history of the mound when it had been abandoned and over-grown with grass. Although the mound is only partially excavated and the changes in material culture have not been precisely correlated with the reoccupations of the site indicated by the sod strata, it is clear that at least six cultural periods may be defined.

Since most of the cultural elements which distinguish each of these six periods particularly characterize Eskimo cultures found at other sites in the Arctic region, the stratigraphic relation of these elements at Kukulik has a significant bearing upon the cultural sequence in the Eskimo area.

Excavation of the Kukulik site was begun in 1931 by Otto Wm. Geist for the University of Alaska, and operations were continued until the fall of 1935. During the last two seasons (1934-35) the work, with Mr. Geist in charge, was conducted as a Public Works project under the auspices of the U. S. Department of the Interior, Bureau of Indian Affairs and the University of Alaska.

The collection resulting from these excavations has been estimated at approximately 50,000 artifacts. The large part of this collection was obtained during the seasons of 1934 and 1935 when the entire surface of the eastern end of the midden was cut down approximately 36 inches. Most of the house and meat cache structures found in this upper level of debris, in addition to native artifacts, contained numerous iron tools, glass beads and bottles, hard wood fragments and other objects which could have been obtained by the Eskimo only through extensive trade with modern ships. Thus most of the collection represents a relatively recent Eskimo culture, not unlike that still functioning on St. Lawrence Island. However, in 1931-32-33 a test cut 30 feet wide, 135 feet long and extending to the base of the deposit was excavated through the midden and in 1934-35 deep cuts were made along the beach slope where the surf was encroaching on the mound. The stratigraphic analysis has been limited primarily to the objects found in these sections of the midden, but material from the general surface level has been used to determine the entire cultural complex of the most recent phase. A summary of each cultural period may be given as follows:

Modern.—In the winter of 1879-80 a famine on St. Lawrence Island destroyed a large part of the population, and Dr. E. W. Nelson has informed Mr. Geist that Kukulik was in all probability one of the abandoned sites which he visited shortly after the famine, where he found the houses filled with the dead. Since the site, therefore, was apparently occupied as late as 1879 and since the material from most of the structures on the surface of the mound contained a large number of modern trade objects, the cultural period represented by this material has been termed "Modern." The depth of the Modern level is indicated in the test cut by a large house structure which extended to a depth of 4 feet.

This last, or Modern, phase of occupation is particularly characterized by bone and ivory harpoon heads (type *A*) with a closed socket, a blade slit parallel to the axis of the line hole and a single spur, a type of harpoon head used throughout a large part of the Eskimo area during modern times.¹ Decorated ivory objects are conspicuously absent. Most of the

associated bone, ivory, wooden, baleen and stone artifacts obtained in these Modern structures are remarkably like those which characterize the prehistoric Thule culture in the eastern Arctic.²

Recent-Prehistoric.—Under the Modern house in the test cut lay a second house structure with the floor six feet below the surface. The majority of artifacts from this structure resemble those obtained in the house above, and correlate similarly with the Thule types. Most of the harpoon heads found in the second house, however, are a distinct type (*B*) which is notably different from the Modern type *A*. These type *B* heads, with a single spur and a blade slit parallel to the round-to-triangular line hole, have an open rather than a closed socket without slots or holes for foreshaft lashings, and are flat rather than oval in cross-section. Harpoon heads of this type were found in various sections of the midden directly below Modern structures.

A third house structure, the floor of which lay nine feet below the surface in the test cut, appeared below the second house but not clearly separated from it, since the second appeared to be a rebuilding of the third after this had filled in with debris. Although the material from the third house is obviously older than that from the second, the same type of harpoon (*B*) predominates in both and there are no significant variations in other artifacts. An awl and a knife blade made of wrought iron and a button-like object of lead were found in the second house, while a single wrought iron knife blade was found in the third. The presence of these implements and the absence of any other objects which might be derived from modern trade leaves some question as to the age of these deposits. The metal objects in the second house may have been obtained through early Russian trade, but the iron knife in the third house, if actually "*in situ*," would probably indicate prehistoric trade with some native people of Siberia in possession of iron, since it is unlikely that nine feet of deposit could accumulate between the time of Russian contact and the desertion of the site in 1879. In any case the material from the second and third houses, since it is characterized by the type *B* harpoon head, differs significantly from the Modern house material and marks a particular phase of occupation which has been termed "Recent-Prehistoric."

