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VOL. 96

"EVERY MAN IS A VALUABLE MEMBER OF SOCIETY WHO, BY HIS OBSERVATIONS, RESEARCHES, AND EXPERIMENTS, PROCURES KNOWLEDGE FOR MEN"—SMITHSON

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C. G. Abbot,
Secretary of the Smithsonian Institution.

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Map of the Bering Sea Region.


60°
70°
80°
90°
70°
100°
110°
120°
60°
130°
50°
140°

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 96, NUMBER 1

ARCHEOLOGY OF ST. LAWRENCE ISLAND, ALASKA

(WITH 84 PLATES)

BY
HENRY B. COLLINS, JR.
Division of Ethnology, U. S. National Museum

(PUBLICATION 3411)

CITY OF WASHINGTON
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PREFACE

The present paper is a report of excavations conducted for the Smithsonian Institution at old Eskimo sites at Gambell, St. Lawrence Island, Alaska, during the summers of 1930 and 1931. The 1930 investigations were conducted by the writer, assisted by James A. Ford; those of 1931 were carried on by Moreau B. Chambers. The results of the writer's previous investigations on St. Lawrence Island in 1928 and 1929 are also utilized to a limited extent. The first section of the paper describes the excavations and the materials found; the second, or comparative section, treats of the distribution of the elements and the archeological problems involved.

This paper, in essentially its present form, was completed in the fall of 1935, and under the title "Archeological Investigations on St. Lawrence Island, Alaska, and their bearing on the problem of the origin of Eskimo Culture" was submitted to the Royal Academy of Sciences and Letters of Denmark in response to a prize competition announced in March 1934 on the subject "Quelles sont les origines de la plus ancienne civilisation des Esquimaux?" In February 1936 it was awarded the gold medal of the Academy, the judgment of the committee appearing in the official organ of the Academy, Oversigt over det Kongelige Danske Videnskabernes Selskabs Virksomhed, Juni 1935–Maj 1936, pages 160-164, and in French on pages 320-322. Since then the paper has been expanded somewhat, a number of illustrations have been added, and numerous changes, principally of a minor character, have been made in the text.

I wish to record here my obligation to James A. Ford, to whom in no small measure is due the successful outcome of the 1930 investigations; to Moreau B. Chambers who carried on so well the work that we had begun; and to our loyal and intelligent Eskimo helpers, Paul Silook, Philip Maskin, and Moses Soonogoruk. I wish also to express my gratitude to Capt. E. D. Jones, Commander of the U. S. Coast Guard Cutter *Northland*, for transportation to and from St. Lawrence Island both years; and finally to Dr. Aleš Hrdlička who was responsible for first directing my interests to the Alaskan field.

The arduous task of identifying the thousands of bird bones from the excavations has been performed by Dr. Herbert Friedmann. The mammal bones have been identified by Dr. Remington Kellogg; the

fish bones by E. D. Reid; mollusks by Harald A. Rehder; and crustaceans by Dr. Waldo L. Schmitt and Dr. H. A. Pilsbry. The mineral identifications were made by E. P. Henderson.

The drawings, maps and charts are the work of E. G. Cassedy, Frank Imrey, and J. W. Wilson. Mr. Cassedy has made the frontispiece, and text figures 1-3, 7, 10-13, 18-22, 24-26; Mr. Imrey has made plates 14, 16, 18, and text figures 5, 8, 14; and Mr. Wilson text figures 4, 6, 9, 15-17, 23. The photographs of specimens were made in the photographic laboratory of the United States National Museum by G. I. Hightower.

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ARCHEOLOGY OF ST. LAWRENCE ISLAND, ALASKA

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(With 84 Plates)

INTRODUCTION

As the northernmost people of the world, the Eskimos have long been a subject of popular and scientific interest. This has fortunately resulted in a number of careful studies which have provided a great amount of detailed information on many aspects of contemporary Eskimo culture. From the works of such authors as Egede, Cranz, Rink, Boas, Murdoch, Nelson, Steensby, Holm, Thalbitzer, Stefansson, Jenness, Rasmussen, Birket-Smith and Mathiassen—to name only a few of those who have made notable contributions to the subject—the modern Eskimos are perhaps as well known as any other group of primitive peoples. Prior to Mathiassen's investigations of 1922 and 1923, however, there had been no intensive or systematic excavations of old Eskimo sites; consequently, it was not until recently that the data afforded by archeology could be utilized in theoretical discussions of the origin of the Eskimo and his peculiar form of culture.

One of the first to express an opinion on this subject was the Danish missionary Cranz, who in 1770 advanced the theory that the Eskimos were originally an Asiatic people, related to the Kalmuks and other tribes of central and northeastern Asia. Pushed northward by the pressure of neighboring tribes, they migrated into northeastern Siberia, crossed Bering Strait into Alaska, and continuing eastward, eventually reached Greenland in the fourteenth century A. D. Markham also sought the origin of the Eskimo in Asia, along the northern coasts of Siberia. According to Markham (1865) the Eskimos had formerly lived along the Arctic coast in northeastern Siberia but were forced to migrate when, during one of the periods of political unrest in central Asia, they were subjected to pressure from the southward. Markham, like Wrangell and Nordenskiöld, saw evidence of such a former Eskimo population in the ruins of underground houses on the Arctic coast from Chaun Bay to Bering Strait, and in certain Chukchee traditions which related that these had formerly been occupied by the "Namollo", or "Onkilon", a maritime people who were driven by the Chukchee to some remote and undiscovered islands in the Polar Sea. From there Markham assumed that they had continued eastward and southward to the positions they now occupy.

Rink, in 1871, was the first to formulate a theory which took into account the specific elements of Eskimo culture and the conditions under which they might have arisen. According to Rink, the Eskimos were originally an inland race, dwelling in the interior of Alaska and possibly of Canada. The transition from an inland to a maritime life took place as they gradually descended the rivers to the coasts, meanwhile adapting their culture to new conditions. When this had been effected, they were able to take possession of the Arctic regions, a few of them crossing Bering Strait to Siberia, the others continuing eastward to occupy the long stretch of coast from Alaska to Greenland.

> In the pages which follow I will try to show, how . . . . the peculiarities of the tribes in the different domains of culture agree with the supposition that the original Eskimo inhabited the Interior of Alaska, that apart from the true Eskimo a side branch of them in the farthest remote period peopled the Aleutian islands, whereas people of the principal race later on settled at the river-mouths, spreading northward along Bering Strait and hiveing off some colonies to the opposite shore proceeded around Point Barrow to the east, the Mackenzie river, over the Central Regions or Arctic Archipelago, and finally to Labrador and Greenland. This dispersion may have taken thousands of years; they can only have proceeded in small bands, very much as still they are used to move about during certain seasons. Their only way of procuring subsistence in the vast deserts they passed over, excluded the possibility of national migrations on a larger scale. While in this way they continued to discover new countries, some families were induced to go farther, others remained and finally gave rise to the present scattered settlements. But in proposing this hypothesis I consider it a matter of course that Alaska as the original home of the Eskimo is not to be taken in the strictest sense, absolutely excluding adjacent parts of the continent towards the east. Tribes of the same race may have come down the Mackenzie or even more easterly rivers, but amalgamated with the principal stock, learning their inventions and adopting their mode of life. [Rink, 1887, pp. 4, 5.]

Rink's theory of a primary dispersal from the interior of Alaska was opposed by Murdoch on the ground that the progressive development of culture from southern Alaska to Greenland was not as regular as Rink supposed; that the culture of the south Alaskan Eskimos was highly specialized rather than primitive; and that the really primitive Eskimos were those of the Central regions.

> According to my theory the tribes of the Central Region, with their primitive culture, are nearest to the original home of the race, which would have been

the region lying south of Hudson's Bay instead of the interior of Alaska. Here one stream should have branched off to populate the peninsula of Labrador, while the main body pushed north along the western shore of Hudson's Bay to settle in the Arctic Archipelago and finally reach Greenland (as Dr. Rink believes) by way of Smith Sound, leaving the traces of their journey in the ruined iglus and other relics now found far north of the present range of any Eskimos on the west of Baffin's Bay.

Leaving their original home—apparently before the Labradorians branched off—another large body should have continued on to the north, in the network of lakes and rivers, always keeping east of the Rocky Mountains, until they were able to pass to the west by way of the basin of the Yukon. Here they would again divide, one body going down the Mackenzie to spread east to Cape Bathurst and west past Point Barrow to Bering Strait and on into Asia. The other body should have passed down the Yukon and Kuskokwim and spread along the coast, growing more and more modified in the south by their new and peculiar environment. It will be seen that from my point of view the Southern Alaskans are not primitive, but highly specialized Eskimos, who have brought with them into a comparatively fertile and temperate region the arts which originated under far different surroundings. [Murdoch, 1888, pp. 129, 130.]

Boas likewise thought that the original home of the Eskimos was in the Central regions, west of Hudson Bay. He was led to this belief principally by the evidence of folklore:

. . . . we arrive at the conclusion, that the more ancient forms of customs and traditions are found west of Baffin Bay. In this way we are led to conclude further that the Eskimo migrated by way of Baffin Land to Greenland and Labrador. The natives of Labrador and the south coast of Baffin Land, believe that the events told in their traditions occurred in the far north. Those of Fury and Hecla Strait point south and south-west to the American continent. The Western Eskimo refer to the east as the place where their heroes performed their exploits. Therefore, it seems probable that the lake region west of Hudson Bay was the home of the Eskimo. [Boas, 1888 b, p. 39.]

Confirmatory evidence of the central origin of the Eskimos seemed also to have been provided by the findings of the Jesup North Pacific Expedition of the American Museum of Natural History, carried out under the direction of Dr. Boas. The reports of the expedition included a number of valuable studies on the languages, material culture, and social organization of the tribes of the North Pacific coast of America and of eastern Siberia by Boas, Swanton, Bogoras, Jochelson, Laufer, and Teit; and on the archeology of British Columbia and Washington by Harlan I. Smith. An outstanding accomplishment of the Jesup expedition was the clear demonstration of cultural affinities existing between these now separated tribes. Some of the resemblances, particularly in the field of folklore, were remarkably close and led to the formulation of the theory that there had been in the past an intimate and extensive contact between the tribes of northeastern Asia and of northwestern America, exclusive of the Eskimo. The latter, according to the theory, were thought to have entered Alaska from the eastward, forming a wedge which separated the northwestern Indians from the related tribes of northeastern Siberia (Boas, 1905, pp. 91-100).

From the standpoint of linguistics, Thalbitzer considers that the Eskimos came originally from the region around Bering Strait, a view which is also shared by Bogoras (1925, p. 225) and Jenness (1933, pp. 380-381).

> The West Eskimo forms of words are as a rule fuller and more heterogeneous than the Greenlandic forms; they are accordingly at an earlier stage of development. [Thalbitzer, 1904, p. 266.]

> I still believe (like Rink), that the common Eskimo mother-group has at one time lived to the west of the Bering Strait, coming originally from the coasts of Siberia. In this way we should best explain the striking agreement in those common archaic features of the Greenland implements or other objects (eye-shades ornamented with ivory reliefs, etc.) and the Alaskan, which are absent from the intermediate regions. . . . . The agreement between the old material culture of the Greenlanders and a little older stage of the Alaskan Eskimo's culture is striking. In a large number of points, further, this common Eskimo culture agrees with the cultures in Asia of the Chukchee and neighbouring coastal tribes. In the points in which the culture of the intervening or central Eskimo groups differs from the main types of this common culture, in special or absent features, we see recent inventions, local specializations or defects. [Thalbitzer, 1914, pp. 717, 718.]

With the publication of Steensby's "Anthropogeographical Study of the Origin of the Eskimo Culture" in 1916, the problem enters a new phase. This work marked a notable advance in that it pointed out and laid particular emphasis upon a stratification in Eskimo culture. Steensby recognized that the Eskimos' material culture, particularly as regards hunting methods and implements, could be divided into three main groups. The first group included those elements which were common to both the Arctic and sub-Arctic Eskimos. The second group comprised the methods and implements which occurred among the sub-Arctic Eskimos of the east and west, but which were lacking in the central regions—kayak hunting on the open sea, the umiak, bird dart, etc. In the third group were included those elements of an essentially Arctic character, typical of the central archipelago—the various methods of hunting on the sea ice, the dog sledge, snow house, etc. Steensby considered that the last group represented the oldest form of Eskimo culture because: (1) the elements of the second or sub-Arctic group were absent in the central regions only because of inhibiting geographical conditions; (2) these sub-Arctic forms could easily be explained as either having been borrowed from outside sources or as special adaptations to sub-Arctic conditions; (3) the last or central group included the most primitive forms of those methods and elements which were peculiar to Eskimo culture; and (4) since a transition from an Arctic to a sub-Arctic form of culture had actually occurred in Greenland (from the Arctic archipelago and North Greenland to sub-Arctic South Greenland), a similar transition might be assumed to have taken place also from the central archipelago westward to Alaska.

We have arrived at the result that the Eskimo culture is oldest in its Arctic form, and that it has arisen in the Arctic Archipelago as a product of adaptation.

From the Archipelago the Arctic Eskimo culture spread east and west as far as the ice-conditions allowed. Towards the west it reached the districts at Bering Strait, where it came under foreign influence, especially under the so-called Pacific-Asiatic influence. . . . .

It so happened that the foreign influence was not so much a refashioning of the Eskimo culture which was created in the Archipelago as a contribution towards a further development in established directions. Some new implements were, of course, adopted, but that contact with a higher and richer technique has no doubt brought about improvements of existing forms is of just as much significance. Thus not only was the Arctic form of the Eskimo culture improved, but simultaneously the Eskimo culture expanded and advanced further in a southern direction, whereby the Subarctic form was first fashioned and developed. [Steensby, 1916, p. 170.]

The "pre-Eskimo mother culture from which the oldest Arctic Eskimo culture has issued" is called by Steensby the *"Palaeeskimo" culture;* the later phase which arose through acculturation at Bering Strait is called the *"Neoeskimo" culture.*

The Palaeeskimo culture was an original North Indian form of culture, the winter side of which had become specially and strongly developed by adaptation to the winter ice of the Arctic Ocean. [Steensby, 1916, p. 186.]

. . . . one must presume that this, the rise of the Palaeeskimo culture through geographical new adaptation, took place in the Arctic Archipelago or, more correctly, at the coasts and indentations between the continent and the islands, which means, firstly, along the district from Coronation Gulf to the Melville Peninsula. It is reasonable to suppose that again, among these areas, on account of its position, it was Coronation Gulf, or rather the regions between the continent and Victoria Land which were first reached by the Eskimo and which played a principal role in the new adaptation. [Steensby, 1916, p. 206.]

. . . . the so-called Neoeskimo culture and population originated around Bering Strait through the influence of various neighbouring peoples, especially of the so-called Pacific Asiatics, and . . . . amongst these latter it is the Japanese seafarers and fishermen who have played the most inciting and refashioning role, even if, perhaps, they have not yielded the greatest direct contribution to the improvement of the Neoeskimo technique. [Steensby, 1916, p. 211.]

Hatt, while recognizing a stratification in Eskimo culture, believed that the succession of the two layers should be reversed; that the greater part of what Steensby had called the " Neoeskimo " culture was earlier than the inland or " Palaeeskimo " phase (Hatt, 1916 a, p. 288). Hatt felt that the absence in the Central regions of certain elements that occurred both in the west and east (the seal net, urine tanning, gut skin coat, quadrangular house, throwing board, etc.) could not be explained geographically even though the absence of the umiak might be accounted for in this way. These elements must therefore have belonged to an old culture stratum, the continuity of which had been disrupted in the central Arctic area by later movements and influences from the interior regions between Hudson Bay and the Mackenzie.

. . . . the northern coasts of America have first been taken into use by an old coast culture, which undoubtedly stood in connection with Palae-asiatic cultures in north-east Asia and which contained just the elements which are now absent in a part of the central region, namely the umiak, the fishing net, the gut-skin shirt, urine tanning, the square house, women's boat, etc. and besides, naturally a part of the elements which are now to be found among all Eskimos, such as the seal harpoon, fish spear, bird dart, etc. Into this old coast culture then came one, or more likely several culture and race streams from the lands between Hudson Bay and Mackenzie River, carrying with them, among other things, the kayak and, just in virtue of this valuable culture element, succeeded in spreading over the northern coasts of America, absorbing and partly transforming the earlier culture and extending the Eskimo language as far as southern Alaska and eastern Greenland. [Hatt, 1916 a, p. 288, quoted by Mathiassen, 1927, vol. 2, p. 198.]

Hatt's views of a cultural stratification in the Eskimo region were in conformity with his previously expressed, more far-reaching concept of two great culture strata in the circumpolar regions—a coast culture and an inland culture. Hatt was led to advance this hypothesis in explanation of certain facts which emerged from his analysis of northern clothing types (Arktiske Skinddragter i Eurasien og America, Kobenhavn, 1914). The theory was further elaborated in two subsequent publications (Hatt, 1916 a; 1916 b).

If this theory [of two clothing complexes of different age and origin] be correct, we shall then have to reckon with two large cultural waves, which in prehistoric times swept over the northern regions. The oldest of these, now most fully represented and highest developed in the culture of the Eskimo tribes, did not have snowshoes and therefore could not conquer the vast inland areas; it must have followed and taken into possession the rivers and coasts, and we would call this first great wave the *coast culture*. The younger culture wave is found fullest and most unmixed in the culture of the Tungusians, although its influence is felt from Lapland to Labrador; it still has the character of an inland culture and must have originated as such. Its most valuable possession is the snowshoe, which has carried it over the greater part of the arctic.

The differences between these two great cultural waves are not confined to clothing only. In the technique of skin-dressing, e. g., we find a number of interesting points. The use of double-handled scrapers (originally a long bone) seems to belong to the inland culture, and also the smoking of the skin and perhaps even the use of fat as a tanning substance. As to habitations, the conical lodge must belong originally to the inland culture. The cradleboard or carrying-cradle and the birchbark canoe are also elements of the inland culture. One of the most important elements of the inland culture is the hunting of reindeer and moose on snow by means of snowshoes; this method is found in use everywhere in northern Asia, Europe, and America where snowshoes of highly developed types are found; and it is not unlikely that it is the deer hunt which more than anything else has furthered the development of the snowshoe. Some elements of the arctic inland culture never reached America; the most important of these is the reindeer nomadism, which in itself contains some elements, due to influence from more southern forms of nomadism, and others which have their root in the methods of hunting wild reindeer. The fact that the ski never reached America and that the Old World has only quite primitive forms of the netted snowshoes, while America has highly developed forms, would indicate that the inland culture reached America at an early period. The great variety of forms of the snowshoes and moccasins, and also the diversity of local terms bear further witness to the considerable age of the inland culture. [Hatt, 1916 b, pp. 248, 249.]

Kroeber (1923, pp. 389-390) is also among those who look to Asia as the original home of the Eskimo. Their occupancy of the Arctic littoral is regarded as a matter of choice rather than necessity.

. . . . it is evident that rigorous environment does not always force development or special cultural adaptations. The tribes of the Mackenzie-Yukon and the most northerly part of the Northeast area lived under a climate about as harsh as that of the Eskimo. In fact they were immediate neighbors; yet their culture is definitely more meager. A series of the most skilled devices of the Eskimo were wanting among them. If necessity were truly as productive a cause of cultural progress as is commonly thought, these Athabascan and Algonkin Indians should have been stimulated into a mechanical ingenuity comparable to that of the Eskimo, instead of continuing to rank below them.

These considerations compel the conclusion that the Eskimo did not develop the achievements of his culture because he lived in his difficult environment, but that he lived in the environment because he possessed a culture capable of coping with it. This does not mean that he had his culture worked out to the last detail before he settled on the American shores of the Arctic ocean. It does mean that he possessed the fundamentals of the culture, and the habits of ingenuity, the mechanical and practical turn of mind, which enabled him to carry it farther and meet new requirements as they came up. Where and how he acquired the fundamentals is obscure. . . . . It is conceivable that the origin of the Eskimo is to be set at a time later than that of the American race and somewhere in Asia. . . . . Somewhere in the Siberian region, then, within occasional reach of influences emanating from higher centers of civilization in Asia or Europe, the Eskimo may have laid the foundations of their culture, specialized it further as they encountered new conditions in new Asiatic habitats, and evolved only the finishing touches of their remarkable adaptation after they spread along the northernmost shores of America.

The past decade has witnessed a greatly increased interest in the problem of the Eskimo. This has been due in large part to the investigations into the ethnography, archeology, language, and folklore of the Central Eskimos inaugurated by the late Dr. Knud Rasmussen and carried out by himself and his colleagues, Kaj Birket-Smith and Therkel Mathiassen. Among the noteworthy results of the Fifth Thule Expedition are the reports by Birket-Smith on the Caribou Eskimos and by Mathiassen on the archeology of the Central Eskimos. Both of these works are landmarks in Eskimo research, not only for the mass of factual material they embody, but also because the opposing theories therein expressed have served as the center of discussion in recent years on the question of the origin of Eskimo culture.

When Knud Rasmussen and Birket-Smith came upon the Caribou Eskimos in the Barren Grounds west of Hudson Bay they felt that they had found in these remote and primitive people " a somewhat—though not essentially altered relic of an ancient culture layer, a form [of culture] which . . . . may be called ' Proto-Eskimo '." (Birket-Smith, 1929, vol. 2, pp. 222, 223.) In his important monograph " The Caribou Eskimos " Birket-Smith has undertaken an extensive analysis of Eskimo culture and has assembled a vast amount of comparative material which he feels bears out his theory of the ancestral status of this particular group of Eskimos. However much one may differ from the views therein expressed, one can not fail to be impressed by the brilliant argument and the industrious marshalling of data in support of the author's bold and stimulating theory of the origin of Eskimo culture. In addition to presenting a detailed picture of one of the most interesting aboriginal groups in Arctic America, Birket-Smith's book is a highly important contribution to theoretical ethnography. In its most essential features Birket-Smith's theory follows that of Steensby, although the argument is more detailed and the final structure considerably more elaborate.

Briefly, the hypothesis in question tends to show the following: Originally the Proto-Eskimo lived inland from Hudson bay and farther west. Whereas some of them, of whom the Caribou Eskimo are the last survivors, remained on the Barren Grounds, others resorted to the coast between Coronation gulf and the Boothia peninsula, where they adapted their living to the sea and were thus enabled to spread along the coast; this is the so-called Palae-Eskimo stage. At a later period the far richer Neo-Eskimo culture came into existence in Alaska; it spread as far to the east as Greenland, but at present it is not known from the central regions except from the so-called Thule culture which was brought to light by the archaeological investigations of the Fifth Thule Expedition, being otherwise obliterated by a modern Eschato-Eskimo advance of inland tribes that penetrated to the sea and constituted the recent Central Eskimo. [Birket-Smith, 1930, p. 608.]

Birket-Smith identifies the Caribou Eskimos with Hatt's "coast culture" but prefers to change the name of the latter to what he considers the less ambiguous term "ice-hunting stage", while the "inland" culture he would call the "snow-shoe stage." These terms, he thinks, are preferable to "coast" and "inland" because certain tribes whose culture is representative of the inland stage dwell on the coasts while others, the Caribou Eskimos specifically, who possess what is essentially a "coast" culture, dwell inland. Since in Birket-Smith's theory it is ice hunting (fish spearing with leister and harpoon) on the frozen lakes and rivers of the interior that originally gave rise to the Palae-Eskimos' ice hunting on the frozen sea, it must be admitted that from this standpoint the term "ice-hunting stage" is more appropriate. On the other hand Hatt's general concept of a "coast" and "inland" culture, applicable to the whole of the circumpolar region, loses something of its clarity and force through the introduction of this additional hypothetical element, so that it would seem preferable, in the broader sense, to retain Hatt's original terminology.

While Birket-Smith's study of the Caribou Eskimos resulted in a reformulation of the theory of the central origin of Eskimo culture, the results of Mathiassen's archeological investigations in the Central regions pointed in the opposite direction, toward Alaska and Siberia. Excavating at a number of abandoned sites to the west and north of Hudson Bay, Mathiassen found abundant evidence of an old and formerly widespread Eskimo culture, the Thule culture, which in many respects was very different from the simple culture of the Central Eskimos, the present inhabitants of the region. It appeared, on the contrary, to be much more closely related to that of Greenland and Alaska; so striking, in fact, were the resemblances to the latter region, particularly to Point Barrow, that Mathiassen decided that it was in Alaska that the Thule culture had originated.

. . . . wherever the Expedition has excavated in the Central Eskimo territory . . . . we have, below the modern Central Eskimo culture, found remnants of an older culture which, after a locality outside the Central Eskimo territory, in North Greenland, we have called the Thule culture. Whereas the present day Central Eskimos live a very nomadic existence, with snow houses and tents as their only dwellings, with caribou hunting as their principal occupation, whilst the hunting of marine animals has, as far as most tribes are concerned, retired somewhat into the background, the Thule culture has to a much greater degree been connected with the coast, has been based upon the hunting of the big marine mammals, especially whales and walruses, and has had permanent winter houses situated at the good hunting grounds; and in the implement technique of these two cultures we see great, fundamental differences. [Mathiassen, 1927, vol. 2, pp. 1, 2.]

. . . . in the central regions proper, west of Hudson Bay, the Thule culture has been entirely swept away; a little more has remained in Baffin Land and Labrador. In the Cape York district in North Greenland we find the pure Thule culture at the bottom, and its present inhabitants have retained much of the old culture, even if they have been exposed to the influence of the Central Eskimos. In North-east Greenland we find a later offshoot of the Thule culture. . . . . In northern West Greenland we recognize in scattered finds most of the types of the Thule culture. . . . . In the western regions we see in all the archaeological finds great similarity to the Thule culture and, in addition, signs that a typical Thule culture would appear at the bottom if a search were made for it, something which for the present we only have from East Siberia. The Western Eskimos, however, have received a great part of their elements from the Thule culture, and an Eskimo group like the Pt. Barrow Eskimos is in reality very closely related to the Thule culture. [Mathiassen, 1927, vol. 2, pp. 180, 181.]

We must therefore imagine that the Thule culture, with all its peculiar whaling culture, has originated somewhere in the western regions, in an Arctic area where whales were plentiful and wood abundant, and we are involuntarily led towards the coasts of Alaska and East Siberia north of Bering Strait, the regions to which we have time after time had to turn in order to find parallels to types from the Central Eskimo finds. There all the conditions have been present for the originating of such a culture, and from there it has spread eastwards right to Greenland, seeking everywhere to adapt itself to the local geographical conditions. And it can hardly have been a culture wave alone; it must have been a migration. [Mathiassen, 1927, vol. 2, p. 184.]

The first Eskimo to migrate over the arctic coasts of Canada and Greenland were thus the carriers of the Thule culture, and as we have the home of that culture in the west, *it is to the west that we must turn to find the original home of the Eskimo.* [Mathiassen, 1930 c, p. 606.]

When Mathiassen's work appeared there was no information available on the archeology of the western regions, and in the absence of this he attributed to the Thule culture a basic importance which, in the light of subsequent investigations in Alaska, seems unjustified. However, Mathiassen's pioneer investigations marked the beginning of systematic work in the American Arctic and his masterly report must be recognized as the first major landmark in Eskimo archeology.

Whatever may be the explanation of the Thule culture—whether it was in reality the first to spread over the Arctic coasts of Canada and Greenland, or whether, as Birket-Smith believes, it is to be identified with the later Neo-Eskimo culture—it is the dominent prehistoric phase of culture in the central regions and since it has obviously had its origin in the west, it is here that we must look for further elucidation of the problem.

It was not until 1926 that systematic archeological investigations were undertaken in northern Alaska. In that year Diamond Jenness, excavating at Cape Prince of Wales and the nearby Diomede Islands in Bering Strait, made the important discovery that there had formerly existed in this region an old Eskimo culture which was ancestral to, but in certain respects very different from, the present form of Alaskan Eskimo culture. From the kitchen middens at Bering Strait, Jenness obtained a large number of artifacts, including some of "fossilized" walrus ivory which were elaborately ornamented, all constituting evidence of an ancient Eskimo culture which apparently many centuries ago had reached a higher stage of artistic development than any culture previously known to have existed in the Arctic regions.

We seem justified, therefore, in concluding that the shores and islands of Bering sea were at one time the home of a distinct and highly developed Eskimo culture, a culture marked by special types of harpoon-heads and other objects that in many cases show the most skillful workmanship, marked too by a very original art, partly geometrical and partly realistic, that suggests in some of its features contact with the Indians of the northwest coast of America, although its roots more probably lie in northeastern Asia. It appears to be the oldest culture yet discovered in the western Arctic, preceding, at least in Wales and on Diomede islands, the Thule stage as exemplified by the mound dwellings at Wales, and by similar ruins at Point Hope and at Barrow. Its true centre seems to have been Bering sea, but its influence extended northward, and conditioned the form of the earliest known sealing harpoon-head at Barrow. Subsequently it passed away, but perhaps we may still trace its influence in the designs on some later specimens from the region of its old home. [Jenness, 1928 a, p. 78.]

What was the date, approximately, of the Bering Sea culture, and from what source or sources did it spring? These are questions we cannot answer in the present state of our knowledge. If the Thule culture goes back at least a thousand years in the eastern Arctic, as seems most probable, its earlier phase at Birnirk and at Van Valin's site near Barrow may quite well date from the early centuries of the Christian era. The Bering Sea culture would then precede the Christian era, but by how long we have not the faintest clue. There can hardly be any doubt that the curvilinear art was not invented *ex ovo* by the Eskimo; it reminds us too strongly of Melanesian art, of the art of the Ainu and of tribes along the Amur River, of certain designs current among Indian tribes on the north Pacific coast of America, and, most of all, of the patterns on Aleutian head-dresses. Possibly there have been culture drifts from a common source to all these places, southward down the coast of Asia into Indonesia and Melanesia, and northward to the Chukchee Peninsula and into America; for civilization reached China long before the Shang Dynasty in the second millenium B. C., and influences from that country must have streamed in all directions. At all events, it is on the north-eastern shores of Asia, probably, and not in Alaska, that we should look for the origin of the mysterious curvilinear art of the Bering Sea culture, and in the same general area for the sources of other elements in that culture that appear unique among the Eskimo to-day merely owing to the limitations of our knowledge. [Jenness, 1933, p. 387.]

While Jenness was excavating at Wales and the Diomedes, Dr. Aleš Hrdlička was making an anthropological survey of the Alaskan coast from Norton Sound to Point Barrow, in the course of which he was able to obtain a number of examples of the old art, most of them from St. Lawrence Island:

The most interesting archeological specimens from the region of the western Eskimo . . . . are some of those in "fossil ivory," the term being applied to walrus ivory that through long lying in the ground has assumed more or less of a pearly yellow, variegated, sepia-brown or black color. These objects are known as yet very imperfectly. They are scarce at and especially north of Point Hope, and again along the west coast south of Norton Sound. Their center of frequency comprises seemingly the St. Lawrence Island, some parts of the Asiatic coast, the Diomedes, and parts of the Seward Peninsula. But they occur at least up to Point Hope, while west of Bering Strait they are said to appear as far as the river Kolyma.

Some of the objects in fossilized ivory show the well-known Eskimo art, with geometrical design. But besides these there occur here and there beautiful specimens, harpoon heads, figures, needle cases, etc., which are of the finest workmanship and which both in form and design differ from the prevailing Eskimo types. They are examples of high aboriginal art; and their engraved decorative lines are not geometrical but beautifully curvilinear. [Hrdlička, 1930, pp. 173-174.]

The discovery of an ancient but highly developed stage of Eskimo culture at Bering Strait opened up an entirely new aspect of the problem of the origin of Eskimo culture. First of all it seemed to weigh heavily against the central origin theory; for if Steensby was correct in his assumption that modern Alaskan Eskimo culture was in large part the result of stimulation from outside sources, archeological investigations should reveal beneath the later accretions, a simple stage of culture resembling that found in the central regions. However, the reverse seemed to be true, the older culture being even further removed from the central form than was the modern. On the other hand, if this ancient Bering Sea culture differed from other phases of Eskimo culture and possessed an elaborate art style somewhat reminiscent of the Northwest Coast and of northeastern Asia, might it not after all be more Indian than Eskimo? Might it not, perhaps, be the very link that was needed to bear out the hypothesis, based on the findings of the Jesup Expedition, that formerly there had existed a close cultural connection between the Northwest Coast Indians and the Palae-Asiatic tribes of Siberia? These are questions which can hardly be answered on the basis of the evidence heretofore available. To understand the significance of the Old Bering Sea culture and its relationship to other phases of Eskimo, Indian, and Asiatic culture, it is essential that we have full knowledge of the elements of which it is composed.

Following the initial discoveries of Jenness and Hrdlička, the writer has engaged in four seasons of field-work in Alaska. Reconnaissance work was carried on along the Alaskan coast from Bristol Bay to Point Hope, and intensive excavations were made on St. Lawrence Island. In 1930, at the northwestern end of St. Lawrence Island, I had the good fortune finally to discover a pure site of the Old Bering Sea culture. In the following pages the results of the 1930 investigations will be presented; the implement types of the Old Bering Sea culture and those of an intermediate stage of culture will be described, and their significance discussed.

GEOGRAPHICAL SETTING

St. Lawrence Island, the largest in the Bering Sea, lies 150 miles below Bering Strait, 100 miles from the mainland of Alaska and 40 miles from Siberia. It is about 100 miles long, extending in a general northwest to southeast direction, and has an average width of about 20 miles. The island, which has never been accurately charted or explored geologically, is mainly of volcanic origin though occasional sedimentary deposits of Tertiary age also occur. The interior is for the most part rugged and mountainous, but there are also extensive stretches of marshy tundra covered with innumerable lakes and a network of small streams. Some of the peaks and plateaus in the central and eastern sections of the island reach a height of 1,500 feet or more, and remain snow-capped throughout the year; at the western end the highest elevations are along the coasts. The coast line is bleak and forbidding in appearance with bold cliffs of basalt descending steeply to the rocky beach or to low forelands of gravel which often extend for a considerable distance seaward. For the greater part of the year the island is locked in ice, which does not finally leave its shores until late in June or July.

Vegetation is of the usual Arctic variety, that in the higher parts being restricted almost entirely to mosses and lichens, while lower down there is an abundant growth of dwarf willows, mosses, grasses, and flowering plants. In Tertiary time there existed a markedly different assemblage of plants, to judge from fossil remains that have been found, first by A. J. Collier, and later, in 1930, by the present writer. Collier's discovery of fossil sequoia on St. Lawrence Island was first announced by Knopf in 1910:

> On St. Lawrence Island . . . . Collier has discovered some coal-bearing sediments carrying plant remains. A few conifers and dicotyledons were found, among which Knowlton has identified *Sequoia langsdorfi*, indicating Kenai age. This bit of evidence, incomplete and unsatisfactory as it is, is the most important yet discovered that bears on the question of a land connection between the continents during the early part of the Tertiary. [Knopf, 1910, pp. 415-416.]

In 1930, at the suggestion of Prof. Ralph W. Chaney, the writer located a coal and shale deposit on the north side of the island, proba-

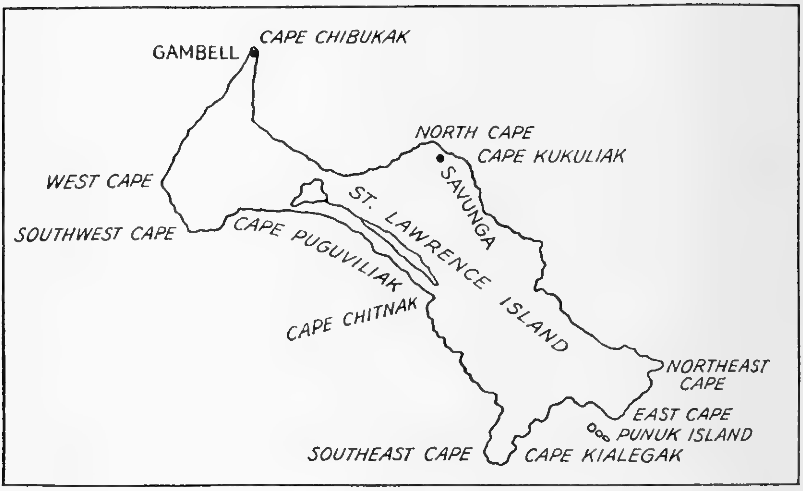

FIG. 1.—Map of St. Lawrence Island, Bering Sea.

bly the same one found by Collier, and obtained from it a number of plant remains, which Professor Chaney identified as sequoia, poplar, sycamore, and alder (Chaney, 1930, pp. 653-654). The occurrence on this barren Alaskan island of trees which are now restricted to a more southerly range, particularly the sequoia or redwood, the seeds of which apparently do not retain their viability after being transported in water, may be regarded as direct evidence of the long postulated Tertiary land connection between Asia and America, the existence of which is necessary in order to explain the many and close resemblances between the plant and animal life of the two continents during past geologic epochs and at the present time.

The indigenous mammalian fauna on St. Lawrence Island includes very few species: the Arctic fox, *Alopex lagopus;* ground squirrel, *Citellus lyratus;* meadow mouse, *Microtus innuitus innuitus;* red-backed mouse, *Clethrionomys albiventer;* shrew, *Sorex jacksoni;* and lemming, *Dicrostonyx exsul.* Polar bears frequently visit the island in the winter, and in recent years the Government has introduced reindeer for the use of the Eskimos.

Only a few birds, such as ravens, the snowy owl, and hawks, remain on the island throughout the year, but in summer there are countless numbers of migratory birds, many of which have their breeding grounds on the marshy inland tundra or on the rocky cliffs along the shore. Dr. Herbert Friedmann, who has recently described the avifauna of St. Lawrence Island on the basis of the few previous records and a collection of 109 skins obtained by the writer in 1930, lists 61 species as occurring on the island, the families represented being loons; albatrosses; fulmars; petrels; cormorants; ducks, geese, and swans; cranes; plovers and turnstones; sandpipers and godwits; phalaropes; jaegers; gulls and terns; murres, guillemots, auklets, puffins; cuckoos; owls; ravens; wagtails; redpolls; longspurs and snow buntings (Friedmann, 1932).

The birds that are of economic importance to the Eskimos are mainly the ducks, geese, cormorants, auklets, gulls, and murres, all of which are eaten; the skins of some of these are also used for clothing but not as extensively as in the past. It is of interest to note that the St. Lawrence Islanders catch the auklets with a long-handled net, in exactly the same way as do some of the Eskimos in Greenland and the Central regions.

The Eskimos inhabiting St. Lawrence belong to the Yuit or Siberian group. At present they number some 400 individuals, but in earlier times there was a considerably larger population, which was greatly reduced by a severe epidemic and famine in the winter of 1878-79. About three-fourths of the population is now concentrated at two large villages, Gambell, or Sevuokok (Chibukak), at the extreme northwestern end of the island, and Savunga, the reindeer village, about 40 miles to the eastward on the north coast. Several smaller settlements of a few families each are found near the southwestern end of the island and also along the coast between Savunga and Gambell.

HISTORY AND PREVIOUS EXPLORATIONS

The northern Pacific, with the lands bordering its shores in Asia and America, was the last large section of the habitable world to become known to European geographers. While the persistent belief in a Northwest passage from Europe to the Orient had led to a number of voyages of exploration in the sixteenth century which had made known at least the main outlines of the geography of the northern Atlantic and even of parts of the Arctic, it was not until the eighteenth century that reliable information was available on the vast region of the Pacific stretching northward from Japan. The accounts of the Jesuit missionaries in China and Japan and of the Dutch and Spanish navigators of the seventeenth century were so vague and conflicting that the contemporary maps of this region were hopelessly inaccurate. The island of Yezo, in the northern part of the Japanese archipelago, had assumed almost continental proportions, and this and other imaginary lands were thought to lie between or to connect the continents of Asia and America.

While the cartographers were busying themselves with these imaginary problems, Russian traders and adventurers were pushing eastward across Siberia, and it was these overland explorations that opened the way for the later voyages that were eventually to settle the question of the geographical relationship between Asia and America. By 1632 the Cossacks had penetrated far into Siberia and established the fortified town of Yakutz on the upper Lena River, from which point military expeditions were sent out to collect tribute from the native peoples. In the course of a few years the Arctic coast was reached and the rivers Yana, Indigirka, and Kolyma, which flowed into the Frozen Sea, were discovered to the eastward.

In 1648 seven small trading vessels set out from the mouth of the Kolyma, and one of these, in command of the Cossack Simeon Deshnev, succeeded in rounding East Cape, passed through Bering Strait, and continuing southward finally reached the Anadyr River, where in the following year the fortress of Anadyrsk was established. News of this remarkable voyage did not reach the Russian court, and it might have remained entirely unknown had not the original manuscript records been discovered in the Archives at Yakutz by the historian Gerhard Friedrich Müller in 1736, almost a hundred years later.

Following the exploits of Deshnev and his companions, the Russians continued their explorations in eastern Siberia. Before the close of the seventeenth century Kamchatka had been discovered, and by 1715 its subjugation had been accomplished. As news of the Russian discoveries reached Europe, the Emperor Peter the Great became personally interested and in 1718 dispatched two of his naval officers to the Pacific, with instructions to sail north and east of Kamchatka to determine whether or not Asia and America were united. This attempt proving fruitless, he drew up instructions in 1724 for a more ambitious undertaking, an expedition under the command of Fleet-Captain Vitus Bering. Although Bering's first expedition (1725-30) fell somewhat short of expectations and failed to settle conclusively the question of the relationship between Asia and America, it marked a tremendous advance in geographic knowledge and provided the first map of northeastern Siberia that could lay even the slightest claim to accuracy. The shores of the Okhotsk Sea, Kamchatka, the Anadyr region, and the Chukchee Peninsula were all delineated with a fair degree of precision. The point of immediate interest in the present connection is the discovery, or at least the naming, of St. Lawrence Island by Bering on August 10, 1728 (Aug. 21, new style). Bering's reference to the discovery is brief:

> A little later the boat [an umiak with Chukchees from the mainland] moved up to us and the men in it told us that large numbers of Chukshi live along the shore, that a short distance from here the coast turns to the west, and that not far ahead of us is an island. We located this island, which we named St. Lawrence, in honor of the day, and found on it a few huts but no people, although I twice sent the midshipman to look for them. [Golder, vol. 1, p. 18.]

It seems unlikely that Bering was the first European to have seen St. Lawrence Island. Deshnev must have passed close by it as he followed the coast from Bering Strait down to the Anadyr, and in later years, but still before the time of Bering, a number of expeditions had been sent out from the Kolyma and the Anadyr to collect tribute from the Chukchees. That some knowledge of the island had been gained by Bering's predecessors would appear from the following statement by Müller, who, as already mentioned, discovered the original account of Deshnev's voyage in the Archives of Yakutz in 1736:

> Another Map which I got at *Jakutzk,* from a *Dworanin,* named *Iwan Lwaw,* who is the Author of it, furnishes us with some more Accounts. It represents a two-fold Noss; the farthermost towards the North East, which, from the Nation of the *Tschutschi,* is commonly called *Tschukotskoi Noss,* and has there the Name of *Schelatzkoi,* from the *Schelagen,* who are a particular Race among the *Tschuktschi.* The other, which lies South from this, though it is far enough from the River Anadir, is called from that River *Anadirskoi Noss.* . . . . In a large Gulph between *Tschukotskoy* and *Anadirskoi Noss* lies an Island, which is said to be inhabited by the *Tschuktschi,* and another over-against *Anadirskoi Noss,* the one farther from the Continent than the other; which are described in the following Manner: "To the first Island is half a Day's Voyage; upon it lives a People whom the *Tschuktschi* call *Achjuchaljat;* these speak their own Language, wear Cloaths of Duck-skins, and live by catching of Sea-Horses and Whales; and, as the Island is without Forests, they boil their Provisions with Train Oil. The second is two Days Voyage Distance from the first; the Inhabitants are called, in the *Tschuktschi* Language *Peekeli.* They have Teeth set in through their Cheeks; they live in fortified

Places, and are also cloathed with Duck-skins." I am of Opinion, that the Situation here given to this Island is a Mistake, and that it must be looked for over-against *Tschukotskoi Noss.* [Müller, 1761, p. xxii.]

Müller is undoubtedly correct in supposing that the second island lay to the north of the first for the reference is evidently to Diomede Island, whose inhabitants wear labrets of walrus ivory and whose villages of stone houses, built into the hillside, might well be described as "fortified places." However, the name "Peekeli" (Peekit) is not that which the Chukchee use in designating the Diomede people but refers to the Eskimos at East Cape, on the Siberian shore just opposite Diomede Island. As to the first island, two days journey from the second, this could only have been St. Lawrence; for the word "Achjuchaljat", the name given the inhabitants, is clearly synonymous with "Eiwhue'lit", which according to Bogoras (1904-09, p. 20) is the term by which the Chukchee still refer to the St. Lawrence Eskimos. This in turn is synonymous with Ōwäh'lāt (Wallit according to Moore, p. 340), the name of one of the groups living at Gambell.[1]

Bering's second expedition, in 1741, which reached the Aleutian Islands and the American mainland near Cape St. Elias, led to a series of private or commercial expeditions by Russian fur traders, all of which were confined to southern Alaska and the Aleutian region. The only official expedition to follow in the path of Bering's earlier discoveries was that of Lieutenant Synd of the Russian Navy in 1764-68. As a result of this expedition a number of nonexisting islands were charted in the northern part of Bering Sea. Synd had apparently sighted St. Lawrence Island from a distance and had mistaken the numerous mountain peaks, connected by low land, for separate islands. For some years afterward St. Lawrence appeared on the Russian maps as Synd's Island.

In 1778 Captain Cook had a distant view of St. Lawrence Island from the eastward and gave it the name of Anderson's Island after Dr. William Anderson, surgeon on the *Discovery.* Later in the same year, approaching more closely, Cook named the eastern part of the island Clerke's Island, after Captain Clerke of the *Discovery,* not suspecting its connection with St. Lawrence, or the supposed Anderson's Island. On this occasion Cook observed the small islands now known as Punuk, off the eastern end of St. Lawrence: "Near its eastern end is a little island, which is remarkable for having on

[1] In 1930 the Ōwäh'lāt were represented by only nine people living in two houses at the extreme north end of the village. They were formerly more numerous, however, and are recognized by the other groups as being the original inhabitants of the village, the others claiming to have come either from Siberia or from other localities on St. Lawrence Island.

it three elevated rocks. Both the greater island, and this smaller one, were inhabited." (Cook, vol. 3, p. 84.)

St. Lawrence Island was next visited in 1791 by Commodore Joseph Billings, in command of an exploring and surveying expedition sent out by the Empress of Russia. Billings himself published no report of the expedition, and the account by Martin Sauer, secretary to Billings, contains nothing of particular interest concerning the island.

The first circumstantial account of St. Lawrence Island and its people is that given by Kotzebue, who sailed around the western end of the island in July 1816 and the eastern end in the same month of the following year. On July 27, 1816, Kotzebue landed on the southwestern coast of the island and gives the following account of his visit:

> . . . . We observed people and tents on the shore; and the wish of becoming acquainted with the inhabitants of this island, who had never been visited by any navigator, and also to give our naturalists an opportunity of examining this unknown country, induced me to pay it a visit. Two of our four-oared boats were directly put into the water, and we set out, well armed with pistols, sabres, and guns. . . . . At a small distance from the shore, we were met by a baydare, (boat,) with ten islanders, who approached us without fear, calling aloud to us, and making the most singular motions, holding fox-skins in the air, with which they eagerly beckoned us. We easily perceived their arms hidden in their baydare, and therefore observed the greatest caution. After some salutations, according to their custom, which consisted in stroking themselves several times with both their hands, from the face to the belly, their first word was Tobacco!—of which I had some leaves, handed to them, which they immediately put into their mouths. I afterwards saw them smoking out of small stone pipes, about the size of a thimble: they repaid my presents with different articles of their workmanship. After this friendly barter, I continued my way to the shore, which seemed to frighten them very much, as they ran anxiously to and fro, and some, probably only women, fled into the mountains. Some of them came up to us bravely enough; but their fear, which they in vain strove to hide under the mask of friendship, was visible. At every thing we did they laughed without bounds; but as soon as any of our motions excited the least suspicion of hostility, they assumed a fierce look; they prepared themselves partly for flight and partly for resistance. Their friendship, however, returned when they perceived their error, and this sudden change from laughing to seriousness, gave their faces, which were smeared with train-oil, an extremely comical appearance. We landed opposite to the tents, followed by the islanders; ten or fifteen of whom assisted us, with great readiness, to draw our boats on shore. This place appeared to us to be visited only in the summer, when the islanders employ themselves in the whale, morse, and seal fishery, as we perceived no settled dwellings, only several small tents, built of the ribs of whales, and covered with the skin of the morse, which indicate only a short stay. A deep cellar dug in the earth, filled with train-oil, blubber, dried seals' flesh, and morses' teeth, likewise shows that they only collect their winter provisions here.

They gave us to understand, by signs, that their real abode was behind the promontory, in the W., whither they invited us. A second boat, coming from the quarter pointed out, in which two women, dressed like men, looked frightfully with their tattooed faces, confirmed this assertion. How much did I regret not understanding their language, as I should then have been able to relate many interesting things concerning these people. In many respects they resemble the inhabitants of Norton Sound, described by Captain Cook; they are of a middle stature, robust make, and healthy appearance; their clothing, which consists of skins, is filthy to the highest degree. My Aleutian, who has passed several years in the peninsula of Alashka, affirms, that there is very little difference between these two people, as well in their language as in other respects. We observed several European utensils of iron and copper. Every islander is armed with a knife, an ell (2 feet) long, and adorned with large blue and white glass beads.

While our naturalists were strolling about the mountains, I entertained myself with my new acquaintance, who, as soon as they learnt that I was the commander, invited me to their tent. A filthy piece of leather was spread on the floor for me to sit on; and then they came up to me one after the other—each of them embraced me, rubbed his nose hard against mine, and ended his caresses by spitting in his hands and wiping them several times over my face. Though these signs of friendship were not very agreeable to me, I bore all patiently. To suppress their further tenderness, I distributed some tobacco-leaves, which they received with much pleasure, and were going to repeat all their caresses again. I hastily took some knives, scissars, and beads, and thus happily prevented a second attack. An almost still greater misery awaited me; when, in order to refresh me, they brought forth a wooden trough of whale blubber, (a great delicacy among all the northern inhabitants of the sea coasts), and I bravely took some of it, sickening and dangerous as this food is to an European stomach. This, and some other presents, which I afterwards made them, sealed the bond of our friendly acquaintance. My host, the proprietor of the tent, and probably the chief of his countrymen present, after our meals ordered a dance; one of them stept forwards, made the most comical motions with his whole body, without stirring from his place, making the most hideous grimaces; the others sung a song, consisting of only two notes, sometimes louder, sometimes lower, and the time was beat on a small tambourine. . . . . The island is called by the inhabitants, Tschibocki; and the country to the east (America) Kililack. That part which we saw had a most dismal appearance; it consists of pretty high mountains, covered with snow. Not a single tree, not even a small bush, adorns the grey rocks, only short grass sprouts up here and there between the moss, only a few stinted plants rise above the ground, and yet many a flower blows here. The arms of the islanders, which they use for the chace as well as war, consist of bows, arrows, and lances; the two latter are furnished with a broad, well-wrought iron head: these, as well as their other European utensils, we afterwards learnt they received from the Tschukutskoi. They do not appear ever to have seen any European, to judge by the amazement with which they beheld us. Nothing attracted their attention so much as my telescope; and when I showed them its properties, and they really saw quite distant objects close before their eyes, they were seized with the most extravagant joy. [Kotzebue, 1821, vol. 1, pp. 189-193.]

Proceeding up the west coast, Kotzebue had a view of the northwestern extremity of the island and of the village of Sevuokok (Gambell) situated on a low gravel plain which extends westward from the cape:

July 29. . . . . We sailed along the west coast during the night; and at daybreak saw the northern point of St. Lawrence islands, which, at eight o'clock, lay at the distance of one mile south of us. The promontory is distinguished by a high rock, rising perpendicularly out of the sea; a little more to the south, a low tongue of land extends to the west, and has a very singular appearance arising from several *jurtes* (subterraneous dwellings), and a number of whale ribs, which the islanders have set up perpendicularly in the ground, between their dwellings. As soon as they perceived us, they pushed three baydares, each containing ten men, from the shore; left off rowing, when they had approached the Rurick within ten yards; and then, with doleful voices, commenced a mournful song. Upon this, one in the middle arose, holding up a small black dog, and after speaking some words, in an expressive manner, drew a knife, with which he gave the dog a mortal wound, and then threw the poor victim into the sea. After the conclusion of this ceremony, during which the deepest silence was observed in the baydares, they approached the ship, but only a few ventured on board. I found no difference between these, and our friends of yesterday. They call themselves, like them, Tschibocko; and the coast of Asia, opposite to them, they call Wemen. [Kotzebue, 1821, vol. 1, pp. 195-196.]

On July 10, 1817, Kotzebue approached the southeastern end of St. Lawrence Island and went ashore at the village of Kialegak:

The 10th. At five o'clock in the morning the south-easterly part of St. Lawrence Island was seen from the mast-head N. by W. The land showed itself to us in two small hills, and was distant from us twenty miles. At mid-day it lay to the north of us, at the distance of nine miles, and after we had sailed round a promontory which projected from S. E., and had discovered, in a low spot on the shore, some habitations consisting of tents and huts, I steered thither in order to acquaint myself with its inhabitants. At five o'clock we cast anchor, two miles distant from the village, in four fathoms and a half deep, over a stony bottom. When our boats were put into the water, we saw through our telescopes some people, loaded with baggage, fleeing from their habitations into the mountains, and others arming themselves with lances for our arrival. On the landing-place when we came, we found twenty tall and robust men, who looked at us with fearful friendliness, without stirring. They had much resemblance to the inhabitants on the western point of this island; and as I perceived the fear which our arrival had occasioned, I did not examine their dwellings, but contented myself with putting the philological skill of our interpreters to the test, which really went so far that they understood each other though with difficulty. We, however, learnt so much that they trade with the Tschukutskoi, from whom they obtain tobacco, iron, and glass-beads, in exchange for skins. While we were conversing with them a baydare was drawn along the strand by dogs, which just came from the Tschukutskoi, and the people shewed us some of the things they had obtained there. They call the inhabitants of the continent of America their brethren; and as they have a constant intercourse with them, and their language is also the same, there seems to be no doubt that these people are of American origin. The eastern part of St. Lawrence Island, on which we then were, they called Kealegack [Kialegak], and the western Tschibocka [Sevuokok]. Their first question to our interpreter was, where we came from, and whether our intention was to kill them? But after we had given them some glass-beads and tobacco, they lost their suspicions. . . . .

The inconvenient anchorage in which the Rurick lay, did not permit us to remain long on shore. We hastened on board, spread the sails, and steered to the northern point of the island. The small island [Punuk] laid down on Cook's chart as a single one, consists, as we perceived in sailing by, of two, separated by a narrow channel. [Kotzebue, 1821, vol. 2, pp. 174-176.]

Lieutenant Shishmareff, who accompanied Kotzebue, surveyed parts of the shore line of St. Lawrence in 1816 and 1817. In 1821 he returned to Alaska in command of the ship *Good Intent* and completed the survey of the St. Lawrence coast.

In 1848 the first American whaling ship passed through Bering Strait and met with such success that the next year it was followed by a large fleet of vessels. With the whaling industry established in the Bering Sea and western Arctic, St. Lawrence Island was visited at frequent intervals but these unrecorded visits, like those of the trading ships which came later, provided no information concerning the island or its people. In fact, it was not until 1880, more than 60 years after Kotzebue's voyage, that there is record of another brief visit to St. Lawrence Island. In that year Capt. C. L. Hooper, in command of the U. S. Revenue Steamer *Corwin,* stopped at St. Lawrence to investigate reports of the starvation of large numbers of the Eskimos during the winter of 1878-79. Captain Hooper gives the following account of the distressing conditions he found on the island, where probably 1,000 people, out of a population of around 1,500, had died during the previous year.

We stopped off the first village [on the north shore] . . . . about midnight of June 25, and found the village entirely deserted, with sleds, boat-frames, paddles, spears, bows and arrows, &c., strewn in every direction. We saw no dead bodies; probably missed them in the faint twilight, as we subsequently learned at the west end of the island that they had all died. From the number of houses, boats, &c., we estimated the number of those who had died to be about fifty.

On the 26th, we followed along the north side of the island, examining the villages as we came to them. At Cape Siepermo . . . . we found the village deserted, not a sign of life remaining. I counted fifty-four dead bodies; and, as these were nearly all full-grown males, there can be no doubt that many more died. The women and children doubtless died first, and were buried. Most of those seen were just outside the village, with their sleds beside them, evidently having been dragged out by the survivors, as they died, until they, becoming too weak for further exertion, went into their houses, and, covering themselves with skins, laid down and died. In many of the houses we saw from one to four dead bodies. One woman was found face down, just outside the door of a house; probably one of the last survivors, she had gone out to find relief from her terrible sufferings, and, overcome by weakness, had fallen and found that relief in death. The body of a boy of perhaps sixteen years of age was found in the village, about half-way down a small hill, he having fallen as he descended and died as he fell. I estimate the number of dead at this place at one hundred and fifty.

About fifteen miles west of Cape Siepermo we found another village, ... also entirely deserted. Here we saw twelve dead bodies, all full-grown males. As at the other villages, the women and children had probably been buried, for we saw none. The number of dead at this place was estimated at thirty.

At a large settlement on the northwest end of the island . . . . [Gambell] which we next visited, we found about three hundred alive. They confirm the report of wholesale starvation, and say that the inhabitants of the villages visited by us on the north side of the island, are all dead, not one escaping. At this settlement two hundred had died, and the entire number had barely escaped starvation by eating their dogs and the walrus-hides covering their boats and houses. At a settlement on the southwest end they said a large number had died, but how many they could not tell.

This general starvation occurred a year ago last winter; but few died last winter. The entire number, however, were again reduced to the necessity of eating their boat-covers, dogs, &c.

These people say the weather was cold and stormy for a long time, with great quantities of ice and snow, so that they could not hunt walrus and seal; and, as they make no provision for the future, but depend upon what they can get from day to day, of course failure means starvation.

They live directly in the track of vessels bound into the Arctic Ocean for the purpose of whaling or trading; they subsist upon whales, walrus, and seals, taking, as already stated, only so much as is actually needed for their immediate wants, never providing for the future. They make houses, boats, clothing, &c., of the skins of walrus and seals, and sell the bone and ivory to traders for rum and breech-loading arms. So long as the rum lasts they do nothing but drink and fight. They had a few furs, some of which we tried to buy to make Arctic clothing, but, notwithstanding their terrible experience in the past, they refused to sell for anything but whiskey, breech-loading rifles, or cartridges.

We saw thousands of walrus while passing the island, lying asleep on the ice, but not an Indian in sight; having a few furs and a small amount of whalebone, they were waiting for that curse of Alaska, a whiskey-trader. As near as I can learn, over four hundred natives had died of actual starvation on this island within the last two years, and, unless some prompt action be taken by the Government to prevent them from obtaining whiskey, they will in a few years become extinct. [Hooper, 1881, pp. 10-11.]

On the basis of Captain Hooper's report it has often been asserted that liquor was directly responsible for the famine of 1878-79. It is claimed that the Eskimos, being on a prolonged spree, had failed to lay in a supply of walrus meat when the game was available, and that as a result of this improvidence they had succumbed to hunger during the following winter. While whiskey may have been a contributing factor in some cases, its importance has undoubtedly been exaggerated, for it is inconceivable that the general mortality which followed, affecting every village on the island, could be attributed to such a cause. The Eskimos themselves deny that liquor was in any way responsible. On the whole it seems likely that many of the deaths were caused by an epidemic which struck the island while the Eskimos were already in a weakened condition from lack of food. That famine was not the sole cause would appear from the Eskimos' statements to the effect that meat was found in the caches at some of the villages where all of the people had died.

In 1881 the *Corwin* again touched at St. Lawrence Island, and E. W. Nelson and John Muir, who were accompanying Captain Hooper, went ashore at several places. It was on this trip that Nelson obtained the large collection of ethnological material from the Island which is now in the United States National Museum and which is partially described in the eighteenth Annual Report of the Bureau of American Ethnology.

In 1894 a school was established at Sevuokok, the large village at the northwestern end of the island. The first teachers, Mr. and Mrs. V. C. Gambell, remained 3 years. They were drowned in 1898 while returning to St. Lawrence after a year's leave of absence, and the village was thereafter called Gambell, in their honor. Mr. Gambell left an interesting account of their experiences called "The Schoolhouse Farthest West."[2] One of the later teachers, W. F. Doty, also published a short account of the St. Lawrence Eskimos which contains considerable information of ethnological value.[3]

The first anthropological work on St. Lawrence Island was conducted by Dr. Riley D. Moore, who spent the summer of 1912 at Gambell making anthropometrical studies of the Eskimos and collecting ethnological and skeletal material for the Smithsonian Institution. Moore's measurements on the living Eskimos and the measurements on the 180 skulls collected by him have been published by Dr. Aleš

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[2] Published in the Youth's Companion and later issued in pamphlet form (undated) by the Woman's Board of Home Missions of the Presbyterian Church, 156 Fifth Ave., New York.

[3] The Eskimo on St. Lawrence Island, Alaska, pp. 186-223, 9th Annual Report on Introduction of Domestic Reindeer into Alaska, 1899, by Sheldon Jackson, Washington, 1900.

Hrdlička,[4] under whose direction the work had been carried out. Dr. Moore has also published a valuable paper on the social life of the St. Lawrence Eskimos (Moore, 1923).

During the summer of 1926 Dr. Hrdlička made an anthropological survey of parts of the Alaskan coast from Norton Sound to Point Barrow on the Revenue Cutter *Bear*. A brief stop was made at Savunga, on the north coast of St. Lawrence Island, and although Dr. Hrdlička had no opportunity to examine any of the old sites, he purchased a number of decorated ivory objects which the Eskimos had excavated at Kukuliak, a large abandoned site 3 miles east of Savunga. He also learned of the existence of a large kitchen midden on Punuk Island, 4 miles off the eastern end of the island (Hrdlička, 1930, p. 93). The archeological material which Dr. Hrdlička obtained at Savunga was of particular significance because some of the specimens bore the same elaborate curvilinear ornamentation as others which he and Dr. Diamond Jenness obtained also at Little Diomede Island. This was a style of art which Jenness, on the basis of systematic excavations conducted at Cape Prince of Wales and the Diomede Islands in the same year, had found to be characteristic of a previously unknown, early stage of Eskimo culture, which he designated the Bering Sea culture.

The first archeological work on St. Lawrence Island was undertaken by Otto Wm. Geist, for the Alaska Agricultural College and School of Mines (now the University of Alaska). Mr. Geist spent the summers of 1927 and 1928 on the island, collecting natural history and ethnological material and carrying on excavations at some of the old sites near Gambell. In 1929 Mr. Geist began to excavate at Kukuliak, and continued his work there up to 1935. The operations at Kukuliak during the last 2 years were conducted as a project of the Public Works Administration and were carried out on a much larger scale than those of previous years.

The writer's investigations on St. Lawrence Island were conducted in the summers of 1928, 1929 and 1930; they have included excavations at old sites on the eastern and western ends of the island, anthropometrical and ethnological studies of the Eskimos, and the collection of skeletal and other material. Assisting me in 1928 was Harry E. Manca; in 1929, G. Herman Brandt; and in 1930, James A. Ford. In 1931 Moreau B. Chambers continued the Smithsonian in-

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[4] Hrdlička, A., Catalogue of human crania in the United States National Museum collections. Proc. U. S. Nat. Mus., vol. 63, art. 12, 1924.

Hrdlička, A., Anthropological survey in Alaska. 46th Ann. Rep., Bur. Amer. Ethnol., 1930.

vestigations, excavating at the old sites around Gambell, at the northwestern end of the island.

Such, in brief, is the historical background of St. Lawrence Island. It remains today one of the least known sections of Alaska, with its shores still imperfectly charted and most of the interior unexplored. It is visited each year by the Revenue Cutter, the Bureau of Indian Affairs ship, and several trading vessels; but there are no white traders or other settlers on the island, the only white residents being the teachers in charge of the native schools at Gambell and Savunga.

ABANDONED SITES, AND EXCAVATIONS OF 1928 AND 1929

Scattered along the coasts of St. Lawrence, not only in the vicinity of the present settlements but also at the now abandoned eastern end of the island, are numerous old village sites and kitchen middens. Some of the latter are of great size, probably larger than any others in the Eskimo region, and yet strangely enough there seems to have been no printed reference to them and no general knowledge of their existence prior to Dr. Hrdlička's brief visit to the island in 1926, when he learned of the important old site of Kukuliak on the north coast, and of Punuk Island, just off the east end of St. Lawrence. We now know of a number of other old sites, the locations of which are given below.

At the southwestern end of St. Lawrence are several large kitchen middens that I have not visited and between there and Gambell at least one important abandoned site, Kitneapalok, at which preliminary excavations were made by Moreau B. Chambers in 1931. Plate 1, figure 1, is a view of one of the two middens at Kitneapalok. In plate 1, figure 2, are shown two rows of "jumping stones" at a small abandoned village site between Kitneapalok and Gambell. Rows of stones similar to these are found at various other localities on St. Lawrence Island. The present Eskimos say that they were made by their ancestors and used in jumping exercises designed to increase their endurance and skill. Stone rows of this kind, called nängissat, are well known in Greenland but have not been reported from other parts of the Eskimo territory.

At Gambell, within a radius of three-quarters of a mile from the present village, are five abandoned sites. It was here that the Smithsonian excavations of 1930 and 1931 were conducted, the results of which form the principal basis of the present paper. Briefer accounts of the Gambell excavations, with an outline of the chronology as indicated principally by changing styles in art and harpoon heads, were published by the writer in 1931, 1932, and 1935. Although none of the Gambell sites are as large as several others on St. Lawrence, they are still of considerable magnitude, the combined depths of the several middens amounting to over 24 feet (pls. 4-11, 61-64).

Three miles east of Gambell are two more rather large contiguous old sites known to the Eskimos as Mirrukta and Missugameet (pl. 1, fig. 3), where a small amount of excavating was done in 1930; and between this point and Savunga there are several other small sites, one of which is called Naskok.

Savunga itself is a recent village, a colony from Gambell, which was established as a herders' camp after reindeer were introduced on the island by the Federal Bureau of Education in 1900. Three miles to the east of Savunga is Kukuliak, the largest old site on St. Lawrence Island, if not in the entire Eskimo territory (pl. 1, figs. 4, 5). This site, which was occupied up to the time of the famine of 1879, is a huge kitchen midden about 50 yards wide which extends along the beach for a distance of some 250 yards and which has a total height—or depth—of around 20 feet. Fortunately, we may look forward to a comprehensive report on this very rich and important old site, where intensive excavations have been carried on for six seasons by Otto Wm. Geist under the auspices of the Alaska Agricultural College and School of Mines (now the University of Alaska).[5]

I am not familiar with the region between Savunga and the Punuk Islands, but have been informed by the Eskimos that numerous old village sites and kitchen middens are found along this strip of coast, where today there are no permanent habitations of any kind.

One of the largest of the old sites is that on Punuk, one of three small islands of that name, 4 miles off the eastern end of St. Lawrence. Here I excavated for 2 months in 1928, assisted by Harry Manca and several Eskimos from Gambell and Savunga. These earlier in-

[5] This report, "Archeological excavations at Kukuliak, St. Lawrence Island, Alaska", by Otto William Geist and Froelich G. Rainey, vol. 2, Miscellaneous Publications of the University of Alaska, U. S. Dept. of the Interior, pp. 1-391, bearing the date May 19, 1936, but issued in April 1937, appeared after the present paper was in press; hence it has not been possible to refer to it or make comparisons in the text. It is gratifying to the present writer that the chronology obtained by Mr. Geist at Kukuliak appears to coincide in every respect with that obtained at Gambell. This is especially significant in view of the fact that Kukuliak is a single site, a huge midden in which the Old Bering Sea, Punuk, and modern material is found in stratigraphic sequence, whereas at Gambell there were five sites, representing successive periods of occupancy as indicated by a stratigraphic linkage of one site to another.

A preliminary account of the Kukuliak excavations, with special reference to the chronology, has been published by Dr. Froelich Rainey. See bibliography, Rainey, 1936.

vestigations properly form the introduction to the work to be described in more detail in the present paper, and a preliminary account has already been given (Collins, 1929). It will be sufficient at this time to mention only the most outstanding results of the Punuk excavations and to state that the tentative chronology established on the basis of the Punuk finds received ample confirmation, and elaboration, through the more comprehensive excavations at Gambell in 1930.

The kitchen midden marking the site of the old village on Punuk Island has a surface area of 400 by 130 feet and a visible height of about 10 feet, but on digging through the sand and gravel at the base, we found that refuse extended for another 6 feet beneath the surface of the present beach (pl. 2, fig. 2). At the bottom were found the whale bone and timber remains of several old house entrances (pl. 2, fig. 1). The fact that storm waves often come right up to the foot of the midden and 6 feet above these old house remains shows that there has been either a considerable subsidence of the shore line since the houses were abandoned, or that some outlying shoals or protecting reefs have been destroyed, thus permitting the encroachment of the sea. On the surface of the midden are the pits of the later houses, appearing now as shallow, leveled depressions, with nothing remaining of the superstructures. Scattered along a flat sandy stretch to the west of the midden are the ruins of several houses of a considerably later period, the last of which are known to have been abandoned about 40 years ago (pl. 2, fig. 3). Three of these later houses were excavated, two of them the very latest and one of them probably dating from about the beginning of the nineteenth century. The large collection of artifacts obtained from these recent houses and the shallow midden deposits around them provided a fairly comprehensive picture of modern St. Lawrence culture and afforded a valuable basis for comparison with the much larger body of material excavated from the old midden.

When we began to excavate at Punuk, I had hopes of finding further evidence of the mysterious "fossil ivory" or Bering Sea culture which had been discovered by Jenness and Hrdlička in 1926, particularly since most of the beautifully decorated objects of this type which Hrdlička had bought from the Eskimos had come from St. Lawrence. The work had not progressed very far, however, before it became apparent that the Punuk midden belonged to a different, and presumably later, stage of culture. True, the artifacts which we were excavating were for the most part very different from those of the modern St. Lawrence Eskimos, and the most important group, the harpoon heads, resembled in form some of those which had been obtained by

Jenness and Hrdlička. But the ornamentation was strikingly different. Instead of the elaborate designs composed of flowing curving lines and elevated concentric circles and ellipses characteristic of the Bering Sea culture, we found a much simpler style of art. The lines were fewer in number and were either straight or only slightly curved; they were also deeply and evenly incised, as if with metal tools; the circles were flat and perfectly round, having been inscribed with a bit or compasses, whereas the Bering Sea circles were all somewhat irregular, having been made free hand; dots were also used, either detached or placed at the ends of straight lines. More than a hundred artifacts decorated in this simplified form of art, which I called the Punuk style, were excavated from the midden, as compared with three decorated in the Old Bering Sea style,[6] but it was significant that the latter were all found at considerable depths.

Having heard from our Eskimo workmen of a large kitchen midden 35 miles away at Cape Kialegak, on the southeastern end of St. Lawrence, I went over with them in a whale boat to make a brief examination of the site. Two middens were found at Kialegak, the principal one of which proved to be even larger than that on Punuk, having a total depth, or height, of 18 feet (pl. 3, figs. 1, 2). The smaller midden about 300 yards away, was about 8 feet deep (pl. 3, fig. 3). In the one day spent at Kialegak I was able to obtain a small but representative lot of material including a number of objects decorated in the Punuk style and one harpoon head from near the exposed base of the larger midden decorated in the Old Bering Sea style. Conditions at Kialegak appeared so promising that I decided upon it as the scene of the next year's excavations.

As a result of the 2 months' work on Punuk Island and the brief trip to Cape Kialegak, a collection of several thousand artifacts was obtained which illustrated in considerable detail a prehistoric phase of Eskimo culture which had intervened between the Old Bering Sea culture and the modern. Although this intermediate, or Punuk culture, was undoubtedly prehistoric, it also knew the use of metal. It is true that all of the cutting implements—knife blades, adzes, harpoon blades, etc.—found in the Punuk midden were made of stone, but the fact that the deeply and evenly incised lines and the mechanically perfect circles of Punuk art could only have been produced with metal tools indicated that these must have been employed to some

[6] The limiting adjective "Old" has been added to Jenness' "Bering Sea" culture in order to set it apart from the later stages of culture in the Bering Sea region.

extent. What was the origin of this metal? If it had been obtained directly from the Russians after the discovery of Alaska in the eighteenth century or indirectly through the Chukchee after the arrival of the Cossacks in northeastern Siberia a hundred years earlier, it would mean that the Punuk Island and Cape Kialegak settlements were less than 300 years old. However, everything pointed to this being nearer the time of the abandonment of the Punuk midden than of its establishment. Most of the objects from the Punuk midden differed from those found in the recent house ruins on the adjoining sand flat just as strikingly as the shallow, leveled pits of the older houses on the midden themselves differed from these later ruins, which even though abandoned for 40 years, still had the walls and roofs practically intact. Furthermore, it would seem incredible that such huge kitchen middens as those at Punuk and Kialegak, 16 and 18 feet deep, had been formed in less than 300 years; or that the houses at the bottom of the Punuk midden, now 6 feet beneath the reach of storm waves, could have been built, occupied, abandoned, and then covered over by an accumulation of debris 16 feet deep all within so short a space of time. If these earliest Punuk Eskimos possessed metal, as the evidence of their art so clearly indicated, they must have received it long before the arrival of the Russians in northeastern Siberia in the seventeenth century. Its source must for the present remain in doubt, but the fact that Laufer has shown that iron was being used in eastern Siberia as early as the third century A. D. indicates at least the possibility of its having been introduced on St. Lawrence Island long before the seventeenth century.

In 1929 I returned to Cape Kialegak, accompanied by G. Herman Brandt, and excavated for one month. While the results were gratifying in that another large collection of artifacts was obtained which increased our knowledge of the Punuk culture, it was again a disappointment that nothing was found that threw any further light upon the elusive Old Bering Sea culture. For just as in the previous year, Punuk art was found almost exclusively, with just enough Old Bering Sea pieces (9, to be exact—and again from the lower levels of the middens) to show that it would be necessary to find some still older site if the Old Bering Sea culture were to be revealed in its entirety. Having tested the possibilities of the two largest and most promising old sites on the eastern end of St. Lawrence, it now seemed advisable to look elsewhere,[7] and the most promising place seemed to be Gambell

[7] I have since learned of a very important site on Punuk Island—apparently a pure Old Bering Sea site—which completely escaped my attention when I was on the island in 1928. This site was discovered by Otto Wm. Geist in

at the opposite or northwestern end of the island. In 1928 I had purchased from our Eskimo workmen a small collection of archeological material from Gambell, and later in the season had stopped there for a few hours and examined several nearby abandoned sites with Mr. Geist, who had been excavating at the old site of Seklowaghyaget, just back of the present village. Mr. Geist very kindly showed me the material he had obtained, some by excavation and some purchased from the Eskimos who were engaged in desultory digging for specimens and old ivory. In 1929, after Mr. Geist had discontinued work at Gambell and begun to excavate at Kukuliak, 40 miles to the eastward, I again visited the site and purchased another collection of artifacts. From examination of the sites themselves and the material obtained from them, it became apparent that the Gambell sites were of different ages. Thus, Seklowaghyaget seemed to belong entirely to the Punuk period, whereas from Miyowagh, three-quarters of a mile away, both Punuk and Old Bering Sea specimens had been excavated. Here then was a site which promised to yield valuable information regarding the Old Bering Sea culture, and it was accordingly selected as the principal objective of the 1930 investigations.

EXCAVATIONS AT GAMBELL (SEVUOKOK)

Cape Chibukak (Sevuokok), at the northwestern end of St. Lawrence Island, is a steep-sided, rocky plateau some 600 feet in height (pl. 4, fig. 1). Its flat summit, several miles in extent, slopes off very gradually to the east and south, and is covered with tundra and rocks, the latter occurring either as huge outcrops of basalt, more or less intact, or as broken down masses of the same material spread out

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1931 and further excavated by him in 1934. It was situated about a quarter of a mile from the large midden. There was nothing on the surface to indicate that the site had ever been occupied and Mr. Geist was led to its discovery by finding among the rocks at the water's edge a few artifacts and pieces of ivory that had washed down from the bank above. In September 1936, when I was in Fairbanks returning from field-work at Bering Strait, Mr. Geist and Dr. Froelich Rainey kindly showed me the St. Lawrence collections including the material from this Punuk site. The significant point with regard to this material is that some of the objects were identical in form with some which I had found at the oldest site at Gambell in 1930. There were a great many decorated objects in the collection and the style of ornamentation seemed to correspond in some degree to what I had described tentatively as Old Bering Sea style 1 (the oldest style, as outlined in the following pages of the present paper), and was even closer to what seemed to have been a related style of ornamentation characteristic of Little Diomede Island, examples of which are also described later.

over areas of considerable extent. On the north side the bluff descends abruptly to the rocky beach except at one or two places where the slope is somewhat gradual. On the west, with an equally abrupt slope, the bluff descends to a flat gravel plain or foreland which

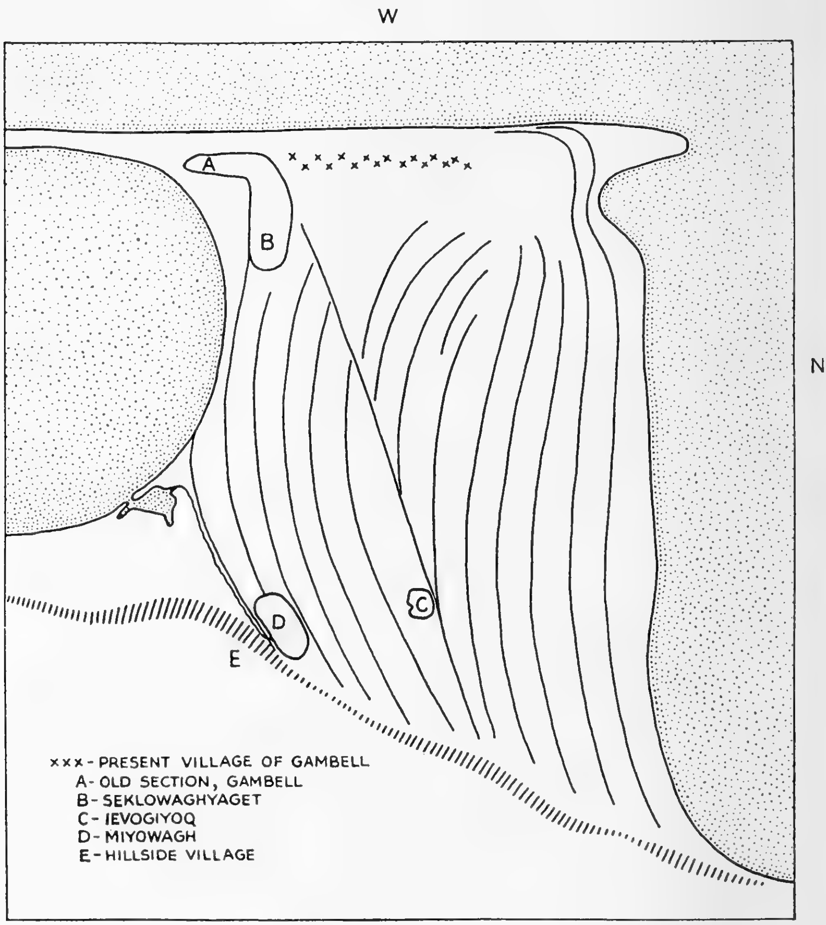

Fig. 2.—Outline map of Gambell and vicinity, at northwest end of St. Lawrence Island.

stretches for three-quarters of a mile westward from its base (pl. 4, fig. 2, and text fig. 2). A large part of the gravel plain is occupied by a lake about half a mile wide and 2 miles long, running parallel with the foot of the plateau and with its western shore separated from the sea by a long narrow bar of gravel. At the northwestern extremity of the gravel plain and beyond the head of the lake is the present village of Gambell (Sevuokok), with its houses arranged in four straggling rows, all facing westward toward the sea and the Siberian coast. Twelve of the houses are of the Siberian Eskimo type, with wooden walls and skin-covered roof. In recent years this type has been largely replaced by lumber houses, of which there are now 43, in addition to the store building, school house, and teacher's residence.

Immediately to the south of the present village are the pits of earlier houses of wood and whale bones, some of which were occupied until about the end of the last century. Sunken caches or meat cellars, built entirely of whale bones, are well preserved, some, in fact, being still in use. Near the head of the lake the ruins of this recently abandoned site merge imperceptibly into those of an older and more extensive site, known to the Eskimos as Seklowaghyaget, "many caches." About half a mile to the northeast a grass-covered midden, marking the site of another old village, rises conspicuously from the gravel plain; this site the Eskimos call Ievoghiyoq, "place of the walrus", from its fancied resemblance to a herd of walrus lying on the ice. Some 200 yards south of Ievoghiyoq, and at the foot of the plateau, is still another old site known to the Eskimos as Miyowagh, "the climbing up place."

A striking feature of the gravel plain on which these four old sites are located is the series of old beach lines—parallel ridges of gravel piled up through the action of sea ice, waves, and currents—which extend westward for three-quarters of a mile from the base of the plateau to the slight elevation occupied by the present village. From the top of the plateau these ridges stand out clearly, becoming indistinct only toward the western end where the surface irregularities and heavy growth of grass around Seklowaghyaget and the present village obscure the original conditions. The earlier beach lines—those between the lake and Ievoghiyoq—curve slightly, but run in a general east and west direction. After the formation of the first six ridges the shoreline changed; the outer or western ends of the older ridges were cut away, leaving a beach which ran obliquely SW. by W. from the base of the plateau. Later, however, the beach lines straightened out, resuming the original E.-W. direction, with the result that a clearly defined **Y** was left at the center of the gravel plain.

Suggestive evidence of the relative ages of the several abandoned villages is afforded by their positions in relation to the old beach lines and the present beach, in view of the universal tendency of the maritime Eskimo to locate their villages within easy access of the sea or other body of water. Thus, the ruins closest to the present village, near the western shore line, and the adjoining site of Seklowaghyaget, should be the latest. In the same way, the oldest of the abandoned sites should be Miyowagh, situated at the base of the plateau three-fourths of a mile and half a mile from the sea and enclosed within the first two old beach lines. Ievoghiyoq, some 200 yards to the north, is separated from Miyowagh by four beach lines and should therefore date from a somewhat later period.

The archeological evidence resulting from four months of intensive excavation bore out this assumed sequence. Miyowagh had been established during the time that the old Bering Sea culture was at its height, for the lower levels of the midden yielded the complicated harpoon heads and elaborate art style known to have been characteristic of that period. But the material from the upper levels, and particularly from the northwestern section, showed that during the later occupancy of the site important cultural modifications had set in, resulting in the decline of the rich Old Bering Sea ornamentation and its replacement by the simpler art of the Punuk period. The next oldest site, Ievoghiyoq, proved to be a pure site of the Punuk period, with no trace of Old Bering Sea art or harpoon types. Seklowaghyaget was likewise of Punuk age, but it had been abandoned later than Ievoghiyoq, for harpoon heads from the upper levels included a type which at the latest site—the ruins adjoining the present village—was found to have evolved directly into the modern St. Lawrence form. The presence of a few glass beads and pieces of metal showed that this latest site could not have been more than 200 years old.

The cultural sequence revealed by these four old sites, while clear enough in itself and unusually complete in detail, still left unanswered one important question. This was the identification of the type forms of the Old Bering Sea culture, that is, the common implement types aside from the decorated objects. It might be considered that the implements from the lower levels of Miyowagh, where only Old Bering Sea art was found, were the types of the Old Bering Sea culture. While such an assumption would appear reasonable, a degree of uncertainty would be present due to the fact that both Old Bering Sea and Punuk objects occurred in the same midden, thus making it possible that an object when found might not occupy its original position, due to disturbances resulting from sloughing, from excavations for houses, etc. This deficiency was fortunately removed by the discovery of a pure site of Old Bering Sea culture, on the lower slope of the plateau immediately back of Miyowagh. This old site, which was unknown to the Eskimos, was completely buried beneath the sod, moss, and stones, and in outward appearance was a normal section of the hillside.

At these five sites excavations were carried on from June 21 until October 9, 1930, when the freezing of the ground finally brought the work to a close. During the greater part of the time our force consisted of the writer, his assistant, James A. Ford, and three Eskimos, Silook, Maskin, and Soonogoruk, with a few other Eskimos occasionally employed. From August 14 to September 19, during my absence on a trip to the interior of Seward Peninsula, Mr. Ford was in charge of the work. In 1931 Moreau B. Chambers was intrusted with the continuation of the work at Gambell and carried on excavations from June 20 to September 17 with two Eskimo helpers at the sites of Miyowagh, Ievoghiyoq, and Seklowaghyaget.

The method of excavation was determined by the frozen condition of the soil and the time at our disposal. There were four large middens to be investigated in addition to the buried site on the Hillside, discovered later; with less than 4 months in which to work, it clearly would not have been possible, even if we had so desired, to excavate even one of the middens in its entirety. Consequently we adopted the method of sampling, sinking pits of uniform size at various parts of the middens in order to obtain as representative a lot of material as possible from each. The cuts, except those for the excavation of houses, were all started as pits 12 feet square and in most cases were continued to the bottom as such. This method was followed at the four middens which were visible when we began operations, but not at the newly discovered Hillside site where conditions were different and where it was necessary first of all to determine the extent of the accumulation. The excavations, as always in these latitudes, were handicapped to a considerable extent by the frozen ground, for the soil remains frozen the year around, with only a thin surface layer thawing out during the summer. Artificial methods of thawing by the use of steam or cold water, such as are employed in mining, are not only expensive and impracticable but have the added disadvantage of being destructive to the more fragile objects. The most satisfactory method was found to be that of taking the excavations down little by little as the frozen soil thawed out through exposure to the atmosphere. The rate at which an exposed frozen surface would thaw depended on the nature of the material: a midden section consisting of a compact mass of soil, bones, and baleen would thaw usually less than an inch a day, whereas sections in which gravel predominated thawed three or four times as fast. As a rule each cut was worked every second or third day. Because of the slow rate of thawing in the more productive sections of the middens, we removed at each digging all the soil that had thawed since the previous digging. Consequently, the layers varied somewhat, some being only 1 or 2 inches thick, others as much as 6 inches, or even a little more in cuts where there was much gravel and little cultural material. This procedure was found to be simpler and more practical, under the circumstances, than the more ideal method of removing the material in layers of exactly the same thickness. By following the latter method it would often have been necessary to leave a layer unfinished for a day or more since the frozen ground would prevent it being taken down to the exact depth required. Hand trowels were used exclusively for the actual excavating, shovels for throwing out the worked over material, and picks only for cutting away the surface layer of sod.

Hillside Site

Fifty yards to the southeast of Miyowagh, on the lower slope of the hillside at an elevation of about 30 feet, we found the ruins of a buried village which hereafter will be referred to as the "Hillside site" (pl. 4, figs. 3-8). The presence of an old village at this spot had not been suspected by the Eskimos, although the trail to the top of the plateau which they and their ancestors had followed for generations, passed directly over a part of it. There was visible none of the refuse commonly found about old Eskimo villages, no projecting whale bones or timbers, no elevations or depressions. The site was completely hidden beneath the sod and stones, and the vegetation above it differed in no way from that on the rest of the hillside. The grass, it is true, was somewhat greener than on the surrounding surface, but valuable as this would ordinarily have been as indicating the presence of an old site, it would not in this case have led to its detection, as there are many other such green spots along the hillside which were caused, as apparently in this case, by water seepage or drainage. The only visible evidence of human occupancy was the presence of a few seal and walrus bones which through weathering had become exposed between two large stones in a rock slide (pl. 4, fig. 4). A little digging showed that similar patches of refuse were held in other crevices and even on the surfaces of some of the rocks, embedded in a thick, tough matting of moss. This would indicate that the refuse had originally been deposited over the rock slide. A small stream, fed by melting snow from high up on the hillside, winds its way in and out among the rocks, and descends to the lake below.

In the course of years this has no doubt washed away most of the refuse from between the rocks. At several places refuse was found to extend beneath the rocks, in tilted strata resulting from water action, which no doubt had produced a certain amount of shifting in the positions of some of the rocks as the earth binding between them was washed away.

After finding refuse among the rocks, a systematic search of the adjoining hillside was made. Immediately to the south of the rock slide, at the base, a small test pit revealed refuse held in the black moist earth beneath the heavy sod. A trench was then begun along the bottom of the slope and continued upward (pl. 4, fig. 5). About a foot beneath the sod refuse became abundant. It consisted mainly of walrus and seal bones; there were also bird, dog, and a few fish bones, together with occasional potsherds and artifacts of stone, bone, and ivory. Realizing that the refuse at the bottom must have rolled down, we next started an excavation 25 feet up the slope to see if a house could be found (pl. 4, fig. 5, small excavation in background).

Immediately beneath the sod potsherds and stone chips were found in considerable numbers. All other artifacts, even those of such relatively durable materials as bone or ivory, seemed to have undergone complete disintegration in the surface layer, although they were found in abundance beginning at about the 12-inch level. It was only among the rocks, where there had been considerable disturbance of original conditions, that artifacts of bone and ivory were found nearer the surface.

At a depth of 2 feet, flat stones were found, covering an area of about 10 feet square; these were closely spaced and apparently represented the remains of an old floor (pl. 4, figs. 6, 7). Three small and poorly preserved timbers were found on or just above the stones. The pit was then enlarged so as to afford a better view of the structure, which will be designated house no. 1. Immediately to the northward more refuse was found but the stone flooring did not continue. Instead, there was a jumble of stones, none of them very large, which gave the impression of being part of a fallen wall (pl. 4, fig. 8). A similar arrangement of fallen stones was found at the rear, to the eastward (pl. 4, figs. 6, 7). Immediately in front of these was a second layer of flat stones, about a foot above the other, which at first we thought to be a house platform. However, it was soon found that the stones rested on refuse which had accumulated on the lower floor, showing that they had been laid down at a later period. Unfortunately, no further details of the structure could be determined. Midden material was found all the way from the paved area down to the bottom of the slope, and between the two points there were a great many rocks, large and small, which may have been parts of fallen walls, etc.; if so, they were too scattered to tell their story. The flat stones of the floors were the only ones that with certainty could be said to have belonged to a house. At the NW. end—down the slope—some of the larger stones seemed to suggest an entrance but this again was uncertain. The possibility that the house may have been demolished by a landslide is seen in the fact that at two places on the south side there were what appeared to be remnants of walls—several medium-sized stones, one above the other—supporting two huge stones which might have rolled down upon them (pl. 5, fig. 1). An alternative explanation would be that the large stones were already there and that the small stones had been so placed in order to keep them from slipping. More conclusive evidence of a rock slide which descended over the spot after the house had been abandoned is seen in the presence of a number of large, heavy rocks lying above the refuse both in the paved area and further down the slope. These were so generally distributed over the site that such an explanation seems more likely than that they all represented the remains of fallen walls.

Fortunately, the site was prolific in artifacts, which provided the much needed information concerning the implement types of the Old Bering Sea culture, even though the house remains were so disappointing. The excavation which revealed the house—or paved area—yielded 77 artifacts of bone, ivory and wood, and 62 artifacts of stone, in addition to large quantities of potsherds, animal bones, pieces of stone implements, and worked pieces of ivory, bone, and baleen. Twenty-six artifacts were obtained from between and below the floor stones, and 72 artifacts, in addition to numerous potsherds and fragmentary objects of stone, ivory, and bone, were obtained from patches of refuse found at various places in the rock slide adjoining the excavation. The midden between the paved area and the foot of the slope yielded 188 artifacts besides quantities of fragmentary objects. The midden ranged in depth from a little less than 1 foot at the bottom of the slope to 3 feet at the upper end and was taken down in layers approximately 9 inches in thickness. The conditions for excavating at the Hillside site were extremely unfavorable. The ground was kept in a constant state of saturation from the melting of a large bank of snow high up the slope, so that as the soil thawed out it was promptly converted into mud. As a result of this condition and also because of the many large stones which were encountered, the work at the Hillside site progressed more slowly than at the middens situated on the gravel plain.

When it became evident that the first house site was too poorly preserved to afford any clear idea as to its construction, we continued our search along the hillside to the northward, and fortunately with better success. About 100 yards to the north of the first rock slide was another, along the side of which passed the main trail to the top of the plateau. Here again refuse was found among the rock crevices, and an excavation in the flat grassy area between the two rock slides revealed a clearly recognizable house ruin, which will be

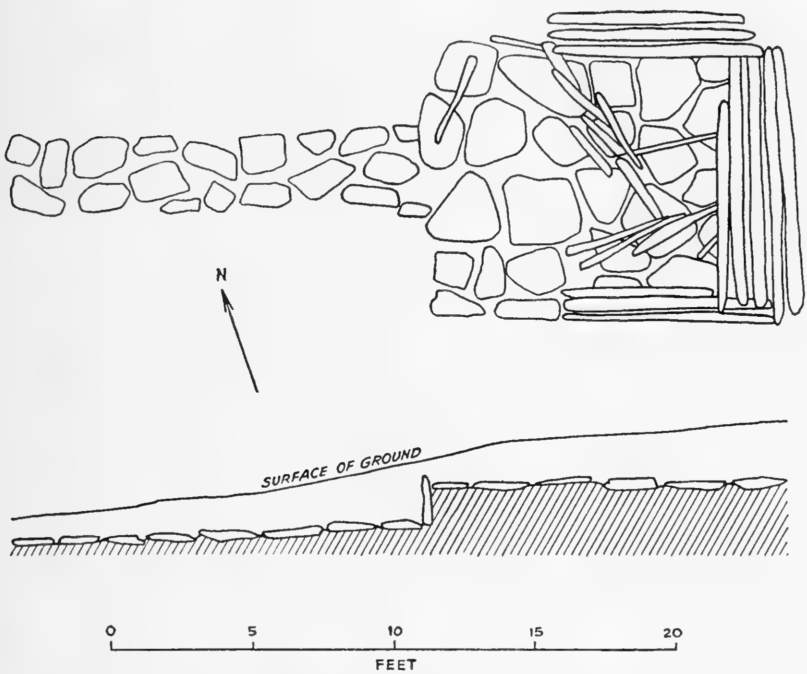

FIG. 3.—Plan and section of house no. 2, Hillside site.

referred to hereafter as house no. 2 (text fig. 3). As in the case of the first house, there was not the slightest depression or surface irregularity to indicate that the spot had ever been disturbed. About 16 inches below the surface, fragments of timbers were found, lying beneath stones which originally may have formed part of a retaining wall (pl. 5, fig. 2). After clearing away the rotted mass of wood fragments and earth, the lower timbers, while flattened and considerably disintegrated, were found to be sufficiently preserved to afford a general idea of their orientation (pl. 5, figs. 3, 4). At the east end it was possible to distinguish at least five small logs, lying parallel, and three each at the south and north ends. They were all rather uniform in size, averaging from 5 to 8 inches in diameter. Additional timbers lay in the intervening space, above the flat stones which formed the floor. The parallel logs lying along the three sides were interpreted as remnants of fallen walls, which had been formed of timbers laid horizontally. The floor stones were approximately 2 feet beneath the outside level, but this is no certain indication that the floor was originally at that depth as there had undoubtedly been considerable erosion of the surface since the abandonment of the site. The house had a width of 10 feet 4 inches (N.-S.); wall timbers were not present on the west (front) side, but the floor stones and the entrance passage showed the length of the house (E.-W.) to have been 13 feet 4 inches. The entrance passage faced N.-NW., and extended $14\frac{1}{2}$ feet down the slope. It was 2 feet wide, and at the upper end where it joined the house, its floor was 1 foot below that of the house. Two stones, set on edge, marked the point of junction. The passage was traced by means of the stone flooring alone; nothing remained to indicate the manner in which the walls and roof had been constructed.

A considerable amount of cultural material was found in and around house no. 2; 76 artifacts, in addition to quantities of broken fragments, potsherds, bones, etc., were obtained from the house site, while 53 more were found beneath the floor stones. Included among the subfloor material were two baleen vessels with wooden bottoms and parts of two others, found in a recess under one of the rear floor stones (pl. 53). Forty artifacts, besides the usual potsherds and fragments, were found in rock crevices in the slide adjoining.

DECORATED OBJECTS, OLD BERING SEA, FROM THE HILLSIDE SITE

The decorated objects from the Hillside site proved to be of unusual interest. Fourteen of them bore the typical Old Bering Sea ornamentation; all of these came from the southern part of the site—house no. 1, the midden below it, and the adjoining rocks. Eleven of these pieces are illustrated in plate 13, figures 1-3, 6, and plate 23, figures 1, 2, 4, 9, 10, 13, 14. The other decorated objects from the Hillside site were either rather nondescript or bore an ornamentation which, though embodying Old Bering Sea elements, was on the whole of a simpler, more generalized nature than that previously known. It is of interest to note that five of the six decorated objects from house no. 2, four of which came from beneath the floor stones, were in this simple, unspecialized style, which in the following pages will be referred to as "Old Bering Sea style 1" (pl. 12, figs. 3, 11-14).

Three more examples, plate 13, figures 5, 7, 8, were found in house no. 1 and the adjoining midden.

In plate 12, figures 1-4, are shown four artifacts of unknown use, representing a class of " winged " objects which has come to be recognized as characteristic of the Old Bering Sea culture (Jenness, 1928 a, p. 77; Mathiassen, 1929, pp. 43-46; Collins, 1929, pl. 6, fig. 7). They all have two prominent wings, a central " body ", in the base of which is a large socket and on the top a small notch. The unfinished specimen, figure 2, from house no. 1, is the only one of the four which corresponds exactly with any previously described; the other three all exhibit new features.

Plate 12, figure 1, found between the floor stones of house no. 1, represents a new type. On the side illustrated two large V-shaped notches were cut out, leaving a triangular-shaped central section and two incurving wings with recurved tips. The tip of the left wing is slightly hollowed; the right, straight. An oval to rectangular socket 11 mm deep, 14 mm long, and 4.5 mm wide is cut into the base of the central section, and above it is a small notch 11 mm long, 2 mm wide, and 3 mm deep. A rectangular perforation was made through the apex of the central section, and in it remain a few strands of baleen, probably part of the lashing which helped to fasten the object to the shaft or handle which fitted into the socket. The opposite side is arched or convex, and the tips of the wings recurved.

Plate 12, figure 3, shows the same basic features, with an elaboration of the wings and central portion. This object is also illustrated in text figure 4. It was found in house no. 2. The socket in the base is 14 mm deep, 16 mm long, and 7 mm wide. On the side illustrated the wings proper were set off by ledges, now broken; undercutting, which proceeded inward from these ledges, has left a prominent, raised center, which by means of two round drilled holes and bordering lines has been given somewhat the appearance of a human face. A round hole, drilled transversely beneath the " chin ", probably had the same function as the rectangular slot on the preceding specimen. The middle of the opposite side is convex, with the wings inclined backward. Both sides bear a decoration of lines and small circles (text fig. 4) so finely incised as to be almost invisible except in just the proper light. On the front the broken wings are outlined by a pair of curved lines with a few straight lines beyond. At the center a line is incised around the rim of each " eye " with another encircling line about 4 mm distant. At the position of the mouth there is a very small irregular circle with central dot and two pairs of upward-radiating, converging lines, to which are attached four long, widely spaced spurs. The same decorative elements are present on the reverse. The central section bears a design centering around four small circles, from each of which radiate three pairs of long, converging lines. The spaces between the angles thus formed have been filled with short, straight lines, which are usually attached as spurs to the longer lines. The decoration on the wings consists of a pair of curving lines at the inner border, a circle at the center with three pairs of radiating lines, and additional straight lines between and beyond these.

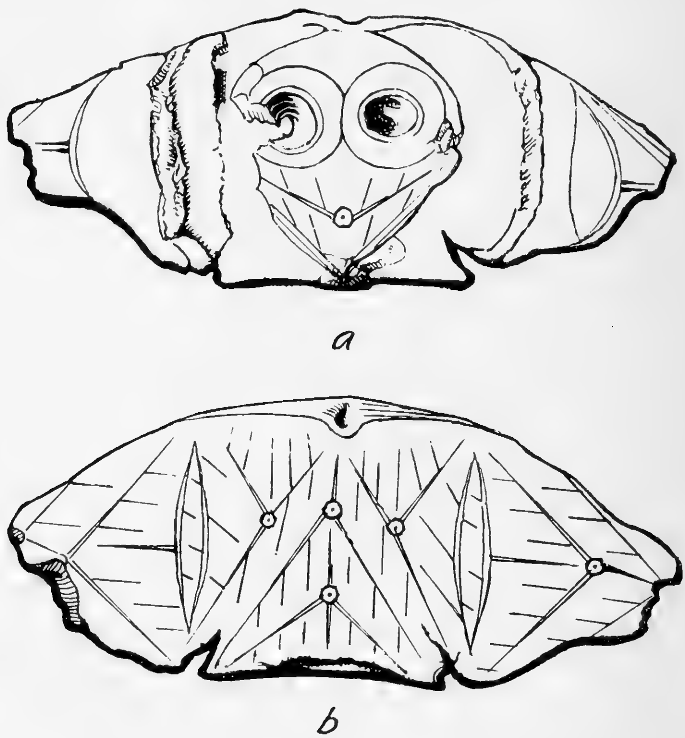

FIG. 4.—Decorated winged object, ivory, from the Hillside site.

Although circles between converging lines are common in Old Bering Sea art, the present combination of circles and radiating lines introduces a new pattern. The lines are also much more lightly incised than is customary. The circles are about 2 mm in diameter, with a tiny central dot; they are slightly irregular, having been made freehand.

The unfinished object, plate 12, figure 4, was found in the upper level of the midden. There is a drilled hole in the base 1.7 cm in diameter and 1 cm deep; no notch above. The wings differ from other known examples in having a slight downward slant. On the side illustrated the wedge-shaped central portion is raised 16 mm above the wings, on the reverse 4 mm. A hole 13 mm in diameter is drilled transversely through the central elevation. There is no decoration.

Plate 12, figure 2, which was found in house no. 1, is unfinished and badly weathered. The wings are straight; three circular pits on the reverse show that it has been used secondarily as a drill rest.

Plate 12, figures 5 and 6, are two small carvings representing highly conventionalized human figures. They were found below the floor stones of houses no. 2 and 1, respectively. Only the head and armless torso are represented. The head of figure 5 is long, the eyes rather deeply cut, the other features not indicated; length, 6.4 cm. Figure 6 shows a marked projection of the lower part of the face, a pointed head, and eyes indicated by short lines; length, 3.8 cm.

The large head, plate 12, figure 7, was found in house no. 1. It is 5.6 cm long, 2.9 cm wide, and is broken off at the neck. The head is pointed, with a small forehead and chin; the nose is very long and rather high-bridged, and the malars are prominent; the eyes are indicated by deep lines beneath the brows; the upper lip is very long and depressed, with two parallel, vertical lines.

The fragment of a harpoon head, plate 12, figure 8, is introduced for the purpose of showing the use of a simple design—pairs of short parallel lines—not previously known from the Old Bering Sea culture. The specimen came from house no. 1; another, exactly similar, was found among the rocks at the south end.

Plate 12, figure 9, is a broken object of unknown use from house no. 1. The upper end is thick and rounded, the lower part flattened, with a flare at the center. The decoration, in addition to a few lines along the edges, consists of a series of short, slightly curved parallel lines between two bordering lines which extend downward from the widened center, and just above, two crudely made concentric circles, the inner one containing a very small V-shaped figure.

Plate 12, figure 10, is a chain, made from a single piece of ivory, found in the third level of the midden. It consists of four links, the last one ornamental. It is interesting to find that the chain, which the modern Alaskan Eskimos so often use as an ornamental attachment to bodkins, awls, handles, etc., was already known during the Old Bering Sea period.

In plate 12, figure 11, is shown a harpoon foreshaft found between the floor stones of house no. 2. It is triangular in cross-section, the three sides being decorated independently and each separated from the other by a deep longitudinal groove. Text figure 5 shows the decoration on the three sides. On the two sides through which the line hole passes, the decoration consists of somewhat irregular concentric circles with spurs attached to the peripheries; similar spurs at the ends of the oval figures bordering the line slot; and connecting and extending beyond the two figures, longitudinal lines within which are numerous short, oblique, cross lines. Additional straight lines occupy the remaining spaces. On the third side, at the center, is a circle which at first glance appears concentric because of curving lines, or arcs, with spurs attached, which are placed on either side. Extending diagonally from these arcs are two pairs of parallel lines within which are numerous closely spaced, oblique cross lines.

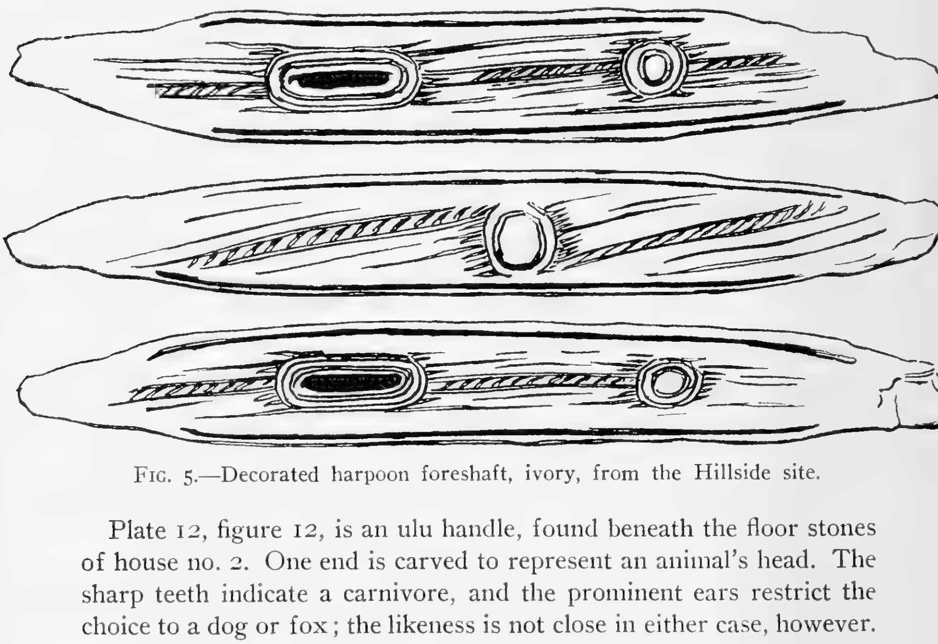

FIG. 5.—Decorated harpoon foreshaft, ivory, from the Hillside site.

Plate 12, figure 12, is an ulu handle, found beneath the floor stones of house no. 2. One end is carved to represent an animal's head. The sharp teeth indicate a carnivore, and the prominent ears restrict the choice to a dog or fox; the likeness is not close in either case, however. Decoration on the two sides is identical. At the center is a large circle with two long spurs above and two below. A bordering line with lateral spurs attached follows the four long spurs and the intervening periphery of the circle. Some of the spurs are continued as long, fine lines. To the right and left of the central design the surface is covered with rows of broken and continuous lines. A unique feature is the presence of rows of small pits or gouges—they can hardly be called spurs—which follow the pairs of closely spaced parallel lines. The lower edge is slighty undercut, with 14 long downward-pointing spurs on one side and 18 on the other.

The decorated fragment, plate 12, figure 13, from the same place, appears to be part of a fat scraper. The design consists of parallel lines with diverging outer ends and alternating similar lines, the diverging ends of which meet at the center to form triangular figures.

Plate 12, figure 14, is a thin ivory object of unknown use which was also found beneath the floor stones of house no. 2. It is carved to represent an animal, with the head of a mammal but the tail more suggestive of a fish. At the center a slot 3 cm long and 3 mm wide has been filled with an inset of wood. The surface on both sides is covered by a number of straight incised lines, carelessly applied. Similar lines are incised along the edges except above the head, where there are 20 short cross lines.

In plate 13, figures 5, 7, 8, are shown three objects from house no. 1 and the adjoining midden decorated in Old Bering Sea style 1, the same general style as was seen in the four objects last described.

Plate 13, figure 5, is a needle case, found in the second level of the midden. After breaking, it was used as a hand drill, the lower end having been provided with a small point. There is a distinct bulge at the center; the lower end is tapering, the upper end constricted, with a slightly flaring rim. Encircling the upper rim is a line, from which descend a number of short spurs and four pairs of longer spurs, one pair to a side. Around the lower end are two lines, the inner one with the same arrangement of spurs. A similar pair of spurred lines encircles the center. Four pairs of long, curving lines, placed opposite each other, extend from the upper and lower rims and meet at the center. Between these, on both sides, are two pairs of short curved lines with inward pointing spurs.

In plate 13, figure 7, is shown a broken object of unknown use, found beneath the floor stones of house no. 1. The fact that there was an enlargement of the under side, apparently with a socket, suggests that this may be half of a winged object such as described above (pl. 12, figs. 1-4). The top surface is flat and is marked off by two pairs of curving lines. At the right end (originally the center?) is a large circle 1.5 cm in diameter enclosing a smaller nucleated circle 4.5 mm in diameter. Two prominent spurs are attached to the periphery of the outer circle, and between these are two still larger, converging spurs which extend outward for a distance of 3 cm. At this point the top surface is constricted to a width of 1 cm by the broadly beveled edges. Toward the end the top surface widens somewhat and is ornamented by two very long, deeply incised, curving spurs, beyond which, at the extreme end, is an ovoid figure enclosing 16 closely spaced parallel lines. The beveled edges, like the top, are bordered by pairs of incised lines and the space between these is covered by long slanting spurs.

Plate 13, figure 8, is a fat scraper found in house no. 1. It has vertical sides, sharp edges, and blunt ends. The ornamentation, although in some respects similar to that on figure 7, is far removed from typical Old Bering Sea. One's first impression is of a " scratchy " decoration, with lines applied almost at random. In reality, the decorative scheme is well organized and balanced, although the execution is somewhat free. The elements employed are pairs of straight or slightly curving lines; short detached lines in rows; very long sharp spurs, usually of two lines; closely spaced long single spurs attached fringelike to curving lines; and, on the sides, bands of four to six very short cross lines between two long parallel lines. At the center of each side, on the lower edge, is an arrangement of straight, converging lines like that shown on the borders of plate 13, figure 7.

The three objects last described, together with the four shown in plate 12, figures 11-14, are decorated in a style very different from the typical Old Bering Sea, as we shall see presently. Although the ornamentation is comparatively simple, it is by no means unorganized. On the contrary, the elements are combined into rather effective patterns, considering that the artists restricted themselves almost entirely to straight or slightly curving lines. They knew the use of the nucleated and concentric circle and of other Old Bering Sea elements such as the spurred line, the double line and the broken line, but the full possibilities of these elements had not been realized; they had not been selected out and made to serve as the basis of elaborate and complex designs such as characterized a later stage of Old Bering Sea art. On the contrary, this simpler style was distinctly linear; and circles, when present, were of incidental importance as compared with a profuse decoration consisting of long radiating lines, shorter detached lines, and single or double lines to which were attached very long, sharp spurs. For convenience of reference more than in recognition of an established chronological position, I have called this simpler style of art " Old Bering Sea style 1 ". Its principal motives are illustrated in text figure 6. That the specimens decorated in this style are actually older than the bulk of the material from the Hillside site is indicated by the fact that most of them were found beneath the floor stones of the two houses. But they are so few in number that it would be well to have more examples, and if possible, from other localities, before definitely assuming its ancestral relationship to the more highly developed Old Bering Sea art, even though on stylistic grounds such a relationship would appear probable. In this connection it is now evident, in the light of the Gambell finds, that the dart foreshaft from the Diomedes which I have previously described as possibly representing a local intermediate style between Old Bering Sea and modern art (Collins, 1929, pl. 9, fig. 2), is in

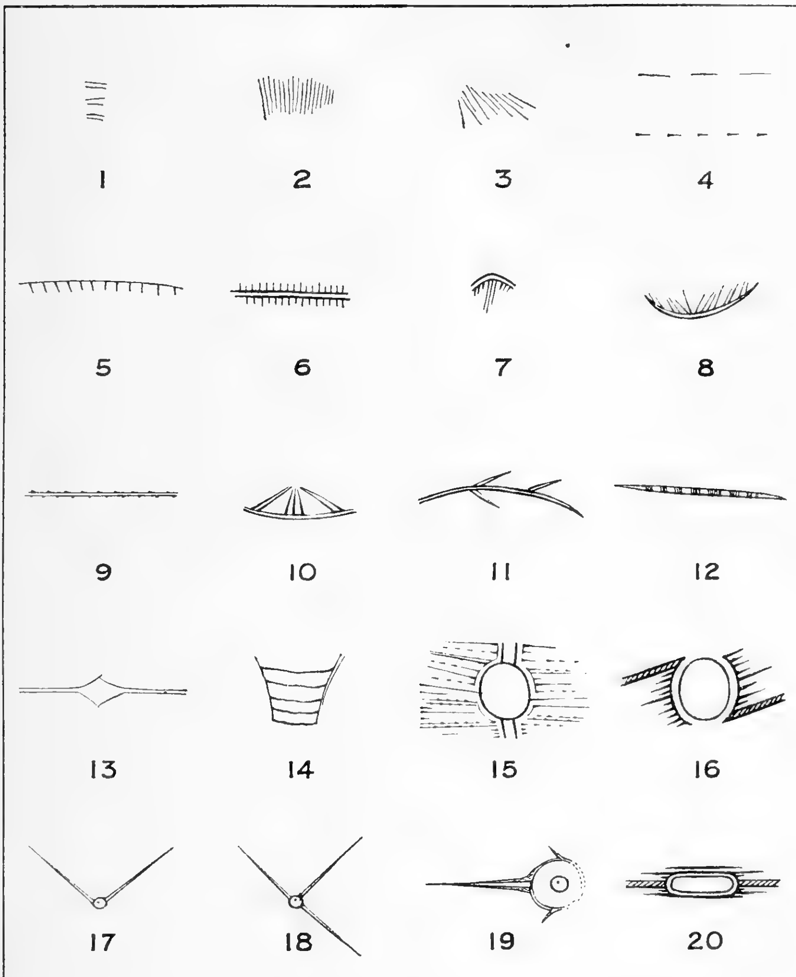

FIG. 6.—Principal decorative motives of Old Bering Sea style 1.

reality an example of this simpler and presumably earlier art. This object, together with three others from the same locality, is reproduced in plate 14, and will be described later.

We will now consider the objects from the Hillside site which are decorated in the more elaborate, harmonious style which I shall call "Old Bering Sea style 2".

Plate 13, figure 1, is a broken harpoon socket-piece from house no. 1. Although the greater part of the surface has been destroyed through weathering, the design is clearly visible. If this specimen were better preserved, it would undoubtedly be one of the finest examples of Old Bering Sea art. The design centers around a graceful figure suggestive of an animal's head with open jaws, a characteristic motive of this art (Jenness, 1928 a, pl. 13, *b.:* Mathiassen, 1929, figs. 13, *a;* 15, *b;* 16, *a:* Collins, 1929, pl. 1, *a-b, e-f;* pl. 4, *a*). The "head" rises from a deeply incised transverse line which divides the decoration into two sections. It is outlined by broad, deeply incised, tapering lines, which, as they approach, are connected by a short cross line, thus forming the "snout" which is made to appear more realistic by being carved in higher relief than the surrounding surfaces. At the center of the snout is a small round pit, behind it another, and then two more to represent the "eyes". The latter are placed just outside of two rather deeply incised converging lines and are bordered by curving lines. There was a replica of this "head" on the opposite side, now obliterated. Adjoining it on both sides is a similar figure, facing the opposite direction, with its open jaws enclosing the head just described. It differs, however, in having a squared-off "snout", and, between the "eyes", a triangle with cross-hatched interior (not visible in the photograph), a feature previously noted on a harpoon head from this region (Collins, 1929, fig. 1). Above this second "head" were two others, now three-fourths obliterated. The remaining parts—at upper right—show that these two figures were similar in arrangement to the other two; in the first one, however, the two pairs of lines streaming from the eyes point downward, and the snout is relatively short and broad, while in the upper figure the snout is again elongated and the lines from the eyes extend upward. The decoration on the lower part of the socket piece is somewhat different. Extending downward from the straight cross line below the head first described, is another shorter head, now almost entirely obliterated. Below and to the side of it is a second head which differs from the others in having a very large eye, 11 mm in diameter, formed by three large concentric circles enclosing a round pit bordered by two smaller circles. In the space between the two groups of circles are four straight radiating lines.

In plate 13, figure 2, is shown an elaborately decorated ornament found in the upper level of the midden; the decoration appears to better advantage on the two drawings shown in plate 14, figures 1, 2. The two circular holes at the upper ends suggest that the object was worn suspended, possibly as a gorget. The design elements employed—

straight, curving, and broken lines; spurs; and small freehand circles between converging lines—are typical of Old Bering Sea art. The circles enclose small round pits 3 mm deep and 2 mm in diameter. Six narrow slits (two no longer visible) divide the flat surface into five distinct panels. Effective arrangement of design emphasizes the values of the separate elements thus formed and at the same time accentuates the harmony of the composition as a whole. On the opposite side the upper corners are treated differently: at both ends a deeply cut curving line sets off a rounded, tapering panel on which slightly curving lines extend downward and outward, in effective contrast to the other panels with their lines flowing downward and

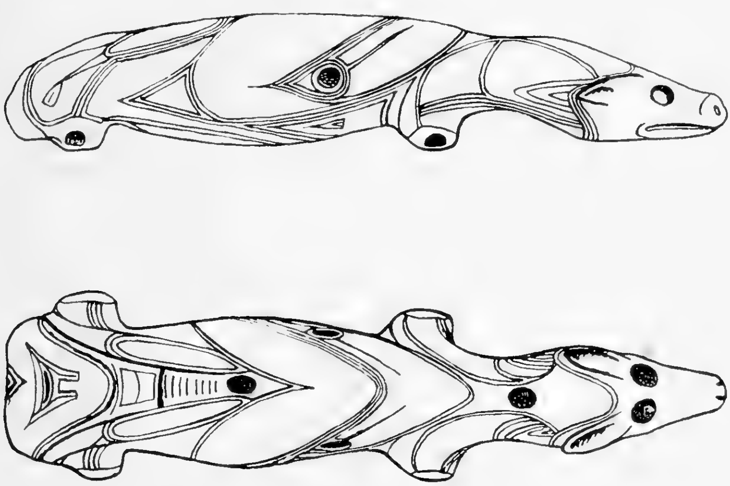

Fig. 7.—Ivory polar bear with Old Bering Sea decoration, Hillside site.

inward. The upper panel, instead of being plain as on the other side, is stippled with small shallow pits.

Plate 13, figure 3, and text figure 7 show a carving of a polar bear, found in the second level of the midden; it is a good example of the added effectiveness of Old Bering Sea ornamentation when applied to sculptured surfaces. The length of the head and neck is somewhat exaggerated, even for a polar bear. The legs, on the other hand, are so short that they do not serve as supports, the resting surfaces being the belly and lower jaw. The legs appear to have been slotted originally, probably in order that the figure could be attached as an ornament or charm to some flat surface. The ears are modeled in relief; the eyes were made by drilling two holes in at an angle so that they meet inside the head. At the middle of the neck is a drilled hole 7 mm deep and 4 mm in diameter; similar holes, not quite so deep, are drilled in the middle of the back, between the hind legs, on the flanks back of the front legs, and on the belly. If we may judge from other examples of Old Bering Sea art, these holes probably contained cylindrical plugs of baleen or wood. Beginning at the top of the head and back of the ears the body is decorated with graceful, flowing lines, usually two or more together. Most of the lines are lightly incised; others, for contrast, are deeper. The surface ornamentation gains strength and harmony through its skillful adaptation to the body contours. The first section of the design covers the curving front legs and neck, and is centered at the circular pit above. Beginning at this point the central design, outlined by four finely incised and closely spaced curving lines, covers the shoulders, the rounded flanks, and most of the back. Additional curving lines extend forward from the lateral pits, which are bordered by three concentric circles, the outer one with small spurs attached. The most prominent part of the decoration, as viewed from above, is that extending from the haunches to the round pit at the middle of the back. This takes the shape of a long, tapering panel formed by deep lines which also mark the position of the legs. The panel is divided into three parts by a straight cross line near the apex and a curving line a short distance below. At the center of the lower section is a small detached design—a triangular figure with curving sides enclosing a small elliptical figure (text figures 15, 18 a)—and below it a circular pit bordered by two concentric lines, the outer one projecting upward to form a prominent spur. The under side, from the belly to the lower jaw, bears a relatively simple decoration consisting of slightly curving lines with small triangular figures and spurs attached.

Plate 13, figure 4, is a small figure of a bird, carved from mammoth ivory. It was found in the upper level of the midden. The wings are outlined by two lines which extend upward from the breast and meet at the middle of the back. On each wing is drilled a hole 3.5 mm in diameter and 4 mm deep. As in the case of the polar bear, the eyes are formed by two round drilled holes which meet in the center of the head. A deep slot has been cut into the flat base by means of which the little figure could be attached to a flat surface.

Plate 13, figure 6, from the second level of the midden, has the rounded body of a bird but the head of a mammal, with sharp prominent teeth, small eyes and ears. The body is decorated in Old Bering Sea style with pairs of straight lines, broken lines, spurs, and a small double circle. The base is deeply slotted as in the preceding specimen.

In plate 23 are shown six harpoon heads from the Hillside site decorated in Old Bering Sea style 2. The surface of plate 23, figure 1, is divided into three decorative fields. The center design occupies the long median spur and consists of a small nucleated and slightly elevated circle set between converging lines; just above it is a small bilobed or two-winged figure suggestive of the "animal head" of plate 13, figure 1. The two shorter basal spurs of the harpoon head and the surfaces immediately above are decorated in similar style: each contains a long ovoid figure, its upper end formed of two curving lines, enclosing a small nucleated concentric circle from which stream two pairs of straight lines. Above the ovoid figure the surface is covered with a series of rather carelessly applied single and double lines and short detached lines.

Only a part of the design remains on the broken harpoon head, plate 23, figure 2. Its most prominent feature is a flat, nucleated, concentric circle with two small opposite spurs, set between two pairs of converging lines. These and similar lines are bordered by rows of broken lines.

The decoration visible in plate 23, figure 4, consists of deeply incised border lines, a pair of straight parallel lines, single lines and broken lines. The opposite side has in addition two nucleated, concentric circles with attached curving lines, one of the circles being on the squared-off projecting spur at the base, the other opposite and above it, to the left of the pit where the lashing slots emerge.

In plate 23, figure 9, is shown another example of the "animal head", to the left of the line hole. The "eyes" consist of elevated concentric circles with attached spurs, bordered by curving lines; the nose or snout is squared off at the end, with three deep spurs in the notch below. Opposite the "head" is a figure somewhat similar but with a curved, slightly everted lower end and one centrally placed, elevated, nucleated circle. The surface between the two designs has a few detached lines enclosed by two curving lines above. A prominent spur rises from the curving line which borders the line hole. The spur or terminal barb of the harpoon head is meagerly decorated with a few curving lines and spurs.

In plate 23, figure 10, there is a less realistic "head" occupying the same relative position as the one just described. It is longer and narrower, and the small concentric circles forming the eyes are flat instead of elevated; there is a third similar circle between the eyes and the snout. The latter is cut off square as in plate 23, figure 9, with two similar spurs in the notch below. The line hole and base of the blade slit are bordered by two pairs of curving lines, between which are two pairs of long pointed spurs and several other irregular lines. The most prominent decorative feature of this harpoon head is a roughly circular figure to the left of the lashing slot. It is formed of two continuous lines enclosing two incomplete lines. At the center is a lozenge-shaped figure with incurving sides, enclosing a small concentric circle. Pairs of straight lines lead off from the periphery of the large circle. The lower extremity, or spur, of the harpoon head is beveled, leaving two flat surfaces, each of which is decorated with a row of seven short transverse lines.

Plate 23, figure 13, from among the rocks at the south end of the site, has had much of the decoration removed by secondary cutting. It consisted as usual of rather deeply cut lines which divided the surface into several decorative fields; and within these, lighter lines, single and double, broken lines, and concentric, nucleated circles and ellipses. The two circles to the left of the line hole and the two ellipses to the right are larger than the other circles shown in plate 23, averaging 6 and 8 mm in diameter, respectively. Their distinct elevation and arrangement in relation to the bordering and other lines produce the appearance of two opposed animal heads. As we shall see later, this particular type of "animal head" is the most characteristic feature of what will be designated as "Old Bering Sea style 3." The principal difference between the style 3 "heads" and those shown in plate 23, figures 9, 10, and plate 13, figure 1, is that the former are more uniform and stylized. The circles or ellipses forming the eyes are relatively large, and the heads themselves constitute the central design; the heads are almost always opposed, one on either side. Those of the Old Bering Sea style 2, if we may judge from the few examples available (*e. g.*, pl. 13, fig. 1; pl. 23, figs. 9, 10), are not only less uniform as to shape, size, and position, but differ also in that the eyes are formed either of large flat circles or of much smaller circles with long double spurs attached. Furthermore, in the case of Old Bering Sea style 2, the accompanying decoration is more diversified, with a strong tendency toward the use of more or less independent or detached design elements.

The ornamentation in plate 23, figure 14, is another example of Old Bering Sea style 2. It is unique in being applied in a single continuous band which runs obliquely from the margin of the blade slit down to the tip of the spur. The upper circle, with two pairs of lines attached, is similar to that of plate 23, figure 9; the lower circle has long tangent spurs like those in plate 23, figure 2.

DECORATED OBJECTS FROM LITTLE DIOMEDE ISLAND

In plate 14, figures 3-6, and text figure 8 are illustrated four decorated ivory objects from Little Diomede Island, purchased from Eskimos who had excavated them from the extensive midden on which is situated the present village. They are introduced here because of certain resemblances in decoration between them and some of the style I specimens from the Hillside site at Gambell. There are indications that some of these objects may have been contemporaneous with the subfloor material from the Hillside site at Gambell; for although depth records are lacking, the pit from which two of them

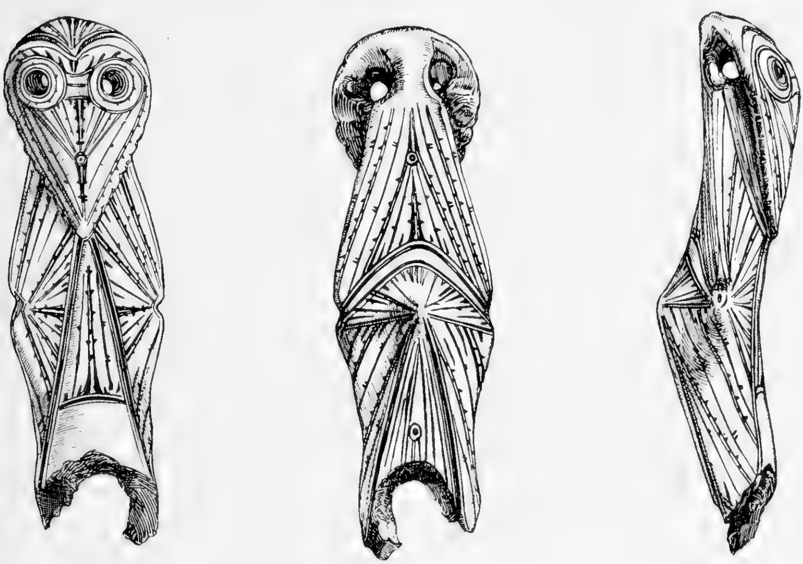

FIG. 8.—Decorated ivory object from Little Diomede Island.

(pl. 14, figs. 1-2, 6) were said to have been excavated, had reached a depth of at least 10 feet when the writer visited the site in 1929.

Text figure 8 shows the three sides of an ivory object of unknown use, natural size. The upper end is raised and flaring; its rounded top, pointed "beak", and two transverse circular perforations give it somewhat the appearance of a bird's head. On the front side the body is divided into three panels by means of two deeply incised lines, with bordering lines which converge upward to the "beak." The spaces so formed are filled with a series of slanting parallel and converging lines with short spurs attached, some pointing outward, some between the lines. The arrangement of the slanting lines on the side panels is essentially the same as was observed on the edges of the object from the Hillside site shown in plate 13, figure 7. The other side, which is arched, is decorated in a similar fashion. The lower end, now broken, was perforated.

On plate 14, figures 3 and 4, are shown two drawings of an ivory drum handle, collected by Dr. Aleš Hrdlička. The outer end has been sawed off by the Eskimo who found it. The incised ornamentation is very similar to that on the object just described, consisting of pairs of straight and curving lines with spurs attached; between some of the parallel lines there are groups of two or three short transverse lines, placed at regular intervals, somewhat similar to those which are barely visible on the sides of the gut scraper (pl. 13, fig. 8). There are also two concentric circles with spurs along the periphery. The most interesting feature, however, is a human face with a long straight nose, large mouth, and eyes formed of nucleated circles set beneath curving double lines representing eyebrows. Short spurs are attached to the eyebrows, eyes, and lips, and there are several angular lines around the nose.

Zoomorphic treatment is also seen on the ivory dart socket piece shown in plate 14, figure 5, although it is not clear just what animal the artist intended to portray. The raised ears are those of a mammal, and resemble those on the ulu handle from the Hillside site (pl. 12, fig. 12). The curving lines in front are more suggestive of the gills of a fish, although from another viewpoint they might be considered as the downward-curving horns of a musk ox. This feature gives it a superficial resemblance to the well-known carving of a musk ox originally described by Merk (1876, pl. 11, 69 a, b) and often reproduced as an example of Paleolithic art. The eyes are formed of cylindrical plugs of baleen around which a circle was inscribed. The incised lines again take the radiating form of those already described; there are also short detached lines similar to those seen in plate 13, figure 8, and pairs of short parallel lines like those in plate 12, figure 8.

Plate 14, figure 6, is a drawing of an ulu handle, reduced one-fifth. The surface bears an elaborate decoration which combines features of both Old Bering Sea styles 1 and 2. The numerous longitudinal lines, and the parallel lines containing short oblique lines are characteristic of style 1; the concentric, nucleated circles and the oval center design are more like style 2.

All four of these objects are deeply patinated, having the same rich brown coloration as the comparable specimens from the Hillside site.

Summarizing, we may say that of the several Diomede pieces described above, the dart foreshaft (pl. 14, fig. 5) shows the closest resemblance to the style 1 pieces from the Hillside site. Similarity is shown in the ears, carved in relief (cf. pl. 12, fig. 12), in the radiating lines, the pairs of short parallel lines and the short detached lines. The arrangement of the radiating lines on the sides of the Diomede specimen shown in text figure 8 is similar to the radiating lines on the Hillside specimen shown in plate 13, figure 7; and the parallel lines with inner bands of two or three short transverse lines (pl. 14, figs. 3 and 4) as well as those with oblique inner lines (pl. 14, fig. 5) recall the similar parallel lines with short inner bands as shown in plate 13, figure 8. In other respects the two Diomede specimens (text fig. 8 and pl. 14, figs. 3, 4) exhibit a decorative treatment which is not in conformity with Old Bering Sea style 1, as exemplified by the objects from the Hillside site. In these two Diomede specimens the decoration consists essentially of pairs of closely spaced straight or curving lines to which externally or internally, or both, are attached numerous short, regularly spaced triangular spurs. The arrangement of these lines in radiating or converging fashion recalls a similar place-

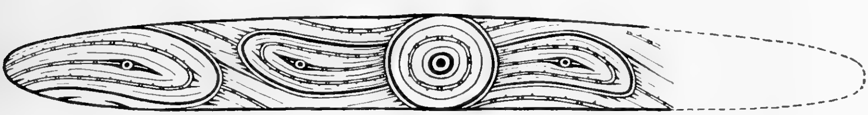

FIG. 9.—Decorated ivory object from the Bering Strait region.

ment of lines on some of the style 1 pieces from the Hillside site, but the combination of triangular spurs and closely spaced straight parallel lines is rare in Old Bering Sea art as known at present even though such spurs are frequently applied to single, usually curving, lines. The arrangement of short spurs on the inside and outside of pairs of closely spaced lines is seen on two specimens from Little Diomede Island described by Jenness (1928 a, pl. 13, a, b) and also on the small object, possibly a pail handle, shown in text figure 9, which I bought at Wales in 1929. It was excavated either at Wales or the Diomedes, probably the latter.

Furthermore, it is spurred double lines of this Diomede type that are present on the decorated objects from the old buried site on Punuk Island recently discovered by Otto Wm. Geist (see p. 30, footnote). In form, some of the objects from this old Punuk site are identical with types which at Gambell were found only at the Hillside site or the older section of Miyowagh, and no doubt a careful comparison would reveal close similarities in decorative elements as well. We are faced here with an interesting problem, namely, the relationship between the old Punuk material and that from Diomede Island and the

Hillside site at Gambell, as well as with the later material from Punuk Island. This, however, is something that cannot be decided until this very interesting and important collection from Punuk Island is described in detail.

Miyowagh

On the flat gravel plain at the foot of the plateau and about 50 yards from the Hillside site, is the low grass-covered kitchen midden known

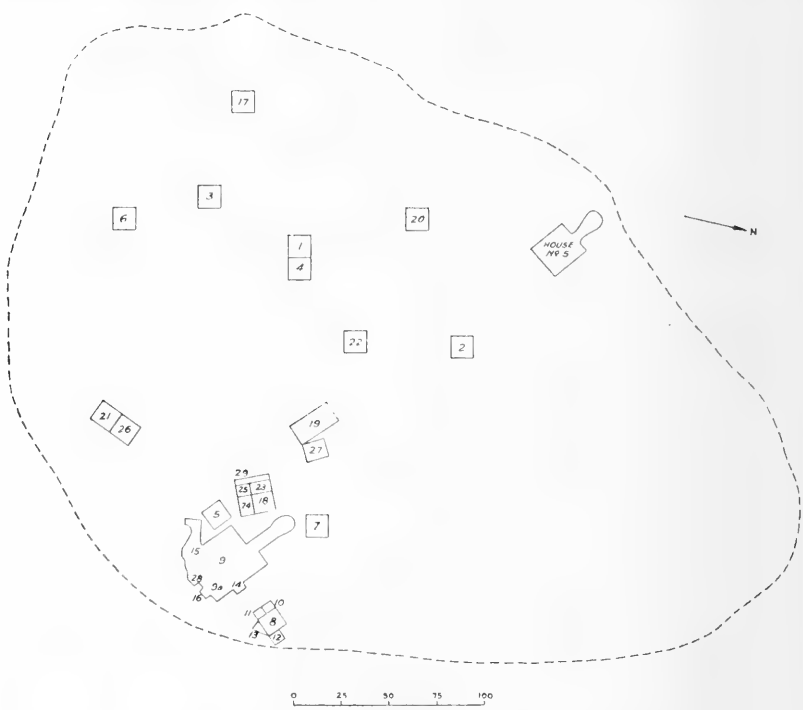

Fig. 10.—Outline of Miyowagh, showing excavations of 1930 and 1931.

to the Eskimos as Miyowagh, the " climbing-up place ", so called because the trail from Gambell here begins to ascend the hillside. The midden lies at the head of the gravel plain within the first two—the oldest—beach lines which extend westward from the base of the plateau for a distance of three-quarters of a mile. It is situated about 100 yards from the north end of the lake and three-quarters of a mile and a half a mile back from the sea (text fig. 2). The midden is irregular in outline with an average diameter of a little over 100 yards (text fig. 10). It appears to be rather low, with a visible height of less than 5 feet. However, this is due to the encroachment of the gravel, for the bottom of the midden was found to extend several feet below the level of the surrounding plain, at one place reaching a total depth of 8 feet. In spring and early summer the small stream which flows down among the rocks of the Hillside site passes along the southeastern edge of the Miyowagh midden and empties into the lake. House pits are represented by shallow depressions, more or less circular in outline. Some 18 or 20 of these pits were visible, but the surface of the midden had been so disturbed by the Eskimos digging for ivory that it was not always possible to recognize a house pit with certainty. The surface of the midden was practically free of whale bones and timbers, such as are found at some of the more recently abandoned sites. No remains of roof or wall structures were visible, most of them no doubt having been utilized in the construction of later houses.

The Miyowagh midden, as well as the three other middens situated on the gravel plain, differed in several respects from that at the Hillside site. Being on the level ground, it had not been subjected to erosion or to disturbances from the shifting or sliding of rocks as had the Hillside midden. As a result the Miyowagh midden represents a full record (although one which may have been altered here and there through sloughing or from the excavation of house pits), whereas at the Hillside site the present configuration of the surface indicates that an unknown amount of refuse has been washed down the slope. There was also a difference in the nature of the deposits: at the Hillside site, as in kitchen middens generally, the débris of human origin was mixed with a certain amount of natural soil, for the gently sloping lower part of the hillside is covered with a fairly deep soil layer. At Miyowagh, on the other hand, the first houses were built on a barren gravel plain, and the extensive pile of débris which slowly accumulated around, and eventually over them, was almost entirely artificial, the greater part of it resulting from the decomposition of animal remains and other organic materials. The midden therefore consists of a heavy, rich, black matrix containing great quantities of animal bones and baleen in addition to artifacts and rejectage of stone, bone, ivory, wood, and baleen. The midden was found to be compact and, in general, unstratified. Occasionally a thin layer of mussel shells or a mass of bones, etc., would stand out distinctly, and along the western periphery lenses of midden material were sometimes separated by masses of gravel. As a rule, however, there was no stratification in the usual sense, the bones, artifacts, and rejectage being a relatively homogeneous mass, held together in a solid matrix of permanently frozen, rich, black soil. This is a condition that would naturally result when a kitchen midden was formed as this one was—by the daily accumulation of rubbish thrown just outside the houses. In appearance such a midden differs markedly from the more familiar type found all along the coasts as far north as the Aleutian Islands. The principal point of difference is that these more typical middens to the southward contain more or less distinct strata which are due in large part to the presence of shells, ashes, sand, and other beach material, none of which is present to any appreciable extent in an Eskimo midden of the Miyowagh type.

The first cuts at Miyowagh were made in the northwestern section of the midden which was slightly higher and had also suffered less from the Eskimos' digging than had the southeastern section. Furthermore, it was relatively dry and well drained, whereas much of the southeastern part of the midden was in a soggy condition and so remained until midsummer when the snow from the hillside, which fed the small stream at the eastern edge of the midden, had almost disappeared. As stated above, the cuts were 12 feet square and were taken down in layers of from 2 to 6 inches in thickness, except for thicker surface layers of sod or sterile layers of gravel. In the following pages descriptions of individual cuts will be reduced to a minimum. Many of the cuts yielded between 200 and 400 specimens, in addition to quantities of animal bones, potsherds, broken slate blades, and other fragmentary artifacts. In the brief descriptions of individual cuts only those artifacts having definite chronological significance will be mentioned. Later, when describing the different types of objects, significant distributions according to cut and depth will be noted. Cuts 1-4, 6, and 17 (season of 1930) were sunk in the northwestern section of the midden, and cuts 5, 7-9, 9 a, 9 b, 10, 10 a, 11-16 in the southeastern section (text fig. 10). In 1931, Mr. Chambers continued the work on cut 17, and cuts 19, 20, 22, and 27 were sunk in the northwestern section of the midden, and cuts 18, 21, 23-26, 28, and 29 in the southeastern section. Three houses were excavated at Miyowagh in 1930, no. 5 in the northwestern section and nos. 3 and 4 in the southeastern.

CUTS IN THE NORTHWESTERN SECTION

Cut 1 (pl. 6, fig. 1, the excavation in foreground).—Cut 1 was 5 feet 3 inches deep; taken down in 10 levels. Surface covered with scattered grass, no sod. The upper 18 inches consisted of almost pure gravel, with sporadic patches of midden material; 8 inches deep was a layer of mussel shells 1 to 2 inches thick. A large piece of walrus hide was found at a depth of 30 inches. Small pieces of wood began to appear at this depth, becoming more numerous in the deeper levels. Artifacts found numbered 198.[6] No examples of Old Bering Sea art or harpoon heads were found in cut 1. Two of the harpoon heads, from depths of 30 and 53 inches, belonged to open socket type III x; one of these is shown on plate 24, figure 22. The other open socket heads belong to the later types: type II (a) x, II (a) y (pl. 28, fig. 2); II (e) (pl. 28, fig. 4); III (a) x (pl. 28, fig. 13). The closed socket heads were also of the small, simple forms, such as type V x (pl. 28, fig. 22) and V y (pl. 28, fig. 26). Nine of the harpoon heads, and two other objects bore Punuk ornamentation.

Cut 2.—Ninety-two feet NE. of cut 1. This cut was 4 feet 2 inches deep; taken down in 10 levels. From the surface to 20 inches deep was almost pure gravel, with occasional artifacts; patches of midden material appeared at depths of from 20 to 24 inches. Stones and whalebones, apparently remains of an old cache, were encountered at 34 inches, and these continued to the base. The end of a large baleen toboggan was found at depth of 43 inches (pl. 6, fig. 3), the greater part of it extending into the south side of the cut, which had to be enlarged for its removal. Two pieces of wood at 28 inches; more in the deeper sections. In this cut were found 85 artifacts, including the toy trident (pl. 22, fig. 6) from depth of 20 inches. Harpoon heads very similar to those from cut 1; three are figured in plate 28, figures 7, 8, 25. Four were decorated in Punuk style; only one example of Old Bering Sea decoration from this cut, a fragment of a harpoon head from depth of 43 inches, which had been made over into a small knife handle.

Cut 3.—Forty-two feet SW. of cut 1; 5 feet deep; taken down in 11 levels. The upper 16 inches was practically solid gravel, and considerable quantities of gravel continued to a depth of 3 feet. Artifacts numbered 238. The ivory from the last three levels (50 to 60 inches deep) was in general noticeably lighter in color than that above.

Two harpoon heads decorated in Punuk style, from depths of 20 inches (pl. 24, fig. 19) and 24 inches; two fragments bearing Old Bering Sea decoration, from 54 inches (pl. 15, fig. 5) and 60 inches deep.

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[6] The number of artifacts listed for this and all the other cuts includes only complete specimens or recognizable fragments; in addition to these there are in every case large numbers of potsherds, fragmentary stone blades, pieces of worked ivory, bone, wood, baleen, etc., which were collected but which are not included in the total count of specimens.

Cut 4.—Adjoins cut 1 on the east; 5 feet 8 inches deep; taken down in 11 levels. Specimens numbered 195. Very similar to cut 1 as to gravel content, etc. Plate 6, figure 1, shows the beginning of work on cut 4, with cut 1 in the foreground; plate 6, figure 2, is a view of the same at a later stage of excavation. A piece of textile found at depth of 26 inches. The decorated needle case shown in plate 17, figure 9, came from a depth of 55 inches. Harpoon heads were were all Punuk types; four of these are illustrated (pl. 24, fig. 8; pl. 28, figs. 12, 14, 15).

Cut 6.—Thirty-five feet south of cut 3; 4 feet 7 inches deep; taken down in eight levels. Specimens numbered 98. At a depth of 20 inches was found a mass of organic material, evidently disintegrated animal flesh, flaky, yellowish, blubber-soaked, together with fallen pieces of wood which had probably formed part of a cache. More of the cache—fallen whale ribs, scapulae, and stones—were found below this to a depth of 50 inches. There was relatively little gravel in cut 6, but more baleen and other organic material which emitted a sour, pungent odor. The ivory winged object with elaborate Old Bering Sea decoration (pl. 20, fig. 4) was found at a depth of 36 inches. The bone harpoon head (pl. 28, fig. 6) comes from a depth of 20 inches; another (pl. 26, fig. 6) from a depth of 26 inches; a fragment, from the latter depth, bears Old Bering Sea ornamentation. On the whole, the midden deposit at this particular spot appears to be older than that to the northward. At a depth of 50 inches was found the skull of a bearded seal, with a baleen thong through the foramen in the palate; it had evidently been preserved prior to being disposed of in some special manner.

Cut 17.—Seventy-five feet W.-SW. of cut 1; 40 feet from edge of midden; three levels, to a depth of 26 inches, taken down in 1930; three additional levels, to depth of 34 inches, in 1931; bottom not reached. Specimens numbered 153. The part of the midden where this cut and cut 20 were made seems to have been the latest section of Miyowagh. One of the harpoon heads, from a depth of 20 inches, is shown in plate 28, figure 3; the others were mostly of open socket type III (a) x. No trace of Old Bering Sea art or artifacts, or even of early Punuk.

Cut 20.—Between cut 1 and house no. 5 Excavated by M. B. Chambers in 1931. Taken down in five levels to a depth of 3 feet 3 inches, bottom not reached. Artifacts numbered 115. Material practically identical to that from cut 17. Fifteen harpoon heads and two other objects bearing Punuk decoration, one weathered fragment of harpoon head with Old Bering Sea decoration. Four of the harpoon heads from cut 20 are shown in plate 28, figures 5, 19, 24, and 28, all from the surface layer. The decorated drill shown in plate 22, figure 8, is from the same level.

Cut 19.—Excavated by M. B. Chambers in 1931. This cut, 18 feet long by 12 feet wide, was made at about the center of the midden, between cut 4 and the end of the entrance to house no. 3. It was the most productive of all the cuts, yielding 514 specimens besides the usual potsherds, baleen, fragments, etc. It was 7 feet 2 inches deep and was taken down in 22 levels. The midden here was very trashy, containing a large quantity of baleen, bones, and wood, which sloped downward from east to west. Plate 6, figure 4, shows the north side of the cut with baleen and other refuse projecting from the wall and some of the timbers of a razed structure lying at the base; plate 6, figure 5, is a view of the same cut showing the timbers at a later stage of the excavation. In plate 7, figures 1 and 2, the north and west walls of cut 19 are visible in the background (cut 27 in foreground); the strings along the north wall (pl. 7, fig. 2) indicate the slope of the refuse. The slope of the midden at this point may account for the fact that harpoon heads of Punuk type occurred at a somewhat deeper level here than elsewhere, for three were found at depths of 51 and 59 inches (pl. 26, fig. 8; pl. 28, fig. 27), in addition to a large number of others at lesser depths. In all 52 harpoon heads and fragments were found in cut 19; 29 of these, from the surface to 59 inches deep, bore Punuk ornamentation, mostly Punuk style 1, while only one fragment, from a depth of 78 inches, bore Old Bering Sea ornamentation. However, there were several other objects decorated in the latter style, from the following depths: 5 inches (pl. 15, fig. 10); 17 inches (pl. 15, fig. 9); 24 inches; 51 inches (pl. 19, fig. 1); 56 inches; 63 inches (pl. 15, fig. 6); 76 inches; 79 inches (pl. 15, fig. 1).

Cut 22.—Between cuts 2 and 27. Excavated by M. B. Chambers in 1931. Taken to depth of 3 feet 10 inches, in six levels; bottom not reached. Specimens numbered 91.

CUTS IN SOUTHEASTERN SECTION

Cut 5.—Near SE. end of midden; taken down in six levels to depth of 3 feet 10 inches, bottom not reached. Specimens numbered 68. At depth of 28 inches a mass of skin, vegetable matter (plants for eating?), wood, and baleen was encountered, along with fallen whale ribs, jaws, and scapulae which had evidently formed the walls of a cache. The baleen consisted of 14 small-sized slabs, from a young whale. On removal, the vegetable matter, baleen, etc., was found to rest on four thicknesses of split walrus hides, lying at a depth of 41 inches. Pieces of wood and bones, from the cache, continued to this depth and beyond.

Cut 7.—Five feet north of entrance to house no. 3; 8 feet deep, taken down in 14 levels. Specimens numbered 235. This cut affords a good example of the extent to which patination may be affected by local conditions. The ivory from the first (upper) four levels was very dark, while beginning with layer 5 (37 in.) it became noticeably lighter in color, that from the last five layers (75 to 96 in.) being the lightest of all. This condition appears to be the result of water action. The midden here is low and in early summer is more or less saturated by water that flows down the hillside. This has discolored the ivory in the upper part of the midden, while that in the permanently frozen soil below has escaped saturation and remained lighter in color. Timbers and whale bones of a razed structure of some sort were found beginning at the 6-foot and extending to the 7-foot level. Two examples of Punuk art from this cut, a harpoon head with a light line and spur decoration, from a depth of 20 inches, and another, 62 inches deep, with the earlier simple line decoration (pl. 24, fig. 20). The other decorated objects were all in Old Bering Sea style; they were found at the following depths: 67 inches (2) (pl. 19, fig. 2; pl. 24, fig. 16); 75 inches (pl. 24, fig. 1); 92 inches (pl. 24, fig. 11); 96 inches (pl. 24, fig. 13). The unfinished winged object shown in plate 20, figure 2, came from a depth of 80 inches; another broken specimen of the same type from a depth of 51 inches. The needle case (pl. 17, fig. 5) came from a depth of 33 inches and the small ivory comb (pl. 58, fig. 10) from 67 inches.

Cut 8.—At east end of midden; 30 feet NE. of house no. 3; 6 feet deep, taken down in seven levels. Specimens numbered 68. This cut was in the lowest part of the midden, which in early summer is covered with water. The bone and ivory, particularly the latter, is dark colored and poorly preserved, even that from the bottom. At the SW. corner of the cut was found part of a filled-in pit which appeared to have been oval and about 6 feet in diameter. The inner side of the pit was of dark, almost black, soil, very firmly packed and soaked with blubber. It was filled with softer and lighter colored soil than the rest of the cut. Bordering the pit and extending NW. by SE. was a row of fallen whale bones, small timbers, and one walrus skull, apparently part of a razed wall. Similar material was found in the eastern part of the cut, beginning at a depth of about 2 feet, and in order to follow this out and determine if possible the nature of the structure it represented, four other cuts were begun (cuts 10, 11, 12,

13) adjoining cut 8. Three decorated objects, all Old Bering Sea, were found in cut 8: the winged object (pl. 20, fig. 3) from a depth of 23 inches; fragmentary harpoon head, 32 inches; another harpoon head (pl. 26, fig. 19), 40 inches.

Cuts 10, 11, 12, 13.—Cuts 10 and 11 were two small cuts, each 6 by 4 feet, adjoining cut 8 on the SW. Cut 10, 4½ feet deep, was taken down in seven levels; cut 11, 5 feet deep, in six levels. Cut 12, 6 by 6 feet, adjoining cut 8 on the north, was taken to a depth of only 27 inches; bottom not reached. Cut 13, adjoining cut 8 on the east, was triangular in shape, 12 by 10 by 6 feet; 5 feet deep, taken down in five levels. Specimens to the number of 162 were found in these four cuts. The material was similar to that from cut 8; the ivory was dark and rather poorly preserved and there was a considerable quantity of baleen. Unfortunately, we were not able to get any clear idea as to the nature of the structure or structures revealed in these cuts. The pieces of whale bones and timbers found in the eastern part of cut 8 were shown to have been part of a cache, for they continued into cut 13, where they were found to enclose two layers of split walrus hides. Below this were found other timbers and whale bones, evidently part of a house, for they rested on the remnants of a stone floor found at a depth of 54 inches. On the floor were found a fragment of a harpoon head and a gut scraper (pl. 17, fig. 2), both with Old Bering Sea decoration, and a wooden object with one end carved to represent a human head (pl. 47, fig. 15). Just outside the stone floor was an upright timber 8 inches in diameter, broken off at the height of 2½ feet. This seems to have been a corner post, for extending at right angles from it were remnants of two small horizontal timbers. Three other broken uprights were found 6 and 9 feet south of the first one, and undoubtedly the other timbers and pieces of whale jaws lying on and above the stone flooring had been part of the walls or roof of the house, but it had been so thoroughly demolished that no structural details could be made out. Six inches below the stone flooring was what appeared to have been an earlier floor of the same kind. On this lower floor was found a small harpoon head with Old Bering Sea decoration (pl. 26, fig. 13).

Cut 9.—Thirty feet south of cut 8, on the low-lying eastern edge of the midden, was a large shallow depression, the pit of an old house. To uncover this house an excavation, cut 9, was begun. The sod here was thicker than at any other part of the midden, and below it barren gravel continued to a depth of 2 feet. The stone floor of the house was found at a depth of 4 feet (pl. 8, fig. 3). Specimens found numbered 294, and the material was segregated according to three levels—1 and 2 above the floor, and level 3 on the floor. The dimensions of the house (no. 3) were 21 feet 3 inches by 18 feet 6 inches, but our original excavation was larger, 26 by 30 feet. This larger excavation took in 5 feet additional space to the SW. and NE. and 11½ feet to the NW. and SE. Only Punuk material was found on and directly above the house floor (some of the objects will be mentioned when describing the house). On the other hand, the decorated objects from outside the house, in the space included in the NE. and SE. extension of cut 9, were all Old Bering Sea. Included among these objects were the two needle cases shown on plate 17, figures 6, 7, and the two harpoon heads (pl. 24, figs. 5 and 14).

Cut 9 a.—This area of approximately 10 by 12 feet, back of (SE. of) house no. 3, was at first included in cut 9, but was designated cut 9 a after the walls of house no. 3 began to appear. Plate 8, figure 1, is a view of this cut (in background) at an early stage of the excavation, before either of the two houses, nos. 3 and 4, had been completely uncovered. Plate 8, figure 2, is a later view of the same, showing James A. Ford excavating in cut 9 a (at the right) and Silook working on the floor of house no. 3; house no. 4 appears in the right foreground. Cut 9 a seemed to have been the site of a razed structure of some sort, probably a house, for a small section of stone flooring was found at a depth of 5 feet, above which were loose stones, whale bones, and numerous pieces of logs. All was in such disorder, however, that we were unable to form any idea as to what the structure may have been like. The cut was fairly rich in artifacts, there being 69 in addition to considerable quantities of potsherds, stone blades, baleen, and wood; the decorated objects, 10 in number, were all Old Bering Sea. Of greatest interest, however, was a burial, the only clearly intentional burial which we found in the Miyowagh midden. It lay 8 feet back of the rear (SE.) wall of house no. 3 at a depth of 4 feet. It was oriented toward the N.-NW. and was covered with several layers of matted skins which seemed to have been two parkas, one of bird skins and one of seal skins, probably *P. hispida* according to Dr. Remington Kellogg. The state of preservation of the body was remarkable; the permanently frozen ground had preserved the tissues in much the same way as dry sand may preserve burials in arid regions. The greater part of the skin, muscles, and tendons remained intact, appearing as a brown, parchmentlike covering, brittle and flaky, but maintaining its original relationship to the bones. The fleshy parts of the thighs and pelvic region, though much flattened, were especially well preserved. The body was flexed, with knees extended to the left at the level of the hips and arms placed over chest.

The skull, badly crushed, rested on a large flat stone—not one of the floor stones mentioned above; there were several more stones and a mass of timbers overlying the body, probably having been so placed at the time of burial. The following decorated objects—all Old Bering Sea—were found above the burial at the following depths: decorated box handle, 12 inches deep (text fig. 14); two harpoon heads, 18 inches deep and one fragment, 20 inches (pl. 19, fig. 7); two needle cases, 20 and 24 inches deep (pl. 17, figs. 8 and 4); harpoon socket piece, 36 inches. Just beneath the stone on which lay the skull was found a much weathered harpoon head with traces of Old Bering Sea decoration. Other objects with similar ornamentation were found nearby but not in contact with the burial: an ivory gut scraper, 50 inches deep (pl. 17, fig. 1); an ivory winged object, 38 inches deep (pl. 20, fig. 5); and four harpoon heads, 36 inches (pl. 24, fig. 18, and pl. 26, fig. 1), 38 inches (pl. 26, fig. 18), and 48 inches (pl. 24, fig. 15).

Cut 9 b.—This was a small, rather unproductive cut adjoining cut 9 on the SW. (pl. 9, fig. 1); the high spot where the two men are working is cut 9 b; house no. 3 appears below, to the right, and no. 4 in the foreground. Cut 9 b yielded only 10 specimens, including a harpoon head with Old Bering Sea decoration at depth of 22 inches. The cut was begun in order to expose a cache, the whale skull walls of which became visible as cut 9 was being dug. Cut 9 b was 6 feet long by 4 feet wide and was carried to a depth of 30 inches; it exposed only the NE. and NW. walls of the cache, which had been constructed of three whale skulls placed base upward, with several connecting timbers.

Cut 14.—A small cut, 6 feet long and 4 feet wide, adjoining cut 9 on the NE.; taken down in six levels to a depth of 3 feet 5 inches. Only seven specimens, in addition to potsherds and stone blades, were found.

Cut 15.—When a little preliminary digging had revealed the entrance passage leading to house no. 4 an excavation was started in the area immediately in front (to the west) so as to uncover the passage in its entirety. This excavation was designated as cut 15. The cut was made in the area to the left of where the two men are shown digging, in plate 9, figure 1; plate 9, figure 3, shows cut 15 after the entrance floor (to house no. 4) had been reached. The cut was taken down in six levels to the floor, which averaged 5 feet below the surface. The first four levels, to a depth of 3 feet, yielded 40 artifacts, including the winged ivory object with Old Bering Sea decoration shown in plate 20, figure 1, found at a depth of 28 inches.

Level 5 (3 to 4 ft. deep) immediately above the roofing timbers, yielded 31 artifacts, including the decorated pail handle (pl. 19, fig. 3) from a depth of 44 inches; one harpoon head with Old Bering Sea decoration, 42 inches deep; and two other fragments from the same depth. Between the roof timbers and floor of the passage (level 6, 4 to 5 ft. deep) 15 artifacts were obtained, including one harpoon head decorated in Old Bering Sea style, found on the floor.

Cut 16.—This was a narrow cut, 6 feet long by 3 feet wide, adjoining cut 9a on the SE. It was taken down in eight levels to the undisturbed gravel at a depth of 4 feet 4 inches. Fifty-five artifacts were found, including a broken drying rack of wood 18 inches deep and two ivory gut scrapers; a wooden drum handle with a large part of the rim (pl. 55, fig. 5) and a long oval cup or ladle of ivory (pl. 51, fig. 12) 22 inches deep; ivory scraper, Old Bering Sea decoration (pl. 16), 30 inches deep; ivory harpoon head, Old Bering Sea decoration, 37 inches deep. At a depth of 30 inches were found 12 seal noses, several of them strung together on a baleen thong. These had no doubt been preserved in accordance with religious practices connected with sealing, such as are still observed on St. Lawrence Island.

Cuts 18, 23, 24, 25, and 29.—Excavated by M. B. Chambers in 1931. These five cuts, which were all connected, were situated just to the west of the entrance to house no. 3, in a section of the midden which yielded an abundance of artifacts and interesting evidence of old house structures at the bottom.

Cut 18, which formed the NE. corner of the quadrangular space occupied by these five cuts was 6 feet 9 inches deep and was taken down in 22 levels. It yielded 363 artifacts, including many of those which are illustrated. The 28 harpoon heads and fragments were all of the older types; a fragment of a wrist guard from a depth of 12 inches has a " modern " decoration of spurred lines; three harpoon heads from depths of 48, 60, and 72 inches, although belonging to old types structurally, have the simple line decoration which I have called Punuk style 1; the others are either plain or bear an Old Bering Sea ornamentation. The following harpoon heads from cut 18 are illustrated: plate 24, figure 3 (78 in. deep), figure 17 (48 in. deep); plate 26, figure 5 (48 in.), figure 11 (48 in.), figure 12 (40 in.), figure 16 (66 in.); plate 72, figure 1 (60 in.). Other objects bearing Old Bering Sea decoration were found at the following depths: 18 inches (3) (pl. 15, fig. 4); 38 inches; 48 inches (2) (pl. 15, fig. 8, and pl. 19, fig. 5); 60 inches; 64 inches; 81 inches.

Cut 23, adjoining cut 18 on the west, was 6 by 12 feet instead of the usual 12 by 12 feet. It was taken down to a depth of 6 feet 10 inches, in 17 levels. It yielded 285 artifacts, very similar to those from cut 18. Three harpoon heads or fragments with early Punuk decoration from depths of 8 inches, and 14 inches (2) (pl. 24, fig. 21). The others are of older types and are either plain or decorated in Old Bering Sea style; those illustrated are: plate 24, figure 2 (65 in. deep), figure 4 (81 in.), figure 7 (14 in.), figure 9 (58 in.); plate 26, figure 2 (81 in.). Other Old Bering Sea objects are shown on plate 15, figure 2 (18 in.), figure 3 (72 in.) and plate 19, figure 4 (80 in.).

Cut 24, adjoining cut 18 on the south, was also 6 by 12 feet. It reached a depth of 6 feet 9 inches and was taken down in 12 levels. It yielded 187 artifacts, very similar to above. One harpoon head with early Punuk decoration from depth of 18 inches, also the object on plate 22, figure 2. Two harpoon heads and two fragments with Old Bering Sea decoration from depths of 13 inches (pl. 26, fig. 20), 18 inches, 25 inches, 54 inches (pl. 26, fig. 3). The seal-headed toggle (pl. 15, fig. 12) comes from depth of 54 inches and two other objects with Old Bering Sea decoration from depths of 64 and 81 inches.

Cut 25, which was 6 feet square, adjoins cut 24 on the west. It reached a depth of 8 feet and was taken down in 13 levels. Artifacts numbered 179. Two harpoon heads with Punuk decoration from depth of 18 inches; seven with Old Bering Sea decoration, from depths of 18 inches (2), 37 inches (pl. 26, fig. 15), 39 inches, 48 inches (pl. 19, fig. 8), 61 inches (pl. 26, fig. 17), 79 inches.

Cut 29 was a narrow strip $2\frac{1}{2}$ feet wide to the west of cuts 23 and 25. It was taken to a depth of only 3 feet, in four levels. Fifty artifacts were found, including the harpoon head shown on plate 25, figure 6, from a depth of 25 inches.

The six photographs shown in plate 10, figures 3, 4, and plate 11, figures 1-4, will afford some idea of the nature of cuts 18, 23, 24, and 25, and of the house remains found at the bottom. Plate 10, figure 3, is a view looking SE. toward the hillside, showing the four contiguous cuts at an early stage of the excavation. The deeper excavation in the left foreground is cut 18. The Eskimo, Silook, is standing in cut 24, and on the ground in front of him is a large piece of walrus hide. Beneath this were found pieces of timbers, shown at the left in plate 10, figure 4. In plate 11 are shown four views of the excavation at a later stage. Plate 11, figure 1, shows the floor stones of the house, 5 feet deep, before being completely uncovered (at left center) and to the right of these, two rows of upright timbers marking the position of the entrance passage. Plate 11, figure 2, shows a different view of the same at a later stage; the remains of the floor consisted of a stone pavement roughly circular in outline and having an E.-W. diameter of 6½ feet. The entrance passage, 2 feet wide, faced W.-SW., and seemed to have been formed of timbers laid horizontally behind upright logs; some of these remained in place behind the uprights on the south side. The floor of the passage, as indicated by a few stones and pieces of whale scapulae, was some 16 inches below the stone flooring of the house. A small whale scapula had been placed in a vertical position at the threshold and had been worn smooth in two places by the scraping of the feet, in just the same way as the whale jaw which formed the threshold of house no. 4 had been worn down. Plate 11, figure 3, is a view from another direction which shows in the foreground the stone flooring of the house and the passage leading off toward the W.-SW. Part of another floor, consisting of flat stones and scapulae may be seen to the right of the passage way; this may have been the floor of an annex to the passage. On the opposite side of the passage a small enclosure of fire-burned stones indicated a fireplace. Plate 11, figure 4, is a view of the stone house floor showing the pit near the center. It was lined with upright stones and probably covered over originally by the piece of whale scapula now fallen inward. The small winged object (pl. 59, fig. 22) is shown here *in situ* at the edge of the pit.

Cuts 21 and 26.—Excavated by M. B. Chambers in 1931. These were two contiguous cuts near the south edge of the midden, to the southwest of cuts 18, 23, 24, 25, and 29. Cut 21 was 5 feet 6 inches deep, taken down in 13 levels. Cut 26 was 4 feet 7 inches deep and was taken down in seven levels. Neither of them was rich in material, cut 21 yielding 123 artifacts and cut 26 only 38. The four harpoon heads from cut 21 are Old Bering Sea types. One of them is the small specimen shown in plate 26, figure 14, found at a depth of 24 inches.

A cache and part of the walls of another structure were found at the bottom of these two cuts. Plate 10, figure 1, shows the upright walls of the cache, at the left, and the horizontal timbers of the other wall, at the right, before either of them had been uncovered. Plate 10, figure 2, shows the same structures at a later stage, with the walls and floor of the cache, at the left, completely revealed. The cache walls had been formed of upright whale jaws and timbers and one whale skull. The floor was of flat stones covered with walrus hide, above which were several whale scapulae. The horizontal timbers at the right were probably part of a house wall. Three superimposed logs were visible, also several bone and wooden stakes that held them in place and one large upright timber that had evidently been a roof support.

Cut 27.—Excavated by M. B. Chambers in 1931. Near the center of the midden, overlapping the SE. corner of cut 19; 4 feet 4 inches deep; taken down in 11 levels; bottom not reached. This cut revealed the remains of a rectangular structure, either a cache or a small house with four corner posts and walls of horizontal timbers. Plate 7, figure 1, looking northwest, with cut 19 in the background, shows the projecting ends of three of the corner posts, that in the upper right corner being a whale jaw, the others logs; at the center may be seen a hollow whale vertebra, probably a ventilator. Plate 7, figure 2, is a view from the same point taken later when the wall timbers were beginning to appear. Plate 7, figure 3, is a view of the cut looking in the opposite direction, southeast, with cut 19 in the foreground. The four corner posts are all visible, one of them, in the foreground, with a section of wall abutting (the post and wall timbers are lashed together to prevent them from falling as the earth was removed from around them). The timbers behind the man may also have been part of the wall. From this cut came 270 artifacts. In contrast to cut 19, there were more Old Bering Sea than Punuk pieces. The latter is represented by a fragmentary wrist guard from a depth of 9 inches (pl. 22, fig. 10) and a harpoon head, 16 inches deep (pl. 28, fig. 20); the Old Bering Sea pieces come from the following depths: 29 inches (pl. 24, fig. 12); 32 inches; 38 inches.

HOUSES AT MIYOWAGH

The house remains mentioned above, which were found at or near the base of the midden at a number of places, were too poorly preserved to afford any clear idea as to their exact size, shape, and manner of construction. However, fragmentary though the evidence was, it indicated that the earliest houses at Miyowagh, like those at the Hillside site, had stone floors, a narrow entrance passage at a lower level than the house floor, and walls built of horizontal, superimposed timbers. Fortunately, two other house ruins were found, which provide a much better although by no means a wholly satisfactory basis for reconstructing the house types of the Old Bering Sea and early Punuk periods. These are the two houses, nos. 3 and 4, which, as mentioned above, were found in cut 9 and in the area immediately to the south. Although the excavation of cut 9 was begun on August 1 and continued into October, the major part of the work on the two houses, nos. 3 and 4, was conducted by J. A. Ford during my absence.

Mr. Ford's careful excavations not only revealed the outlines and essential structural features of the houses themselves but also brought out the important point of their mutual relationship, as described below.

House no. 3.—In plates 8 and 9 are shown a number of views of houses no. 3 and 4, both of which were originally included in the excavation which was begun as cut 9. They are also shown in text figure 11. The larger house, no. 3, faced NW. Plate 8, figure 3, looking NW., shows the exposed stone floor, the remnants of walls and the roof timbers of the entrance passage after the superimposed débris had been cleared away. The outer end of the passage had been enlarged to form a small antechamber 11 feet long by 6½ feet wide. This antechamber was roughly oval in outline, with a stone floor, and walls made of whale skulls, stones, timbers, and smaller bones. The roof was formed of timbers placed transversely across two whale jaws which extended NW.-SE. The inner (SE.) wall consisted principally of a small whale skull which had been placed base downward on cross timbers beneath which the occupants had to crawl to enter the passageway leading to the house.

The entrance passage proper was 5 feet wide and 16 feet 3 inches long and had a stone floor. The walls were made of stones and whale bones—principally jaws and scapulae—with an occasional walrus skull. The roof was of timber, consisting first of three transverse beams, of about 10 inches diameter, which spanned the passage at 4-foot intervals; and over these a layer of smaller logs averaging 6 inches in diameter, laid lengthwise. There were two series of these small horizontal timbers, one extending for 12 feet from the antechamber toward the SE., with their ends resting on the third transverse beam; the other only 4 feet long, with ends resting on the same beam and abutting the ends of the longer logs. The SE. ends of the 4-foot timbers rested on two cross beams which formed the inner end of the passage (pl. 8, fig. 4); just beyond were laid a few additional timbers and a whale jaw, with an opening between, through which the occupant would emerge as he left the passage and entered the house. Remains of two roof supports were found at the entrance, one the upright whale jaw visible in plate 8, figures 3 and 4, and the other a small log on the opposite side. In front of these, embedded in the floor, was a 5-foot section of a large whale jaw, which formed the threshold. The roof of the entrance passage had fallen almost to the floor, only 6 inches to 1 foot of heavy sand and gravel lying between the fallen timbers and the floor stones. From the positions of the broken off ends of the transverse roof beams it could be seen that originally the roof sloped downward toward the house,

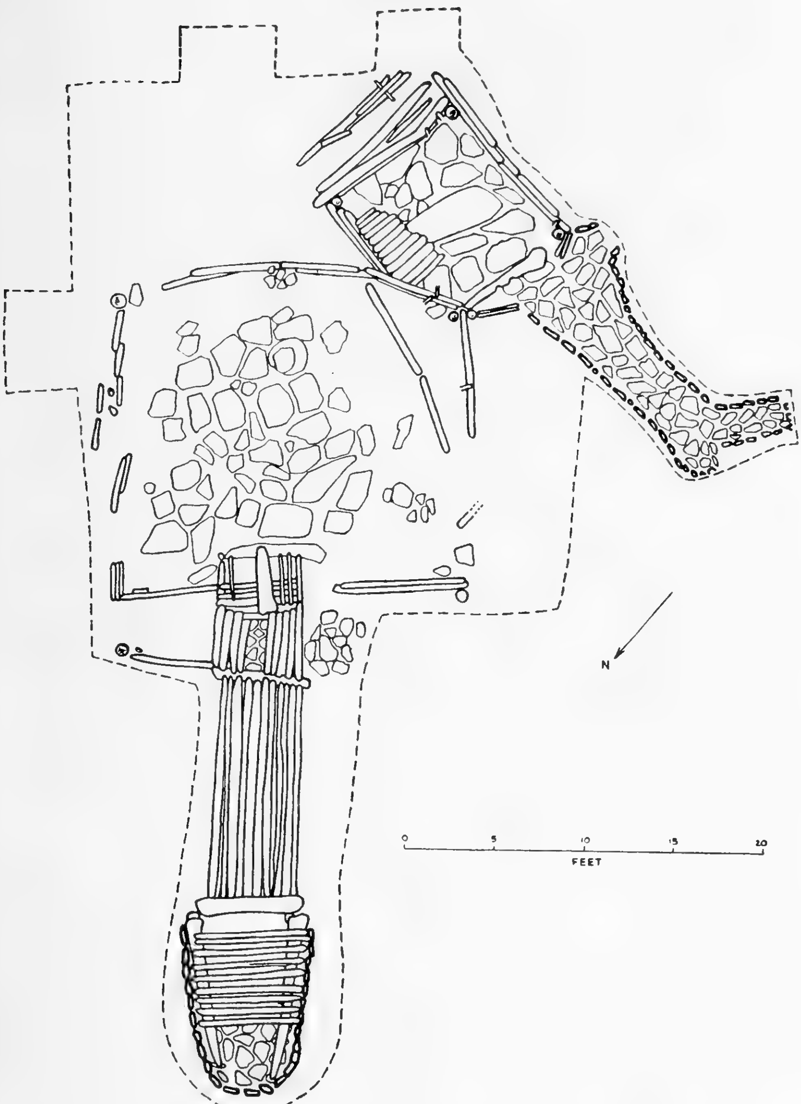

FIG. 11.—Ground plan of houses nos. 3 and 4, Miyowagh, showing remaining timbers.

from a height of about 6 feet at the point of junction with the antechamber to 4 feet at the SE. end where it entered the house. Above the original level of the roof, except at the extreme NW. end, was a layer of soil 30 to 50 inches thick. The floor of the entrance passage was about 16 inches lower than the floor of the inner room.

The dimensions of the house or inner room were 18 feet 6 inches NW.-SE. and 21 feet 2 inches NE.-SW. Unfortunately we were unable to obtain any evidence as to the nature of the roof which covered the inner room. Timbers and whale bones were found in the débris overlying the floor but in such disorder that it was impossible to say whether or not they had formed part of the roof. The same was true of the upper part of the walls, although enough remained to show that at least the lower part had been formed of horizontal timbers laid one above the other, as in the case of house no. 2 at the Hillside site. The largest number of superimposed logs was four, at the north corner to the right of the entrance (see pl. 8, fig. 3). Five feet beyond the north corner was the remnant of an upright timber (in front of man standing, pl. 8, fig. 3), from which two horizontal timbers extended to the entrance, but it was not clear whether the small rectangular space thus formed had any real connection with the house. Of the NW. wall four logs remained, two to the left and two to the right of the entrance. At the west corner back of the two wall timbers, was the broken off section of a large upright wall support. Along the NE. side only scattered remnants of horizontal wall timbers were found, extending to a large upright timber, a corner roof support, at the east corner. The opposite, or SW. wall, was likewise much demolished, although enough single logs remained to show the outline. Across the south corner were two logs laid end to end, the purpose of which was not clear. Within the triangle thus formed were two small parallel logs, 30 inches apart, just below the floor level. Stuck into the ground along both sides of these two logs were a dozen or more small wooden stakes, no doubt for the purpose of holding in place additional logs which originally lay above them. These parallel logs might be interpreted as the remnants of an entrance to an earlier house which may have occupied the space back of (to the SE. of) house no. 3. In this area, which was included in cut 9 a, we found a confused mass of fallen timbers, stones, and bones which seemed to be the remains of a house or structure, the nature of which we were unable to determine. The remains of the rear or SE. wall of house no. 3 were somewhat better preserved than those of the two side walls (pl. 8, fig. 2, in front of the man at left). Beginning at the east corner the wall remnant consisted of a whale jaw resting on one small log and overlaid by another; just inside was a pile of four stones, the function of which is unknown. Continuing from these were two more logs, one above the other, followed by two similar logs extending to the south corner, braced on the inside by a wooden stake. The last mentioned logs are of particular interest in that they were laid directly over the fallen timbers of another and earlier house (no. 4), which is at the right in plate 8, figure 2, in the immediate foreground in plate 8, figure 3, and plate 9, figure 1, and in the background in plate 9, figure 2.

The central part of the floor of house no. 3 was covered with large flat stones, but along the walls the floor was of earth except for an occasional stone slab. Four feet from the entrance was found a small pit or cache between the floor stones. It was roughly triangular in outline, 2 feet long by 1 foot wide, and was covered by a piece of whale scapula. It was $3\frac{1}{2}$ feet deep and the sides were lined with stones and whale and walrus bones. The contents were loose earth and gravel with little refuse. Five artifacts were found in the cache: a strip of baleen $11\frac{1}{2}$ inches long by $1\frac{1}{4}$ inches wide; an ivory pick; bone snow knife (pl. 79, fig. 5); bone awl; and a broken ivory box handle.

The material found on and above the floor of house no. 3 was noteworthy in two respects: (1) the bone and ivory, particularly the latter, was very dark in color, ranging from a deep brown to almost black; it was also brittle and poorly preserved; (2) every harpoon head and decorated object belonged to the early Punuk stage, not one example of Old Bering Sea art being found. This was in striking contrast to the adjoining areas where, except for a few Punuk pieces in the upper levels, only Old Bering Sea art was found. The following harpoon heads from cut 9 are illustrated: plate 24, figure 10 (36 in. deep) and figure 23 (24 in.); plate 26, figure 7 (48 in.); plate 28, figure 11 (12 in.) and figure 18 (24 in.). It is evident, therefore, that house no. 3 dates from the early Punuk period. It was probably one of the last houses occupied in the SE. section, which no doubt accounts for the fact that before excavation, it appeared as the deepest and most prominent pit of any on the midden proper.

House no. 4.—As stated above, an interesting case of superposition was found at the back of house no. 3, the south corner of this house having been built over the fallen timbers of an earlier house (no. 4). The latter was a smaller, square structure, 9 feet 6 inches E.-W. by 9 feet 7 inches N.-S. (text fig. 11). It had a stone floor which was 1 foot lower than that of the larger house and a long curving entrance passage which faced toward the west. Plate 8, figures 2 and 3, and plate 9, figures 1 and 2, show the relationship of the two houses.

The remains of the rear or east wall of house no. 4 consisted of two whale jaws and two small logs laid horizontally behind two upright corner roof supports (pl. 8, figs. 1, 2, at right center, and pl. 9, figs. 4, 5). The larger whale jaw was cracked so that it was somewhat bowed inward; it rested on one of the logs, and both were propped up with a small wooden post and a walrus penis bone. The upper whale jaw had slipped from its original position and lay about a foot to the rear and just a little above the lower (pl. 9, fig. 4). Between the two lay the second small log. Three feet back and about one foot above the whale jaws was the remnant of another wall section or perhaps of the same wall. It consisted of four pieces of logs and a fifth fragment superimposed, with a stake wedged in between.

The south wall (pl. 9, fig. 2, in background) consisted of a tier of horizontal timbers and a piece of whale jaw, the ends extending 2 feet beyond the SE. corner post. The wall was braced on the inside by wooden stakes and a walrus penis bone. Plate 9, figure 4 (extreme lower right corner), shows the outside of the wall at the SE. corner, consisting of three superimposed logs, just behind the corner post. (The post is shown wrapped with string to keep it from disintegrating.) At the SW. corner was another large upright corner post.

The north wall consisted of three superimposed logs, the back ends of which are visible at the right foreground, plate 8, figure 3, behind the cord-wrapped NE. corner post. The end of one of the logs projected 8 inches into house no. 3, at a level just below the floor. Above the wall timbers of house no. 4 and partly beneath those of the larger house, no. 3, lay a row of small timbers which had fallen inward from a vertical position. They could hardly have been part of a fallen roof, for the outer ends were resting directly on the uppermost of the three wall timbers, and the latter alone would not have been high enough to have constituted the entire wall. More likely they were supplementary wall timbers, which had been set into the ground, either upright or leaning slightly inward, just behind the horizontals which formed the base of the wall. Twelve of these fallen timbers remain, but there were evidently others, extending to the NW. corner, which had been broken into and removed in the construction of the later house, no. 3. Further and unmistakable evidence of the superposition at this point is afforded by the two stakes which had been driven into the ground to help support the rear wall of the later house. Plate 8, figure 2, shows the stake (at the left center) placed against the inside of the wall of the later house, and just opposite it the similar stake which had been driven into the gravel overlying the fallen walls of the earlier house. In plate 9, figure 1, the same stake is visible from another angle, still resting on the pillar of gravel which was left in place so as to show this detail. In the disturbed NW. corner we were unable to find a roof support such as had been placed at the three other corners.

Of the front or west wall nothing remained save the threshold, a whale jaw (pl. 9, fig. 3, in foreground) which extended from the NW. corner to within 20 inches of the post at the SW. corner. It was laid on edge and projected about 6 inches above the stone floor. Two deep, smoothed notches had been cut into the somewhat sharp upper edge of the bone, over which the occupants crawled as they entered the house.

The entrance passage was traced out and excavated for a distance of 18 feet, beyond which point we were unable to go because of the lateness of the season and the frozen ground. The floor of the passage was of stone slabs (pl. 9, fig. 3), those just below the whale jaw at the entrance being 15 inches lower than the floor of the house; from this point outward the passage floor descended very gradually until about midway of its length it was 22 inches below the floor level of the house. The walls of the passage were formed of stones, most of them long slabs set upright; some were braced with walrus penis bones and tusks. The roof of the passage, like that of house no. 3, had been constructed of logs, first a series of transverse beams spaced at intervals of 3 to 4 feet and over these a covering layer of longer timbers running lengthwise. Two wooden uprights placed in front of the whale jaw threshold served as roof supports for the inner end of the passage. There were three other upright timbers set into the walls of the passage which helped to carry the superstructure of the roof. Most of the transverse roof beams, however, rested on the upright stone slabs except at one place, where the ends of two of them rested on two of the longer lengthwise pieces. At the inner end the entrance passage was 5 feet wide. Beyond this, at the center, it narrowed to a width of about 3 feet; then, at a distance of 12 feet, it turned rather sharply to the left, making a bulge or recess as it turned. Beyond this point the passage narrowed to a width of 27 inches. How much further it extended we were unable to determine, for the excavation did not reach this stage until October, and it was impossible to remove both the 5 feet of undisturbed frozen soil above the passage floor and the additional 4 feet or so of similar material, now also frozen, which we had thrown out. For the same reason the wall was not traced out entirely at two other places—the recess where the passage turned to the left and the enlargement at the inner end.

No artifacts of any kind were found on the floor of house no. 4 and few in the refuse immediately above. A badly damaged human skull and incomplete skeleton were found resting on the largest of the floor stones, at about the center of the house. Another skull, with the lower jaw and most of the face missing, was found on the floor of the entrance passage 46 inches from the SW. corner of the house.

House no. 5.—Of the third house excavated at Miyowagh, nothing remained except some of the floor and wall stones and an imperfectly preserved passage way which faced W.-NW. (text fig. 12). The dimensions of this house were 22 feet 4 inches long (in the direction of the passage) by 19 feet 8 inches wide; the passage was 16 feet long by 3 feet wide, expanding at the front end to a width of 5 feet 8 inches. The walls of the passage had been formed of upright slabs, and the same was true of the house walls to judge from a few slabs which remained in place. Unlike the entrances just described, the floor of this one was at the same level as that of the house. No timbers or bones were found, nor any artifacts. Since the house was located at the north edge of the midden, which section was found to be later than the opposite side, this house was probably one of the latest to be occupied at Miyowagh. The floor was 2 to 3 feet below the surface. There was no evidence as to how the roof may have been built; possibly it was of skin.

DECORATED OBJECTS, OLD BERING SEA, FROM MIYOWAGH

The decorated objects from Miyowagh included no clear examples of what has been described above as Old Bering Sea style 1. The greater number of them fall into the more inclusive style 2, the principal design elements of which are shown in text figure 15; others fall into what I have tentatively assumed to be the still later Old Bering Sea style 3, the principal characteristic of which is the predominance of paired " eyes." Stratigraphic evidence of the sequence of the styles is less striking than at the Hillside site, where five of the eight objects decorated in style 1 came from beneath the floor stones of the two houses. Stylistic changes along the lines indicated undoubtedly occurred at Miyowagh but the evidence is less direct, as indeed might be expected in view of the fact that there is no sharp line of demarcation between styles 2 and 3, the latter being only a modification and in a sense a simplification of the more variable style 2. The distribution of the various styles of decoration is shown in table 1 (p. 202).