Thule.—Below the third house in the test cut the stratigraphic study has been based on a limited number of precisely located specimens, as collections adequate for this purpose could not be associated with particular house structures. Directly below the third house, between the depths of 9' and 10' 6", two types of harpoon head (*C* and 8) predominated. These types are characteristic of the Thule Culture sites in the eastern Arctic and have been defined by Mathiassen² as "Thule types 2 and 3." The other artifacts definitely located in this level are not sufficient in number for a comparison with those from the house structures above.

A meat cache structure (No. 35), discovered in 1935 at a depth of 5 feet in the eastern end of the mound, lay directly below Recent-Prehistoric structures and contained harpoon heads which are also clearly "Thule types." Three are the "Thule type 3," two are the "Thule type 2," and two are very closely related to the "Thule type 1." The associated artifacts are, as a whole, the same as those from the three house levels in the test cut. "Thule type" harpoon heads were also found at depths of from four to six feet below Recent-Prehistoric refuse in the beach slope cut.

The presence, in three different sections of the mound, of "Thule type" harpoons in strata below Recent-Prehistoric type *B* quite certainly represents a "Thule phase" at Kukulik. Only one of these sections (meat cache No. 35) produced an adequate collection of associated artifacts. These are also "Thule types."

Punuk.—Three types of harpoon heads (*D*, *E* and *F*) found in the test cut below "Thule types" and between the depths of 10' 6" and 12' 3", are incised with decorations of the "Punuk style" which particularly characterizes a "Punuk Culture" discovered by H. B. Collins³ at sites on Punuk and St. Lawrence Islands. These harpoons, numbering ten specimens, are not distinctive in form, since *D* specimens are similar in shape to *C* (Thule type 3) and *E* specimens are similar to the Modern *A* harpoon heads. They are classed as separate types primarily because of the incised decorations which are simple patterns of converging lines, *Y* figures, spurs and punctures. Twenty specimens of the same types (*D*, *E* and *F*) were found below "Thule types" in the beach slope cut at depths ranging from 6 to 11 feet. No adequate collection of other artifacts has been obtained from these levels in the deposit, but several implements decorated in the "Punuk style" were found associated with the harpoon types *D*, *E* and *F* in both deep cuts. Some of these objects are decorated with the "late Punuk," while all of the harpoon heads are decorated in the "early Punuk" pattern, as defined by Collins.³ This distinction is essentially based upon the appearance of precise "compass-made" circles on objects found in late Punuk deposits at Gambell, St. Lawrence Island.

Birnirk.—Two types of harpoon heads (*G*, *H*) found in the lower levels of the deposit are very similar to the harpoons which predominate at the Birnirk site near Point Barrow,⁴ Alaska, and also in the Van Valin collections⁵ from Point Barrow. The *G* type heads have side cutting blades parallel to the line hole, an open socket and a bifurcated spur. Most of the specimens are made from bone, unlike other harpoons at Kukulik which are normally ivory, and the cutting blades are made from shells. The *H* type heads have side cutting blades at right angles to the axis of the line hole, an open socket and a trifurcated spur. Most of them are also made from bone, but the side blades are usually flint. Harpoon heads of both types are occasionally incised with simple straight lines

running the length of the head on both sides of the line hole. Seven of these "Birnik type" harpoons are definitely located in the test cut and nine in the beach slope cut, but a large number have been found in various sections where stratigraphic relationship of types is not clear. Field notes state that "Birnik types" when "*in situ*," always appear associated with sod-strata which are older than the sod-strata with which "Punuk types" are associated, but a definite correlation of sod-strata with the various types has not yet been possible, and the stratigraphic charts leave some question as to the relative age of these two types. However, relying upon the field notes, a "Birnik phase" at Kukulik may be recognized.