On some of the Miyowagh objects there appear new design elements and combinations, some of them apparently quite old, which add to

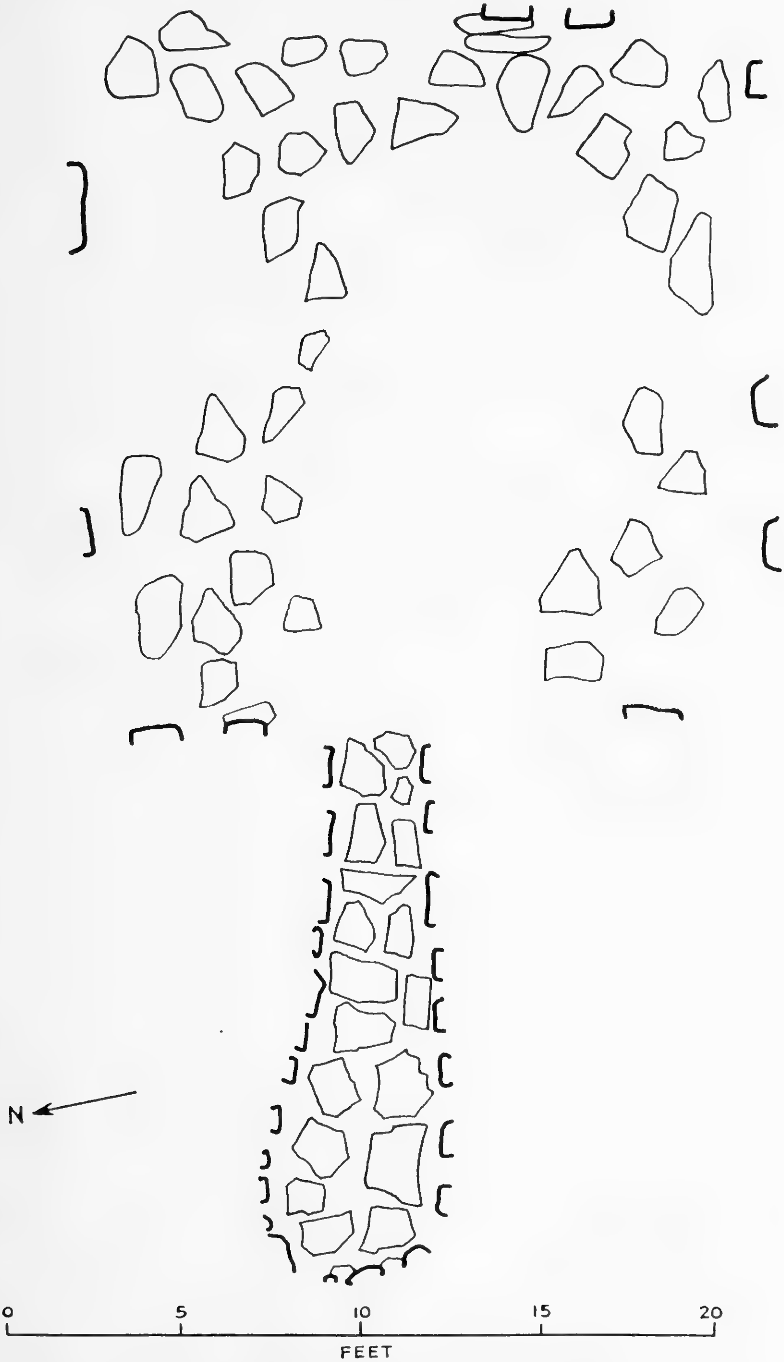

FIG. 12.—Plan of house no. 5, Miyowagh.

the richness and diversity of this old northern art. These objects, which are listed in table 1 under the heading "Old Bering Sea art, style indeterminable", will be considered first.

The flat ivory object shown in plate 15, figure 1, comes from cut 19, at a depth of 79 inches. The tapering ends, now broken, were originally perforated, suggesting that the object was worn suspended as an ornament of some kind. Decoration consists of pairs of curving lines forming bands with single or double rows of dots in the intervening spaces. At the center are two opposed arcs formed in the same manner, one attached to the upper border, one to the lower. There is also a vertical elliptical figure, rather crudely executed, containing at the center a square formed of dotted lines. Dotted triangles, some incomplete, occupy the triangular spaces above and below, and appropriately shaped dotted figures also fill in the ovoid and hourglass-shaped panels to the right and left respectively, of the center. This particular

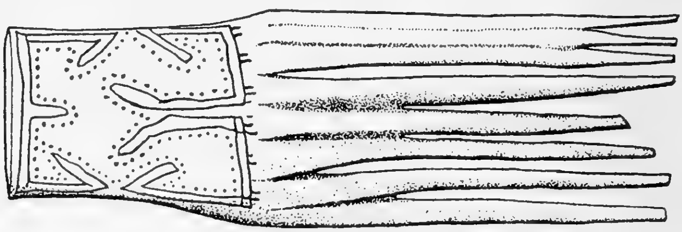

FIG. 13.—Bone comb from Kurile Islands (after Baba, 1934).

combination of pairs of curving lines bordered by rows of dots has not been observed previously in Old Bering Sea art, although the elements themselves are common enough. A rather striking parallel, considering that it comes from beyond the Eskimo territory, is provided by a bone comb recently described from the Kurile Islands, (Baba, 1934, pl. 1, fig. 3), a sketch of which is shown in text figure 13.

The broken adz handle shown in plate 17, figure 3, has an arrangement of curving bands and dotted lines very similar to that of plate 15, figure 1. This specimen was purchased from an Eskimo who had dug it up at Miyowagh. The framework of the design consists of converging rows of slightly curving parallel lines. The center line, which is deeply incised, is flanked on either side by a more lightly incised line and a row of closely spaced dots. Several small round pits occupy some of the free spaces, and on the upper edge, in high relief, is a realistically carved human head. The combination of lines and dots is characteristically Old Bering Sea, but the small round pits are more typical of the early Punuk stage.

The function of the small perforated ivory object shown in plate 15, figure 9, is uncertain; the smaller end has been roughened, probably for the purpose of holding a lashing. This object was found in the upper part of cut 19 (depth 17 inches) accompanied by harpoon heads of early Punuk type. The ornamentation, however, is definitely Old Bering Sea in conception even though the design is unique. It consists of a double line which runs along the edges and rises to two sharp prongs and a rounded projection at the upper end, an oval central figure, and two small detached crescents—all bordered by delicate dotted lines.

The design on the broken brow band shown in plate 15, figure 11 (cut 27, depth 42 in.), is another that is new to the Old Bering Sea complex. Rising from a base line are three equidistant triangular figures with incurving sides and hatchured basal angles. In the curving spaces between and beyond are four "boat-shaped" figures, the two outer ones with spurs attached to the upper line, the two inner ones with short cross lines between. In its conception the design as

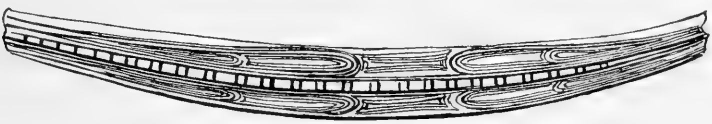

Fig. 14.—Ivory pail handle with Old Bering Sea decoration, Miyowagh.

a whole is similar to that on another fragmentary brow band illustrated in plate 58, figure 12.

Plate 19, figure 1, is an ivory handle, probably for a baleen pail, from cut 19, depth 51 inches. The ornamentation, although simple, is unusual; it is the same on both sides. The long row of slanting spurs, with one upright spur at the center is similar to the end designs on the scraper shown in plate 13, figure 8. Paralleling this spurred line is a dotted line which also follows the indentations made for finger grips. Along the upper, beveled edge is a long row of inward-pointing straight spurs, facing a similar row from the other side.

Text figure 14, from cut 9 a, 18 inches deep, is a drawing of another pail handle, which is decorated in a somewhat unusual fashion. Down the center is a long narrow panel containing short cross lines arranged in pairs. To either side of this is a curvilinear ornamentation comprising three elements: (1) at the ends four extremely attenuated petaloid figures composed of concentric lines; (2) continuing from these, four other figures, similarly formed but with concave outer ends, and (3) at the center two narrow rectilinear panels with concave ends.

Plate 19, figure 5, is a small, flat ivory object of unknown use, evidently an ornament. It comes from cut 18, depth 48 inches. The upper, slightly convex surface bears a simple, graceful design, which, though typically Old Bering Sea in spirit, contains few of the elements usually associated with this style. A pleasing bilateral symmetry is produced through the harmonious arrangement of three closely spaced petaloid figures around a deep V-shaped depression, and at either end a curving panel enclosing two ovoid figures, each of which has at the center a pair of oblique, deeply incised lines bordered by more faintly incised lines.

The small fragment, plate 15, figure 2 (cut 23, depth 18 in.), is decorated in a somewhat similar style: angular spaces outlined by double lines and bordered by faintly incised broken lines; at the end is a "ladder" design—a pair of horizontal lines between which are numerous closely spaced cross lines.

The ivory fat scraper shown in plate 17, figure 2, from cut 10, depth 54 inches, provides an interesting example of the possibility of individual expression in the use of a conventional design—in this case of the bilobed figure, suggestive of the flattened-out head of a fish, which is often seen in Old Bering Sea art. One of these "heads" is visible on the harpoon socket piece shown in plate 13, figure 1 (the second "head" from the top, on the right side); other examples will be described below. In the present specimen the two bilobed figures lack the customary "eyes" and the slightly everted "snout" in low relief, which are usually responsible for the zoomorphic appearance. Instead, they contain small crescents and curving lines and "ladder" figures, some of which are so arranged as to form an inner design similar to the enclosing one. These two opposed bilobed elements are now brought together in a most skillful manner by means of a centrally placed quadrangular figure with incurving sides. The ends of this central figure, formed of a series of concentric curves, appear at first glance as continuations of the bilobed figures themselves, the effect of which is the blending of the three independent elements into a graceful, compact, harmonious design.

The ivory objects illustrated in plate 15, figures 3-6 and 10, are decorated in what I have called Old Bering Sea style 2. Comparable examples from the Hillside site have already been described (pl. 13, figs. 1-3, 6; pl. 23, figs. 1, 2, 4, 9, 10, 14). The stratigraphic evidence obtained at that site, although less conclusive than one might wish, seemed clearly to indicate that style 2 was later than style 1, an interpretation which finds further corroboration in the fact that style 1 is absent at Miyowagh. As pointed out previously, there are marked stylistic differences between the two, even though certain elements are possessed in common. Style 1 was characterized by a relative preponderance of straight, radiating lines, short detached lines and prominent spurs; concentric circles were also used, but these did little to relieve the general appearance of diffuseness. Style 2, on the other hand, makes effective use of curving lines, and these, together with circles, dotted lines, and independent design elements of various kinds, are combined to form graceful, harmonious patterns of rare beauty. The principal motives and design elements of style 2 are illustrated in text figure 15.

Plate 15, figure 3, is a flat ivory object, evidently an ornament, from cut 23, depth 72 inches. Two slots on the under side show that it was attached to some flat surface. This is one of the few instances in which the geometric elements of Old Bering Sea art have been so arranged as to produce a clearly recognizable, almost realistic animal form. The exposed teeth, particularly the long, sharp canines, are indicative of a carnivore, an appearance which is further accentuated by having the nose carved in relief with a pit at the end for the nostril. The eye is represented by a nucleated, concentric circle enclosed between two pairs of lines which come together just below a deep round pit set in an elevation representing the ear. From this point back, the ornamentation follows the usual course in being essentially geometric, although, as is so often the case, the two elevated "eyes" near the edges are so placed in relation to curving panels as to suggest the idea of a pair of animal heads. If viewed with the "snout" inclined upward, these are suggestive of a fish or mammal; if downward, of a bird. The impression of a bird's head is heightened by having the "beak" divided and by having the "eye" set cometlike between diverging lines which give it a decidedly avian appearance. An unusual detail is the backward continuation of the faint dotted lines that enclose the circles and their appended spurs. These two "heads" are outlined by two deeply incised lines, widely separated at either end, close together at the center. At the front they enclose an oval panel formed of concentric lines, spurred along the outer periphery, and containing in the center an elevated nucleated circle with streaming lines attached. This filler design serves as an effective balance between the two curving side panels, or "heads", and the realistic mammal head at the end. Similar oval panels, it will be recalled, were present on an elaborately decorated gorget found at the Hillside site (pl. 13, fig. 2). At the back the composition ends with a panel of triangular outline with rounded apex enclosing a small nucleated circle and a V-shaped figure set between two long oblique spurs. The

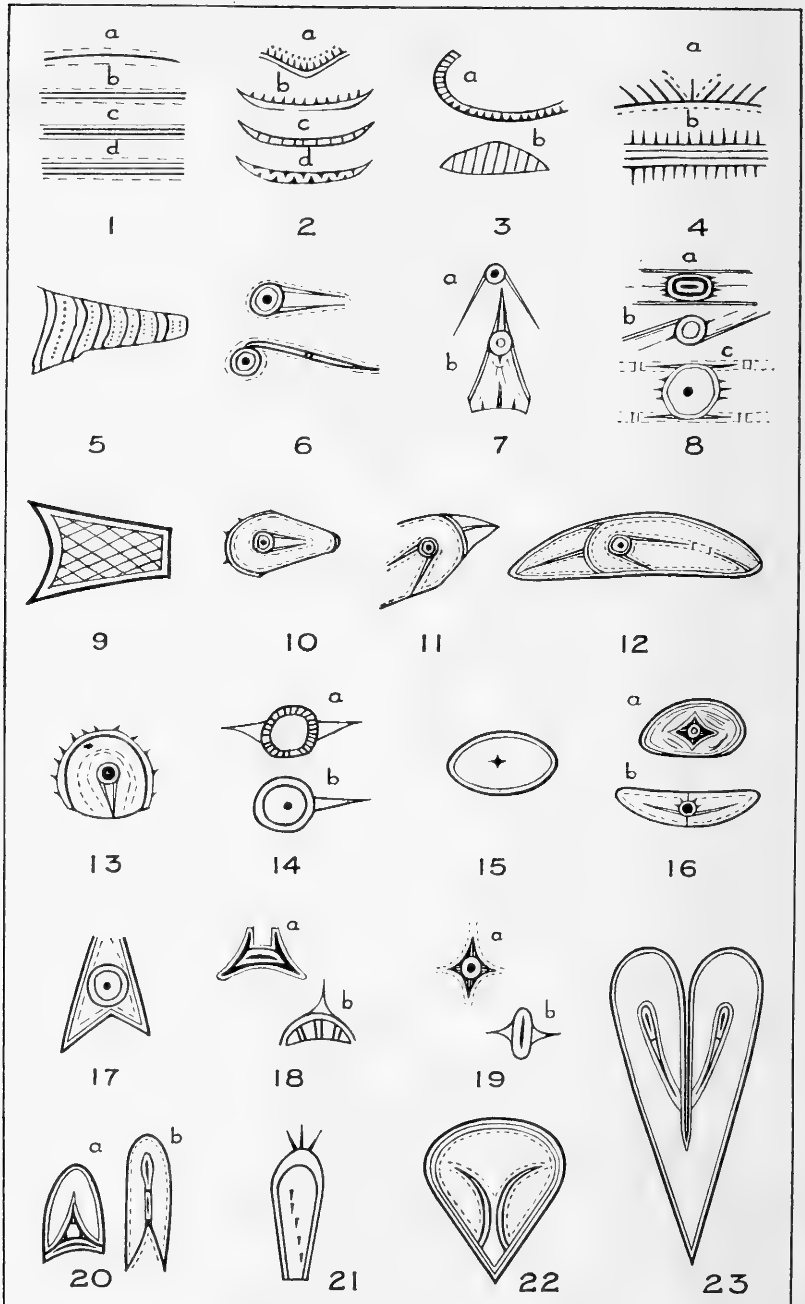

FIG. 15.—Principal decorative motives of Old Bering Sea style 2.

pits around which the circles are inscribed are slightly more than 3 mm deep, and each of them, except the one at the rear, is placed on a rounded elevation. The two larger holes extend through to the under side, emerging at the openings formed by the two slots.

Plate 15, figure 4, is a small pendant or toggle with a slotted base from cut 18, depth 18 inches. Decoration is restricted to a series of lines around the lower border: first a pair of parallel lines with cross lines at regular intervals forming narrow rectangular spaces, each with a single straight line at the center; rising from this base line at either end is a curving line, terminating in a sharp tip at the center; a broken line follows the lower border of the opening at the top.

Plate 15, figure 5, is the lower end of a harpoon head from cut 3, depth 54 inches. The broken edges are smoothed and worn as if by constant handling, suggesting that it was preserved, perhaps as an amulet, long after it had been broken and discarded. The ornamentation was applied with more than ordinary skill. The design centers around two figures placed on either side of the sunken pit where the lashing slots emerge; one of these is ovoid in shape, with a small four pointed star at the slightly raised center; the other is an oval panel with a straight base from which rises a small triangular figure with incurving sides, a design similar to that observed on the haunch of the ivory polar bear from the Hillside site (pl. 13, fig. 3).

The button-shaped ivory ornament shown on plate 15, figure 6, was found in cut 19, at a depth of 63 inches. The base is slotted in the manner of plate 15, figures 3 and 4, and a central perforation extends through to the slot from the upper side. By cutting out four triangular segments the remaining central portion was given the appearance of a Maltese cross. Each of the four arms is ornamented by bordering lines, continuous and broken, inclosing at the center a nucleated concentric circle.

Plate 15, figure 10, is a small hook which appears to have been readapted from some other implement. It comes from the surface layer of cut 19 in the Punuk section of the midden and should probably be regarded as a relic or an heirloom. At the lower end are two small circles with appended lines, placed at the center of oval panels, and on the upper end is a similar panel enclosing a circle (partly cut through by the hole) from which two pairs of appended lines descend obliquely to the right. The design is completed by the usual broken and continuous lines.

In plate 17, figure 1, is shown a fragmentary fat scraper from cut 9 a, depth 50 inches, which is decorated in a style difficult to classify exactly. Despite the prominence of the circles, which are suggestive of style 3, the design as a whole should probably be classed as style 2. The execution is not particularly good and is carried out with more of a flourish than is customary. The design differs from others of comparable complexity in that the component elements are enclosed in a single field. The most prominent part of the design—the lower, as shown—takes the form of a large bilobed figure with the characteristic upcurving end which is usually responsible for the animal-like appearance. In the present instance, however, the filler elements seem to carry no further implication of zoomorphism. The pair of large concentric circles in the two lobes are placed too far back to resemble " eyes ", and the three other circles toward the end are likewise inconsistent with such an interpretation. To the uppermost pair of circles is attached a long single spur, or V-shaped figure, pointing obliquely downward. The two lower circles are each formed of two lines with the space between filled with numerous cross lines; these circles have a pair of opposite spurs attached and they differ from the two circles above in the further particular of having no dot or " nucleus " at the center. Between the two lower circles is another, which is nucleated and concentric, with two backward-pointing, hachured spurs attached. A series of five parallel lines, the center one more deeply incised than the others, begins at the lower end of one of the uppermost circles, and curving downward, continues up to join the opposite circle. At the lower end of the design is an oval figure flanked by hachured triangles, so opposed as to appear hourglass-shaped. The upper borders of the two lobes are formed of rather carelessly made double lines with cross lines or spurs in between. Where the cross lines are relatively uniform as to length and breadth, they produce a curving " ladder " design; where they are shorter and thicker at one end, they produce only the effect of a " toothed " or spurred line. It is such a design—a double line, part of which is spurred and part ladderlike—that encloses an oval panel, the long tapering end of which extends down between the two lobes of the larger figure. At the center of this oval panel is another prominent concentric circle (the sixth) with two large V-shaped spurs attached.

In plate 16 are shown three views, drawings, of one of the most splendid examples of Old Bering Sea art thus far found. It comes from cut 16, depth 30 inches. The function of the object is uncertain; the hole at the end was no doubt for a suspension thong, and the two broad, smoothed notches on the sides seem clearly designed as finger grips; the hollow, bifurcated end is suggestive of a scraper of some kind—perhaps for removing the fat from small intestines—but if so, it is a type not previously known. The general conception of the design, the harmonious relationship of carefully selected elements, mark the work as that of an assured artist. The esthetic effect of a naturally pleasing composition is heightened by a virtuosity of execution which makes this object stand out as one of the finest accomplishments of Old Bering Sea art. At the perforated end are two opposed pairs of "animal heads" practically identical with those on the ivory object previously described (pl. 15, fig. 3). The space between the open "jaws" is covered by a series of deeply incised lines, broken lines, circles, and spurs; at the center is a small elevated, nucleated circle with four spurs attached which give it the appearance of a four-pointed star. Between the constricted finger grips is another circle, with three spurs attached. From this point on the ornamentation is somewhat attenuated, consisting of bold curving panels which follow the outline of the curving bifurcated end. The under surface, although unetched, is divided into panels by a continuation of the deeply incised bordering lines from the upper side.

Additional examples of Old Bering Sea style 2 may be seen on a number of harpoon heads, such as plate 24, figures 1, 5, 7, 11-13, 17, 18; and plate 26, figure 17. The ornamentation in plate 24, figure 1 (cut 7, depth 75 in.) centers around a pair of large concentric circles near the center and a pair of smaller circles between converging lines above and below the two line holes; all of the circles are flat and have short spurs attached. Plate 24, figures 5, 7, and 11 (from cut 9, depth 24 in.; cut 23, 14 in.; cut 7, 92 in.) have parallel rows of continuous and broken lines, some of which form curving panels; circles are absent. Plate 24, figures 12 and 13 (cut 27, depth 29 in. and cut 7, 96 in.) are somewhat more elaborately ornamented. In both cases the surface is divided into well defined panels; in figure 12 effective use is made of very small circles and long lines or spurs bordered by lightly incised broken lines; figure 13 has two side panels resembling animal heads but lacking the pair of "eyes" usually found on these; between the line hole and blade slit is a rectangular panel containing cross-hatched lines, one of the rarer Old Bering Sea designs. Plate 24, figures 17 and 18 (cut 18, depth 48 in., and cut 9 a, depth 36 in.) might be considered as belonging to style 3, were it not that the opposed "eyes" are subordinated to a rather profuse linear ornamentation. It is of interest to observe that traces of red pigment are visible in the lines on both specimens.

As explained above, "Old Bering Sea style 3" is the somewhat arbitrary designation given to that style of ornamentation which is based primarily on the use of elevated concentric circles or ellipses, usually arranged in such a manner as to suggest the eyes of an animal. A typical example is the small ivory object from cut 18, depth 48 inches, shown in plate 15, figure 8. The ornamentation on both sides centers around a pair of raised, concentric ellipses, which combined with curving lines at the rounded tip, produce a strong impression of an animal head. Small plugs of baleen with the centers hollowed out are placed in the "eyes" and in the smaller circle below.

The harpoon head fragment shown in plate 19, figure 7 (cut 9, depth 20 in.) is decorated in a similar manner, although a certain variety is afforded by a judicious use of bordering lines, spurs, and a small graceful petaloid figure.

The elaborately decorated pail handle shown in plate 19, figure 2, from cut 7, depth 67 inches, is a good example of what can be accomplished by an effective grouping of concentric circles or ellipses. In this case the elevated concentric ellipses are so profusely applied as to prevent any close resemblance to an animal's head, even though the individual panels enclosing the "eyes" might well represent a series of such heads. Whatever may have been the intent of the artist, the composition as a whole is more suggestive of a feather or plant design than anything else. Although repetitive in character, the design is remarkable for its beautiful flowing symmetry; repetition has served only to intensify the feeling of life and movement inherent in the graceful component elements of the design.

The ivory pail handle shown in plate 19, figure 3 (cut 15, depth 44 in.) is unique in combining a typical geometric design with a perfectly realistic animal carving. The head is that of a walrus, with one tusk broken off. It is carved in high relief and is remarkably lifelike in every detail. The accompanying incised decoration is a scrolled design made up of concentric rows of continuous and broken lines, enclosing a pair of raised ellipses. This design is the nearest approach to a true scroll that has yet been found in Old Bering Sea art. The curving lines, however, instead of being free at the ends, all come together and continue as a single line to join the opposite curve.

Another example of style 3 is the beautifully decorated harpoon socket piece (with lower end broken off) shown in plate 27, B. This specimen is owned by Capt. E. D. Jones, former Commander of the Coast Guard cutter *Northland,* who obtained it from an Eskimo at Sevunga. It probably came from the Kukuliak midden. In the two well-defined animal heads just above the center we have another of the rare examples where the artist chose to portray an actual life form by a varied arrangement of the usual geometric motives. With consummate skill the two animal heads are so blended into the composition as to avoid any feeling of disharmony. Although they form the dominant element in the decorative scheme, there is no undue emphasis or contrast to impair the effectiveness of the composition as a whole. This harmonious relationship has been consciously retained by having the eyes and inner border of the mouth made to conform exactly with the other elevated circles and curving lines. The ears are carved in low relief, the nose is higher. The opening of the oblique line hole lies at the inner angle of the jaws, and the open mouth with its long sharp teeth is shown holding the upper end of the socket piece. Behind the animal heads is a graceful bilobed figure, which with its two elevated concentric circles, has the appearance of a flattened-out fish head. Opposed to this is a somewhat similar figure enclosing circles which are set off by outward-pointing curving lines. Between the two figures are two small animal heads in low relief, featureless except for the eyes which are small drilled holes.

Style 3 was peculiarly adapted to the rounded contours of harpoon heads, and many of the finest Old Bering Sea specimens are so decorated. Several have been described previously (Mathiassen, 1929, fig. 13, *a;* fig. 14, *b:* Collins, 1929, pl. 1). A single example was found at the Hillside site (pl. 23, fig. 13); others from Miyowagh are shown in plate 24, figures 14-16, and plate 26, figures 1-3, 15, 18-20. Although there may be considerable variation in details, the general pattern remains constant: pairs of elevated concentric circles or ellipses, usually with a small pit at the center, placed on either side of the line hole and often on the basal spur. As a rule the artist chose to emphasize the idea of an animal's head by having the " snout " stand out in relief, thus forming small ornamental projections or barbs along the edges. The panels enclosing these " heads " are marked off by deeply incised lines within which are more lightly incised continuous and broken lines. As decorative schemes, these " animal heads " are highly effective on both closed and open socket harpoon heads. Although they appear somewhat more standardized when applied to the closed socket heads, they definitely add to the graceful symmetry of these forms (pl. 26, figs. 18-20). They likewise appear to excellent advantage on open socket heads, where the prominent divided spur provides opportunity for interesting variation (pl. 24, figs. 14-16; pl. 26, figs. 1-3).

In plates 20 and 21 are shown five of the ivory winged objects which are so characteristic of the Old Bering Sea period. None of these Miyowagh specimens has recurved wings such as were seen on two comparable specimens from the Hillside site (pl. 12, figs. 1, 3). They are, however, very similar to the unfinished specimen from that site shown in plate 12, figure 2.

The beautifully decorated winged object shown in plate 20, figure 1, comes from cut 15, depth 28 inches. In shape and to a certain extent in decoration, it is much like one described by Gordon (1916, fig. 100). On the front, or flat, side the wings extend out at an upward angle from the wedge-shaped center; on the reverse (pl. 21, fig. 1) the wings were cut down, leaving the central part in high relief. At the base is a square socket measuring 1.3 cm across and 1.5 cm in depth. Above this socket are two round lashing holes 7 mm in diameter, drilled obliquely from the bases of the wings and meeting at about the center. The ornamentation is to be classed as style 3, in that it is based primarily on the use of circles. Real artistry has been shown in the selection and execution of an appropriate design, and the harmonious relationship of the circles and the rows of parallel and curving lines produces a bold sweeping surface ornamentation which is perfectly adapted to the flowing symmetrical contours of the object itself. The ornamentation on the reverse (pl. 21, fig. 1), while pleasing, has not this same feeling of motion. It consists of three independent design elements: a very large circle surmounting a central boss, enclosing a smaller nucleated circle and radiating lines; and two panels formed of a succession of curving lines within which are two large flat circles with the usual streamers attached. In the free spaces below and to either side of the large central circle are four smaller circles, all of them nucleated and concentric.

Plate 20, figure 2, is an unfinished object which is practically identical in general outline with the one just described. It comes from cut 7, depth 80 inches.

Plate 20, figure 4, is a poorly preserved specimen from cut 6, depth 36 inches. The raised central portion on the reverse (pl. 21, fig. 4) has small upwardly inclined wings like the two preceding specimens, but on the front or flat side the wings have the appearance of sloping downward. This impression is due in large part to the decorative treatment of the wings, the panels of which flow downward from the center in contrast to plate 20, figure 1, where the lines on the wings radiate upward, thus giving the wings the appearance of a more marked upward inclination than they actually have. The ornamentation in plate 20, figure 4, belongs to style 2, consisting of relatively complex designs composed of closely spaced straight and curving lines—continuous and broken—small nucleated concentric circles and rows of short, parallel lines. The elaborately ornamented front surface is badly cracked and eroded. On the reverse the central circle and its appended spurs enclosing a V-shaped figure is practically a counterpart of the design at the back end of the flat ivory object shown in plate 15, figure 3; furthermore, the "bird heads" with downward pointing beaks which are incised on the wings are practically identical in form and spirit with those shown in plate 15, figure 3. The basal socket on the present specimen is rectangular in shape and is 1.4 cm deep; the cylindrical lashing holes were drilled obliquely through the wings, beginning at their bases and emerging at the notches above.

The small winged object shown in plate 20, figure 3 (cut 8, depth 23 in.) differs from the others in having a raised central section on the back side which is more or less rectangular in outline with very short wings. The basal socket is oval-rectangular, and the circular lashing hole runs transversely through the raised center. The decoration on the back side (pl. 21, fig. 3) consists of several carelessly incised lines and a very schematic human figure—the body represented by a straight line, arms by two short lines and head by an oval with eyes, eyebrows, nose, and mouth indicated by dots and lines—just such a drawing as might be made by a child. The crude and carelessly incised figures on the front side also appear to be the work of a child or an amateur.

Plate 20, figure 5, is a poorly preserved specimen from cut 9 a, depth 38 inches. The raised central section on the back side differs from the others in having the wings pointed downward. The socket in the base is 2.3 cm long, 1.7 cm wide, and 1.2 cm deep. The lashing holes were drilled up from the bottoms of the wings as in plate 21, figures 1 and 3, but they stop at the center of the raised section where they meet in a deep groove. Ornamentation on this side consists of nucleated concentric circles, long, pointed spurs, and straight and curving lines, skillfully arranged with reference to the deep groove at the center.

On all of the above objects except the unfinished specimen, plate 21, figure 2, there is a shallow indentation or pit at the end of the pointed central projection. The possible significance of this feature with regard to the function of the winged objects as a group will be discussed later when the comparable forms from the Punuk sites are described.

In addition to the above there are three unfinished specimens (from cut 7, 51 in.; cut 23, 25 in.; cut 27, 16 in.) and a small decorated fragment of a wing from cut 18, depth 18 inches. There are also three toys, well made miniature replicas of the full size objects, from cut 18, 60 inches; cut 27, 46 inches; cut 5, 23 inches. These are illustrated with other toys in plate 59, figures 22, 23, 24.

Six decorated ivory needle cases from Miyowagh are shown on plate 17, figures 4-9. The ornamentation on figures 4, 8 and 9 shows up more distinctly in the drawings on plate 18. Plate 17, figures 4 and 8 (cut 9 a, 24 and 20 in. deep, respectively) are examples of Old Bering Sea style 3, the ornamentation in both cases centering around pairs of "animal heads" with prominent eyes formed of elevated concentric circles. Plate 17, figure 9 (cut 4, depth 55 in.) is decorated in an unusually delicate, graceful style. Four looped figures formed of finely incised concentric lines occupy the flattened center and enclose a long, narrow, sharp-pointed figure and three detached dots; a fourth dot has a circle inscribed around it with two short spurs attached to the periphery. The graceful symmetry of this entire central design is further enhanced by the decorative treatment applied to the projecting flanges at the center and the top.

The ivory needle case shown in plate 17, figure 6 (cut 9, depth unknown) bears an unusual decoration consisting of obliquely incised longitudinal bands each composed of three parallel lines, each pair of bands connected by a series of short, curving cross bands also formed of three lines.

Plate 17, figure 7, is a poorly preserved needle case from cut 9 a, depth 13 inches. Around one end is a band of three parallel lines, with spurs attached to the lowermost line. At the center is a similar band of four lines with spurs pointing both upward and downward, and four equidistant petaloid figures each enclosing a row of five dots and having at the top three sharp projecting spurs. Below these are four more petaloid figures, each with a short "arrow" design at the center.

The simplest of the needle cases is that shown in plate 17, figure 5, from cut 7, depth 33 inches. It has a double flange along either edge and a simple straight line decoration.

In plates 15 and 19 are shown several Old Bering Sea objects with simple ornamentation which does not fall into any of the three recognized "styles." Plate 15, figure 7 (cut 19, depth 34 in.) is an ivory plug with an oval face and blunt cylindrical tang. At the center is a deep, four-pointed figure with concave sides, cut out around a central nucleated circle—or cylinder—and outside of it four small round pits. In the central excavation is the remnant of a wooden inset.

Plate 15, figure 12 (cut 24, depth 54 in.) is probably a drill cord handle. It is similar to one from St. Michael figured by Nelson (pl. 37, fig. 15). It is formed of two seal heads facing in opposite directions; the eyes are formed of slightly projecting wooden plugs set in round pits.

Plate 19, figures 4 and 6, are two more animal figures. The first (from cut 23, depth 80 in.) is an ivory object with a deep cylindrical socket in the larger end and the smaller end carved to represent the head of a mammal with prominent teeth. Figure 6 is a poorly preserved carving of a walrus from cut 9, depth unknown. The base is slotted in the same manner as the two small bird figures from the Hillside site (pl. 13, figs. 4, 6).

From the foregoing analysis we have seen that there are three general styles of Old Bering Sea art. Style 1, which was found only at the Hillside site and under conditions which seemed to indicate that it was the earliest of the three, is also the simplest and most generalized (text figure 6 and pl. 12, figs. 11-14; pl. 13, figs. 5, 7, 8). One object from Little Diomede Island (pl. 14, fig. 5) is also in this style and three others are similar (pl. 14, figs. 3-4, 6, and text figure 8). It is essentially a linear style, being characterized by a profusion of radiating lines, long, sharp spurs and broken lines. Concentric circles and slightly curving lines were also used to a certain extent.

Style 2 is distinctly curvilinear, and stands out in rather striking contrast to style 1, even though it employs some of the same elements, such as spurs attached to lines, broken lines, and circles. The characteristic motives of style 2 are illustrated in text figure 15 and also in plate 13, figures 1-3, 6; plate 23, figures 1, 2, 4, 9, 10, 14, all from the Hillside site, and plate 15, figures 3-6, 10; plate 24, figures 1, 5, 11-13, 17, 18, etc., from Miyowagh. In addition to those illustrated there are 15 other examples of Old Bering Sea style 2, mostly fragments, from various depths at Miyowagh, as follows: cut 2, 43 inches; cut 3, 60 inches; cut 6, 26 inches; cut 9, depth unknown; cut 9 b, 22 inches; cut 10, 54 inches; cut 18, 18 and 64 inches; cut 19, 24 and 78 inches; cut 24, 18, 25, and 64 inches; cut 27, 32 and 38 inches.

The distinction between styles 2 and 3 is less sharply defined and the chronological implications less clear; however, the fact that style 2 is well represented at the Hillside site and that most of the comparable specimens from Miyowagh come from the lower levels of the midden, would seem to indicate its priority over style 3. The latter is stylistically nothing more than an adaptation of style 2 in which special emphasis is placed upon concentric circles. These circles are larger than those of style 2 and are usually, but not invariably, arranged so as to suggest the eyes of an animal. In some cases the smaller circles of style 2 also carried out the "animal head" concept, but as a rule they were not so employed. Along with the increased emphasis on, and dominance of, circles in the decorative scheme of style 3 there is also a general tendency toward simplification or subordination of the accompanying ornamentation with the result that parts of the surface are frequently left smooth and plain; this is in contrast to style 2, where the profusion of small circles, straight and curving lines, and spurs, together with the practice of filling in the intervening spaces with dotted or broken lines, is suggestive of something like an *horror vacui* on the part of the artists. While the rich and diversified ornamentation of style 2 is effective in avoiding even the slightest feeling of monotony, the smooth, flowing, and somewhat more restrained ornamentation of style 3 (e. g., plate 20, figure 1; plate 27, B) is in its way even more pleasing.

Style 3 is especially characteristic of St. Lawrence Island. A few examples are also known from Bering Strait and the Arctic coast (Jenness, 1928 a, pl. XIII, c; Mathiassen, 1929, figs. 13 a, 14 b, 15 b), so that it cannot be regarded as a strictly local development on the island. However, it is nowhere so prominent as on St. Lawrence, where it may have first appeared, as a late and specialized development from style 2.

There are seven additional examples of style 3 which have not been illustrated, all of them harpoon heads, from the following locations: cut 8, 32 inches; cut 9, depth unknown; cut 9 a, 18 inches; cut 13, 54 inches; cut 16, 37 inches; cut 25, 18 and 39 inches.

Finally, there are five specimens on which it cannot be definitely determined whether the decoration is style 2 or 3: cut 15, 60 inches; cut 18, 38 inches; cut 19, 56 inches; cut 25, 81 inches; cut 20, 12 inches.

DECORATED OBJECTS, EARLY PUNUK, FROM MIYOWAGH

We have now to consider the Punuk or intermediate style of art from Miyowagh. Punuk art is characterized by the use of straight or slightly curving lines, which in contrast to those of Old Bering Sea art, are deeply and evenly incised. It also employs perfectly round compass-made circles, and small circular pits or dots either free or placed at the ends of short lines. The resulting patterns, though graceful enough, appear rigid and mechanical as compared with the elaborate flowing designs of Old Bering Sea art. Furthermore, there is a striking difference in technique. Old Bering Sea circles are invariably somewhat irregular, having been made freehand; these and the accompanying lines could well have been made with stone tools. Punuk ornamentation, on the other hand, is clearly the product of metal tools, as may be seen from even a cursory examination of such typical examples of the art as those from Ievoghiyoq shown on plates

65 to 69. First, however, we will consider the Punuk pieces from Miyowagh, most of which, significantly enough, are somewhat less straightened in appearance than the later and more typical examples from the pure Punuk site, Ievoghiyoq. The earliest Punuk style, which we will designate as Punuk 1, may be divided into two phases. Phase 1, which is restricted to harpoon heads, makes use of lightly incised lines, straight and cleanly cut, but not very deep. Phase 2 employs the same kind of lines but in addition has short, lightly incised spurs, dots, and (rarely) freehand circles.

At Miyowagh, Punuk ornamentation was applied to harpoon heads much more frequently than to any other artifacts. Consequently, these provide the best basis for chronological determinations, not only because of their large numbers, but also because of definite and consistent changes of form which are correlated with this particular style of art. These will be discussed in some detail in the section on harpoon heads. It will be sufficient here to point out that practically all of the harpoon heads with Punuk decoration came from the northwestern part of the midden or from the upper levels of the southeastern part. One of the oldest forms of harpoon heads with this decoration is that shown in plate 24, figures 19-21. These heads, belonging to open socket type III x, represent a stage in the process of simplification which took place within this type; they differ from the earlier form (represented by pl. 24, figs. 11-18) in that they are smaller, have a less prominent basal spur, and a decoration of simple lines instead of elaborate Old Bering Sea designs. However, they have retained the graceful shape of the earlier heads, as well as the small curving barbs along the edges. Furthermore, the small rounded elevations around the line hole are clearly survivals of the Old Bering Sea "eyes" which were formed of circles or ellipses surmounting elevations that occupied the same positions. It should also be noted that the lines in figures 19, 20, and 21 follow the same paths as those more deeply incised lines which, on the Old Bering Sea heads, served to divide the surface into decorative fields. This particular style of decoration, consisting of nothing more than lines, is designated as phase 1 of Punuk style 1. Plate 24, figures 22 and 23, represent the end result of simplification within this type of harpoon head; they have lost the smooth, rounded contour and the graceful barbs of the older heads; the vestigial "eyes" are still further reduced, and the ornamentation (in fig. 23), which includes the use of light spurs, is that which is typical of phase 2 of Punuk style 1.

Exactly the same condition is observed in the next group of harpoon heads—open socket type III y—which differs from the foregoing only in having the blade slit at right angles to the line hole. The earlier examples of this type from Miyowagh (pl. 26, figs. 1-5) are large, and most of them have prominent divided basal spurs and an Old Bering Sea decoration; the later forms (pl. 26, figs. 6-10) are smaller, have basal spurs which have been reduced to a point where they are merely "irregular", and have a typical Punuk 1 decoration consisting either of lines alone (phase 1—pl. 26, fig. 6) or of lines together with short spurs and dots (phase 2—pl. 26, figs. 7-9). Plate 28, figure 23, is one of the few closed socket heads with a phase 1, style 1, decoration.

Phase 2 of Punuk style 1 comes into greater prominence with the appearance of the next group—open socket types III (a) x and III (a) y—which are the two dominant types of the early Punuk stage at Miyowagh. Examples are shown in plate 28, figures 8-17, as well as on the less common closed socket forms, such as plate 28, figures 19-22, 25-27. One of these (pl. 28, fig. 15) differs from the others in having rows of dotted lines down the sides, a feature reminiscent of Old Bering Sea art.

A typical example of phase 2 of Punuk style 1 is that incised on the ivory ulu handle shown in plate 22, figure 1. This specimen was purchased from an Eskimo who had excavated it from a depth of 3 feet. A unique feature is the circular opening at the front end for the index finger; there is also an oval depression for the thumb and on the opposite side two grooves for the fingers. The ornamentation is rather simple, consisting of single lines and dots, the latter either detached or placed at the ends of short lines. At the front end, around the finger opening, is a pair of lightly incised parallel lines and several rows of dotted lines, both of which are Old Bering Sea elements. At the back end there was a small perforation which may originally have held an ornamental link. The blade slit is 4 mm wide and 10 mm deep.

Another example of phase 2 of style 1 is the small ivory plaque or ornament shown in plate 22, figure 4, from cut 19, depth 12 inches. It is decorated with curving lines and dots and has at the center a nucleated circle which was made freehand. The lines lack the regularity and precision of those typical of later Punuk art, but they have the characteristic straight, flat bottom.

In addition to the above described examples of Punuk style 1, there are others not illustrated, but which are listed according to depth and locality in table 1.

Punuk style 2 is somewhat more diversified than style 1, and for that reason may be divided into four more or less distinct phases.

Phase 1 is a decoration restricted to harpoon heads, such as plate 28, figure 14. It is characterized by very long spurs attached to lines and is merely a later and more advanced stage of Punuk style 1, in which the spurs were shorter, as on the three harpoon heads shown in plate 28, figures 11-13. The lines and spurs are also lightly incised as in style 1.

In phases 2, 3, and 4 of style 2 the incisions are deeper and more sharply defined. Phases 3 and 4 were not present at Miyowagh; they will be described later. Phase 2 employs lines, spurs, dots (pits), and nucleated circles, the latter made with a metal bit or compasses. This phase is represented by only 10 examples at Miyowagh, all but one of them from the upper levels of the northwestern section. The ivory hand drill or reamer shown in plate 22, figure 8 (from cut 20, depth 12 in.) is a typical example of phase 2. Another is the ivory object shown on plate 22, figure 2 (from cut 24, depth 18 in.). On both of these objects the arrangement of the shorter lines and dots is that of style 1, but the mechanically made circles place them in style 2. The only harpoon heads from Miyowagh decorated in phase 2 of Punuk style 2 are the two shown in plate 28, figures 24 and 28, both of them from the surface layer of cut 20.

The other decorated objects shown on plate 22 do not fall exactly into any of the above categories. They are to be classed as "indeterminable", but since all of them, with the exception of figure 10, were purchased, they are not included in table 1, which, as previously stated, contains only those objects which we ourselves excavated.

Plate 22, figures 3 and 5, are two small ivory objects which are slotted at the base, recalling the two bird figures from the Hillside site. Figure 5 has the head carved realistically to represent an eider duck; the surface ornamentation consists of a few lines with spurs attached. In figure 3 the incised lines are applied rather carelessly; the head is grotesquely human, the body is conical in shape.

Plate 22, figure 6, is a miniature winged object of Punuk type (cf. pls. 68, 69) from cut 2, depth 20 inches. It is made from the sternum of a bird.

Plate 22, figure 7, is an ivory ornament with a flat base and a slot at the center; the upper surface is convex and bears a simple decoration of lines, spurs, and short cross lines.

The ivory wrist guard shown in plate 22, figure 10 (from cut 27, depth 9 in.) has a decoration consisting of pairs of lines with short spurs attached, which should probably be included in style 2. The bold, deeply cut lines of plate 22, figure 9, are likewise to be classed as style 2. This object, which was purchased from an Eskimo, is flat on the under side, slightly convex above, and has a slanting hole evidently made to receive a prong; the small slot at the upper, forked end is probably for suspension, suggesting that the object was used as a hook of some kind.

If we examine the distribution of the objects bearing Punuk decoration in table 1, it will be seen that by far the greater number of them (89 out of 107) come from the northwestern section of the midden, and that most of those from the southeastern section came from the upper levels. As to the relative positions of styles 1 and 2, we have also seen that practically all of the few examples of style 2 which were found at Miyowagh came from the surface layers of the northwestern section, indicating that it is the most recent of the several art styles present. The distribution of Punuk art is exactly the reverse of Old Bering Sea; the latter, it will be recalled, was the only style present at the Hillside site, while at Miyowagh it predominated at the southeastern section of the midden and at the northwestern section was found for the most part in the lower levels of the midden. The conclusion to be drawn is that the southeastern part of Miyowagh is the older, having been either in part contemporaneous with the adjoining Hillside site or established soon after its abandonment. After a considerable interval of time, the Old Bering Sea art fell into decline and was gradually replaced by the simpler Punuk art, which is now found superimposed upon it in all sections of the midden. The question now arises whether Punuk art is a direct outgrowth of the Old Bering Sea or an importation from without. If the former hypothesis is to be upheld, it will be necessary to point out intermediate stages, and in fact there are several examples which might be regarded as affording evidence of such a transition. One of these is the knife handle shown in plate 22, figure 1, on which a typical Punuk 1 decoration of lines and dots is combined with rows of faintly dotted lines, which are just as definitely Old Bering Sea. The same is true of the harpoon head shown in plate 28, figure 15, where rows of broken lines accompany a typical Punuk 1 decoration. The needle case shown in plate 17, figure 9, is another example, this time of an Old Bering Sea pattern to which have been added Punuk dots and spurs. The ivory object shown in plate 22, figure 4, has another unusual combination, a freehand circle accompanying a Punuk 1 decoration. This might in a way be considered as bridging the gap between the freehand circle of the Old Bering Sea period and the compass-made circle of the Punuk. It appears, therefore, that there was a period during the occupancy of Miyowagh when Old Bering Sea and Punuk motives were both in vogue. Probably if we had more material from just this period, the nature of the transition would be clearer, but the fact that there are so few specimens on which the two art styles are combined is in itself evidence that it was a period of no long duration. There is, of course, no reason to believe that Punuk art had its origin at this particular site. We know that it was by no means limited to St. Lawrence Island, even though it seems to have been more prominent there than elsewhere. The existence of even a few specimens such as those just described suggests the possibility that future excavations may reveal a more gradual transition between the two styles. In this connection there will be other evidence to consider, especially harpoon heads; as we shall see presently, these were undergoing constant modification during the Old Bering Sea and Punuk periods, and there is ample evidence that in this case the transition from one stage to the other was quite gradual.

HARPOON HEADS, OLD BERING SEA

Of the many ingenious devices which have enabled the Eskimo to meet the needs of their exacting environment, none is of more importance than the harpoon. Without such an effective means of capturing the sea mammals on which they so largely depend, the Eskimo could hardly have adapted themselves to a life on the Arctic coasts. Fortunately for our present purpose, the harpoon is a complex implement, which differs from one locality to another; furthermore, archeological investigations have shown that throughout the course of its history it has been undergoing constant modification. Regional variations and developmental changes may be observed in various parts of the harpoon—in the ice pick at the butt end, the bone or ivory finger rest, the socket piece, the foreshaft, but most particularly in the detachable bone or ivory head. The toggle harpoon head is the most dependable criterion of cultural change at our disposal, and as such it is destined to bear the main weight of the chronology that must be established if we are to have a clear understanding of the stages of development in Eskimo culture. As a " time indicator ", the harpoon head occupies a position in Eskimo culture analogous to that of pottery in the Southwest. To a peculiar degree it possesses the characteristics which Kidder has described as essential to any class of material that is to be utilized for diagnostic purposes.

> Valid cultural histories . . . . can only be compiled by studying series of specimens whose age, relative to each other, is known. Only from chronologically seriable specimens can dependable conclusions be drawn as to the origin and spread of culture traits and as to the improvement or decline of techniques. . . . . But the time sequence of archeological materials is usually very hard to establish.

They are found in all sorts of places and under all manner of conditions. Very often they come from widely separated sites. They are collected in enormous quantities and in most bewildering variety. And, being undocumented, they are at first contact entirely undatable. To bring these into sequence, there must be selected certain classes of specimens which, more clearly and more easily than others, can be used as indicators of the passage of time, and which can serve as preliminary criteria for determining the relative age of the less readily seriated remains with which they are associated. Any class of objects to be employed in this way must possess certain indispensable characteristics. The specimens which go to make it up must be imperishable, they must be abundant and widely disseminated, and they must be of such a nature as very sensitively to register cultural change. [Kidder, 1931, pp. 3-4.]

Harpoon heads fulfill the above requirements admirably. They are abundant (the Gambell excavations yielded 417 specimens that could be identified as to type, in addition to many fragments); they are widely distributed, in a number of different forms, from northeastern Asia to Greenland; they are of durable material—ivory or bone—which is usually well preserved in the frozen soil; and most important of all, they are complicated in form, and in Alaska, often elaborately ornamented. The relative abundance of harpoon heads in the middens is explained by the fact that this is the detachable part of the harpoon, the part that strikes and enters the prey, and which being subject to considerable stress and strain, is often broken, and later discarded. The harpoon head is complex in structure, possessing at least six features that often exhibit a wide range of variability: (1) the shaft socket at the lower or proximal end for engaging the end of the foreshaft; (2) the lashing slots or other means whereby (in those with open sockets) the foreshaft is held in the socket; (3) the pointed lower end, or spur; (4) the central perforation, or line hole, by means of which the harpoon head is attached to the line; (5) the presence or absence of lateral barbs or inset stone blades; (6) the anterior end which may or may not be slit for the purpose of holding an end blade. In addition there are certain combinations of these features to be noted, and other characters such as size, proportion of parts, and technique, all of which may and often do have a diagnostic value. A further fortunate circumstance is that during the Old Bering Sea and Punuk periods harpoon heads were decorated more frequently than any other class of artifacts, and in such a way that there was often a very definite correlation between the form of the harpoon head and the ornamentation it received.

For convenience of reference it will be necessary to arrange our harpoon heads according to some definite order. We have the choice of two methods: first, to establish an exact, comprehensive classification by letters or numbers, such as Mathiassen has used in describing the harpoon heads of the Thule culture; or second, merely to describe and give an appropriate name or number to each type. As stated above, Alaskan harpoon heads are complex, possessing at least six variable features, the inclusion of which alone would require cumbersome formulae for the designation of the types. At that, the features included would be only those which would correspond in a biological sense with the more fundamental divisions—class, subclass, order, family, subfamily, and genus; a still further division would sometimes be necessary to include the specific, subspecific, and varietal features on which a demonstration of close genetic relationship would depend. In view of this condition, I have therefore, after fully testing both methods, chosen the second, that of merely describing and naming the various types, with numerals and letters used as sparingly as possible. Eventually, when systematic excavations have revealed the sequence of harpoon types at more places and when homologies can be clearly distinguished from analogies, it should be possible to establish a comprehensive classification in which the various regional forms can be arranged in the order of their development. At the present time this cannot be done for the entire Eskimo area, not only because we have too few series for which chronological relationships have been definitely established, but also because the original forms remain to be determined. Thus we have no knowledge whatsoever of the presumably simpler forms antecedent to the complicated harpoon heads of the Old Bering Sea culture.

The excavations at Gambell produced abundant evidence of a number of stages of development through which harpoon heads passed, beginning with the complicated and numerous forms of the Old Bering Sea culture and ending with the one simple form now in use on St. Lawrence Island (text fig. 24, opposite p. 216).

At the Hillside site 16 harpoon heads were found which were sufficiently complete for type identification; 14 of these are shown in plate 23. Among them were examples of the several Old Bering Sea types already known, in addition to other types previously unknown. From Miyowagh there are 164 harpoon heads, more or less complete, in addition to an even larger number of fragments. We have at our disposal, therefore, a large body of material, fully documented as to depth and locality, upon which to base our study of the harpoon heads of the Old Bering Sea and early Punuk periods.

The harpoon heads are divided below into two groups, those with open sockets and those with closed sockets. The types are indicated by roman numerals; subtypes by letters (a, b, c, etc.) in parentheses;

and the relation of line hole and blade by the letters x and y, the former indicating that the line hole and blade are parallel, the latter that they are at right angles. The types in each group that are described first are those which were found only at the Hillside site or in the southeastern section of the next site, Miyowagh; these are, therefore, the Old Bering Sea types. Following these are the few early Punuk types, found mainly at the later, northwestern section of Miyowagh. Later, as we describe the material from Ievoghiyoq, Seklowaghyaget, and the recently abandoned ruins adjoining the present village of Gambell, the sequence will be continued to include the various Punuk, protohistoric, and modern types.

The distribution of the various types of harpoon heads according to depth and site is given in table 2 (p. 216). Text figure 24 (p. 216) is a graphic arrangement of the principal open socket harpoon types at Gambell, showing developmental stages from Old Bering Sea to modern times.

Open Socket Harpoon Heads

Open socket type I x.—Two lashing slots; at proximal end a symmetrical median spur, trifurcated, with center prong longer than the two adjoining; two line holes, one above and one below the socket, connected on the side opposite the socket by a deep groove into which the lashing slots open; two deep, narrow pits or sockets, parallel with the line holes, for holding the stone side blades; no end blade; oval to almost round in cross-section; decorated (Old Bering Sea) or plain. (Pl. 23, figs. 1, 2 and text fig. 24.)

Two harpoon heads of this type have been described previously, one by Jenness from Little Diomede Island and one by the writer from northern Alaska, exact locality unknown (Jenness, 1928 a, pl. 13, *a;* Collins, 1929, pl. 2, *f*—the blade slots and one of the line holes incomplete).

Three examples were found at the Hillside site, two of which are illustrated in plate 23, figures 1, 2; both were found among the rocks at the south end. Plate 23, figure 1, is complete except for the tip; the thin partition between the blade sockets has broken through. The two line holes are drilled at an angle, converging slightly as they enter the deep connecting groove on the back side. The lower end just below the socket has been hollowed out smoothly to a depth and width that exactly fits the end of one's thumb. The lower end of plate 23, figure 2, is broken and the upper end has been reworked into a drill or reamer; the side blades of jasper, parallel with the line holes, are still firmly in place. The decoration, as in figure 1, is Old Bering Sea.

The third, fragmentary, head of this type, from the upper level of the midden, is decorated in the same style.

From Miyowagh there is a single fragmentary example, undecorated, from cut 18, depth 53 inches; and an unfinished specimen from cut 27, depth 44 inches. (From cut 7, 48 in. deep, there is the lower end of a harpoon head with Old Bering Sea decoration that is unique in having the line hole (originally two ?) *in the plane* of the spur. The latter is trifurcated and symmetrical, the socket wide and deep with two lashing slots. This is the only instance I have seen of a symmetrical trifurcated spur which was not at right angles to the line hole or holes.)

Open socket type I y.—Same as above except that it is a flattened oval in cross-section, and has the side blades at right angles to the line holes; decorated (Old Bering Sea) or plain. (Pl. 23, fig. 3; pls. 24 and 25, figs. 1, 2; pl. 25 shows the socket side of the same harpoon heads figured on pl. 24.)

Three harpoon heads of this type have been described previously, one by Wissler from Cape Smythe near Point Barrow, one by Jenness from Little Diomede Island, one by Mathiassen from northern Alaska (Wissler, 1916, p. 410; Jenness, 1928 b, fig. 3, *c;* Mathiassen, 1929, fig. 13, *b.*).

No finished examples were found at the Hillside site—only the unfinished one shown in plate 23, figure 3, from the second level of the midden, and one other from among the rocks at the south end. The beginning of the groove into which the two line holes would have opened is visible on the side opposite the socket; on the opposite side the lower end has been slightly hollowed and beveled in preparation for a trifurcated spur.

From Miyowagh there are three specimens (pl. 24, figs. 1, 2) and an undecorated fragment, from cut 18, depth 72 inches. Plate 24, figure 1 (cut 7, depth 75 in.), is almost straight-sided with a rather wide, blunt end; the side opposite the socket is almost flat, whereas in the other known examples it is gracefully rounded. The side blades, of chipped slate, are also placed nearer the tip than is customary. Plate 24, figure 2 (cut 23, depth 65 in.), is undecorated and small—only 6.6 cm long; the blades are of chipped jasper; the groove at the lower end was for a lashing which was applied after a split occurred between the central spur and lower line hole.

Open socket type I (a) y.—Same as type I y except that there are two pairs of small barbs, at right angles to the line holes, in addition to the side blades. (Pl. 24, fig. 3.)

This type is represented by the single specimen shown in plate 24, figure 3. It is from cut 18, depth 78 inches. The sockets for the side blades are placed between the two barbs.

Open socket type I (b).—(In part hypothetical.) Two lashing slots; two line holes, same arrangement as above; no blades; pair of small barbs at tip, at right angles to line holes; form of spur unknown, probably like above. (Pl. 24, fig. 4.)

A single specimen is known, that shown in plate 24, figure 4. It is from cut 23, depth 81 inches; the spur is broken, so this feature is tentative.

Open socket type II x.—Two lashing slots; at proximal end an asymmetrical, lateral spur, trifurcated, with sharp slightly curving prongs all of the same length; single line hole, below which is usually a groove into which the lashing slots open; two side blades, parallel with the line hole; oval to almost round in cross-section; decorated (Old Bering Sea) or plain. (Pl. 24, figs. 5-8.)

None were found at the Hillside site. From Miyowagh there are six examples. Four are from the older, southeastern section, as follows: cut 23, 14 inches deep (pl. 24, fig. 7); cut 9, depth 24 inches (pl. 24, fig. 5); cut 29, 25 inches (pl. 24, fig. 6); cut 15, 42 inches. Two are from the northwestern section: cut 4, depth 36 inches (pl. 24, fig. 8) and cut 19, 63 inches. A striking feature of these harpoon heads is the marked asymmetry of the spur, which is placed partly below and partly to one side of the socket. The spur is definitely trifurcated, with the center prong straight and the two outer ones curved; the prongs all have sharp points. Plate 24, figure 5, has one of the side blades, of chipped jasper, remaining in place. The slot extends through to the other side as is also the case with plate 24, figure 6, and one other. In plate 24, figures 7, 8, and one other, the blade sockets do not quite meet, a thin partition remaining at the center. Plate 24, figure 8, which was found in cut 4, 36 inches deep in the later, northwestern section of the midden, differs from the others in having one of the prongs of the spur set off from the other two by a deep straight groove which extends beyond the line hole. Figures 5 and 7 also have small grooves between the prongs of the spur, but figure 6 has no suggestion of these, the upper part of the spur being perfectly smooth. In the latter specimen the groove which extends downward from the line hole takes a slanting path, whereas on the others it is straighter.

Morphologically, harpoon heads of this type appear to be derived from type I x: the side blades, parallel with the line hole, are retained as is also the trifurcated spur, although it has become asymmetrical. The stratigraphic evidence also indicates that it is actually a later form than either type I x or I y; for whereas the latter were found only at the Hillside site or at considerable depths in the old section of the Miyowagh midden, those of type II x all come from Miyowagh, and mostly from the upper levels.

Open socket type II y.—Same as above but with the side blades at right angles to the line hole; flattened oval in cross-section. (Pl. 24, figs. 9, 10.)

This type was not found at the Hillside site, and there are only four examples from Miyowagh. Two of these are shown in plate 24, figures 9 and 10. The other is the decorated fragment shown in plate 15, figure 10, from cut 3, in the later, northwestern, section of Miyowagh, but at a depth of 54 inches. The spur, which is damaged, is definitely trifurcated, and there are two lashing slots. Although the upper end is broken, parts of two sockets for side blades, at right angles to the line hole, are still clearly visible. Plate 24, figures 9 and 10, from the southeastern section of Miyowagh (cut 23, depth 58 in., and cut 9, depth 36 in., respectively) and the one not illustrated (from cut 5, 41 in. deep) are of particular interest because they represent the first appearance at Gambell of harpoon heads that embody the essential features of the Birnirk type, predominant at the older sites around Point Barrow. They all have the trifurcated, asymmetrical spur, the two side blades at right angles to the line hole, and the general shape, long and narrow, flattened oval in cross-section—features which are characteristic of the Birnirk heads, although as a rule the latter have only one side blade, with a sharp, prominent barb opposite, instead of two side blades. As we shall see later, harpoon heads of this generalized Birnirk type occur with somewhat greater frequency in the Punuk stage, and resemble the Birnirk heads of the Arctic coast in the further particular of being made of bone instead of ivory. Added evidence of the relationship of plate 24, figure 10, to the Birnirk group is shown in the decoration, which consists of two straight lines down the sides, one of them forking at the line hole, and a V-shaped depression just above the line hole.

Open socket types II (a) x; II (a) y; II (b) x; II (b) y; II (c) x; II (c) y.—Under the above headings come a number of harpoon heads all of which have bifurcated spurs or side blades, or both. They are all derivatives of types II x and II y, but since they do not appear until fairly late—well into the Punuk period—their description will be deferred until we come to deal with the Punuk material.

Open socket type III x.—Two lashing slots; a prominent, asymmetrical spur which is trifurcated, bifurcated, or otherwise irregular; single line hole, below which there is usually a groove into which the lashing slots open; end blade, parallel with the line hole; usually small barbs along the edges; oval in cross-section; decorated (Old Bering Sea or early Punuk) or plain. (Pl. 23, fig. 4; pl. 24, figs. 11-23.)

Four examples described previously, one by Mathiassen from Bering Strait, and three by the writer, two from northern Alaska, exact locality unknown, and one from Kukuliak, St. Lawrence Island (Mathiassen, 1929, fig. 20; Collins, 1929, pl. 2, *a-e*).

Three heads of this type were found at the Hillside site, one of which is shown in plate 23, figure 4. Half of the tip is broken and the remaining half reworked into a reamer. The spur is formed of one long, pointed prong to which is attached another, shorter and squared off at the end. Plate 23, figure 7, from house no. 1, exhibits some of the features of type III x but is not assigned thereto because of its small size (6.1 cm long) and its flat, squarish sides. Neither the line hole nor the socket has been completed.

Type III x is one of the most characteristic forms at Miyowagh, and one which is of particular importance because of the evidence it affords of the transition from the Old Bering Sea to the Punuk. It is represented by 25 examples. Twenty-one are from the older, southeastern section of the midden, distributed as follows: Cut 7, 62 inches (pl. 24, fig. 20); 67 inches (pl. 24, fig. 16); 92 inches (pl. 24, fig. 11); 96 inches (pl. 24, fig. 13). Cut 9, 12 inches; 24 inches (pl. 24, fig. 23). Cut 9 a, 18 inches (2); 26 inches (pl. 24, fig. 14); 36 inches (pl. 24, fig. 18); 48 inches (pl. 24, fig. 15). Cut 18, 18 inches; 29 inches; 38 inches; 48 inches (2) (pl. 24, fig. 17). Cut 23, 14 inches (pl. 24, fig. 21); 22 inches. Cut 24, 62 inches. Cut 27, 16 inches; 29 inches (pl. 24, fig. 12). Four are from the northwestern section of the midden, from the following cuts and depth: Cut 1, 30 inches (pl. 24, fig. 22); 53 inches. Cut 3, 20 inches (pl. 24, fig. 19). Cut 6, 55 inches.

The harpoon heads of this type display considerable variability, ranging from those of large size, with a very prominent divided spur and an elaborate Old Bering Sea ornamentation (pl. 24, figs. 11-16) to those of smaller size in which the spur is simpler, though still irregular, and in which the ornamentation is reduced to the simple lines of the early Punuk (pl. 24, figs. 19-21, 23). There is clear stratigraphic evidence that these smaller and simpler heads are later than the others, but since there is no sharp dividing line between them typologically, they are here all grouped together.

The bone harpoon head shown on plate 24, figure 11, differs from others of the group in having the spur divided into three sharp prongs of equal length, a feature which is characteristic of types II x and II y. In plate 24, figure 12, the spur is also trifurcated, but in an entirely different manner. It is essentially a lateral spur, for its most important part—the long center prong—continues straight down the side, at right angles to the line hole, even though the smaller prongs curve inward toward the socket. One of these is shorter than the other, thereby producing an asymmetry of the spur; otherwise it is very similar to a type of spur found on *closed* socket harpoon heads of the Old Bering Sea period from the Diomede Islands, in which the two smaller prongs are of equal length (pl. 27, figs. 5-7). The spur of plate 24, figure 13, although broken, seems to have been exactly similar to that of figure 12. In figure 15 the spur is of the same general shape, although there is only one projection from the main prong. Figures 14 and 16 are examples of the most prevalent form of spur associated with harpoon heads of this type. The spur is flatter than those just described, extending beyond the mid line and to some extent beneath the socket; it is bifurcated, with the inner prong very prominent. Figures 17 and 18 exhibit a variation of this form of spur, in which the inner prong is reduced in size. In figures 21-23, through a process of simplification, the elaborately divided spurs have been reduced to a point where they are more appropriately described as merely " irregular ". That this typological distinction has also a chronological significance is seen in the fact that these three specimens and the three similar ones not illustrated are all from the upper levels of the midden at depths of 14, 16, 22 (2), 30 and 38 inches. In figure 20 a rounded median elevation produces a thickening of the spur which is unusual.

The orientation of the spur, whether to the right or left of the socket, seems to have no significance, about the same number of specimens having one arrangement as the other.

Very often harpoon heads of type III x have small pointed projections or barbs along the edges. In most cases these are small and distinctly ornamental (e. g. pl. 24, figs. 11-13) ; sometimes, however, they are large enough to have served as real barbs (e. g., figs. 14, 17, 18) even though they still form an essential part of the decorative scheme. The position of these small barbs is invariably along the edges at right angles to the line hole, and they are present only on those harpoon heads in which the line hole and blade slit are parallel.

Most of the harpoon heads of this type which are relatively large, with an elaborately shaped spur, are decorated in Old Bering Sea style (pl. 24, figs. 11-16), and these same heads, it will be recalled, came mostly from the deeper parts of the midden; figures 17 and 18, also ornamented in Old Bering Sea style, had less prominent spurs. Those of smaller size, with the spur simplified but still irregular (pl. 24, figs. 20-23), and which according to stratigraphic evidence are definitely later, are either plain or decorated in early Punuk style. Here, instead of an elaborate all over decoration, we have only simple lines, which, however, were placed in exactly the same positions as those lines which on the older specimens had served to divide the surface decoration into definite panels or fields. In both cases a pair of lines, beginning at the base of the blade slit, takes a downward, diverging course, passing around the line hole and terminating on both sides at a small barb above the spur. Similar lines, beginning nearer the tip, emerge just above the other pair of barbs, which are thus accentuated and set apart. In the Old Bering Sea heads, the areas between these dividing lines are filled in with more or less elaborate designs; in the early Punuk heads they are left plain. The homology may also be traced in another feature, namely the pairs of elevated circles or ellipses, suggestive of "eyes", which form so prominent a part of the Old Bering Sea ornamentation. In the early Punuk heads these elevations are still present, although less prominent, and they occupy the same position, on either side of the line hole. Although as a group these smaller and simpler heads are later than the more elaborate forms, they appeared at a rather early stage, for one of them, plate 24, figure 20, comes from a depth of 62 inches, and two others, not illustrated, which have the same simple ornamentation (although they are larger and have prominent bifurcated spurs) were found at depths of 48 and 62 inches.

Plate 24, figures 22 and 23 (cut 1, 30 in. deep, and cut 9, 24 in. deep, respectively) represent the latest of the several forms included in type III x. In fact, it is only by virtue of their irregular spurs that they are included in this group. They have lost the smooth, flowing contour and the graceful, curving barbs which characterize such intermediate forms as those shown in plate 24, figures 19-21. Furthermore, the decoration in figure 23 is that of phase 2 of Punuk style 1 (lightly incised lines with small spurs attached—in this case with the spurs connected) a style which becomes quite common at a somewhat later period.

Open socket type III y.—In general, similar to type III x except that the blade slit is at right angles to the line hole. The spur is bifurcated or irregular, and the barbs along the sides inconspicuous or absent; decorated (Old Bering Sea or early Punuk) or plain. (Pl. 23, figs. 5, 6; pl. 26, figs. 1-2, 4-10.)

Two heads of this type were found at the Hillside site (pl. 23, figs. 5, 6). Figure 5, from house no. 1, is unusual in having a series of four sharp barbs bordering the blade slit on one side. The unfinished head, figure 6, from the upper level of the midden, was clearly designed to have had the blade slit at right angles to the line hole. The latter was made in an unusual manner: the hole first drilled was not well centered, and evidently to correct this, the hole was filled with a cylindrical ivory plug (not a drill core) and another hole drilled adjoining it at the center.

The broken specimen, figure 8, from house no. 2, is difficult to classify. The spur, while not symmetrical, lacks the marked asymmetry of type III. Instead of two lashing slots, it has a single slot with an opposite groove. Decoration consists of short detached lines, carelessly incised. On the whole it seems best to defer classification of this particular specimen until additional examples have come to light.

From Miyowagh we have 12 examples of type III y. Eight of these are from the older, southeastern section, distributed as follows: Cut 7, depth 16 inches (pl. 26, fig. 4). Cut 9, 48 inches (pl. 26, fig. 7). Cut 9 a, 36 inches (pl. 26, fig. 1). Cut 18, 48 inches (pl. 26, fig. 5). Cut 23, 58 inches; 81 inches (pl. 26, fig. 2). Cut 24, 13 inches (pl. 26, fig. 10); 54 inches (pl. 26, fig. 3).

Four come from the later, northwestern section, as follows: Cut 6, 26 inches (pl. 26, fig. 6). Cut 19, 24 inches (pl. 26, fig. 9); 51 inches (pl. 26, fig. 8). Cut 20, 22 inches.

The range of variation parallels that of type III x, and includes heads of both Old Bering Sea and early Punuk age. The earlier examples are large, with prominent divided spurs and typical Old Bering Sea ornamentation (pl. 26, figs. 1-3). The later forms are reduced in size, have simplified spurs which, however, are still irregular, and ornamentation when present is early Punuk (pl. 26, figs. 6-10). The Old Bering Sea heads had prominent "eyes" formed of concentric circles which occupied rounded elevations on either side of the line hole, on the spur, and sometimes near the tip. In the early Punuk heads these, along with the other elements of Old Bering Sea art, are absent, although the idea survives in the slight elevations around the line hole which are sometimes accentuated by having a small circular pit at the center. In figure 8 these pits are filled with small cylindrical plugs of baleen.

A characteristic feature of the harpoon heads of type III y and of most others which have the blade slit at right angles to the line hole is the prominent median ridge which extends downward from the tip to the line hole.

Plate 26, figure 3, has a secondary blade slit, parallel with the line hole, made after the upper end had broken; originally the blade slit was at right angles to the line hole. Figure 5 is unfinished and was probably discarded because the line hole was not well centered.

Types III x and III y are with a few minor exceptions the last of the open socket harpoon heads to be decorated in Old Bering Sea style; on the other hand, some of the specimens of these types are already decorated in early Punuk style. The latter (pl. 24, figs. 20-22; pl. 26, figs. 6-10) are the forerunners of types III (a) x and III (a) y, which above all others are characteristic of the Punuk stage. These will be described later with the other Punuk material. Meanwhile, we will consider the closed socket types, beginning with those which were found at the Hillside site and at the older section of Miyowagh.

Closed Socket Harpoon Heads

Closed socket type I x.—At proximal end a plain, symmetrical, median spur; two line holes, close together, connected on the back side by a deep groove; end blade parallel with line holes (pl. 26, fig. 11).

This type is represented by the single specimen from Miyowagh (cut 18, depth 48 in.) shown in plate 26, figure 11; it has the appearance of being unfinished. The combination of a symmetrical median spur and double line holes connected by a deep groove is in itself suggestive of age, in view of the fact that these features are found only on the oldest of the open socket harpoon heads. Hence the designation of this as one of the earliest closed socket forms even though it was evidently an unimportant one.

Closed socket type II x.—A lateral trifurcated or irregular spur; single line hole; end blade, parallel with line hole; small, ornamental barbs on edges; very thin in cross section; decorated (Old Bering Sea) or plain. (Pl. 23, figs. 11, 12.)

There are only two examples of this type, one from the Hillside site, the other, exact provenience unknown (pl. 23, fig. 12). Plate 23, figure 11, from house no. 1, has an irregular spur similar to that of figure 6. A row of small barbs, four on one side, two on the other, gives the edges a serrated appearance. The most striking feature of this type of harpoon head is its extreme thinness, which is unusual for a closed socket type. Figure 12 was obtained from the Eskimos at Gambell by Dr. Riley D. Moore in 1914, and while its exact provenience is uncertain it is included here since it is the only other known example of the type. Originally there were small barbs along the edges as in figure 11, but these were destroyed when the specimen was filed down and polished by the Eskimos from whom it was purchased. The spur is trifurcated and seems to have been symmetrical. The rectangular slots near the middle were for the purpose of lashing the two sides together after a split had appeared. Vestiges of Old Bering Sea ornamentation still remain.

Closed socket type III x.—Similar to the above, but thicker in cross-section; the lateral spur is trifurcated and symmetrical, with the center prong longer than the other two. (Pl. 27, fig. 5.)

Closed socket type III y.—Same as type III x except that it has the blade slit at right angles to the line hole. (Pl. 27, figs. 6, 7.)

These two types are based on four harpoon heads from Little Diomede Island. The fact that none were found at Gambell may be due to accident, for several specimens from the Hillside site and Miyowagh have spurs which approach this type, e. g., plate 23, figure 12, and plate 25, figure 12. Furthermore, the symmetrical trifurcated spurs of these Diomede heads, although placed to *one side* of the socket, are essentially similar to the *median* spurs of our open socket types I x and I y. In view of these circumstances it seems permissible to reserve for these two types the designations here given, on the chance that they will eventually be found on St. Lawrence Island.

Closed socket type IV y.—Straight, symmetrical spur; round line hole, beveled below; end blade at right angles to line hole; upper end tapering and conical, without the longitudinal ridge which is usually present when the blade slit is at right angles to the line hole; almost round in cross-section. (Pl. 23, fig. 14; pl. 26, fig. 12.)

There are only two examples of this type—plate 23, figure 14, from among the rocks at the south end of the Hillside site, and plate 26, figure 12, from Miyowagh, cut 18, 40 inches deep. Although in its main features this type conforms to type V y, it possesses certain minor but significant characters which set it apart. First of all, its shape is unusual—perfectly straight and smooth from tip to spur—whereas in all of the types previously considered there were surface elevations and depressions and usually some degree of a flare either along the edges or at the spur. Harpoon heads like plate 26, figures 16 and 17 (type V y), which most closely approach the present type, differ in having a more or less pronounced longitudinal ridge between the line hole and tip in addition to well-defined elevations, usually surmounted by " eyes ", around the line hole. None of the other closed socket types have the smoothly rounded contour, and particularly the tapering conical upper end of the present type; these features are found elsewhere only in the open socket type I x. Finally, in these two examples of type IV y, the application of the design differs from that on all of the other harpoon heads. In both cases the decoration extends *obliquely* around both sides, enclosing the line hole. In plate 23, figure 14, the ornamentation is Old Bering Sea style 2 and is applied as a band which begins at about the middle of the blade slit on the side opposite the spur and extends downward obliquely to the tip of the spur. The ornamentation in plate 26, figure 12, has the appearance of being unfinished; it consists of only a few lines, but again applied obliquely, this time beginning near the upper end on the same side as the spur and extending downward to terminate beneath the line hole. The narrow rectangular slot opening into the shaft socket beneath the line hole is a feature frequently found on closed socket harpoon heads; it may have been for the purpose of facilitating the drilling of the socket.

Closed socket type V x.—A single, symmetrical spur; line hole usually round, and beveled below; end blade parallel with line hole; flattened oval in cross-section; decorated (Old Bering Sea or early Punuk) or plain. (Pl. 23, fig. 13; pl. 26, figs. 13-15.)

This form of the closed socket harpoon head was not used very extensively during the Old Bering Sea period. Two examples, with Old Bering Sea ornamentation, have been described previously (Collins, 1929, pl. 9, *c, d,* possibly *b*). From the Hillside site we have only two examples, plate 23, figure 13, and one other undecorated head from among the rocks at the north end. Plate 23, figure 13, from among the rocks at the south end, is decorated in Old Bering Sea style 3, that is, the ornamentation centers around two pairs of raised "eyes" placed on either side of the line hole. The decoration on the spur has been obliterated by secondary cutting. In the groove beneath the line hole is a small slot which opens into the socket, similar to those in plate 26, figures 12 and 19.

From Miyowagh there are 22 harpoon heads of this type, the greater number of which are clearly of Punuk age as they are mostly from the later, northwestern section and are decorated for the most part in early Punuk style. There are only four with Old Bering Sea ornamentation (pl. 26, figs. 13-15, and one other poorly preserved specimen from cut 6, 26 in. deep). Figures 13 and 14, from cut 13, depth 60 inches and cut 21, depth 24 inches, respectively, are remarkable for their small size, which as we shall see later, is also a distinguishing characteristic of the Punuk heads of this same type. The decoration in figure 14 is rather simple, and it might be questioned whether it is Old Bering Sea, consisting as it does of nothing more than straight lines bordering the blade slit and a single transverse connecting line.

However, we have already seen that a design similar to this—pairs of short cross lines between straight lines which extend downward from tip to line hole—was found at the Hillside site (pl. 12, fig. 8). The ornamentation in plate 26, figure 13, is typically Old Bering Sea, with finely incised straight lines, broken lines and "eyes" formed of pairs of concentric, nucleated circles surmounting rounded elevations on either side of the line hole. On the spur are two independent design elements, small concentric oval figures, placed transversely. On both of these harpoon heads the groove beneath the line hole takes an oblique path. Plate 26, figure 15 (cut 25, 39 in. deep) has a piece broken off the spur, and the upper end is broken and reworked into a reamer; the blade slit has been completely obliterated, but the configuration of the remaining upper end shows that it must have been parallel with the line hole. The decoration is the simplified Old Bering Sea style 3, consisting mainly of three (originally four?) pairs of opposed "eyes" placed on rounded elevations.

The Punuk heads of type V x will be described later.

Closed socket type V y.—Same as type V x except that the blade slit is at right angles to the line hole. (Pl. 26, figs. 16-20.)

This form of type V harpoon head was used more frequently during the Old Bering Sea period than was the preceding type, which had the blade slit parallel with the line hole. Six heads of this type, decorated in Old Bering Sea style, have been described previously (Mathiassen, 1929, fig. 13, *a;* Collins, 1929, pl. 1, *a-b, c, d, e-f;* Mason, 1930, pl. 5, fig. 1).

None was found at the Hillside site.

From Miyowagh there are 21 examples, 10 of them decorated in Old Bering Sea style, 4 in early Punuk, 1 in late Punuk, and 6 undecorated. The 10 Old Bering Sea heads all come from the southeastern part of the midden as follows: cut 7, 33 inches; cut 8, 40 inches (pl. 26, fig. 19); cut 9 a, 38 inches (pl. 26, fig. 18); cut 15, 60 inches; cut 16, 37 inches; cut 18, 60 inches; 66 inches (pl. 26, fig. 16); 72 inches; cut 24, 13 inches (pl. 26, fig. 20); cut 25, 61 inches (pl. 26, fig. 17). In addition to these there are two undecorated heads from cut 18, 60 inches deep, and cut 21, 46 inches deep, which are probably of Old Bering Sea age.

One of the most striking features of these harpoon heads, and one which often adds greatly to the symmetry of form and decoration, is the longitudinal ridge between the line hole and tip. On the small specimen, plate 26, figure 17, this ridge is less noticeable than on any of the others; in figure 19 it is most pronounced. On the latter, and frequently on others, the ridge is outlined by rather deeply incised bordering lines, and being left undecorated, stands out in effective relief between the decorated panels which flank it on either side.

The type V y heads from Miyowagh which belong to the Punuk stage will be considered later.

This brings to an end our study of the harpoon heads of the Old Bering Sea period. We have seen that the oldest heads, those from the Hillside site and from the lowest levels of the Miyowagh midden, are more complicated in form and more elaborately ornamented than others which came into use at Miyowagh at a later period. Thus, of the most complicated form of all (open socket types I x and I y, with trifurcated spurs, double line holes, and side blades) 10 examples were found, 5 of them from the Hillside site and 5 from the lower part of the older, or southeastern, section of Miyowagh. Although the double line hole was discontinued at a very early period, divided spurs and side blades were retained for a much longer time. The first important derivative forms seem to have been types II x and II y, which have only one line hole but which continue the old association of side blades and trifurcated spurs. The spur, however, has become asymmetrical and more or less lateral in position instead of symmetrical and median as previously. Types II x and II y, in turn, passed out of use at a relatively early period, although the tradition of side blades and divided spurs (but bifurcated instead of trifurcated) was carried on into the Punuk stage, as we shall have occasion to observe later.

The rest of the open socket harpoon heads from the Hillside site and the older part of Miyowagh fall into two groups—types III x and III y. Both of these types display a wide range of variability, which, however, is expressed in developmental changes within defined limits, the basic features remaining constant. The stratigraphic evidence indicates clearly enough that the observed variations are truly developmental in nature, reflecting definite stylistic trends over a considerable period of time. Thus the types III x and III y heads that are stratigraphically the oldest (pl. 24, figs. 11-18; pl. 26, figs. 1-3) are characterized by relatively large size, prominent divided spurs, and an elaborate Old Bering Sea ornamentation. Through a process of simplification these features became gradually reduced, with the result that the later harpoon heads of these types are of smaller size, have spurs which are much simpler although still irregular, and are either undecorated or bear the simple ornamentation of the early Punuk (pl. 24, figs. 19-21, 23; pl. 26, figs. 6-10). Through still further changes in the same direction the latter in turn developed into types III (a) x and III (a) y, the predominant types of the Punuk period, to be described later.

Closed socket heads were much less common during the Old Bering Sea period than those with open sockets. Types I-IV, represented by only a few specimens, played an unimportant part as compared with type V. However, this may not have been the case everywhere, for type III (which was not found at Gambell) seems to have been fairly common on the Diomedes. The predominant closed socket types at Gambell are types V x and V y. The former, with the line hole and blade slit parallel, was of less importance than the latter. The most striking feature of this type is its small size. On the other hand, type V y, with the line hole and blade slit at right angles, displays the same range of variation in regard to size and ornamentation as was shown by the open socket types III x and III y. Thus the older specimens, with Old Bering Sea decoration, are for the most part large; while the younger forms (to be described later), which are either plain or decorated in early Punuk style, are considerably smaller.

One important distinction between the open and closed socket heads of the Old Bering Sea period is in the form of the spur. In the great majority of cases the open socket types have elaborate, divided spurs, which have been described above as trifurcated, bifurcated, or irregular; in fact, there are only three examples that have single spurs, plate 23, figures 9, 10, and one other from Miyowagh, cut 25, depth 18 inches. Heads of this type, with single rather than divided spurs, will be described later under the designations of types III (a) x and III (a) y. When we come to the closed socket heads, however, we see that the single, lateral spur is the prevailing form. Types V x and V y, comprising more than 90 percent of all the closed socket heads, have only this type of spur; and the same is true of the less common types, IV y and I x, although in the latter the spur is placed medially instead of laterally. The only closed socket types possessing divided spurs are types II x, III x and III y, the last two being known as yet only from the Little Diomede Island.

In conformity with the extensive use of ivory during the Old Bering Sea period is the fact that the harpoon heads were made almost exclusively from this material. Only four harpoon heads in the entire series are made of bone, one of these being the specimen shown in plate 25, figure 11. In the Punuk period, as we shall see later, bone harpoon heads become somewhat more common, although the use of this material is restricted almost entirely to forms which are related in one way or another to the Birnirk type.

Almost invariably the harpoon heads were made from the tips of very small, young walrus tusks. This is clearly indicated by the fact that in practically every specimen a very small core of dentin, less than 1 cm in diameter, is visible at the center, surrounded by enamel, whereas the average adult walrus tusk has a dentin layer three or four times this size. Most of the harpoon heads were apparently made of young tusks from about 12 to 20 cm long. Further evidence that " baby " walrus tusks were used in this way is shown by the fact that on many of the harpoon heads the inner side of the basal spur still shows the original hollow of the proximal end of the tusk, with an inner diameter of less than 1 cm as compared with the very much larger hollow base of an adult tusk.

With regard to technique, several points should be noted. The line holes on all of the harpoon heads which we have been considering were made by drilling and are perfectly round. The edges were usually trimmed down and smoothed, and there is usually a rounded depression or groove extending downward from the line hole; in closed socket heads the groove is usually present on both sides, in open socket heads only on the back side at the place where the lashing slots emerge.

In the closed socket forms the socket is invariably made by drilling and consequently is cylindrical. An unexplained feature is the occasional presence of a narrow rectangular slot cut through to the socket from one or both sides (pl. 23, fig. 13; pl. 26, figs. 12, 19), possibly for the purpose of facilitating the drilling.

On open socket heads the sockets are rectangular and were made by cutting. In the older examples there is a marked tendency for the socket to be relatively shallow with a somewhat concave bottom and slightly flaring sides. These features may to some extent be correlated with a relatively increased size, particularly breadth, but they are also found on the smaller Old Bering Sea heads, such as plate 24, figures 2, 5-7, 11. On the other hand, the smaller early Punuk types have sockets which are distinctly narrower and deeper, with flat bottoms and vertical sides.

In making the socket one of the first steps was the cutting of a small transverse slot just below the line hole. This formed the upper end of the socket and was often deeper than the floor of the socket.

One of the most interesting features of the open socket heads from a technological standpoint is the lashing arrangement—the narrow rectangular slots on either side of the socket through which passed the strands of baleen or sinew which held the end of the foreshaft in place. On the older heads that have lateral spurs the two slots are usually of unequal length, the one on the side of the spur averaging 10 to 13 mm, the one opposite the spur 8 to 10 mm; on the later heads the slots are usually of equal length, averaging around 10 mm. On those heads which have median spurs the lashing slots are invariably equal in length. Most remarkable, however, is the extreme narrowness of these slots, usually a little less than 2 mm; the vertical length, or height, averages around 8 mm. The cutting of such a long, narrow slot must have been difficult, and it would be of interest to know just what kind of tool was employed.

In several instances closed socket heads were found which, after breaking, had been provided with a groove and used in the manner of the open socket type.

The position of the lateral spur on open socket heads, whether to the right or to the left, seems to have been a matter of choice, somewhat more than half of them having the spur on the right side.

It was somewhat surprising that among the great number of harpoon heads from Gambell which had been provided with end blades of stone, only one had the blade still in place. Side blades, on the other hand, being firmly wedged in deep slots, were often found in place. The slit for the end blade was rather wide, averaging on the whole around 2 mm, some being as wide as 3 mm. This width of the blade slit, together with the great number of complete or fragmentary slate blades which were found, shows clearly that stone was the only material used for harpoon blades. If iron blades had been used, some traces of the metal would have remained, either as corroded particles or as stains, but nothing of this nature was found.

From a number of unfinished specimens and from the appearance of many of the blade slits themselves, it can be seen that in many cases the slits were not made by cutting directly from the tip, but that instead, a slot of uniform breadth was first cut through from one side to the other, leaving the upper ends connected. This connection at the tip was then cut through, but by means of a narrower slit. When completed, therefore, the blade slit was wider at the bottom than at the top, with the result that the tips would have to be sprung back slightly to receive the blade which would then be held firmly in place.

It should be noted that in harpoon heads with an end blade, those having the blade parallel with the line hole are usually *thin* in cross-section, whereas those in which the blade and line hole are at right angles are *thicker*. The reverse is true of harpoon heads with side blades: those having the blades parallel with the line hole (or holes) are relatively *thick* in cross-section, whereas those with blades and line hole (or holes) at right angles are *thin*.

HARPOON HEADS, EARLY PUNUK, FROM MIYOWAGH

In plate 28 are shown a number of open and closed socket harpoon heads of Punuk type from Miyowagh, most of them from the later, northwestern section of the midden.

Open Socket Harpoon Heads

Open socket type II (a) x.—Two lashing slots or one slot and an opposite groove; bifurcated, asymmetrical spur; round line hole; two side blades, parallel with line hole; long and slender, squarish in cross-section; usually made of bone. (Pl. 28, fig. 1.)

Two examples, both of bone: cut 1, depth 12 inches; cut 19, depth 24 inches (pl. 28, fig. 1).

This is a derivative of the older type II x, from which it differs in having two instead of three prongs on the spur; it is also long and slender in shape, whereas type II x was shorter and more or less rounded in cross-section. A further difference is that both specimens of the present type are of bone, and that one of them (pl. 28, fig. 1) has a single lashing slot, with an opposite groove instead of two slots.

Open socket type II (a) y.—Same as above but with the side blades at right angles to the line hole; flattened oval in cross section. (Pl. 28, fig. 2.)

Three examples, all of bone: cut 1, depth 12 inches (pl. 28, fig. 2); cut 19, depth 17 inches; cut 20, depth 22 inches.

This form is derived from type II y, differing from it in having two instead of three prongs on the spur, and in sometimes having one lashing slot with an opposite groove instead of two slots. The remaining fragmentary side blade of plate 28, figure 2, is made of a piece of shell.

Open socket types II (b) x, II (b) y, II (c) x, and *II (c) y* are variants of the type II group which were not found at Miyowagh. Examples from the next site, Ievoghiyoq, will be described later.

Open socket type II (d).—Two lashing slots; a bifurcated asymmetrical spur; round line hole; neither end nor side blades; long and slender; made of bone. (Pl. 28, fig. 3.)

This type, which apparently was little used at Gambell, is based on the single specimen shown in plate 28, figure 3, from the northwestern section of the midden, cut 17, depth 20 inches. It is a late variant of the type II head, and is of particular interest as representing the first appearance at Gambell of a harpoon head which has neither blade nor barbs.

Open socket type II (e).—One lashing slot and an opposite groove; a bifurcated, asymmetrical spur; triangular to rectangular line hole; two small lateral barbs, at right angles to line hole; no blades; long and slender. (Pl. 28, fig. 4.)

Another uncommon type, represented by the single specimen, of ivory, shown in plate 28, figure 4, from cut 1, in the northwestern section of the midden at a depth of 24 inches.

Open socket type II (f) x.—Two lashing slots; bifurcated, symmetrical (median) spur; triangular line hole; end blade, parallel with line hole; ornamental, vestigial slots for side blades, at right angles to line hole. (Pl. 28, fig. 5.)

This type is based on the single specimen, of bone, shown on plate 28, figure 5, from cut 20, depth 12 inches. The bifurcated, symmetrical spur, placed medially below the socket, the triangular line hole, and the two vestigial sockets for side blades are features that show relationship to type II (b) y; a type not found at Miyowagh but represented by two specimens from the Punuk site, Ievoghiyoq. The slit for an end blade relates it to the following type, type II (g) x. Decoration consists of a pair of straight lines diverging downward; the shallow grooves along the edges at the constricted center, although now only ornamental, undoubtedly represent vestigial sockets for side blades.

Open socket type II (g) x.—Two lashing slots or one slot with an opposite groove; a bifurcated, asymmetrical spur; round line hole; end blade, parallel with line hole; made of bone; simple line decoration. (Pl. 28, figs. 6, 7.)

This is one of the instances where a determination of relationship based strictly on definition would be misleading. Thus, plate 28, figure 7, possesses the general features that would place it in type III x: two lashing slots, a bifurcated, asymmetrical spur, an end blade parallel with a round line hole. But both this specimen and plate 28, figure 6, lack the graceful, flowing contour and the small barbs of type III x. Furthermore, the nature of the bifurcated spurs, the decoration of straight lines, and the fact that these heads are made of bone rather than ivory show that their true relationship is with the type II group.

Plate 28, figure 6, from cut 6, depth 20 inches, is rather crudely made: it has one lashing slot and an opposite groove. Plate 28, figure 7, from cut 2, depth 28 inches, has two lashing slots; in addition to the simple line decoration, it has a deep V-shaped depression above the line hole.

The harpoon heads above described [types II (a) x and y; II (d); II (e); II (f) x; II (g) x] are collectively the most recent of all the Miyowagh forms. They all come from the northwestern section of the midden, one of them (pl. 28, fig. 7) from a depth of 28 inches, the nine others from even shallower depths. They were relatively unimportant at Miyowagh, being overshadowed by the more dominant forms of type III (a) x and y. One of them—type II (a) x—is a degenerate form of type II x (pl. 24, figs. 5-8), a type which goes back to the Old Bering Sea period. The others are all related to the somewhat later type II (a) y (pl. 24, figs. 9, 10), which, as was pointed out previously, represents the first appearance in the Gambell sequence of a harpoon head which embodies the essential characteristics of the Birnirk (Point Barrow) type. In these later forms of the type II head the Birnirk relationship may still be seen, even though each of the subtypes has in one feature or another departed from the full Birnirk. Thus they all have bifurcated spurs, usually lateral and asymmetrical; two of the forms have functional side blades, and one has ornamental grooves representing vestigial side blades; three of them lack end blades; and most of them have a single lashing slot with an opposite groove as frequently as two lashing slots. It is also significant that of these 10 specimens, 9 are of bone (in addition to 4 unfinished heads and 1 fragment which are not included in table 2 because of uncertainty as to which particular subtype of type II they would have belonged). On the other hand, bone was very seldom used in making other types of harpoon heads at Miyowagh; among the hundreds of specimens, fragments and all, there are, in addition to those enumerated above, only nine which are made of bone. The fact that more than half of all the bone harpoon heads from Miyowagh are of these Birnirk-like forms would make it appear either that the latter were importations on St. Lawrence Island; or if of local manufacture, that they were made by emigrants from some region where bone was the predominant material used and the Birnirk head the predominant type. Further evidence in the same direction is afforded by the decoration on these Birnirk-like specimens. Wherever decoration is present it conforms rather closely to that found on the Birnirk heads from around Barrow—a pair of straight lines (one of which may be forked) down the sides, and frequently a **V**-shaped depression just above the line hole. Plate 28, figures 1, 2, 4-7, all show this style in some degree, although the decoration is rather crudely applied. The four harpoon heads shown in plate 27, figures 1-4, from Punuk Island and Cape Kialegak, are better examples of the Birnirk type, both in form and ornamentation, than those which we happened to find at Gambell.

Open socket type III (*a*) *x*.—Two lashing slots; a single, lateral spur; round line hole, below which is usually a shallow groove into which the lashing slots open; end blade, parallel with line hole; decoration Punuk (rarely Old Bering Sea), or plain. (Pl. 28, figs. 8-14.)

This type includes very few of the Old Bering Sea heads, mainly for the reason that during this period the spur was usually divided rather than single. There are, however, three specimens with Old

Bering Sea decoration which must somewhat arbitrarily be included in the group because they possess single spurs and the other features characteristic of the type. One of these is from the Hillside site (pl. 23, fig. 10), the other two from the southeastern section of Miyowagh, cut 25, 18 inches deep, and cut 9 a, 52 inches deep. The last mentioned specimen is so badly weathered that most of the superficial features are obliterated; the other two, however, both have small ornamental barbs along the edges, such as are characteristic of type III x. These barbs, together with the ornamentation, indicate relationship to type III x, even though for the purpose of classification it is necessary, because of the single spur, to include them in type III (a) x.

Type III (a) x is an important one at Miyowagh, being represented by 38 specimens in addition to the 2 just mentioned. Of these 38, only one is undecorated, the others all bear a Punuk ornamentation. Three are from the older, southeastern section, as follows: cut 7, depth 20 inches; cut 9, 12 inches (pl. 28, fig. 11); 36 inches.

Thirty-five are from the later, northwestern section: Cut 1, 12 inches; 24 inches (2) (pl. 28, fig. 13); 48 inches. Cut 2, 12 inches; 24 inches (2) (pl. 28, fig. 8). Cut 3, 24 inches. Cut 4, 15 inches; 20 inches; 25 inches (pl. 28, fig. 14); 31 inches (pl. 28, fig. 12); 39 inches. Cut 17, 26 inches; 27 inches (2); 34 inches. Cut 19, 5 inches (3); 12 inches (3) (pl. 28, fig. 10); 17 inches (6) (pl. 28, fig. 9); 24 inches; 48 inches. Cut 20, 12 inches; 22 inches; 26 inches (2).

In describing the harpoon heads of the Old Bering Sea period, it was pointed out (pp. 104-106) that open socket type III x was a variable form that had undergone considerable modification during the period in which Miyowagh was occupied. The older specimens were mostly large, elaborately ornamented, and possessed prominent, divided spurs; the later specimens were of smaller size, were decorated in the simplified style of the early Punuk, and had spurs which, although considerably reduced, were still to be classed as "irregular." The type III (a) x heads represent a continuation of this process of simplification. In general shape and style of ornamentation they are similar to the latest of the type III x heads, such as plate 24, figures 22 and 23; the principal difference being that the spur has lost all trace of its former irregularity and is now perfectly straight and plain. Furthermore, while the earlier forms of the type III x heads were oval in cross-section, with a more or less rounded contour, a few of the later examples, like plate 24, figures 22 and 23, were somewhat squarer in outline, with plane median surfaces and beveled edges. In the type III (a) x heads the same tendency is continued:

the edges descend at a rather sharp angle from the center, which is either flat or slightly concave. The small rounded elevations to either side of the line hole—survivals of the elevated Old Bering Sea "eye"—are to be seen on these type III (a) x heads just as they were on the early Punuk forms of type III x. They are lacking on plate 28, figure 14, a head which, to judge from the decoration, is one of the latest of its type at Miyowagh.

In short, the harpoon heads of type III (a) x have become thoroughly standardized; they exhibit hardly a trace of the rich diversity of form that characterized the ancestral Old Bering Sea heads of type III x. The ornamentation has likewise arrived at an almost dead level of uniformity. The same basic design, with but slight variation, is repeated with monotonous regularity on each decorated harpoon head of this type. This design consists of two parts: a pair of lines beginning at a single point at the base of the blade slit (on the side opposite the socket), then diverging to pass around either side of the line hole, and becoming forked at the lower ends; paralleling these are two outer lines, beginning nearer the tip and extending downward along the edges, where at a point below the level of the line hole they each meet a similar line from the opposite side. Between these outer lines on the opposite (or socket) side there is again a pair of lines passing around the line hole, but because of the space taken up by the socket, these lines do not fork at the ends but continue straight. Such is the skeleton of the design on each of these harpoon heads. Within these lines are smaller decorative elements—light spurs and dots—which fortunately are less stereotyped than the lines themselves. At first the spurs are small and faint, and are attached to the lines more or less at a right angle (pl. 28, figs. 8-11). They may occur either singly or in pairs; when they occupy a space between two converging lines there is a tendency for them to join and for a dot, or two dots, to be placed just above or below the point of junction. Later, the spurs became longer (pl. 28, figs. 12, 13) and of necessity more acute in order that they might occupy the narrow space between the converging lines. Plate 28, figure 14, is the end result of this elongation of the spurs, which, having joined, now appear as bold **V**-shaped figures between the forks and angles of the lines. This and two others (cut 17, 34 in., and cut 20, 26 in.) are the only harpoon heads from Miyowagh with spurs that have reached this exaggerated stage, which as we shall see later is a characteristic style of decoration at the Punuk site, Ievoghiyoq.

Open socket type III (a) y.—Same as type III (a) x except that the blade slit is at right angles to the line hole; decoration Punuk, or plain (rarely Old Bering Sea). (Pl. 23, fig. 9; pl. 28, figs. 15-18.)

One head of this type was found at the Hillside site (pl. 23, fig. 9), decorated in Old Bering Sea style 2. This is one of the few specimens from the Hillside site on which the " animal head " is clearly depicted. The opposed " eyes ", to the left of the line hole, are formed of small concentric circles placed on rounded elevations, two pairs of short converging lines extending downward from the periphery of the outer circle. This element is enclosed within an ovoid panel; the " nose " is indicated by a shallow notch cut in the edge. The groove leading down from the line hole is rather deep, and the spur projects outward to an unusual degree.

Type III (a) y is represented at Miyowagh by 13 examples. Seven of these are from the southeastern section, as follows: Cut 9, 24 inches (3) (pl. 28, fig. 18); 36 inches. Cut 21, 29 inches. Cut 23, 64 inches. Cut 25, 18 inches. The other six are from the northwestern section: cut 4, 43 inches (pl. 28, fig. 15). Cut 19, 17 inches; 38 inches (pl. 28, fig. 16); 45 inches (pl. 28, fig. 17); 51 inches; 59 inches.

As in the case of other open socket heads, this type with blade slit at right angles to the line hole was less frequently used than the type with blade slit and line hole parallel. However, the distribution indicates that it was a somewhat earlier form. It is a modification of open socket type III y (pl. 26, figs. 1-10), and it closely resembles the later forms of that type, differing only in having a single instead of a divided spur. It has retained the sharp, prominent ridge between line hole and tip, a feature that contributes greatly to the symmetry and beauty of this and other types of harpoon heads which have the line hole and blade slit at right angles. Plate 28, figure 16, was provided with a secondary blade slit, parallel with the line hole, after part of the upper end had broken. Figure 18 is the only harpoon head excavated at Miyowagh which had the lashing thong still in place. It consisted of a narrow strip of baleen passing through the slots and was tied together in a neat, tight knot just over the socket. Seven of the 13 specimens from Miyowagh are decorated in Punuk style, and six are undecorated. Plate 28, figure 15, is of particular interest because in addition to the usual Punuk ornamentation of lines and spurs it has two curving transverse lines at the upper end and longitudinal rows of very short lines (broken lines) extending down the sides from the tip to below the line hole. Broken lines of this kind are common in Old Bering Sea art, but this is the first instance in which they have been found accompanying a typical Punuk ornamentation. The decoration on the other specimens (pl. 28, figs. 16, 17, and the four not illustrated) is practically identical to that occurring on the type III (a) x heads (pl. 28, figs. 8-13). Plate 28, figure 16, and one other have plugs of baleen set in the small round pits, and most of them have the rounded elevations beside the line hole that are so characteristic of the early Punuk heads in general.

Closed Socket Harpoon Heads

We will now consider the closed socket harpoon heads of Punuk type from Miyowagh, most of them from the northwestern section of the midden.

No examples of the older types—I-IV—were found in this section.

Closed socket type V x (pl. 28, figs. 19-22).—Definition of the type was given on page 110, where the six specimens with Old Bering Sea ornamentation were described, two of them from the Hillside site and four from Miyowagh. The remaining 18 specimens from Miyowagh are either undecorated or bear a Punuk ornamentation. Six of them come from the southeastern part of the midden, as follows: Cut 9, 24 inches (2); 25 inches. Cut 23, 8 inches. Cut 24, 18 inches. Cut 27, 16 inches (pl. 28, fig. 20). Twelve are from the northwestern section: Cut 1, 30 inches (pl. 28, fig. 22). Cut 2, 12 inches. Cut 3, 24 inches. Cut 4, 43 inches. Cut 6, 6 inches. Cut 19, 12 inches; 17 inches; 24 inches; 42 inches; 45 inches; 48 inches (pl. 28, fig. 21). Cut 20, 12 inches (pl. 28, fig. 19).

Most of the harpoon heads of this type are small, from 6 to 8 cm long.

Three of the heads have line holes that depart from the usual round shape. That of plate 28, figure 20, is somewhat squarish, figure 21, oval-rectangular, and that of another from cut 24, depth 18 inches, is triangular. The small specimen, plate 28, figure 22, was provided with a lashing slot and opposite groove, and used in the manner of an open socket head, after a piece had broken away from the socket.

The Punuk ornamentation on most of these closed socket heads differs from that on the open socket forms. On the latter, the lines that descend from the blade slit pass around the line hole and continue downward, each line becoming forked at the end. On the closed socket heads the lines begin in the same way, but instead of continuing to diverge, they come together again below the line hole, which is thereby enclosed in a lozenge-shaped figure. Another line, parallel with the edge, extends down both sides, and dots or spurs are applied at intervals.

Closed socket type V (a) x.—Single, symmetrical spur; round line hole, beveled below; end blade parallel with line hole; small barbs along edges; oval in cross-section; decoration Punuk. (Pl. 28, figs. 23, 24.)

This is a relatively unimportant type, represented by the two specimens shown in plate 28, figures 23 and 24, from cut 27, depth 22 inches, and cut 20, depth 12 inches respectively. It is a variant of type V x, from which it is distinguished by the presence of pairs of small lateral barbs. Although these appear to be primarily decorative, they may also have been functional to a certain extent. Figure 23 is of bone; its graceful, flowing contour and the marked elevations suggestive of "eyes" around the line hole and on the spur bring this specimen into close relationship to the Old Bering Sea forms. The line decoration, however, is rather simple. After part of the upper end had broken, a blade slit was cut in the remaining tip at right angles to the line hole and the original blade slit. The second harpoon head of this type, plate 28, figure 24, is clearly younger, coming as it does from the surface layer of the latest section of Miyowagh, and bearing a decoration in the more developed Punuk style. The design above the line hole—a **V** or **Y**-shaped figure—is closest to that of plate 28, figure 14. The decoration on the spurs consists of deep round pits at the center of rather lightly incised mechanically made circles, each circle connected to a line that descends obliquely from a line near the center.

Closed socket type V y (pl. 28, figs. 25-28).—The type was defined on page 111. In all, it is represented at Miyowagh by 21 examples. Twelve of them came from the older, southeastern section and have been described with the Old Bering Sea forms; ten of them were decorated in Old Bering Sea style, two were undecorated. The remaining nine are from the northwestern section of the midden, five of them decorated in Punuk style, four undecorated. They are distributed as follows: Cut 1, 30 inches (pl. 28, fig. 26). Cut 2, 28 inches (pl. 28, fig. 25); 40 inches. Cut 19, 12 inches (2); 30 inches; 59 inches (2) (pl. 28, fig. 27). Cut 20, 12 inches (pl. 28, fig. 28).

The harpoon heads of this type which are decorated in Punuk style are as a group considerably smaller than the Old Bering Sea heads of the same type. The smallest of these is plate 28, figure 27, only 5.7 cm long. Like plate 28, figure 17, and plate 26, figure 8, it has plugs of baleen set in the small round pits, a feature which appears to be characteristic of a rather early stage of the Punuk. Plate 28, figure 28, is the only harpoon head found at Miyowagh having the large nucleated, mechanically made circles of the fully developed Punuk (Punuk style 2), although two other heads (pl. 28, figs. 10 and 24) have smaller, more faintly incised circles of the same kind. The two latter specimens should probably be regarded as intermediate stylistically between those having simple dots—or more accurately small, deep, circular pits—and the large bold circles surrounding similar pits as on figure 28.

IMPLEMENT TYPES, OLD BERING SEA

Harpoon Parts

Foreshafts.—Considering the importance of the foreshaft, and the many that must have been used, it is somewhat surprising that only 11 examples, and those mostly fragmentary, were found at the Hillside site and only 45 at Miyowagh. The relative scarcity and the poor condition of the foreshafts is probably to be explained by the fact that this is perhaps the least stable part of the harpoon, a slender rod of ivory fastened into the heavy socket piece, which is very likely to break on the impact, either because of a poor cast or because the free end fails to become disengaged from the socket of the harpoon head with the first vigorous movements of the quarry. Many foreshafts must have been broken in this way and discarded immediately, since the harpoon would be useless until another had been fitted in place.

The foreshafts from the Hillside site, though few in numbers, varied considerably in form. One of them is the decorated specimen shown in text figure 5, which was found beneath the floor stones of house no. 1. It is triangular in cross-section. The lower end, which rests in the upper end of the socket piece, is tapering and was probably somewhat pointed originally; the upper end, which fits into the socket of the harpoon head, is broken. Just below the center is the line hole, a narrow slit 11 mm long. Plate 29, figure 2, is quadrangular in cross-section with one face much narrower than the other three. The line hole is a narrow slit as in text figure 5 but is placed nearer the middle. The lower end, broken, is tapering; the upper end is also tapering, and its rounded shape shows that it was intended for a harpoon head with a closed socket. Plate 29, figure 3, is similar in cross-section but the line hole is higher up. The base is conical and sharpened, the upper end broken. Two other fragments resemble it in having sharply pointed tangs and narrow rectangular line holes 9 and 12 mm long respectively. One other fragment has a triangular and another a round line hole. Plate 29, figure 1, differs from the others, having an enlarged and somewhat bulbous lower end, just above which is the narrow rectangular line hole; it is only 6.7 cm long; the tang is blunt and the tip cylindrical. Plate 29, figure 4, is a complete specimen 9.9 cm long with pointed tang and tip and a narrow line hole.

The foreshafts from Miyowagh are also for the most part fragmentary and it is difficult to describe the types very exactly. There seem to have been two main general types: (1) rather heavy and long, squarish to rounded triangular in cross-section, with narrow rectangular line hole between center and tang; the tang conical and rather blunt; length 12 to 25 cm; (2) a smaller, more slender form; cross-section round or as above; line hole narrow and rectangular or short and triangular; tang conical but sharper and more tapering; length 6.5 to 12 cm.

The first type, of which there are 25 examples, is illustrated in plate 31, figures 1-5. The first two, from cut 9, are the only two fairly complete specimens of this type; the curved tang of plate 31, figure 1, is probably due to warping. Plate 31, figure 7, from cut 7, depth 75 inches, is a small, sturdy foreshaft which structurally resembles figures 1 and 2; it has a blunt tang and cylindrical upper end for use with a closed socket head. Plate 31, figure 3, from cut 27, depth 26 inches, is broken off above the line hole, and has a squared-off tip, being intended for use with an open socket harpoon head. Plate 31, figure 4, the tip of a similar foreshaft, is from cut 18, 27 inches deep. Plate 31, figure 5, the tip only, is cylindrical, for use with a closed socket; it is from cut 4, 40 inches deep.

The second type of foreshaft, represented by 20 examples, is illustrated on plate 31, figures 8-10. Plate 31, figures 8 and 9, cut 9, 24 inches deep and cut 24, 13 inches deep, have the tang roughened and the line hole about midway. Plate 31, figure 10, from cut 7, 51 inches deep, illustrates the triangular type of line hole. Plate 31, figure 6, from cut 19, 51 inches deep, differs from both types in having had a large round line hole. It is larger than type 2, and probably fell within the length range of type 1. Its rounded tip shows it to have been used with a closed socket harpoon head. It is decorated in Old Bering Sea style, with the line hole bordered by double, spurred circles to which were attached streamers—pairs of straight, rather deep lines paralleled by very finely incised lines. Provenience of the specimens not illustrated need not be given, as the distribution reveals nothing of chronological significance. Comparison with the foreshafts from the Hillside site (pl. 29) shows essentially the same types; figures 2 and 3 of that plate correspond in general with plate 30, figures 1-5, whereas figure 4 and other fragments not illustrated fall within the range of the type illustrated in plate 31, figures 8-10.

In addition to the unquestioned foreshafts, there are a few perforated objects and a very large number of plain, slender ivory and bone rods from both the Hillside site and Miyowagh which conceivably might have been foreshafts. In view of the many possible uses which such simple objects might have had, it seems better not to attribute any particular function to them as a group.

The two fragments shown in plate 33, figures 26 and 27, from cut 19, 12 and 24 inches deep, respectively, seem too small to have been socket pieces for harpoons; they were probably for darts, although there is no evidence as to the nature of the heads used with them. The first has a rounded knob at the end and a small, round socket 13 mm deep and 7 mm in diameter. Encircling the socket are two closely spaced lines with spurs attached, and below these a third line, also spurred. Plate 33, figure 27, has a raised rim and a small round socket 19 mm deep and 6 mm in diameter. The exact function of the two small socket pieces shown in plate 33, figures 28 and 29, is likewise uncertain; they are from cut 7, 37 inches, and cut 10, 40 inches deep. Both have rounded sockets and triangular holes near the base; the tang of the first is conical, that of the second wedge-shaped with the hole passing through it.

Shafts.—Plate 46, figure 15 (cut 18, depth 44 in.) is probably a piece of a harpoon shaft. It is oval in cross-section and has a slanting, scarfed surface where another section, cut in the same way, was joined on. At the upper end is a socket 5.7 cm deep in which the tang of the socket piece rested.

Lances.—Plate 57, figure 1, is a detachable wooden foreshaft for a lance, from cut 23, depth 81 inches. It is a flattened oval in cross-section and is 32.3 cm long, with a blunt, rounded tang and a blade slit 3 cm long. Nelson figures several lance foreshafts of this same general type from western Alaska (pl. 57) and describes their use as follows:

> These lances are used when the seal or walrus has been disabled, so that it can not keep out of reach of its pursuers, when the hunter paddles up close alongside and strikes the animal, driving the detachable head in its entire length. The head remains in the animal, and the hunter immediately fits another point into the shaft and repeats the blow, thus inserting as many of the barbed heads as possible, until the animal is killed or the supply of points exhausted. [Nelson, p. 147.]

Socket pieces.—Two harpoon socket pieces were found at the Hillside site; one of these is the beautifully decorated but badly weathered specimen shown in plate 13, figure 1, the ornamentation of which has been described on page 48. It is 15 cm long and is broken off at the line hole. It is oval to round in cross-section, and was probably more than 20 cm long originally. In the upper end is a pit for the foreshaft 1.5 cm deep and 1.4 cm in diameter, which appears to have been widened somewhat through weathering. Most socket pieces of this type (others to be described later) had a small opening near the upper end through which passed the line that held the foreshaft in place, and below it another and larger hole for the line that connected the socket piece with the wooden harpoon shaft. On this specimen, however, there is no hole near the upper end, from which it would appear that the foreshaft was attached in some other manner, probably by means of a line fastened to the lashing which held shaft and socket piece together. An unfinished socket piece was found in house no. 1. It is 21 cm long, oval in cross-section with a conical tang 4.5 cm long.

Socket pieces are also scantily represented at Miyowagh, with two complete and seven fragmentary specimens. Plate 31, figure 18, is a badly weathered socket piece from cut 13, depth 14 inches. Only a few traces of the Old Bering Sea ornamentation remain, although the deep circular pits, or "eyes", are quite distinct. In the upper end is an oval socket 18 mm deep. Five cm from the top is a circular line hole from which, on either side, descends a deep narrow channel. This upper line hole would normally have received the line attached to the foreshaft, but in this case the downward-pointing grooves would seem to indicate a line connecting with the wooden shaft. If so, one of the two lower holes could have been for the foreshaft line. The tang was conical and was set in the end of the wooden shaft, as was the case with an Old Bering Sea socket piece from Little Diomede Island figured by Jenness (1928 a, pl. 13, *c*). The few other socket pieces of this period that have been described have bifurcated tangs.[9] One half of such a tang is shown in plate 31, figure 15 (cut 24, 54 in.). It is decorated in typical Old Bering Sea style, having two ovoid panels, both spurred, enclosing small, deep circles between converging lines, suggestive of "eyes"; and between and beyond these a number of deep and lightly incised lines together with broken lines. Through the lower end is a small rectangular slot for the line which passed around the inserted end of the wooden shaft, the same arrangement as on the two specimens figured by Mathiassen, 1929, figure 15.

Plate 31, figure 11, is a poorly preserved socket piece, probably unfinished, from cut 16, 26 inches deep. It had a conical tang and a triangular line hole; the upper end is broken. Plate 31, 17 and 19,

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[9] Mathiassen, 1929, fig. 15, *a*, *b*, from Point Hope and Kotzebue Sound. Collins, 1929, pl. 7, *c*, from Miyowagh; (pl. 8, *c*, is incomplete). Collins, 1935, pl. 5, fig. 1, from Kukuliak, St. Lawrence Island.

are the lower ends of two similar socket pieces, one from cut 9, depth 24 inches, and one from cut 23, 25 inches deep. The first has a simple decoration consisting of four pairs of lines, one to each side, extending upward from the level of the line hole. The second was ornamented in Old Bering Sea style, with the line hole bordered by continuous and broken lines and with panels (only the tips of which are left) made in a similar fashion. Plate 31, figure 16, is a small socket piece from cut 17, depth 27 inches. It is squarish in cross-section and appears to be unfinished; the socket is circular, 14 mm in diameter and 16 mm deep. Three fragments are shown in plate 31, figures 12-14. Plate 31, figure 14 (cut 27, depth 9 in.) has a socket 17 mm deep and 11 mm in diameter; it is decorated in the Punuk style with lines and spurs and detached dots. Plate 31, figure 13, from cut 19, 79 inches deep, is made from a walrus penis bone and has been cut off; the socket is 9 mm deep and 12 mm in diameter. The remaining decoration consists of a pair of lines connected by a short curving line, and on the reverse a Punuk design composed of two straight lines, two lines forming a V, and two detached dots. Plate 31, figure 12, from cut 27, 52 inches deep, is likewise only the upper end. It has a socket 20 mm deep and 14 mm in diameter and is decorated with two curving lines.

Ice picks.—Twelve ice picks for the lower end of the harpoon shaft and eight fragments were found at the Hillside site, three of which are illustrated on plate 29, figures 13-15. They are all of ivory, almost always the distal end of a small walrus tusk. They are shorter than most Eskimo ice picks, the average length being around 15 cm. The upper part, or tang, which is roughened for inserting in the lower end of the shaft, is relatively long, sometimes being half of the total length. The lower end is either pointed or spatulate.

The Miyowagh collection includes 103 complete or broken ice picks and a far greater number of broken tangs. Two of the ice picks are of bone, the rest of ivory. Four types can be recognized:

Type 1 (pl. 32, figs. 1, 2).—Heavy; under side more or less flat, upper side convex; roughened conical tang; no abrupt shoulder; average diameter 3 cm.

Fifty-four examples, from all parts of the midden, top to bottom. It is an old type (found also at the Hillside site, pl. 29, fig. 15) used during the entire period Miyowagh was occupied.

Type 2 (pl. 32, figs. 3, 4).—Same as type 1, except that it has a well-defined shoulder between tang and body.

Thirty-four examples, distributed in same manner as type 1 and apparently of same age. For examples from Hillside site, see plate 29, figures 13, 14. On the small broken specimen, plate 32, figure 4, are the outlines of two small human faces, with the eyes, nose, and mouth indicated by dots.

Type 3 (pl. 32, fig. 6).—Slender; rounded triangular to squarish in cross-section; roughened conical tang; no shoulder; average diameter 1.5 to 2 cm.

Ten examples, distributed as follows: Cut 10, 22 inches deep. Cut 13, 54 inches (pl. 32, fig. 6). Cut 15, 24 inches. Cut 18, 24 inches; 49 inches. Cut 19, 56 inches. Cut 23, 52 inches; 58 inches; 64 inches. Cut 24, 64 inches. With 7 of the 10 examples coming from the lower levels of the older (southeastern) section of the midden, and none at all from the later (northeastern) section, this is shown to be an old type, and one that apparently passed out of use before the abandonment of the site. Three examples were found at the Hillside site (U. S. N. M. nos. 352622, 352755, 352853).

Type 4 (pl. 32, fig. 5).—Flat; roughened conical tang; well-defined shoulder.

Only four examples: Cut 1, 63 inches (pl. 32, fig. 5, bone). Cut 4, 15 inches. Cut 5, 23 inches. Cut 9, depth unknown.

The distribution shows this to be a more recent type than the other three, and comparatively unimportant. It is of interest to note that both of the bone ice picks found at Miyowagh belong to this type; they are made of walrus penis bones.

Finger rests.—No finger rests for the harpoon shaft were found at the Hillside site, but this was no doubt due to accident. From Miyowagh there are seven examples, all of ivory. They are divided into two general types:

Type 1.—Long, with slightly concave base and sloping top; a round hole, a slot or two slots for the lashing (pl. 32, figs. 9-12). Plate 32, figure 9 (cut 7, depth 62 in.), has an almost flat base, a deep notch at the rear where the finger rests, and a single drilled hole for the lashing. Plate 32, figure 10 (cut 27, depth 38 in.) has a concave base, a slightly projecting back end and two slots for the lashing. Plate 32, figure 11 (cut 7, depth 37 in.) has the base concave, the back end sloping forward, the front end truncated, and a single long lashing slot. Plate 32, figure 12 (cut 27, depth 16 in.) has a concave base, straight back end, and single small lashing slot.

Type 2.—High, with a flat base; sides slightly incurving; rounded tip; large circular hole for the lashing (pl. 32, figs. 7, 8).

Three examples: The two figured (cut 22, 46 in., and cut 18, 32 in.) and a third from cut 27, depth 38 inches.

Float mouthpieces.—It is of interest to observe that no tubular ivory mouthpieces such as the modern Eskimos use for inflating the bladder floats on light harpoons were found at the Hillside site or the Old Bering Sea sections of Miyowagh, although several were found in the later sections of Miyowagh. The Old Bering Sea type of mouthpiece was a round or oval wooden plug, evidently for a sealskin float used with a heavier harpoon. Twenty-one of these wooden mouthpieces, with a hole through the center and a deep groove around the edge were found at Miyowagh. The three examples shown in plate 32, figures 13-15, illustrate the range of shapes: oval to circular, and with the top surface flat, convex, or conical. They were found as follows: Cut 4, 43 inches; 55 inches. Cut 9, depth unknown. Cut 9 a, 60 inches. Cut 18, 36 inches; 44 inches (2) (pl. 32, fig. 13); 48 inches (pl. 32, fig. 14); 68 inches. Cut 19, 34 inches; 59 inches (2); 63 inches. Cut 23, 39 inches; 45 inches; 58 inches. Cut 24, 54 inches; 64 inches; 72 inches. Cut 25, 55 inches (pl. 32, fig. 15). Cut 29, 36 inches. This distribution is rather striking; most of the 21 specimens come from the older section of the midden and mostly from the lower levels, and the two from the later section (cut 4) are also fairly deep. It would appear, therefore, that this is an old type which began to fall into disuse during the period Miyowagh was occupied.

For closing the openings of such mouthpieces, a *wooden stopper* was used (pl. 32, figs. 21, 22). There are 19 of these, distributed in much the same way as the mouthpieces: Cut 18, 28 inches; 34 inches; 36 inches; 44 inches (pl. 32, fig. 21); 48 inches; 49 inches; 59 inches; 60 inches; 63 inches; 66 inches; 72 inches. Cut 19, 56 inches (pl. 32, fig. 22). Cut 22, 36 inches. Cut 24, 54 inches; 72 inches. Cut 25, 72 inches. Cut 27, 26 inches; 38 inches. Cut 28, 31 inches.

No float mouthpieces were found at the Hillside site, but the presence of two wooden stoppers like those illustrated from Miyowagh shows that they were used.

Float plugs.—Wooden or ivory plugs were used for closing holes (either the natural orifices or wound tears) in the sealskin floats. Three of these, of wood, are very similar to the mouthpieces, lacking only the perforation. One is shown in plate 32, figure 16 (cut 9, 48 in.); it is oval and has a very deep, wide groove. The other two are from cut 1, 42 inches, and cut 18, 44 inches. There are also four ivory plugs: plate 32, figure 17 (cut 2, 12 in.) is long and narrow, with a deep, wide groove; it has a flat base and a convex top, on which a decoration, much eroded, is still visible. Plate 32, figure 18 (cut 22, 41 in.) is the same, but shorter and wider; it may be unfinished as the groove is very shallow. Plate 32, figure 19 (cut 25, 18 in.) is convex at both ends and has a groove 13 mm wide and 4 mm deep. The fourth specimen comes from cut 20, depth 34 inches.

Float bars.—For attaching a line to the float, the modern Seward Peninsula and St. Lawrence Eskimos fasten an ivory bar or handle to one end (Nelson, p. 145). The only object in the present collection which has the sunken center and knobbed ends characteristic of the modern type is the one shown in plate 32, figure 20 (cut 4, depth 25 in.). In all probability, however, some of the " handles " illustrated on plate 47 were float bars.

Bird Darts and Fish Spears

Side prongs for bird darts.—Ivory prongs, three of which were lashed onto the shaft of the bird dart at a point usually a little below the middle. Twenty-five complete and thirty-two fragmentary prongs were found at Miyowagh, indicating that the bird dart was an implement of some importance; however, it differed in several respects from the modern types. On the basis of the 25 complete specimens, two general types, with one subtype each, are recognized:

Type 1 (pl. 33, figs. 1, 2).—Short (7.5 to 8.5 cm long); oval to round in cross-section; one outside, two inside barbs; narrow rectangular lashing slot, with outer opposite edge usually smooth; tang spatulate (rarely pointed) and beveled on inside.

Eleven examples: Cut 4, 15 inches; 20 inches. Cut 7, 33 inches. Cut 18, 53 inches (2). Cut 19, 58 inches. Cut 23, 8 inches (pl. 33, fig. 1); 14 inches (2). Cut 24, 39 inches. Cut 27, 29 inches (pl. 33, fig. 2).

The prong from cut 7, 33 inches deep, was the only other one having a projection just above the end of the tang, like that shown in plate 32, figure 1.

Type 1 a (pl. 33, figs. 3, 4).—Same as type 1, except that it has two outside and three inside barbs.

Two examples: Cut 7, 75 inches (pl. 33, fig. 3). Cut 18, 66 inches (pl. 33, fig. 4).

Type 2 (pl. 33, figs. 5, 6).—Longer (10 to 14.5 cm long); usually a longitudinal ridge down one or both sides; two outside, three inside barbs; narrow rectangular lashing slot, sometimes with two notched elevations on opposite edge; tang spatulate and beveled on inside.

Five examples: Cut 2, 24 inches (2) (pl. 33, fig. 6). Cut 18, 27 inches. Cut 20, 12 inches (pl. 33, fig. 5). Cut 22, 46 inches.

Type 2 a (pl. 32, fig. 7).—Same as type 2 except for lashing arrangement, a groove replacing the slot.

Three examples: Cut 2, 24 inches (2) (pl. 33, fig. 7). Cut 9, 24 inches.

Four specimens do not belong to any of the above groups. One of them, plate 33, figure 8 (excavated by an Eskimo), has four barbs on both inside and outside; otherwise it conforms to type 2. Plate 33, figure 9 (cut 19, 24 in.) is unique in being regularly triangular in cross-section; it has a single notched elevation opposite the lashing slot.

From their distribution, the small and relatively simple types 1 and 1 a appear older than types 2 and 2 a. The latter two types were contemporary, for two type 2 and two type 2 a prongs were found all in a group together in cut 2.

The notched elevations, one to three in number, opposite the lashing slot (pl. 33, figs. 5, 6), belong to the later period (Early Punuk) rather than to the Old Bering Sea, for they are found on a majority of the complete specimens of type 2 and also on most of the broken specimens (of uncertain type) from the later sections of the midden. The use of small circular holes, sometimes plugged with baleen, as decorations around the lashing slot is another feature associated with the later type.

Two badly weathered fragmentary side prongs were found at the Hillside site. They were small and apparently belonged to type 1.

End points for bird darts.—There is no very good evidence as to the nature of the single points which were set in the end of the bird darts. The only specimen from Miyowagh which is at all comparable to the long heavy points used on modern bird darts (see Nelson, pl. 59, figs. 7-10) is that shown in plate 33, figure 11, from cut 9, 24 inches deep. It is roughly triangular in cross-section with two pairs of opposite barbs and a plain conical tang. Plate 33, figure 10 (cut 19, 34 in.) seems also to have been an end point; the barbs are placed alternately instead of opposite, and there is a longitudinal ridge down each side, giving it a lozenge shape in cross-section; the tang is roughened. Plate 33, figure 12 (cut 20, 30 in.) may have been an end point; it has a long sharp tang and three barbs. Two other doubtful examples are shown in plate 33, figures 13 and 14 (cut 18, 18 in., and cut 9, 24 in.); the first has two barbs (partly removed by secondary cutting) and the second, one barb; both have plain tangs. Plate 33, figure 15 (cut 19, 38 in.) is the only example of an end point which was lashed in place; for this purpose it was provided with a scarfed surface on the inside, with the opposite edge notched.

The only end point found at the Hillside site was the badly weathered specimen shown in plate 29, figure 5. It has a conical tang and a line hole made by connecting two round drilled holes. There are seven barbs, four on the right edge and three on the left, each placed midway between the two opposite barbs.

Points for fish spears.—In plate 33, figures 16-22, are shown several slender ivory and bone points from Miyowagh, the use of which is not certain, although they may have served as points for light fish spears or darts. Plate 33, figures 16 and 17, from cut 19, 12 and 51 inches deep, have a single row of barbs and long pointed tangs; the latter specimen is lashed with baleen to a wooden rod or shaft, so light and small that it would seem to have been a toy rather than a real projectile. Plate 33, figure 18 (cut 1, 30 in.) is similar but longer. Plate 33, figure 19 (cut 20, 22 in.) is the longest of these points; it is 20.8 cm long, has 11 widely spaced barbs, a pointed tang, and two small protuberances similar to the notched elevations on the side prongs of bird darts; it is of bone. Plate 33, figures 20 and 21 (cut 17, 26 in., and cut 1, 18 in.) are short, relatively thick, and are equipped with three and two barbs near the tip. Plate 33, figure 22 (cut 27, 32 in.) is flat with three bilateral semicircular "barbs."

Throwing Boards

Four pieces of throwing boards were found, all at Miyowagh. Plate 37, figure 1 (cut 28, 37 in.) shows the general shape, except for the upper end. The index finger rested in a deep hole on the back, so deep that it has worn through to the front; just below, along the left edge there are three pits for the other fingers; the thumb rested in a broad notch on the opposite edge. The smaller fragment, plate 37, figure 2 (cut 18, 53 in.), is from the lower end, which was rather narrow and straight. Two other fragments similar to this come from cut 18, at depths of 32 and 40 inches. The throwing board is no longer used on St. Lawrence Island, and these old examples differ in certain respects from all other known types. In the style of grip, they resemble the old Point Barrow form more than any other.

The two small ivory objects shown in plate 29, figures 8 and 9, from the Hillside site, appear to be pegs which were placed at the end of the throwing board for engaging the butt end of the dart. The shank end of plate 29, figure 8, was set into the end of the throwing board at an oblique angle; plate 29, figure 9, was probably lashed on, with the flat lower side downward, leaving the point to engage in the end of the dart shaft.

Two similar specimens are shown in plate 33, figures 23-24 (from cut 24, 39 in., and cut 1, 24 in.). In the first the tang extends almost straight back, having been set in an oblique hole. In the second the tang is more nearly at right angles to the upper part. In both cases the free end or tip is pointed or nearly so, and the top surface flat.

Plate 33, figure 25 (cut 27, 16 in.), is an ivory peg with a small rounded socket in the upper end. This may have been set in the butt end of a dart shaft to engage the tip of a spur such as just described; the socket, however, seems rather small for this purpose.

Ice Creepers

Like the modern Eskimos of northern Alaska, those of the Old Bering Sea period used "ice creepers"—flat pieces of bone or baleen with inset ivory spikes, which were attached to the soles of the boots to keep the feet from slipping when walking on ice (see Nelson, p. 215). The collection from Miyowagh includes six, all different from those used at the present time. Plate 37, figure 3 (cut 18, 81 in.) is of whale bone, with three inset ivory pegs or spikes. It was fastened to the foot by means of thongs which passed through a pair of holes at each end; the holes are connected by sunken grooves to prevent the lashing from being worn down. Plate 37, figures 4, 5 are of baleen; the first (cut 19, 51 in.) has the ivory pegs in place, the other (cut 23, 58 in.) has the pegs missing. Another baleen specimen similar to this but shorter was found at a depth of 44 inches in cut 27. The two other ice creepers from Miyowagh are of bone and ivory, but since they were found in the upper levels of the later section of the midden, they are described with Punuk material (see pl. 75, figs. 23 and 25).

Bows and Arrows

There is no clear evidence as to the exact nature of the Old Bering Sea bow. From a number of fragments—and toys—it appears that the middle was constricted and thickened and the ends tapering. The baleen bow shown in plate 55, figure 1, was no doubt a toy, as was also the smaller one in plate 56, figure 15, and the two of wood shown in plate 59, figures 26, 27. In this connection it should be noted that flat bone braces such as are used on some of the modern Alaskan sinew-backed bows and the sinew twisters which are always associated with the latter are both characteristic of the Punuk stage but do not appear to have been used during the Old Bering Sea period. From this it would seem fair to infer that the sinew-backed bow was unknown to the Old Bering Sea Eskimos. The only clear example of a backed bow in the present collection is a toy, with rather elaborate reinforcements of baleen and wood from cut 19, depth 42 inches, in the early Punuk level at Miyowagh (pl. 60, fig. 8).

Arrowheads.—Three arrowheads were found at the Hillside site, two of which are shown on plate 29, figures 6, 7. The first is of bone with smooth, sharp, conical tang just above which are two barbs. These are made in a somewhat unusual manner; beginning a little above the center four deep incisions, two on the front and two on the back, are carried downward becoming deeper and deeper, until, just above the tang, they cut through and meet, leaving two sharp barbs which lie close to the shank and point straight downward. The third specimen from the Hillside site is of the same type, but has a blade slit; on it a decorative effect is provided on one side by two shallow lines which extend from the ends of the deeply cut lines to the blade slit, and by a faint median line which runs from tang to a little above center; the latter feature is also present on the reverse of plate 29, figure 6. The latter had a pointed tip with no inserted blade. Plate 29, figure 7, is an ivory arrowhead of an unusual type, 15.8 cm long, with smooth conical tang and a blade slit 3 mm wide. It is square in cross-section, but the four sides instead of being straight were cut spirally, so that each side makes between a quarter and a half turn as it runs from tang to tip.

The Miyowagh collection contains 25 arrowheads and 2 recognizable fragments. It is of interest to note that 23 of these are of bone and only 4 of ivory. This is one of the few instances where bone is employed in preference to ivory. Six types of arrowheads can be distinguished:

Type 1 (pl. 34, fig. 1).—Rounded in cross-section; end blade; no barbs.

One example, of bone, from cut 27, depth 26 inches. This was the only arrowhead found with blade in place; the latter is of chipped chert, with a straight base.

Type 2 (pl. 34, figs. 2, 3).—Round to oval in cross-section; end blade; a single barb near the tang.

Three examples, of bone, from cut 18, 36 inches (pl. 34, fig. 2), 42 inches, and 44 inches (pl. 34, fig. 3). The barbs lie close to the body and are made in the same manner as those on the specimen from the Hillside site (pl. 29, fig. 6). In figure 2 a line extends upward from the barb for a considerable distance, meeting another line which continues downward to the tang. The long triangular space thus formed is divided in the middle by two short transverse lines, with a long, deep line occupying both halves. This decoration is present on one side only. The second example of this type (pl. 34, fig. 3) is larger—18 cm long—and the barb has an outward flare. The line extending from the barb is opposed by a similar line ending with a slight shoulder or notch; there are two more of these shoulders or ornamental barbs at the center; at the top, two lines converge to the blade slit, and on the lower end a decorative effect is provided by two oblique lines.

Type 2 a (pl. 34, fig. 4).—Rounded to oval in cross-section; end blade; two opposite barbs near the tang.

Two examples, of bone, from cut 18, 60 inches (pl. 34, fig. 4) and cut 23, 72 inches. In both of these the barbs are close to the body, and a deep line continues upward as in type 2. In plate 34, figure 4, decoration is restricted to a long, deep line between the barbs and another down one edge.

Type 3 (pl. 34, fig. 5).—No end blade; a single barb near the tang.

Two examples: Cut 21, 38 inches. Cut 27, 26 inches (pl. 34, fig. 5). The first is of ivory, with a longitudinal ridge down both sides, giving it a squarish cross-section. The second, of bone (pl. 34, fig. 5), is roughly triangular in cross-section, apparently unfinished; the single barb (with tip broken) lies very close to the body, and as a continuation of it, a deeply cut straight line extends upward, almost meeting a similar line opposite, which, however, does not end in a barb; between the two lines are three short, oblique lines, with a similar one lower down. In the form of the barb this type of arrowhead shows a close relationship to types 2 and 2 a.

Type 4 (pl. 34, fig. 6).—Rounded in cross-section; no end blade; two opposite, prominent barbs at about center.

Three examples, all of bone: Cut 19, 17 inches; 24 inches; 34 inches (pl. 34, fig. 6). The other two of this type have deeply cut lines above the barbs like plate 34, figures 2-5.

Type 5 (pl. 34, figs. 7-9).—Flat, or somewhat rounded in cross-section; no blade; a single, prominent barb at about center.

Eight examples, seven of bone, one of ivory: Cut 4, 25 inches. Cut 9, 36 inches. Cut 17, 12 inches; 20 inches (pl. 34, fig. 7). Cut 18, 25 inches. Cut 19, 38 inches; 42 inches (pl. 34, fig. 8). Cut 20, 12 inches (pl. 34, fig. 9).

Type 6 (pl. 34, fig. 10).—Flat; neither blade or barbs.

Five examples, four of bone, one of ivory: Cut 4, depth 68 inches. Cut 9, 24 inches. Cut 19, 12 inches (pl. 34, fig. 10). Cut 22, 36 inches (2).

There remain two arrowheads which do not fall into any of the above types. Plate 34, figure 11 (cut 25, 61 in.), is of bone and is 21.1 cm long. There are three prominent barbs on one side, which were made in the same manner as those of plate 34, figures 2-6, with an opposite line in place of another barb as in plate 34, figures 2, 3,

5. The decoration, consisting of two short and two longer lines, separated by two groups of short transverse lines, is very similar to that in plate 34, figure 2; it is present on one side only. Plate 34, figure 12 (cut 22, 30 in.), of bone, has the lower end cut away to a shoulder just above the tang. There were three barbs, near the tip, so small as to be hardly more than notches. Plate 34, figure 13, from cut 9, depth 24 inches, is an ivory point set in the end of a wooden shaft, with the baleen wrapping still preserved. In shape the point is more like a foreshaft than anything else, although it has no line hole. On the other hand the manner of hafting is that of an arrow, which it probably was, in spite of the blunt end; it may have been a child's arrow, never intended for serious use. With this was found a "cache" of finished and unfinished projectile points, foreshafts, etc., including several arrow points which were triangular in cross-section. This is a recent type on St. Lawrence Island, and its occurrence, together with a quantity of other ivory artifacts, mostly unfinished, at this one place in the midden, but not elsewhere, suggests that the entire "cache" may have been later than the other material in this part of the midden.

None of the tangs have knobs or projections; they are either perfectly smooth or merely roughened by hacking. It should also be noted that all of the blade slits, or sockets, are around 4 mm wide, evidently in order to accommodate a rather thick, chipped stone blade like that of plate 34, figure 1.

We may now consider the relative ages of the types. It will be noted that five of the type 5 and type 6 specimens come from the later, northwestern section of the midden, and eight from the upper levels of the older, southeastern section. On the other hand all 10 of the examples of types 2, 2 a, 3, and 4, in addition to plate 34, figure 11, came from the older part of the midden, most of them from around the 3-foot level with the two examples of type 2 a coming from depths of 5 and 6 feet. It seems clear, therefore, that types 2, 2 a, 3, and 4 are older than types 5 and 6. As pointed out above, the principal distinction between the two groups is the unusual appearance of the barbs: in the older types they lie usually close to the shank, with a deep line, extending upward, and opposite, a similar line which may or may not terminate in a barb. It will be recalled that both of the barbed arrow points from the Hillside site (pl. 29, fig. 6) had barbs made in this way.

Arrow shafts.—The lower ends of two arrow shafts are shown in plate 57, figs. 4, 5 (cut 19, 32 in., and cut 18, 66 in.). Neither of them shows evidence of having been feathered, although another specimen, from the Hillside site, has two splits extending through the shaft, evidently for this purpose.

The ivory object shown in plate 48, figure 24 (cut 18, 27 in.) may have been used for setting the feathers in the arrow shaft; the sharp, straight lower end would have been well adapted to such a purpose.

Wound Plugs

Wooden plugs like those shown in plate 35, figures 11-14, are described by Nelson as follows:

> To insure the seals floating while being towed, it is a common practice to make slits in the skin at various points and, with a long pointed instrument of deer-horn, to loosen the blubber from the muscle for a space of a foot or more in diameter. Then, by use of a hollow tube, made from the wing-bone of a bird or from other material, air is blown in and the place inflated; wooden plugs are then inserted in the slits and driven in tightly to prevent the air from escaping. By the aid of several such inflated spots the seal is floated and the danger of losing it is avoided. [Nelson, 1899, p. 131, pl. 52, fig. 19.]

It is likely that they were also used as in the Central region and Greenland to close the wound made by the harpoon. Twenty-three were found at Miyowagh, as follows: Cut 1, 60 inches. Cut 5, 30 inches; 42 inches. Cut 9, depth unknown (3). Cut 10, 31 inches (2); 54 inches. Cut 13, 40 inches. Cut 16, 12 inches; 26 inches; 46 inches; 52 inches. Cut 18, 49 inches; 53 inches. Cut 19, 45 inches (pl. 35, fig. 11); 59 inches (pl. 35, fig. 14); 86 inches (pl. 35, fig. 12). Cut 23, 45 inches; 64 inches. Cut 24, 64 inches. Cut 25, 72 inches (pl. 35, fig. 13). None was found at the Hillside site.

The general shape is wedgelike, with the upper end pointed and tapering and the lower thicker end either rounded or squared off. They were perforated at the upper end, so that a number of them could be strung together on a line. Plate 35, figure 12, is unique in having two small wooden plugs set in rectangular slots at the larger end. The distribution shows the wound plug to have been an Old Bering Sea type which seems to have been less extensively used during the Punuk period.

Meat Hooks

Although no longer in use on St. Lawrence Island, these implements no doubt correspond in function with the blubber hooks from Point Barrow described by Murdoch: "For catching hold of pieces of blubber or flesh when 'cutting in' a whale or walrus, or dragging them round on shore or on the ice, or in the blubber rooms, they use hooks made by fastening a backward-pointing prong of ivory on the end of a wooden handle, which is bent into a crook at the other end." (Murdoch, 1892, p. 310). From Kotzebue Sound southward to the

Kuskokwim similar hooks are used as boat hooks (Nelson, 1899, pp. 222-223), and it may well be that some of the larger examples in the present series were used for this purpose.

Forty-six hooks of ivory were excavated at Miyowagh, in addition to six unfinished forms and nine fragments; one specimen was found at the Hillside site. They fall into the following types:

Type 1 (pl. 35, fig. 1).—Single, long lashing slot through the top; small slot through base of prong; prong about same length as body.

Twenty examples, distributed as follows: Cut 1, depth 48 inches. Cut 2, 24 inches. Cut 3, 20 inches; 24 inches; 50 inches; 54 inches. Cut 4, 39 inches (2); 43 inches (2). Cut 7, 28 inches; 33 inches; 37 inches (pl. 35, fig. 1). Cut 8, 40 inches. Cut 9, depth unknown. Cut 18, 27 inches (2). Cut 19, 24 inches. Cut 22, 41 inches. Cut 24, 54 inches.

Type 1 a (pl. 35, fig. 2).—Same as type 1, except that it is larger, with prong longer than body.

Seven examples: Cut 2, 48 inches (pl. 35, fig. 2, the end reworked into a drill). Cut 3, 20 inches. Cut 9, 48 inches; another, depth unknown. Cut 19, 42 inches; 54 inches. Cut 23, 8 inches.

Type 2 (pl. 35, fig. 3).—Two short lashing slots through top; otherwise same as type 1.

Five examples: Cut 3, 12 inches. Cut 4, 70 inches. Cut 19, 51 inches; 56 inches (pl. 35, fig. 3). Cut 27, 29 inches.

Type 3 (pl. 35, fig. 4).—Two or three circular lashing holes through the top; a similar hole through base of prong; prong about same length as body.

Five examples: Cut 1, 55 inches. Cut 3, 24 inches; 54 inches. Cut 22, 24 inches; 36 inches (pl. 35, fig. 4). The single example from the Hillside site belongs to this type.

Type 3 a.—Same as type 3, except that it is larger, with prong longer than body.

Two examples, one from cut 15, 40 inches deep, the other picked up on the surface.

Type 4 (pl. 35, fig. 6).—Five or six circular lashing holes through center of body; body longer than spur.

Two examples, from cut 4, 31 inches, and cut 20, 26 inches (pl. 35, fig. 6).

Type 5 (pl. 35, fig. 5).—A wide lashing groove across top and one or two circular holes through base of prong; prong about same length as body.

Three examples: Cut 7, 85 inches (pl. 35, fig. 5). Cut 9, depth unknown. Cut 18, 40 inches.

Type 6 (pl. 35, fig. 7).—Long and slender; lashing groove across top; no holes; prong longer than body.

One example, from cut 3, 24 inches (pl. 35, fig. 7).

Type 7 (pl. 35, fig. 8).—Large and heavy; deep, wide lashing groove across top; prominent upstanding back end; prong about same length as body.

One example, from cut 17, 20 inches (pl. 35, fig. 8).

Little can be said regarding the chronology of the forms. Types 4 and 7 were restricted to the later section of the midden and are therefore Punuk types, and presumably later than types 1 to 3 a, 5, and 6. The latter, however, were generally distributed throughout the midden, suggesting that there was no segregation according to period, the several types having been more or less contemporaneous.

The two small ivory hooks, plate 35, figures 9, 10 (cut 5, 32 in., and cut 23, 78 in.), may be barbs for salmon spears. They have flat bases, like the meat hooks, so that if they were salmon barbs they differ from those of the Thule Culture (Mathiassen, 1927, vol. 1, pl. 12, figs. 10, 11; pl. 43, figs. 1, 3-5; pl. 71, figs. 2, 3; pl. 77, fig. 13) and of the modern Alaskan Eskimo (Nelson, 1899, fig. 42, fig. 1).

Fishline Sinkers

The plummet-shaped fishline sinker is an important element of the Old Bering Sea culture. Seventy complete and eleven broken specimens were found at Miyowagh, all of ivory except two which were of bone; four, of ivory, were found at the Hillside site. Although relatively simple, there is sufficient variation in size, shape, and position of the line holes to warrant a division of the fishline sinkers into several types, as follows:

Type 1 (pl. 36, figs. 1-4).—Thick; line holes at right angles; lower end tapers abruptly, upper end gradually, so that the maximum thickness is below the center; sometimes a prominent side bulge below center, projecting in plane of the lower line hole.

Nineteen examples were found, distributed as follows: Cut 1, depth 38 inches. Cut 7, 46 inches (pl. 36, fig. 3). Cut 9 a, 12 inches. Cut 10, 50 inches. Cut 18, 51 inches (pl. 36, fig. 2); 57 inches; 59 inches (pl. 36, fig. 1); 60 inches (2); 66 inches. Cut 19, 24 inches; 56 inches (2). Cut 20, 12 inches. Cut 21, 29 inches. Cut 23, 68 inches. Cut 24, 36 inches (pl. 36, fig. 4). Cut 27, 38 inches. Cut 29, 29 inches.

This is perhaps the most striking and clear-cut of the several types and also one of the oldest. Only five examples (those from cuts 1, 19, and 20) were found in the northwestern part of the midden, the others coming from the older, southeastern section. It should be noted in this connection that one of the three sinkers from the Hillside site was of this type.

Type 1 a (pl. 36, figs. 5, 6).—An extreme form of type 1, with the characteristic side bulge accentuated and the upper end very long and slender.

Two examples were found: Cut 4, 48 inches (pl. 36, fig. 6) and cut 13, 20 inches (pl. 36, fig. 5). The upper end of figure 6 is notched, as in the case of four examples of type 1; in figure 5 the notch is enlarged so as to suggest a fish's tail, and the line holes are parallel.

Type 2 (pl. 36, figs. 7-9).—Thick to slender; more symmetrical than type 1; the side bulge, when present, is more centrally placed; from this it grades into a more slender, symmetrical form, oval to almost round in cross-section, with evenly tapering ends; line holes at right angles.

Twenty-two examples, as follows: Cut 6, 20 inches. Cut 7, 51 inches; 92 inches. Cut 9, depth unknown (pl. 36, fig. 7). Cut 9 a, 12 inches (2). Cut 10, 31 inches. Cut 18, 27 inches (pl. 36, fig. 8); 60 inches. Cut 19, 17 inches; 38 inches (pl. 36, fig. 9); 48 inches; 51 inches; 72 inches. Cut 21, 24 inches; 42 inches; 46 inches. Cut 23, 68 inches. Cut 25, 96 inches. Cut 27, 9 inches; 22 inches. Cut 29, 24 inches.

This, the most common type, is the least clear-cut, including forms as diverse as plate 36, figures 7 and 9. However, there is no sharp line dividing them; from an asymmetrical form with a side bulge which differs from that of type 1 only in that it is nearer the center, there is a gradual transition into the more slender, symmetrical forms with evenly tapering ends. The distribution according to cut and depth (almost all of them coming from the southeastern section of the midden) shows it to be an old type, probably contemporaneous with type 1, to which it is also typologically related.

Type 3 (pl. 36, figs. 10-12).—Thick to slender, with an inclination to flatness; no side bulge; symmetrical or nearly so; line holes parallel.

Nine examples, as follows: Cut 3, 16 inches (pl. 36, fig. 12). Cut 8, 72 inches. Cut 9, depth unknown. Cut 18, 12 inches (pl. 36, fig. 10); 25 inches; 40 inches. Cut 19, 5 inches (pl. 36, fig. 11). Cut 23, 14 inches. Cut 25, 52 inches.

Like the preceding, this is a variable type, the range of which is shown by the three specimens figured. Plate 36, figure 12, is unusual in that the two line holes are in the direction of the greatest breadth; in the eight other examples of this type, the two line holes are at right angles to the greatest breadth. Judging from the depth and distribution, this appears to have been another of the older types, only two examples coming from the northwestern section.

Type 4 (pl. 36, fig. 13).—Slender; symmetrical; round in cross-section; maximum thickness at center; both ends long and tapering with long, triangular, parallel line holes.

This is a special form, represented by a single specimen from cut 7, 75 inches deep (pl. 36, fig. 13).

Type 5 (pl. 36, figs. 14, 15).—Flat and relatively wide; small; line holes at right angles.

Three examples: Cut 1, 38 inches (pl. 36, fig. 14). Cut 4, 31 inches. Cut 19, 34 inches (pl. 36, fig. 15).

With all three examples having been found in the later, northwestern section, the indications point to this type being later than those described above.

Type 6 (pl. 36, figs. 16, 17).—Same as type 5 except that line holes are parallel.

Six examples: Cut 4, 43 inches (pl. 36, fig. 16). Cut 7, 28 inches. Cut 18, 12 inches; 36 inches (pl. 36, fig. 17). Cut 23, 64 inches. Cut 26, 38 inches.

This type is somewhat variable as to shape: three others approximate plate 36, figure 16 (which is of bone), in outline; plate 36, figure 17, is unique in being very flat and narrow; the remaining example of this type is wider than the others and had also been made to serve as a drill rest. Age rather uncertain, but present indications suggest contemporaneity with type 5.

Type 7 (pl. 36, fig. 18).—Small and thick; line holes at right angles.

One example, from cut 6, 12 inches (pl. 36, fig. 18).

Type 8 (pl. 36, figs. 19, 20).—Same as type 7 except that line holes are parallel.

Three examples: Cut 1, 30 inches (pl. 36, fig. 20). Cut 17, 26 inches. Cut 23, 79 inches (pl. 36, fig. 19).

Plate 36, figure 20, and the third example of the type (cut 17, 26 in.) are walrus teeth, the former with both ends slightly worked for the line holes, the latter with only one end worked. Age uncertain: the two specimens last mentioned are from the later section of the midden, although plate 36, figure 19, must be old.

Four of the sinkers, two of which are shown in plate 36, figures 21, 22, do not conform to any of the above types. Plate 36, figure 21, from cut 15, depth 40 inches, was made to represent a fish; curving lines around the gills and the peculiar arrangement of the lower line hole, suggesting a mouth, add to the general impression. The lower line hole is a perforation just above the end and to the side, at right angles to the upper line hole.

Plate 36, figure 22, also from cut 15, 40 inches deep, is an unfinished harpoon head, which has been converted into a sinker by cutting line holes at the tip and through the end of the spur; both ends are deeply grooved and notched.

The distribution of the various types in the two sections of the Miyowagh midden may be summarized as follows:

	Type 1	Type 1 a	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	Type 8	Total
Southeastern section........	12	1	17	7	1	..	5	..	1	44
Northwestern section........	5	1	5	2	..	3	1	1	2	20

It appears from the above that of the 44 sinkers from the older, southeastern section of Miyowagh, 38, or 86.3 percent, belonged to types 1 to 4, and 6, or 13.6 percent, to types 5 to 8; of the 20 sinkers from the later, northwestern section, 13, or 65 percent, belonged to types 1 to 3, and 7, or 35 percent, to types 5 to 8.

Another feature which seems to possess chronological value is the notched end (pl. 36, figs. 3-7, 13, 17, 22). Fifteen sinkers had one or both ends notched, and of these, twelve belonged to types 1 to 4.

The shape of the line hole seems to have no particular significance, although triangular or slightly irregular holes are more frequently associated with types 1 to 4 than with the later types.

Men's Knives

Wooden handles.—Four wooden knife handles were found at the Hillside site and twenty at Miyowagh. Two of the Hillside specimens are shown in plate 29, figures 11, 12. The first of these, which has the stone blade still in place, was found beneath the floor stones of house no. 1. The wooden handle is 19.8 cm long and is notched at the lower end for suspension. The blade is of chipped chert, with one edge curved and one practically straight. At the socket end the handle was cut down somewhat, providing a slight depression for the lashing, which was prevented from slipping off by the elevated triangular tip. A shorter knife handle is shown in plate 29, figure 12. It is flat, pointed at the lower end, distinctly curved along one edge and straight or very slightly curved on the other. The socket is like that of the preceding specimen, with a slightly sunken area for the lashing below the thickened tip; another handle similar to this in shape has the socket end flush with the rest of the surface. The fourth handle from the Hillside site is straight-sided and oval in cross-section, with the tip fashioned like plate 38, figure 2.

The 20 wooden handles from Miyowagh fall into three distinct groups.

Type 1 (pl. 38, fig. 1).—For end blade. Short (length 10 to 13 cm), and flat; blade slit 2.5 to 4.5 cm long; a slightly elevated, wedge-shaped tip below which the lashing was wrapped.

Ten examples, distributed as follows: Cut 7, 37 inches. Cut 18, 42 inches. Cut 19, 54 inches; 63 inches; 79 inches. Cut 21, 35 inches. Cut 24, 64 inches (2). Cut 26, 55 inches (pl. 38, fig. 1). Cut 27, 38 inches.

The specimen illustrated is the only one of the type found with the blade intact, but another has the tang remaining in place. All handles of this type seem designed for such end blades, either of rubbed slate or of chipped stone like that from the Hillside site shown on plate 29, figure 11.

Type 2 (pl. 38, fig. 2).—For side blade. Longer (14.5 cm or more), and either round or rounded oval in cross-section; blade slit at the end 5.5 to 8.3 cm long; plain, pointed tip with ivory rivet for holding the blade in place.

Three examples: Cut 13, 29 inches (pl. 38, fig. 2). Cut 18, 36 inches. Cut 19, 79 inches.

Type 3 (pl. 38, figs. 3, 4).—For side blade. 13.8 to 19 cm long; differs from type 2 in having the side blade set in a long deep socket instead of an end slit; the socket does not extend to the tip; blade held in place by lashings above and below.

Four examples: Cut 18, 42 inches. Cut 19, 63 inches. Cut 23, 64 inches (pl. 38, fig. 3). Cut 24, 36 inches (pl. 38, fig. 4).

In the length of the blade this type approaches the ulu, or woman's knife.

The distribution of these three types of knife handles is striking, all having been found in the older, southeastern section of the midden or in the deeper levels of cut 19, the southernmost of the cuts in the northwestern section. These are, therefore, types of the Old Bering Sea culture. Two comparable examples were found at the Hillside site—plate 29, figure 11, and one other; these are to be included in type 1; the other type from the Hillside site (pl. 29, fig. 12) is not represented at Miyowagh.

In addition to the knife handles enumerated there are two which do not fall into any of the above types and one which is doubtfully classed as a handle. The latter, from cut 25, 89 inches deep, is 26.8 cm long, oval in cross-section and has a blade slit only 2.2 cm long;

it lacks the rivet hole characteristic of type 2. Another (cut 29, 36 in.), is half of a compound knife handle, made to enclose a long, tapering, and slightly curved tang. The third handle, from cut 7, 51 inches, approaches the second main class of knife handles, of bone or ivory, described below. It has a socket 3 cm long and 1.2 cm deep opening both on the side and at the end; there is a small shoulder to hold the lashing, which passed around the side on which the socket opens, showing that the cutting part of the blade projected above the tip—in other words that the handle was provided with an end blade in spite of the appearance of a side socket.

The width of the blade slits or sockets—from 2 to 5 mm—indicates that all of the wooden knife handles were fitted with stone blades.

Ivory and bone handles.—There are 62 knife handles of ivory and bone from Miyowagh, among which the following types can be recognized.

Type 1 (pl. 38, figs. 5-7).—Consists of two pieces which were lashed together to enclose a small blade at one end, sometimes at both ends, blade being set in a short narrow socket with the opposite side roughened or cut away, leaving a more or less prominent tip for holding the lashing in place; occasionally a short transverse or longitudinal slot for pegging the two halves together. Length range, 5 to 15 cm; average length 8 to 9 cm.

This is the well-known Eskimo tool used for cutting bone or ivory—the "antler chisel" of Murdoch, the "whittling knife" of Mathiassen. In all, 56 were found, 48 of ivory and 8 of bone. Since the size and shape of the blade socket may have a bearing on the kind of blade used, it may be well to consider this feature. On this basis the type 1 handles fall into three rather distinct groups: (1) with rather large, straight blade sockets—12 to 30 mm long, about 2 mm wide, and 3 to 10 mm deep; (2) with very small, straight sockets—4 to 8 mm long, about 1 mm wide, and 1.5 to 3 mm deep; (3) with large, curved socket, 11 to 28 mm long, 2 to 5 mm wide, and 2.5 to 8 mm deep.

There are 19 of the first group, distributed as follows: Cut 7, 28 inches. Cut 8, 32 inches (2, one of bone). Cut 17, 36 inches. Cut 18, 30 inches (pl. 38, fig. 6); 40 inches; 42 inches. Cut 19, 12 inches; 27 inches; 32 inches. Cut 23, 14 inches (bone); 18 inches; 52 inches; 68 inches. Cut 27, 16 inches (socket at both ends); 44 inches (bone); 46 inches; 52 inches (socket at both ends). Cut 28, 31 inches.

Of the second group, with very small blade sockets, there are 31 examples: Cut 1, 55 inches. Cut 2, 28 inches (2). Cut 7, 28 inches; 46 inches (2, one with sockets at both ends—pl. 38, fig. 7). Cut 8, 32 inches. Cut 9, 25 inches; depth unknown (2). Cut 17, 27 inches;

28 inches. Cut 18, 12 inches; 27 inches (2); 81 inches. Cut 19, 12 inches; 17 inches; 32 inches (pl. 38, fig. 5). Cut 20, 12 inches (3, all of bone); 22 inches; 26 inches (2, both bone). Cut 23, 14 inches (2); 18 inches. Cut 24, 45 inches. Cut 27, 29 inches; 38 inches. One handle of this kind was found at the Hillside site.

The sockets of the first group are large enough to have held stone blades, but those of the second group are so small that they must have been designed for metal blades. The distribution is not very enlightening; the older, southeastern section yielded proportionately more of the larger socketed type, and the northwestern section more of the small socketed type; furthermore, the five small socketed bone handles from cut 20 may safely be regarded as the most recent of the entire lot. However, the distribution as a whole does not point to a clear-cut chronological distinction between the two groups.

Of the third group, those with rather large socket with distinct curve at lower end, there are seven examples, distributed as follows:

Cut 4, 43 inches. Cut 9, 36 inches. Cut 19, 12 inches (2); 32 inches; 56 inches. Cut 20, 22 inches.

It will be observed that with the exception of the specimen from cut 9, all of these come from the later, northwestern section of the midden. One of the handles from cut 19, depth 12 inches, has the lower end of the socket in the shape of a **T**; in the others, the lower end is curved. The purpose of such sockets is to hold a *curved* tang in place, and this would seem to indicate beyond a doubt that the blade was of metal.

Type 2 (pl. 38, fig. 8).—Heavy, around 15 cm long; a deep, rectangular, open socket at the end, in which the blade was held by means of a plug; opposite side cut down or roughened for lashing. Socket around 30 mm long, 8 to 12 mm wide, and 6 mm deep.

Two examples: cut 19, 46 inches and 73 inches (the latter shown on pl. 38, fig. 8). Both have the lower end perforated for a suspension thong.

Type 3 (pl. 38, figs. 9, 10).—Ten to 12 cm long; a narrow, rectangular, enclosed blade socket at one or both ends.

Three examples, all of bone: Cut 18, 48 inches (pl. 38, fig. 10). Cut 19, 79 inches. Cut 25, 72 inches (pl. 38, fig. 9).

The last mentioned has a blade socket at the end 14 mm long, 3 mm wide, and 13 mm deep; at the lower end is a narrow slot for a suspension thong. The handle from cut 18 has a narrow, rectangular blade socket in each end, one 7 and one 10 mm deep. These three handles were found at considerable depths, indicating that the type is an old one.

Knife Sharpeners

On plate 38, figures 11-14, are shown four knife sharpeners, made from very young walrus tusks. Knife sharpeners of this type are still used on St. Lawrence Island. Twelve were found at Miyowagh, as follows:

Cut 3, 40 inches. Cut 4, 20 inches. Cut 18, 27 inches (pl. 38, fig. 12); 36 inches (2, pl. 38, figs. 13 and 14). Cut 19, 5 inches; 12 inches; 17 inches; 24 inches; 42 inches; 76 inches (pl. 38, fig. 11). Cut 24, 54 inches.

They are usually unworked except for the upper end which is beveled and perforated for the suspension cord. Exceptions are plate 38, figure 14, the central part of which has been cut down and plate 38, figures 12, 13, with the upper ends carved to represent whales' tails. In the first of these there is no perforation, the line evidently having been tied on. In the case of plate 38, figure 13, the perforation is a slot, placed about midway, with part of the baleen line still attached.

Stone Implements

One of the most striking features of the Old Bering Sea culture is the extensive use of chipped stone implements. At the Hillside site 242 artifacts of chipped stone were found, far more than at all the other Gambell sites combined. Of these, 101 were of chert or jasper; 141 of slate. There were also 140 specimens of rubbed slate. Chipped stone implements were also fairly common at Miyowagh, but here there were many more of rubbed slate. At the three later sites chipped implements were rarely found. In plates 39 to 43 are shown the various types of stone implements found at the Hillside site; the same types were found to occur also at Miyowagh.

The classification of stone implements is always difficult. Some types, like drills, gravers, and ulu blades, can be recognized easily enough, but there are others which are more questionable. Thus, it is not possible to assign a definite function to many of the cruder implements, such as flakes with a retouched edge which could have served either as knives or scrapers, and it is still more difficult to distinguish in many cases between projectile points and knife blades.

Harpoon blades.—No harpoon heads with an end blade in place were found at the Hillside site and only one at Miyowagh. I have designated as harpoon blades, therefore, only those tangless forms of rubbed slate which are very thin, symmetrical, and triangular in shape. Examples are shown in plate 39, figures 1-5, all broken; in all, 23 were found, none of them complete. It is probable that these blades were used only on the smaller harpoon heads. They are beveled only at the tip or just along the edges; none has the median ridge or broad faceted edges such as are found on the Thule harpoon blades; they are also longer and somewhat narrower at the base than the Thule types. At about the center they are usually no more than 1 mm in thickness, at the tip about 2 mm.

Harpoon or knife blades.—Under this heading comes a much larger number of blades of rubbed slate, chipped slate, and chipped chert or jasper.

a. Rubbed slate.—Those of rubbed slate are tanged, symmetrical in outline, and usually have a median ridge extending from tip to about center; below the ridge and to each side of it the blade is beveled, producing a three-faceted surface (pl. 39, figs. 6-12). The average length is 5 to 6 cm and breadth 3 to 3.5 cm. The greatest thickness is at the lower or proximal end of the median ridge, where it averages 4 to 6 mm. Undoubtedly, some of these were used as harpoon blades. Many of the Old Bering Sea harpoon heads have blade slits 3 mm wide and up to 4 cm long, which would require a blade of just this length and thickness but which would be too large for the very thin blades of the type shown in plate 39, figures 1-5. On the other hand, it is also certain that some of these larger tanged specimens were used as knife blades (e. g. pl. 38, fig. 1), and since there seems to be no way of distinguishing between the two, they are here grouped together.

Plate 39, figure 13, is the lower end of a large slate blade for either a knife or a lance. Blades of this size and shape were rare at the Hillside site.

b. Chipped slate.—The 76 blades of chipped slate from the Hillside site are difficult to classify because of uncertainty as to which are finished and which unfinished specimens. In plate 40, figures 1-10, are shown some of the tanged forms, most of which were no doubt used as knife blades, although plate 40, figure 8, might possibly be an unfinished blade of the type shown in plate 39, figures 6-12. The two slate blades, plate 40, figures 20-21, are unfinished forms or rejects, and there are numerous others similar in shape but smaller, which may have been arrow points or unfinished harpoon blades of the thin, small, tangless type.

c. Chipped chert or jasper.—There are 20 of these, the types of which are shown in plate 40, figures 11-19. The smaller blades, such as figures 12-14, were probably used as arrow points, and figures 15 and 16 may have been side blades for harpoon heads. The larger ones, figures 11, 17-19, were no doubt knife blades.

Knife blades.

a. End blades for men's knives.—Among the rubbed slate blades I have definitely classed as end blades for men's knives only those which are (1) slender with one edge straight or almost so and the other curved inward or outward (pl. 39, figs. 14-17), and (2) slender with symmetrical edges but too long to have been suitable for harpoon blades (pl. 39, fig. 18). All seem to have been tanged and most of them have a median ridge, which, however, is not very prominent.

b. Blades for ulus or women's knives.—The ulu blades, 30 in number, are all of rubbed slate (pl. 39, figs. 23-25). The prevailing shape is oval to rectangular, and the cutting edge is either curved or straight. Figure 23 is unusual in shape, being very high and with the upper edges thickened and smoothed where ordinarily they would have been left unfinished; the smooth, wide, rounded upper end suggests that it was used without a handle. A few other blades, of which figure 24 is an example, have two cutting edges, and these also may have been used without handles.

Implements with rubbed edges.—Under this heading are four slate artifacts of unknown use (pl. 39, figs. 19-22) representing a type of implement which does not appear to have been described previously, although the smaller end is suggestive of certain "drill points" from Greenland (Solberg, 1907, pls. 5 and 6). They are flat pieces of ground slate, with one straight smoothed edge (the left as shown on the plate) about 3 mm thick and 3 to 3.5 cm long. The tip is rubbed down, leaving a short upper edge 7 mm to 1 cm long which joins the longer edge either at a right angle or a 45° angle. Below this the right edge is smoothed in a similar manner, leaving one or two straight sections (pl. 39, figs. 19, 20) or a somewhat rounded edge (fig. 21, 22). The function of such implements is uncertain. The smoothed edges could well have resulted from their use as rubbing stones but the peculiar shape is surely intentional and suggests that they had a specific use, possibly in connection with the dressing of skins, or as boot sole creasers.

Drill points.—Seven stone drill points, two of them problematical, were found at the Hillside site; all are shown in plate 41, figures 1-7. Two are of ground slate, three of chipped slate, one of chert, and one of quartz. Plate 41, figure 1, is a four-sided point of rubbed slate, the sides of which taper very gradually down to the tip; the tip is rubbed, producing three facets and one short sharp cutting edge. Plate 41, figure 2, is a natural quartz crystal, columnar, and hexagonal in cross-section. Its use as a drill is uncertain; its shape is perfectly adapted for the purpose, although it shows no certain signs of wear. Plate 41, figure 3, is included among the drills because of its shape, although it is quite possible that it was used as a scraper. It is of dark gray chert roughly four-sided in cross-section and is rubbed down to a chisel-like edge at both ends. Plate 41, figures 4 and 7, are of chipped slate, somewhat similar in shape to figure 3, although somewhat flatter; figure 4 is the only one of the seven drill points showing unmistakable signs of wear. Slender drill points of this type were undoubtedly hafted, but those with widely flaring upper ends such as plate 41, figures 5 and 6, were probably used as hand drills or perforators, instead of being set in a wooden shank; figure 5, has been rather carefully chipped all over and brought to a long tapering point. Figure 6 is a flake, only the tip having been chipped out; the upper curved edge has been retouched, suggesting that it also served as a knife or scraper.

Gravers.—Eleven artifacts are identified as gravers. The characteristic feature is one or more sharp points, even though there may be chipping along other edges or over the entire surface. Plate 41, figure 8, is made from a thin flake of dark-colored chert. The sharp tip has been smoothed somewhat from use. On the side visible on the plate a curving edge has been chipped a short distance up from the point while on the reverse the straight edge has been chipped from tip to upper corner. The remaining gravers were fashioned from flakes of jasper, chalcedony and quartz. Plate 41, figure 13, of white, translucent quartz, has a thin cutting edge 5 mm wide which is worn smooth through use; it has not been worked otherwise. Plate 41, figures 9-12 and 14, are thick flakes. Figure 12 is chipped on both surfaces, the others only on one surface. All have finely rechipped edges, indicating that they were used for cutting or scraping as well as engraving. Figure 14 has been chipped with more than ordinary skill; flakes have been thrown off along an abrupt curving ridge which runs from tip to tip; the upper shorter tip is slightly worn, the lower broken. The tips of figure 12 and two others not figured are also considerably worn.

Plate 56, figures 1 and 2, are two engraving tools of jasper, from Miyowagh, complete with wooden handles and baleen lashings. These show the probable manner in which stone gravers such as plate 41, figures 10-13, were hafted.

Scrapers.

a. Side scrapers.—In dealing with stone artifacts with chipped edges it is not always possible to differentiate between those used as scrapers and those used as knives. I have, therefore, arbitrarily classed as side scrapers all irregularly shaped stone implements—almost all of them flakes—which have been chipped along one or more edges, even though some were in all probability designed for cutting rather than scraping. Those that are relatively thick, with an abruptly chipped concave edge, may safely be classed as scrapers; in this category come those shown in plate 41, figures 15-26. Plate 41, figures 18, 19, and 20, are included, for even though they are straight-edged or almost so, the abruptly chipped edges would be poorly adapted for cutting. The thinner flakes, such as plate 41, figures 27-31, are more doubtful, for these, with their finely chipped, relatively straight edges, could have been used effectively as knives. On these five implements a thin and already sharp edge has been chipped just enough to prevent dulling. The chipping on the others, plate 41, figures 15-26, seems to have been designed to produce a strong rather than a sharp edge. Figures 15 and 16 have been chipped only along one edge, the left; figure 17, on two edges; figures 18 and 19 are chipped along three edges; and figures 20 to 23, all the way around. All of these flakes are more or less concave-convex, having been struck off from a core, and the chipping is invariably restricted to the edges of the convex surface. Plate 41, figures 24, 25, 26 are not flakes but cores showing all-over chipping.

On plate 42, figures 1-3, are shown three-sided scrapers which differ from those described above in that edges are chipped on both surfaces. Plate 42, figure 1, is a piece of dark-colored silicious slate, with chipping along the curved edge on the side that is visible and on the straight edge on the reverse side. Plate 42, figure 2, of greenish prase, is triangular in shape with one abruptly chipped edge shown at the left and a similar one opposite it on the other side. Plate 42, figure 3, is a flake of jasper with chipping along all edges; on the convex side, which is visible in the photograph, chipping extends along the left edge and around the bottom; about half way up the right edge the chipping on the convex surface stops but continues on the opposite or concave surface from that point around the upper right corner and along the straight upper edge.

b. End scrapers.—This is the well known type of scraper that is referred to under various names, such as "turtle-back", "hump-backed", "snub-nosed", "thumb-nail", etc. Twelve were found, seven of which are illustrated in plate 42, figures 4-10. They are made from thick heavy flakes of jasper, the concave or under side being left unworked while the convex side is chipped either along the lower rounded edge or over the entire surface. The more finished examples of this type of scraper are thickest at the lower end, just above the blunt, steeply sloping edge. All-over chipping of the convex surface is shown in plate 42, figures 4, 6, and 7. The lower ends of figures 4 and 5 are thick and wide, the upper ends tapering. Figures

6 and 7 are shorter, and are rounded or squarish in outline. Figure 8 has the rounded sloping lower edge characteristic of end scrapers, whereas the chipping along the two other edges suggests that the implement may also have served as a side scraper. Plate 42, figure 9, is a flat type of end scraper, unfinished, with the shape blocked out but with only crude primary chipping along the edges. Figure 10 also appears unfinished, although the polished and worn lower edge shows that it has been put to use. The flat slate implement, figure 11, is included among the end scrapers because of its shape, although the chipped edges indicate that it has been used also as a side scraper.

Adzlike scrapers.—We now come to a type of implement which is characteristic of the Old Bering Sea culture but which, as far as I know, has not been reported from outside the Eskimo territory. In general shape and size these resemble an adz blade with a rough chipped body and a straight, sharply beveled, smoothed lower edge (pl. 42, figs. 12-14). The edge, however, instead of being merely beveled or sharpened as on the usual adz blade, is very abrupt, in some cases being ground down practically flat so that it forms a right angle with the sloping lower portion of the blade. Four scrapers of this type, from Miyowagh, are illustrated in text figure 16. In plate 42, figure 13, the under side meets the straight smoothed lower edge at a right angle, and the upper side, visible in the photograph, descends almost as abruptly. The exact function of implements of this type is not clear, although a reasonable assumption would be that they were used in scraping skins or wood since the edges are too abrupt to have been effective for cutting. Furthermore, the edges are so sharp and perfect that they could hardly have been used for scraping anything as hard as bone or ivory.

Another feature of these adzlike scrapers may be seen in plate 42, figure 12 (of dark-colored chert), namely, the smoothed and sharpened upper end. Unlike the abruptly beveled lower end, it is smoothed down from both sides, producing an ordinary cutting or scraping edge. The fact that both ends are fashioned for use would seem to show that it was not hafted but held directly in the hand. Figure 14, also of chert, is somewhat different in shape, the sides tapering down to the scraping edge, which is only 1.8 cm long instead of the customary 3 to 4 cm; the upper end appears to have been broken off. Figure 15, of prase, differs from the first three in having a thickened lower end which descends abruptly to the scraping edge, in this respect resembling the end scrapers shown in plate 42, figures 4 to 7. Figure 16, of prase, is very similar, although it is not clear whether the chipped lower edge is unfinished or was used as it is; the upper edge is sharpened as on figure 12.

In plate 42, figures 17-19, are shown three smaller implements of greenish prase, with four, six, and four faceted edges, respectively. Although at first glance these might appear to be the broken ends of scrapers of the type described above, the arrangement of the faceted surfaces shows that they were used just as they are. In figure 18 there is a smooth, perfectly flat lower edge 12 mm wide and 36 mm long at right angles to the smoothed part of the outer face. The smaller end has also been rubbed down, leaving a small smoothed surface

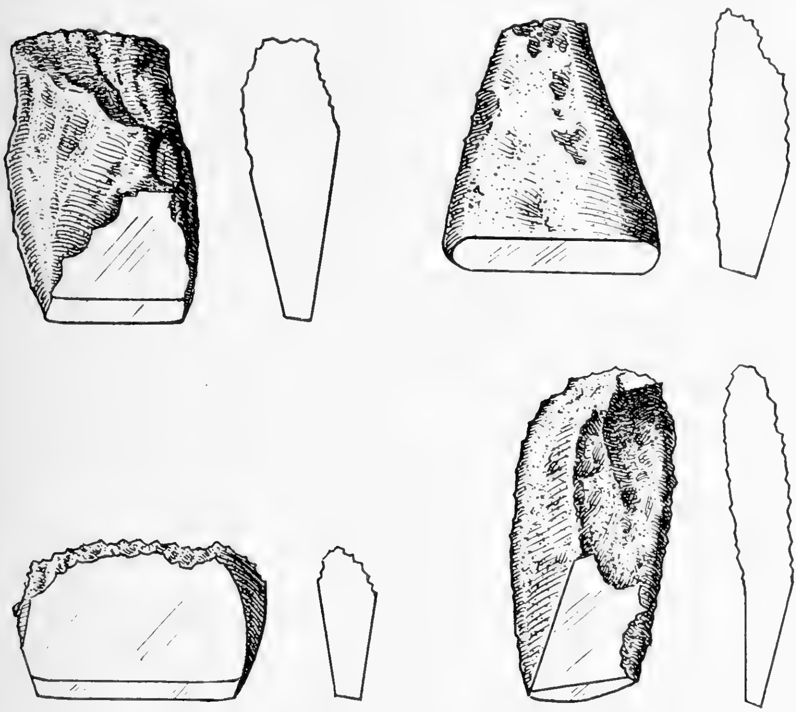


Fig. 16.—Adzlike scrapers of stone from Miyowagh.

which meets the other two at right angles as in the case of the thin slate forms shown in plate 39, figures 19-22. Just above the squared-off end is a fourth smoothed surface, rubbed down to a 45° angle. Figure 17 is generally similar in shape, but the faceted surfaces, except those at either end, are not perfectly flat and level; the upper surface is slightly concave while the two along the lower end are somewhat rounded or convex. Both corners are squared off, and at the smaller end a small area on the back side has been rubbed down, making in all six faceted surfaces. Figure 19 has four smoothed surfaces, tapering to a point below. Figure 20 is a piece of carbonaceous shale with four faceted surfaces, which indicate its use as a rubbing tool; a deep groove along one edge is evidence of sawing or rubbing with an edged implement.

Adz blades.—Six adz blades were found at the Hillside site, the type being illustrated in plate 42, figure 21. This was made from a small beach boulder of basalt, the natural surface of which forms the outer face. It has been shaped by crude chipping on the back and along two edges. The cutting edge is somewhat rounded and beveled, meeting the flat edge of the back side at an angle of about 45°

Rubbing stones and whetstones.—Rubbing stones of different materials and a variety of forms were found at the Hillside site. The most striking of these were columnar or pyramidal blocks with five smoothed surfaces. Five of these were found at the Hillside site (pl. 43, figs. 1-5) and several others at Miyowagh. Figure 1, of basalt, is shown resting on its broadest surface, which is 4 cm wide at the upper end, tapering to a width of 3.5 cm at the lower end. The right side, which is seen foreshortened in the photograph, rises vertically, while the left side rises at a 60° angle. The right side is slightly wider than the left, the average widths (at center) being 3 cm and 2.7 cm respectively. The two upper surfaces, averaging 2.6 cm in width, rise from the sides at an angle of 45°. All five of the slightly tapering sides are smoothed down to a perfect plane; the two ends are unworked. Plate 43, figure 2, of vesicular basalt, is identical with plate 43, figure 1, in the arrangement and proportions of the five smoothed surfaces. It differs in that it is less tapering. The upper end is the rounded water-worn surface of the original beach boulder from which it was fashioned. The lower end is broken. Plate 43, figure 3, is of fine-grained sandstone, pyramidal or tapering in shape, with the five surfaces rubbed down at the same angles as plate 43, figures 1 and 2. Figure 4, of basalt, is still more distinctly pyramidal in shape, but here again the angles formed by the faceted areas are essentially the same as those already described. Plate 43, figure 5, is made from a small, rounded beach boulder of vesicular basalt. It also has five smoothed sides, but the inclinations of these differ somewhat from those just described. There is also a rounded unworked space between two of the facets. Plate 43, figure 6, is a piece of scoria with three sides and the smaller end smoothed down.

Plate 43, figure 7, is a block of basalt with the two larger surfaces smoothed. Unlike the rubbing stones described above, on which the sides were smoothed down to a perfect plane, there is here a slight concavity of the smoothed surfaces, indicative of a whetstone. The same function should probably be assigned to plate 43, figure 8, for the surface is slightly concave. One edge is also smoothed. The material is a fine grained sandstone.

Plate 43, figure 9, is a small rectangular piece of sandstone with the sides, edges, and one end smoothed; the opposite end is broken.

Plate 43, figure 10, is a slab of diorite which has evidently been used as a whetstone to judge from the slightly concave rubbing surface. The opposite side has also been rubbed to a slight extent.

The two pieces of scoria shown in plate 43, figures 11 and 12, were no doubt used for rubbing skins. The first is wedge-shaped, with the thicker end (below) rounded off. Figure 12 has been worked on all surfaces except the upper end. Even the edges, which have a breadth of 2.4 to 2.7 cm, have been rubbed flat.

Plate 43, figure 13, is a small beach boulder of basalt, unworked except for a small flattening of the lower end, produced by rubbing. A shallow depression just below the center and two similar ones on the opposite side allowed a firm grip.

The flat beach boulder of diabase shown in plate 43, figure 14, was probably used as a hammer stone; the lower end is broken. Finger grips have been pecked in on both sides near the upper rounded edge, and smaller pitted areas occur lower down. The upper edge and parts of the lateral edges show slight signs of wear; there is also a small notch on one edge opposite the finger grip.

Sledges, Boats, Etc.

It is a point of considerable importance that at the four oldest Gambell sites no objects were found which could be recognized as having been used in connection with the modern type of dog sledge—no flat bone shoes for the built-up sledge, no trace buckles, swivels, or ferules for whip handles. As we shall see later, such objects are not found at any of the older Alaskan sites, although they are common at the late prehistoric and modern sites. If we may judge from the Gambell finds, the sledge of the Old Bering Sea Eskimos was very similar to the short low type with heavy ivory runners such as is still used on St. Lawrence Island and at Point Barrow for hauling umiaks and loads of blubber and meat over the ice (Nelson, 1899, pl. 76, fig. 1; Murdoch, 1892, p. 358).

Sledge runners.—Six ivory sledge runners were found at the Hillside site, five of which are shown on plate 44. They are of two distinctive types. Type 1, illustrated by plate 44, figures 3, 4, 5, is a heavy runner made from a walrus tusk which was but little modified.

At the upper or proximal end of the tusk a single large hole was cut through, and above it a wide shallow notch was made for holding the end of the cross bar. There is no certain evidence that more than one cross bar was used; only at the lower end of figure 5 is there a small roughened area which may have been made for the attachment of another cross bar. The lower ends of the two tusks may have been fastened together with a lashing. A characteristic feature is the flattening of the under side which seems to have been caused entirely by wear, as there is no evidence of cutting or shaping; figures 4 and 5 show a pronounced flattening of the under side, figure 3 only a slight flattening. There is some question as to whether the latter was really used as a sledge runner. The large hole and notch above it show that it was intended for such a use, but the beveled and sharpened lower end shows that it was also used as a pick. In addition, one side (visible in the photograph) has been adzed down to a flat surface, apparently in order that it might serve still another purpose, possibly as a sleeper or prop for timbers.

The other type of runner, type 2, is made from a section of tusk, its height being about the same as the original diameter of the tusk, its width or thickness around 1 cm. The three other sledge runners from the Hillside site are of this type, two of them being illustrated in plate 44, figures 1, 2. Figure 1, which is rather badly warped and weathered, is a thin, narrow strip of ivory 44.5 cm long and 1.4 cm thick; one end, broken, is 5 cm high, tapering to 2.5 cm at the opposite end, at the first hole. Near the upper border are five round holes (probably six originally) about 6.4 cm apart, and above each of them a shallow flat-bottomed notch for holding the end of the cross bar. Figure 2 is a broken runner of the same type, 25 cm long, 4.8 to 5.8 cm high and .9 cm thick. It differs from the other in having the lower edge somewhat beveled so that in use it leaned slightly outward instead of upright.

The distribution of all of the sledge runners and shoes from Gambell is given in tabular form on p. 230, following the description of the Punuk types.

In plate 45 are shown nine sledge runners and shoes from Miyowagh. In all, 48 complete and fragmentary specimens of ivory were found at this site, including several types which were not represented at the Hillside site. In addition to the ivory runners there were two whale ribs, which by their notched ends and smoothed and worn outer surfaces are shown to have been used as sledge runners.

The type 1 sledge runner of ivory, described above, was represented at Miyowagh by only two examples. However, there is a modification of this type, here designated as type 1 a, and illustrated by the two runners shown in plate 45, figures 1, 2, and four others not shown. They have the large hole and the wide notch of type 1, but they differ in that they have been cut down to the same shape as type 2. Type 2 is represented at Miyowagh by five examples, including the well preserved specimen shown on plate 45, figure 3. It is 26 cm long, from 5.7 to 7.9 cm high, and 1.3 cm thick; it differs from the two runners of the same type shown on plate 44, figures 1, 2, by having a greater number of holes—nine, each with a shallow notch above, and two additional holes at one end and one at the other.