Old Bering Sea.—Three types of harpoon heads (*I*, *J* and *K*) and a number of other implements found on or within a few inches of sterile clay at the base of the midden are incised with decorations of the "Old Bering Sea Style" as described by Jenness,¹ Hrdlička,⁶ Collins³ and Mathiassen.⁷ This style of decoration particularly characterizes the "Old Bering Sea Culture" discovered by Collins³ at Gambell, St. Lawrence Island. The forms of the "Old Bering Sea harpoon types" at Kukulik are not distinctive, since *I* specimens are like *F* specimens (Punuk) and type *J* is similar to type *H* (Birnik). The types are distinguished principally on the basis of the incised decorations which are made up of elaborate curvilinear design elements, bosses punctured at the center and outlined by incisions, zoöomorphic heads in low relief outlined by incisions, and petaloid elements.

Six of the "Old Bering Sea type" harpoons were found at the base of the deposit (13 to 14 feet deep) in the test cut, and seventeen within 2 feet of sterile clay in the beach slope cut. Among the implements other than harpoons decorated with the "Old Bering Sea" design are several winged "ceremonial" objects similar to others found in the Bering Sea region and previously described.⁸ These objects, like the somewhat similar wedge-shaped "ceremonial" specimens found in a more recent level at Kukulik associated with "Punuk type" harpoons, are of conjectural use and unknown to the modern Eskimo. Other objects found in the lowest level of refuse are essentially Eskimoid in character, and many are types which are the same as, or very similar to, those found throughout all levels in the midden, but specimens with the "Old Bering Sea type" of decoration are, apparently, limited to the lowest level of refuse. Above this the field notes record the presence of an "Old Bering Sea sod-stratum" marking the termination of the first period of occupation at Kukulik.

Conclusions.—The six cultural horizons observed in the Kukulik midden have been determined by a change in particular cultural elements only. Styles of decoration characterize the Old Bering Sea and Punuk periods, while distinctive types of harpoon heads characterize the Birnik, Thule, Recent-Prehistoric and Modern. The last three periods (Thule, Recent-

Prehistoric and Modern) appear to be stages in the development of a "Thule Culture complex." These stages are marked primarily by a change in the form of harpoon heads, since most of the other artifacts found in the three upper levels of refuse are the "Thule types" as defined by Mathiassen. With the limited number of specimens obtained from the lower levels it is not possible to determine the entire complex of characterizing elements nor the extent of the cultural change which occurred during the Old Bering Sea, Birnirk and Punuk periods. That objects Eskimoid in type are found throughout the entire deposit is, however, clear. Many of these types have a wide distribution in the Arctic area, and future excavations in the lower refuse levels at the site, together with a detailed study of the relation between Kukulik and other sites in the Arctic region, will undoubtedly make it possible to estimate the extent of the cultural changes which took place, and to determine whether these were due to local development, to immigration of new peoples or to contact with distinct cultures in the Eskimo area.

¹ Jenness, D., "Archaeological Investigations in Bering Strait" (1926), Annual Report for 1926, *Natl. Mus. Canada*, Ottawa (1928).

² Mathiassen, Therkel, "Archaeology of the Central Eskimos," *Rept. Fifth Thule Expedition*, 1921-24, 4, Copenhagen (1927).

³ Collins, Henry B., "Archaeology of the Bering Sea Region," The Smithsonian Report for 1933, 453-468, Washington, D. C. (1935).

⁴ Wissler, Clark, "Harpoons and Darts in the Stefánsson Collection," Anthropological Papers of the *Am. Mus. Natl. Hist.*, 14, pt. II, New York (1916).

⁵ Mason, J. Alden, "Excavations of Eskimo Thule Culture Sites at Point Barrow, Alaska," *Proc. 23rd. Internat. Cong. Americanists*, New York, 1928. N. Y. (1930).

⁶ Hrdlička, Aleš, "Anthropological Survey in Alaska," *46th Ann. Rept. Bur. Ethnology*, Washington, D. C. (1930).

⁷ Mathiassen, Therkel, "Some Specimens from the Bering Sea Culture," *Indian Notes*, 6, No. 1, *Mus. Am. Indian*, Heye Foundation, N. Y. (1929).

TORSION OF RECTANGULAR TUBES¹

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Read before the Academy, April 27, 1936

The problem of determining the stresses in prismatic bars subject to a twisting moment was solved by Saint-Venant. Lord Kelvin pointed out a hydrodynamical analogy and Prandtl developed a membrane analogy, rigorously correct for solid bars of simple section as well as for tubes of circular section and greatly facilitating an approximative solution. The hydrodynamical analogy was extended by R. Bredt² to thin-walled rec-