Sledge shoes.—Of sledge shoes there were 31 specimens, all of ivory and only one of them complete. Type 1, the most common form (14 specimens) is illustrated by the two shown in plate 45, figures 4, 5. The upper surface is flat, but the lower edges are somewhat curved, giving a slight convexity to the under side; they range from 5 to 7.4 cm in width and from 1.2 to 2.3 cm in thickness. They lack the peg holes found on modern sledge shoes, the only method of attachment being a pair of round holes connected by a sunken groove on the bottom to protect the lashing. The complete specimen, figure 4, shown with the lower side up, has in addition two holes at the back end with grooves leading from each, showing that it has been attached to a similar shoe.

The type 2 shoe (pl. 45, figs. 6, 7, 8—four specimens in all) resembles type 1 as to thickness and width, but has an unusual arrangement by means of which it is attached to the runner—a knoblike elevation at the end 1 cm or more high, beneath which passes a transverse perforation.

The type 3 shoe (13 specimens) is illustrated in plate 45, figure 9. It is of about the same thickness as the preceding types but somewhat narrower. The method of attachment consists of a single hole at the end; this hole either extends straight through the end, which slants upward from the bottom so as to protect the lashing; or it is drilled through at an oblique angle, as in figure 9, connecting with a sunken groove on the lower side for holding the lashing.

From the later, northwestern section of Miyowagh there are four sledge shoe-runners of Punuk type 1 a, which will be described later.

None of the sledge shoes above described conform to any known types, ancient or modern. Rather large sledge shoes, usually of bone, are known from the Thule culture, and some of them have pairs of holes connected by sunken grooves for a lashing; but on the whole they seem to have been longer, narrower, and thinner than the St. Lawrence forms, in addition to which they have holes for pegs as the usual means of attachment to the runner (Mathiassen, 1927, vol. 2, pp. 60-61). We know nothing as to the nature of the runners to which these heavy ivory shoes were attached; most likely, however, they were short and low, forming with the shoe itself a composite runner comparable to those described above.

Cross bar.—Plate 50, figure 3, is a sledge cross bar, made of walrus penis bone, from Miyowagh; both ends are notched and roughened and the under side is flattened where it rests on the runner.

Toy sledges.—The parts of a toy sledge of wood, all found together in cut 25 at a depth of 43 inches, are shown in plate 59, figures 8-10; the two cross bars (fig. 10) were lashed to the runners (figs. 8, 9) just above the holes. Figure 11 (cut 18, 12 in. deep) is a toy sledge runner of ivory, of the type illustrated in plate 44, figures 1 and 2, and plate 45, figure 3.

Baleen toboggan.—The Old Bering Sea Eskimos also used the baleen toboggan, such as is known from the Thule culture and the Sadlermiut and which the modern St. Lawrence and Point Barrow Eskimos use for hauling loads of meat and blubber over the ice (Mathiassen, 1927, vol. 2, p. 45; Boas, 1901, p. 71; Murdoch, 1892, pp. 356-357; Bogoras, 1904-09, p. 107). None of the baleen slabs which formed the toboggans were found at the Hillside site, but two cross pieces show that they had been used. These are strips of baleen slightly more than 30 cm long and 6.5 cm wide with three pairs of round holes by means of which they were lashed to the slabs of baleen beneath. At Miyowagh a number of these cross pieces were found, in addition to one practically entire toboggan and numerous fragments. The most complete specimen was the one from cut 2, shown *in situ* in plate 6, figure 3. It is 18 inches wide at the front end and slightly more than 6 feet long.

Umiak paddle.—In plate 50, figure 1, is shown a section of an umiak or kayak paddle, from cut 23, depth 81 inches. It was 8 cm wide (one edge is broken off), and the entire surface is covered with a coat of red paint, made from pulverized hematite or ocher. Plate 37, figure 9, is one of the cross braces for the framework of a kayak, from cut 19, depth 59 inches.

Umiak keel.—The wooden object shown in plate 46, figure 14 (cut 18, depth 44 in.), is probably the end of an umiak keel; there is a transverse groove across the thickened front end; below this is a round hole and at the opposite end a smaller perforation. Plate 59, figure 3 (cut 18, depth 32 in.), shows a replica of such a keel piece, from a toy boat; a baleen lashing remains in place in the hole at one end and the opposite end is spliced by means of a carefully made dovetailed joint. Plate 59, figure 2 (cut 13, 54 in.) is one of the cross pieces from the bottom of a toy umiak; figure 7, from cut 18, 32 inches—of bark—is one of the end blocks, or seats, for the prow or stern.

A general idea of the external appearance of the boats may be obtained from the two toys shown in plate 59, figures 1 and 6, from cut 18, depth 44 inches, and cut 19, 54 inches respectively; the first represents a kayak; the second an umiak, of bark. Plate 59, figures 4 and 5 (cut 18, depth 44 in., and cut 6, 42 in.), seem to be stylized representations of the man seated in the kayak, the projecting upper part possibly representing a hunting helmet.

Ten other toy wooden boats were found at Miyowagh, mostly from the lower levels of the midden, as follows: Cut 10, depth 50 inches; cut 18, 32 inches (2); 44 inches; 53 inches; cut 19, 48 inches; cut 24, 64 inches; 72 inches; cut 25, 84 inches (2). Two fragmentary toy boats were found at the Hillside site (pl. 30, fig. 25, from house no. 2; and fig. 24, from beneath the floor stones of the same house).

Adzes, Picks, Wedges, Etc.

Adze handles and heads.—In plate 46, figures 1-7, are shown several types of Old Bering Sea adz handles and heads from Miyowagh. Figure 1 is an ivory handle from cut 19, 76 inches deep. It bears an Old Bering Sea decoration consisting of narrow bands of obliquely incised parallel lines and four nucleated, concentric circles which are given the appearance of scrolls by the attachment of pairs of short parallel lines. The handle is broken off at the notch which formed the finger grip. The upper end was made to rest in an oval pit on the adz head and was held in place by lashings which passed through two circular holes. The fragmentary ivory handle, figure 2 (cut 9, depth unknown), has two deep, wide finger grooves; it seems to have been rectangular at the upper end; it was lashed to the socket, the lashing passing through the large triangular opening at the end.

The only adz handle found at the Hillside site is the well-preserved wooden specimen shown in plate 29, figure 16. It came from house no. 2. It is slightly curved, 24 cm long, square in cross-section with rounded edges. The lower end is slightly enlarged, the upper end is cut square to fit the hole in the socket, and a small wooden wedge, still in place, was driven in to insure a tight fit.

Plate 46, figure 3 (purchased from an Eskimo) is a rather elaborate adz head of ivory. The stone blade was attached to the lower end, which was sunken for the purpose, and the lower edge on the opposite (back) side was provided with a lip or ridge to hold the lashing in place. The end of the handle rested in a shallow, oval-rectangular concavity on the back side and was held in place by thongs passing around the two circular elevated bosses which extend from the back side around to the front; there are also four pairs of lashing holes on the back side. At the center of the two bosses are circular pits 3 mm deep, in one of which is a wooden plug; a row of smaller pits extends along the periphery, with five more in between the bosses. The upper end, now broken, seems to have been bilobed. Figure 5 (cut 25, depth 84 in.) is a wooden adz head with a deep oval depression on the back side for the end of the handle, and an opposite groove for the lashing; on the opposite—or front—side there is a deep sloping concavity for the blade. Figure 4 (cut 18, 25 in.) shows the front side of an ivory adz head with a slightly sunken bed 6.8 cm long for the blade; on the opposite side is a raised lower edge to hold the lashing in place. On the back side the upper end is cut down slightly to provide a resting place for the end of the handle; opposite this is a deep wide groove for the lashing. Figures 6 and 7 are two adz heads made of whale rib (from cuts 15, 33 in., and cut 24, 52 in. deep, respectively), which differ from those just described in that the blade was set in a deep socket in the end instead of being lashed on. In the first of these there is a transverse oval hole for the handle, in the second a rectangular pit with an opposite lashing groove.

In addition to those illustrated there are four other adz sockets with a transverse hole for the handle; these are from cut 7, 51 inches deep; cut 15, 40 inches; cut 16, 30 inches; cut 18, 49 inches. There are also six others with a sunken bed for the end of the handle, from the following locations: Cut 4, depth 55 inches; cut 7, 51 inches; cut 9, 25 inches; cut 17, 27 inches; cut 18, 42 inches; cut 23, 81 inches.

Pick handle.—Plate 46, figure 8, is a wooden pick handle from cut 27, 46 inches deep. The lower, enlarged end is perforated for a suspension thong, and there is a deep notch or finger rest at the center; the upper end is somewhat concave and slanting so that the bone or ivory pick, which must have been a light one, might project at an angle; there is a wide groove on the back side of the upper end for the lashing which held the pick in place. The implement was probably used for digging roots.

Ivory picks.—Heavy ivory picks are among the most common implements of the Old Bering Sea culture. They were made from a whole walrus tusk or a large section, sharpened at the lower end and designed for digging in frozen ground or ice. Seven of the picks from the Hillside site are shown in plate 49. The lower end was given a rounded cutting edge by beveling from both sides. In a few instances the ends are pointed; one of these, plate 49, figure 3, also differs in the manner of hafting: at the upper end of the convex side there are two deep grooves separated by a prominent ridge, and the opposite side has been hacked to a flat surface for a distance of 10.5 cm in order to provide a firm resting place for the end of the handle. Usually the upper end of the pick was prepared for the handle by scarfing along one side with the opposite side roughened to hold the lashing (pl. 49, figs. 2, 5, 6). Some, like plate 49, figure 1, have two large widely spaced grooves on one side with a single groove opposite. The most finished type is illustrated by plate 42, figure 4, which has two deeply cut, rounded, transverse grooves. Plate 49, figure 7, was lashed to the handle by means of two small notches.

Ivory wedges.—Ivory wedges, mainly for splitting wood, were found in large numbers both at the Hillside site and Miyowagh (pl. 47, figs. 8, 9). They are usually made from the distal end of the tusk, which was beveled to a rather sharp edge; the upper end usually shows signs of hammering. Such wedges were often used secondarily as drill rests, as in the case of one of those illustrated. The average length is around 12 cm.

In plate 29, figure 17, and plate 47, figures 12 and 13, are shown three wedge-shaped ivory objects from the Hillside site and Miyowagh respectively, which are characteristic of the Old Bering Sea culture, but the use of which is uncertain. Plate 47, figure 12, is 6 cm long; the upper end is 1.4 cm wide by 1 cm thick, and the lower end 2.3 cm wide by .3 cm thick. On both sides the right half has been cut down lower than the left, thus producing two opposite offsets which would help to hold the object firmly in place if it were inserted wedge-like in a socket shaped in a similar manner. The small hole in the lower, thin end was probably for a peg or rivet for fastening to the socket. Figure 13 is made in the same way, but is somewhat thicker and less tapering. Plate 29, figure 17, from the Hillside site, shows the same characteristic features. It is possible that these objects were wedges which were driven into the end of the wooden adz handle to hold it tightly in place in the socket.

Mattock blade.—Plate 50, figure 2, is a broken mattock blade, made from a section of a whale rib. The upper end is roughened for the lashing.

Snow shovels.—In plate 50, figure 6 (cut 18, depth 49 in.) is an example of the Old Bering Sea type of snow shovel, made from a walrus scapula. The concave inner surface, shown in the photograph, served as the front or upper side of the shovel; it was smoothed down by cutting away the processes at the proximal end, the longitudinal crest or spine, and the thickened opposite edge. The handle was lashed on by means of two round holes.

Bone knife.—Plate 50, figure 4, is a bone knife from cut 19, depth 67 inches, the principal use of which, if we may judge from modern analogy, was to scrape the snow from fur clothing before entering the house. It is made from a section of walrus penis bone, split lengthwise, flat on one side, convex on the other. The four notches and intervening knobs at the handle are suggestive of those found on modern ivory snow knives from western Alaska, and also of those on a bone knife for squeezing out water, which Mathiassen describes from the Thule culture (1927, vol. 1, p. 48, pl. 13, fig. 14). The present specimen may represent the prototype of these knives; at any rate, the small knobbed grip and the curving shape would have rendered it ineffective for cutting or stabbing. It was not a common type, however, as this and a few doubtful fragments were the only examples found at definite Old Bering Sea levels; as we shall see later, another type of bone knife, evidently a dagger, comes in with the Punuk period.

Drills, Reamers, Awls, Etc.

Drill rests.—Ivory drill rests were found in large numbers both at the Hillside site and Miyowagh. Plate 46, figure 13, shows one of these, a section of tusk with five deep holes on one side and three on the other. Drill rests of this kind were held in the hand and pressed down on the upper end of the drill shank as it was being rapidly revolved by the bow which was held in the other hand. Many of them had served more than one purpose; usually they were wedges, like the one shown in plate 47, figure 9, or picks or pieces of heavy sledge runners which later had been utilized as drill rests. They were used no doubt both for fire drilling and for drilling holes in implements.

Mouthpieces.—Only a few mouthpieces for bow drills were found. Two of these, from the Hillside site, are shown in plate 30, figures 2, 3. The first is a small segment-shaped piece of ivory 5.7 cm long and 2.5 cm wide with just enough of a groove on each side to insure a firm grip with the teeth. Figure 3 is a walrus tooth unworked except for two longitudinal grooves to facilitate grasping between the teeth.

Drill bows.—It is not always possible to distinguish between drill bows and handles for pails, boxes, etc. Assuming the longer ones to have been drill bows, however, we see that these were made either of wood or bone. Those of bone were usually made of a section of walrus rib, which already possessed the necessary curve; those of wood are usually somewhat less curved (pl. 47, fig. 1); all have the ends notched for attachment of the cord.

Drill shafts.—Numerous wooden drill shafts were found, some of which (from Miyowagh) were painted red. Plate 30, figure 1, is a drill shaft from the Hillside site; it is round in cross-section, slightly enlarged at the lower end and has the tip charred. Two specimens from Miyowagh are shown in plate 57, figures 2, 3.

Drill points.—Drill points of bone were found in great numbers at Miyowagh; eight were found at the Hillside site. Most of them were made from seal fibulae (pl. 48, figs. 1-4). The enlarged distal end of the bone, after being trimmed down, was set into the end of the wooden shaft; the proximal end, below a somewhat abrupt shoulder, was made cylindrical and sharpened to a chisellike tip. In some cases, as in figures 3 and 4, the shoulder was less pronounced.

Hand drills.—Three hand drills are shown in plate 48, figures 5-7. These have very small, sharp points, about 2 mm in diameter; the upper end, which was held in the hand, is unworked. Such drills were usually made from dog or seal ulnae or slivers of ivory.

Reamers.—We may consider as reamers those implements having a blunt cylindrical point and an unworked upper end for holding in the hand. One of these, from the Hillside site, is shown in plate 30, figure 15. Four examples from Miyowagh are shown on plate 48, figures 8-9, 13-14. The first is made from the distal end of a walrus rib, the second is of ivory; figures 13 and 14 are also made from sections of walrus ribs. The principal function of such reamers was no doubt that of enlarging or smoothing out holes in skin, wood, baleen, etc.

Rubbing or scraping tools.—In plate 48, figures 10-12, are shown three examples of an implement which was found in considerable numbers and which seems to have been used primarily as a rubbing or scraping tool, probably for working hides. They are almost invariably made of walrus ribs, with one end smoothed and spatulate, the other unworked as in figure 12, or smoothed and blunt as in figures 10 and 11. The upper, blunt end of such implements would seem well adapted for stone flaking, and they may have been so used.

Stone flakers.—The three objects shown in plate 48, figures 18-20, may safely be regarded as stone flakers. In all, 19 of these flakers were found at Miyowagh. They are shorter than the type just described; both ends are usually provided with a blunt point, less frequently one end is somewhat flattened, as in figure 18. They may have been held directly in the hand; at any rate no recognizable handles were found. Three stone flakers from the Hillside site are shown in plate 30, figures 9-11; 10 others were found at this site.

Awls.—Bone awls (pl. 48, figs. 15-17) do not show any features of particular interest. Most of them are made of bird bones, usually the humerus of larger birds, such as cormorants, geese, gulls, etc. Figure 15 is made from the ulna of a fox. In addition to those of bone there are also awls made of ivory, usually sharpened at both ends. From the sharp, smooth, well-made examples such as figures 21 and 22, there is a gradation into cruder types—ivory slivers which may have had a wide variety of uses. Two specimens from the Hillside site are shown in plate 30, figures 16, 17.

Needles.—Needles were made of small bird bones, usually ribs. The only complete specimen was one from the Hillside site. It is 3 cm long; the eye is a round drilled hole about half a millimeter in diameter, just large enough to receive the point of a common pin.

Women's Knives

The ulus or women's knives from Miyowagh and the Hillside site had all been provided with stone blades; most of the handles were of wood, a few of ivory. In plate 51, figures 1-7, are shown two complete ulus and five wooden handles from Miyowagh which illustrate the range of types. In addition to these there were 16 other handles rather uniformly distributed throughout the midden. Most of the handles are straight or only slightly curved, the crescent shape of figure 6 (cut 19, depth 45 in.) being unusual. When there was a tendency for the handle to split, it was grooved at one or both ends and tied (pl. 51, figs. 3, 4—from cut 9, 20 in., and cut 19, 86 in.). Figure 1 (cut 22, 86 in.) is unusual in having the blade held secure by a thong placed around a central groove and through a hole in the blade. An interesting feature, shown in figure 5, from cut 25, depth 33 inches, is a broad groove or notch at one end for the index finger. Figure 7 (which is shown accidentally reversed) has a narrow rectangular inset of ivory on the top, and there seems to have been an attachment at either end which fitted over a small cylindrical core projecting from the handle; it comes from cut 27, depth 36 inches.

Fat Scrapers

Another typical woman's implement was the ivory scraper for removing fat from intestines and skins. A few of these approach an oval or rounded shape, somewhat like the modern forms, but the prevailing types are flat-bottomed, with upright or slightly flaring walls, and open at both ends; or trough-shaped, with flat or rounded bottom and upturned ends. The edges along the side are sharpened; on the type with open ends the ends may or may not be sharpened. Four examples, of the rectangular type, were found at the Hillside site. One is the decorated specimen already described (pl. 13, fig. 8). The other three are shown in plate 30, figures 5-7. Plate 30, figure 5, from house no. 1, is 14.1 cm long and about 3 cm wide. The bottom is flat; the sides, which are for the most part broken away, were almost vertical, with a height of 2.4 cm. The one small remaining section of rim is beveled but not sharp. The upper end is slightly upturned, and through it a small rectangular slot has been cut, evidently for suspension; the opposite end has no rise, but was cut off straight. Plate 30, figure 6, in two pieces, also from house no. 1, is of the same general shape but somewhat shorter and broader. It is 12.6 cm long, but 4.3 cm wide and 1.1 to 1.8 cm high. The sides have a slight outward flare and slope gradually downward from the upper end. The upper end, like plate 30, figure 5, turns upward and is perforated for suspension while the lower end continues level with the bottom. Plate 30, figure 7, from the third level of the midden below house no. 1, is half of a smaller fat scraper which differs from the first two in that both ends turn upward, making it boat-shaped. The drilled hole and the rectangular slot show that it had been mended after breaking.

From Miyowagh there are 26 more or less complete scrapers and fragments. Two of these, bearing Old Bering Sea ornamentation have already been described (pl. 17, figs. 1, 2, from cut 9 a, depth 50 in., and cut 10, 54 in.). Three others are shown in plate 51, figures 8, 9, 11. The first of these (cut 12, depth 25 in.) is rectangular in shape with open ends like the two decorated specimens just mentioned. In addition to plate 51, figure 8, there are nine other fairly complete specimens and five fragments of the same type, distributed as follows: Cut 1, depth 55 inches; cut 3, 45 inches; cut 5, 32 inches; cut 9, 25 inches (2), 36 inches; cut 16, 18 inches; cut 18, 44 inches, 60 inches; cut 19, 17 inches, 67 inches; cut 22, 18 inches; cut 24, 36 inches; cut 27, 52 inches.

Plate 51, figure 9 (exact provenience unknown) and figure 11 (from cut 10, depth 22 in.) are examples of the more rounded type with curved ends. Five other examples of this type were found, as follows: Cut 7, 51 inches; cut 9, depth unknown (2); cut 18, 81 inches; cut 19, 67 inches. Another specimen from cut 16, depth 18 inches, differs from the last mentioned type in being rectangular in outline, with a flat bottom and straight deep sides and ends.

Lastly, there is to be mentioned a small ivory scraper, or perhaps a cup or ladle from cut 29, depth 17 inches. It is short and deep, squarish in shape, with a flat bottom, rounded corners, and smoothed edges.

Plate 51, figure 10, is a long, narrow section of a beluga jaw, with one edge sharpened for use as a scraper, from cut 10, depth 22 inches.

Another, less common type of scraper, found only at the Hillside site, was made from a dog femur, with a section of the shaft cut away, leaving two parallel and fairly sharp scraping edges. Three of these are shown in plate 30, figures 12-14. The first two are from the midden, first and fourth levels respectively, the third from house no. 1; the fourth specimen is also from house no. 1. From Miyowagh, cut 19, depth 51 inches, there is a larger scraper of this same general type made from the metatarsal bone of a reindeer. This is the only example from Gambell of the two-handed scraper, a type which occurs at Point Barrow, among several groups of Central and Eastern Eskimos and among many Indian tribes (Birket-Smith, 1929, vol. 2, p. 37).

Ladles, Vessels, Etc.

Ivory vessel.—The ivory vessel (pl. 51, fig. 12, cut 16, depth 23 in.) in general shape resembles some of the scrapers, but the incurving edges would make it unsuitable for such a purpose. It was a receptacle, probably designed for some special use, as in a ceremony. A line of very small round pits encircles the rim; at the smaller end is the broken remnant of a handle.

Ladles.—Plate 51, figure 14 (cut 19, depth 30 in.) is a much smaller utensil of ivory, probably a ladle. Figure 15, from cut 19, depth 67 inches, is a small spoon or ladle of antler, with the larger end split and then lashed together with baleen to make it concave. Figures 13 and 16 are two wooden ladles from cut 23, depth 72 inches, and cut 18, 48 inches.

In plate 47, figure 16 (cut 23, depth 81 in.) is shown a ladle or spoon of a different type made from a beluga jaw. It has a long, narrow handle, perforated at the end, and a flaring and slightly concave lower end, made from the proximal part of the jaw. Three pairs of narrow rectangular slots were cut in the lower end to hold it together after it had split.

Pottery

In a treeless region like St. Lawrence Island the oil-burning lamp is of vital importance, performing as it does the indispensable functions of heating and lighting the interior of the house, of drying wet clothing, and of cooking. From the Old Bering Sea period down to modern times lamps and cooking pots on St. Lawrence Island have been made of earthenware; steatite and sandstone lamps, such as are used by the modern Eskimo from Bering Strait northward and eastward did not reach St. Lawrence. Considering the numbers of vessels that must have been used and their fragile nature, it is not surprising that pottery fragments should be found in such abundance at the old sites. Potsherds were by far the most numerous of all artifacts found at the Hillside site and Miyowagh.

Compared with that from other parts of the world, Eskimo pottery is crude and poorly made. The paste is coarse and rather crumbly in texture, the walls of the vessels are usually quite thick, the surface finish is poor, and there is usually no decoration. The poor quality of the ware was probably due in large part to the absence of suitable clay, although a contributing factor must also have been an imperfect knowledge of the technique of mixing, shaping, and firing. In plate 52 are shown the various types of ware found at the Hillside site.

Paste.—The prevailing color of the paste is a rich sooty black; this color, with but few exceptions, is uniform throughout the thickness of the sherd, showing that the material from which the pottery was made was originally black and that it had been subjected to very little firing; otherwise the surfaces would have been burned to a different color. In a few instances this happened, one or both surfaces having been burned to a light buff or gray, with the rest of the paste remaining black. A very few sherds, like plate 52, figure 7, are light brown in color, but this apparently should be attributed to the use of a brownish clay rather than to intensive firing.

Temper.—The tempering material most commonly used was coarse sand and gravel. The latter seems to have been carelessly selected, for it is often very coarse, containing particles up to the size of a kidney bean. Such coarse tempering material could not have been very effective as a binding agent. Fine grass was also used for tempering. The small grooves left by the grass stems and even the carbonized stems themselves are plainly visible on sherds which have weathered or flaked off (pl. 52, figs. 9, 10). The modern Alaskan Eskimo are known to have made use also of mammal hair in tempering, and the present material has a superficial resemblance to hair. However, microscopic examination shows plainly that it was grass. The sherds with grass tempering are appreciably lighter in weight than those in which sand and gravel had been used, and they show a more pronounced tendency to flake off in layers. I have found no instance in which both methods of tempering had been used in the same vessel.

Thickness.—In addition to its coarse texture, Eskimo pottery is remarkable for its thickness, and in this respect the sherds from the Hillside site are no exception. The average thickness of the ware is 1 to 1.5 cm. The thinnest sherd found measured .5 cm, but those with a thickness of more than 2 cm were much more common; one sherd was 2.7 cm thick. Grass-tempered sherds were either thin or medium in thickness; sand- and gravel-tempered sherds were thin, medium, or thick.

Method of manufacture.—The vessels seem to have been shaped by molding directly from the clay rather than by the coiling process. A single rim sherd (pl. 52, fig. 2) bears evidence of coiling, three distinct strips being visible at the rim. However, this would appear to be an exceptional case, for the many other sherds show no evidence of coiling, and their strong tendency to flake off in layers shows that in most cases at least, this method could not have been employed.

Shapes.—No entire vessels were found, but many of the sherds were large enough to show that they were rounded in shape. The bases and rims were uniformly rounded; not a trace was found of a square, flat bottom or a rectangular rim, features which are invariably present on modern St. Lawrence cooking pots and lamp rests. There was also no evidence of the lugs and suspension holes such as are found on modern St. Lawrence cooking pots, nor of the ridges which are so typical of the modern St. Lawrence lamps. It appears that the lamps were shallow, thick-walled, circular vessels, somewhat similar to those used by the modern Eskimo of the Yukon-Kuskokwim region, but flatter, with a straight slope from the rim to the somewhat conical base. Plate 84, figure 3, shows half of a lamp of this type from the Punuk site, Ievoghiyoq. Plate 53, figure 2, is a lamp of similar type excavated by the writer at an old site on Imaruk Basin, Seward Peninsula. The cooking pots were thinner, much deeper, and somewhat cylindrical in shape. On many of the sherds there is a thick black incrustation, caused by the burning of oil which adhered to the surface.

Surface finish and decoration.—The surfaces were finished by smoothing, no attempt having been made at polishing; a slip or wash was never applied. Although the pottery was for the most part undecorated, a large number of the sherds were corrugated on the exterior, a decoration which had resulted from the application of a paddle or other implement bearing parallel grooves. One of these wooden pottery paddles, from Miyowagh, is shown in plate 47, figure 17. It is 27 cm long and 8.4 cm wide at the lower end; the back side is convex; the front, with six deeply cut, parallel oblique grooves, has just enough of a concavity to fit the sides of a large rounded vessel.

A large sherd, picked up from the surface at the northwestern section of Miyowagh, was decorated with a typical "check-stamp" pattern (text fig. 17). The indented squares were rather deeply imprinted and of uniform size, measuring about 6 mm across.

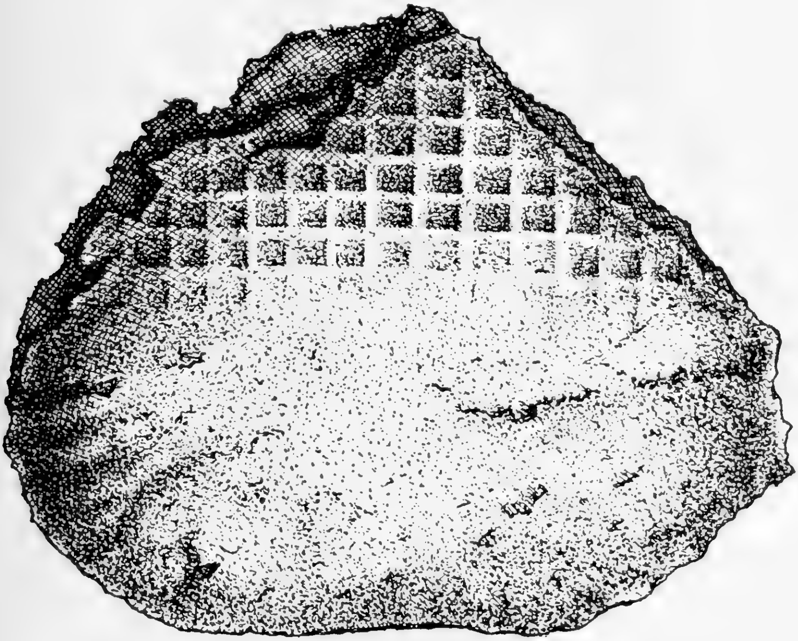


FIG. 17.—Potsherd with check-stamp decoration, Miyowagh.

In plate 58, figure 14, is shown the only example of a molded decoration; this is a small human figure applied to the inner rim of a thick-walled vessel, apparently a lamp.

BALEEN AND WOODEN VESSELS

Parts of baleen vessels—the round or oval wooden bottoms and the flattened sides of baleen—were found in considerable numbers at Miyowagh. Four were found at the Hillside site, one of them the well-preserved specimen shown in plate 53 found together with three others in what appeared to have been a small storage space beneath the rear floor stones of house no. 2 at the Hillside site. It is straight-sided, 8.5 cm high, with an oval wooden bottom 9.4 and 10.7 cm in diameter. The upper part of the vessel is formed of a piece of baleen bent around and held together by an in-and-out stitching of baleen. The wooden bottom is held securely in place by four long stitches of the same strip of baleen, which passes in and out through four rather widely spaced splits in the wood. The bottom is set about 1 cm above the lower edge of the baleen, resting in a shallow groove which extends all the way around. Most of the baleen vessels from Miyowagh and the few others from the Hillside site differ from this one in that the baleen stitching which holds the ends together is narrower and is set in a narrow shallow groove; occasionally there is a double row of stitching. Some vessels were made higher by having another band of baleen of the same size attached to the lower one.

Wooden bottoms.—Three wooden bottoms for baleen vessels, from houses nos. 1 and 2, Hillside site, are shown in plate 54, figures 1-3. The first of these was attached to the upper part of the vessel by means of loops of baleen, one at either end; the three circular holes along the left edge and the one opposite were made to hold the pieces together after they had split. Plate 54, figures 2 and 3, were attached in the same manner as plate 53 as shown by the remaining slits and pieces of baleen lashings. Plate 54, figure 3, which is thicker than the others, has a small wooden peg set in the edge which no doubt helped to hold the bottom in place.

Handles of wood or bone.—Some, at least, of the baleen vessels had handles of wood or bone, of which the three shown in plate 47, figures 2-4, are examples. The first of these, from cut 23, depth 72 inches, is of whale bone; it is widened at the middle and a decorative effect is provided by four rather deeply cut lines; figures 3 and 4 (cut 25, 89 in., and cut 2, 40 in.) made of a walrus rib and wood, respectively, are undecorated.

Wooden vessels.—Two fragments of wooden vessels from the Hillside site are shown in plate 54, figures 4, 5. The first is crudely made, with thick uneven sides and bottom; it seems to have been narrow and rather shallow. Figure 5 shows better workmanship, the cutting being smooth and even on both sides. The bottom has a thickness of about 5 mm, the rim of about 7 mm. There are three small pits along the rim which appear to be intentional. From Miyowagh there are several fragments of long, trough-shaped wooden vessels.

Objects of Baleen

Baleen was relatively scarce at the Hillside site. Besides the baleen vessels, the collection contains several toboggan cross pieces, and a larger number of knots, strands and fragments of various sizes, but nothing approaching the quantities of this material found at Miyowagh and the later sites. The same was true of whale bones, only a very few being found at the Hillside site. On the whole it would seem that whaling, if practiced at all, was only incidental with the earlier Old Bering Sea Eskimos; certainly it did not occupy the prominent place it came to have later.

The baleen objects described below are all from Miyowagh.

Ice scoop.—Plate 55, figure 7, from cut 18, depth 44 inches, illustrates the type of the Old Bering Sea ice scoop, made entirely of baleen. The rim and part of the handle consist of a single strip about 2 cm wide bent around and forming a triangle with rounded corners. The netting is of smaller strands of baleen, one looped around the other, the loops occurring at regular intervals and radiating in nine bands from the center. The netting is fastened to the rim at 11 places and is further strengthened by being looped around a straight strip which extends from the apex to the opposite side. Four more baleen ice scoops were found at Miyowagh, two in cut 9, depth unknown, one in cut 18, depth 48 inches, and one in cut 19, depth 45 inches.

Ventilator rim (?).—The heavy grass ring with baleen wrapping (pl. 55, fig. 4—cut 23, depth 32 in.) was thought by the Eskimos to be a border or rim for the circular opening which serves to ventilate the inner sleeping room. In the modern houses the opening is cut in the upper part of the reindeer skin which hangs as a heavy curtain and forms the front of the sleeping compartment. A similar grass ring was found in cut 10, 40 inches deep, and also one made from the epiphysis of a whale vertebra, in cut 23, depth 81 inches. These grass rings also resemble the hoops used by the Plains Indians in various kinds of hoop and pole games (Culin, 1907, pp. 458, 483, 495-6).

Plate 55, figure 2 (cut 23, depth 39 in.), is a slender strip of baleen, rounded in cross-section and pointed and notched at one end. Both ends appear to have been bent over and may possibly have been held by the baleen loop placed somewhat below the center. It may have been part of a snare.

Baleen knots.—Plate 55, figure 3, is one of a great number of baleen knots, the exact use of which is unknown; this specimen consists of two connected knots, both formed of two layers of square plaiting, the same technique as shown by the two smaller baleen objects in plate 56, figures 8, 9.

Figure 6 is a broken wooden shaft, composed of two sections spliced together and held with a wrapping of baleen.

Figure 8 is a baleen ring, from cut 9, 48 inches deep, the ends held together with baleen wrapping; small strands of baleen, attached to the rim, may have extended across.

Fishing line.—Figure 9 is a fishing line from cut 26, depth 39 inches, made of thin strips of baleen tied together with small tight knots; it has been carefully looped and tied together at the middle so as to unroll without tangling.

Fishhook.—Plate 56, figure 3, is probably a fishhook; it consists of a wooden shaft, with a small pebble for a weight, and a sharpened bird bone for a barb, both attached by means of baleen lashings.

Figures 8 and 9 (cut 18, 27 in., and cut 23, 22 in.) are two small objects of unknown use, square in cross-section, made by plaiting together four interlocking strips of baleen. The technique has a wide, if sporadic, distribution. An object identical with those illustrated, but made of bark and used as a child's toy, is described from the Tver government in the Volga region, U. S. S. R. (Zolotarev, 1926, p. 154, fig. 10, *9*). The British Guiana Indians make toys of leaf strands which are exactly similar; and specimens in the United States National Museum show that similar plaited ornaments were made by the Mohave and by certain Mexican tribes.

Figure 10 (cut 18, 40 in.) is a fragmentary object consisting of three small pieces of wood lashed together with baleen; use unknown. Figure 11 (cut 18, 32 in.) is a strip, or strips, of baleen, neatly wound and tied up with a strand of the same material. Figure 12, from the same location, is a flat sliver of wood with a small baleen loop—a slip knot—tied to one end; possibly a snare. Figure 13 (cut 27, 16 in.) is a piece of wood to which a small sharp sliver of bird bone has been lashed by means of a strand of baleen. Figure 16 (cut 21, 24 in.) is a small piece of wood with a wisp of human hair attached.

Figure 14 (cut 27, 26 in.) is a small bundle of grass, tapering to a bifurcated end, and wrapped with baleen. Its use is unknown, although it resembles the arrow targets of grass wrapped with sinew used by the northern Plains Indians (Culin, 1907, p. 384, 391).

The toy bows of baleen (pl. 55, fig. 1, and pl. 56, fig. 15) have already been described.

Objects of Wood

Many wooden objects and fragments were found in the permanently frozen soil at the lower levels of the Hillside site and Miyowagh, but their identification presents unusual difficulties. Most of them are broken and incomplete, and others—as is also the case with many artifacts of ivory, bone, and stone—seem to have no counterparts in modern Eskimo culture. Furthermore, a great many of them are of a rather generalized nature and could easily have served more than one purpose. Some of these wooden objects, the exact functions of which are uncertain, are described below.

Shovels (?).—In plate 54, figures 6-8, are shown three flat wooden objects from house no. 1, Hillside site, which may have been used as spades or shovels for some particular purpose such as cleaning out the bottom of the umiak. Such a function is suggested by the fact that on each of them the tapering lower edge, and the edge only, is battered and worn as if through constant scraping. The photograph shows the flat, presumably upper, surface; the under side is somewhat convex. The edges of plate 54, figure 7, are rather sharp, those of the other two thicker and more rounded. The two pairs of narrow slots or small holes near the upper ends were evidently for the lashing by which the handle was held on. A few strands of the lashing—of baleen—remain in place in one of the slots in figure 6.

Plate 47, figure 14, cut 22, depth 41 inches, seems to have been a hook, with an oblique perforation through the enlarged lower end for holding the prong; there is an incrustation of some charred greasy substance around the lower hole.

Plate 47, figure 15 (cut 10, 54 in.), represents a highly stylized human face on the enlarged end of a wooden object of unknown use. The eyes and mouth are indicated by depressions made when the nose was carved out in relief.

The gougelike lower end of plate 47, figure 10 (cut 27, 46 in.), and plate 37, figure 7 (cut 8, 32 in.), suggests that these objects may have been used as scrapers, possibly for removing the fat from intestines.

Plate 47, figure 11 (cut 27, 42 in.), represents a rather common type of implement, probably a scraper handle, with a deep rounded socket for the blade; on the opposite side there is a prominent lip at the rim for holding the lashing in place. Seven other handles of this type were found at Miyowagh, as follows: Cut 7, depth 37 inches, 62 inches; cut 18, 42 inches, 53 inches; cut 19, 45 inches, 79 inches; cut 24, 54 inches.

Engraving tool.—The wooden object shown on plate 57, figure 6 (cut 19, 79 in.), is probably the handle of an engraving tool. In the upper end is a small pit or socket about 1.5 cm deep and 2 to 3 mm in diameter. Such a socket would seem to call for a metal point, although it might have been of bone or ivory. There is a lashing of baleen around the upper end; the lower end is widened and flanged, producing a shape somewhat suggestive of certain Alaskan needle cases.

Plate 57, figure 7, is a long, narrow piece of wood with one end pointed and notched—possibly part of a trap or snare.

Plate 57, figures 9 and 10 (cut 23, 81 in.) are two fragmentary wooden rods carefully carved and painted with red pigment, over which designs in black were applied; the latter consisted of rows of very small circles between heavy **V**-shaped figures. The painting of wooden objects with red pigment was a common practice with the Old Bering Sea Eskimos.

Drying rack.—Plate 57, figure 22 (cut 19, 45 in.), is part of the wooden frame of a drying rack. The wooden slats or cross pieces, of which figure 20 is a fragment, were set in deep slots along the edge averaging 2.5 cm long, .8 cm wide and 1 cm deep. One complete wooden slat for a drying rack was 60 cm long. A number of pieces of such slats were found in other cuts at Miyowagh; there were also several questionable fragments from the Hillside site.

Plate 57, figures 18 and 19 (cut 23, 32 in. and 45 in. deep), are two small wooden cylinders 2.7 and 2.2 cm long respectively; both have a groove around the middle containing a small strand of baleen. These objects were found in considerable numbers at Miyowagh, many of them, like figure 19, being painted red; they may have been floats for small bird snares of looped baleen.

Plate 57, figures 11 and 13 (cut 24, 68 in., and cut 18, 36 in.), are pointed and slightly curved wooden objects; use unknown.

Figures 14-16 (cut 18, 49 in., 59 in.; cut 28, 31 in.) are three more wooden objects of uncertain use; figure 15 is painted red.

Plate 57, figure 12 (cut 18, 36 in.) is flat on the bottom and constricted at center, has a wooden peg in one end and a small piece of wood set in a transverse groove at the opposite end. Figure 17 (cut 23, 81 in.), apparently a fragment, has a small piece of wood inserted through a central perforation. Figure 21 (cut 18, 40 in.) is carved in a single piece and is possibly one of the end pieces for the framework of a toy umiak.

Drum rim.—A small section of a drum rim is shown in plate 57, figure 8 (cut 16, 46 in.). It is of wood, 1.9 cm wide and has a continuous groove around the outer side. Pieces of drum rims were also found in cut 9; cut 18, depth 44 inches; cut 23, 72 inches; cut 24, 25 inches; cut 25, 89 inches.

Drum handle.—Only one drum handle was found at an Old Bering Sea level (pl. 55, fig. 5—cut 16, 23 in.). Unlike the later handles, this one is carved from the same piece of wood which forms the rim. Enough of the latter was found to show that the diameter was around 35 cm.

In plate 37, figure 8, is shown a wooden object of unknown use, purchased from an Eskimo who dug it up at Miyowagh. It is 28.5

cm long, oval in cross-section, and somewhat pointed at one end. A narrow longitudinal tapering section was cut out and the channel enlarged and cut down to a depth of about 1.8 cm. The longitudinal strip was then replaced, leaving a squarish to rectangular canal through the middle, apparently in order that the object might be used as a tube of some kind. The loose strip was held in place by means of two tightly wound loops of baleen.

Several small rolls of birch bark were also found, evidently obtained from drift wood.

Objects of Ivory and Bone

Comb.—Plate 58, figure 10, is a small ivory comb, with eight teeth, from cut 7, 67 inches; the under side is flat, the handle part of the upper side is convex, with an irregular freehand circle at the highest point; the upper end was perforated. This is the only example of an Old Bering Sea comb in the entire collection.

Shuttle.—Plate 58, figure 11, is a small ivory shuttle (cut 7, 67 in.), used probably for making baleen netting. A similar specimen comes from cut 7, depth 75 inches and two fragments from cut 25, depths 61 and 72 inches. The only examples of netting were a few small sections which seemed to be parts of a baleen dip net, such as the modern St. Lawrence Eskimos use for catching tom cod (Nelson, 1899, pl. 70, fig. 12).

Four bone and ivory objects of unknown use are shown in plate 58, figures 13, 15, 17, 18. Figure 13 (cut 23, 58 in.), of ivory, is rounded at one end, bifurcated at the other; it has sharp tips and a circular hole through the center. Figure 15 (cut 5, 32 in.) is a small plaque, made of a flat square piece of bone. Figures 17 and 18 (cut 7, 67 in., and cut 8, 20 in.) are two broken ivory objects which are flat on the back side, somewhat rounded on the front, and widened or flanged at the center; there is a perforation through the upper, thinner, end, from which a deep V-shaped groove extends down the front side; paralleling the lower end of the groove and continuing to the end are two rows of small round pits; both objects are broken at the point where a large transverse hole has been drilled through. What seems to have been a similar object, from the fourth level of the Hillside midden, is shown on plate 30, figure 27.

Plate 58, figure 16 (cut 16, 36 in.), shows two walrus teeth, fused along the approximal surfaces, a rare condition; a small pit on the opposite site shows that they had been used as a drill rest.

In plate 30, figures 18-20, are shown three heart-shaped ivory objects of unknown use. Figure 18 was found in house no. 2, the two others (pl. 30, figs. 19 and 20) between the stones of house no. 1. All three show the same characters, a deep, wide notch above with a slight beveling of the two upper edges, and a small notch below. Plate 30, figure 18, differs from the other two in having an oval-rectangular perforation through the center. The small button-shaped ivory object, plate 30, figure 21, was found among the rocks at the north end of the site. It is 2.3 cm square with rounded corners, a flat base and a rounded top. Plate 30, figures 22 and 23, are small plaques of ivory, both broken; their average thickness is 3 mm. Plate 30, figure 28, is a smaller, thinner piece, with a longitudinal groove (on the opposite side), and two small round holes at the larger end; it is 3 mm thick. Plate 30, figure 29, is a section of a small walrus tusk, notched at the end.

In plate 46, figures 9-12, are shown four ivory objects which seem to be parts of what Nelson has described as " sinew spinners " from St. Lawrence Island (Nelson, 1899, pp. 111-112, fig. 31) but which in all probability were instead parts of toy " spindle buzzes " such as Bogoras has described from the Chukchee and Kerek (1904-09, vol. 1, pp. 273-274, fig. 197, *d*, *e*) and which are also known from the Ammasalik and Egedesminde districts in Greenland (Thalbitzer, 1914, pp. 654-655, figs. 379, 380; Birket-Smith, 1924, fig. 300). Plate 46, figures 9 and 10 (cut 9, 48 in., and cut 27, 22 in.), are probably the bases of such toys. Figure 9 is rectangular in form, with a flat base and a convex upper surface in the center of which is a round pit 12 mm deep. Figure 10 is of the same shape but has the corners rounded and the central hole extending completely through. Two others were found, one oval, from cut 21, 42 inches, and one circular, from cut 7, 80 inches. We found none of the flattened rods or handles; the small ivory object, figure 11 (cut 24, 64 in.), perforated at one end, is the only specimen in the collection which might have had such a function. Figure 12 is one of several spike-shaped ivory objects corresponding to the slender knobbed rod which was inserted in the ivory base. The latter, it should be noted, might in the round form be regarded as tops.

In plate 37, figure 6, is shown an ivory object of unknown use from cut 24, depth 80 inches. It resembles in certain respects an ivory object previously described by the writer (Collins, 1929, pl. 5). It is 11.8 cm long and 5 cm wide and has the under side hollowed. In addition to the two perforations shown there are two smaller transverse openings near the upper end. This end of the object was carved to represent the blunt head or snout of an animal with a large mouth and with eyes indicated by round deep holes in which were set plugs of wood. The surface has been ornamented with incised designs—Old Bering Sea—but these are so weathered as to be hardly visible.

Clothing Ornaments, Etc.

We know very little as to the kind of clothing worn by the Old Bering Sea Eskimos, though there is no reason to believe that it differed essentially from that of the modern Eskimos. The gut parka was used, for several large fragments were found at Miyowagh. The heavier garments were made of seal and bird skins, to judge from fragmentary pieces found in association with the burial back of house no. 3 at Miyowagh.

Ornaments were surprisingly rare. In addition to the few previously described, they are represented only by an occasional button, pendant, or brow band.

Buttons.—Three buttons are shown in plate 58, figures 3-5. Figure 3 (cut 24, depth 64 in.), is an oval button of bone, undecorated; on the under side, which is shown, the center is raised and slotted; the front side is convex, rising to a pointed center. Figure 4 (cut 19, 30 in.), is half of a larger button, of ivory; it is also slotted on the base.

Figure 5 (cut 24, 25 in.), is a piece of a smaller ivory button, oval in shape, flat on the under side, with the upper side convex and rising to something of a peak at center; around the edge are three incised lines, the inner one spurred; encircling the raised center is another spurred line, with four equidistant hatchured triangles pointing inward; the base is slotted in the same manner as figure 4.

Brow bands.—Plate 58, figures 6-9 and 12, are probably to be interpreted as brow bands; all are of ivory. The smallest, figure 9 (cut 27, 52 in.) is 5.3 cm long; the largest, figure 7 (cut 7, 75 in.) 9.5 cm. Figure 12 is the only one that is decorated; it comes from cut 3, depth 60 inches. The design consists of a continuous wavy line made by opposed spurs thickened into triangles; beneath the base line on which the lower row of triangles rests, is another line which curves upward at the ends and forms two crude, irregular circles. The object appears to have been broken, probably at about the center, and the remaining half used again; there are two circular holes, remarkable for their smallness, at either end, the smallest of them being about half a millimeter in diameter. Plate 58, figures 6 and 8, come from cut 18, depth 81 inches, and cut 23, 72 inches. Eleven additional brow bands or fragments were found, as follows: Cut 1, 12 inches, 18 inches; cut 2, 12 inches; cut 4, 8 inches; cut 17, 20 inches (2); cut 20, 12 inches; cut 23, 72 inches; cut 26, 55 inches; cut 27, 38 inches, 42 inches (pl. 15, fig. 11). A single example was found at the Hillside site, the broken specimen shown on plate 30, figure 26, found in the third level of the midden.

Snow goggles.—Two wooden snow goggles are shown on plate 58, figures 1, 2 (cut 19, 54 in., and cut 24, 39 in.). Both are well made and have the nose clearly indicated. In figure 1, the eyeslits are distinctly oblique; in figure 2, the eyebrows are carved in low relief. Unfinished snow goggles of wood were found in cut 18, depth 32 inches, and cut 19, 59 inches.

Toys

In addition to the toy boats, sledge, and bows already described, several other toys were found at Miyowagh (pl. 59).

Plate 59, figure 12 (cut 18, 12 in.), is a small ivory disk, perforated at about the center and presumably used as a top. There are two others, one made of baleen, from cut 9, 36 inches, and one from the epiphysis of a walrus vertebra, from cut 7, 33 inches. Plate 59, figures 13 (exact location unknown) and 14 (cut 7, 75 in.), are small bark figures that seem to represent whales. Four others were found, in cut 5, depth 12 inches; cut 18, 44 inches; cut 23, 68 inches; cut 24, 64 inches. Plate 59, figures 16 and 17, are dolls; the first, from cut 19, 34 inches, of wood, has legs but no arms; the second, of bark, from cut 9, 48 inches, lacks both arms and legs. Figures 18-21 are toy harpoon heads, all with closed sockets, found in cut 24, depth 54 inches, cut 18, 59 inches, cut 19, 56 inches, and cut 7, 75 inches. Figures 22-24 (cut 18, 60 in., cut 27, 46 in., cut 5, 23 in.) are three small ivory replicas of the elaborate winged objects that are so characteristic of the Old Bering Sea culture; figures 22 and 24 are well made and have all of the distinguishing features—a rectangular basal socket, graceful, rounded wings, and a small indentation at the end of the projecting central part; the ornamentation consists of only a few simple lines; figure 22 has two small cylindrical plugs of baleen through the wings. Figure 23, showing the opposite side, is unfinished. Figure 25 (cut 24, 54 in.) represents a small ivory polar bear, the eyes indicated by shallow pits and the teeth by short straight lines. Figure 15 (cut 10, 54 in.) may not be a toy, although it probably had no serious function; this example of a continuous spiral groove is of interest as showing a knowledge of the simple principle on which the screw is based, even though it was never utilized.

Plate 50, figure 5 (cut 7, 37 in.), is probably an ajagaq of the simplest form—a seal humerus; the roughened center would indicate the attachment of the line to which the stick or peg was tied and the foramen at the upper end the opening in which the end of the stick was caught.

Some of the baleen objects illustrated in plate 56 were in all probability also toys. Figures 4, 5, and 6 (from cut 19, 45 in., 38 in., and cut 27, 26 in.), would seem to come in this category, representing probably a snow knife and paddles; figure 7 (cut 19, 42 in), is more doubtful; its rather heavy sharpened end might have been intended for use.

IMPLEMENT TYPES, EARLY PUNUK

In plate 60 are shown a number of objects representing types which, at Miyowagh, were found either in the later, northwestern section of the midden or in the upper layers of the older, southeastern section, but neither at the Hillside site nor from the lower levels of Miyowagh. Such types may therefore be regarded as belonging to the early Punuk stage. There are undoubtedly other types characteristic of this transitional period, but an attempt to segregate them, when they occur in the same midden with Old Bering Sea and later Punuk material, would result in considerable uncertainty. Full knowledge of the type forms of the early Punuk stage must await the discovery of a pure site of this period; for the present our information regarding it must be limited to the evidence afforded by harpoon heads and art styles, and the few objects such as shown in plate 60.

Bone dish.—Plate 60, figure 1, is half of a bone dish from cut 17, depth 34 inches, made from the epiphysis of a whale vertebra; the entire inner surface has been carefully smoothed and slightly hollowed out; the outer surface is worked only along the periphery.

Adz head.—Figure 2 is an ivory adz head from cut 19, 42 inches deep. The two lateral " ears " for the lashing thong are similar to those on the Old Bering Sea specimen shown in plate 46, figure 3. On the under side there is a shallow oval pit for the end of the handle, and just above it two holes for the lashing. The blade rested in the concave lower end of the front side. The decoration is simple, consisting of a crescent-shaped and circular figure, both divided into sections by means of short cross lines; circles at the center of the " ears "; and a few slightly curving lines on both sides at the upper end.

Plate 60, figure 3 (cut 9, 36 in.), is an ivory object of unknown use; one end—the upper as here shown—is rather sharp edged and spatulate in shape, the opposite end is wider with a longitudinal groove 3 mm deep and 3 mm wide in the base.

Figures 4 and 5 (cut 19, 17 in., and cut 23, 24 in.) are two ivory objects which may have been cord handles. Figure 4 appears to be unfinished.

Snow goggles.—Figure 6 is one half of a pair of ivory snow goggles picked up on the surface of the midden. The eye slit is small, only 2.5 cm long and .5 cm wide. Decoration consists of a few curving lines with spurs attached.

Plug.—Figure 7 (cut 2, 28 in.) is an ivory plug, probably an ornament of some kind. It has a rough conical tang and a flat smooth upper face on which there are five small round pits, drilled to a depth of between 2 and 3 mm.

Toy bow.—Figure 8 (cut 19, 42 in.) is a toy bow of wood, heavily reinforced with baleen. A thick strand of baleen, loosely twisted into a cable, extends along the back, being held on by cross lashings at regular intervals. The under side is reinforced by a strip of wood bound on with baleen. In this toy we have the earliest evidence of the use of the sinew-backed bow on St. Lawrence Island—for in all likelihood the baleen on the toy is a substitute for the sinew backing of the real bow.

Drill shaft.—Figure 9 is a drill shaft of unusual type, the upper part of wood, the lower part of ivory. It was purchased from an Eskimo who had excavated it at Miyowagh, from a depth of between 1 and 2 feet. The upper end of the wooden section is smoothed and worn where it revolved in the drill rest; the lower end is set into the hollowed out upper end of the ivory section. The latter is decorated in Punuk style, with four encircling spurred lines and intervening circular pits, some drilled to a depth of 3 mm. At the lower end is a shallow concavity for the point which was probably of metal; opposite this is a lipped edge to prevent the lashing from slipping. There is also a small round pit in the end 1.5 mm deep, which would seem too shallow to have held a point, even of metal. Another drill shaft of bone, with particles of iron remaining in the small socket at the lower end, was found in cut 20, at a depth of 22 inches.

Engraving tools.—The two small ivory objects, plate 60, figures 10 and 11, are engraving tools from cut 27, 22 inches, and cut 3, 20 inches. Another comes from cut 23, depth 52 inches. They are both delicately made; with the maximum thickness—around 6 mm—at the center, and both ends constricted. Figure 10 is 6.2 cm long. The upper end of figure 11 is broken; the center is pierced by four slots. These implements are of particular interest because they were provided with iron points, a few corroded particles of which still remain on figure 11. These, presumably, were the implements used by the early Punuk Eskimos in engraving designs on ivory—designs which, as we have already seen, show clear evidence of having been produced by metal tools.

Shovel.—Figure 12 is a small shovel, made from a walrus scapula, from cut 4, depth 15 inches. It is 13.2 cm long and 10.4 cm wide, much smaller than the more common type made from an entire scapula, illustrated in plate 50, figure 6; it is likewise more carefully made than the larger forms. At the upper end are two small drilled holes for the lashing which held the handle on. Fragments of two similar shovels were found in cut 5, 23 inches deep, and cut 19, 32 inches.

Ievoghiyoq

Some 200 yards to the north of Miyowagh is the smaller site, Ievoghiyoq, a grass-covered midden rising like a small island from the flat gravel plain (pl. 61, fig. 1 and text figs. 2 and 18). It is separated from Miyowagh by four old beach lines, and to the northward six more beach lines lie between it and the sea. Its position would thus indicate that it had been built later than Miyowagh and that during the time of its occupancy and after its abandonment the sea had receded still farther, piling up still more gravel ridges. The Ievoghiyoq midden is roughly oval in outline, with an average diameter of around 150 feet. The shallow depressions of about a dozen house pits are visible on the surface; two of these were excavated—houses no. 6 and 7. In recent years, probably after the famine and epidemic of 1878-79, burials were made on the surface of the midden, and there is an old cemetery on the gravel ridge extending eastward toward the hillside. The burials on the ridge had been enclosed by oval rows of stones, similar to those observed by Nelson on the south side of the Island (Nelson, 1899, p. 321).

Although the Ievoghiyoq midden stands out more prominently than Miyowagh, its total depth was only 5 feet as compared with the 8-foot depth of the older midden. Its apparently greater height is due to the fact that not so much gravel had piled up along the edges. Being situated on the gravel plain, the Ievoghiyoq midden is rather dry, and the material found in it was in a much better state of preservation than that from the southeastern section of Miyowagh. The ivory was likewise more uniform in color, ranging from a light cream to light brown, in contrast to much of that from Miyowagh, which had been turned to a dark brown or black from the action of water.

In 1930 seven cuts (one incompleted) were excavated at Ievoghiyoq, and two others in 1931. These will not be described individually as the material obtained was remarkably uniform from top to bottom in contrast to that from Miyowagh, where there was evidence of cultural modifications along many lines. Ievoghiyoq proved to be a pure Punuk site, one which had been established and abandoned during the period

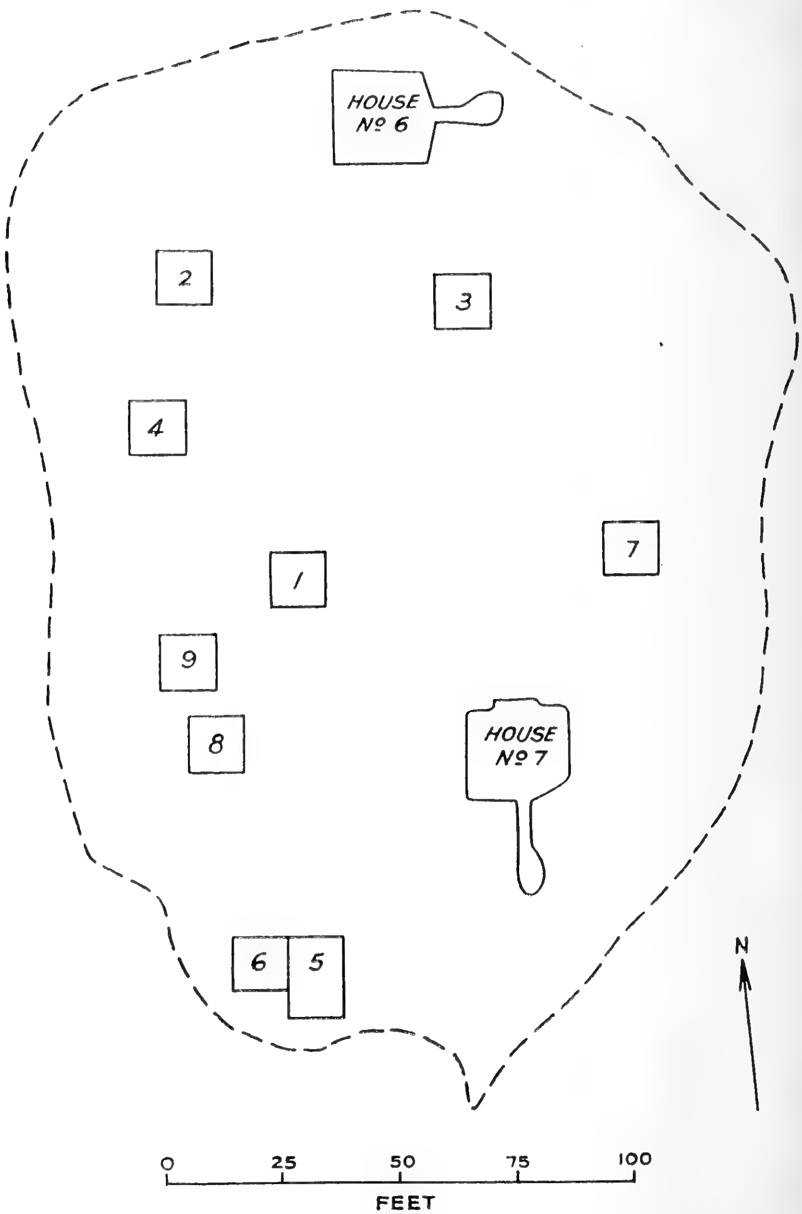


Fig. 18.—Outline of Ievoghiyoq, showing excavations of 1930 and 1931.

when Punuk culture was flourishing on St. Lawrence Island. But as we shall see later, the material obtained from this site was not identical with the Punuk material from Miyowagh. It represents a more developed, more typical aspect of Punuk culture, showing that Ievoghiyoq was established just before the time Miyowagh was abandoned, and that it continued to be occupied for many years afterward. Around 2,000 artifacts were excavated at Ievoghiyoq, in addition to the usual quantities of potsherds, animal bones, pieces of slate blades and other fragmentary objects.

The Ievoghiyoq midden was structurally much like Miyowagh except that in some places, particularly cut 4, there was more gravel. There was also a larger content of mussel shells; these were particularly abundant in the upper levels of cuts 5 and 6, and they formed a distinct stratum about 6 inches thick in cut 1, sloping from a depth of 1 to 3 feet. Cuts 1, 2, 5, and 6 extended through thick, solid refuse which thawed very slowly. These cuts were prolific in artifacts and yielded large quantities of mammal, bird, and fish bones as well as baleen.

The above mentioned cuts in the midden revealed no remains of house structures and parts of only two caches. Both of the caches were found in cut 4, which was mostly gravel. One of them, at the southeast corner, had been built of whale skulls, two of which were visible, resting on logs and whale vertebrae. The other cache was only 2 feet away; it had been constructed of stones, one above the other, the upper tiers evidently having been removed, as no fallen stones were found nearby.

HOUSES AT IEVOGHIYOQ

Two houses were excavated at Ievoghiyoq. One of them, house no. 6, closely resembled house no. 5 at Miyowagh, but was much better preserved. The other, house no. 7, was excavated by Mr. Ford during my absence from the island. It was larger, apparently older, and differed in important structural features from house no. 6.

House no. 6 (text fig. 19, and pl. 62, figs. 3, 4).—This house was 19 feet 4 inches long by 19 feet wide; it had stone walls and floor; the entrance passage, facing east, was 8 feet 8 inches long and 25 inches wide. The floor of the passage was at the same level as that of the house, a little less than 2 feet below the surface; the roof, walls, and floor of the passage were of stone slabs. The end of the passage was enlarged into a rounded antechamber (pl. 62, fig. 4) 7½ feet long by 6½ feet wide. It had been roofed with whale ribs, had a stone floor, and walls built of stones, walrus skulls, whale vertebrae, and five small

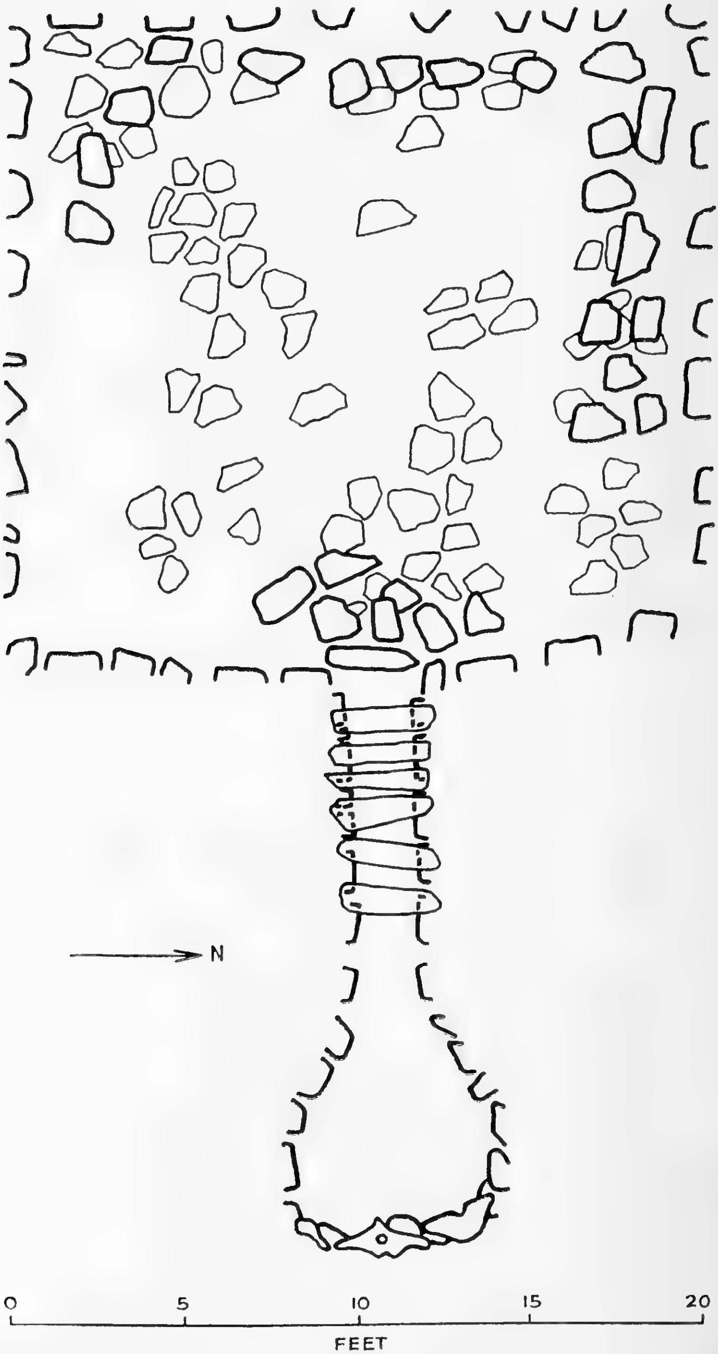


Fig. 19.—Plan of house no. 6, Ievoghiyoq.

whale skulls. The antechamber evidently had been used for cooking, for on the north side was found a mass of burnt gravel and bones. No artifacts were found in the house or passage.

House no. 7 (text fig. 20, and pl. 61, figs. 2-4; pl. 62, figs. 1, 2).—This house faced toward the south, was 20 feet 10 inches long and $19\frac{1}{2}$ feet wide, and at the back had a narrow recess or annex; the floor was 4 feet 9 inches below the surface. The house was entered by a passage 23 feet long by 21 inches wide, with an enlarged end 4 feet 10 inches wide. The narrow part of the passage seemed to have been roofed with stones, but the enlarged outer end had been roofed with timbers. The passage had a stone floor and sides, but unlike those

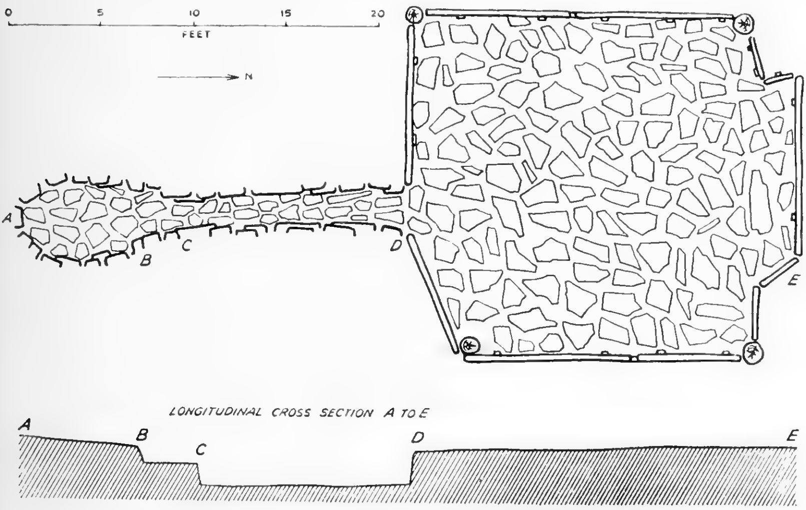


FIG. 20.—Plan and section of house no. 7, Ievoghiyoq.

previously described, it had three different levels, the third or outer one being higher than the floor of the house. The house floor was also of stone slabs, but the walls and roof had been constructed entirely of timbers. These were fairly well preserved, and here for the first time a clear view could be had of the unique type of wall structure that had been so imperfectly preserved at Miyowagh. The timbers were laid one over another horizontally, passing around a large upright timber or whale jaw (roof support) at each corner, and several smaller uprights in between. The wall appeared to have had a height of about 4 feet. The roof timbers had collapsed and covered the entire floor, but unfortunately the roof structure could not be made out, for the excavation of this house was not begun until the middle of August, and by the time the roof timbers were completely exposed the ground had begun to freeze again, so that the excavation had to be left unfinished.

Artifacts from house no. 7 include a number of potsherds; slate blades; adz blade; adz handle; ivory fishline sinker; drill rest; wooden drum handle (pl. 81, fig. 6); kayak paddle (pl. 84, fig. 2); board used in making fire (by drilling) (pl. 84, fig. 1); and 35 small wooden pegs, for bird snares. Two poorly preserved human skeletons, with crushed skulls, were found beneath the fallen roof timbers.

Seklowaghyaget

Seklowaghyaget, the largest of the old Gambell sites, is a low, spreading midden situated at the northwest end of the lake and immediately behind—to the east of—the present village. It has an average breadth, north and south, of 200 feet and a length of some 200 yards but its exact boundary on the west cannot be determined, since it merges imperceptibly into the older section of the present village. Numerous house pits are visible and the surface has been much disturbed by the digging of the Eskimos. On the south side the midden stands out rather prominently as it slopes down to the low land bordering the lake, but one of our cuts, no. 4, sunk just back of the highest point, showed that the refuse extended to a depth of only 4 feet 4 inches. The appearance of greater depth was due to the fact that on the south side the refuse had been distributed along the top of the gravel ridge bordering the lake, some of it falling down to the low ground below.

Seven 12-foot cuts were made at Seklowaghyaget, four in 1930 and three in 1931. The cuts ranged in depth from 4 feet 1 inch to 5 feet 7 inches. There was more gravel than at the three older sites and not nearly as much cultural material—less than 700 specimens were found. However, these were sufficient to indicate that the site had been established during the Punuk stage and occupied until a comparatively late period, when the Punuk culture had begun to be supplanted by the modern. The midden differed from those previously described in that much of the gravel and refuse was saturated with blubber, a condition similar to that observed at Point Hope on the Arctic coast. This is an indication not only of the younger age of the Seklowaghyaget midden as compared with the three already described, but also of the fact that whaling had now become an important occupation (as is also shown by the relatively large number of whaling harpoon heads) and that larger stores of whale blubber had to be preserved. It was no doubt this whale blubber, stored in underground caches all over the midden, that permeated the gravel. Remains of stone and whale bone caches were found in three of the cuts. Plate 63, figure 1, shows a mass of fallen whale bones and stones which seemed to be part of such a cache, lying above a piece of blubber soaked walrus hide.

HOUSE AT SEKLOWAGHYAGET

House no. 8.—This house, the best preserved of its type that we excavated, was not situated on the Seklowaghyaget midden but on

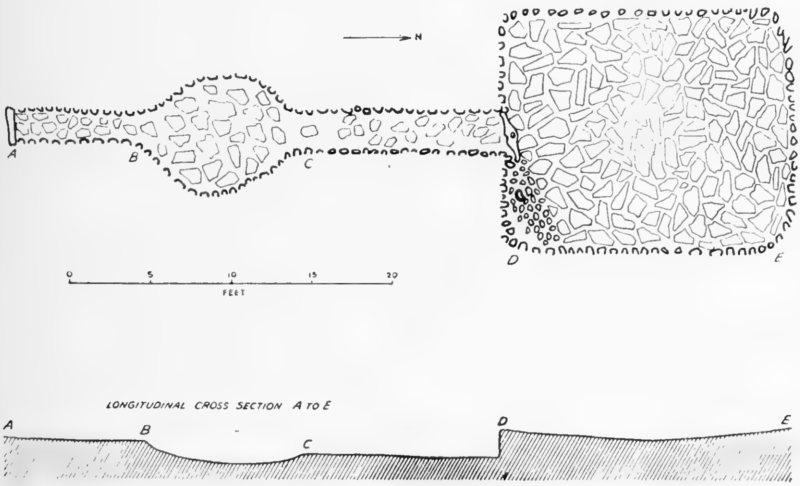


FIG. 21.—Plan and section of house no. 8, Seklowaghyaget.

the gravel flat a short distance to the eastward. It consisted of a rectangular inner room 18 feet long by 15 feet wide (text fig. 21 and pl. 63, figs. 2, 3) and an entrance passage 30 feet long facing to the south. The walls of the inner room, mostly fallen, had been built of walrus skulls, whale vertebrae, and stones. The floor, which is $2\frac{1}{2}$ to $4\frac{1}{2}$ feet below the surface, was covered with flat stone slabs and was somewhat sunken at the center. At the entrance, on the south side, a small whale skull was driven into the gravel, the flat occipital portion serving as a threshold over which the occupants crawled as they entered or left the house. To either side of the whale skull was a long upright stone slab. On the east side of the entrance a number of stones and whale vertebrae were piled up around a projecting whale jaw, the only one of the roof supports still standing, and just beyond, in the corner, was a circular space about 2 feet in diameter, probably for storage.

The entrance passage was 29 inches wide and the floor level 16 inches below that of the inner room. The floor, like that of the inner room, was of flat stone slabs; the walls were of heavier stones piled one above the other, and across the tops of these were laid the whale ribs and jaws forming the roof. Plate 63, figure 5, shows the entrance passage before it had been entirely uncovered. The man at the center is standing in the narrow part of the passage, between the whale ribs which formed the roof. In the foreground are seen the fallen whale ribs of the roof of an anteroom—an enlargement of the passage—13 feet beyond the entrance to the inner room. This anteroom was an oval chamber 8 feet 8 inches long and 7 feet 8 inches wide. Plate 63, figure 4, shows the west side of it after the fallen roof bones and gravel had been cleared out. Its floor was of stone slabs sloping from the sides toward the center, and the walls of stones with an occasional walrus humerus or whale vertebra included. The height of the walls here was slightly over 3 feet. The roof had been constructed of whale ribs and jaws. In this enlargement of the passage, which had no doubt served originally as a store room, were found six human burials. These had been made after the house had been abandoned, for they were resting on about 2 feet of gravel which had accumulated above the floor. The roof, however, was at least partly intact when the bodies were placed there for the whale bones had fallen in on top of them.

At the southern end the anteroom contracts and then continues again as a narrow passage 25 inches wide. The walls and floor were built in the same manner as those just described, but the floor level was 4 inches above that of the anteroom. Across the outer end of the passage was laid a long narrow slab of stone and resting partly on this and partly on a whale rib laid across the wall was a whale skull. Three feet beyond was another whale skull which had fallen and partly blocked the passage. The entrance to the passage was apparently between these two skulls. Two human skulls and a few long bones were found in the outer entrance at the same level as those in the anteroom. The tops of the walls of the passage and anteroom are at present about 1 foot below the surface.

The cultural material found in house no. 8 indicates that it was contemporaneous with the latest period at Seklowaghyaget, probably early eighteenth century. The fragments of lamps and cooking pots were all of the recent types, and one half of a blue glass bead was found. The bulk of the material, however, is to be classed as late Punuk as is shown by such objects as the harpoon heads (pl. 71, figs. 15-20), adz socket (pl. 78, fig. 21), plates of bone armor, bone knife, arrow point, harpoon socket piece, etc.

Old Section of Gambell

The latest of the old sites in the vicinity of Gambell is that at the north end of the long narrow gravel bar which lies between the lake and the sea. Here, immediately to the south of the present village, are found the ruins of the underground houses of the nineteenth century, the last of which were abandoned between 40 and 50 years ago. The site is nothing more than a continuation of Seklowaghyaget, although the Eskimos use that name only in referring to the larger midden extending along the north end of the lake. The house pits in this latest section are deeper and more sharply outlined than those at the older sites, and the midden deposits around them are much shallower, perhaps not exceeding 3 feet in depth. Two cuts were made, one of them through refuse 20 inches thick, the other 32 inches. The midden here was no less prolific in artifacts than the older ones (about 250 artifacts being found), and the material obtained was of value as illustrating the latest stage in the transition from the Punuk to the modern culture. The evidence furnished by harpoon heads was of particular interest in this connection, since it showed that the modern thick, rounded form with closed socket had evolved directly, and rather suddenly, from the immediately preceding form which was thinner in cross-section, with a wedge-shaped socket, which, though still open, had functioned as a closed socket.

HOUSES AT OLD SECTION OF GAMBELL

House no. 9.—On the low ground between the midden and the lake and about 100 feet SW. of Seklowaghyaget is a house ruin very similar to house no. 8. The inner room is roughly square in outline with a stone floor 3 feet below the surface (text fig. 22). The walls, which are now mostly fallen, had been built of whale vertebrae, walrus skulls, and stones, with a single upright whale jaw in the rear (west) wall. At the NE. corner there was an upright wooden roof support, and another at the NW. corner together with a small upright whale jaw and a whale skull. The stone flooring does not extend to the wall on the north, west, and south sides, and it may be that sleeping platforms had occupied these spaces. Just as in house no. 8, an inverted whale skull had been placed at the entrance. The narrow passage way was built of stones and roofed with whale ribs; the enlarged anteroom was constructed in a similar fashion, with a stone floor, walls of long upright stones, above which were placed smaller stones, and above these a roof of whale ribs. A unique feature of this house was an oval annex, evidently a cache, opening from the anteroom on the south side (pl. 64, fig. 1). The floor of this annex was of dirt, and it was 3 feet above the floor of the passage. It had stone walls and a roof of whale ribs. Two whale skulls were placed at the point where the anteroom narrows at the outer end, and another at the extreme outer end of the passage.

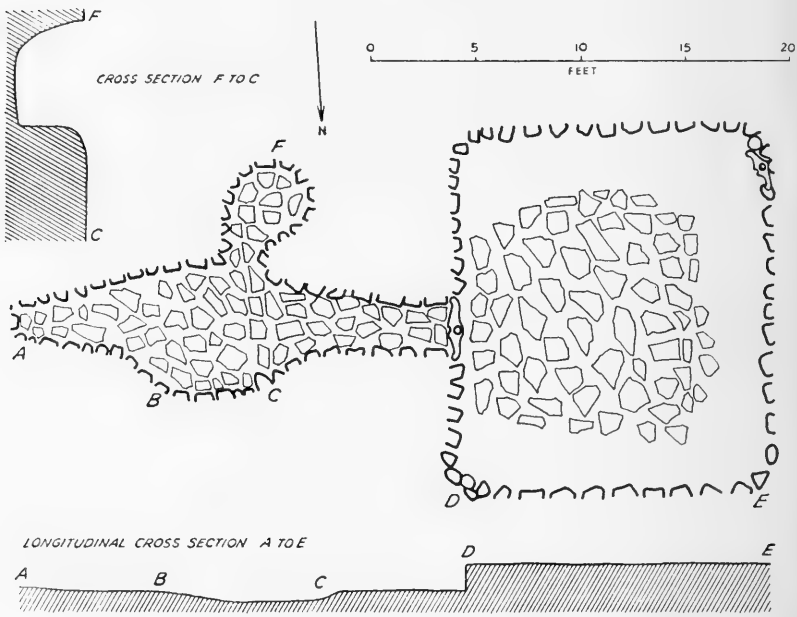


FIG. 22.—Plan and section of house no. 9, old section of Gambell.

The cultural material from house no. 9 was scanty but sufficient to date it as contemporaneous with house no. 8. Fragmentary lamps, lamp rests, and cooking pots were of the modern types and identical with those found in house no. 8; a bone adz socket of the type illustrated in plate 78, figure 19, from Seklowaghyaget, was also found; there were only two harpoon heads, one of them, weathered and possibly a relic, was of open socket type III (a) x; the other was of the later type III (b) x with wedge-shaped socket.

House no. 10.—This was one of the latest of the underground houses at Gambell, having been abandoned, according to native testimony, around 50 years ago. It was situated on the midden and appeared as a rather deep depression; excavation showed about 2 feet of gravel over the center and about 4 feet at the corners. The house was not completely excavated, since it belonged to the same type as several much better preserved houses previously excavated at the eastern end of St. Lawrence Island. This type is illustrated in plate 2, figure 3, and plate 3, figure 4. House no. 10 differed from all of the older Gambell houses in having a wooden floor and sleeping platforms, features also present in the Punuk Island houses. Our excavation uncovered only the floor (pl. 64, fig. 2), parts of the sleeping platforms on three sides, and the entrance, which faced to the east. The floor had been built of split logs neatly fitted together, with flat sides up; it measured 7 feet 6 inches north and south by 7 feet 3 inches east and west. The platforms, which extended along three sides, had been built of similar timbers laid horizontally across timbers extending out from the wall along the floor. The rear wall, which was only partially uncovered, had been constructed of upright timbers, whale jaws, and a few stones. The passage had floor and walls of stones like those of houses no. 8 and 9, but no anteroom.

The material found in house no. 10 was modern in every respect, including a large quantity of metal—hoop iron, files, large knife blades, and sheets of copper. There were also numerous fragments of modern type lamps, lamp rests, and cooking pots, a stone sinker for a tom cod net, an ivory bird figure, blunt arrow tip of ivory, whetstones, and long, flat sledge shoes made of whale bone.

At Mirrukta, a deserted village about 3 miles east of Gambell, ruins of stone-walled houses somewhat different from those described above were found. These may be somewhat more recent than most of the stone-walled structures at Gambell, as they are in a better state of preservation. They are about 18 feet square, and the walls, built entirely of stones, are mostly above ground (pl. 64, fig. 5). We did not excavate any of them, so the depth of the floor beneath the surface is uncertain, but it was probably no more than a foot. A stone wall extending the length of the room formed an inner partition about 6 feet wide, the purpose of which is uncertain unless it served as a storage space. Some of the houses had attached at one corner, on the outside, a roughly circular stone-walled cache. The roof construction could not always be determined, but in some cases two large parallel whale jaws had formed the main framework of the roof, which had no doubt been formed of walrus skins. These houses lacked the long sunken entrance passages such as were attached to the other early forms of St. Lawrence dwellings; the only entrance now visible was a low opening in the east wall of one of the houses across which was laid a large flat stone (pl. 64, fig. 5). Houses of this type apparently represent summer dwellings, used along with the semi-subterranean house with walls and roof of wood and whale bones.

Decorated Objects, Punuk, from Ievoghiyoq, Seklowaghyaget, and Old Section of Gambell

Decorated objects from the three later sites are illustrated on plates 65 to 69. At none of these sites was Old Bering Sea art found, and there is only one doubtful example of Punuk style 1.

The objects shown in plates 65 and 66 are from Ievoghiyoq, all of them examples of Punuk style 2. Plate 65, figure 1, is a broken needle case from cut 5, depth 43 inches. The flaring end distinguishes it from the Old Bering Sea forms shown on plate 17. Ornamentation is in phase 2 of Punuk style 2, consisting of deeply incised lines, spurs, dots, and compass-made circles. The other needle case, plate 65, figure 2 (cut 9, depth 12 in.), is similarly decorated; it also has a flaring end, and somewhat below the center two protuberances or "wings" upon each of which is inscribed a nucleated circle. These lateral "wings" are set off by curving lines which extend from the enlarged and flattened upper end to the constricted, tubular lower end. This "winged" needle case is similar both in form and ornamentation to two others from Point Barrow described by Mathiassen (1929, vol. 2, p. 95).

Plate 65, figure 3, is the handle of an ivory knife from cut 1, depth 28 inches, a common implement type of the Punuk period (other examples illustrated on pl. 79, figs. 4-6). It is decorated with pairs of longitudinal lines, nucleated circles and small spurs. The latter, which are attached obliquely to both the circles and lines, are deeply gouged pits, very different from the straight, slender spurs of the preceding stage, Punuk 1. These short, deeply cut spurs, usually attached in pairs to lines and circles, are distinguishing characteristics of phase 3 of Punuk style 2. The two fragmentary objects (dart socket pieces ?) shown in plate 65, figures 4 and 5, are also examples of phase 3; these come from cut 1, 31 inches, and cut 5, 24 inches deep, respectively.

The same arrangement of lines and spurs may be seen in plate 65, figure 6 (cut 8, 8 in.). This is a link ornament, which was probably attached to a drum handle; the end has been carved to represent a seal's head. This is one of the examples where the pairs of oblique, deeply gouged spurs of phase 3 resemble very closely the modern Eskimo **Y**-figure.

Plate 65, figure 7 (cut 1, 42 in.), is an oval ivory block of unknown use, with a piece of wood in the central perforation. It bears a decoration (phase 2) of nucleated circles at the ends of short lines extending from the opposite borders, with a bold zigzag line formed of large connected **Y** figures, running down the center.

Plate 65, figure 8, is an ivory object of unknown use from cut 5, depth 31 inches. The pairs of deeply cut lines at the center are arranged chevronlike; the lower one takes the form of a bold **Y**. This is a favorite device of Punuk art, variations of which are illustrated in plate 65, figures 2, 9; plate 67, figure 8; plate 68, figure 7; plate 70, figures 22, 23; plate 74, figure 21. It was also employed during the Old Bering Sea period (e. g. pl. 17, fig. 3; pl. 19, fig. 2).

In plate 65, figures 9-11, are shown three wrist guards, implements which are characteristic of the Punuk, but which seem not to have been known to the Old Bering Sea culture. Figures 9 and 10 are made of ivory, figure 11 of bone. They all came from cut 1, at depths of 36 inches, 44 inches, and 36 inches respectively. The incised design on figure 9 consists of pairs of curved **V**-shaped figures; arcs; short, straight lines and spurs. The designs on figures 10 and 11 are very much alike and are recorded in table 1 under the heading " Modern." The upper rounded end, like figure 9, is divided off by a pair of transverse lines, and a **V**-shaped figure is placed in the space so formed. Below, a narrow strip down the center is left plain, being outlined by two pairs of parallel, longitudinal lines. Pairs of short transverse lines are placed between these and the bordering lines; on figure 10 the transverse lines are placed obliquely, on figure 11 they are at right angles. Short spurs are attached to some of the lines in various arrangements, some as single rows on the inside, some on the outside, and some as opposite or alternate rows; between the oblique lines of figure 10 they take the form of short connecting lines.

The four ivory objects from Ievoghiyoq shown in plate 66, figures 1-3, 6, are examples of the more linear style of Punuk ornamentation which in some cases cannot be distinguished from the work of the modern Eskimos of southwest Alaska and which is here designated as phase 4 of style 2. Since most of the pieces decorated in this linear style were purchased from the Eskimos and are therefore lacking in depth records, they are not included in table 1.

Plate 66, figure 2, is a wrist guard of rather unusual form. The decoration is in three sections, each consisting of a transverse band of closely spaced, deeply incised parallel lines, at the center of which is a series of short vertical lines arranged in pairs.

Plate 66, figure 1, is a fragment of another wrist guard. It has the same arrangement of transverse bands of parallel lines, with the addition of occasional long, sharp spurs.

Plate 66, figure 3, is a broken socket piece for a harpoon. The decoration is very simple, consisting principally of pairs of encircling lines connected by shorter pairs of lines forming **H**-figures; at intervals there are deep, circular pits containing remnants of wooden plugs.

Plate 66, figure 6, is an object of unknown use, which is ornamented with parallel longitudinal lines and pairs of short transverse lines, with four bold spurs in the center. It comes from cut 8, depth 44 inches.

Plate 66, figure 7, is a broken needle case similar to several previously described from St. Lawrence Island (Collins, 1929, pl. 17, *b-d*). It has a "modern" decoration of encircling lines to which are attached alternating spurs.

The function of the object shown on plate 66, figure 8, is uncertain. The central notch and the two holes above show that it was lashed to something, possibly as a cleat on an umiak for holding a line. The surface is profusely ornamented with straight longitudinal lines, single and double; and numerous short, oblique, deeply cut spurs attached in pairs to the longer lines. It is a typical example of phase 3 of Punuk style 2.

Plate 66, figures 4 and 5, are two other objects of unknown use; they come respectively from cut 1, depth 42 inches, and cut 5, 14 inches. On figure 4 the decoration consists of nothing more than three rows of short detached vertical lines arranged in pairs. Figure 5 shows the combination of lines and short, deeply incised, oblique spurs (phase 3 of Punuk style 2) that was observed in plate 65, figures 3-5, and plate 59, figure 8.

Among the 144 harpoon heads and fragments from Ievoghiyoq, only 29 are decorated. This is in striking contrast to the conditions observed at Miyowagh and the Hillside site, where out of a total of 255 heads and fragments, 162 were decorated.

Eight of the decorated harpoon heads from Ievoghiyoq are illustrated in plate 70. There was no clear example of Punuk style 1, which had been so prominent at Miyowagh (pl. 24, figs. 19-21, 23; pl. 26, figs. 6-9; pl. 28, figs. 8-17, 19-22, 25-27). Plate 70, figure 21 (cut 4, 42 in.), is the only possible exception; stylistically it is quite conformable, but the lines and pits are much deeper than on the Miyowagh heads which were decorated in Punuk style 1.

Plate 70, figure 8 (from cut 4, depth 59 in.), is one of six harpoon heads from Ievoghiyoq decorated in phase 1 of Punuk style 2; the lines are rather deeply incised, mostly straight, and have very long spurs attached. This particular arrangement of lines and spurs (which was also found on several harpoon heads from Miyowagh—pl. 28, figs. 13, 14) appears to be the oldest style of ornamentation at Ievoghiyoq, for the six heads so decorated conform structurally in every particular to the Miyowagh specimens mentioned, and lack the specialized characters possessed by the other Ievoghiyoq heads; furthermore they all come from the lower levels of the midden, from depths of 31 to 59 inches.

Phase 3 of Punuk style 2 was the more common form of decoration applied to harpoon heads at Ievoghiyoq (pl. 70, figs. 15, 18, 20, 22, 23). The lines are very deeply incised, the nucleated circles (when present) are mechanically perfect, and the spurs have taken the form of small, deeply gouged pits which are attached obliquely to the lines.

Very few decorated objects were found at the two latest sites, Seklowaghyaget and the old section of Gambell, partly, no doubt, because of the relatively small amount of digging done there. However, the scarcity of decorated objects is also an indication of the fact that by this time the artistic impulse was dying out, and the implement forms were assuming the heavy, utilitarian aspect so characteristic of the culture of St. Lawrence Island in the nineteenth century.

Plate 67, figure 7, is an ivory wrist guard from cut 3, depth 20 inches, Seklowaghyaget. It is identical in form with another wrist guard from the same site illustrated in plate 74, figure 22. The decoration, which is rather crude, consists of short, vertical lines attached to pairs of horizontal lines, all very deeply incised; it is to be classed as phase 4 of Punuk style 2.

The ivory wrist guard shown in plate 67, figure 5, comes from cut 1, depth 8 inches, old section of Gambell. It is straight at both ends and has two round holes on one side and two slots on the other for the lashing. The decoration is modern; four curved lines, or arcs, the inner three with light spurs attached, rise from the rim and enclose both of the slots; at the lower end is a band of seven lines with an alternate arrangement of spurs, and at the upper end a similar band of nine lines.

The other six objects in plate 67 were purchased from Eskimos and are reported to have been excavated at Seklowaghyaget.

Plate 67, figure 3, is a broken dart socket piece bearing a characteristic phase 2, Punuk style 2 decoration of lines, circles, dots, and spurs.

Plate 67, figure 4, is a bodkin with a simple decoration of lines and spurs, and at the center two V-shaped figures.

Plate 67, figure 1, is an ivory ulu handle, bearing a phase 3, style 2 decoration consisting of deeply cut straight and curving lines, spurs, and compass-made circles. The bordering bands are of particular interest in that they show so clearly the relationship of the spurred line to the zigzag, a negative design resulting from the thickening of the bases of the spurs. The lower band contains a perfect zigzag or wavy line and so does the left half of the upper band. On the right half of this band, however, the alternate spurs are longer and more slender and present the usual appearance of the "toothed line." For some reason the artist chose to leave the spurs at this stage instead of widening the bases so as to produce the negative zigzag design. This is the only Punuk example I know of in which the very common alternate spur design has been transformed into a zigzag, although the process is constantly recurring in modern Eskimo art, as well as in Melanesian, European Iron Age, and other styles that employ the spurred line motive. We might also note here that although the single spurred line and the ladder design are characteristic of Old Bering Sea art, the simple alternate spur design has not appeared. This, however, may be due to accident, for on the fragment of an Old Bering Sea brow band shown in plate 58, figure 12, there appears a fully developed zigzag pattern.

Plate 67, figure 2, is an ivory object similar to several found at Miyowagh (pl. 46, figs. 9, 19), and which apparently is to be regarded as part of a spindle buzz. The present specimen is flat on the under side, convex on the upper, and perforated through the center. The upper surface is rather elaborately ornamented in phase 2 of style 2. Around the periphery is a band formed of two lines with alternate spurs pointing inward, and about half way up there is a similar band. The spaces between the bands and at the center are divided off by means of narrow inverted **V**-shaped figures, and between these are pairs of slightly curving lines connected at the center by a small nucleated circle; rising from the curving lines are pairs of short lines terminating in circles to which are attached three equidistant spurs.

Plate 67, figures 6 and 8, are two objects which I am unable to identify. They are straight across the lower end, rounded above, and have in the base a deep cylindrical socket. Figure 8 seems to have had a link pendant at the end; the decoration consists of very deeply incised lines, some straight, some **V**-shaped and others curving around to the opposite side. The lines on figure 6 are less deeply incised; at the base is a band containing long alternating spurs and from this rises a pair of vertical lines which are joined at the center by two oblique bands of three lines each in the open spaces; above these are two short detached lines each with a pair of downward-pointing spurs attached. Red pigment still remains in most of the incisions, as is so often the case with objects bearing a Punuk decoration.

Just as at Ievoghiyoq, the harpoon heads at the two latest sites were for the most part undecorated. Of the 80 harpoon heads and fragments found at Seklowaghyaget, 14 were ornamented; of the 68 from the old section of Gambell, only 2. One of the decorated heads from Seklowaghyaget (cut 2, 49 in.) is shown in plate 71, figure 2. It has the phase 1, style 2 decoration of lines and long spurs which seems to have been the earliest style present at Ievoghiyoq. Three other Seklowaghyaget heads have this same decoration and all of them came from the deeper levels—34 to 52 inches. On the basis of these few specimens, therefore, it would appear that the earliest period at Seklowaghyaget was approximately contemporaneous with the earliest period at Ievoghiyoq. However, from the evidence afforded by other implement types, particularly the forms of the harpoon heads themselves, it is clear that Seklowaghyaget was occupied for a considerable period after Ievoghiyoq had been abandoned. Of the 10 other decorated harpoon heads from Seklowaghyaget, 3 are to be classed as phase 2 of style 2, 6 as phase 3 (including plate 71, figure 14), and 1 as indeterminable.

Of the two decorated heads from the old section of Gambell, one (from cut 1, depth 16 in.) has the deep lines, spurs, and dots of phase 2, style 2; the other specimen (from cut 1, 24 in.) is so badly weathered that the design is unrecognizable.

The early Punuk stage witnessed an interesting development in those artifacts which for want of a better name have been referred to on previous pages as " winged objects ", the Old Bering Sea forms of which were illustrated in plates 12, 20, and 21. In plates 68 and 69 we have views of both sides of eight specimens showing the forms that these " winged " objects assumed during the Punuk stage. The initial step in the transition from the Old Bering Sea to the Punuk forms is not illustrated by the material excavated at Gambell, but fortunately there are two specimens which do show it. The first of these is the winged object from Point Hope figured by Mathiassen (1929, p. 45). The second, which is very similar in form and ornamentation, is shown in text figure 23; this specimen was purchased by Dr. Hrdlička, and although the exact provenience is unknown, it probably came from St. Lawrence Island or Little Diomede Island. The central projection is broken off on both this object and the one figured by Mathiassen. Structurally, these two objects are closer to the Old Bering Sea than the Punuk type: both have the Old Bering Sea form of socket—square or rectangular—and in the specimen shown in text figure 23 there are round lashing slots leading into the socket from the sides; the wings are still rather wide, although they are pointed instead of rounded at the ends and their sharp upward inclination approaches the Punuk trident; the notches at the bases of the wings are the same as on the Old Bering Sea forms. On the back side (text fig. 23, *b*, and Mathiassen, fig. 19, *b*) the raised central section retains the general Old Bering Sea outline, although the short inner "wings" are narrower and are directed upward rather than outward. This is the crucial step in the metamorphosis, for it was this

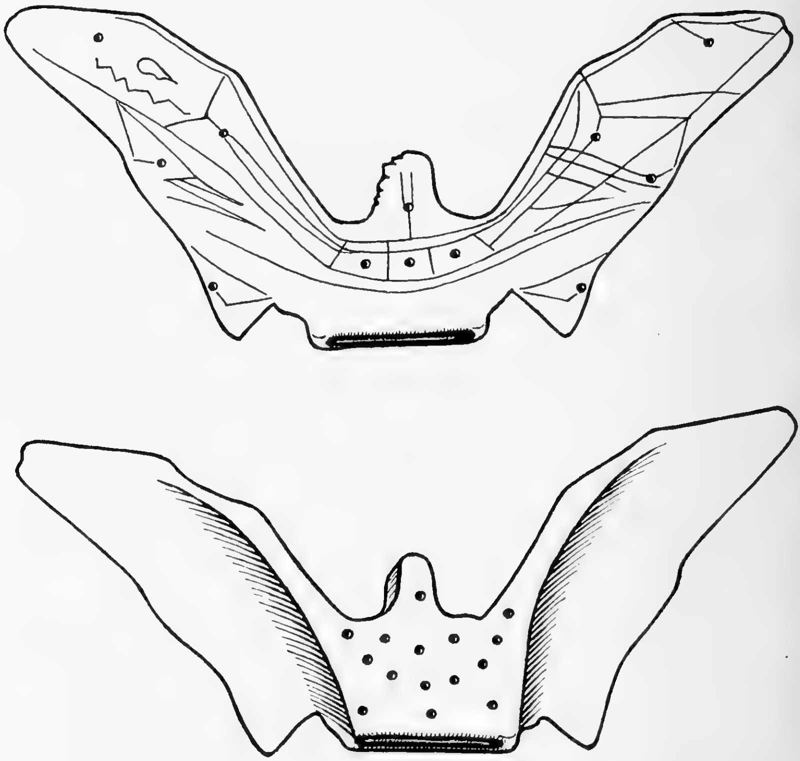


FIG. 23.—Ivory "winged" object with early Punuk decoration, northern Alaska.

raised central portion, divested of the flaring outer wings, that later developed into the Punuk trident. The ornamentation on both specimens is typically Punuk—straight or slightly curving lines and dots, the latter either free or enclosed in the spaces of a "ladder" design.

Another stage in the transition is represented by two specimens from Punuk Island and Cape Kialegak previously described by the writer (Collins, 1929, pl. 10, *a-b*; pl. 13, *b*). Here we have the square basal socket characteristic of the older forms, and wings that, although pointing upward in a Punuk fashion, are still relatively broad and flaring. The central projection and the ornamentation on these two specimens are typically Punuk.

From this we come to the dominant, or later, Punuk form, that of a trident, as illustrated in plate 68, figures 1-5. Figures 1, 2, and 5 are from Ievoghiyoq; figures 1 and 2 are both from cut 4, depth 31 inches, figure 5 from cut 5, depth 24 inches. There are also two fragments—pieces of wings—from cut 6, depth 36 inches, and cut 8, depth 13 inches. Figures 3 and 4 were purchased from the Eskimos and are said to have come from Seklowaghyaget. The sockets on all of these are perfectly round, about 1.2 cm in diameter and 2.1 to 3.2 cm deep, and there are no lashing holes. A piece of the wooden handle or shaft remains in place on the broken specimen, plate 68, figure 5. The central projection is rather prominent, being of approximately the same length as the wings, and at the end is the shallow pit that is always present, both on the Old Bering Sea and Punuk forms. The wings are much narrower than formerly and are homologous to the *inner* wings of the Old Bering Sea type, which were visible only on the back side. The flaring outer wings, which were so prominent on the Old Bering Sea pieces and which gave them their beautiful symmetry, are greatly reduced and appear only in the form of small triangular projections at the base. On plate 68, figure 4, even this vestige of the outer wings has been lost.

The incised designs on these five specimens are all generally similar in arrangement. All are to be classed as Punuk style 2, mainly because of the deep, sharply cut lines; plate 68, figures 1-3 and 5, have the lines, dots and compass-made circles characteristic of phase 2 of style 2, whereas figure 4 with its straight, short cross lines, falls into phase 4.

Plate 68, figures 7 and 8, are two objects which, though wingless, are genetically related to the above. Both were purchased from the Eskimos who had excavated them at Seklowaghyaget. They appear to be late forms—probably the latest—of the winged-trident objects, which have completely lost the wings but retained the thickened body and central projecting element. The basal socket and the opposite notch are identical with those described above. Figure 7 is decorated in phase 4 of Punuk style 2.

Plate 68, figure 6 (from Seklowaghyaget, purchased) represents another Punuk variant of the " winged " object, several of which have been described previously (Collins, 1929, pl. 10, *c-d, e;* Hrdlička, 1930, pl. 23, *b*). Here again we have the cylindrical basal socket and upper notch, but the wings, instead of rising free, are attached at the top to the upright central element. It has vestigial outer wings—small triangular projections along the sides—just as in the case of plate 68, figures 1-3 and 5. The surface decoration of deeply incised lines—

single, double, or in horizontal bands of four—is to be classed as phase 4 of Punuk style 2; most of the incisions are filled with red pigment.

There is no stratigraphic evidence to indicate the age of this form in relation to the trident. Typology, however, points clearly to the trident as the older form, one which through a series of intermediate stages is linked with the winged form of the Old Bering Sea period. The decoration on the "turreted" pieces is likewise of a later style (phase 4 of style 2), whereas that most commonly seen on the tridents is phase 2 of the same style. On the other hand, there is strong probability that the latest of the tridents, e. g., plate 68, figure 4, were contemporaneous with the turreted forms.

In no other class of artifacts is the Eskimo's feeling for form and symmetry better exemplified than in these "winged", "trident", and "turreted" objects. The Old Bering Sea forms with their broad spreading wings, some of them resembling a whale's tail, some a bird or a butterfly, possess all the grace and symmetry of these same forms in nature. Through gradual modification, in which the wings become more and more attenuated, there evolves a different form, the trident; this form, although having in its perfected stage no exact counterpart in nature, is a concept possessing an intrinsic esthetic appeal which no doubt accounts for its wide distribution in the Old World among both primitive and civilized peoples. As a final stage there is the more angular "turreted" form, in which the wings and center are united. Here we have strict artificiality, somewhat reminiscent of a heraldic device; but this last stage, though far removed from the flowing beauty of the earlier forms, has a straightened and pleasing symmetry of its own.

What may we say as to the function of these curious objects? Explanations advanced by the modern Eskimos are of little assistance, since they have no recollection of even the most recent forms. Some of the St. Lawrence Island Eskimos thought that the tridents might have been ornaments for war helmets and the fact that the Japanese warriors of feudal times wore metal helmet ornaments of a somewhat similar shape would seem to lend plausibility to such an explanation. However, this would fail to explain the use of the earlier winged forms of the Old Bering Sea culture since there is no evidence that defensive armor of any kind was used on St. Lawrence Island until well into the Punuk period. Gordon (1916, p. 62) was of the opinion that the winged objects were used in whaling ceremonies, and on the whole this seems as good an explanation as any, even though Gordon was undoubtedly mistaken in assuming that they had been so used in modern times. Gordon also considered that they were genetically related to the prehistoric banner stones of the eastern part of the United

States, but as I have suggested before (1929, p. 9) this seems unlikely in view of the great distance separating the two forms. In a way these winged objects recall some of the canoe ornaments from Micronesia (Müller-Wismar, 1912, fig. 11), particularly the Caroline Island form in which the pointed, flaring ends are connected to the center, just as in the case of the "turreted" Eskimo form; but it would seem hardly likely that these were related in origin. There is, however, still another possibility to be mentioned, namely, that these objects may have been "wings" for the butt end of a harpoon or dart used with the throwing board. It will be recalled that all of them have a basal socket seemingly designed to hold a handle or shaft tightly in place. This may take the form either of a deep cylindrical pit in which a shaft would fit tightly, or a square or rectangular opening with lateral slots for a lashing. More significant, however, is the invariable shallow notch or groove at the end of the central projection. This is precisely the kind of a pit that would be necessary to engage the bone or ivory spur at the end of the throwing board; the fact that such a pit is present on every specimen that has been found and that very often these pits show signs of wear, strongly suggest that they had a definite function. It would not be difficult to think of the "trident" and "turreted" forms as adapted to such a use, for they would probably have been as effective as the bone harpoon "wings" used by the Greenland Eskimos. It must be admitted, however, that some of the larger and heavier "winged" forms of the Old Bering Sea period would seem very poorly adapted to such a purpose, and this alone would be sufficient reason for looking for a better explanation. For the present, therefore, the interpretation of these curious objects must remain in doubt, but whatever it may be, it must satisfactorily explain the presence of the small notch at the upper end. This seemingly insignificant feature evidently had a function just as definite as the basal socket, and it will, no doubt, provide the final explanation of the manner in which these objects were used.

Were it not for the fact that the tridents all have this shallow notch, and the further fact that the form represents only one stage in a demonstrable sequence, we might be inclined to look for a genetic relationship between them and certain more or less comparable Asiatic trident forms such as the Yenisei shaman's staff (Karutz, 1925, p. 95, figs. 2-4), old Japanese helmet ornaments, Indian, Chinese, and Tibetan standards, etc. In view of other Asiatic affinities of prehistoric Eskimo culture such a connection cannot be ruled out in advance; the present evidence, however, points to convergence as the most likely explanation of the resemblances between these widely separated trident forms.

TABLE 1.—*Distribution of Decorated Objects at the Five Gambell Sites*

	Old Bering Sea art				Punuk art							Modern art	Total
	Style 1	Style 2	Style 3	Indeterminable	Style 1		Style 2				Indeterminable		
					Phase 1	Phase 2	Phase 1	Phase 2	Phase 3	Phase 4			
Old section, Gambell	...	...	...	...	...	...	...	1	...	...	1	1	3
Seklowaghyaget:													
Surface to 23 in.	...	...	...	...	...	...	...	2	6	...	...	...	8
24 to 47 in.	...	...	...	...	...	...	3	1	...	1	1	...	6
48 to 72 in.	...	...	...	...	...	...	1	...	...	...	...	...	1
Ievoghiyoq:													
Surface to 23 in.	...	...	...	...	...	...	...	2	10	...	3	...	15
24 to 47 in.	...	...	...	...	...	...	6	12	6	1	4	2	31
48 to 72 in.	...	...	...	...	...	...	2	2	...	...	...	...	4
Miyowagh, N. and W.:													
Surface to 23 in.	...	1	1	3	1	22	10	10	...	...	2	1	51
24 to 47 in.	...	4	1	2	4	24	4	...	...	...	1	...	40
48 to 71 in.	...	4	...	2	5	6	...	...	...	...	...	...	17
72 to 96 in.	...	...	...	2	...	...	...	...	...	...	...	...	2
Miyowagh, S. and E.:													
Surface to 23 in.	...	4	4	6	3	8	...	...	...	...	1	...	26
24 to 47 in.	...	6	11	7	2	...	...	...	...	...	...	...	26
48 to 71 in.	...	11	6	3	3	...	...	...	...	...	...	...	23
72 to 96 in.	...	4	1	2	1	...	...	...	...	...	...	...	8
Hillside site	8	13	1	4	...	...	...	...	...	...	...	...	26
Total	8	47	25	31	19	60	26	30	22	2	13	4	287

Harpoon Heads from Ievoghiyoq

From Ievoghiyoq there are 133 harpoon heads sufficiently complete for type identification, in addition to a number of fragments and unfinished specimens.

Open Socket Harpoon Heads

Open socket type II (b) x.—Two lashing slots; bifurcated, symmetrical (median) spur; round line hole; two side blades parallel with the line hole (pl. 70, fig. 1.)

A comparatively unimportant type, represented by the single specimen shown in plate 70, figure 1, from cut 1, depth 12 inches. The spur, although broken, was symmetrical like that of plate 28, figure 5. The side blades had been inserted in a slot which passes through from one side to the other; no end blade.

Open socket type II (b) y.—Same as above except that the side blades are at right angles to the line hole and that the latter may be triangular in shape (pl. 70, fig. 2).

This type is also represented by the single specimen illustrated, from cut 5, depth 18 inches. The material is bone, and the remaining side blade is made of shell; the line hole is triangular. From cut 5, depth 50 inches, there is the upper end of a head corresponding to this, but made of ivory and with a round line hole.

Open socket type II (c) x.—Two lashing slots; a single, lateral spur; triangular line hole; two side blades, parallel with the line hole (pl. 70, fig. 3).

The specimen illustrated, from cut 1, depth 22 inches, is the only example of the type. It is of bone and the side blades were of shell; the latter were set in a slot which passes completely through from one side to the other.

Open socket type II (c) y.—Same as above but with the side blades at right angles to the line hole; the latter is round.

Two examples, both fragmentary and of bone, from cut 1, depth 28 inches, and cut 9, 34 inches.

Open socket type III (a) x.—Defined on page 118. (Pl. 70, figs. 8-15). This, the dominant form of harpoon head at Ievoghiyoq, is represented by 98 specimens, distributed as follows: Cut 1, depth 12 inches (4); 22 inches; 28 inches; 31 inches; 34 inches; 40 inches; 44 inches (2). Cut 2, 16 inches; 30 inches; 37 inches. Cut 3, 12 inches. Cut 4, 42 inches (2); 59 inches (2) (pl. 70, fig. 8). Cut 5, 12 inches (12); 18 inches (3); 24 inches (2); 28 inches (2); 31 inches (4); 33 inches (2) (pl. 63, fig. 10); 39 inches (4). Cut 6, 5 inches (6) (pl. 70, figs. 13, 14); 9 inches (4); 22 inches (5) (pl. 70, fig. 12); 30 inches (pl. 70, fig. 11); 36 inches (2) (pl. 70, fig. 9). Cut 7, 8 inches; 18 inches (2); 24 inches (2). Cut 8, 8 inches (2); 25 inches; 28 inches; 30 inches; 34 inches (2); 39 inches (3); 44 inches (3) (pl. 70, fig. 15). Cut 9, 12 inches (4); 19 inches (4); 31 inches (3); 34 inches (3).

This large group includes a few harpoon heads which are identical in every respect with some of the type III (a) x heads from the northwestern section of Miyowagh. The greater number, however, although still falling within the limits of the type as defined, have become modified in several respects, principally in the shape of the spur. We will consider first the specimens which are directly comparable with those from Miyowagh. Plate 70, figure 8, from cut 4, depth 59 inches, is one of these; in both form and ornamentation it is identical with the two heads from Miyowagh shown in plate 28, 13 and 14. There are five other open socket heads from Ievoghiyoq with the same ornamentation, and significantly enough, all of these come from the lower levels, from depths ranging from 31 to 59 inches. Plate 70, figures 9 and 15 are two more specimens that are very similar in form to the Miyowagh examples shown in plate 28, figures 8-14. However, they lack the small elevations around the line holes which were present on the Miyowagh heads; and the decoration in figure 15, consisting of deeply cut lines, spurs, and mechanically made circles, can be compared only with two of the latest of the Miyowagh heads, plate 28, figures 24 and 28. It is, therefore, only the latest style of ornamentation at Miyowagh (pl. 28, figs. 13, 14, 24, 28) that is carried over on these open socket heads at Ievoghiyoq; among all of the decorated harpoon heads from the latter site, with the possible exception of plate 70, figure 21, there is not one with the lightly incised line, spur, and dot ornamentation that was so characteristic of the earlier phase of the Punuk at Miyowagh as illustrated by such specimens as plate 28, figures 8-12, 15-17, 19-22, 25-27. It is to be noted further that only a small number of the type III (a) x heads at Ievoghiyoq are decorated at all—17 out of a total of 98, in contrast to Miyowagh where all but one of the 40 heads of this type were decorated.

The majority of the open socket heads from Ievoghiyoq, although possessing the general features that bring them within the defined limits of type III (a) x, have nevertheless become modified to such an extent that they stand clearly apart from the older examples of the same type from both Ievoghiyoq and Miyowagh. The principal difference is in the altered form of the spur. In the Miyowagh heads the spur extends straight down and is fairly wide across the tip; in the later Ievoghiyoq heads the spur flares outward and becomes narrow and arched, the sides having been cut down at an acute angle from the median ridge, which is thereby made to stand out more prominently (pl. 63, figs. 10-14). This arched form of spur, in the most typical examples, is still further accentuated by having the tip cut off obliquely, giving it the appearance of curving inward, as in some cases (e. g., fig. 12) it actually does. About 90 percent of the Ievoghiyoq heads have this arched form of spur in some degree, and, just as in the case of ornamentation, those which do not have it come for the most part from the lower levels of the midden.

As a rule the line holes on the Ievoghiyoq heads are somewhat larger than those from Miyowagh and the shallow groove beneath the line hole is usually lacking.

In addition to such specific differences in individual features, many of the later heads from Ievoghiyoq are heavier and thicker, particularly around the lower end (pl. 70, figs. 10, 11, and 14).

Plate 70, figure 9, has part of the baleen lashing remaining in one of the slots, and the same is true of one other specimen from cut 5.

Plate 70, figure 16, from cut 9, depth 12 inches, possesses several features that set it apart from type III (a) x. It has a bifurcated spur, a groove opposite the single lashing slot, and a deeply cut **Y**-figure above the line hole on both sides; furthermore, it is of bone, whereas all but one of the other type III (a) x heads are of ivory.

Open socket type III (a) y.—This type, with the blade slit at right angles to the line hole, is not represented at Ievoghiyoq. As noted previously, the distribution of this type at Miyowagh indicated that it was somewhat earlier than type III (a) x, in which the blade slit and line hole were parallel. The present evidence is confirmatory in this respect, the type apparently having been discontinued before Ievoghiyoq was established.

Open socket type IV.—Two lashing slots; single, lateral spur; round or triangular line hole; two prominent lateral barbs, at right angles to line hole; no end blade; undecorated. Differs from type II (e) in the lashing arrangement and size of the barbs. (Pl. 70, figs. 4, 5.)

There are nine examples of this type, distributed as follows: Cut 1, depth 22 inches (pl. 70, fig. 4); 31 inches. Cut 5, 24 inches (2, one bone, one ivory—pl. 70, fig. 5). Cut 6, 9 inches; 36 inches. Cut 8, 25 inches. Cut 9, 31 inches; 34 inches (bone). In form these harpoon heads are identical with Mathiassen's Thule type 2. However, they do not have the **Y**-shaped figure above the line hole as do the

Thule heads, and most of them are made of ivory, whereas the Thule heads are of bone. Six of the Ievoghiyoq specimens have triangular line holes, like plate 70, figure 4; three, including figure 5, have round line holes. One of them—from cut 8, 25 inches—departs somewhat from the type in having the end of the spur notched.

Open socket type IV (*a*) *x*.—Same as preceding type but with two pairs of barbs, and an end blade, parallel with the line hole. (Pl. 70, fig. 6.)

This variant of type IV is represented by the single specimen illustrated, from cut 8, depth 28 inches. The material is bone.

Closed Socket Harpoon Heads

Closed socket harpoon heads occupied a subordinate position at Ievoghiyoq; only 19 were found as compared with 114 of the open socket forms. Furthermore, only 5 of the 19 are directly comparable with the Miyowagh heads, the others having undergone modifications that give them a distinctive appearance, just as was the case with the open socket type III (a) x heads from Ievoghiyoq.

Closed socket type V x.—Definition on page 110. (Pl. 70, figs. 17, 18.) There are six specimens that fall into this group: Plate 70, figure 17, cut 9, depth 31 inches; plate 70, figure 18, cut 5, 12 inches; and four others from depths of 5, 18 (2), and 44 inches. The small specimen, figure 17, in a general way resembles the two heads from Miyowagh shown on plate 28, figures 21, 22, although its contour is different. The ornamentation is basically the same as that on other closed socket heads from Miyowagh, e. g., plate 28, figures 19, 20, 25. Plate 70, figure 18, has a sharply beveled spur like those on the open socket heads, figures 10-14. However, it is pointed at the end instead of being cut off obliquely. This specimen bears a typical late Punuk ornamentation of deeply cut lines and spurs, which were originally filled with red pigment, traces of which still remain. Another head of this type is ornamented in a similar fashion with lines, spurs, and small. deep, round pits, and in this case the red pigment is still in place. The three remaining heads of type V x are undecorated.

Closed socket type V (*b*) *x*.—Long, tapering, pointed spur; round line hole, beveled below; end blade parallel with line hole; oval to almost round in cross-section, with a constriction between line hole and tip; decoration Punuk, or plain. (Pl. 70, figs. 19, 20.)

Five examples, as follows: Cut 1, 22 inches; 40 inches (pl. 70. fig. 20); 50 inches (pl. 70, fig. 19). Cut 2, 30 inches. Cut 9, 19 inches.

This is a specialized form of the general type with line hole and blade slit parallel, but one which is so different in contour, shape, and style of spur that it seems advisable to describe it as a subtype. To judge from the depth distribution, it came into use at a rather early period at Ievoghiyoq. The spur, instead of being sharply arched as in the case of the prevailing open socket forms, is relatively wide above, tapering down to a long, sharp point that flares out from the body. Four of these heads are undecorated. The fifth (pl. 70, fig. 20) bears an ornamentation generally similar to that of plate 70, figure 15—deeply cut lines, short spurs, and compass-made circles with central pits. Plugs of baleen were set in the latter, and all of the incisions were filled with red pigment.

Closed socket type V y.—Defined on page 111. (Pl. 70, fig. 21.) This type, which is carried over from Miyowagh without change of form, is represented by only two examples, plate 70, figure 21, cut 4, depth 42 inches, and an unfinished specimen from cut 8, depth 39 inches. Figure 21 has the same graceful outline, the median ridge between line hole and tip, and the small rounded elevations around the line hole that were observed on some of the Miyowagh examples, such as plate 28, figures 25, 26. The decoration, furthermore, falls within the defined limits of Punuk style 1, consisting of incised lines and long spurs terminating in small round pits although the lines are much more deeply incised than on the comparable examples from Miyowagh. As in the case of so many of the decorated objects from this site, the deep incisions and pits were originally filled with red pigment.

Closed socket type V (a) y.—Differs from type V y in general contour and in the shape of the spur. The upper part of the body is straight and the median ridge between tip and line hole is less pronounced than in type V y. The spur is like that of open socket type III (a) x (pl. 70, figs. 10-14), having an outward flare and being sharply beveled or arched, with the end cut off obliquely. (Pl. 70, figs. 22, 23.)

There are five heads of this type, as follows: Cut 2, depth 22 inches (pl. 70, fig. 23). Cut 5, depth unknown (2). Cut 6, 9 inches (2) (pl. 70, fig. 22). Four of these are decorated, all with deeply incised lines and short, oblique spurs; all of them have had red pigment rubbed into the lines.

Closed socket type VI.—Single, lateral spur; triangular line hole; two prominent lateral barbs, at right angles to line hole; no end blade; undecorated. (Pl. 70, fig. 7.)

The specimen illustrated, from cut 1, depth 44 inches, was the only one of the type found at Ievoghiyoq. In spite of the closed socket its closest relationship is to the group of open socket heads shown on plate 70, figures 4-6, i. e., open socket types IV and IV (a) x. It was apparently an unimportant type on St. Lawrence Island, although it occupies a prominent place on the Arctic Coast, where it appears as a comparatively late derivative of the Thule type 2.

Summary

The harpoon heads from Ievoghiyoq, although including some examples identical with those from the later section of Miyowagh, have for the most part undergone considerable modification. The predominant form, open socket type III (a) x (pl. 70, figs. 8-15), includes a few heads from the lower levels, e. g., figure 8, which are indistinguishable from some of the Miyowagh specimens. The great majority of heads of this type, however, have taken on a distinctive appearance; the spur has become thin, rather sharp edged and flaring, with the end cut off obliquely; the line hole has become somewhat larger, and there is a general tendency toward heaviness, particularly of the lower end. Correlated with this change of form is an absence of ornamentation. None of these later heads are decorated, whereas on the other hand most of those that have retained something of the old form bear a Punuk ornamentation comparable to that which appeared during a late stage at Miyowagh.

The closed socket heads show similar resemblances and differences. A definite linkage between Ievoghiyoq and Miyowagh is provided by a few of the closed socket forms such as plate 70, figures 17 and 21 (types V x and V y), but a majority of them have become specialized in much the same manner as the open socket heads. The spur has either become arched as on the open socket forms or long and pointed, and the graceful, tapering outline has been lost.

Among the new forms at Ievoghiyoq is open socket type IV, with two prominent lateral barbs but no blades of any kind. In general outline these heads correspond exactly with Mathiassen's Thule type 2; open socket type IV (a) x is a closely related form with two pairs of barbs and also an end blade. The subtypes of type II, plate 70, figures 1-3, intergrade with similar forms from the later section of Miyowagh (pl. 28, figs. 1-3) and are probably contemporaneous; and just as at Miyowagh, most of these type II heads are made of bone.

Another point to be noted is the preponderance of open socket heads at Ievoghiyoq—114 as compared with only 19 with closed sockets. At Miyowagh, on the other hand, 40 percent of all the heads had closed sockets.

Harpoon Heads from Seklowaghyaget

The harpoon heads from Seklowaghyaget, numbering 54, are of particular interest inasmuch as they provide a definite linkage between the prehistoric forms already described and those in use at the present time.

Open Socket Harpoon Heads

Open socket type III (a) x.—Defined on page 118. (Pl. 71, figs. 2-4.) This type of harpoon head, which was found in such large numbers at both Ievoghiyoq and Miyowagh, is also well represented at Seklowaghyaget, even though it has begun to give way to another type, to be described presently. The 20 type III (a) x heads from Seklowaghyaget were distributed as follows: Cut 1, depth 38 inches. Cut 2, 18 inches; 49 inches (pl. 71, fig. 2). Cut 3, 12 inches (2); 18 inches (2) (pl. 71, fig. 3); 30 inches; 34 inches (2); 42 inches. Cut 4, 12 inches; 18 inches (pl. 71, fig. 4); 44 inches (2). Cut 7, 12 inches; 20 inches. Cut 8, 12 inches; 19 inches; 67 inches.

Eight of the above heads, including plate 71, figure 2, are decorated, all of them in phase 1 of Punuk style 2 which was found at Ievoghiyoq and also at the later section of Miyowagh. Three of them have traces of red pigment remaining in the incisions. The older type of spur—relatively wide and only moderately beveled—was present in only three instances: on the head shown in plate 71, figure 2, and on two other heads which are practically identical in form and ornamentation, from depths of 34 and 38 inches. Eleven, including plate 71, figures 3 and 4, have the later form of spur—sharply beveled and with a slight inward flare—which was so common at Ievoghiyoq. On the remaining six the spur is not clearly distinguishable.

Open socket type III (b) x.—Two lashing slots, one slot with an opposite groove, or no slots; a single lateral spur which is usually made asymmetrical by an acute beveling on the socket side; slanting walls produce a wedge-shaped socket in which the lower (outer) end and the floor are wider than the upper end and the top; line hole usually round or triangular, sometimes squarish; end blade, parallel with line hole; undecorated. (Pl. 71, figs. 5-9.)

Twenty-one examples, distributed as follows: Cut 1, 12 inches. Cut 2, 12 inches (3) (pl. 71, figs. 6 and 8); 18 inches (2) (pl. 71, fig. 5); 22 inches (5) (pl. 71, fig. 9); 28 inches (pl. 71, fig. 7). Cut 3, 12 inches. Cut 7, 20 inches (3); 28 inches; 36 inches; 44 inches (2). Cut 8, 39 inches.

This specialized form of type III (a) x is marked by a series of rather sudden developmental changes, particularly in the region of the socket. The most important of these is the manner in which the socket itself is formed. The open sockets which we have heretofore considered have been straight-sided and perfectly rectangular in shape. Since they were as wide across the top as along the floor, the foreshaft rested lightly in place and was only prevented from slipping out by means of a lashing which passed through a pair of slots and across the open socket. In the present group, the two lashing slots or a single slot with an opposite groove are retained in a number of cases, but in addition to this method of lashing, the socket is cut out in such a manner that it alone will at least partially hold the foreshaft in place. This was accomplished by making the socket walls slant inward; with the floor of the socket now wider than the opening along the top, the foreshaft remains in place without the aid of a lashing, just as in the case of a completely enclosed socket. The wedgelike appearance of such sockets is further increased by having them taper from the base upward, so that in an extreme form, like plate 71, figure 8, the width of the socket at the upper end is only half that of the lower end.

The symmetrical lateral spur of type III (a) x is here replaced by one which is made asymmetrical by having the lower end on the socket side beveled off obliquely. A few, like plate 71, figure 5, have retained the older form of spur, uniformly beveled from both sides.

The line holes are more variable both as to size and shape than any previously considered. Most of them are rounded and relatively large, others are triangular, either large or small, and still others that were originally round have by secondary cutting taken on a squarish shape.

Along with these specific changes of the spur and socket is a change in contour. The majority of the type III (b) x heads differ from those of type III (a) x in their somewhat smaller size and straighter lines; they have lost completely the graceful shape that in the past was always associated with the type III head. As to material, 19 of the type III (b) x heads from Seklowaghyaget are of ivory; 2, including plate 71, figure 7, are of bone; all are undecorated.

It should be mentioned here that one harpoon head of type III (b) x was found at Ievoghiyoq, cut 9, depth 31 inches. However, there is a strong probability that this specimen is intrusive, for it was the only one of the large number of harpoon heads from that site which showed any inclination to the peculiar form of socket characteristic of this type.

Open socket type III (b) y.—Same as above but with the blade slit at right angles to the line hole. (Pl. 71, fig. 10.)

The specimen shown in plate 71, figure 10, from cut 2, 18 inches deep, was the only example of this type found at Seklowaghyaget.

The line hole is large and squarish. Except for the direction of the blade slit, this specimen conforms in every way with type III (b) x.

Open socket type III (c) x.—Differs from type III (b) x in having a pair of small barbs in addition to an end blade. (Pl. 71, figure 11.)

The specimen illustrated, from cut 2, depth 22 inches, is the only example of this type. Part of the upper end is broken off, and also a small piece at the socket.

Open socket type IV (a).—One lashing slot and an opposite groove; wedge-shaped socket, as in type III (b) x; single (?) lateral spur; triangular line hole; two pairs of prominent barbs, at right angles to line hole; no blade; undecorated. (Pl. 71, fig. 1.)

The specimen illustrated, from cut 2, depth 22 inches, was the only one found. It is another western variant of the Thule type 2 head. The triangular line hole, the bladeless tip, and probably the spur are features which correspond with our type IV; the two pairs of barbs are like type IV (a) x. The peculiar form of the socket, however, brings it into relationship with type III (b) x. The spur is damaged, so its exact form must remain in doubt; however, it was placed laterally, and very likely was single. The deep, narrow groove above the line hole is like that in plate 70, figure 6.

Open socket type V.—Two lashing slots, one lashing slot with an opposite groove, or a groove alone; socket and spur as in Type III (b) x; line hole triangular, rarely round; no blade; undecorated. (Pl. 71, figs. 12, 13.)

Three examples of this type were found at Seklowaghyaget, the two illustrated, from cuts 2 and 7, depths 18 and 12 inches respectively, and another picked up on the surface.

In its general shape and lack of an inserted blade, this type conforms to Mathiassen's Thule type 1, but the peculiar wedge-shaped socket and beveled spur relate it to our types III (b) x and y.

Closed Socket Harpoon Heads

Only seven harpoon heads with closed sockets (exclusive of those used in whaling) were found at Seklowaghyaget.

Closed socket type V y.—Defined on page 111. Only two of this type were found, an unfinished specimen from cut 3, depth 62 inches, and a smoothed, waterworn specimen from cut 6, depth 28 inches. This was a type which apparently passed out of use soon after Seklowaghyaget was established.

Closed socket type V (a) y.—Defined on page 207 (pl. 71, fig. 14). There are three specimens of this type, as follows: Cut 3, depth 30 inches; cut 4, depth 12 inches (pl. 71, fig. 14); cut 8, depth 60 inches.

Figure 14 bears a phase 3, Punuk style 2 ornamentation of deeply cut lines and short oblique spurs; traces of red pigment remain in the incisions. The other two heads are undecorated.

Closed socket type V (b) x.—Defined on page 206. This type is also represented by two specimens. They come from cuts 4 and 7, at depths of 34 and 3 inches respectively. Both are decorated in late Punuk style, with deeply incised lines, spurs, dots, and circles, and one has red pigment remaining in the incisions.

Summary

We have seen from the above that some of the harpoon heads from Seklowaghyaget are identical with the prevailing types from Ievoghiyoq. These are open socket types III (a) x (pl. 71, figs. 2-4) and closed socket types V y, V (a) y, and V (b) x (pl. 71, fig. 14). These forms indicate contemporaneity with Ievoghiyoq and the latest period at Miyowagh, but there are several new types which show that Seklowaghyaget continued to be occupied after the abandonment of both of the other sites. The most important of these new types is open socket type III (b) x (pl. 71, figs. 5-9), a specialized form of type III (a) x, characterized especially by a wedge-shaped socket which in some cases functions as a closed socket. This peculiar form of socket is also found on the less common open socket types III (b) y, III (c) y, III(c) x, and V; and, as we shall see presently, it is the predominant form of socket at the latest of the midden sites (the old section of Gambell) and at two house ruins of comparatively recent date.

Harpoon Heads from Old Section of Gambell and Houses 8, 9, and 10

House no. 10, it will be recalled, was the most recent of the 10 house ruins excavated (pl. 64, fig. 2). According to native testimony it was the last of the semisubterranean dwellings at Gambell, having been occupied up to about 50 years ago. The correctness of this statement was proven by the material obtained: five harpoon heads of modern type, one of which is shown on plate 71, figure 26; broken pottery lamps and cooking pots of modern type, the former with high wick ledges, the latter with suspension lugs; considerable quantities of hoop iron, copper, etc.; small ivory bird figures; flat bone sledge shoes; and various other modern types of implements.

House no. 8 (described on p. 187, pl. 63, figs. 2-5) was older, dating probably from about the eighteenth century. Lamp and pot fragments were like those from house no. 10, but no other implements of strictly modern types were present. There were nine harpoon heads, six of which are shown on plate 71, figures 15-20. Open socket type III (b) x is represented by five examples, including figures 18, 19, and 20. The last of these is of particular interest, since it represents a very close approach to the modern form. In fact, it is only the wedge-shaped open socket that brings this head into type III (b) x; the rounded contour and the large triangular line hole with deeply beveled lower border are characteristic features of the modern St. Lawrence type. Of the bladeless form, open socket type V, there are three examples, all of bone, two of which are illustrated (pl. 71, figs. 15, 16). These are of smaller size than the previous examples of this type from Seklowaghyaget. Figure 17 is apparently a slightly older form of the bladeless head, for it lacks the wedge-shaped socket.

House no. 9 was apparently contemporaneous with house no. 8. Only two harpoon heads were found here, one of open socket type III (a) x, the other of type III (b) x.

The excavation in the shallow midden deposit adjoining the present village of Gambell yielded 39 harpoon heads and fragments large enough for type identification. Among these was a single example of open socket type III (a) x (from cut 1, depth 16 in.), a badly weathered, broken specimen with Punuk ornamentation, probably a relic from an earlier period. The same may be true of the only closed socket head found at this site (cut 1, depth 24 in.). This was a small, much worn specimen of closed socket type V y, which had originally been decorated in Punuk style. Since these two heads, which are typically Punuk both in form and ornamentation, are weathered to a much greater degree than any of the others from the same site, it seems reasonable to suppose that they are older specimens, belonging perhaps to the adjoining site, Seklowaghyaget.

There are three examples of the bladeless, open socket type V, all from cut 1, at depths of 8, 16, and 32 inches. The first two are shown on plate 71, figures 22, 23; figure 23 and the one not illustrated are of bone. It will also be observed that figure 23 differs from the usual form in having the bladeless upper end flattened transversely, so that the cutting edges lie parallel with the line hole instead of at right angles to it.

Of the remaining 34 specimens, all but one belong to open socket type III (b) x, the form with narrow, wedge-shaped socket and acutely beveled spur which has already been described from Seklowaghyaget and houses no. 8 and 9. The depth distribution of the type III (b) x heads is as follows: Cut 1, depth 8 inches (7); 16 inches (5); 24 inches (5); 32 inches (10). Cut 2, depth 10 inches (2) (pl. 71, fig. 25); 20 inches (4) (pl. 71, fig. 24). This type of harpoon head, which is the latest of the prehistoric forms on St. Lawrence Island, affords evidence of an interesting metamorphosis, the last and one of the most striking of the long series of developmental changes which began as far back as the Old Bering Sea period at Miyowagh. This final step is of particular interest in that it shows the precise manner in which the modern St. Lawrence head developed. We have already seen how in the type III (b) x heads the inward inclination of the socket walls produced a socket which though still "open" actually functioned as a closed socket. The present examples illustrate the last stage in this process: Plate 71, figure 24, which has a socket of this kind, differs from the somewhat earlier examples of the type in having a large triangular line hole with deeply beveled lower border which is characteristic of the modern type (pl. 71, figs. 26, 27); plate 71, figure 25, is a still closer approach, showing not only the large triangular line hole with the deep, wide groove below, but also the rounded, thickened shape of the modern head. As may readily be seen, this particular specimen and also plate 71, figure 20, (and three others not illustrated), differ from the modern type only in that they have "open" sockets.

Plate 71, figure 26, from house no. 10 (abandoned some 50 years ago), and the iron bladed head, figure 27, collected by E. W. Nelson in 1879, are examples of the modern St. Lawrence form in which a round drilled socket has replaced the wedge-shaped, barely open, cut out socket of type III (b) x. We thus have evidence of a rather unusual condition, a late reversion or secondary evolution whereby the closed socket harpoon head, which was prominent during the Old Bering Sea period but which seems to have practically disappeared during the late Punuk, appears again as a direct outgrowth of a late form of the open socket head. Although there is clear typological and stratigraphical evidence that this particular metamorphosis actually occurred, it is not to be supposed that the idea of a closed socket *per se* was anything new to these Eskimos; for whaling harpoon heads, which had been in common use from the Punuk stage on, had always had closed sockets.

Plate 71, figure 29, is another modern St. Lawrence head, collected by Riley D. Moore. It is an example of the rather uncommon modern form in which the blade is at right angles to the line hole. Its prototype is open socket type III (b) y, of which we have two examples (pl. 71, figs. 10 and 28). The first of these, from Seklowaghyaget, still retains the general shape and features of type III (b); figure 28, from cut 1, old section of Gambell, depth 8 inches, is a later and more specialized form, which differs from its modern descendant (pl. 71, fig. 29) only in having an "open" socket. The spur has lost the acute unilateral beveling which characterized its predecessor (pl. 71, fig. 10) and the closely related heads of type III (b) x. It should also be noted that those examples of the latter type, such as plate 71, figure 25, that have the thickened, rounded contour and the form of line hole peculiar to the modern head, also have the modern symmetrical form of spur; whereas the smaller, flatter examples, e. g., plate 71, figure 24, have the asymmetrical spur produced by an acute beveling on the socket side.

The bone harpoon head shown in plate 71, figure 21, was purchased from an Eskimo at Gambell, and its exact provenience is unknown. However, the wedge-shaped socket and the large triangular line hole both attest its recency. It is introduced for the purpose of illustrating two features which none of our harpoon heads happened to show: drilled lashing holes around the socket, and rivet holes at the tip for holding the blade in place. On St. Lawrence Island, as elsewhere in Alaska, it is only the modern harpoon heads which have rivet holes at the tip (e. g., pl. 71, fig. 27, and two others from house no. 10). However, a number of the Thule heads have such rivet holes (e. g., Mathiassen, 1927, plate 1, figure 6), in which the blade is either of stone or of meteoric iron. As for the drilled lashing holes around the socket, these are surprisingly rare at Gambell, even on the latest of the prehistoric heads. Nelson figures a harpoon head which has them (pl. 57, fig. 13—U.S.N.M. no. 63334); the general form of this head is Thule type 2, but it also possesses an iron blade, with rivet holes. From Jenness' work at Wales and Little Diomede Island we know that drilled lashing holes were common at Bering Strait but here again they were relatively late, the older heads all having had slots for the lashing. In this connection it is of interest to note that drilled lashing holes appear to be more common at the old site of Kukuliak, to the east of Gambell, than elsewhere on St. Lawrence Island, if we may judge from several small collections from that site obtained by the writer.

Whaling Harpoon Heads

Whaling harpoon heads were scarce as compared with those used for seal and walrus. The excavations at the five Gambell sites yielded only 13 more or less complete specimens and three fragments. None were found at the Hillside site, and only two at Miyowagh (pl. 72, figs. 1, 2). The first of these is from cut 18, depth 60 inches. It is unusually large, measuring 21 cm in length, 4 cm in breadth, and 2.7 cm in thickness, and has a blade slit 7 cm long. It is much thicker than the modern St. Lawrence form and lacks the deep groove below the line hole. The socket also is large—1.4 cm in diameter and 2.5 cm deep—and the long offset spur is another feature not found on modern whaling heads. The decoration consists of incised lines and small round pits containing plugs of baleen. The simple arrangement of the lines does not conform very closely to either the Old Bering Sea or Punuk patterns, but the two rounded elevations on either side of the line hole, each surmounted by a small circular pit, are common to both styles. As a whole the decoration is more suggestive of early Punuk than anything else. The second whaling harpoon head from Miyowagh is shown in plate 72, figure 2. Although smaller than the other specimen, it is similar structurally. It comes from cut 12, depth 27 inches. From cut 20, depth 12 inches, there is half of the tip of another, with a Punuk decoration consisting of straight, evenly incised lines and dots.

From Ievoghiyoq there are no complete specimens, and only two fragments, one from a depth of 42 inches, the other purchased from an Eskimo. Both are decorated in Punuk style, with deeply incised lines, spurs, dots, and circles.

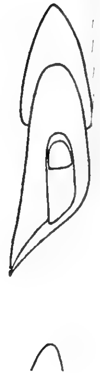
Plate 72, figure 3, decorated in the same fashion, was excavated by Mr. Chambers at Kitneapalok, an old site about 20 miles south of Gambell. The surface of the ivory is much weathered, but the lines and nucleated circles of the Punuk ornamentation are still visible. The line hole has an oblique slant, but the form of the spur is essentially the same as on modern examples.

Five whaling harpoon heads, none of them complete, were excavated at Seklowaghyaget. They come from cut 2, depth 12 inches (2). Cut 7, 26 inches; 44 inches. Cut 8, 26 inches; 34 inches. Plate 72, figure 4, which was purchased from an Eskimo, is a better example of the Seklowaghyaget type than the incomplete specimens that we excavated. The deep beveling below the line hole, the curving of the lower part of the body just above the socket, and the two narrow slots along the lower edges of the spur are all features which are characteristic of the modern St. Lawrence form.

From the old section of Gambell there are five specimens, two from cut 1, depth 8 inches (pl. 72, fig. 6) and three from cut 1, depth 16

TABLE 2.—*Distribution of Harpoon Types at the Five Gambell Sites*

	Open socket forms																										Closed socket forms									
	I x	I y	I (a) y	I (b)	II x	II y	II (a) x	II (a) y	II (b) x	II (b) y	II (c) x	II (c) y	II (d)	II (e)	II (f) x	II (g) x	III x	III y	III (a) x	III (a) y	III (b) x	III (b) y	III (c) x	IV	IV (a)	IV (a) x	V	I x	II x	IV y	V x	V y	V (a) x	V (a) y	V (b) x	VI	Total
Old section of Gambell																			2		38	2					7					1					50
Seklowaghyaget:																																					
Surface to 23 in.																			11		15	1	1		1		3							1	1		34
24 to 47 in.																			7		6											1		1	1		16
48 to 72 in.																			2													1		1			4
Ievoghiyoq:																																					
Surface to 23 in.									1	1	1								49					2							4			5	2		65
24 to 47 in.												2							47		1 (?)			7		1					1	2			2	1	64
48 to 72 in.																			2												1				1		4
Miyowagh, N. and W.:																																					
Surface to 23 in.							2	3					1		1	1		1	18	1											6	3	2				39
24 to 47 in.					1									1		1	2	2	15	4											7	4					37
48 to 71 in.					1	1											2	1	2	2											1	2					12
72 to 96 in.																																					
Miyowagh, S. and E.:																																					
Surface to 23 in.					2												8	2	3	1											2	1					19
24 to 47 in.	1				2	2											6	1	1	4										1	5	5					28
48 to 71 in.	1	2				1											5	4	1	1								1			1	5					22
72 to 96 in.		1	1	1													2	1														1					7
Hillside site	3	2															3	2	1	1									1	1	2						16
Total	5	5	1	1	6	4	2	3	1	1	1	2	1	1	1	2	28	14	161	14	60	3	1	9	1	1	10	1	1	2	30	26	2	8	7	1	417



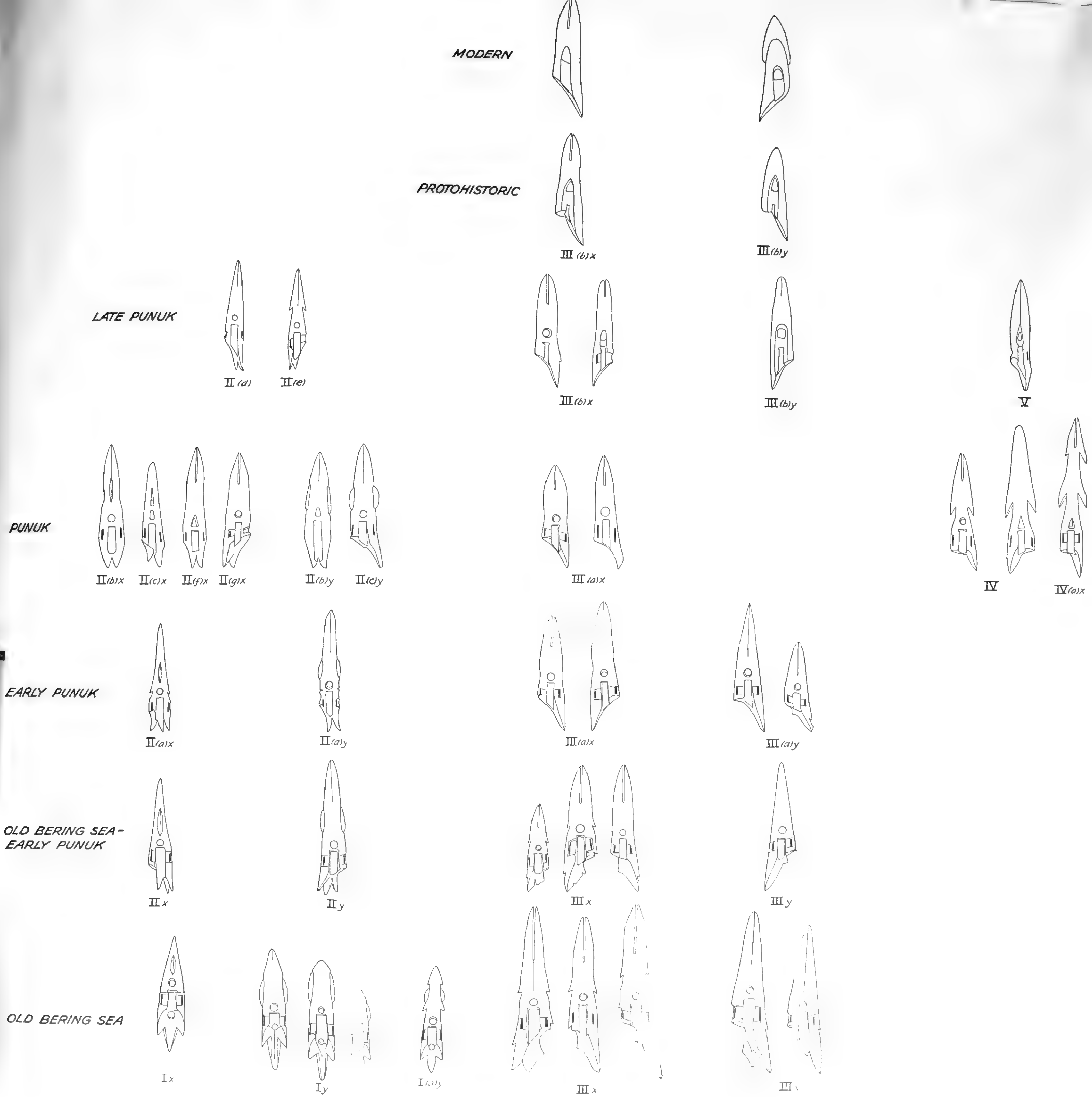


Fig. 24.—Chart showing chronological development of open socket harpoon heads at Gambell.

inches (pl. 72, fig. 5). None of them differ essentially from those found at Seklowaghyaget.

The whaling harpoon head shown in plate 72, figure 7, was purchased from an Eskimo, who had excavated it at Kukuliak, the large old site to the east of Gambell. It is somewhat longer than most of the others, and the edge opposite the spur is straight, wide, and flat as on the whaling harpoon heads from the Arctic coast of Alaska. Some of the Gambell specimens also have this kind of edge, e. g., plate 72, figure 6, but more often it is beveled.

The fact that 10 whaling harpoon heads were found at Seklowaghyaget and the old section of Gambell, the two sites where the least amount of excavating was done, whereas only two heads and three fragments were found at Miyowagh and Ievoghiyoq, shows conclusively that it is only in relatively recent times that whaling has become an important occupation with the St. Lawrence Eskimos. The few specimens from Miyowagh and Ievoghiyoq (four of them bearing Punuk decoration and one plain) show that whaling had begun to be practiced to a slight extent in Punuk times; on the other hand, the absence not only of whaling harpoon heads, but also of whale bones, at the Hillside site, would seem to indicate that the Old Bering Sea Eskimos had not hunted the whale at all. The baleen at the Hillside site might have been obtained from animals that had drifted ashore after having been killed by killer whales.

In plate 72, figures 8 and 9, are shown two ivory objects which the local Eskimos thought had been used as walrus lance heads. Both of these specimens were purchased; figure 9 was excavated at Kukuliak, figure 10 probably at Seklowaghyaget. We did not find any of these implements in our excavations at Gambell though I have previously obtained examples from Punuk Island and Cape Kialegak. They seem to occur only in the Punuk period and their exact function remains doubtful. They differ from harpoon heads in the absence of a central line hole, the line having passed through a narrow slot at the lower end. The open socket is very long and deep. The foreshaft was held in place by means of a lashing which passed through two slots, as in figure 9, or ran along a groove as in figure 8. The blade slit is parallel with the socket. Figure 8 is round in cross section; figure 10 is hexagonal.

Implement Types of the Punuk Period

Most of the specimens described below are from the pure Punuk site, Ievoghiyoq. Others are from the later, northwestern section of

Miyowagh, from Seklowaghyaget, and from the old section of Gambell; an occasional specimen is from Punuk Island, off the southeastern end of St. Lawrence Island.

Foreshafts.—Two Punuk foreshafts are shown in plate 73, figures 1, 2 (from Seklowaghyaget, cut 2, depth 28 in., and surface). They are generally similar to those of the Old Bering Sea period, the principal difference being that the line hole is somewhat wider, usually more triangular in outline, and is placed near the edge instead of at the center as was the case with most of the Old Bering Sea specimens. A modern St. Lawrence foreshaft with two line holes, plate 73, figure 3, is shown for comparison. In all, 34 foreshafts were found at the three later sites, 11 from Ievoghiyoq, 9 from Seklowaghyaget, and 12 from the old section of Gambell.

Socket pieces.—In contrast to the elaborately decorated socket pieces of the Old Bering Sea period, those of the Punuk are generally plain and of simpler construction (pl. 73, figs. 6, 7, from Seklowaghyaget, surface, and house no. 9, respectively). The tang, instead of being conical or bifurcated, is wedge-shaped, like the modern St. Lawrence examples; the tang may also be perforated for rivets which hold it in place in the shaft, and just above the tang there may be one or more line holes.

Plate 73, figure 5, seems to be a toy socket-piece, from Ievoghiyoq, cut 6, depth 22 inches. Seven other specimens of the same type come from this site. In addition there are three somewhat larger specimens resembling the two from Miyowagh shown on plate 33, figures 28, 29.

Ice picks.—Punuk ice picks are among those objects which show a clear transition from the Old Bering Sea to modern times. Old Bering Sea types 1 and 3 (pl. 32, figs. 1, 2, and 6) are each represented by a single example from Ievoghiyoq; Old Bering Sea type 2 (pl. 32, figs. 3, 4) is well represented at Ievoghiyoq and Seklowaghyaget. At both of these sites, however, the shoulder, which is characteristic of type 2, becomes more pronounced, resulting finally, at the old section of Gambell, in the type of ice pick shown in plate 73, figure 8, which with its straightly scarfed lower end and tang, approaches the modern St. Lawrence form, illustrated by figure 9; it differs from the modern type in not having a lashing slot at the tang. It should be noted also that rather flat ice picks, usually made of walrus penis bones (type 4), are characteristic of the Punuk stage (pl. 73, fig. 4, from Ievoghiyoq, cut 5, depth 24 in.).

The following table shows the distribution of the 34 ice picks at the three sites according to depth:

	Type 1	Type 2	Type 3	Type 4
Old section of Gambell:				
Surface to 1 ft.	..	2	..	..
1 ft. 1 in. to 2 ft.	..	..	..	..
2 ft. 1 in. to 2 ft. 6 in.	..	..	..	..
Seklowaghyaget:				
Surface to 2 ft.	..	1	..	..
2 ft. 1 in. to 3 ft.	..	2	..	..
3 ft. 1 in. to 4 ft.	..	1	..	..
4 ft. 1 in. to 5 ft.	..	1	..	..
Ievoghiyoq:				
Surface to 2 ft.	1	10	..	4
2 ft. 1 in. to 3 ft.	..	4	..	1
3 ft. 1 in. to 4 ft.	..	3	1	1
4 ft. 1 in. to 5 ft.	..	1	..	1

Finger rests.—The few finger rests found at the Punuk sites do not include any of the Old Bering Sea type with flat base and sloping top, but this may be accidental. Plate 73, figure 13 (Ievoghiyoq, cut 5, depth 18 in.), has a concave base for resting on the shaft, and a narrow slot for the lashing; it is somewhat similar to one of the Thule types (Mathiassen, 1927, vol. 1, pl. 5, figs. 1, 2). Another of the same type comes from Ievoghiyoq, cut 1, depth 40 inches. Another finger rest (pl. 73, fig. 14, old section of Gambell, cut 1, depth 16 in.) is short, with a flat base, a large, round line hole, and a blunt end; it is of the same general type as one of the Old Bering Sea forms shown on plate 32, figure 8.

Sealing scratcher.—This is another implement that appears in the Punuk stage. One of these, of wood, is shown in plate 75, figure 17; it was purchased from an Eskimo who excavated it at Ievoghiyoq. It has two prongs to which the seal claws were attached, and a transverse lashing hole below. The bone object shown in plate 81, figure 14 (Ievoghiyoq, cut 6, depth 22 in.), seems also to have been a sealing scratcher, although it lacks the lashing hole; the lower end is roughened as if for insertion in a handle.

Harpoon shafts.—The collection also includes sections of harpoon shafts and a few wooden lance foreshafts like those previously described.

Throwing board.—Plate 80, figure 3, is an unfinished throwing board, from the midden on Punuk Island. It is 44 cm long and has a maximum width of 7.4 cm. It is somewhat heavier and wider than the Old Bering Sea type, if we may judge from the incomplete specimens shown in plate 37, figures 1, 2. It seems designed for the same kind of grip, however. It is, on the whole, very similar to the old Birnirk (Point Barrow) throwing board (Mason, 1928, pl. 1), even though it might not have been cut out at the center as was the latter.

Spurs for the end of the throwing board (pl. 73, fig. 17, Iev., cut 5, 12 in.).—These differ from those of the Old Bering Sea period in having the upper, free end at a right angle to the tang. In addition to the specimen illustrated are two more from Ievoghiyoq, 12 and 22 inches deep, and one from Miyowagh, cut 19, 5 inches deep.

Plate 73, figure 18 (Iev., cut 1, 50 in.), is an ivory peg like the one shown in plate 33, figure 25; it has a shallow pit in the upper end; possibly for the butt end of the dart shaft.

Wooden mouthpieces for seal skin floats.—These forms, which were common at Miyowagh, were represented by only a single example, a specimen with stopper in place, found at Ievoghiyoq, cut 5, depth 33 inches. Plate 73, figure 16 (Iev., cut 9, 19 in.) is a mouthpiece of this type, but made of ivory.

Plate 73, figure 19 (Iev., cut 5, 31 in.), shows the Punuk type of wooden plug for closing holes in the seal skin float. It is very different from the Old Bering Sea type, being longer but of smaller diameter. Three others were found at Ievoghiyoq, at depths of 33 and 39 inches.

Mouthpieces for bladder floats.—The present evidence suggests that the bladder float for the light harpoon may not have been known to the Old Bering Sea Eskimos. In contrast to the large number of wooden mouthpieces for seal skin floats which were found at Miyowagh, there is but a single example from the older section of Miyowagh of the tubular ivory mouthpiece or nozzle such as is used for inflating the bladder float. This is a specimen from cut 27, depth 42 inches. It is a straight tube, with the center sunken and roughened, leaving a rounded projecting rim at either end. Since this was the only ivory mouthpiece found in the older section of Miyowagh, and since it comes from a cut which adjoins cut 19 where much early Punuk material was found, it would seem permissible to regard it as of early Punuk age. The four other tubular mouthpieces for bladder floats found at Miyowagh are definitely of Punuk age, all of them coming from the later, northwestern section of the midden. One of these is the specimen shown on plate 73, figure 11, from cut 4, depth 20 inches. It has the "cannon" shape of the modern Alaskan examples (Nelson, pl. 56). The forward end, which was inserted in the bladder, is cut down; it is also roughened and has a slight lip for holding the lashing in place. Below the tubular body there is a constriction on both sides through which the lashing slot is cut; the base then flares outward, with the under side concave for resting on the harpoon shaft. It was hollowed by drilling from both ends. A similar nozzle not quite finished, comes from cut 20, 39 inches deep, and one which is just blocked out, from cut 2, 24 inches deep. Another, from cut 17, depth 26 inches, lacks the slotted base and has only a suggestion of the elevated rear part of the body.

Plate 73, figure 10, from Ievoghiyoq, cut 6, depth 30 inches, shows an approach to the " cannon " shape, with the middle part sunken and the bottoms of the rims cut so as to rest evenly on the harpoon shaft. Plate 73, figure 12, from Ievoghiyoq, cut 6, depth 40 inches, has a prominent lip at the front, and a back end with flaring base through which is a drilled hole; the wooden stopper was found in place. There are two more specimens from Ievoghiyoq, one, similar to figure 11, from cut 7, depth 18 inches, the other, unfinished, similar to figure 12, from cut 9, depth 12 inches.

Float bars (pl. 73, fig. 20, Iev., cut 4, depth 53 in.).—These are all of wood; none of the ivory handles of the Old Bering Sea period (pl. 47, figs. 6, 7) were found at the Punuk sites.

Plate 73, figure 15, is a heavy ivory tube, probably the mouthpiece for a water bag. It is from Seklowaghyaget, picked up on the surface.

Side prongs for bird darts.—From Ievoghiyoq there are 29 side prongs for bird darts, most of them fragmentary. Plate 74, figures 1 and 2 (from Iev., cut 4, 45 in., and cut 1, 28 in.), illustrate the principal type, which instead of being rounded like the Old Bering Sea type (pl. 33, figs. 1, 2), tends to be either flat or more or less triangular in cross-section, with one surface flat and the other arched; there are often two small notched elevations opposite the lashing slot and two or more small round pits for decoration. No side prongs were found either at Seklowaghyaget or at the old section of Gambell though this is doubtless due to accident. One specimen was found in house no. 8.

Thirteen small, slender points, apparently for the end of the bird dart, were found at Ievoghiyoq, and a few others at Seklowaghyaget and the old section of Gambell; three examples are shown in plate 74, figures 3-5; they are from Ievoghiyoq, cut 5, depth 12 inches; cut 8, 29 inches, and cut 1, 44 inches.

Arrowheads.—The arrowheads of the Punuk period are strikingly different from those of the Old Bering Sea, and in contrast to harpoon heads there is no gradation from one stage to the other. Although a few individual features are carried over, the types as a whole are quite distinct. Arrowheads are much more common in the Punuk than in the Old Bering Sea; no less than 88 were found at Ievoghiyoq alone, with smaller numbers from the other two sites. It is also of interest to note that almost half of the arrowheads from Ievoghiyoq are of ivory, whereas at the two earlier sites bone was used almost exclusively. The most common type by far is that with a single barb (pl. 74, figs. 6-9). Also represented are types with two or more barbs (fig. 10) and no barbs (fig. 14). Figure 15 (Iev., cut 1, depth 28 in.) is an uncommon type, of bone, with three pairs of opposed barbs and a bifurcated tang. Many of the ivory arrowheads, particularly those with one or more barbs on the same side, are triangular in cross-section, thus approaching the modern St. Lawrence form (Nelson, pl. 61 a, figs. 1, 2).

None of the above types, with the possible exception of figure 14, were found at the Old Bering Sea sites; on the other hand, some of them resemble rather closely some of the Thule types (Mathiassen, 1927, vol. 1, pl. 8, figs. 2-4; pl. 9, figs. 1, 3). Some of the tangs particularly resemble the Thule in that they are provided with a shoulder or conical enlargement. It should also be noted that the large collection of Punuk heads included only one specimen with a blade slit, a feature which was often present on the Old Bering Sea heads.

Plate 74, figure 11, is an ivory peg, from Seklowaghyaget, cut 2, depth 12 inches; it has a sharp slender tang and a blunt, rounded head; possibly an arrow tip. Pegs of this kind, of both bone and ivory, are characteristic of the Punuk stage.

Blunt tips for bird arrows.—These were found neither at the Hillside site nor at the older section of Miyowagh. We may therefore assume that they were unknown to the Old Bering Sea Eskimos. However, five examples were found in the later, northwestern section of Miyowagh, as follows: Cut 4, depth 43 inches; cut 6, 12 inches; cut 19, 48 inches (the first two are conical in shape, like the example from Seklowaghyaget, cut 8, depth 67 in., shown in pl. 74, fig. 13; the third is similar in shape, but longer, with a large round socket 2 cm deep, and two lateral lashing slots at the lower end). An unfinished specimen similar to the latter comes from cut 20, depth 12 inches. Apparently the straight-based, conical form is older than the ovoid. The fifth specimen from Miyowagh (cut 2, depth 43 in.) is of another type, with a bifurcated tang instead of a round socket and with an enlarged end into which were cut three deep slanting grooves; it is of bone (cf. Nelson, pl. 61, b, fig. 17; c, figs. 3-7).

Plate 74, figure 13, from Seklowaghyaget, cut 8, depth 67 inches, was the only example of the conical type of blunt arrow tip found at the three later sites; the others, like plate 74, figure 12 (Sek., cut 8, 60 in.) are constricted at the lower end, producing the ovoid shape which still prevails on St. Lawrence Island (Nelson, pl. 61, c, fig. 2). Four other specimens of this type come from Seklowaghyaget, depth 44 inches, the old section of Gambell, depth 24 inches (2), and house no. 10.

In keeping with the large number of arrowheads from the Punuk sites are two other implements, bone bow braces and sinew twisters, which were found in considerable numbers and which afford definite evidence of the use of the sinew-backed bow during this period.

Bow braces.—These are of two kinds: flat, short, narrow strips of bone which were placed at the center of the bow beneath the sinew reinforcement on the outer side; and similar strips, but curved, for strengthening the bow at its most vulnerable point, that is, at the recurved ends. Plate 74, figure 16 (Iev., cut 6, depth 5 in.), is one of the flat braces for the center; others range from 7 to 13.5 cm in length. Figures 17 and 18 are two braces for the backward curving ends; figure 17 (old section of Gambell, cut 1, 8 in.), the more common type, has a shallow longitudinal groove on the concave side and was placed on the outside, in the bend, beneath the sinew cable; figure 18 (Iev., cut 8, 44 in.), with a rather deep groove down its convex side, was fastened to the inner side. All three of the above types are found on modern Alaskan bows.

In all 21 bow braces, including the three illustrated, were found at Gambell, as follows:

From the Hillside site and Miyowagh, none; from Ievoghiyoq, 13, from the following depths: 5 inches (2), 9 inches, 12 inches, 24 inches (3), 28 inches, 33 inches, 36 inches, 44 inches, unknown (2); from Seklowaghyaget, 3, as follows: 18 inches, 19 inches, 22 inches; from the old section of Gambell, 5, as follows: 8 inches (3), 10 inches, 32 inches.

Sinew twisters.—Plate 74, figures 19, 20, are sinew twisters—slender bone rods with opposite curved ends, used for tightening the sinew cables on the backs of the bows (Murdoch, 1892, pp. 315-316). They are somewhat thicker and more curved than the modern examples.

Sinew twisters were found only at Miyowagh and Ievoghiyoq. From Miyowagh there were four, as follows: Cut 4, 25 inches, of bone; 61 inches, of ivory; cut 17, 28 inches, of wood; cut 27, 29 inches, of ivory. From Ievoghiyoq there are 10 examples, all of bone, as follows: 5 inches, 9 inches, 12 inches (2), 18 inches (pl. 74, fig. 20), 25 inches (2), 28 inches, 31 inches (pl. 74, fig. 19), 42 inches.

Wrist guards.—Another object connected with the bow that appeared during the Punuk stage is the wrist guard. Four of these, all of ivory, are shown in plate 74, figures 21-24. Figure 23, from Ievoghiyoq (purchased), is straight across the bottom, rounded at the top, and has a narrow lashing slot on either side. The ornamentation is Punuk, consisting of pairs of lines, some straight, some curving, with shorter pairs of lines attached, and light spurs placed at sparing intervals. Figure 22 is also from Ievoghiyoq, and was purchased; it has a straight base in which there are five slots, and rising from this, two pointed wings; it has a very simple decoration of deeply incised lines. Figure 21, a surface find from the old section of Gambell, is similar in shape but has the upper part undivided. The decoration is neatly applied and consists of bands of horizontal, vertical, and oblique lines, with spurs at regular intervals. Figure 24, purchased from the Eskimos at Savunga, illustrates the modern St. Lawrence wrist guard, which is practically identical in shape with the modern Chukchee type (Bogoras, 1904-09, vol. 1, fig. 73). In its essential features it is also similar to the older St. Lawrence form, plate 74, figure 23. Little can be said regarding relative ages of the different forms, as several of them appear to have been more or less contemporaneous. On the basis of the present rather meager material, however, it would seem that plate 74, figure 23, represents the older type.

Six wrist guards have already been described in the sections on art. One is the fragmentary specimen from Miyowagh, cut 27, depth 9 inches, shown on plate 22, figure 10. The others are from Ievoghiyoq, cut 1, depths 36, 44, and 36 inches, respectively (pl. 65, figs. 9-11); Seklowaghyaget, depth 20 inches (pl. 67, fig. 7); and old section of Gambell, depth 8 inches (pl. 67, fig. 5).

In plate 75, figures 20-22, are shown three objects which to a certain extent resemble wrist guards, but which apparently were used in some other way, perhaps being worn as ornaments. Figures 21 and 22, of ivory, come from cut 1, depth 12 inches, and cut 17, depth 12 inches, in the later section of Miyowagh. One edge is straight with round holes or small rectangular slots near the ends; the ends are curved and incline inward, and between them, at the center, is a pronged projection. Figure 20, of baleen, was found at Ievoghiyoq, cut 1, depth 40 inches. It is bilobed with a small round hole and two notches at the edge of each lobe; opposite are three large round scallops, leaving two narrow projections at the end and two similar but notched projections at the center.

Plate armor.—This is another important element introduced during the Punuk period. It is interesting to note that on St. Lawrence Island it was made entirely of bone, whereas at Bering Strait both bone and ivory were used (Hough, 1895, pp. 632-3). Twenty-four of the bone plates were found at Ievoghiyoq, nineteen at Seklowaghyaget, and eight at the old section of Gambell; none were found at the Hillside site or Miyowagh. The greater number of them were long narrow strips, like plate 76, figures 22, 23, with three pairs of holes, either round or rectangular, for the thongs which held them together. From Ievoghiyoq there are several plates which differ in size from the usual type, being both wider and longer (pl. 76, figs. 20, 21). Figure 24 was probably one of the pieces of a helmet such as used by the Chukchee, Koryak, and Gilyak (Bogoras, 1904-09, vol. 1, figs. 84, 89, and 90).

The 24 pieces of plate armor at Ievoghiyoq were found for the most part in the upper levels of the midden, as follows: 8 inches; 12 inches (4); 16 inches (2); 20 inches (5); 22 inches (2); 24 inches (4); 28 inches (2); 30 inches (2); 37 inches; 42 inches. The 19 pieces of armor from Seklowaghyaget occurred at deeper levels, as follows: 20 inches; 22 inches; 30 inches (2); 34 inches (3); 38 inches (11); 60 inches. Those from the old section of Gambell were all found at depths of 24 and 32 inches.

Fish spears.—The three small ivory points (pl. 75, figs. 1-3) are probably prongs for the end of a light fish spear such as Nelson describes from western Alaska (Nelson, 1899, pp. 194-5; pl. 67, figs. 1, 2).

Barbs for salmon spears.—Plate 75, figure 19, is an ivory barb for a salmon spear from the midden at Cape Kialegak, southeastern end of St. Lawrence Island. Several similar specimens were found on Punuk Island, but not at any of the Gambell sites. Their absence there may be accidental, but on the other hand, the salmon spear seems never to have been used very extensively on St. Lawrence Island. The above specimen is of the modern Alaskan type (Nelson, fig. 42, 1) which is practically identical with the Thule type (Mathiassen, 1927, vol. 1, pl. 12, figs. 10, 11; pl. 43, figs. 1, 3, 4, 5; pl. 71, figs. 2, 3; pl. 77, fig. 13).

Compound fishhook.—This form makes its first definite appearance in the Punuk stage. Plate 75, figures 4, 5 (old section of Gambell, 10 and 24 in. deep) are the bone shanks of two such fishhooks, used no doubt for catching tom cod. The lower end is enlarged, with three or four deep vertical grooves in which the prongs were set; the upper end has a perforation for the line. From Ievoghiyoq there is a similar specimen of ivory and six others of wood; from Seklowaghyaget there are two specimens, one bone, one ivory. The prongs for these hooks are of ivory, as a rule slightly curved, with the tang beveled on the inner side so as to fit into the groove, and with the upper end either barbed or plain (pl. 75, figs. 6-9, from Iev., depth 12 in., and old section of Gambell, 8, 24, and 32 in. deep). This type of fishhook has continued in use on St. Lawrence Island down to modern times (Nelson, 1899, pl. 68, fig. 20; pl. 69, fig. 28).

The fishhook in one piece, plate 75, figure 10 (old section of Gambell, depth 10 in.), is later and seems to represent a development from the compound type. The prongs, four in number, project upward from the base in the same way as the detachable prongs of the earlier type. This specimen, from the old section of Gambell, is in general similar to some of the modern fishhooks of the Siberian Eskimo (Nelson, 1899, pl. 69, fig. 2) and of the Chukchee (Bogoras, 1904-09, fig. 67, *e*).

Fishline sinkers.—The fishline sinker undergoes an interesting development during the Punuk period. Twenty-six ivory sinkers were found at Ievoghiyoq, about half of them with the two line holes parallel and the other half with the line holes at right angles. The first type, illustrated by plate 75, figure 12, is practically identical with one of the Old Bering Sea types, but it is somewhat less symmetrical and in most cases is less carefully made. The second type, figure 13, with the line holes at right angles, also resembles one of the Old Bering Sea types in that the lower end is thicker than the upper. Here again, however, there is a difference in technique; the Punuk examples are of poorer workmanship and lack particularly the studied asymmetry of the earlier forms which was produced by the prominent side bulge below the center. At Seklowaghyaget only five fishline sinkers were found. Three of these are like the types from Ievoghiyoq, but the other two, figures 14 and 15, are modern types. Figure 14 has two small slots near the lower end to which lines, with hooks attached, were tied. Sinkers of this type from St. Lawrence Island, but usually more crudely made, are described by Nelson (pl. 69, figs. 28, 31, 33). The other sinker, figure 15, has seven cylindrical oblique holes in the sides in which barbs were set, thus being a fishhook and sinker in one; there are also perforations in which lines, with hooks at the end, were fastened. A modern fishhook-sinker of this type from Cape Nome is described by Nelson (pl. 69, fig. 4).

Net sinkers.—Heavy ivory net sinkers are also characteristic of the Punuk stage (pl. 75, fig. 16, from Iev., cut 5, depth 28 in.). These are sections of tusks, with only the ends worked and perforated; the present specimen had been used originally as a pick. These net sinkers are larger and heavier than those described by Nelson (p. 189). Three examples were found at Miyowagh, from cut 1, depth 42 inches; cut 4, 15 inches; and cut 8, 12 inches. From Ievoghiyoq there are two more, one from cut 2, depth 52 inches, the other depth unknown. The only other sinker of this type comes from house no. 8.

Stone sinkers.—Plate 80, figure 4, is a stone sinker for a tom cod net, found at the old section of Gambell, depth 8 inches. Just above the center is an encircling groove, joined by two vertical grooves from the lower end. Tom cod nets of baleen with grooved sinkers at the bottom are described from the Chukchee and Siberian Eskimo (Bogoras, 1904-09, vol. 1, p. 149, fig. 65; Nelson, 1899, p. 187, pl. 70, fig. 12). They are also used on St. Lawrence Island at the present time. Five other sinkers similar to this were found at the old section of Gambell and one at Seklowaghyaget. The tom cod net was known earlier, however, for in the later section of Miyowagh we found the bottom of one of the baleen nets and several small sections of netting, but none of the sinkers.

Meat hooks.—Only two meat hooks were found at the later sites. One of these, from Ievoghiyoq, was of the type shown on plate 35, figure 8; the other, from Seklowaghyaget, depth 61 inches, is shown on plate 75, figure 18. It is of bone, with a concave base and a slender pointed prong; there is no slot, the lashing passed around the top, which was roughened to prevent it from slipping.

Wound plugs.—Wedge-shaped wooden wound plugs were also rare. Plate 75, figure 11 (Iev., cut 1, depth 31 in.) illustrates one of the three which were found, all at Ievoghiyoq; the other two come from cut 1, depth 50 inches, and cut 2, 26 inches. They are smaller and more pointed than the earlier examples.

Ice creepers.—Only one ice creeper was found at the three later sites, the specimen shown on plate 75, figure 24, from Seklowaghyaget, purchased. However, two of those from the later section of Miyowagh may also be regarded as of Punuk age. One of these, plate 75, figure 23 (cut 19, 24 in.), is of ivory with the three spikes carved out in relief; it is convex on the opposite side. Plate 75, figure 25, of bone, from cut 19, depth 5 inches, approaches the modern ice creeper in shape (Nelson, p. 216), although it has the three widely spaced ivory pegs characteristic of the Old Bering Sea type. Plate 75, figure 26 is a modern ice creeper from St. Lawrence, shown for comparison.

Bird bolas.—The bird bola is another important element that makes its appearance in the Punuk stage. No bola weights were found at the Hillside site. At Miyowagh, 37 were found, all of them confined to the upper levels of the later, northwestern section, as follows: Cut

1, 12 inches (6); 38 inches. Cut 2, 12 inches; 20 inches. Cut 4, 15 inches (2); 31 inches (2); 43 inches. Cut 17, 20 inches (5); 26 inches (2); 27 inches; 28 inches (4). Cut 20, 12 inches (2); 22 inches (6); 26 inches (2). Cut 19, 17 inches, 32 inches. At Ievoghiyoq, there were 167, found at all levels; at Seklowaghyaget, 38; and at the old section of Gambell, 14. Thus, in all there are 256 bola weights from the four sites. They may be divided into three general types: (1) Walrus teeth, unworked except for the beveled end—usually the upper end—where the line hole is cut through (pl. 76, figs. 1-4, 9). (2) Pieces of ivory or bone—rarely the latter—of irregular shape; usually unworked except for the line hole but sometimes with sides and lower end slightly worked (pl. 76, figs. 5-7). (3) Well made, with lower end conical, rounded or flattened (pl. 76, figs. 8, 10-19). The distribution of the three types is as follows:

	Miyowagh	Ievoghiyoq	Seklowaghyaget	Old section of Gambell
Type 1	19	61	18	9
Type 2	2	37	1	3
Type 3	16	68	19	2

Plate 76, figure 19, it should be noted, has the line holes sunk into the top, which is the prevailing method north and east of Bering Strait. It is probably an importation, as the type is represented in the present extensive collection by only three specimens, all from Seklowaghyaget, at depths of 8, 12, and 18 inches. The bola weights of the Thule culture resemble in general those of north Alaska, being small and rounded or squarish in outline, in contrast to the prevailing St. Lawrence types, which are longer and tapering at the upper end.

Sledge runners.—These underwent considerable modification during the Punuk period. In order to bring this out more clearly, we will consider the several finds separately. From Ievoghiyoq there are 25 complete and fragmentary specimens, all of ivory. Two of these are of the Old Bering Sea type 1 a, and one of the Old Bering Sea type 2. The remaining 22 are quite different. They fall into three rather distinct but related groups, which developed not from any of the Old Bering Sea types of sledge runners but on the contrary from the Old Bering Sea type of shoe illustrated in plate 45, figures 4-9. (See also table 3, p. 230.)

The first of these, which will be designated as Punuk type 1, is represented by three examples, two of which are shown in plate 77, figures 1 and 2. All of these are ends, so that we do not know the original length; the average width at the holes is 4.2 cm and the thickness—or height—2.9 cm. A short distance from the end is a transverse ridge, which was left when the top surface was cut down, and beneath this ridge passes the lashing slot—two holes drilled obliquely and meeting at the center.

Type 1 a (pl. 77, fig. 3), of which there are five examples, is flat on the upper surface, like type 1 and seems to have been of the same general shape. The lashing arrangement, however, consists of two holes, either at the tip or a short distance back, drilled completely through and connected on the under side by a sunken groove to protect the lashing. This groove, connecting the two holes, is visible in plate 77, figure 3. Four of this type were also found at Miyowagh in the later, northwestern section of the midden.

Type 2 (pl. 77, figs. 4, 5), 14 examples, differs from type 1 a in having a V-shaped concavity extending the entire length of the upper surface. Figures 4 and 5 show the upper and lower sides, respectively, of this type of runner; the sides are straight. The lashing slots either extend completely through, as in type 1 a, or are drilled in obliquely, beneath a transverse ridge as in type 1. The average width, at center, is 5 cm; thickness—or height—3 cm. The above three types, whether they be considered runners or shoes, are clearly derivatives of the flatter, Old Bering Sea shoes illustrated in plate 45, figures 4-9. Thus the Punuk type 1, with its transverse ridge beneath which the lashing holes are drilled, has its prototype in the Old Bering Sea shoe types 2 and 3 (pl. 45, figs. 6-9), which though flatter and wider, also had the lashing holes passing under a knoblike elevation; whereas the Punuk types 1 a and 2, which lack this ridge, are descended from the Old Bering Sea shoe (type 1, pl. 45, figs. 4, 5), which was flatter but had a similar arrangement of the lashing holes. In view of their height, which increases still further in the late Punuk and modern specimens described below, it seems better to call them runners, or shoe runners.

From the next site, Seklowaghyaget, we have 11 sledge runners and fragments. Old Bering Sea type 1 a (which was illustrated on pl. 45, figs. 1, 2) is represented by two specimens, which differ however in having two drilled holes, instead of a rectangular cut-out hole, beneath the notch on the top side.

Punuk type 1 a is represented by one specimen and type 2 by two. One of the type 2 specimens, however, differs from the previous examples (such as pl. 77, figs. 4, 5) in being much narrower and somewhat higher, with the sides inclining downward to the bottom.

The remaining six runners from Seklowaghyaget belong to what will be called type 2 a (pl. 77, fig. 6), a further specialization of type

2, but with the lashing arrangement of type 1 at the front end; toward the back end there are several additional oblique holes drilled through from the top to the sides. The upper surface has the usual V-shaped concavity, but the sides are made differently, first sloping sharply inward from the rim, and then descending vertically to the bottom, making it Y-shaped in cross-section, like the modern St. Lawrence examples. Plate 77, figure 6, is 36.8 cm long, 2.9 to 3.5 cm wide, and 3.4 cm high; the three fragmentary specimens average 3.8 cm in width and 4 cm in height.

From the last site, the old section of Gambell, there are five sledge runners. One of them is an example of Old Bering Sea type 2. Another, shown in plate 77, figure 7, is like the preceding Punuk type 2 a, but still higher and narrower, with a height of 4.7 cm and a width of 2.7 cm across the flaring top and 1.3 cm across the constricted bottom. Of the remaining three, two are too fragmentary for classification although their shape is that of type 2 a. The other, shown in plate 77, figure 8, possesses two features which set it somewhat apart, so that we may call it type 2 b. The shape is that of 2 a, but the lashing arrangement at the end consists of two oblique holes drilled through the flaring edge; in addition, there were two long transverse holes, rectangular or oval in shape, like those on the old Bering Sea types 1 and 1 a.

The distribution of the various types of sledge runners and shoes at the five sites is given in table 3. Summarizing the distribution shown therein, we see that the heavy sledge runners made from entire walrus tusks are of Old Bering Sea age, being found only at the Hillside site and Miyowagh; but that in a modified form (type 1 a) it continues into the Punuk stage. Type 2, on the other hand, may have continued in use until modern times, although

TABLE 3.

	Old Bering Sea sledge runners			Old Bering Sea sledge shoes			Punuk sledge shoe-runners				
	Type 1	Type 1 a	Type 2	Type 1	Type 2	Type 3	Type 1	Type 1 a	Type 2	Type 2 a	Type 2 b
Old section of Gambell.....	..	..	1	..	..	..	..	..	..	1	1
Seklowaghyaget	..	2	..	..	..	..	..	1	2	6	..
Ievoghiyoq....	..	2	1	..	..	..	3	5	14	..	..
Miyowagh.....	2	6	5	14	4	13	..	4[a]	..	..	..
Hillside site....	3	..	3	..	..	..	..	..	..	..	..

[a]All four of these are from the later, northwestern section of the midden.

it was in large part superseded by later types, which as was pointed out above, developed during the Punuk period from the Old Bering Sea sledge shoes.

The transition from shoe to runner is brought about mainly by an increase in height. Thus, the Punuk shoe-runners of types 1 and 1 a are only modified forms of the Old Bering Sea shoes with higher sides, and—in type 1—a more prominent transverse ridge over the lashing hole. The next type, 2, differs in having the upper side concave, and in the later types, 2 a and 2 b, this **V**-shaped concavity becomes more pronounced, developing into flaring rims as the runner becomes higher and narrower and the form in cross-section changes from a straight-sided **M** to a wide-bottomed **Y.**

Sledge cross bars, made from walrus penis bones, were also found at the Punuk sites.

Bone and ivory knife handles.—We find that the compound form, which was the most common type of the Old Bering Sea period (pl. 38, figs. 5-7) is also well represented in the Punuk finds. Twenty-six handles of this type were found at the three Punuk sites; two of these are shown on plate 78, figures 4, 5. In two respects, however, they differ from the Old Bering Sea forms: first, bone (usually a piece of walrus rib) has largely replaced ivory as the material, 23 being of bone, 3 of ivory; second, the face, instead of being straight, as in the great majority of the Old Bering Sea handles, was sharply beveled at the end, so that in order to complete the handle only a short section, about 3 cm long, had to be lashed on.

In addition to the compound handle there were a few specimens with deep, wide sockets, somewhat like the Old Bering Sea type shown in plate 38, figure 8, and a few others with narrow slot for an end blade, like plate 38, figures 9 and 10.

Of more importance is the fact that in the Punuk we have the first appearance of the " crooked knife ", with a small side blade near the tip, a type which in its later and more developed form is now widespread among the Eskimo, particularly in Alaska. Fifteen of these were found at the three Punuk sites, all of them made from walrus ribs. Most of them are short and only slightly curved, like the two shown in plate 78, figures 1 and 2. These are rather far removed from the later and more specialized Alaskan forms which are longer, more sharply curved and flattened, and which often have the iron blades riveted to the outside; these Punuk handles are, in fact, much closer to some of the Thule types (Mathiassen, 1927, vol. 1, pl. 18, figs. 2, 4; pl. 68, fig. 4; pl. 83, fig. 10). Plate 78, figure 3, is an example of the more curved Punuk type. Most of the handles have no hole for a suspension cord. The 15 knife handles of this type were found as follows: Ievoghiyoq, depth 8 inches (pl. 78, fig. 3), 12 inches, 16 inches, 33 inches, 39 inches, 44 inches (2). Seklowaghyaget, 4 inches (pl. 78, fig. 1), 18 inches, 20 inches, 38 inches. Old section of Gambell, 8 inches (pl. 78, fig. 2), 10 inches, 24 inches (2).

Wooden knife handles.—There are 15 wooden knife handles, all but one of them from Ievoghiyoq. They all have slits for end blades, like one of the three Old Bering Sea types. Plate 78, figures 6 and 8 (Iev., depths 33 and 39 in.), are in all essential respects the same as the Old Bering Sea handle shown in plate 38, figure 1. Plate 78, figure 7, however, from Ievoghiyoq, depth 37 inches, represents a specialization of this basic type and apparently one which is confined to the Punuk stage. The end is so narrowed that the lower part of the blade would have projected at the sides; this being the case, there must have been two drilled holes at about the center of the blade for the lashing which was fastened to the handle around the narrow grooved end. Three others of this type were found at depths of 24, 44, and 45 inches, at Ievoghiyoq. Eight others similar to plate 78, figures 6 and 8, were found at Ievoghiyoq, at depths of 30 inches (3), 36 inches, 37 inches, 39 inches, 42 inches, and 60 inches. There is also a single example of this type from Seklowaghyaget, depth 58 inches.

Knife sharpeners.—These, made of young walrus tusks, also occur in the Punuk finds. None of them are carved to represent a whale like the Old Bering Sea specimens shown in plate 38, figures 12, 13.

Stone implements.—Implements of rubbed slate were as abundant at the Punuk sites as at Miyowagh and the Hillside site, and the types were generally the same. Adzlike scrapers, like plate 42, figures 12-14, also occurred, but infrequently. With regard to chipped stone implements, conditions were entirely different. Only a very few implements of chipped stone—slate or any other kind—were found at the three later sites, although these were abundant at the Hillside site and fairly common at Miyowagh. The small slate implements with rubbed edges (pl. 39, figs. 19-22) and the columnar rubbing stones (pl. 43, figs. 1-5) were also absent at the Punuk sites.

Ulu handles.—There are 17 wood and 4 ivory ulu handles from the Punuk sites. They show less variation than the Old Bering Sea forms, most of them being rather straight and thick like the one with part of the slate blade still in place, from Seklowaghyaget, depth 48 inches, shown on plate 78, figure 10; a few are crescent shaped. Plate 78, figures 9, 11, 12, and 13 are of ivory. Figure 9 (Iev., depth 5 in.) is only 4.9 cm long and has four dots for decoration. Figure 12 has the characteristic late Punuk ornamentation of pairs of deeply cut horizontal and vertical lines with occasional gouged oblique spurs; it is from Ievoghiyoq, purchased. Figure 13 is decorated with two rows of nucleated circles enclosed by a narrow bordering band of two lines with inward pointing alternating spurs attached. The circles in the upper row are separated by pairs of short vertical lines, those in the lower row have large Y-shaped figures attached; the circles are all compass-made. This is an example of disintegrated Punuk art; all continuity of design has been lost and decorative effect is accomplished only through the repeated use of detached elements. It was excavated at Seklowaghyaget, and purchased from an Eskimo. Figure 11 is a late Punuk type, also purchased, and probably from Seklowaghyaget; it is pointed at one end, squared off at the other with a large opening which originally held an ornamental link or pendant like that shown in plate 82, figure 30.

Fat scrapers.—Two fragments from Ievoghiyoq (depths 12 and 42 in.) indicate that the straight-sided scraper for removing fat from intestines and skins, like plate 13, figure 8, was also used during the Punuk period. However, another though related form, was more common (pl. 78, fig. 14, Iev., depth 26 in.). It was made of bone and was somewhat curved, with the inner edge rounded for holding in the hand and the outer edge sharpened for scraping. There are three other specimens like this, two from Ievoghiyoq, depths 12 and 19 inches, and one from house no. 9. Figure 15 is a broken scraper made from a caribou or reindeer cannon bone, from Ievoghiyoq, depth 12 inches. The modern St. Lawrence scraper, which is of ivory, oval in outline with rounded base (Nelson, 1899, pl. 50, fig. 10), was not found at the Punuk sites, but this was probably due to accident. At any rate we have a prototype for it in such scrapers as those shown in plate 51, figures 9, 11.

Spoons.—The spoons of the Punuk period are of bone and have long handles. One of these, from Ievoghiyoq, depth 12 inches, is shown in plate 78, figure 16. It has a shallow rounded bowl and is constricted at the neck. Three similar specimens from Ievoghiyoq come from depths of 5, 12, and 36 inches.

Awls.—Bone and ivory awls are abundant, just as they were at the earlier sites.

Needles.—The absence of needles is undoubtedly due to accident.

Adz heads.—Certain developmental tendencies may be observed when comparing Punuk adz heads with those of the Old Bering Sea period, but the picture is somewhat obscured by the fact that several types were in use at the same time. First, we must note the absence on the Punuk specimens of any "ears" for the lashing thongs, such as are present on the two earlier adz heads shown in plate 46, figure 3, and plate 60, figure 2. Most of the Punuk adz heads of ivory (pl. 78, figs. 17, 18, from Ievoghiyoq, depth 50 in., and Seklowaghyaget, depth 12 in.) are also more slender in outline and have a prominent projection or knob at the upper end. The "shoe-shaped" ivory adz head—figure 20—is from Punuk Island, 4 miles off the east end of St. Lawrence Island; it is shown lying on its side; the socket for the handle is a narrow rectangular pit, above which is a slot through which the lashing passed. The knobbed projection extends forward, in the plane of the socket, giving it the appearance of a shoe heel, and the lower part, to which the blade was fastened, has an oblique downward slope. This type of adz head represents a late Punuk specialization of the straighter type, figures 17, 18. That it was not found at Gambell is probably due to accident, for figure 21, from house no. 8, is clearly a derivative form, one which is still further specialized in the increased height of the upper part where the handle is attached. In this case there is no socket for the handle, but a scarfed surface with two round holes for the lashing thongs; there is no knob at the upper end.

Six more adz heads of the same general type as the two shown on plate 78, figures 17, 18, were found, all at Ievoghiyoq, at the following depths: 22 inches (2), 28 inches, 36 inches, 42 inches, 48 inches.

None of the Punuk adz heads had a transverse hole for the handle, like the earlier one shown on plate 46, figure 6. The type with large socket in the end for a stone blade (pl. 46, figs. 6, 7) seems not to have been carried over into the Punuk, as the later type of end socket (pl. 78, fig. 19, Sek., depth 36 in.) is very narrow, for an iron blade. Three other adz heads of this type were found at Seklowaghyaget, depth 28 inches, and houses no. 9 and 10; they are all of bone, with the upper end tapering, and with a flattened surface instead of a pit for the attachment of the handle.

Adz handles.—Plate 79, figure 3, is a well-made wooden adz handle from house no. 7, at Ievoghiyoq. The lower end is flattened and somewhat spatulate, with a deep groove and shoulder for the index finger. The upper part is narrower, 3.5 cm high and 2 cm wide; at the end is a small rectangular-oval projection which was inserted in the socket of the adz head, and a narrow slot for the lashing which held the head and handle together. Another wooden adz handle comes from Seklowaghyaget, depth 34 inches.

Pick handles.—Two pick handles are shown in plate 79, figures 1 and 2. The first, of wood, is from Seklowaghyaget, depth 52 inches;

it is 19 cm long, with a smooth-rounded grip and a slight groove for the index finger; the pick, which was probably of ivory, rested in a groove at the front end and was held on by thongs passing through a large triangular notch. Figure 2, a surface find from Seklowaghyaget, is of ivory, and has the same arrangement for the attachment of the pick; the grip, however, is provided with three broad notches for the fingers. A similar specimen comes from Miyowagh, cut 20, depth 39 inches.

Picks and wedges.—Ivory picks and wedges were plentiful and differ in no way from those of the Old Bering Sea period, already described.

Mattock blade.—Plate 80, figure 2, is a mattock blade, 38 cm long, made from a whale rib. It is from Ievoghiyoq, depth 34 inches. At the upper end is a hole for the handle, and somewhat below the middle two notches for the thongs which helped to hold the handle taut.

Snow shovels.—Snow shovels made of walrus scapulae, like those of the Old Bering Sea period, were found at all of the Punuk sites.

Bone knife.—The bone knife, or dagger, is another characteristic Punuk element which seems to have been lacking in the Old Bering Sea period. Thirty-four were found, twenty-four of bone, ten of ivory. Three of them are illustrated in plate 79, figures 4-6. The prevailing type at Ievoghiyoq and the northwestern section of Miyowagh is illustrated by the bone knife, figure 5. The average length is a little more than 20 cm, and the width around 3 cm; one side is flat, the other is arched and has a distinct median ridge; the end is pointed and the edges fairly sharp; there is usually a perforation at the end of the handle for a suspension cord, and occasionally a narrow lateral slot through the upper edge of one blade. Seven examples were found at Miyowagh, as follows: Cut 1, depth 42 inches; cut 3, 54 inches; cut 9, 25 inches; cut 12, 20 inches; cut 19, 51 inches; cut 22, 18 inches; and from cache in the floor of house no. 3 (pl. 79, fig. 5). Eight similar specimens come from Ievoghiyoq, at the following depths: 5 inches; 12 inches (3); 19 inches; 25 inches; 31 inches; 42 inches. From Seklowaghyaget there are three, depth 12 inches, 25 inches, and depth unknown. From the old section of Gambell there are four, depths 16, 24, and 32 inches (2). There is also a single specimen from house no. 8.

Plate 79, figure 6, of ivory, Ievoghiyoq, depth 39 inches, along with three others, differs from the prevailing type in having a median ridge on both sides; it is the only one that is decorated.

Plate 79, figure 4, of ivory, represents what seems to be a later type found only at Seklowaghyaget and the old section of Gambell. Like figure 5, the lower side is usually flat and the upper side convex with a median ridge; occasionally there is a median ridge on both sides. These knives, however, are smaller, averaging 16 cm or less in length and 2 cm in width; the handle is short and perforated at the end, and there is usually a small narrow slot through the edge of the blade just below the handle. Knives of this smaller type were found as follows: Seklowaghyaget, depths 12 inches (pl. 79, fig. 4), 18 inches, 20 inches, 26 inches, 28 inches (2), 60 inches; old section of Gambell, depths 24 inches (2), and 32 inches.

Bone knives are no longer used on St. Lawrence Island, so there must be some doubt as to the exact function of the present specimens. It is possible that they were used for scraping snow from the fur clothing, but the pointed end and straight, sharp edges make it appear more probable that they were daggers used in hunting or in war. Similar knives are known from the Thule culture (Mathiassen, 1927, vol. 1, p. 48, pl. 13, fig. 15). The smaller type (pl. 79, fig. 4), is more doubtful, as it could hardly have been very effective as a weapon.

Mouthpieces.—Mouthpieces for bow drills are somewhat more common in the Punuk than in the Old Bering Sea finds. Almost all of them are small, like the three of ivory shown in plate 82, figures 37-39, the average length being between 4 and 5 cm. Figure 37, from Miyowagh, cut 20, depth 12 inches, has the drill hole on the convex end; the upper end was cut down, leaving a ledge which was held between the teeth; through this ledge is a round hole, probably for a suspension cord. Figure 38, from Miyowagh, cut 6, 12 inches, is similar except that the ledge extends completely across. In figure 39 (Iev., cut 5, depth 33 in.) the hole for the end of the drill shaft is on the straight, under side, the convex upper part being held in the mouth; there is a groove on either side to allow a firm grip with the teeth, and at the center of this a narrow slot for a suspension cord. Figure 40 is the largest mouthpiece found, 7.3 cm long and 2.1 cm thick. It comes from Mirrukta, an old site 3 miles east of Gambell. The drill shaft was held in a large circular hole on the under side 2 cm in diameter and 1.8 cm deep. Two pointed wings extend upward and between them is the mouth grip, an oval projection with a concave face and a suspension slot through one edge.

Drill rests.—Plate 80, figure 5, is a drill rest made from a whale's ear bone, from Ievoghiyoq, cut 6, depth 22 inches. It has three deep pits on either side. Ivory drill rests like those from Miyowagh and the Hillside site were also common at the Punuk sites.

The following objects connected with the bow drill were found in large numbers at the Punuk sites, but differ in no significant respect from those already described: shafts of wood, some painted red; bows of bone and wood; points of bone.

On plate 84, figure 1, is shown a wooden fire hearth from house no. 7, at Ievoghiyoq; it is a large, flat piece of wood with numerous charred pits made by the shaft of the fire drill.

Hand drills and reamers.—Hand drills and reamers of bone and ivory were equally abundant, but likewise similar to those of the Old Bering Sea period. Plate 81, figure 21, is one of these, from Miyowagh, cut 19, depth 24 inches, made from the distal end of a dog humerus. The point is unusually fine, being 1.5 mm in diameter, with a sharp edge beveled from both sides.

Engraving tools.—Plate 81, figures 17-20, are four engraving tools similar to those from the later section of Miyowagh shown in plate 60, figures 10, 11. The first three are from Ievoghiyoq, depths 22, 12, and 31 inches; figure 20 is from the old section of Gambell, depth 16 inches. Figure 19 is made of wood, the others of ivory. Another wooden specimen comes from Ievoghiyoq, cut 1, depth 60 inches. The later Punuk type of engraving tool is of simpler construction than those of the early Punuk shown in plate 60; those from Ievoghiyoq all have a buttonlike head, whereas figure 20 has no enlargement at all. On the last-named specimen a part of the iron point still adheres to the lower end.

Rubbing tools and stone flakers.—Rubbing tools are as abundant in the Punuk as in the Old Bering Sea, and stone flakers of bone are also found.

Plate 79, figure 7, is an ivory object of unknown use, from Miyowagh, cut 2, depth 28 inches. It is 22.3 cm long, pronged at one end, rounded at the other; the under side is flat, the upper somewhat convex; it gives the impression of being unfinished.

Another pronged ivory object of unknown use, from the old section of Gambell, depth 8 inches, is shown on plate 79, figure 9. It has somewhat the appearance of a "sealing scratcher", even to the slot below the prongs; but the small size, the decoration, and the wide lashing groove around the lower end are features which are not found on any of the sealing scratchers known at present.

Bone hook.—Plate 79, figure 8, is a bone hook peculiar to the Punuk culture. It is made from a dog humerus which is perforated near the proximal end for the insertion of a sharp sliver of bone. The exact function of these hooks is uncertain; but the fact that they are invariably made of dog humeri which have a natural foramen at the distal end suggests that the latter was utilized as a suspension hole. In that case it could have been attached to a line, or more likely used inside the house as a wall hook. The present specimen is from Seklowaghyaget, depth 3 inches. Two others come from the same site at depths of 28 and 64 inches. There are also three from Ievoghiyoq, two from depths of 26 inches and one 24 inches.

Harpoon rest.—Plate 79, figure 10, from Seklowaghyaget, depth 34 inches, is a harpoon rest for the umiak, made from two pieces of walrus ribs. According to Nelson such rests were "lashed to the bows of umiaks, just inside and between the front ends of the rails; in these the ends of the lances and spears rest, and through them the lines run out" (p. 226). The present specimen, which was the only one found, is much cruder than those of ivory which Nelson illustrates from the mainland (pl. 78, figs. 33, 37).

Boat hooks.—Plate 79, figures 12 and 13, are two large boat hooks of ivory, from Ievoghiyoq, depth 12 inches and depth unknown (purchased). They both have a slightly concave base, a body constricted at the middle, and a straight projecting prong. Figure 12, which is badly weathered, had the upper surface covered with a typical Punuk ornamentation consisting of small compass-made, nucleated circles, from which stream single and double lines. Figure 13 has a median ridge along the top, and a backward-projecting end.

Plate 84, figure 2, is a well-preserved wooden paddle probably for a kayak, found in house no. 7 at Ievoghiyoq. The blade—tip broken—is 9 cm wide and appears to have been about 39 cm long. It may have been a double paddle, for it was made in two sections, lashed together by means of a simple scarfed joint, with wooden pegs at the ends and wrappings of some kind to afford additional strength.

Pottery.—Pottery was no less abundant in the Punuk than in the Old Bering Sea period. Just as at the two earlier sites, potsherds were found in great numbers at Ievoghiyoq, and the ware differed in only two respects from that previously described: only a relatively small number of sherds had the roughened or corrugated exterior which was so common during the earlier period, and none were grass-tempered. The shapes of the vessels apparently remained unchanged. The lamps were shallow, circular, and thick-walled, with conical bases and no wick ledges. Plate 84, figure 3, from Ievoghiyoq, illustrates the type. Plate 53, b, is a complete lamp of this kind, excavated by the writer from an old grave at Kowieruk, Seward Peninsula.

The cooking pots at Ievoghiyoq, to judge from the fragments found were round, steep-sided, thin-walled, with rather heavy rounded bases.

These same types were also found at Seklowaghyaget, but along with them were fragments of the pottery which is so characteristic of St. Lawrence Island today (Hough, 1898, pl. 15, fig. 16; Nelson, 1899, pl. 28, figs. 1, 4, 5, 7-10). At the most recent site, the old section of Gambell, this modern type of pottery was found exclusively (pl. 84, figs. 4, 5).

Baleen vessels.—Baleen vessels with wooden bottoms are as characteristic of the Punuk as of the Old Bering Sea period.

Wooden vessels.—Long, narrow wooden vessels also continued to be used. Plate 80, figure 1, is one of these, a food platter from Ievoghiyoq, cut 1, depth 41 inches. It is 44 cm long, 6.2 cm deep, and 13 and 6.4 cm wide at the ends.

Drum.—The drum occupied a much more prominent place in the Punuk than in the Old Bering Sea culture. Five wooden and seven ivory handles were obtained from the three Punuk sites, in addition to a considerable number of rim fragments. Five of the handles are illustrated in plate 81, figures 2-6; the first three are from Seklowaghyaget, purchased; figure 6 is from house no. 7, Ievoghiyoq. Figure 2 was originally about 17.8 cm long, with a deep square notch for a thick rim and a narrow lashing slot below it. At the front end is an oval projection bearing a Punuk ornamentation of spurred lines radiating from rim to center. Originally there was a perforation at the lower end. Figure 3 is very similar, but only 9.3 cm long; the flange-like projection at the upper end is proportionately larger and slightly concave. Figure 4 is provided with four small notches as finger grips, and a rather large hole at the lower end where a link ornament was probably attached. Figure 5 lacks the flange at the end; it bears a late Punuk ornamentation consisting of two bands of four and five lines connected by a pair of straight longitudinal lines having two very oblique spurs at the center. The wooden drum handle, figure 6, lacks ornamentation of any kind. The drum handles not illustrated come from Ievoghiyoq, depths 12 inches (2), 26 inches, 30 inches, 31 inches; and Seklowaghyaget, depths 12 inches and 60 inches.

Objects of wood and baleen.—These are not nearly as abundant at the three later sites as at Miyowagh or the Hillside site. This does not mean that these materials were less used but that the conditions for their preservation were less favorable at the three later sites. There was much more gravel in the Ievoghiyoq and Seklowaghyaget middens (especially the latter) than at the sections of Miyowagh where the greatest amount of digging was done, and as was pointed out previously, cultural material is always less abundant at such places. This is not only because the gravel itself is often an intrusive fill, and therefore more or less sterile, but also because cultural material, when included is not likely to be permanently preserved due to the fact that the gravel thaws rapidly and to a considerable depth. At the sections of Ievoghiyoq where conditions were comparable to those at Miyowagh, baleen and wood were plentiful. In addition to those previously mentioned, the following classes of objects were found, none of which, so far as could be determined, differed essentially from those described from the Old Bering Sea sites: pieces of wooden arrow shafts, small wooden cylinders, painted red (like pl. 57, figs. 18, 19), wooden objects with scoop end (like plate 47, fig. 11), pail handles, drill handles, drying racks, toy boats of wood and bark, wooden shafts of various kinds, painted red; baleen ice scoop, toy bows, knots, toboggan cross pieces, plaited baleen objects like plate 56, figures 8, 9.

Miscellaneous objects of ivory and bone.—Plate 81, figure 1, is a bone tube, from Ievoghiyoq, depth 24 inches, made from a swan's wing bone with both ends cut off. There are several others from the same site made from smaller bones. They may have been drinking tubes, although such an interpretation would be conjectural.

Plate 81, figure 12 (Iev., depth 12 in.) is the canine tooth of a polar bear, with the upper end perforated for suspension. It may have been used as a charm against sickness, a custom still in vogue on St. Lawrence Island.

Plate 81, figure 13 (from Sek., purchased) is an ivory object with a smooth flat top 8.9 cm long and 1.9 cm wide, and two cylindrical " legs " 1.3 cm in diameter. The flat upper surface is crudely ornamented with a crooked longitudinal line and a series of irregularly spaced transverse lines. The only objects comparable to this that I have seen are some of bone excavated by Dr. Hrdlička on Kodiak Island.

Another characteristic Punuk element is a small bird bone inserted in another. Two of these, from Ievoghiyoq, depth 12 inches, are shown in plate 81, figures 15, 16. There are four others, all from Ievoghiyoq at depths of 5, 12, 18 and 30 inches. Their use, if any, is problematical; none of them show any signs of having been worked, the ends of both bones being invariably broken off. Such bones, but with one or both ends sharpened, are known from the Thule culture and are regarded by Mathiassen as gull hooks and bodkins (Mathiassen, 1927, vol. 1, pl. 43, fig. 10; pl. 52, fig. 10).

Plate 82, figures 19 and 20, are two ivory objects, from Ievoghiyoq, depths 22 and 30 inches, the function of which is unknown. They have a short neck or shaft, through which is a transverse perforation with deep grooves leading down to the end. The head is enlarged, and somewhat conical; that of figure 20 has been carved to represent a seal with prominent eyes made of round wooden plugs set in deep pits, the pupils represented by small ivory insets at the center of the plugs.

A similar object has been described from Point Hope (Mathiassen, 1930 a, pl. 13, fig. 9).

Plate 82, figure 21, is an ivory plug from the old section of Gambell, depth 20 inches. It is probably an ornament of some kind, and is similar to one shown in plate 60, figure 7.

Plate 82, figure 23, is an ivory " thimble guard " from house no. 8. It has the shape of a double crescent, like one described by Nelson (pl. 44, fig. 24, p. 110) ; similar forms are also known from the Thule culture (Mathiassen, 1927, vol. 1, pl. 52, fig. 17 ; pl. 63, fig. 6: Mathiassen, 1930 b, pl. 14, fig. 7). Plate 82, figure 24, from Ievoghiyoq, depth 24 inches, may have had a similar function, although this is rather uncertain. It is a thin ivory bar 7.4 cm long, perforated at the middle.

Plate 82, figures 25 and 26, from Seklowaghyaget (purchased) and Ievoghiyoq, depth unknown, respectively, seem to be handles for either drill cords or drag lines, although I do not know that any of this exact form have been described elsewhere.

A distinguishing feature of the Punuk culture in its later phase is the use of ornamental links of ivory. These are found on ulu and drum handles, combs, and other implements, as a part of the same piece of ivory from which the object itself is carved. An example is shown on plate 82, figure 30 (Sek., purchased), which is an ivory ulu handle, of the same type as shown in plate 78, figure 11. The slit for the blade is between 2.5 and 3 mm wide. Plate 82, figure 31, also from Seklowaghyaget (purchased), is a larger link of the same kind, and no doubt used in a similar fashion. Plate 82, figures 32 and 33, are two smaller links, the latter carved to represent a walrus head ; they are from Cape Kialegak and Punuk Island. Figure 34 is a rather crudely carved link pendant with part of another link still remaining ; it comes from the old section of Gambell, depth 8 inches.

Plate 82, figure 29 (from Sek., purchased) is an ivory object of unknown use, with a double link at either end. In the base of the object is a narrow lozenge-shaped socket, which tapers upward and emerges as a narrow rectangular slot on the upper side. The collection contains four other link ornaments, one from Ievoghiyoq, depth 16 inches, the others from Seklowaghyaget, two purchased and one from 12 inches deep.

Plate 82, figures 27 and 28, are two objects with the same general contour and the same kind of socket as figure 29, but lacking the links at the ends. In a general way these objects resemble the guards at the ends of sword hilts from the Scandinavian iron age (Nerman, 1929, p. 65 ff.), although there is nothing else to suggest that they were used in this way.

Small flat square pieces of bone, like the one illustrated in plate 58, figure 15, were also found at the Punuk sites.

From Ievoghiyoq there is a bone ring, made by cutting out the center of the epiphysis of a whale vertebra. According to the Eskimos, it is a rim to the ventilation hole in the front wall of the inner sleeping room.

Plate 82, figure 35, from the old section of Gambell, depth 24 inches, is an ivory trace buckle for a dog harness. It is of the usual modern Alaskan form, with one hole through the lower, somewhat square end, and another, at right angles to it, through the smaller, notched end (Nelson, 1899, pl. 76, figs. 3-5). This is the only example of a trace buckle from any of the old sites at Gambell. Furthermore, the other elements which are invariably associated with dog traction in its known form—swivels, ferrules for the whip handle, and flat bone sled shoes—are likewise missing. Not one of these objects was found at the four older sites which all together yielded over 7,000 specimens. On the other hand, a considerable number of such objects are included in the much smaller quantity of material excavated from recent house ruins and midden deposits of comparable age at Gambell, Punuk Island, and Cape Kialegak. The conclusion is unmistakable that dog traction, insofar as its presence is indicated by the above classes of objects, was unknown to both the Old Bering Sea and Punuk Eskimos, and that it was introduced on St. Lawrence Island only in very recent times, probably not until near the beginning of the nineteenth century.

The small ivory object shown in plate 82, figure 36 (Iev., depth 24 in.), appears to be a harpoon or dart rest for a kayak (cf. Nelson, p. 226, pl. 78, fig. 2). The base is slightly concave and down the center is a longitudinal groove 4 mm wide which opens through a small slot at the back end and through a similar slot at the junction of the curving prong and the base. By means of this slotted groove it was attached to one of the cross lines which extended over the deck of the kayak

Objects of personal adornment.—These are considerably more common in the Punuk than in the Old Bering Sea culture, although the categories are still somewhat limited.

Ivory pendants are found in considerable numbers and in a wide variety of forms. These are illustrated in plate 82, figures 1-13. Some are long, and either straight-sided or thickened at the end (figs. 1-4); some are squarish with a rounded end (fig. 5); some are conical (figs. 6-9); and some deeply grooved (fig. 10). Others are suspended from the middle, and are bilobed (fig. 11), four-lobed (fig. 12), or knobbed at the ends (fig. 13). Provenience of the illustrated specimens is as follows: Plate 82, figure 1, Miyowagh, cut 20, depth 12 inches;

figure 2, Ievoghiyoq, depth 12 inches; figure 3, Miyowagh, cut 1, 12 inches; figure 4, Ievoghiyoq, 28 inches; figure 5, Ievoghiyoq, 22 inches; figure 6, Punuk Island; figure 7, Punuk Island; figure 8, Seklowaghyaget, purchased; figure 9, Miyowagh, cut 20, 12 inches; figure 10, unknown, purchased at Gambell; figure 11, Punuk Island; figure 12, Ievoghiyoq, 24 inches; figure 13, unknown, purchased at Gambell. In addition to these there are two more from Ievoghiyoq, depths 22 and 60 inches.

Plate 82, figures 14 and 15, are two dog tooth pendants perforated at the upper end. They were excavated from the old section of Gambell, depth 32 inches, along with several others. Since none were found at the four older sites, they must be regarded as rather recent on St. Lawrence Island. It should also be noted that perforated bear teeth, which were very scare at the Old Bering Sea sites, were fairly common later.

Ivory brow bands and buttons also occur at the Punuk sites.

Plate 82, figure 16, is an ivory ear ornament inset with small lumps of iron pyrites, held in place by some black sticky substance, now hardened. Of the original eight insets, four remain. At the upper end is a small slot for the suspension cord. This ear ornament comes from the midden on Punuk Island. Plate 82, figure 17, also from the Punuk midden, is an unfinished ear ornament of the same type. The view is of the back side and shows the high ridge from which the hook would have been carved. These two specimens are of particular interest because they represent a type which is common in southwest Alaska, especially on Nunivak Island, but which has not been reported previously from north of the Yukon. Otto W. Geist has also excavated an ear ornament of this kind at Kukuliak, on the north side of St. Lawrence Island (Bunnell, 1934, p. 5).

Plate 82, figures 22 and 18 (from Seklowaghyaget, 22 in., and the old section of Gambell, 16 in., respectively), are probably also ear ornaments, of a different type.

Combs are rather prominent in the Punuk finds, being represented by 13 examples, all of them of ivory (pl. 81, figs. 7-11). There is considerable variation in shape, some with wide handles, like figure 8 others with smaller, thinner handles, like figure 10. The teeth are usually about 2.3 cm long. Figure 8 has unusually short teeth and a crude ornamentation on the handle consisting of straight lines and long alternating spurs. Figure 10 has an ornamental link attached to the handle. The combs were found as follows: Miyowagh, cut 6, depth 20 inches. Ievoghiyoq, depth 12 inches (2) (pl. 81, fig. 10); 22 inches (pl. 81, fig. 9); 28 inches; 30 inches; 34 inches; 36 inches.

purchased (pl. 81, fig. 8). Seklowaghyaget, depth 12 inches, picked up on surface; purchased (pl. 81, fig. 11). Old section of Gambell, 12 inches (pl. 81, fig. 7); 32 inches.

Plate 79, figure 11, is a pair of crude snow goggles from Seklowaghyaget, made from a section of walrus penis bone.

Toys.—From the Punuk sites we have a number of toys, mostly of ivory, but there are also wooden dolls, bows and kayaks, and (from Ievoghiyoq) the small bark figures, single or double, representing whales—all similar to the Old Bering Sea types shown in plate 59, figures 1, 2, 6, 7, 13, 14, 16, 17, 26, 27.

Other Punuk toys of ivory are shown in plate 83. We have here the first appearance of the small ivory bird figures (pl. 83, figs. 7-11) which today are so common on St. Lawrence Island, in northeastern Siberia, and at Bering Strait. They are used by the children in playing a kind of dice game just as among the central Eskimo (Boas, 1888 a, pp. 567-8). They are also very common in the Thule culture (Mathiassen, 1927, vol. 2, pp. 117-118). At Gambell they appear to be restricted to the two latest sites, none having been found at Ievoghiyoq or Miyowagh; the two carved figures of birds found at the Hillside site had evidently a different function. The great numbers of small dogs, bears, foxes, and human figures carved out of ivory, which today are used as toys by the children on St. Lawrence Island, may be somewhat later than the bird figures, as none were excavated at Gambell; however, this might be because of the relatively small amount of work done at the two latest sites. Plate 83, figures 8, 9, and 11 come from Seklowaghyaget, depth 12 inches; the other two were purchased from Eskimos and are said to have been excavated at Seklowaghyaget. A sixth specimen comes from house no. 10.

The three ivory whale figures, plate 83, figures 16-18, are probably not toys but objects of some religious significance. The first is from Ievoghiyoq, depth 8 inches, the other two from houses nos. 9 and 8, respectively. Figures 16 and 17 are carved realistically, but in figure 18 only the tail is represented naturally; it also has a long hollow on the under side; both figures 17 and 18 have a slot just below the tail. There are also several whale figures of wood, carved rather crudely and larger than these.

Two toy sledges and a sledge runner are shown in plate 83, figures 1-3. The runner, from Ievoghiyoq, depth 31 inches, is of the form described above as Punuk type 2. The sledges, both of which were purchased from the Eskimos, have the sides and runners carved in one piece; otherwise they are identical with one from St. Lawrence Island figured by Nelson (fig. 132). Figure 2 is 14.7 cm long; it has round perforations at several places, and rows of small pits, for decoration, on the sides.

The three ivory kayaks, plate 83, figures 4-6, present several features of interest. In the first, from Seklowaghyaget (purchased), the framework at the bow is open and visible, an arrangement which, if it represents the actual conditions, is unique among the Eskimo. Figure 5, from Ievoghiyoq, depth 31 inches, is 6 cm long and shows the rider sitting in the manhole. Back of him is a double seal skin float (cf. the single float on the specimen figured by Nelson—fig. 134). Although the figure of the man is very schematic, it may be that the projection at the head represents a hunting helmet. The base of the kayak is slotted, indicating that it was attached to something as an ornament, rather than used as a child's toy. Figure 6 is from the old section of Gambell, depth 16 inches. It has two pairs of sealskin floats, and a small pit at the center in which the figure of the rider may have been set.

Plate 83, figure 15, is an ivory top from Seklowaghyaget, depth 36 inches; it is oval, with a flat base and low convex upper side. Two ivory weights for spindle buzzes like plate 46, figure 10, were found at Ievoghiyoq, depth 22 inches, and Seklowaghyaget, depth 48 inches.

Plate 83, figure 12, is an ivory doll, and figures 13 and 14 are the heads of two similar dolls. The larger specimen, 19.7 cm long, is armless and legless, with the lower part of the body brought to a blunt point. The features of the face consist of narrow slits for the eyes and mouth; it is from Cape Kialegak. Figure 14 is from Punuk Island and has the features more clearly indicated. Three parallel lines beneath the eyes represent tattooing and the hair is shown knotted at the top of the head. Figure 13, from Seklowaghyaget, purchased, is round-faced; the eyes and mouth are represented by small pits and the nose is carved in low relief.

Textile.—The piece of textile found at a depth of 26 inches in cut 4, northwestern section of Miyowagh, was submitted for examination to Dr. Gene Weltfish, of Columbia University, who makes the following comment:

The textile fragment taken from an Eskimo kitchen-midden on St. Lawrence Island, Alaska, is clearly not intrusive on two counts: On the one hand I know of no modern Eskimo work which is exactly of this kind, though most of it is similar; therefore, while technically congruent with modern Alaskan Eskimo style it is not identical. On the other hand it is not intrusive Russian since it is sufficiently like the native twined basketry and bag work of the whole north west coast of the continent to be indigenous.

The technique of the textile is plain twined, with stitches trending upward to the right, on a double twisted warp. The material appears to be a grass used for both warp and weft and the texture was semi-stiff very much like that of bags of the Klamath-Modoc of northeast California and Oregon, made of tule rush. It is like the Klamath-Modoc twining also in the fact that the warp is double-twisted, a characteristic not found either in the rest of modern work along the coast or in modern Eskimo twining.

There are a few horizontal rows of decorative stitching of an elementary kind, involving the introduction of one dark-colored weft thread instead of the natural.

It is interesting to notice by way of comparison that O. T. Mason, "Aboriginal American Basketry", pp. 397-8, comments on Asiatic twined bags. While the Chukchi example he mentions is like the Bering Strait modern Eskimo work, the wallet from Kamchatka resembles your specimen according to his comment in that it has a coarse hemp cord warp (which would undoubtedly refer to the double-twisted type of warp).

Skeletal Remains

Although careful search was made for early burials on the top and along the slopes of the mountain, no traces of these were found. There are large numbers of recent burials among the rocks on the mountain slope, and it was here for the most part that Dr. Riley D. Moore obtained his extensive collection of skulls and skeletons in 1912. However, neither at Gambell nor elsewhere on St. Lawrence Island have I ever found burials which from the accompanying grave offerings could be identified as of Punuk or Old Bering Sea age. If, as seems probable, the prehistoric St. Lawrence Eskimos followed the usual practice of simply placing the body among the rocks, either on a flat surface or in a natural crevice, it is easy to understand why no skeletal remains of any antiquity have been found, since in this method of burial the bones very soon become scattered and broken. Fortunately, a sufficient number of crania from houses and middens of Punuk age, both at Gambell and the eastern end of the island, have been collected to indicate with some degree of certainty the physical type that was associated with the Punuk culture. The measurements will not be given here as they are to be included in the next issue of Dr. Hrdlička's Catalog of Crania. However, the essential point for the present is that in general they conform to the modern St. Lawrence type, which is mesocephalic.

Unfortunately, the excavations at the oldest sites have yielded very little skeletal material, only two incomplete skeletons and a detached skull found at Miyowagh. Of these, the skeleton found in cut 9 a, back of house no. 3, had a skull that was mesocephalic. The other two skulls, found in the Old Bering Sea house at Miyowagh (house no. 4), were extremely dolichocephalic, falling in this respect beyond the range of normal variation for modern St. Lawrence crania. Though it would not be proper to draw any far-reaching conclusions on the basis of these two skulls alone, they represent nevertheless the most ancient Eskimo skeletal remains that have yet been found, and the fact that they are markedly long-headed is something to be considered by any theory which seeks to trace the origin and spread of the Eskimo on the basis of physical characters.

Animal Remains from the Five Sites

Animal bones were found in such abundance in the middens and house ruins that it was impossible to preserve all of them. Consequently, only representative samples from each cut were collected. The order of occurrence of the more easily recognizable forms, such as whale, walrus, seal and dog bones, were observed at the time and samples preserved, but the smaller and more questionable mammal bones were collected as found. Dr. Remington Kellogg, assistant curator of mammals, United States National Museum, has kindly examined and identified the mammal bones as follows:

From the Hillside site: Ringed seal (*Phoca hispida*); harbor or hair seal (*Phoca richardii pribilofensis*); bearded seal (*Erignathus barbatus nauticus*); walrus (*Odobenus divergens*); dog (*Canis familiaris*); polar bear (*Thalarctos maritimus*); fox (*Vulpes alascensis*); beluga (*Delphinopterus leucas*); and whale (represented by baleen). Of the above the seal, walrus, and dog bones are greatly in the majority, the others being relatively scarce.

At Miyowagh all of the above forms are represented, and in the same relative proportions, but in addition there are bones of the bowhead whale (*Balaena mysticetus*); the humpback whale (*Megaptera novae-angliae*); the common finback whale (*Balaenoptera physalus*); the ground squirrel (*Citellus lyratus*), and the field mouse (*Microtus innuitus innuitus*), both probably intrusive; the varying hare (*Lepus americanus dalli*), rare; a few reindeer or caribou bones and pieces of antler; and the horn of a mountain sheep (*Ovis*, sp). The hare, caribou, and mountain sheep are not indigenous on St. Lawrence Island and hence were no doubt brought over from Siberia as meat used for food on the voyage.

From Ievoghiyoq we have the dog and the same species of marine mammals, in abundance, in addition to the fox. The absence of other forms is probably due to accidental selection.

The Seklowaghyaget midden contained more gravel and less refuse than the other middens, and as a result of this condition and the relatively small amount of digging done there, not many mammal bones were collected. Only the following species are recorded: Walrus, ringed seal, harbor seal, dog and whale.

The old section of Gambell and the more recent house ruins (no. 8, 9, and 10) yielded walrus, seal, dog, whale, fox, and polar bear bones. From the most recent house ruin (no. 10) came the cervical vertebra of a horse.

Comparison of the mammal remains from the various sites shows that the Old Bering Sea and Punuk Eskimos hunted the same species as do the present day Eskimos. A possible exception is the right whale, for the bones of this mammal were not found at the Hillside site, although baleen was present. The abundance of walrus bones in all of the middens and the great number of implements made of ivory show that the walrus has always held a position of prime importance in the economy of the St. Lawrence Eskimos. Considering that the walrus was the principal source of food, of oil for heating, cooking, and illumination, and of the skins used for lines, thongs, and boat coverings, it might seem that this animal, if any, would have been the object of ceremonial observances designed to propitiate the spirits of the dead animals in order to insure good hunting in the future. We have, of course, no means of knowing definitely whether or not there were ceremonial practices in connection with the walrus in prehistoric times. It seems significant, however, that walrus skulls were found in large numbers at all of the old sites, whereas seal skulls were exceedingly rare, evidently having been disposed of in some particular manner—no doubt thrown into the sea—in accordance with a ceremonial custom still observed by the St. Lawrence and other Eskimos. It is evident from the dried seal muzzles tied together with baleen thongs and the bearded seal skull with suspension cord of baleen found in cuts 16 and 6 at Miyowagh that ceremonial practices, much like those of today, were observed by the Old Bering Sea Eskimos in connection with the disposal of seal remains. On the whole, it would seem that just as today, the walrus, in spite of its economic importance, was accorded scant respect as compared with the seal.

Seal bones, however, were found in large numbers at all of the sites, showing that as a food animal it was second only to the walrus.

We found no evidence—such as burned or cracked scapulae—to indicate that scapulimancy had ever been practiced.

In connection with the dog bones, which were also abundant, it is of interest to observe that Gerrit S. Miller, Jr. and Dr. Kellogg think that the skulls from the Hillside site and the southeastern section of Miyowagh represent a different breed from those found at the

Punuk and later sites. The older skulls show a remarkable uniformity, being somewhat smaller than the later ones and possessing a characteristic beveling or deep longitudinal depression along the frontal sinus. The skulls from Ievoghiyoq (also those from Punuk Island and Cape Kialegak), in addition to being larger, are more variable, with a relatively smooth frontal region more like that of the modern St. Lawrence dogs. It should also be noted that many of the dog skulls, particularly those from the Old Bering Sea levels, had a large opening in the parietal region, evidently made for the removal of the brain, which must have been eaten.

The several thousand bird bones from the Gambell sites have been carefully studied by Dr. Herbert Friedmann, curator of birds, United States National Museum, who has published a separate report upon them (Friedmann, 1934). The collection was found to include the bones of 32 species, two of which, the red-legged kittiwake (*Rissa brevirostris*) and Kittlitz's murrelet (*Brachyrhamphus brevirostris*), represented additions to the known avifauna of the island.

As to the relative abundance of the various species, Dr. Friedmann reports as follows:

> The species most abundantly represented in the collection is Pallas's murre. It is obviously the most important single bird species to the Eskimo, and it is obvious from the enormous number of bones, that the species was as abundant in the past as it is in the present.
>
> The other birds commonly used for food include the crested and the paroquet auklets, the Pacific and king eiders, and, strangely enough, the pelagic cormorant. One of the surprises was the paucity of goose bones, especially of the emperor goose. Pigeon guillemot, old-squaw, long-tailed jaeger, red-faced cormorant, and short-tailed albatross come next in descending order of frequency, and after them come a large number of species, present in varying quantities. [Friedmann, 1934, p. 84.]

Table 4, compiled from Dr. Friedmann's paper, shows the occurrence of the different species according to site. The relative abundance of the various species, as shown on the table, may be taken as a fair index of the Eskimos' selection for food purposes of the birds most desired—and most readily obtained—from among those frequenting the western end of the island. It is of interest in this connection to observe that the bird bone collection from Cape Kialegak, at the opposite end of the island, though not as large as that obtained at Gambell, included the following species which were not found at Gambell: the whistling swan, cackling goose, black brant, American pintail, spectacled eider, white-winged scoter, surf scoter, American scoter, merganser, red-breasted merganser, pomarine jaeger. Furthermore, the fact that the emperor and the white fronted geese, the old squaw, the Steller, Pacific, and King eiders, and the paroquet auklet were all more abundantly represented at Kialegak than at Gambell would indicate that these species also were more common at the eastern than at the western end of the island.

It should be recognized that the accidental selection involved in collecting the bones might be responsible in some degree for the conditions shown in table 4; and that many of the gaps would certainly be filled if a still larger collection of bones were available. This would apply particularly to Seklowaghyaget, where material of all kinds was rather scarce and where relatively little excavating was done. However, there is no reason to believe that the relative occurrence of the various forms would be materially affected.

One of the most striking facts to appear from the table is the large number of species and the quantity of bones from Ievoghiyoq, indicating that birds were a more important item of food during the Punuk period than at any other time. It will also be observed from table 4 that there was always a strong preference for sea birds. This is shown by the fact that the murre, the tufted puffin, the pelagic cormorant, the long-tailed jaeger, and even such a strong flying bird as the albatross were all obtained in greater numbers than either the loons or the geese. The waders, the small land birds, the raven, and the owl are among the local forms which seem not to have been utilized at all for food.

Samples of fish bones collected from the five sites were all identified by E. D. Reid, of the division of fishes, United States National Museum, as those of the cod, genus *Gadus*.

Barnacle shells collected from all of the sites, except Seklowaghyaget, were identified by Dr. H. A. Pilsbry, of the Philadelphia Academy of Sciences, as belonging to the species *Coronula diadema* (L.), the whale barnacle, and *Balanus balanus* (L.), a north Atlantic form which is also found in Bering Sea and which commonly grows on molluscan shells.

Harald A. Rehder, assistant curator, division of mollusks, United States National Museum, has identified the molluscan remains as follows: *Thais saxicola* Val., the West Coast rock purple; *Volutopsis* sp.; *Mytilus edulis* L., the edible mussel; *Pecten islandicus* Müll., the northern scallop; *Serripes laperousei* Desh., one of the cockles; *Macoma middendorffi* Dall; *Spisula polynyma alaskana* Dall, the "Alaskan" surf clam; and *Saxicava pholadis* L., one of the rockborers. Most of the forms were represented at all of the sites, except Seklowaghyaget, but in view of the relatively small size of the sample, the absence of a particular species is of no significance.

TABLE 4

Species	Hillside site	Miyowagh	Ievoghiyoq	Seklowaghyaget	Old section of Gambell
Yellow-billed loon	....	×	×	....	....
Pacific loon	....	....	×	....	×
Red-throated loon	....	×	×	×	....
Short-tailed albatross	××	××	××	×	×
Slender-billed shearwater	....	×	×	....	....
Rodgers fulmar	....	....	×	....	....
Pelagic cormorant	×	××	×××	××	×
Red-faced cormorant	×	....	××	....	....
Emperor goose	....	....	....	×	....
White-fronted goose	....	....	×	....	....
Greater scaup duck	....	....	×	....	....
Old squaw	....	××	×	....	×
Western harlequin duck	....	....	××	×	....
Steller's eider	×	....	....	....	....
Pacific eider	....	××	×××	....	××
King eider	×	××	××	××	....
Little brown crane	....	××	××	....	....
Parasitic jaeger	×	×	....	....	....
Long-tailed jaeger	×	××	×××	....	××
Glaucous gull	×	×	×	....	....
Glaucous-winged gull	....	×	×	....	×
Short-billed gull	....	....	××	....	....
Pacific kittiwake	×	×	×××	....	....
Red-legged kittiwake	....	....	×	....	....
Pallas's murre	×××	×××	×××	××	×××
Pigeon guillemot	××	××	××	....	××
Kittlitz's murrelet	....	....	×	....	....
Paroquet auklet	....	××	××	××	××
Crested auklet	××	×××	×××	×	××
Least auklet	....	×	×	....	×
Horned puffin	....	×	×	....	....
Tufted puffin	××	××	××	....	××

The number of ×'s indicate the relative abundance of species.

RÉSUMÉ

The excavations at Gambell have enabled us to trace in some detail a long succession of changes through which the culture of the St. Lawrence Eskimos has passed. They have revealed a chronological cross-section of Eskimo culture which will be of value in interpreting archeological materials from other parts of the Island even though the full story cannot be known until detailed information from other old sites is available to show the local variations in culture which must surely have occurred in a region as large and as well populated as St. Lawrence Island was in prehistoric times. The results of the excavations at Kukuliak will be of particular value in this connection; they will provide a check on the Gambell finds and also information on a very large site which already has shown some evidence of minor variations from the Gambell pattern. However, the conditions at

Gambell in several respects were especially propitious for the elucidation of cultural sequences. For though the combined depths of the five middens amounted to more than 24 feet, the fact that the middens were separated enabled us in one season and in spite of the frozen ground to excavate to the bottom of each of them at a number of places; whereas this would not have been possible if they had been superimposed, forming a huge accumulation such as the 16- or 20-foot middens on Punuk Island and at Kukuliak. Furthermore, the middens at Gambell represented villages of different ages which had been abandoned one after the other; their positions in relation to the old shore lines offered preliminary evidence of this succession, which was fully borne out by the material excavated from them. Most fortunate of all, however, was the fact that two of the middens proved to be pure sites. The discovery of the Hillside site, the presence of which had been unknown to the local Eskimos, removed one of the principal desiderata of Alaskan archeology, for it revealed the first pure site of the Old Bering Sea culture, a site that had been established and abandoned during the period in which this old Eskimo culture was flourishing around Bering Strait. The larger site, Miyowagh, provided further and fuller information concerning the Old Bering Sea culture and also of the transitional stage that carried it into the Punuk. The next site, Ievoghiyoq, was found to be a pure site of the fully developed Punuk culture, with no trace of Old Bering Sea art or harpoon heads. Seklowaghyaget seems to have been established about the same time as Ievoghiyoq, but it was occupied for a longer period, having been abandoned probably around 200 years ago. The last site, the old section of Gambell, represents a still later stage and brings us up to the nineteenth century.

It seems natural to suppose that the first permanent settlement on St. Lawrence Island should have been established here at the northwestern extremity of the island, the point of land that most closely approaches the Siberian shore, only 40 miles away. We may therefore visualize the first of the St. Lawrence Eskimos as coming over in their umiaks from somewhere in the vicinity of Indian Point and establishing their village—the Hillside site—on the western slope of the Gambell cape. It would seem safe to assume, however, that at that time the sea was much nearer the foot of the plateau and that the present extensive gravel spit had not been fully formed; for a village would hardly have been established at this site if the sea had been then, as now, three-quarters of a mile and a half a mile away.

There were many natural advantages here for a permanent settlement: both the west and north shores of the island for hunting and fishing; an abundance of game—walrus, seal, and whales, although the latter may not have been actually hunted; nearby cliffs which were the breeding places of countless numbers of auklets, murres, guillemots, puffins, and cormorants, valuable alike for food and for clothing; and back of the plateau, low stretches of tundra with lakes and lagoons where other birds such as geese, ducks, swans, and loons could be captured.

The Old Bering Sea Eskimos at the Hillside site and those who first settled at Miyowagh lived in small, rectangular, stone-floored houses with wooden walls and apparently wooden roofs, and long, narrow stone-floored entrance passages. Light and heat were provided by round earthenware lamps, and food was cooked in deep, round pots of the same material. These Eskimos were adept at stone chipping, and although they also made implements of rubbed slate, many of their knives, scrapers, arrow points, and gravers were of chipped stone. They apparently had no knowledge of dog traction, their only sledge being a small, low form with heavy ivory runners, used no doubt for hauling umiaks and loads of meat over the ice. They subsisted chiefly on sea mammals; the bones found in the middens show that the principal food animals were the small seals, the walrus, bearded seals, and (at Miyowagh) whales; a great many dog bones were also found, and at least the brains of the dogs were eaten, for most of the skulls had a large opening in one side, evidently made for the removal of the brain. In contrast to the large numbers of walrus skulls, there were very few seal skulls in the middens, showing that these had not been merely cast aside but disposed of in some particular manner, perhaps thrown back into the sea. The finding of a seal skull with a baleen suspension cord attached to the jaw and of a number of seal muzzles strung together on baleen thongs indicates ceremonial observances connected with these animals.

The seals and walrus were captured with harpoons, and the seal skin float was used. Whales do not seem to have been hunted during the Old Bering Sea period, for whaling harpoon heads are absent, though the quantity of baleen, especially at Miyowagh, shows that they were obtained in some way. Baleen was put to a great variety of uses; from it were made toboggans, fishing lines, lashings of many kinds, ice scoops, pails, toys, and ornaments. Ivory was abundant and was used in the manufacture of many types of implements, weapons and utensils which in other parts of the Eskimo region would be made of bone. That umiaks and kayaks were used is shown by the presence of paddles, a few frame pieces, and a number of toys. Ice creepers were used to prevent slipping when walking over the sea ice. Birds were caught in great numbers to judge from the quantities of bones in the middens; these were mostly of sea birds, such as murres, cormorants, auklets, gulls, ducks, etc. and of other large birds such as loons, geese, and cranes. The bow and arrow, and the bird dart with side prongs, used with a throwing board, seem to have been the principal means of capturing birds, though baleen snares were doubtless employed also; the bola was not used. Fishing was also an occupation of some importance if we may judge from the number of ivory sinkers; but, curiously enough, hooks were not found, these probably having been a sharp sliver of bone fastened to a shaft.

The tools used by the Old Bering Sea Eskimos were stone-bladed knives of various kinds, stone gravers, side scrapers, and end scrapers, adzes, bow drills, reamers, and wedges. Heavy ivory picks and mattocks made of whale ribs were used for digging in the frozen ground; snow shovels were made of walrus scapulae. Household utensils included baleen pails with wooden bottoms and handles, wooden bowls, ladles, spoons, ivory fat scrapers, earthenware lamps and cooking pots.

Ornaments were rather uncommon, consisting only of brow bands, buckles, gorgets, and others of uncertain identification. Children's toys were made of wood, bark, baleen, ivory, and bone. A striking feature of the Old Bering Sea culture is the great number of objects, even those of a utilitarian nature, which are beautifully ornamented with the art characteristic of the period. During the earlier stage of the occupancy of Miyowagh this art reached its highest stage of development. Later, as the village expanded toward the north and west, changes came about in art, harpoon heads, and other types of implements. These changes are clearly revealed by the objects excavated from the northwestern section of the midden (except from the very bottom) and at some places in the upper levels of the older, southeastern section. It was these changes, which with regard to art, were all in the direction of simplification or degeneration, that inaugurated the Punuk stage.

We may assume that during the time Miyowagh was occupied, the low gravel foreland was taking its present shape, as one beach line after another was formed by the scouring action of the ice pack and of storm waves along the north shore. When, after a considerable period, the sea had receded so far as to leave Miyowagh more than a quarter of a mile inland from the north shore, the third village, Ievoghiyoq, was established further out on the gravel spit, and the fourth village, Seklowaghyaget, may have been settled at about the same time.

At Ievoghiyoq, and also at Miyowagh during its latest stage of occupancy, life continued on much the same basis as before. Houses were larger but were constructed on the same plan; earthenware lamps and cooking pots were apparently unchanged and the same was true of a number of implement types such as walrus scapula shovels; baleen pails; picks; mattocks; wedges; meat hooks; some forms of knives, arrows, and harpoon heads; drills and drill rests; reamers; awls; ulus.

There were other features, however, which underwent modification: art; harpoon heads and parts; bird darts; ice creepers; arrows; fish line sinkers; knives; adzes; "winged" objects; needle cases; sledge runners; etc., and implements of chipped stone were almost entirely replaced by rubbed slate. On the other hand, many new types of implements appeared which should probably be explained as having been brought to the island by newcomers from the Siberian mainland. These include whaling harpoon heads; blunt bird arrows; bird bolas; wrist guards; bow braces and sinew twisters for the sinew-backed bow; slat armor; sealing scratchers; fishhooks; heavy ivory net sinkers; bone and ivory daggers; iron-pointed engraving tools; many ornaments and toys. At this time came also the rectangular houses with stone and bone walls. The modern underground houses, with walls of vertically placed timbers and whale bones and with two or more low sleeping platforms, along with the modern types of pottery lamps and cooking pots, seem to have been introduced at a still later time.

Finally, we have a number of cultural elements which are characteristic of the present day St. Lawrence Eskimos but which were not found at any of the old sites, although the absence of some of them at the old section of Gambell is no doubt due to the small amount of excavating done there. These elements, which must have been introduced from Siberia within the past 200 years, include the following: Built-up sledge with flat bone shoes; swivels and trace buckles for dog harness; ferrules for end of whip handle; wooden sealing retriever with iron prongs; ivory blocks for umiak sail lines; small ivory bird, mammal, and human figures, used as toys; torsion trap for foxes; net gauges; pipes; beads; long, barbless arrowheads, triangular in cross-section; iron lance blades; curved bone snow beaters for clothing; two-handed skin scraper with small stone or iron blade at center; grass combs with circular row of teeth; and snow shoes.

Although the order of the establishment and abandonment of the several old Gambell sites may safely be assumed to have been as outlined above, there seems at present no way of determining their actual ages. Sections of timbers from the sites were preserved for study, but it seems somewhat doubtful whether the methods of dendrochronology can be applied successfully to Arctic driftwood. Physiographic changes have evidently occurred since the time of the Old Bering Sea and Punuk cultures: there has been an extensive building up of the gravel foreland at Gambell as one shore line after another was deposited by the action of sea ice and storm waves; while at the opposite end of the Island, and especially on Punuk Island, there has been a considerable subsidence of the shore line or encroachment of the sea so that the earliest houses of the Punuk period, at the base of the midden, now lie 6 feet below the present beach over which storm waves extend several times each summer. However, little is known as to the rate of occurrence of shore-line changes of this nature in northern latitudes, so that they throw no light upon the ages of the sites. For the present, therefore, we must be content with a relative chronology; whatever deductions may be made as to the age of the Old Bering Sea culture must be based on comparative analysis of its elements.

In the following pages we shall trace the distribution of the more important elements of the Old Bering Sea and Punuk cultures in an attempt to determine the relationships of these prehistoric phases of western Eskimo culture to that of other Eskimo groups, ancient and modern, and of neighboring aboriginal peoples and cultures in America and Asia. With regard to many of the elements, our task is facilitated by the recent comprehensive studies of Mathiassen and Birket-Smith, which treat fully of the distribution of the individual elements of the Thule and Caribou Eskimo cultures. It will be unnecessary therefore to give an exhaustive account of the distribution of many of the simpler common Eskimo elements that are found in the Old Bering Sea and Punuk cultures. We will be concerned mainly in analysing those elements which are especially characteristic of the two cultures and in noting the particular forms in which the more widespread elements are here exhibited.

COMPARATIVE ANALYSIS

Houses

One of the most important aspects of Arctic ethnology is the problem of the origin of the various forms of Eskimo dwellings, their relationships one to another and to those of aboriginal peoples in other parts of America and Asia. The question has been discussed by a number of writers, and various theories have been advanced, none of which, however, has provided a satisfactory explanation of the conditions known to exist. That a certain amount of confusion should be observed in the theoretical discussions involving Alaskan Eskimo houses is perhaps natural, for with the exception of the Point Barrow and Mackenzie types, there are few adequate descriptions of the houses in this region.

In 1927, while making a reconnaissance of the Alaskan coast from Bristol Bay to the mouth of the Yukon, I was able to obtain detailed information, including photographs and measurements, on the houses in this area, where dwell the most primitive group of Eskimos remaining in Alaska. This is particularly true of Nunivak Island and the adjacent mainland; in this isolated region the underground houses, like many other features of native culture, have been unaffected by contact with civilization. In the two succeeding years I examined the coast to the northward and obtained information on house types on St. Lawrence Island, at Bering Strait, and at Point Hope. It is not my intention to enter here into a detailed discussion of the Eskimo houses of southwest Alaska, but since it is essential that their relationship to those of northern Alaska be understood, a brief summary and comparison will be required.

It is essential first of all to recognize that the Eskimo houses south of Bering Strait differ fundamentally from those to the northward. The failure to recognize this distinction on the part of most of those who have discussed the problem of Eskimo houses seems to be due mainly to their reliance on the very general and sometimes misleading statements of Petroff, rather than on the more explicit descriptions given by Sagoskin, Nelson, and Gordon.

Another important fact, which has not been sufficiently noted heretofore, is that the ordinary dwellings in this region differ in certain specific respects from the ceremonial houses or "kashims." Thalbitzer has made a careful study of the ceremonial house among the Eskimo, tracing its distribution from the fully developed stage in Alaska to the more attenuated forms found in the Central regions and Greenland (1925, pp. 236-255). Architecturally, these northern forms of the ceremonial house show little interrelation, the connection being primarily one of function. There is, however, a rather striking agreement in architectural detail as well as in function between the kashims of the Briston Bay-Yukon region of Alaska and the kivas or ceremonial rooms of the Pueblo Indians of the Southwest. This agreement consists of a high cribbed or vaulted roof, a central fire pit, a ventilator shaft extending from the fire pit to the outside, and a low platform or bench built along the walls. Except for the platform, the other features are common to the ceremonial structures in both regions but are lacking in the dwellings. I will not discuss here the possible significance of these resemblances as the question would not be entirely germane to the present inquiry since the ceremonial house was probably not an original feature of Eskimo culture. At a later time, however, I hope to be able to discuss the wider aspects of this problem, in connection with a more detailed study of Alaskan houses in relation to those of other American and Asiatic tribes.

Although there are minor variations from village to village, the houses in southwest Alaska are fundamentally of one general type; it will be sufficient for our present purpose to describe briefly a house on Nunivak Island which may be regarded as a typical unmodified example of the Eskimo house of this region.

This house (see text fig. 25) is entered through a sloping rectangular opening into a very small anteroom, the sides of which are formed of two upright whale skulls spanned by short timbers. This leads directly into an inner connecting room, the floor of which is 16 inches lower. This room is 6 feet wide and 10 feet long, and the roof slopes from a height of about 5 feet at the outer end to less than 3 feet at the rear. The roof is supported by a single sloping timber which rests at the outer end on a cross piece supported by two small uprights and at the inner end on a lower cross beam. Against this center beam small timbers are leaned tentlike with their lower ends behind logs laid at the ground level. The entrance room is connected with the inner living room by a sunken passage two and one-half feet lower than the floor of the entrance. This passage is 6 feet long and about 40 inches wide and, where it is spanned by the lower wall beams, is less than 3 feet deep, making it necessary to enter on hands and knees. The sunken passage extends about two and one-half feet into the inner room; the latter is about 10 feet square and is sunk into the ground to a depth of about $2\frac{1}{2}$ feet. Along three sides of the room is a bench or platform between 3 and 4 feet wide and 1 foot above the floor. It was made by leaving a bank of earth when the floor was excavated an additional foot. On the earthern floor against the bench opposite the entrance is a fireplace about 2 feet square enclosed by thin stone slabs. Along the outer edges of the bench are placed logs to hold in place the bedding and other household equipment. On the two sides parallel to the entrance the bench is used as a sleeping place; at the rear it is used for storage.

The walls are built of small driftwood logs leaning inward at about a 45° angle, the lower ends being held behind larger logs that lie on the original ground level about 16 inches above the bench. The upper ends of the wall pieces rest against cross beams (the lowermost members of the roof) which are supported by four upright logs that

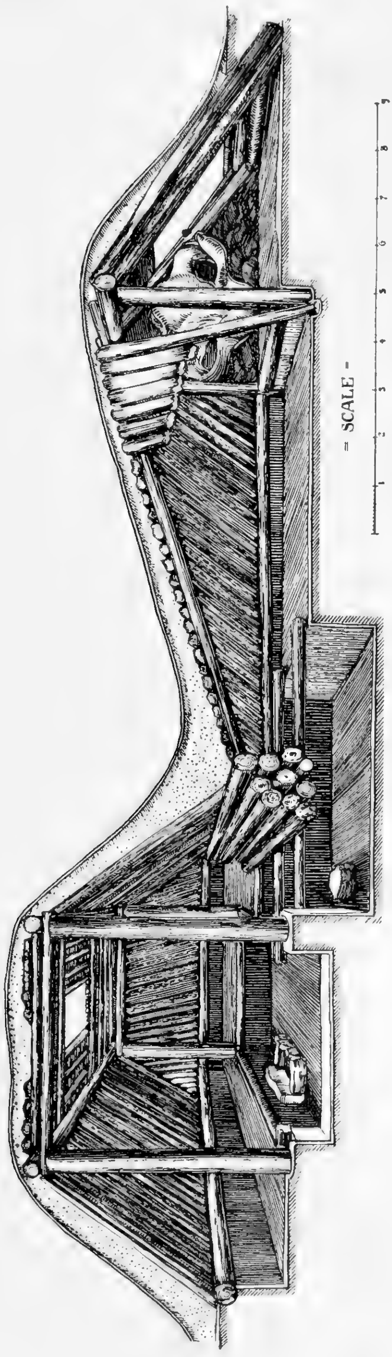


FIG. 25.—Cross-section of an Eskimo house on Nunivak Island.

rise from the floor near the outer edge of the platform. Over the first horizontal roof beams are laid smaller logs, then three more layers, which bring the roof to the top, where an opening 16 by 20 inches wide is left.

At Norton Sound we find a blending of the southwest and north Alaskan house types. Thus at Rocky Point, near Golovin Bay, Nelson found houses with small square anterooms, used for storage, which were entered from above by means of a ladder (Nelson, 1899, pp. 252-254), a form of entrance which is characteristic of the Arctic coast. From Nelson's description these Norton Sound houses seem to have had a single high sleeping platform at the rear like those north of Bering Strait, in contrast to the low platforms along two or three sides which are always found south of Norton Sound. However, in Sagoskin's earlier account of Norton Sound dwellings we have a specific reference to the latter type of platform (Erman, 1848, pp. 536-537). Norton Sound, therefore, marks the northern limit of the low sleeping platform which extends along two or more sides of the room, as it does the southern limit of the single rear platform.

Nelson does not describe the manner in which the roofs of these houses were constructed, although his plan of the Cape Nome house (fig. 82) seems to indicate a double slant as on the more northern houses. Fortunately, however, we have a description by Sagoskin of the roof structure of Norton Sound houses, from which it is seen that some, at least, were cribbed or vaulted in exactly the same manner as those found to the southward (Erman, 1848, p. 536).

The excavations at Gambell have shown that Eskimo houses on St. Lawrence Island have in the past undergone numerous and far-reaching changes. These have evidently come about both through the modification or evolution of local forms and the importation of new forms which either replaced or were employed in conjunction with those already existing.

Beginning with the earliest forms, the sequence of house types that could be distinguished at Gambell may be summarized as follows:

(1) Houses of the Old Bering Sea period, small, square to rectangular; semisubterranean; stone floors; walls of horizontally laid small timbers with occasional whale jaws, held in place by wood and bone stakes; form of roof unknown; long entrance passage lower than floor of house, with stone floor and walls and timbered roof. (Pls. 5, 9; text fig. 3.)

(1 a) A modification of the Old Bering Sea house, coming into use during the early stages of the succeeding Punuk period; similar in all essential features to the earlier form but almost twice as large;

roof of timbers. (Pl. 8, figs. 3, 4; pl. 9, fig. 2; pl. 61, figs. 2-4; pl. 62, figs. 1, 2; text fig. 11, the larger house; and text fig. 20.)

(2) A house of different type, belonging apparently to a later stage of the Punuk; semisubterranean; square to rectangular; stone floor; walls made of stones, walrus skulls and whale bones instead of timbers; form of roof unknown, probably of skins; entrance passage narrower and either lower than or at same level as floor of house; passage roofed with whale ribs or stones; a circular enlargement of or annex to the passage. (Pl. 62, figs. 3, 4; pl. 63, figs. 2-5; pl. 64, fig. 1, text figs. 12, 19, 21, 22.)

(2 a) A modification of the preceding form with walls entirely of stones and mostly above ground; no entrance passage; an inner stone wall forming a rectangular partition; roof structure sometimes of whale jaws; probably covered with walrus hides; apparently a summer dwelling. (Pl. 64, fig. 5.)

(3) A house differing in certain fundamental features from those preceding it; introduced during the Punuk period and continued in use up to 40 or 50 years ago; semisubterranean; square to rectangular; floor of neatly fitted hewed planks or logs; walls of small timbers and whale jaws placed on end and leaning slightly inward; low, wide sleeping platform along two or three sides; two to six heavy uprights rising from floor near the center supporting two or three large whale jaws, placed parallel, as roof beams; center part of roof flat, lower parts sloping, all covered with turf; small ventilator of whale vertebra; long narrow entrance passage at same level as house, sometimes turning abruptly, lined and roofed with timbers, sometimes having a stone floor; small wood and whale bone shelter over end of passage. (Pl. 64, fig. 2; pl. 2, fig. 3; pl. 3, fig. 4; Nelson, fig. 87.)

(4) The modern St. Lawrence winter house, octagonal, built on the surface; framework of wood, roof of split walrus hides; inner sleeping room; introduced from Siberia probably in the eighteenth century.

(4 a) The summer shelter, with light wooden frame covered with walrus hides or canvas; small inner sleeping room.

At Bering Strait we find a very different type of house from those which prevail to the southward. The largest Eskimo village in the vicinity of Bering Strait, on the Alaskan side, is at Cape Prince of Wales, but most of the houses there are so modified as to be no longer good examples of the original type. However, the few remaining underground houses at Wales, some of which are still occupied, are identical with the well preserved ruins at the abandoned village of Metlatavik, 22 miles to the northward, at which place I carried on excavations in 1928. The following description of the Metlatavik house may therefore be taken as applying also to Wales and the American side of Bering Strait generally.

The Metlatavik houses differ in several important respects from those below Bering Strait, principally in having a more elaborate entrance room, a different form of sleeping platform and roof, and in the lack of separate upright roof supports. Text figure 26 shows the outline of the best preserved house at Metlatavik. There are two entrances to the house, both opening into the entrance chamber (A),

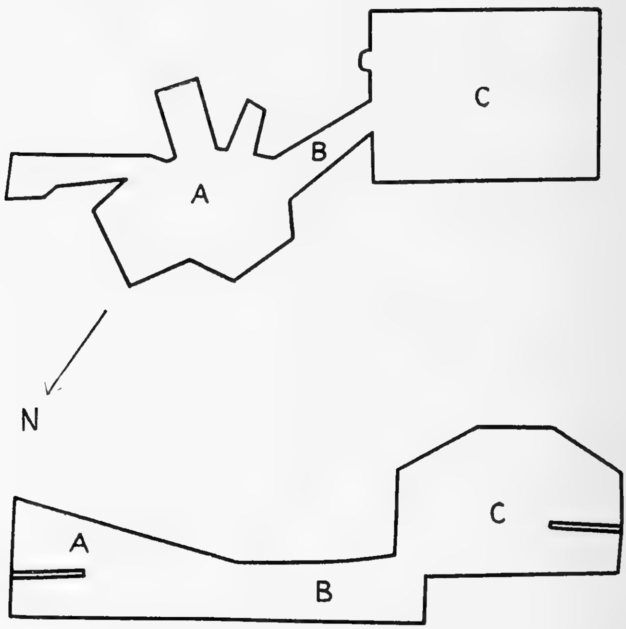


FIG. 26.—Outline of floor plan and profile of Eskimo house at Metlatavik, Bering Strait.

which is very irregular in shape. The main entrance is through the top of a passage 12½ feet long, 4 feet 10 inches wide, and 4 feet 3 inches high, lined with split timbers. The floor of the passage is 14 inches higher than the floor of the entrance room, which is covered with heavy planks. The walls of the entrance room are of split logs, leaning slightly inward on all sides. The roof is 5 feet 9 inches high at the center and is held up by two cross beams which are supported by uprights. Over the two cross beams lie the timbers forming the flat central portion of the roof; from this the roof of the large alcove at the N.-NE. end slopes upward. In the top of this roof is a second entrance, through which descent is made by means of a short notched log to a platform used for storage purposes, 4 feet above the floor and extending the length of the alcove. There is a similar alcove just beyond, on the west side, the roof of which slopes directly to the floor at about a 45° angle. Opposite are two narrow recesses, one 5 feet long by 2 feet wide and the other 6 feet 2 inches long and 3 feet 7 inches wide; the floors of these recesses are 14 inches above the floor of the entrance room. In the top of the larger recess is an opening 26 inches long by 21 inches wide, which might have served as a third entrance but which was more likely a smoke hole since such annexes were commonly used as cooking rooms. The various entrances, passages and alcoves with their different floor levels and roof slopes give to this entrance room a more irregular appearance than is customary, though the other houses at Metlatavik also have a few alcoves and deep, narrow storage recesses.

Connecting the entrance room with the inner living room is a passage (B) 10 feet 9 inches long and 2 feet 4 inches wide. The floor level of the passage and entrance room is 2 feet lower than that of the inner room. Where the passage opens into the inner room it is only 23 inches wide and 21 inches high, just large enough for an average-sized man to squeeze through.

The inner or dwelling room (C) is 17 feet 5 inches long and 11 feet 3 inches wide. The floor and walls are of heavy hewed planks. The roof construction differs markedly from that of the St. Lawrence, Nunivak, and other Alaskan houses south of Norton Sound. There are no separate upright supports, but instead the roof is gabled, being supported by two pairs of horizontal beams 5 feet apart extending across the width of the room, their ends resting on the tops of the upright wall pieces. The particular wall uprights which support the roof beams are at the center of the NW. and SE. walls and are higher than the other wall timbers. The NE. and SW. sections of the roof, consisting of small logs, are thus made to slope downward, the lower ends of the logs resting on the tops of the wall pieces, and the upper ends on the horizontal transverse roof beams. The central portion of the roof is flat, consisting of small split logs laid across the roof beams. At the center is an opening 28 by 24 inches for light and ventilation.

Across the back end of the room is a single wide sleeping platform 3 feet 2 inches above the floor and extending 5 feet 7 inches from the wall. It is constructed of heavy planks laid lengthwise across the room and is supported by two logs in addition to cleats at the ends.

At Metlatavik we leave behind the type of house that prevails between Bering Strait and Bristol Bay, a house in which there was a slightly domed roof supported usually by uprights, and with low sleeping platforms along the walls. Instead, the inner room of the Metlatavik house approaches closely the Point Barrow type with roof supported by beams extending from wall to wall and sloping downward at front and rear; and the sleeping platform, instead of running along the three sides of the house, is single as at Point Barrow, extending out from the back wall.

The Metlatavik entrance room, which seems to differ from those known elsewhere, is, strangely enough, similar in certain respects to another Arctic form of dwelling, the Mackenzie house. These resemblances are: the irregular shape of the floor plan; central part of roof supported by four uprights; alcoves with sloping roofs and floors higher than that of the central floor space. The Metlatavik house thus seems to show, in somewhat modified form, a combination of the features characteristic of the two types of houses of the Western Arctic, those of the Point Barrow and Mackenzie regions.

Kotzebue describes houses at Shishmareff Inlet, between Metlatavik and Kotzebue Sound, which were also of the Metlatavik type (1821, pp. 199-201); and Simpson (1875, p. 258) says that small houses "with two recesses opposite each other, and raised about a foot above the middle space, are very common on the shores of Kotzebue Sound."

Charles Brower, the trader at Barrow, who some 45 years ago lived at Point Hope, has informed me that the old houses there also were practically identical with the Metlatavik type.

For the houses at Point Barrow we have the detailed descriptions of Simpson and Murdoch. The houses were entered through a low underground passage 25 feet long, at the outer end of which was a ladder or blocks of wood for steps. Opening from the passage on both sides were several small chambers or recesses used for cooking and storage. The passage enters the inner room through a round opening in the floor, which is covered with heavy planks. There is a single roof beam stretching across the room somewhat back of the center and resting on the upper ends of upright wall pieces which are higher than those in the front and rear walls. The roof is thus given a double and unequal slant, the planks sloping from the roof beam down to the walls in front and rear. This is the same general arrangement of roof and walls as described above from Metlatavik except that at the latter place there were two pairs of roof beams spaced 5 feet apart, between which were laid cross timbers, making the central part of the roof flat. The Point Barrow sleeping platform is also of the Metlatavik type, consisting of a single broad bench extending from the back wall.

To the east of Point Barrow we find a house of a distinctly different type, the well-known Mackenzie house, described and illustrated by Petitot and reproduced later by Murdoch. The Mackenzie house is built in the form of a cross, with four alcoves with sloping roofs. The alcoves at the rear and the two sides have raised sleeping platforms; the entrance hole from the passage opens through the sloping floor of the front alcove. The central space between the alcoves is square and like them is floored with planks. The center of the roof is likewise square and is supported by four upright timbers and cross beams.

Considering the distribution from Bering Strait to the Mackenzie region, we see that there are two distinct types of houses along the Arctic coast of Alaska, the Point Barrow and the Mackenzie types. We have also seen that from Bering Strait to Point Hope there is a blending of the two—the Metlatavik type—in which the inner room is like that of the Barrow houses, with a gabled roof and a single wide platform at the rear, whereas the entrance room resembles the Mackenzie house in the irregular shape of the floor plan, the alcoves with sloping roofs and floors higher than that of the central floor space, and sometimes in having the roof supported by four uprights. In spite of its rather specialized form, the Mackenzie house betrays a relationship to the houses of southwest Alaska in the form of its roof and in the presence of low platforms along the sides. The Point Barrow house, on the other hand, is unlike anything below Norton Sound, and appears to be intrusive. It will be well, therefore, to inquire further into the relationship between these two types of houses and determine if possible their respective origins.

The Point Barrow and Mackenzie houses have both figured prominently in previous discussions of the origin and relationships of the various types of Eskimo houses.

Thalbitzer (1914, p. 360) considers that there is a relationship between the Point Barrow house and those of Ammassalik and South Greenland. Steensby (1916, pp. 190, 181) admits a similarity between these but emphasizes the difference in size, the South Greenland house being larger and, he thinks, the result of a row of smaller houses being built into one.

Mathiassen (1927, vol. 2, pp. 150, 151) and Birket-Smith (1929, vol. 2, p. 47) think it improbable that the rectangular houses of Alaska and Greenland are related in origin, pointing to the absence of such houses in the central regions. Birket-Smith explains the rectangular houses of Greenland as being the result of Norse influence, and Mathiassen while leaving the question open, shows at least that the earlier Greenland form was the rounded whale bone house of the Thule type.

Mathiassen questions Steensby's view that the pear-shaped house of the Polar Eskimo had its prototype in the rectangular Point Barrow house. It is, he contends, " a local derivative of the round whale bone house of the Thule culture and is a type of house that has certainly originated in North Greenland." He regards the Point Barrow and Thule houses as " co-ordinate forms of dwellings, born of different materials ", and mentions the possibility that the latter may have originated from a Point Barrow house transplanted to regions where whale bones had to replace wood as a building material (1927, vol. 2, pp. 149, 153). Whatever may have been the origin of the Polar Eskimo and Thule houses, one fact seems clear, as recognized by Thalbitzer, Steensby, and Mathiassen, and that is that there are definite resemblances in platform arrangement and roof structure between these eastern forms and the Point Barrow house of Alaska.

This brings us to a consideration of an important question, namely, the status of the Point Barrow house in Alaska and its relation to other Alaskan forms. The statement is often made that the Point Barrow house is the typical Alaskan form of dwelling. Thus, Steensby (1916, p. 192) says, "A house of the Point Barrow type is predominant . . . . along the entire west coast of Alaska from Point Barrow to the region south of the mouth of the Kuskokwim River." And Mathiassen (1927, II, pp. 152, 153): " The prevailing form of house in Alaska is the four-sided house supported by timber, which, in its Arctic, typical form we know from Point Barrow. . . . . The other house forms in Alaska and the long earth house of the Aleuts . . . . seem to be variants of the Point Barrow house. . . . ."

However, as we have seen, it is only by disregarding the Eskimo house types to the south of Bering Strait that one can say that the Point Barrow house is typical of Alaska. Below Norton Sound we find a house which, though varying somewhat from place to place, is still of a single general type, in which the roof is at least partially domed (except on St. Lawrence Island) and supported by uprights set either in the floor or along the walls, and in which low platforms extend around two or more sides. The Point Barrow house differs fundamentally from this type in roof structure and in the arrangement of the platform. The roof is gabled, with a doubled slant, and is supported by a single transverse ridge pole, resting on the wall uprights; and the single platform extending from the back wall is wide and high, and occupies about a third of the room. This type of house is first found, in modified form, at Bering Strait (Metlatavik). Considering the entire range of Alaskan Eskimo houses, the Point Barrow form, instead of being typical, is seen to be the most divergent of all.

What, then, is the status of the Point Barrow house? In spite of its wooden framework and rectangular shape, which give it an outward resemblance to other Alaskan houses, the presence of a rear platform and gabled roof show it to be structurally more closely related to the houses of the Eastern Eskimo. The explanation which seems best to explain this condition is that there is a direct connection between the Point Barrow and the Thule house, as Mathiassen has recognized.

Mathiassen (1927, vol. 2) has shown conclusively how in a great many respects the extinct Thule culture of the east closely resembles that of the Alaskan Eskimo, and particularly that at Point Barrow. Jenness (1928 a, p. 80) in speaking of cultural changes which occurred in the Bering Sea region after the establishment of the Old Bering Sea culture, mentions the possibility of there having been "an invasion of tribes from the north, bringing in a Thule culture that had evolved somewhere along the Arctic coast"; and the writer (Collins, 1929, pp. 43, 44; 1934, p. 311; 1935, p. 463) has suggested that there may have been a comparatively late return migration of Thule peoples into northern Alaska subsequent to the original eastward spread of the Thule culture from Alaska to the Central regions. As we shall see later, there are certain important Thule elements which in Alaska are never found at the older sites but which are prominent at the late prehistoric or modern sites, particularly those along the Arctic coast, a condition which apparently could have come about only through such a return movement of Thule peoples from the eastward. It will be sufficient at this time to mention only one important feature associated with habitations, the crescent-shaped steatite or sandstone lamp; this follows exactly the line of Point Barrow houses, stopping at Bering Strait, where, as we have seen, the first recognizable house of Point Barrow type was found at Metlatavik.

Considering, therefore, that (1) the Point Barrow house is the farthest removed of all Alaskan houses from the general type which occurs below Bering Strait, and (2) that the features which set it apart from other Alaskan houses are the very features which connect it with those of the east, and (3) that the territory along the Arctic coast of Alaska where the Point Barrow type of house occurs, particularly at Point Barrow itself, is the region in Alaska where also the greatest number of Thule traits occur, we seem to have valid grounds for assuming a relationship between the Point Barrow and Thule houses. The exact nature of the relationship, however, is obscure, and must remain so until information is available concerning the prehistoric house types of the Arctic coast of Alaska. The present indications, however, point to its prototype having been the whale bone house of the Thule culture, which on being transplanted to a region where wood was available, took this particular form, retaining the gabled roof and platform arrangement that had come to be characteristic of eastern Eskimo houses generally.

Speculation has also centered on the Mackenzie house. Mathiassen and Birket-Smith both regard it as a modification of the Point Barrow house. Mathiassen (1927, vol. 2, pp. 151, 152) says: "The modern Mackenzie house, with the peculiar cross form, must presumably be regarded as being a locally-restricted variant of the usual four-sided Alaskan house (Point Barrow), presumably arising out of a joining together of several of these." Birket-Smith (1929, vol. 2, p. 46), rejecting Steensby's theory which sought the origin of the Mackenzie house in that of the Gilyak, expresses the same opinion: "In this case it seems to be much more reasonable to regard the Mackenzie house as having originated through building together three smaller, rectangular houses of the Point Barrow type in the same manner as the Eskimos further to the east often build their snow houses together. This view . . . . is confirmed by the fact that in northern Alaska there are also houses which obviously have come about by building two together."

No evidence is offered in support of the view that the Mackenzie house represents a joining together of several houses of Point Barrow type; apparently the facts that they are both wooden structures and that one is square and the other built in the form of a cross are sufficient reasons for considering them related in this particular manner. The houses in northern Alaska referred to by Birket-Smith as having resulted from two being built together are those mentioned by Simpson (1875, p. 258) from Kotzebue Sound. It is true that Simpson advanced this explanation, but, again, no reasons were given in support of it. Such an explanation of the origin of the Mackenzie house is open to serious objection. If it represents a grouping of several Point Barrow houses, it should be possible to point to certain features of the latter that were carried over in the process of combination. This can be done in the case of the snow houses mentioned by Birket-Smith and also of the large rectangular houses of Greenland which Steensby (1916, pp. 322-324) considers to have resulted from the building together of a row of smaller houses. Here the secondary forms represent merely enlargements of the smaller original forms and do not differ from them in any important structural feature. But this is not the case with the Mackenzie and Point Barrow houses, which, as we have seen, differ fundamentally in roof structure and in the arrangement of the sleeping platform. If we wish to find the origin of the Mackenzie house, which is clearly a local and specialized form, it should be sought in a house in which the roof is partly vaulted and supported by upright timbers and in which the sleeping platforms extend around the sides along the floor. It is exactly this type of house which prevails to the southward of Bering Strait and particularly below Norton Sound. It is easy to imagine such a house developing into the Mackenzie form, not through a joining together of two or more but merely through the bringing in of the corners, which would have resulted in alcoves over the shortened platforms. As a matter of fact, a house described by Simpson (p. 258) from Kotzebue Sound may be regarded as an intermediate stage in such a transition. It has the central fire pit and the vaulted central section of the roof like the kashims of southwest Alaska; the four upright roof supports at the center are common to both the southwest Alaska and the Mackenzie houses; and the low sloping walls at the rear and two sides produce, in effect, three recesses as in the Mackenzie house even though these do not project separately and have no elevated floors. But recesses with elevated floors, although not present in this particular house, were, according to Simpson, very common on the shores of Kotzebue Sound. There seems to be clear evidence, therefore, of relationship between the Mackenzie house and the house of quadrangular shape typical of southwest Alaska, the Mackenzie house being apparently a specialized Arctic form of the more general type of Eskimo dwelling found to the southward.

Thalbitzer (1914, p. 361) and Steensby (1916, p. 194) looked for the origin of the Mackenzie house in Asia, for which there was certainly more justification than in seeking a relationship with the Point Barrow house; for there is plainly a definite relationship between Alaskan Eskimo houses in general, with the exception of the Point Barrow type, and those of northeastern Asia. Such comparisons cannot be complete, however, as long as the American example cited, the Mackenzie house, is considered as an isolated American type; the affinities of the Mackenzie house are first with other Alaskan forms south of Bering Strait, and next with certain forms of northeastern Asia. On the other hand, a valid comparison must also distinguish between the various Asiatic types. In the following pages we shall attempt to determine in what particular respects the houses of the Alaskan Eskimo are related to those of northeastern Asia, beginning with those of the Chukchee Peninsula in the extreme northeastern part of Siberia and continuing southward to include the territory occupied by the other Palae-Asiatic peoples.

The typical form of dwelling of the maritime Chukchee and Siberian Eskimo is the skin-covered house like the type now in use on St. Lawrence Island. An antecedent form in northeastern Siberia, however, was the semisubterranean whale bone house which passed out of general use there several generations before it did on St. Lawrence Island. Bogoras (1904-09, pp. 181, 182) has given the best description of one of these whale bone houses, located at Nunligren on the south coast of the Chukchee Peninsula.

This house appears to be of the same general type as that which we found to be the last of the prehistoric forms on St. Lawrence Island—square to rectangular, semisubterranean, with walls of upright timbers and whale bones and roof of similar material supported by uprights. It differs from the St. Lawrence examples in having an entrance in the upper part of the wall in addition to the underground passage, in a different arrangement of the upright roof supports, and in the absence of a wooden floor; also, to judge from the illustrations (Bogoras, pl. 18, figs. 2, 3), the roof is constructed more in the irregular fashion of the underground St. Lawrence caches than of the dwellings.

Until the much needed archeological investigations are made in northeastern Siberia, the history of the whale bone house there must remain in doubt; in view of the series of prehistoric house types now known for St. Lawrence Island, it may be expected that excavations in Siberia will reveal forms which on the whole will be comparable.

Mathiassen, in tracing the extent of the whale bone house, shows that permanent semisubterranean dwellings constructed at least partly of whale bones are found over a wide stretch of the Arctic coast of Siberia where the present form of dwelling is the skin-covered tent (1927, vol. 2, pp. 153-154). The earliest reference is given by Wrangell (1840, p. 372):

There are traditions which relate that two centuries ago the Onkilon occupied the whole of the coast from Cape Schelagskoi [Chaun Bay] to Behring Straits; and it is true that there are everywhere along this tract the remains of huts constructed of earth and whalebones, and quite different from the present dwellings of the Tschuktschi.

Nordenskiöld (1882, pp. 334-336) found similar ruins at Irkaipij, on the coast between Chaun Bay and Kolutschin Bay:

We saw also *ruins,* viz. the remains of a large number of old house-sites, which belonged to a race called *Onkilon,* who formerly inhabited these regions, and some centuries ago were driven by the Chukches, according to tradition, to some remote islands in the Polar Sea. . . . . The houses appear to have been built, at least partly, of the bones of the whale, and half sunk in the earth. The refuse heaps in the neighborhood contained bones of several species of the whale, among them the white whale, and of the seal, walrus, reindeer, bear, dog, fox, and various kinds of birds. . . . . At many places the old Onkilon houses were used by the Chukches as stores for blubber.

Sverdrup (1926, p. 177) also describes house ruins of this type along the north coast of the Chukchee Peninsula and excavated several of them on an island at the mouth of the Kolyma River. He speaks of having found potsherds and stone and bone implements; among the latter were two harpoon heads (described by Mathiassen, 1927, vol. 2, p. 180) which are identical with the oldest type known from the Point Barrow region, the " Birnirk " type.

As Nordenskiöld, Bogoras, and Jochelson have all recognized, the names Onkilon and Namollo are nothing more than Ankali or Anqualan, and Nimilu, designations applied by the Chukchee and Koryak to any coast dwellers. However, in the light of recent archeological developments, it now appears as highly probable that the ruined habitations along the Arctic coast of northeastern Siberia are actually those of Eskimos who formerly occupied the region. The old Eskimo harpoon heads found by Sverdrup at the mouth of the Kolyma River seem to afford clear evidence of such an occupancy, which may also be deduced from the fact, that, according to Bogoras (1904-09, p. 22), Chukchee villages along the Bering Sea and Arctic coasts have names that are more Eskimo than Chukchee.

Farther west, along the Arctic coast in the present domain of the Yukaghir, there are found semisubterranean house ruins which from the meager descriptions available appear to have been constructed entirely of driftwood, covered with earth. On the basis of these references Jochelson is of the opinion that the Yukaghir formerly occupied semisubterranean houses (1910-26, pp. 346-348). Unfortunately, the original descriptions are so inadequate that the exact nature of these houses must for the present remain in doubt; it would be highly desirable if excavations could be extended to this region in order to clear up the relation between these more westerly house ruins and those presumably left by the ancestors of the Asiatic Eskimo along the Siberian coast east of the Kolyma delta.

The next Asiatic house to be considered is that of the Koryak, to the south of the Chukchee Peninsula. We will not be concerned here with the habitations of the Reindeer Koryak, which are heavy skin-covered tents resembling those of the Chukchee and Siberian Eskimo, but only with the wooden house of the Maritime Koryak. From Jochelson's detailed description we see that it is a large semisubterranean structure, octagonal in ground plan, and built entirely of logs and heavy planks (1905-08, vol. 2, pp. 453-460). The walls are formed of a double row of split logs or poles placed upright, although some wall sections may have the inner row of wall boards laid horizontally. Dry grass is placed in the space between the two rows of wall pieces. An upright beam is placed at each of the eight corners and extending from one to the other of these are cross beams, against which the lower ends of the first slanting roof timbers rest. At the center of the earthen floor four pillars support the central roof structure which is to some extent vaulted, being composed of four series of timbers, one above the other, with a square opening at the top which served as smoke hole and winter entrance. Descent into the room is made by means of a ladder, a log of split poplar with holes cut in it to serve as steps. A short distance in front of the ladder is the hearth, which consists of two stones placed on the earthen floor.

At the rear, behind the posts which support the roof, is a low platform of boards, 1 to 2 feet high, which serves as a seat and as a bedroom for visitors. Along the right and left sides of the house are the rectangular skin sleeping tents used by the family.

The most striking feature of the Koryak house, especially when viewed from the outside, is the heavy timber framework or storm roof, in the shape of a funnel or inverted umbrella, which is built around the roof entrance as a protection from the weather.

The winter roof entrance is used from November to May. During the rest of the year the house is entered by a covered passage way somewhat lower than the height of an average man. The floor of the passage, like that of the house itself, is excavated but is at a slightly higher level; it slopes downward slightly toward the door leading into the house.

In late November the outer door to the entrance room or passage is walled up for the winter and the room from then on serves mainly as a storage space. Women and children, however, continue to enter the house through a circular opening in the roof of the entrance room.

As to the resemblances between this house and those of the Alaskan Eskimo, it will be observed that in floor plan and wall and roof construction the Koryak house resembles that of southwest and west Alaska (Bristol Bay to Norton Sound). Thus, the roof is supported by four upright pillars rising from near the center of the floor and the upper part is to some extent cribbed or vaulted, just as in the Alaskan examples. Furthermore, the outline of the house is octagonal, and the only octagonal structures in Alaska are the kashims between the mouth of the Kuskokwim and Bristol Bay (observed by the present writer at Goodnews Bay and Kulukak). The lower part of the roof is formed of sloping timbers and the walls usually of upright timbers; in these two respects the Koryak house is more similar to the St. Lawrence form 3 (p. 261) than to those further south. The use of dry grass in the walls recalls a similar use in the inner sleeping room of the modern St. Lawrence Island skin house and in the skin houses of King Island; grass is also placed between the timbers and the sod covering of the Kulukak houses (Bristol Bay district). Another resemblance to southwest Alaska, although not strictly architectural, is the wooden lamp rest shown in Jochelson's illustration (pl. 37), which is practically identical with the lamp rests used by the Nunivak Island Eskimo. The Koryak entrance passage is shorter and wider than those found in Eskimo houses. The opening in the roof of the entrance passage corresponds with the arrangement found in Eskimo houses from Norton Sound to Point Barrow.

Certain other features of the Koryak house are further removed from the Alaskan examples. An entrance through the smoke hole at the center of the roof is not known in Alaska at the present time, although the early form of Aleutian house as described by Cook and other early explorers was entered in this manner. From Norton Sound northward to Point Barrow a roof entrance is the normal one, but it is into the anteroom and never through the smoke hole or sky light of the inner room.

Likewise, there is little in the interior arrangements of the Koryak house to remind one of Alaska. Instead of low sleeping platforms along two or three sides as in southwest Alaska, or a single high platform at the rear as in northern Alaska, the Koryak house has a single low platform of boards at the rear for use as a seat and as a sleeping place for visitors. The occupants of the house sleep in rectangular skin tents placed along the side walls, similar to the inner skin-covered sleeping rooms of the Reindeer Koryak, the Chukchee, and Siberian Eskimo, and in recent years the St. Lawrence Island Eskimo.

The exaggerated form of the Koryak storm roof has no parallel elsewhere. In Eskimo houses there is no superstructure of any kind around the roof opening, but neither is this used as an entrance. Holmberg (1856, p. 305) describes a windbreak around the smoke hole on a Tlingit house, and elsewhere on the north Pacific coast sliding roof boards were sometimes adjusted in such a manner as to deflect the wind from the smoke hole. The elaborate funnel-shaped storm roof of the Koryak should no doubt be regarded as a local specialization, which arose from the necessity of protecting from snow and wind a roof opening which was used both as smoke hole and entrance.

When we consider the architectural features which distinguish one type of Alaskan Eskimo house from another, it is seen that the Koryak house, as might be expected, does not resemble exclusively any one of the Alaskan forms, but instead embodies certain features occurring separately in various of them (with perhaps a greater resemblance to southwest Alaska than elsewhere) together with a few others which are lacking in Alaska.

The next type of Palae-Asiatic house is that of the Kamchadal, who occupy the Kamchatka Peninsula to the southward of the Koryak. Since coming under Russian influence the Kamchadal no longer use the underground winter house, but descriptions have been left by Steller, Krasheninnikoff, and Cook.

The winter house was rectangular in floor plan and excavated to a depth of 3 to 5 feet. There was no entrance room or passage. The walls were of upright timbers and the roof was supported principally by four wooden pillars rising from the center of the floor space. Back of the wall and roof timbers dry grass was laid and over that an outer covering of earth. Low sleeping platforms of boards were built along three sides of the house. At the center of the roof was the smoke hole, which served also as window and entrance. The house was entered by means of a log into which were cut footholds or steps. The women and children (according to Steller, only the small children) were accustomed to use a lower entrance opposite the fire place, the principal purpose of which was to serve as a draft channel for the fire.

On comparing the Kamchadal and Koryak houses it is seen that the principal difference between the two is that the former is rectangular in floor plan with low sleeping platforms along the walls, whereas the latter is octagonal with a single low platform at the rear and inner skin sleeping tents along the sides. Both were entered through the roof and both had a second and lower entrance. However, in the Koryak house, which was occupied throughout the year, the lower entrance was the regular one for summer use by men, women, and children alike, whereas in winter when its outer opening was closed, it served only as a draught passage and as an entrance for women and children. The Kamchadal house, on the other hand, was occupied only during the winter, and the lower entrance (which was also a draught channel) was never used by the men, but by women and children only.

It will be observed that those features which distinguish the Kamchadal house from that of the Koryak (rectangular floor plan, low sleeping platforms along three sides, and absence of the elaborate storm roof) are features which it shares with the houses of west and southwest Alaska. The Kamchadal house, therefore, is closer to these Alaskan forms than is the Koryak house, despite the fact that one typical Alaskan feature—the entrance room—is lacking in the Kamchadal house. However, it is the absence of this very feature, and the presence of a ladder and roof entrance, that brings the Kamchadal house into direct relationship with another Alaskan form, that of the Aleutian Islands.

The Gilyak, who occupy the northern half of Sakhalin Island and the adjoining coast of the mainland at the mouth of the Amur River, possess a winter house of the general Kamchadal-Koryak type (v. Schrenck, 1881, pp. 322, 323; Jochelson, 1905-09, p. 462; 1907, pp. 120, 121). It is square in outline and excavated to a depth of 3 or 4 feet. The roof timbers are supported by four central uprights. Sleeping platforms are placed along the rear and side walls. Instead of being continuous there may be a break in the platforms at the two back corners, which are left open to serve as a storage space. The fireplace is at the center of the floor, and the smoke escapes through an opening in the roof above. The house is entered through a short passageway, the floor of which is somewhat higher than that of the house. On the occasion of the Bear Festival the Gilyak enter the house through the roof opening instead of through the passage, and the flesh and skin of the bear as well as other sacred objects connected with the ceremony are taken into and removed from the house in the same manner. Sternberg and Jochelson are of the opinion that the ceremonial use of the roof opening as an entrance is an indication that in the past this was the regular form of entrance, just as in the Kamchadal and Koryak houses, a supposition which appears reasonable in view of the many cultural resemblances between all three of these Palae-Asiatic tribes.

The resemblances between the Gilyak house and those of west and southwest Alaska are unmistakable. The presence of an entrance passage instead of a roof entrance serves to bring the Gilyak house even closer than the Kamchadal house to the Alaskan forms.

Originally the Ainu lived in underground houses which were probably similar to those of the Gilyak, but of lighter construction. According to Schrenck (p. 333), the Ainu houses on the southern part of Sakhalin Island had an entrance room with steps leading down into the living room. Larger houses had two hearths at the front of the room near the entrance, with separate openings in the roof for the escape of the smoke. Smaller houses had a single hearth, placed either near the entrance or at the center of the floor. Schrenck cites references showing that low sleeping platforms extended along two sides of the house. Beneath these were sliding compartments or drawers which Schrenck attributes to Japanese influence.

On Shikotan, a small island to the northeast of Yezo, dwellings are described which are composed of two parts, a front thatched house for summer occupancy and a connected earth-covered house for use during the winter (Hitchcock, 1891 a, pp. 423-425). The square summer house with thatched walls and roof resembles that described by Schrenck from Yezo, but the earth-covered winter house is of especial interest in that it represents in all probability an approach to the original Ainu semisubterranean dwelling. The floor is slightly sunken, to a depth of 12 to 18 inches, and is approximately circular in outline, with two connected sleeping platforms. The two houses are connected by a covered passageway. This Asiatic example of a summer and a winter house connected by a passage recalls the somewhat similar arrangement in Alaska where there is commonly a large anteroom connected with the inner room; and more specifically it recalls the arrangement described in the report of the Eleventh Census (Porter, 1893, pp. 104, 105, 172) of houses from the middle Kuskokwim and Yukon regions in Alaska. "The buildings . . . . (consist) generally of two parts, one underground and the other above. The latter, which is generally used in summer and connected with the other by a tunneled passage, is constructed of logs and roofed with sods; it also contains a central fireplace for cooking, which is utilized throughout the year. The winter habitation differs in no way from the common subterranean dwelling. . . . ."

From Torii's account (1919, p. 237) of the houses of the Kurilian Ainu it is seen that these also had a separate entrance room, used for cooking and storage, and connected by means of a passage with the inner living room.

As in the case of the Koryak, Kamchadal, and Gilyak, the underground houses of the Ainu also show certain resemblances to those of west and southwest Alaska. However, the similarities are mainly those of shape and interior arrangement, for the walls and roof in the Ainu house were more lightly constructed, and lacked the four centrally placed roof supports which characterized the three other Asiatic examples and the Eskimo houses south of Bering Strait.

The houses in use on the Aleutian Islands in the eighteenth century have been described, though very imperfectly, by Cook, Sauer, and Langsdorff. Those at Unalaska are described by Cook (1784, vol. 3, pp. 108-110) as follows:

The following is their method of building: they dig, in the ground, an oblong pit, which rarely exceeds fifty feet in length, and twenty in breadth; but the dimensions are in general smaller. Over this excavation they form the roof of wood, which they cover first with grass, and then with earth, so that the external appearance resembles a dung-hill. Near each end of the roof is left a square opening, which admits the light; one of these openings being intended only for this purpose, and the other being also used to go in and out by, with the assistance of a ladder; or rather a post, in which steps are cut. In some of the houses there is another entrance below, but this is rather uncommon. Round the sides and ends of the habitations, the families, several of which dwell together, have their separate apartments, where they sleep, and sit at work; not on benches, but in a sort of concave trench, dug entirely round the inside of the house, and covered with mats, so that this part is kept pretty clean and decent. . . . . We did not observe a fire-place in any one of their habitations. They are lighted, as well as heated, by lamps; . . . .

Cook's statement that the Aleut house had "a sort of concave trench, dug entirely round the inside of the house", which took the place of the customary platform, is somewhat surprising in the light of our knowledge of Eskimo and other northern houses generally. The possibility suggests itself that what was observed might not have been an excavated trench but a narrow space along the walls enclosed by logs laid end to end. These logs (which are visible in Webber's drawing, Cook, vol. 2, opposite p. 110) served to set off the sleeping places from the rest of the room; and the enclosed space when viewed from a distance might have a somewhat sunken appearance. A similar arrangement of logs bordering the sleeping spaces along the side and rear walls was reported from Kodiak Island by Lisiansky (1814, p. 213).

This early historic form of the Aleutian house appears so far removed from Eskimo houses generally, and the Point Barrow house particularly, that it is impossible to regard it, as Mathiassen does, as a variant of the Point Barrow house (1927, vol. 2, p. 153); and Birket-Smith's statement (1929, vol. 2, p. 51) that it is "a local alteration of the usual type, obviously arising out of the building together of several smaller houses" does not explain it at all. In two important features—the absence of an entrance room and the presence of a ladder and roof entrance through the smoke hole—it differs from other Alaskan houses. Conversely, it is these very features that link the Aleutian house with that of the Kamchadal.

From Holmberg's description (1856, pp. 376-378) we see that the house of the Kodiak Eskimo was a semisubterranean wooden structure, consisting of a central inner room to which were connected several smaller sleeping rooms. The walls were formed of vertical timbers leaning slightly inward and the roof was vaulted, being formed of whale ribs, covered with earth. The shape of the house and the form of entrance are not mentioned by Holmberg, but from Lisiansky's description both the inner room and the sleeping rooms seem to have been square, and Lisiansky, Langsdorff, and Sauer all speak of an entrance in the side, evidently through the wall. Benches or platforms are not mentioned, but according to Holmberg they were present in the kashims.

From de Laguna's excavations (1934, pp. 157, 158) we see that stones and whale bones were used in the construction of the oldest houses thus far known in the Cook Inlet region:

We know nothing about the houses of the First Period of the Kachemak Bay culture, and of those of the Second Period we know little, except that large stones and whale vertebrae were used in their construction. The use of stone in building is anomalous in a region so heavily timbered. It could only be accounted for by the supposition that the builders were people who had come from a region where timber was not plentiful and where stone was the natural building material.

The houses of the Third Period of the Kachemak Bay culture were semi-subterranean—that is, they were excavated to a depth of a least 2 or 3 feet—and were entered by a semi-subterranean entrance passage, very narrow and at least 12 feet or more long. The houses were built of wood, with posts in the corners and at other places along the walls. Some of the houses had more than one room, and some seem to have had a fire-place in the main room.

There is little information on the houses of the southernmost group of Eskimos, those at Prince William Sound. Petroff (1884, p. 28) remarks only that they were underground, a statement which seems borne out by Steller's brief description of a house (or cache?) that he saw on Kayak Island in 1741.

I pushed the grass aside at once and found underneath a cover consisting of rocks; and when this was also removed we came to some tree bark, which was laid on poles in an oblong rectangle three fathoms in length and two in width. All this covered a cellar two fathoms deep. [Golder, 1922-25, vol. 2, p. 48.]

The houses of the Northwest Coast Indians present a special problem, the solution of which will require a more comprehensive and searching analysis than has as yet been made. The presence of an inner pit would seem to indicate a basic relationship with the semisubterranean earth covered houses to the north and south, as Waterman (1921, pp. 23-30) has pointed out. But in many respects the Northwest Coast houses have developed so far beyond these simpler and undoubtedly more primitive forms that they constitute a definite break in the line of such houses. In spite of this, it is here on the Northwest Coast that Birket-Smith seeks the origin of the rectangular house of the Western Eskimo, while denying a relationship between the latter and the houses of northern Asia.

The rectangular houses among the Western Eskimos are in direct geographical connection with the rectangular houses which extend right from Alaska southwards to northern California. All these dwellings are, like the Eskimo dwellings, partly dug down in the ground and inside are furnished with platforms. With regard to construction there is, it is true, a great difference between the Eskimo type which we find in its most primitive form at Point Barrow, and the big plank buildings of the nearest Indian peoples, the Tlingit, Haida and Tsimshian; but from central Washington southwards we find smaller wooden houses which, with their vertical wall-boards and lack of interior timbering, are surprisingly like the Point Barrow type. The principal difference between them is that the Indian forms have no entrance passageway; this, however, conforms with the fact . . . . that the entrance passage in the Alaskan house has apparently been taken from earlier types for practical reasons. Just this divided diffusion of the simple, rectangular houses, interrupted partly by the peculiar "shedlike" type at Puget Sound and Juan de Fuca Strait, which are perhaps connected with the advance of the Salish to the coast, and partly by the more developed forms among the three principal peoples, the Tlingit, Haida and Tsimshian, argue an inner connection which points in the direction of the North Pacific coast as the home of the rectangular house of the Western Eskimos, as it has been for many of their other culture elements (their rich wood-carving, the grotesque masks, the *potlatch* feasts, slavery, the raven myths, head trophies, the finer development of basket work, etc. etc.). [Birket-Smith, 1929, vol. 2, pp. 47, 48.]

I must confess that I am unable to see the cogency of this argument unless structure is to be wholly subordinated to considerations of geographical position and of cultural relations which are of doubtful value in this connection because of the strong probability that they are relatively recent manifestations. If we leave out of consideration the Point Barrow house, which, as the most divergent of the Alaskan Eskimo houses, is also the farthest removed from the Asiatic forms, we see that there are clear and unmistakable resemblances of a fundamental nature between the Alaskan Eskimo houses south of Bering Strait (and also the Mackenzie house) and those of the peoples of northeastern Asia. The Northwest Coast houses, on the other hand, differ fundamentally from the Siberian and Eskimo forms in such features as shape, roof structure and support, sleeping platforms, wall structure, and the form of entrance. It may well be, as Birket-Smith suggests, that the houses of the modern Northwest Coast tribes may not represent the original type there; but they differ in so many important respects from the houses both to the north and south that it is difficult to postulate just what the ancestral form may have been. Birket-Smith finds support for the view that the western Eskimo house originated on the Northwest Coast in the fact that certain other features of Eskimo culture are known to have emanated from that region. However, it now appears as highly probable that such influences have been exerted only in relatively recent times; at any rate in the oldest culture layers that have been revealed archeologically in the north there are no traces of labrets, masks, or other characteristic elements of Northwest Coast culture.

The underground houses from southern British Columbia southward, both those with a roof entrance and those with an entrance passage, are no doubt related to the Asiatic houses described above, as well as to the Aleutian and Eskimo houses, with the exception of the Point Barrow type. The intrusion of the Northwest Coast plank house renders more difficult the problem of determining the relative ages and probable paths of diffusion of the two forms of entrance. The roof entrance through the smoke hole is much more widely distributed in America than in Asia, being found in the Pueblo region of the Southwest, from California to southern British Columbia, and then again in the Aleutian Islands; in Asia it is found only among the Kamchadal and Koryak, although recent excavations tend to show that it was known in China during the Neolithic (Bishop, 1933, p. 393; 1935, p. 44). Jochelson (1907, pp. 125, 126) and Waterman (1921, p. 33) call attention to the fact that references to houses with a roof entrance occur in the mythology of the Quinault, Bella Coola, and Tsimshian, from which it would appear that among these tribes also it had been in use at an earlier period; and as mentioned above, the same may have been true of the Gilyak. Assuming a relationship between the Asiatic and American examples, the Aleutian Islands must have formed the connecting link, and although it would be hazardous to decide just where this feature originated, the known distribution would seem to point to its diffusion into Kamchatka by way of the Aleutian chain rather than from the opposite direction. For although the roof entrance, used alone, has a wide and sporadic distribution in America, it is only in Kamchatka, the Asiatic coast nearest the Aleutians, that we find this to be the only form of entrance used by the men; the only other modern Asiatic house with a roof entrance, that of the Koryak, conforms more to the usual Asiatic pattern in that it possesses also a passage entrance which in summer is used by men, women, and children alike.

On the other hand, the passage entrance is even more widely distributed in America (Southeast, Plains, Plateau, California, Prehistoric Pueblo) and although there is a great gap along the Northwest Coast, southern Alaska, and the Aleutians, it appears again at Bristol

Bay and continues as the typical form of entrance in the Eskimo area, as it is also in many parts of Asia. The fact that the Old Bering Sea houses had an entrance passage indicates that it was a very early if not an original feature of Western Eskimo houses, and not as Birket-Smith has assumed, one that was "taken from earlier types for practical reasons."

Birket-Smith has expressed what seems to be the most tenable hypothesis as to the chronological order of the various house types when he says (1929, vol. 2, p. 54):

> . . . . the earth lodge with the entrance passage is the oldest, then comes the earth lodge with entrance through the roof, and youngest is the square plank house.

But instead of placing the semisubterranean, square to rectangular house of the Western Eskimos with the latest of these, i. e., the plank houses of the Northwest Coast, as Birket-Smith has done, I would relate them (with the exception of the Point Barrow house) to the first group, the semisubterranean earth lodge with entrance passage. Birket-Smith has made a somewhat better case for the assumed relationship between the Northwest Coast and Eskimo houses by selecting the Point Barrow house as an example, rather than the more typical form occurring south of Bering Strait. For both the Point Barrow house and a number of the plank houses of the Northwest Coast possess one feature in common—a gabled roof. But even this is a superficial resemblance, for in the houses of the Tlingit, Tsimshian, Kwakiutl, etc., the roof beam or beams extend from front to back, and the roof slopes from this down to the side walls; whereas in the Point Barrow house the roof beam is placed transversely making the roof slope toward the front and back. As pointed out above this particular form of gabled roof and the single wide platform at the rear are the two features which bring the Point Barrow house into relationship with those of the Eastern Eskimo, and make it appear as probably a recent form, a reproduction in wood that has retained the roof structure and platform arrangement of its whale bone or stone prototype in the East. On the other hand, the very fact that the Northwest Coast houses are gabled, whereas the Eskimo houses below Bering Strait have a flat or somewhat vaulted roof supported by four central uprights, is one of the strongest arguments against these two types being closely related.

In the foregoing pages we have noted the distribution of Western Eskimo house types and have attempted to point out their relation to other Eskimo houses and to those of neighboring tribes in northeastern Asia and America. In so doing we have been concerned more with such architectural features as wall and roof structures, platform arrangement and entrance, rather than with the shape of the house itself. But since considerable emphasis has been placed on this feature in previous discussions of the problem, it may be well to consider it here briefly from the standpoint of the archeological finds.

Thalbitzer (1914, p. 360) has recognized three forms of permanent Eskimo dwellings: "(1) the roundish, dome-shaped type, with whale-bone as material, (2) a rectangular type, in which the material consists of wood, stones, and turf; (3) and a pear-shaped house, mainly built of stones and turf." Thalbitzer points out that two of these types, the domed and the rectangular, are found both in the east and the west: the small whale bone houses of northeastern Siberia with domed roof and roughly circular outline were related to houses of similar shape in the east, and the Point Barrow house to the houses of South Greenland and Ammassalik. The third type, the pear-shaped house typical of the Polar Eskimo, was supposed to have been derived from the Mackenzie house.

Steensby, on the other hand, grouped the eastern rectangular and pear-shaped houses together, and derived them both from the Point Barrow house (1916, p. 191).

It will be observed that both of these writers have recognized the significant fact that the Point Barrow house was related to certain of the Eastern houses, even though, as we have seen, the Mackenzie house has affiliations only to the southward of Bering Strait. The apparently conflicting views of Thalbitzer and Steensby with regard to the affinities of the Point Barrow house are in considerable measure reconciled as a result of Mathiassen's investigations, which have shown that the ancestral form of house in the east was the whale bone house of the Thule culture, and that this in turn was probably related to the Point Barrow house. In this case the shapes of the several types of houses are of less importance than the structural features that connect them; for although the shapes have undergone considerable change since the time of the Thule culture, the fundamental principles of the round Thule house are still carried out even in such widely separated forms as the rectangular houses of the Point Barrow and Ammassalik Eskimos and the pear-shaped house at Smith Sound.

The original form of the Thule house in the West is uncertain. Mathiassen, in tracing its distribution, has been concerned mainly with the material from which it was constructed and its round shape, and has therefore assumed that the ruins of whale bone houses found in northeastern Siberia and the type of house that Nelson found still in use at East Cape were all to be regarded as Thule houses. In one important respect, however, the East Cape houses do not conform to the Thule type, for instead of a platform they have an inner sleeping compartment or polog like other Siberian Eskimo and Chukchee houses. The rounded shape of the stone foundation and the skin roof covering are also features which apparently are to be explained on the basis of a relationship with the other Chukchee and Eskimo forms. For this reason I should regard these East Cape houses as only variants of the prevailing type of modern house which is octagonal in shape, with a domed skin-covered roof and a skin sleeping room on the inside.

Except for these modern Siberian houses, which are obviously related to the circular dome-shaped houses of the nomadic tribes to the westward, and which have only in relatively recent times supplanted the underground wood and whale bone house in northeastern Siberia, there seems to be no evidence of circular houses anywhere in this region. The only examples cited by Mathiassen as showing that round houses have occurred in Alaska are some ruins described by Nelson on Kotzebue Sound:

On Elephant point, at the head of Kotzebue Sound, I saw the site of an old village, with about fifteen pits marking the locations of the houses. The pits sloped toward the center and showed by their outlines that the houses had been small and roughly circular, with a short passageway leading into them, the entire structure having been partly underground. [Nelson, 1899, pp. 264, 265.]

But aside from the fact that the outward appearance of a house pit, after it has been long abandoned, gives little indication of its original shape, there seems to be direct evidence that the particular houses referred to by Nelson were originally square. In Beechey's account of his exploration of Kotzebue Sound in 1826 we find the following reference to a deserted village, apparently the same one seen by Nelson in 1881:

We sailed up the bay, which was extremely shallow, and landed at a deserted village on a low sandy point, where Kotzebue bivouacked when he visited the place, and to which I afterwards gave the name of Elephant Point, from the bones of that animal being found near it. . . . . The deserted village upon the low point consisted of a row of huts, rudely formed with drift-wood and turf, about six feet square and four feet in height. [Beechey, 1831, p. 222.]

Both Waterman and Birket-Smith have attempted to show that the round house was the original Eskimo form. In speaking of Alaskan houses, Waterman says (1927, p. 211):

Houses were built in a circular style when the first European explorers arrived, and nobody as far as I know has ever suggested the existence of any type that preceded the circular ones in that region. . . . . The first white man who came into the region, the explorer Captain Cook, reported circular dwellings. His artist sketched them, both on the Aleutian Islands and on the mainland north of the Strait. The square houses of today seem to be due to contact with the Russians. . . . .

If we turn to Cook's description (1784, p. 108), however, we see that the only reference he makes to the shape of the Aleutian houses is that they were "oblong." But by this he seems to have meant rectangular, for Webber's illustration accompanying the description shows the interior of an unmistakably rectangular house. The other Alaskan dwelling described and illustrated in Cook's narrative was in Norton Sound and here again Webber's drawing (opposite p. 75) is clearly that of a rectangular house. The only round houses illustrated by Webber (opposite p. 32) are some skin-covered Chukchee houses on the Siberian side of Bering Strait.

Birket-Smith says (1929, vol. 2, p. 53): "Round houses with a roof entrance are again found on both sides of the plank house: on the one hand among the Aleut (in an altered form), Koryak and Kamchadal. . . . ." However, as we have seen above, the Aleutian and Kamchadal houses are rectangular and the Koryak octagonal.

It may be said, therefore, that no evidence has yet appeared to show that round houses have ever been used in Alaska, even though on theoretical grounds these might be expected to occur. As far as I am aware the nearest approach to the round form is found in certain octagonal structures at Kulukak and Goodnews Bay in southwest Alaska. On the other hand archeological investigations on St. Lawrence Island have clearly demonstrated the antiquity, in that area at least, of the square or rectangular house, an antiquity extending many centuries beyond the time of Russian contact. All of the prehistoric St. Lawrence houses were quadrilateral, beginning with those of the Old Bering Sea period and ending with the latest prehistoric form which was in use as late as 40 years ago. The only approach to a round house is the octagonal skin-covered surface structure recently adopted from the Siberian Eskimo.

The archeological data for St. Lawrence Island are of interest also as showing how little relation there is between the shape of a house and the material of which it is constructed. Sarfert, Steensby, and Mathiassen, in their studies of Eskimo habitations, have all assumed that the shape of a house is dictated by the nature of the building material available, that a whale bone house must necessarily be round and a wooden house quadrangular. It is true that walls made of logs or planks laid horizontally can hardly be round, but if the wall timbers are placed upright there is nothing to prevent their taking a circular outline as, in fact, so many American Indian houses do, while the roof may according to custom be either domed, conical, gabled or flat. This has been pointed out by Hatt (1928, p. 8) who also cites the rectangular whale bone house at Nunligren, northeastern Siberia, described by Bogoras, as showing that whale bone houses need not be round. To this we might add that the underground caches on St. Lawrence Island, constructed either entirely of whale bones or of whale bones together with stones and walrus skulls, are always quadrilateral. Some of the comparatively late St. Lawrence Island houses had circular annexes to or enlargements of the entrance passage, used evidently for storage, the walls of which were of whale and walrus bones and stones, but the houses themselves, built of precisely the same materials, were invariably square or rectangular. When we see that St. Lawrence Island houses from the time of the Old Bering Sea culture down to the nineteenth century were quadrilateral in shape regardless of whether they were constructed of wood, bones, or stone, we are led to the conclusion that custom alone is the determining factor and that the nature of the building material in no way dictates the shape that the structure is to assume.

If we examine the various types of houses which have been revealed on St. Lawrence Island, we see that it is only one of these—the latest of the prehistoric types—that shows any close agreement to the general style of Eskimo house found below Bering Strait. This house (type 3, p. 261), which seems to have appeared late in the Punuk period, continued in use until about 40 years ago. It conforms to the southwest Alaskan type in having the roof supported by uprights rising from the floor, in having the walls made of small vertical timbers or whale jaws, leaning slightly inward, and in the presence of low sleeping platforms along two or more sides. The sudden appearance of this type of house, which embodies features not previously known on St. Lawrence, points to its being an importation from some other region. It would be premature at the present stage of our knowledge to say whether it had been introduced from southwest Alaska (Bristol Bay to the Yukon), where houses of this general type prevail, or from northeastern Siberia. Since Siberia was the source from which many other cultural traits were received during the Punuk period, the house might have been acquired in the same way. That houses of this general type occurred in Siberia is shown by Bogoras' description of a rectangular whale bone house at Nunligren, but until we have more precise information on Siberian house types, the exact relationships of the St. Lawrence Island form must remain uncertain.

The somewhat older type of Punuk house (type 2, p. 273), constructed of whale bones and stones, was in all probability derived from Siberia, as nothing like it is known from the Alaskan mainland. This house resembles the Thule type in its use of stones and whale bones as building material, although its square shape and lack of a platform distinguish it from the Thule houses.

The discovery of the Old Bering Sea house (type 1), instead of clarifying the problem of the origin and relationships of Eskimo houses generally, seems only to have added to its complexity, for the walls were formed of small logs laid horizontally and held in place by bone and wooden stakes, a form of construction unknown in any other part of the Eskimo area, although outer retaining walls were often so constructed. The Salish houses in southern British Columbia have walls of horizontal planks which are also held in place by wooden stakes, but it is difficult to see a connection here in view of the absence of anything similar in the intervening region. We may, with more reason perhaps, seek the affiliations of this particular method of wall construction in the Old World, but direct comparisons cannot be made until information is available on the prehistoric house types of northern Siberia.

Art

The most striking single feature of the Old Bering Sea culture is its art. The artistic impulse was so strong, the designs so thoroughly integrated and seemingly deep rooted, that one feels that the first and most important step in determining the origin of the culture lies in the elucidation of the art style which is so peculiarly its own.

The distribution of Old Bering Sea art as known at present is from St. Lawrence Island northward to the Diomede Islands and Cape Prince of Wales, and thence north and east along the Arctic coast to Point Hope and Point Barrow. Future explorations will very likely reveal it at intervening points on the Arctic coast between Kotzebue Sound and Barrow and probably elsewhere along the west coast of Seward Peninsula. There is no indication, however, that it ever extended south of Norton Sound or even along the south coast of Seward Peninsula. Its southernmost limit seems to have been St. Lawrence Island, and the cultural connections here have apparently always been with the nearby coast of Siberia rather than with Alaska. Although a sufficient number of Old Bering Sea objects have been found in Siberia to show that the art was also firmly rooted on that side of Bering Strait, little is known as to the exact provenience of these random specimens.

The distribution of Punuk art is very much the same. It has been found on St. Lawrence Island, on the Siberian side of Bering Strait, at the Diomedes and Cape Prince of Wales, at Point Hope, and at Point Belcher, 60 miles below Barrow.

When comparing Old Bering Sea and modern Eskimo art we are impressed first of all by the obvious dissimilarity between the two. The elaborate Old Bering Sea designs are totally foreign to later Eskimo art, but upon analysis we find that they incorporate some of the simple elements which form the basis of the modern art. They both make use of small plugs of wood, baleen, or ivory at the centers of circles; the circles themselves are differently made, those of the Old Bering Sea period being always made free hand and often surmounting a slight elevation, whereas the modern circles, like those of the Punuk stage, are flat and mechanically inscribed with a bit or compasses. The idea of a dot or nucleus at the center is common to all three stages. Another common element is the "ladder" design, which, however, is much more frequently employed in Punuk and modern art than in Old Bering Sea art. The simple spurred line is another very important element of modern Eskimo art that goes back to the Old Bering Sea period, but we find a different condition with regard to the related designs, the alternate spur and the zigzag,[10] which are such favorite devices of the modern Eskimos. In the Punuk stage the alternate spur design is present but has not taken on the stereotyped appearance of the modern design, and the zigzag is known from only a single Punuk specimen (pl. 67, fig. 1). The alternate spur is as yet unknown to Old Bering Sea art, but the presence of a single example of the related zigzag (pl. 58, fig. 12) suggests that it may have been employed occasionally. Finally, there are a few Old Bering Sea pieces on which red pigment was rubbed into the lines, a practice which was very common during the Punuk and modern periods. The remaining basic design elements employed by the modern Eskimos are all to be found in Punuk art. These are the simple Y figure, detached dots, bands of straight lines, and short cross or connecting lines. It appears, therefore, that modern Eskimo art is to be explained as the result of simplification or degeneration; that from the rich reservoir of the prehistoric art it has selected and retained certain simple motives, which through repeated use during a long period of

[10] As here used, the term "alternate spur" refers to the design formed by two parallel lines with inward-pointing alternating spurs; it is sometimes referred to as the "seal tooth" or "fish trap" design. The term "zigzag" refers to the negative design left between the two parallel lines when the alternating spurs are thickened at the base so as to produce triangles.

transition have become more and more stylized, resulting finally in the stiffly conventional geometric art of the present time. It is of interest to note in this connection that there is no basis for the assumption that the simple Y figure had its origin in a tree design, a raven's foot, or a whale's tail; on the contrary, as Boas has already indicated (1908, p. 325), these more elaborate forms of the Y are later specializations to which various realistic meanings have become attached secondarily. In its oldest recognizable form, in Punuk art, the Y figure is always plain with no suggestion of any life form. It differs from the modern Y in being rather large, in often having a dot at the base, and in usually being connected with a unit design, whereas in modern Eskimo art it is smaller and usually rises from a base line.

In attempting to trace the origin of modern Alaskan Eskimo art it is important first of all to observe that the art which is typical of northern and northwestern Alaska, from Norton Sound northward, is quite different from that which prevails from Norton Sound southward to Bristol Bay. In the latter region we find an art style based on Punuk elements: nucleated concentric circles, often with spurs attached to the periphery; straight, deeply incised lines, either single or in bands; pairs of spurs attached to lines; detached dots; and Y figures. The close resemblances between Punuk art in its later phases and the modern geometric art of southwestern Alaska (Bristol Bay to the Yukon) indicate that we are dealing with two aspects of the same general art style. The differences between the two are mainly in the organization of the design. In the modern art the design elements are usually detached, or if connected, are repetitive. In early Punuk art, as in Old Bering Sea, there is usually a continuity of design and very often a studied arrangement of the elements in relation to surface contours. The modern art of southwestern Alaska may, therefore, be regarded as a disintegrated form of Punuk art.

From Norton Sound northward we find a simpler style of geometric art, based largely upon the use of the spurred line, usually in the form of the alternate spur design. The Y figure and the simple nucleated circle are also present, but there is no evidence of the bands of parallel lines or the more elaborate concentric circles that are typical of the region to the southward. At Norton Sound, which is the dividing line, there is a blending of the two styles, the northern style predominating. Correlated with these differences in geometric art is the wide-spread occurrence in the northern region of the well-known pictographic art. This distinction between northern and southern art is consistent with a general dichotomy of modern Alaskan Eskimo culture, which is manifested in a number of important culture traits, and which extends even to linguistics and physical characteristics. As the writer has previously suggested, this is a condition which might be explained on the assumption that there had been a return migration of Thule peoples to northern Alaska within the past few centuries, subsequent to the original eastward spread of the Thule culture (Collins, 1935, pp. 463, 464). We will return to a consideration of this problem later.

If the art of southwestern Alaska had its origin in Punuk art, what was the basis of the more northern style, that prevailing from Norton Sound to the Arctic coast and extending even to north Greenland? The archeology of the Arctic coast of Alaska is not yet sufficiently known to permit a definite answer, but according to present indications it might well have been the Old Bering Sea style 1, with its profusion of straight lines and spurs, that gave rise to the northern style of modern art in which the spurred line is such an important element.

When we examine the art of other prehistoric phases of Eskimo culture we find certain correspondences to individual Old Bering Sea elements, but few definite clues which might throw light upon the origin of the art itself. Thule art offers nothing for comparison, since it differs in no way from the northern style of modern Alaskan art. The art of the Dorset culture, consisting of straight lines, long, oblique spurs, and short detached lines, is somewhat suggestive of Old Bering Sea style 1 (compare, for example, pl. 12, fig. 14, pl. 13, figs. 7, 8, and pl. 19, fig. 1, with Jenness, 1925, fig. 9, and Mathiassen, 1927, vol. 1, pl. 62, and vol. 2, fig. 10, 1). The long, slanting spurs and detached lines on these Dorset objects produce an effect rather similar to that of Old Bering Sea style 1. The human faces carved on some of the Dorset specimens show little resemblance to those of the Old Bering Sea culture, but the carving of a mammal head with ears in relief (Jenness, 1925, fig. 7, *j*) is not unlike that seen on the knife handle from the Hillside site (pl. 12, fig. 12). The possible significance of these resemblances is somewhat obscured by the fact that the ornamentation in both cases is very simple, and therefore of questionable value as indicating genetic relationship.

The Dorset practice of carving a crude human face on the side of an object finds a parallel in the Aleutian Islands, where Jochelson reports finding many fragments of bone dart heads decorated in this manner (Jochelson, 1925, p. 95, figs. 81-83). If one may judge from Jochelson's few illustrations, these Aleutian carvings are quite different from the realistic human faces found at other ancient sites in this part of Alaska (e. g., Weyer, 1930, figs. 13 and 23, *c*—Alaska Peninsula;

Hrdlička, 1932, fig. 96; 1933, fig. 44—Kodiak Island; de Laguna, 1934, pl. 52, figs. 1, 7—Cook Inlet). The human carvings of the Old Bering Sea culture differ from both of these southern styles. The small head carved in relief on the adz handle from Miyowagh (pl. 17, fig. 3) is realistic, but the face is long and relatively narrow in contrast to the short, wide faces characteristic of Kodiak and Cook Inlet. The three carvings from the Hillside site (pl. 12, figs. 5-7) also have long oval faces; furthermore, the heads come to a point at the top, in this respect resembling one of the Cook Inlet carvings (de Laguna, 1934, pl. 52, fig. 2). The latter has a beveled forehead comparable to two of the northern examples: Plate 14, figures 3, 4, and the large ivory doll figured by Hrdlička (1930, pl. 26). In both of the latter and to a certain extent in the head from the Hillside site (pl. 12, fig. 7) a median ridge extends from the forehead down the long narrow nose dividing the face into two sloping planes. Faces beveled in this manner, although often lacking features of any kind, are common in Siberia, as on the wooden fetiches of the Gilyak, Koryak, Yakut, and Yeniseians. In this connection our plate 14, figures 3-4, and the ivory doll figured by Hrdlička are also somewhat suggestive of the narrow oval human faces on Bronze Age stone pillars from the Minussinsk region of central Asia (M. Griasnov and E. Schneider, 1929; H. Appelgren-Kivalo, 1931).

With regard to incised ornamentation, the prehistoric material from the Alaska Peninsula, Aleutian Islands, Kodiak, and Cook Inlet provides nothing comparable to the elaborate designs of fully developed Old Bering Sea art. However, some of the simple, geometric Old Bering Sea elements are found in this region: pairs of long, lightly incised parallel lines (Jochelson, 1925, fig. 45; de Laguna, 1934, pl. 52, fig. 2); pairs of short transverse lines (de Laguna, 1934, pl. 40, fig. 2); and the spurred line (Jochelson, 1925, pl. 23, fig. 4; text fig. 72 *A*, and de Laguna, 1934, pl. 50, fig. 31). The latter element is also known from British Columbia (Smith, 1900, fig. 110).

Mathiassen (1929, pp. 48, 49) and Jenness (1933, p. 387) have suggested that there may be some connection between Old Bering Sea art and the rich ornamentation on Aleutian hunting hats. Although I can see little resemblance to Old Bering Sea art in the painted geometric designs on these hats (Ivanov, 1930, pls. 5, 9), there seems to be one possibly significant resemblance, namely, the designs on some of the bone ornaments attached to them (Ivanov, pl. 4, figs. 14, 15). Here we have panels of curving, petaloid shape, suggestive of "birds heads", which recall similar panels on such Old Bering Sea objects as plate 15, figure 3, and plate 21, figure 4.

We also find a number of Punuk elements in this region though nothing closely resembling Puńuk composition. The Aleutian dart points figured by Jochelson (1925, pl. 23, figs. 2-6) have lines along the bases of the barbs and sometimes a row of nucleated circles, somewhat reminiscent of Punuk art; detached dots are also found (pl. 26, figs. 24, 25, and text figs. 70 *A* and 70 *B*). Another object figured by Jochelson (pl. 26, fig. 28) is decorated with a nucleated circle and two spirals. It is of interest to note that this form of the spiral, which is also found on old wooden masks and hunting hats from the same region (Dall, 1884, pl. 29, fig. 75, and Ivanov, 1930, pl. 2, fig. 1; pl. 5; pl. 9) is lacking in the Punuk and represented by only one example in Old Bering Sea art (pl. 46, fig. 1).

The mechanically made circle and dot is also found at Cook Inlet, where it belongs to the Third Period of the Kachemak Bay culture (de Laguna, 1934, p. 120, pl. 55, fig. 2); other Punuk elements known from Cook Inlet are encircling lines, straight lines, spurred lines, and dots (de Laguna, p. 120).

Farther south, Smith has found the mechanically made circle, the single spurred line and the alternate spur design on objects from prehistoric shellheaps in British Columbia and Washington (Smith, 1900, figs. 109, 110; 1903, fig. 50; 1907, fig. 141), and the same designs are employed by some of the modern tribes, such as the Tahlton (Emmons, 1911, p. 53, fig. 12, *B, F, H*). Still farther south, in the Columbia River Valley, there is evidence of an old and rather highly specialized art style which depicts human figures with prominent eyes formed of concentric ovals and wide mouths with teeth represented by opposed rows of "spurs" (Steward, 1927, pl. 1). Spurred lines are also incised on the forehead (pl. 1, *a, d*), the arms (pl. 1, *j*), and on other decorated fragments as well (pl. 2, *a-d, f, g*); but the favorite motive is the related zigzag, which is present on many of these bone carvings, and which, together with raised freehand circles and chevrons, may also be seen on an object from another prehistoric site in the same region (Krieger, 1928, pl. 6, fig. 1). The presence here on the southern part of the Northwest Coast of an old art style based on the same simple geometric motives that are found in old Eskimo art suggests a greater antiquity for this style (and the related modern art of the same region) than for the elaborate representative and symbolic art of the Northwest Coast proper. Excavations along the north coast of British Columbia and in southeastern Alaska would be necessary to prove definitely whether or not modern Northwest Coast art is a relatively recent development. It is significant, however, that the excavations of Smith in southern British Columbia and of de

Laguna in Prince William Sound have revealed no evidence of this art in its modern form. On the basis of the present evidence, therefore, we would be justified in accepting the view expressed by Boas that the geometric ornamentation of the southern British Columbia tribes represents a survival of an older art style and that to the northward " we are dealing with the gradual intrusion of ever fuller animal motives into a well-established conventionalized art " (Boas, 1927, p. 281).

Although it is thus possible to point to certain resemblances between old Eskimo art and an old style of art from southern British Columbia and Washington, there is little evidence of relationship between the former and the highly developed modern art of the Northwest Coast. It is true that the Northwest Coast is the only area of high art development near Bering Strait; and in view of the fact that the modern Alaskan Eskimos have undoubtedly been influenced to some extent by Northwest Coast culture one might reasonably suppose that the elaborate art of this region was in some way related to Old Bering Sea art. But when we analyze the two styles, we see that they have so few elements in common and are so different in spirit and apparently in motivation that it is difficult to avoid the conclusion that they represent separate growths. Whether these growths were wholly independent of each other or sprang originally from a common source in the distant past is a problem concerning which we can say little until archeological data for the Northwest Coast are available. It must be borne in mind first of all that Old Bering Sea art is geometric. Its graceful and often complex designs are made up entirely of simple geometric elements: straight and curving lines, dotted or broken lines, spurs, circles, and ovals, which only secondarily are given the appearance of life forms. The prevailing tendency is to cover entire surfaces with delicate and harmonious patterns of curving lines and elevated circles or ellipses. The lines serve to divide the surface into fields or panels and at the same time to unify the composition as a whole; the circles and ovals, with their appended streamerlike spurs, serve to center the design and to fill in the blank spaces. Northwest Coast art, on the other hand, is very different both in conception and execution. The designs are elaborate representations of animal forms, distorted and combined into massive patterns which have a distinctly symbolic or totemistic significance, and in which geometric motives play only a negligible part. One of the few correspondences between Northwest Coast and Old Bering Sea art is the use of cross-hatched surfaces, which are common in the former, and comparatively rare in the latter art. The most obvious resemblance, the significance of which remains to be determined, is the prevalent eye motive. The Old Bering Sea " eye " is a geometric element—a concentric, and usually nucleated circle or ellipse surmounting a slight elevation, to which is added a second geometric element, a simple spur. The Northwest Coast eye is flat and is formed of a continuous line enclosing a solid figure. These differences in manner of production alone need not preclude a common origin for the two designs, since we have no knowledge as to what may have preceded the modern form on the Northwest Coast. It is by no means improbable that future archeological investigations there may reveal an earlier style of art closer to that of the Old Bering Sea. In the absence of such information, all we can say is that modern Northwest Coast art is so highly developed, so obviously localized and specialized that its ultimate origin cannot at present be determined.

Our comparison of old Eskimo art with that found in contiguous areas in America has revealed a number of resemblances between individual design elements but nothing closely resembling either Old Bering Sea or Punuk composition. Dorset art represents a fairly close approach to some of the simpler examples of Old Bering Sea style 1, but this very simplicity renders an explanation of genetic relationship uncertain. On the other hand, there is good reason for believing that this simple and presumably very early stage of Old Bering Sea art, based primarily on the use of straight or slightly curving lines and spurs, is the prototype of the northern style of modern Eskimo art in which the spurred line plays so important a role. The stiff, conventional appearance of the modern spurred line, particularly of the double line with alternating spurs, is that of an old and formal design which has become fixed and stereotyped through centuries of traditional use (see de Laguna, below, on this point); when, therefore, we find a prehistoric art style in the same region employing the same elements but in more variable form, it would seem entirely logical to regard it as ancestral.

Turning now to the Old World, we find the regular Eskimo form of the spurred line or the double line with rows of alternating spurs among the Chukchee (Bogoras, 1904-09, vol. 2, fig. 73); Koryak (Jochelson, 1905-08, vol. 2, fig. 191, *a, b*); Yukaghir (Jochelson, 1910-26, p. 452, fig. 157); Gilyak (Karutz, 1925, p. 33, fig. 11, 23); Tungus and Yakut (Karutz, 1925, p. 43, fig. 12; p. 75, fig. 24); and Lapps (Holmquist, 1935, fig. 1). Here, however, these designs, although frequently employed, do not occupy the important place they do in Eskimo art, but are overshadowed by the more developed angular style that in one form or another is widely spread throughout northern

Eurasia. Rows of triangles play an important part in this northern style but they may to some extent represent a secondary development, for as de Laguna has observed (1932, 1933, p. 96) ". . . . in some cases, under the influence of the gouged triangular ornamentation so popular in Siberia, the spurs are enlarged until they almost become little triangles." The transition from spurs to triangles is so easily effected that in this particular case one might be inclined to believe that there had existed here an earlier art style based on the more extensive use of the spurred line and rows of alternating spurs.

Though we have no archeological data for northern Siberia, there is ample evidence of the antiquity of both of these designs in Europe. The alternating spur, the more developed of the two designs, occurs at Maglemose, Megalithic, and late Iron Age sites (de Laguna, 1932, 1933, p. 96) and although rare in Paleolithic art, it is found in a few instances and in forms which are distinctly suggestive of Eskimo art (Piette, 1907, pl. 7, fig. 3). The single line with spurs attached is much more common, and in Scandinavia, in medieval times, it assumed forms very similar to those of the Eskimo (Holmquist, 1935, figs. 2-4). It occurs also in the Maglemose and Neolithic and is one of the most common geometric designs of Paleolithic art. In Paleolithic and Maglemose art, however, the spurred line is a highly variable element, occurring in a number of different forms, whereas in modern Eskimo art it is very uniform and is most often employed as a border design.

A number of writers have attempted to point out resemblances between Eskimo and Paleolithic art. As a rule the comparison has been drawn on the basis of realistic rather than geometric art, even though Hoffman, Sollas, and others have pointed out the obvious dissimilarity between the spirited and artistic creations of the Paleolithic artists and the simple pictographic art of the Eskimo. Since it now appears that pictographic art was unknown to the Old Bering Sea and Dorset cultures, this theory would seem to require no further consideration. Comparisons must be drawn, if at all, on the basis of geometric art. An important contribution in this direction has recently been made by Dr. Frederica de Laguna, whose scholarly paper constitutes the first really critical or analytical comparison of Eskimo and Paleolithic art. Her conclusions, conservatively expressed, emphasize the essential differences between these two art styles though at the same time admitting the possibility of a remote connection:

> It remains to be investigated whether both arts have the same underlying principles of style, that is, the same principles of combining decorative motifs and applying them to objects. We are struck, even from the first, however, by very great differences. Palaeolithic style is fluid: the creation and arrangement

of motifs appears to be a matter of individual taste, and we often seem to catch a particular pattern in the process of formation. The cases in which the decoration appears to be imperfectly achieved and but poorly adapted to the shape of the object, are due, I feel, to the fact that the artist has not really thought out his design. He has not thoroughly mastered his technique; he is learning through experimentation. . . . .

Eskimo art, however, is different. One feels that the patterns and the principles governing their arrangement, and even the choice of objects to which they are applied, were developed and fixed long ago. The clumsiness which we so often encounter is the result only of slovenly workmanship. In some cases the aesthetic appreciation of the design has atrophied to such an extent that it is apparently no longer necessary to execute the design neatly; it is enough if it is incised in the conventional manner. This, however, is an extreme case of the degeneration which has taken place in Eskimo art. The chief differences between Eskimo and Palaeolithic art are those between age and youth, and are perhaps what we should have expected, were Eskimo art derived from that of the Palaeolithic. [de Laguna, 1932-33, pp. 99-100.]

These considerations seem to show that a fundamental difference separates the art of the Eskimo from that of Upper Palaeolithic Europe. On the basis of the material at present available it is impossible to prove that Eskimo art is more closely related to that of the Palaeolithic than are other arts of comparatively simple content. Yet I am not sure that this negative conclusion is final. The differences in style upon which we have laid so much emphasis, may be only those which we should expect to find between an old and a young art; they are not differences in fundamental principles. Indeed, we may be demanding too great a uniformity and stability of tradition over such an enormous lapse of time. In view of the great changes in Alaskan art style from the Old Bering Sea period into modern times, is it surprising that Eskimo and Palaeolithic art have so little in common? [Pp. 102-103.]

The question now arises as to what bearing the Old Bering Sea art may have on this problem. Does this ancient Eskimo art show a closer approach to Paleolithic art than does that of the modern Eskimo? Certainly not in its most highly developed form, for the curvilinear patterns of Old Bering Sea styles 2 and 3 are very different from anything in Paleolithic art. This is not altogether true, however, of style 1. Even though specific resemblances are also lacking here, it is to be observed that the rather " scratchy " ornamentation on some of the style 1 objects (and also on some of the Dorset specimens) resembles in a general way the equally variable line and spur designs of the Paleolithic. The distinction between the line and spur ornamentation of the Paleolithic (and Maglemose) and that characteristic of Neolithic and later horizons in Europe is very much the same as that observed in the Eskimo area between the Old Bering Sea style 1 form of the design and that characteristic of the later Punuk and modern ornamentation: in both cases the older style is more generalized, more variable, whereas the later style has become fixed and formalized. In attempting to interpret this condition, however, we are confronted with the difficulty that immediately arises when an explanation is sought for simple and generalized resemblances of any kind. I have no doubt that the formal and conventional spurred line and alternating spur designs of the modern Eskimo are genetically related to the comparable designs that have been employed in parts of northern Eurasia from Neolithic to modern times. But whether a similar relationship may have existed between Old Bering Sea style 1 and Paleolithic art is problematical, not only because of the simplicity and instability of these particular designs but also because our knowledge of this earliest phase of Eskimo art is still so meager. We can only point to the significant fact that in the two oldest known phases of Eskimo art—the Old Bering Sea and Dorset—the modern, stereotyped line and spur designs do not occur; that they were preceded by a related but more generalized ornamentation employing the same elements; and that the latter ornamentation seems to show closer stylistic affinities with Paleolithic art than with later styles in either America or Eurasia.

If we extend our search to eastern Asia we fail to find a general distribution of the line and spur motives comparable to that observed in northern Eurasia, and when they do occur, it is in the Amur region, Kamchatka, and the Kurile Islands, where northern influences have been the strongest. Thus, both the spurred line and the alternate spur are known to the Gilyak (Laufer, 1902, pp. 8-11; Karutz, 1925, p. 33, fig. 11, 23) and the Ainu (Torii, 1919, pl. 17, *D*). From a prehistoric site in Kamchatka, Jochelson figures a bone belt buckle with a zigzag band formed of alternating triangles; this encloses an interwoven ribbon design suggestive of old Scandinavian art (Jochelson, 1928, pl. 16, fig. 8). From another prehistoric Kamchatkan site comes a bone object ornamented with rows of alternating spurs (Nakayama, 1934, pl. 4, and fig. 13, 10). Torii figures a bone needle case with a simple decoration including spurred lines, which was excavated from a Neolithic site on the Kurile Islands (1919, pl. 32, *B*, 3), also a bone belt buckle (pl. 32, *B*, 1) with a decoration similar to the one from Kamchatka obtained by Jochelson; both this object and a bone comb (pl. 32, *A*, 1) have the interlaced ribbon design, which, however, is better executed than on the Kamchatkan specimen and closer to the old Norse designs. Three more bone objects with this same ribbon design have been excavated recently in the Kuriles (Baba, 1934, pl. 1, figs. 1, 4, 6). Figure 3 of the same plate is the bone comb previously referred to (p. 78) bearing a double line and dot ornamentation reminiscent of Old Bering Sea art.

The spurred line is employed in this part of Asia in much the same way as it was in old Scandinavian art; in both cases it appears as a rather incidental part of a more elaborate ornmentation, to which it bears no intrinsic relation. One has the feeling that it is an old, formal element, so fixed in the minds of both peoples that it has survived to hold a place, even though a relatively unimportant one, in the more sophisticated ornamentation that came into use later. And in both cases, the more developed ornamentation is one based on scrolls and interwoven ribbon designs.

As far as I am aware, the only instance in which the spurred line and alternating spur motives are found on the Asiatic mainland south of the Amur is on the painted pottery of the Neolithic Yang Shao culture of northern and western China (Palmgren, 1934). However, the general ornamentation on these vessels is so unlike anything else known from China and so close to the form of ceramic decoration prevailing at Anau and Tripolje in Turkestan and South Russia that it seems necessary to regard it as part of a cultural complex introduced into China from these regions. If we disregard the Yang Shao pottery, therefore, it would appear from the geographical distribution that the simple line and spur ornamentation which stands out so prominently in the art of northern Eurasia and America penetrated only to a slight extent into eastern Asia, no further in fact than to the southernmost of the Palae-Asiatic peoples. This is probably to be explained on the assumption that such a simple " barbarian " design would have little appeal to a people like the Chinese, who possessed an indigenous, self-contained art which had reached a high stage of development more than 3,000 years ago.

In the foregoing pages we have noted the distribution in northern Eurasia and eastern Asia of the line and spur motives that formed so important a part of what seems to have been the oldest phase of Old Bering Sea art. There remains to be considered the more typical, curvilinear art of Old Bering Sea styles 2 and 3. Are these graceful and elaborate compositions that at first glance appear so exotic, so strangely out of place in the Arctic, to be regarded as of strictly local origin, or is there, perhaps, as Jenness has suggested (1933, p. 387), some remote relationship with the highly developed art styles of eastern Asia? It seems more than likely that the later forms of Old Bering Sea composition are of local origin; at least nothing closely approaching them is known from eastern Asia. The particular combination of elements employed—straight and curving lines, dotted lines, spurs, small circles set between converging lines, and larger circles or ovals—is to be found in no other art style, and the patterns formed by these elements are also unique. We may, however, look for correspondences in the elements themselves. The two regions of highest art development in eastern Asia are China and the lower Amur valley. In the Amur region we find today a highly specialized exuberant art style based on the use of continuous wavy lines and spirals. The spirals are employed in a great variety of forms, usually in rich conventional representations of plant, bird, and fish designs, all of which seem far removed from Old Bering Sea art. We will likewise search in vain for any Old Bering Sea resemblances in Chinese art of the last 2,000 years, from the Han dynasty on. However, during this period Chinese art has undergone radical changes, so that it is in many respects quite a different art from that which prevailed in the Shang (Yin) and Chou dynasties (1766-255 B. C.). And although here again we are unable to point to anything resembling Old Bering Sea composition, there is one possibly significant resemblance, namely, the presence of the elevated circle or ellipse representing an eye. In Shang and Chou art the eye motive holds a most important place, being employed in conventional representations of the ever present *t'ao t'ieh* head, that of a fabulous monster with large staring eyes and prominent ears and nose. On bronze vessels the eyes are usually rounded bosses, but on some of the ivory and bone carvings they are formed of turquoise inlays [11]—recalling the similar use of inlays of baleen and wood by the Old Bering Sea Eskimos. These elevated, nucleated eyes, though always part of a recognizable animal design, present a close parallel to the elevated "eyes" of later Old Bering Sea art, much closer in fact than that afforded by the flat Northwest Coast eye. On the other hand, it is likewise true that the eyes on the *t'ao t'ieh* heads, particularly when they are not raised above the surface, are very similar in appearance to the Northwest Coast eyes. The similarity in this case lies mainly in the triangular appendages which both the Chinese and Northwest Coast artists placed at the ends of the eyes in order to produce a more realistic appearance; whereas the Old Bering Sea artists, though clearly recognizing the zoomorphic implication of paired "eyes", usually shopped short of portraying an actual animal design by this means.

The eye design in early Chinese art, therefore, finds close parallels in both early Eskimo and Northwest Coast art. On the whole, it would seem not improbable that the "eye" motives in the three regions were

[11] The exhibition of early Chinese bronzes. Bull. 6, Mus. Far Eastern Antiquities, pp. 81-136, pls. 1-53, Stockholm, 1934. Introductory text unsigned, description of plates by Dr. Nils Palmgren. Reference to turquoise inlay on p. 99, pl. 3, figs. 6, 7.

related in origin. Though we have no means of knowing the age of the old Eskimo art, it might well have been roughly contemporaneous with the old Chinese style; at least there would be no serious anachronism if we were to assume a relationship between the two. There is less certainty, however, that this would be true of Northwest Coast art; and until we have archeological evidence of the antiquity of the latter it would be best to reserve judgment with regard to its possible affinities with early Chinese art.

If we assume that the "eye" designs in old Eskimo and Chinese art may have been related, Old Bering Sea art might then be explained as a blending of northern and southern elements—a linear, geometric, basically line and spur ornamentation that was later enriched by the addition of curvilinear motives, especially circles and ellipses. In just what way and through what intermediaries this might have come about we have no way of knowing. Verification of such a hypothesis might be possible if archeological data for the intervening coastal area were available. There may have existed an older art style in the Amur valley that was closer to old Chinese or even to Old Bering Sea art than is the present elaborate spiral ornamentation of this region.

If the above tentative suggestion of a relationship between the elevated "eye" motives of old Chinese and Old Bering Sea art be valid, it would mean that the indirect contacts which brought this about occurred after the rise of civilization in China. The predynastic culture stages afford no parallels, for, with the exception of the painted pottery of the Yang Shao culture, the Chinese Neolithic is practically devoid of art. Although the Yang Shao culture possesses several important features in common with Chinese culture of the Shang dynasty—semilunar slate knives, the adz, and certain vessel shapes—and although the time interval between the two may have been considerably less than a thousand years, they show not the slightest connection in art.[12] Shang art, to judge from the recent finds at An Yang in northern Honan, already exhibits in matured, though perhaps classic and simple form, the matlike decoration of angular scrolls,

[12] The sudden appearance of Shang art and its lack of connection with anything earlier in China is the more remarkable in view of the fact that the recently discovered Ch'êng-tzŭ-yai or "black pottery" culture of northern China, of Neolithic age, in certain other respects bridges the gap between the Yang Shao or "painted pottery" culture and the Shang. In addition to the semilunar slate knives, adzes, and vessel shapes referred to above, it possessed oracle bones (but without inscriptions), "white" pottery, walls of pounded earth, the horse, ox, and sheep, all of which were also present in the Shang (information from Herlee G. Creel, manuscript).

the characteristic "double F" motive, and the *t'ao t'ieh* and other animal designs that continued to dominate Chinese art for well over a thousand years.[13]

In attempting to trace the beginnings of Chinese art, the sinologist is faced with a problem very similar to that presented by the sudden appearance of Old Bering Sea art. Here in China, just as at Bering Strait, we find an ancient and highly developed art style for which there are no known direct antecedents, even though occasional affinities may be traced and general similarities in spirit detected. As they appear today, both Shang and Old Bering Sea art (at least styles 2 and 3 of the latter) seem thoroughly indigenous in their respective localities, but this might not be true if we had knowledge of the stages leading up to them, particularly the stages antecedent to the Shang.

Students of early Chinese culture have frequently been impressed with resemblances between Shang art and what in a general sense may be termed "Pacific" art,[14] but the significance of these general resemblances is obscured by the fact that the Pacific examples usually mentioned, such as Maori, Melanesian, Northwest Coast Indian, are all modern, whereas the comparable Chinese art dates from the first or even the second millenium B. C. If we bring Eskimo art into the comparison, however, we are not faced with this particular dilemma, for the parallels in this case are found only in the art of the Old Bering Sea culture, the most ancient form of Eskimo culture thus far known. The fact that both of these old art styles employed the elevated eye design and that there is also at times a vague and general resemblance in spirit, leads one to wonder whether closer resemblances may not be shown when we know more of the prehistoric art styles of the intervening areas. On the basis of the information at present available it would not seem unreasonable to anticipate that either in China or somewhere in the coastal area between Manchuria and Bering Strait—perhaps in the Amur Valley—there will yet be discovered an art which may have possessed more features in common with both Old Bering Sea and Shang and which may provide us with the source from which the two styles may have derived at least some of their elements.

A fact to be borne in mind in connection with the possible relationship between the elevated eyes of Shang and Old Bering Sea art is that in the case of the latter we have a local prototype in the smaller

[13] Hamada, 1926; Siren, 1929; Exhibition of Early Chinese Bronzes, 1934, pl. 1-7; Karlbeck, 1935, pl. 1-7.

[14] Fenollosa, vol. 1, pp. 3-9; Exhibition of Early Chinese Bronzes, p. 85.

flat circles of style 1. Since these seem to have developed into the larger, elevated, paired "eyes" of styles 2 and 3, there might seem to be little need of bringing Chinese art into the comparison at all. However, regardless of antecedent stages in either region, the resemblances between the developed Eskimo and Chinese eye motives are so striking that I cannot avoid the feeling that we are dealing with homologous features. Accordingly, for the present, we can only point to the facts which lead to this conclusion and leave for future determination the exact nature of the cultural movements and contacts responsible.

Jenness has called attention to the resemblances between Old Bering Sea and Melanesian art, and, strangely enough, this is one of the few regions where we find anything approaching Old Bering Sea composition. Melanesian art employs, among other elements, the spurred line, rows of alternating spurs—usually thickened into triangles—zigzags, and freehand circles, and although it exhibits a far greater variety of design and a freedom of execution that contrasts strongly with the delicacy and restraint of Old Bering Sea art, there are nevertheless certain correspondences to be observed. The closest perhaps are the designs applied to the pronged ends of drums or to lime spatulas, where, just as in Old Bering Sea art, pairs of circular or elliptical figures are so arranged in relation to curving lines and surfaces as to suggest the eyes of an animal (Haddon, 1912, vol. 4, p. 371, fig. 359). Also, the common Melanesian practice of placing a circle or "eye" at the larger end of a long, tapering, oval space or panel recalls the equally characteristic Old Bering Sea design of a circle placed at the outer ends of two converging lines. Unfortunately, we know nothing of the ancestry of Melanesian art. The present evidence suggests a local origin, as there seems to be nothing comparable to it on the Asiatic mainland. The fact that certain other Oceanic culture elements such as shouldered celts, star-shaped club heads of stone, and other forms of stone implements have their parallels in Neolithic Japan, China, or Indo-China suggests a stratification of Oceanic culture, such elements as these being older than the various local art styles. The resemblances between modern Melanesian and Old Bering Sea art would therefore be explained as the result of convergence, an explanation that appears the more probable in view of the fact that the resemblances here are closer than between the old Eskimo art and any other, ancient or modern, from the intervening Asiatic mainland.

There remains to be considered the question of the Old World relationships of Punuk art. When I first described Punuk art I assumed that it represented an outgrowth from that of the Old Bering

Sea (Collins, 1929, pp. 14, 38-39). This interpretation was questioned by de Laguna (1932-33, p. 79), who felt that "rather than regard Punuk art as a purely autonomous growth on Alaskan soil out of the Old Bering Sea culture art, ... I am inclined to see in it strong Siberian influences."

The compass-made circle of the Punuk which I had regarded as having been derived from the freehand circle of the Old Bering Sea culture, was thought by de Laguna to be related to the dot-and-circle which had a wide distribution in Europe during the Bronze and Iron Ages, and which is frequently employed by the modern tribes of northern Eurasia:

> From the appearance of the dot-and-circle at the beginning of the Bronze Age in Scandinavia, ... we can trace a continuous distribution across northern Europe and Siberia, to the Aleut and the Eskimo. The dot-and-circle, curiously enough, does not appear in the East Finmark find, described by Solberg, though it was a popular design all over Europe in the Iron Age and among the modern Lapps. However, it does occur in the bowl of an archaeological spoon from Norwegian Lapland. The evidence, I suggest, points to a Siberian and ultimately to a Eurasian Bronze Age origin of the Eskimo dot-and-circle. This motif came to Alaska during the Punuk culture stage, along with metal in small amounts, the technique of applying dots to lines and of filling the incisions of the design with paint,—all elements of Siberian art. [de Laguna, 1932-33, p. 82.]

It might be argued that the excavations at Gambell have now demonstrated the close relationship between Old Bering Sea and Punuk art. Although the evidence for continuous local change is not as complete for art as it is for harpoon heads or the winged ivory objects, it is clear that there was a period—the early Punuk—when the technique of engraving the lines and the manner of their arrangement were typical of neither the Old Bering Sea nor the Punuk, but of something intermediate between the two. There was evidently a definite breaking down of Old Bering Sea art on St. Lawrence Island and a blending of some of its elements into the early Punuk. But while we may recognize that changes of this nature did occur locally, it must be admitted that de Laguna is entirely correct in contending that the more developed form of Punuk art, including the nucleated compass-made circle, has distinct Siberian affinities. The relationship between the Old Bering Sea and Punuk circles is probably as stated by de Laguna (1932-33, p. 83):

> However, there has been some connection with the art of the Old Bering Sea culture. It is because the free-hand concentric circles and ovals were used so much in the older period that the mechanical dot-and-circle, coming from Siberia, was adopted so readily by the Punuk Eskimo. The neatness and

ease with which it was executed must have been largely responsible for its supplanting the free-hand figure.

De Laguna has also remarked upon the similarity between the Punuk design of dots attached to the ends of lines and the same design as it occurs in Solberg's Iron Age site in East Finmark, Norway (de Laguna, 1932-33, p. 79). There is no mistaking this resemblance, and although the designs illustrated by Solberg (1909, figs. 86, 127, 131, 148) are simpler and somewhat more uniform than those of the Punuk, they seem to provide the closest approach to Punuk composition that we have anywhere outside the Bering Sea region.

An old site on Kola Bay, northern Russia, excavated by A. V. Schmidt, has yielded certain implement types identical with those from East Finmark, and has provided another parallel to late Punuk art—bands of deeply incised parallel lines (Schmidt, 1930, pl. 1, figs. 4, 5; pl. 4, fig. 3).

The less common Punuk design of connected **Y** figures (pl. 65, fig. 7) is another that is widespread in northern Eurasia. It occurs in simple form at the East Finmark site (Solberg, 1909, figs. 107, 131) and in more developed form among the Vogul and Ostiak (Rudenko, 1929, p. 16, fig. 1; p. 17, fig. 1; p. 18, figs. 5, 9-11) and the Yakut (Karutz, 1925, p. 75, fig. 17).

The later form of Punuk art, therefore, shows unmistakable affinities with that of the existing tribes of northern Siberia and with that which existed in Iron Age times in northern Europe. The earlier form of Punuk art seems to have been derived directly from that of the Old Bering Sea, and like the latter, is definitely limited in its distribution.

Engraving Tools

The small engraving tools of ivory and wood, some with particles of iron still adhering to the points (pl. 60, figs. 10, 11; pl. 81, figs. 17-20), are of particular significance as showing definitely that the St. Lawrence Eskimos of the Punuk stage knew the use of metal. It has been apparent for some time that the designs of Punuk art were executed with metal tools (Collins, 1929, pp. 20, 21, 27, 28; 1932, pp. 117, 118). This is indicated by the extreme precision and regularity of the lines, which are deeply and evenly incised in contrast to the more delicate and variable lines of Old Bering Sea art, and especially by the perfectly round nucleated circles, which could only have been produced by metal bits or compasses and which are so different in appearance from the freehand circles and ellipses of the older art. From the Gambell finds we can now see the kind of implements with which, in all probability, the lines on the Punuk pieces were engraved, though as yet we have none of the implements that were used in making the circles.

Except for these iron-pointed engraving tools, the only other evidence of metal at the old sites was furnished by the ivory knife handles described on page 146, the sockets of which seemed designed for metal blades. Other cutting and piercing tools—knives, scrapers, harpoons, arrows, adzes, etc.—were provided with stone blades, which were found in large numbers at all of the sites. Apparently, when metal in small quantities first reached St. Lawrence Island, it was so treasured that it was used only for the most delicate work; only after contacts with the Russians had been established were the ordinary types of implements equipped with iron blades.

The question that now arises is the source from which the Eskimos of the Punuk stage derived their iron. As was pointed out previously the conditions at Punuk Island and Cape Kialegak, to say nothing of Gambell, were such as definitely to preclude the possibility of its having been obtained from the Russians either directly or indirectly; for the Cossacks did not reach northeastern Siberia until about 300 years ago, and yet Punuk art, with its metal engraved lines, was found even in the lowest levels of the 16-and 18-foot middens at Punuk Island and Cape Kialegak. Furthermore, according to every indication the Punuk midden had been abandoned for around 200 years. It seems obvious therefore that iron in small quantities must have been introduced on St. Lawrence Island some centuries before the arrival of the Russians in northeastern Siberia early in the nineteenth century. The exact source of the metal must for the present remain in doubt, but since there is historical evidence that iron was being used in China around 500 B. C. (Bishop, 1932, p. 630), and since it has an even greater antiquity in central Asia, there is no reason why it should not also have reached the more northerly tribes at a later date, possibly in the early centuries of the present era. In fact, from a Chinese reference cited by Laufer (1914, p. 262 *et seq*), it appears that iron was known to at least one of the tribes to the north of China in the third century A. D. These were the Su-shên, a barbarian tribe dwelling somewhere north of Korea, who in A. D. 262 sent to China a tribute consisting of bows, arrows, crossbows, and suits of armor made of leather, bone, and iron.[15] If iron was as common as this reference would seem to indicate, one might reasonably suppose that

[15] Laufer's statement is quoted on p. 329 in the section on plate armor. For a fuller account of this incident, and of the Su-shên themselves see Ikeuchi (1930, pp. 97-163); reference on p. 136.

some knowledge of it had also penetrated still farther north and that before many centuries had passed it would have been in the possession of the tribes of northeastern Siberia. In this way iron in small quantities might possibly have reached Bering Strait and St. Lawrence Island more than a thousand years ago.

Ornaments and Toys

It is somewhat surprising that the Old Bering Sea Eskimos, who felt impelled to decorate even their most commonplace implements, seem to have cared so little for personal adornment. Labrets and ear ornaments, worn so extensively by the modern Alaskan Eskimos, seem to have been entirely unknown. If we may judge from the Gambell finds, brow bands and buttons were about the only objects of personal adornment used during the Old Bering Sea period.

In the Punuk stage we find a number of ivory pendants—apparently ear ornaments (pl. 82, figs. 1-12) and ivory links for attachment to the handles of knives, drums, etc. (pl. 82, figs. 29-34). Both the ear pendants and the link ornaments are very similar to those of the Thule culture (Mathiassen, 1927, vol. 1, pl. 30). Drop pendants are seldom used by the modern Alaskan Eskimos, but they are common in Greenland and the Central regions, both in archeological and modern collections (Mathiassen, 1927, vol. 2, p. 116; 1930 b, pl. 18, figs. 3-6; 1934, pl. 7, figs. 13-15). They are likewise characteristic of the Kachemak Bay culture of Cook Inlet (de Laguna 1934, pl. 50). Link ornaments have a wide distribution in the Old World. In the Iron Age of Europe a great variety of such ornaments are found (e. g., Hoernes, 1898, esp. pl. 13, figs. 1, 8). They likewise occur in Mongolia as appendages to bronze objects of Scytho-Siberian style (Anderson, 1933, pl. 2, figs. 1, 2), and in southeastern Asia, in post Han times, as attachments to bronze buckles (Goloubew, 1930, pl. 14, fig. 13). It is probably from the latter source that the link ornaments of the modern New Guinea natives have been derived (e. g., the link pendants on lime spatulas—Edge-Partington and Heape Album, 1892, pl. 260, figs. 2, 3). The prevalence of these ornaments in the Iron and Bronze Ages of Europe and Asia would seem to point to a Eurasian origin for the various forms of link and pendant ornaments so characteristic of the Punuk, Thule, and modern phases of Eskimo culture.

Although the Old Bering Sea Eskimos used ivory extensively for other purposes, the children's toys were mostly made of wood, bark, or baleen. The small ivory birds, dogs, foxes, bears, etc., which are so common on St. Lawrence Island today, were entirely lacking in the Old Bering Sea and Punuk periods. The few animal carvings of Old Bering Sea age give the impression of having been ornaments rather than toys; the slotted bases of the two small ivory birds (pl. 13, figs. 4, 6) and the slots in the feet of the polar bear (pl. 13, fig. 3) from the Hillside site show clearly that these had been attached to some flat surface. The Amassalik Eskimos often attach small figures of birds and mammals to their wooden eye shades, boxes, and other objects, and a similar practice is sometimes observed in Alaska. In the Old World we find bird figures used in somewhat the same way, and it may be that there is some relationship between these and the bird ornaments of the Old Bering Sea period: compare, for instance, the small birds sometimes attached to the covers of Chinese bronzes—ceremonial vessels of the Chou dynasty; similar small birds perched on the backs and the breasts of larger birds mounted on wheels—bird chariots—of the Han and the later dynasties in China (Laufer, 1906, figs. 19, 20, 24; Seligman, 1928, pl. 20, figs. 1, 2); on Sarmatian standard tops of bronze (Rostovtzeff, 1929, pl. 12, fig. 4), and on various other kinds of objects from the Iron Age of central Europe (Hoernes, 1898, pl. 8, figs. 12, 13; pl. 9, figs. 1, 6, 7).

The small ivory bird figures, used as toys or as " dice " in children's games (pl. 83, figs. 7-11) seem to be confined to the Eskimo. They were found in large numbers at the Thule culture sites in the Hudson Bay region; they occur in both archeological and modern collections from Greenland and are used by the modern Eskimos in Baffin Land and Labrador. In the west they are known only from the vicinity of Bering Strait, at Cape Prince of Wales, St. Lawrence Island, and East Cape and Plover Bay in northeastern Siberia (Mathiassen, 1927, vol. 2, pp. 117-118). Although they are exceedingly common on St. Lawrence Island today, they must have been introduced only in recent years, as they were not found at the four oldest sites but only at the old section of Gambell and one of the recent house ruins. Their age at Bering Strait is not known; at Barrow they do not occur at all, either in modern times or at the old sites. As the writer has pointed out previously (1929, p. 44) the absence of these ivory bird figures at the older Alaskan sites and their presence among the modern Eskimos would seem to indicate that they were among those elements of culture brought to northern Alaska by a late return migration of Thule Eskimos from the eastward.

Harpoon Heads

The collection of harpoon heads from Gambell was sufficiently large to enable us to trace, step by step, an unbroken line of development from the Old Bering Sea period down to the present time. We shall now consider the harpoon heads from other parts of the Eskimo area in an attempt to determine the relation they may bear to the St. Lawrence forms, and if possible the lines of development they may have followed.

The harpoon heads obtained by Jenness at Bering Strait are in general conformable to those from Gambell, and the chronological relationships, as originally outlined by Jenness, find ample confirmation in the Gambell sequence. There seems to have been a parallel course of development at the two places, although the types were never identical; thus while the greater number of the Wales and Diomede heads would be included by definition in certain of our Gambell types, there are, as might be expected, subtle differences in shape, proportion of parts, and in various other minor features which stamp them with an individuality of their own. Jenness found the oldest types to be those with trifurcated symmetrical spurs, double line holes, and side blades—features which were also characteristic of the oldest Gambell types, open socket types I x and I y. The only other locality from which this type of harpoon head has been reported is Point Barrow (Wissler, 1916, fig. 9). Jenness also illustrates a harpoon head corresponding to our open socket type II y, which differs from I y in having a single line hole and a spur that is asymmetrical and somewhat lateral instead of symmetrical and median (Jenness, 1928 a, pl. 12, d). This type, which appears to have been derived from type I y, is of particular interest because of its close relationship to the Birnirk group, characteristic of the older sites around Barrow. The type II y heads from St. Lawrence Island all have two side blades; some of the Birnirk heads also have two, but the most common form is that with one side blade and an opposite barb. The latter has been found as far west as the Kolyma River in Siberia (Mathiassen, 1927, vol. 2, p. 180) and seems to be the form which gave rise to the Thule type 2, with two barbs.

Although some of the earliest St. Lawrence forms have divided spurs and side blades—features especially characteristic of the Birnirk heads—it should be noted that heads closely resembling the Birnirk type in shape as well as in structural features do not appear on St. Lawrence until the Punuk stage. Some of these Birnirk-like heads have been shown in plate 24, figures 9, 10; plate 27, figures 1-4; plate 28, figures 1, 2; plate 70, figures 1-3. The fact that almost all of them are made of bone, which is very rarely used for other types of harpoon heads on St. Lawrence, but which is the material from which the Birnirk heads are commonly made, is further evidence of a direct relationship. It is by no means improbable that these Birnirk-like heads were introduced into St. Lawrence Island from the north.

Most of the harpoon heads which Jenness excavated at the old mound site at Wales belonged to Mathiassen's Thule type 3. On St. Lawrence Island this is the predominant type of the Punuk period (open socket type III (a) x), of which 161 examples were found at Gambell. However, Jenness found that the lashing arrangement on this type of harpoon head was not always the same:

> [the modern closed socket type] was preceded at Wales and the Diomede islands by a type with an open socket into which the foreshaft of the harpoon was lashed through a series of holes (either two or three) drilled on each side of the socket. Earlier still, a rectangular slot on each side fulfilled the same function as the drilled holes; or else the edges of the implement were trimmed away for the lashing. Only the two last forms (considered here as one type) were present in the mound dwellings at Wales. . . . . The rubbish heap on Little Diomede island . . . . showed the succession fairly clearly. In the upper layers there were only closed-socketed harpoon-heads of different varieties; lower down, nearly all had open sockets with drilled holes for the lashings; and at the 3-foot level the open-socketed type with rectangular slots or no holes at all for the lashing began to predominate. [Jenness, 1928 a, p. 76.]

In describing the harpoon heads in the collection which Knud Rasmussen purchased from the Eskimos at East Cape, Siberia, Mathiassen (1930 a, p. 72) remarks on the fact that "of the harpoon heads, the Thule types are very much in the majority." Thule types 1 and 3 are both included in this collection, some of them having slots and others drilled holes for the lashing. Because these two lashing arrangements occur promiscuously in this collection, in similar collections from the Arctic coast of Alaska, and at all of the Thule sites in the Central region, Mathiassen (1930 a, p. 77) feels that "no general rule can apply; the one method seems to be just as ancient as the other. There is, however, something that might indicate that the method with holes is the one *that has held out longest*." However, if we base our conclusions on the western material that has been systematically excavated, this question appears in a different light. First of all, we see that these East Cape harpoon heads can have no bearing on the question as to what features may be ancient in the Bering Strait region, since they do not belong to the older types, but on the contrary, to the late Punuk types. Thus, the small bladeless form, Thule type 1, does not appear at Gambell until very late in the sequence—only from Seklowaghyaget, the old section of Gambell, and the contemporaneous house ruins which appear to date from about the eighteenth century. Most of these Gambell heads, which I have described as open socket type V (pl. 71, figs. 12, 13, 15, 16) differ somewhat from Mathiassen's Thule type 1 in having the "wedge-shaped" socket, which is perhaps the most striking feature of the protohistoric heads from St. Lawrence. The other East Cape type (Mathiassen, 1930 a, pl. 18, figs. 3-4—Thule type 3) is somewhat older, conforming to our open socket type III (a) x, and particularly to the heads of that type from Ievoghiyoq and Seklowaghyaget (e. g., pl. 70, figs. 9-14; pl. 71, figs. 3, 4). None of the harpoon heads excavated at Gambell had drilled lashing holes, although these were present on one specimen purchased from an Eskimo (pl. 71, fig. 21). This was a very late form, with large triangular line hole and rivet holes at the tip. Nelson figures another harpoon head from St. Lawrence Island with drilled lashing holes (pl. 57, fig. 13); this head has the general features of Thule type 2 and has also an iron blade and rivet holes.

In view of the above conditions it is evident that in Alaska drilled lashing holes on harpoon heads are relatively recent and definitely later than rectangular slots.

Strangely enough, drilled lashing holes are rare at Barrow, although they are found on some relatively late types of heads at Point Hope to the southward, at Point Atkinson near the mouth of the Mackenzie (Mathiassen, 1930 a, pl. 12, figs. 2, 4; pl. 1, figs. 1, 2), and at Langton Bay—Franklin Bay district—to the east of the Mackenzie (Wissler, 1916, figs. 22, 23 *b*). Wissler (p. 439) has called attention to the relationship between the old harpoon heads from Alaska and the Central regions as shown by this feature, pointing out that drilled lashing holes are also found at Southampton Island, Ponds Bay, and Smith Sound. Now that we know that this feature was characteristic of the Thule culture we have an explanation of its occurrence on Southampton Island and at Smith Sound, for at these places the Thule culture survived up to modern times (Mathiassen, 1927, vol. 2, pp. 163, 167). Drilled lashing holes are also characteristic of the Greenland phase of the Thule culture (Mathiassen, 1930 b, pl. 5, figs. 2-5; 1934, pl. 1, fig. 1; pl. 3, fig. 3; pl. 8, figs. 1, 2). Wherever the Thule culture has existed, therefore, we find that this method of lashing has been employed. On the other hand, it was unknown in Alaska until relatively recent times, and was, according to every indication, one of a considerable number of culture traits brought to Alaska by a return migration of Thule peoples within the past few centuries (Collins, 1929, pp. 43, 44; 1935, p. 463).

Another feature, often associated with drilled lashing holes, and apparently having the same history, is the rivet hole at the tip of the harpoon head for holding the blade in place. Rivet holes are not present on any of the older harpoon heads from St. Lawrence Island, Bering Strait, or Barrow, although the modern iron-bladed heads almost always have them. In Alaska, apparently, rivet holes are always associated with metal blades, whereas in the Thule culture they are found on both iron- and stone-bladed heads. It seems possible that the Thule custom of having a rivet to hold stone blades in place in harpoon heads, which is not actually necessary, may have had it origin in the Thule lance heads (Mathiassen, 1927, vol. 1, pl. 12) where the stone blade was lashed to the end, on the outside, and held more securely in place by means of one or more pegs or rivets.

We may now examine the Thule types as a whole and see what relation they may bear to the Old Bering Sea and Punuk types. Mathiassen (1927, vol. 2, p. 11) says of his harpoon head classification: " This system is so arranged that the forms of harpoon heads which, from a typological point of view, must be regarded as being the simplest, are always placed before the more complicated, derived forms." Then, after observing the distribution of the several types at the Central Thule sites, he finds (1927, vol. 2, p. 14) that " The composition of these finds indicates that the forms which for typological reasons are regarded as being the most simple are really the oldest too. The Thule group A 1 [the open socket group] is the oldest and, within this, the fundamental types a, b 1 and c 1 are the oldest. Within B [the flat group] it is I [those with open sockets] that is the oldest group; B II [flat with closed socket] must be regarded as the youngest of all four main groups."

As stated above, the small bladeless harpoon head—Thule type 1—is one of the very latest of the prehistoric types at Gambell, however old it may be elsewhere. It appears suddenly at Seklowaghyaget and may therefore have been imported. If it developed locally the most likely prototype would be one of the Birnirk-like forms such as open socket type II (a) y or II (d) (pl. 28, figs. 2, 3), but of this there is no definite evidence. The Thule type 1 is a very simple form of harpoon head, and one which on theoretical grounds might well be very ancient. But simplicity of form alone is of little value as evidence of antiquity until the possibility of the alternative explanation—degeneration—has been removed. In the present case, lacking the specific data that might clarify the problem, we must judge the age of the Thule type 1 harpoon head from its setting: if the accompanying elements of the Thule culture prove to be ancient we may assume that the simplicity of this particular element represents an original condition; if not, then we must recognize that the simplicity in question may just as readily be the result of degeneration.

We find a similar condition with regard to the barbed form, Thule type 2. Here again the Gambell finds throw no light on the origin of the type, for it appears quite suddenly and rather late in the sequence, at Ievoghiyoq (pl. 70, figs. 4-6—open socket type IV). It is, however, earlier at Gambell than the Thule type 1, which appeared only at Seklowaghyaget and the old section of Gambell. The present evidence indicates that the Thule type 2 head originated on the Arctic coast, probably around Point Barrow, and was later introduced on St. Lawrence Island; for at Barrow the barbed form holds an important place, from the " Birnirk " stage, when there was usually one prominent barb with an opposite side blade, to late prehistoric times when the form with two or even four barbs, but with a closed socket, became common (Collins, 1935, pl. 11, figs. 3, 4).

Because of its relatively simple form and wide distribution, Mathiassen considers that the Thule type 2 head is older at Point Barrow than the Birnirk type, which was the prevailing form revealed by the excavations of Stefansson and Van Valin at old abandoned sites around Barrow:

> . . . . the Birnirk types are almost predominant in the Van Valin collection, which otherwise contains hardly anything else than implements of the Thule types, and also in the Birnirk collection, which forms a transition from the Van Valin stage to the later Pt. Barrow culture, whereas the Thule harpoon heads do not occur in any of these collections and thus must presumably be earlier than these . . . . judging by their shape the Birnirk types seem to have been derived from the Thule harpoon heads and presumably have appeared as the result of the influence of the Thule types from the Bering Sea Culture . . . . this influence must have been brought to bear after the Thule Culture had spread from Alaska to the east. [Mathiassen, 1930 a, p. 33.]

It is difficult to see why the absence of the Thule heads in these archeological collections should be taken as presumptive evidence of their having belonged to some still earlier period, particularly since these same Thule heads were by no means lacking in the collections from northern Alaska which were purchased from the Eskimos. A more likely explanation would be that the collections obtained from the Eskimos were relatively recent (for wherever the Alaskan Eskimos dig for specimens they choose the most accessible ruins, and these are usually the most recent) whereas the material excavated by Stefansson and Van Valin at old " mound " sites away from the present villages represented an earlier stage of culture.

Confirmation of this view seems to have been furnished by the more recent systematic excavations made at these same Barrow sites by James A. Ford for the Smithsonian Institution, the principal results of which have been summarized by the writer (Collins, 1933, pp. 45-

48; 1935, p. 462). The oldest site at which Ford excavated was Birnirk. Here the bulk of the harpoon heads were of the type that had been previously designated by that name—the Birnirk type—being made usually of bone, with an open socket, a side blade of chipped flint with an opposite barb (sometimes with another blade in place of the barb), and with two or more asymmetrical spurs at the base. Only one harpoon head of the Thule no. 2 type (with two barbs) was found at Birnirk. However, this type was common at the more recent site of Utkiavik, where somewhat later it developed into forms characteristic of the period just preceding the historic, as shown by their association with metal and late types of implements. There is no certain evidence here as to the origin of the Thule type 2 head, although on typological grounds, it might be considered a descendant of the Birnirk type (Collins, 1935, pl. 11, fig. 1) in which the single side blade had been replaced by another barb and the bifurcated spur by a plain spur. But whether or not the Thule head developed in this particular manner, the significant fact revealed by Ford's excavations is that it is not one of the earliest forms of the Barrow sequence, but a form that appeared after the typical Birnirk head and that eventually gave rise to the dominant protohistoric closed socket type, which was flat on one side, convex on the other, and with one or two pairs of opposed barbs (Collins, 1935, pl. 11, fig. 4).

With regard to the Thule type 3 head (Mathiassen, 1927, vol. 1, pl. 1, figs. 6-12), we now see that this belongs to that variable group of harpoon heads which in one form or another has held an important place in the West from the Old Bering Sea period down to modern times. At Gambell the earliest forms (from the Hillside site and the older section of Miyowagh) described as open socket type III x (pl. 23, fig. 4; pl. 24, figs. 11-18) were large, had prominent asymmetrical spurs that were trifurcated, bifurcated, or otherwise irregular, and were decorated in Old Bering Sea style. From this old form there developed through gradual modification a simpler form, marked by a reduction in size, by a simpler though still irregular form of spur, and usually an early Punuk ornamentation (pl. 24, figs. 19-23). This relatively simple form in turn gave way to a still simpler form (open socket type III (a) x, pl. 28, figs. 8-14), which had a straight plain spur, plain edges, and a Punuk decoration. This form, which at Miyowagh was practically restricted to the later northwestern section of the midden, continued in use at Ievoghiyoq, where it was represented by 98 examples (pl. 70, figs. 8-15). Most of these, however, had undergone additional slight modifications, and again in the direction of simplification, becoming somewhat straighter and heavier and being for the most part undecorated. It is within this last, the dominant Punuk group, that the Thule type 3 harpoon heads belong, although in contour they are closer to the still later St. Lawrence form, open socket type III (b) x (pl. 71, figs. 5-7); the latter, however, has the characteristic "wedge-shaped" socket, whereas the Thule sockets are all wide and straight-sided.

From Jenness' description of the harpoon heads at Wales and the Diomedes, it is evident that the development of the open socket harpoon head has followed the same general course at Bering Strait as on St. Lawrence Island, although probably in no instance have the comparable forms been identical in every feature. Everything points to the Thule type 3 head being closer to the Bering Strait than to the Gambell form of the open socket type III (a) x head. Thus, of the two heads of this type illustrated by Jenness (1928 a, pl. 12, *b, c*) the one with lashing slots is practically identical to Mathiassen, 1927, vol. 1, plate 1, figure 6; these later Wales and Diomede heads have the same straight contour as the Thule forms, whereas at Gambell a tendency to a curvature of the sides persists until the appearance of the very latest prehistoric form, that with the "wedge-shaped" socket. Furthermore, as we have already seen, a close linkage between the Thule and Bering Strait forms is provided by the drilled lashing holes, which at a rather late stage supplanted slots at Bering Strait. At Barrow these drilled lashing holes are very rare, and furthermore the open socket heads with end blades which have been described from there (Mason, 1930, pl. 5, figs. 4-7; Collins, 1935, pl. 11, figs. 5-6) are not very close to the Thule type 3 head in general shape—not nearly so close as are the Wales-Diomede heads already mentioned.

The Thule type 4 head (rather small, with closed socket and a blade at right angles to line hole—Mathiassen, 1927, vol. 1, pl. 2, figs. 1-2) occupies a subordinate position in the Thule culture. In the west, harpoon heads of this general type are known from all culture stages, but if we may judge from the St. Lawrence forms the older ones were almost invariably decorated and possessed certain minor features as of shape, form of spur, median ridge between tip and line hole, etc., which serve to distinguish them from the plain Thule type; later, the closed socket heads are usually undecorated and have quite simple contours, but they have become larger than the Thule forms.

It appears, therefore, that the three most characteristic forms of Thule harpoon heads all have their counterparts in the west, and that without exception where systematic excavations have been made, they have been found to be later than the more elaborate Old Bering Sea and Birnirk forms.

What, then, has been the role of the Thule harpoon types in other parts of the Eskimo territory? Mathiassen (1930 b, p. 181) is of the opinion that "they form the earliest, most primitive group of harpoon heads and have been distributed from Siberia to Greenland, everywhere predominating in Thule Culture finds, to whose most characteristic types they belong", a view that harmonizes with his belief (1930 b, p. 325) that the eastward movement of the Thule peoples was "the first spreading of the Eskimos over the Arctic coasts of America." If the Thule harpoon heads are the oldest forms that have existed in the Central regions and Greenland, then it is evident that subsequent developments in these regions have followed an entirely different course from those observed in Alaska. In the sequences established in the west we have a typological development consistent with stratigraphic conditions; on St. Lawrence Island it is possible to trace the development of the local forms step by step and to observe the exact manner in which the simple modern forms have evolved. Furthermore, if we take into account the specific characters that distinguish the forms, we see that none of the older types have persisted or reappeared. When we turn to the Thule culture, on the other hand, we find that the Thule type 3 head, which is one of the most important types, even at the oldest sites, differs in no way from the form still in use among the Polar Eskimos, as Mathiassen has shown; and the same is true of the less important Thule types A II c 1 and A II c 2—(thin, with closed socket, and with blade parallel and at right angles, respectively, to the line hole) which are still in use over a large part of the Eskimo territory. If the Thule culture has an antiquity of a thousand years, as Mathiassen believes, we have here a remarkable example of cultural stability, the more remarkable because of the striking contrast it affords to conditions in the west, where as we have seen, harpoon heads have been undergoing constant change from the Old Bering Sea period down to the present time.

There is a further difference to be observed. Excavations at Barrow, Bering Strait, and St. Lawrence Island have shown that in the west the oldest forms thus far found are the most complicated, the later forms simple; in the central region and Greenland the older Thule forms are simple, the later forms more elaborate. This in itself is not surprising, as there would be no reason to expect absolute uniformity of cultural development over so wide an area. The immediate question, however, is how to account for the later, more elaborate forms of harpoon heads in the east. Are we to suppose that some of the Thule forms have persisted without change down to the present time, and that others have undergone the far-reaching modifications necessary for the production of these complicated later forms? Undoubtedly some developments of this nature have occurred; the barbed Thule type 2 head, for instance, is no doubt the ancestral form that gave rise to the various barbed types of the Hudson Bay region and Greenland, just as it is also ancestral to the late barbed forms of Arctic Alaska. But the most characteristic features of many of the eastern harpoon heads are a " flat " shape, a bifurcated symmetrical spur, and a curving line hole with both openings on the same side. These are features which none of the four Thule types possesses, although some of the less extreme forms of these " flat " heads are already present at the Thule sites. If the Thule heads are not adapted structurally to have served as the prototype of these flat forms, where are we to look for their origin? It seems to me that the Dorset harpoon heads are to be considered in this connection. That there is a relationship of some kind can hardly be doubted, for the curious arrangement of the line hole and the prominent divided spur of the modern central type are also found on some of the larger forms of the Dorset heads (c. f., Jenness, 1925, fig. 5, *a, b,* both modern types, with *i, j, k,* Dorset types). The only real difference between them is that in the Dorset heads the closed socket is narrow and rectangular whereas in the later heads it is round. Assuming these larger and heavier Dorset heads to represent the later forms, their prototypes would be the smaller, thinner forms with the same kind of rectangular, enclosed sockets and bifurcated spurs, but with the double line holes extending through from side to side.

In accordance with his view that the Dorset is nothing more than a locally stamped phase of the Thule culture, Mathiassen (1927, vol. 2, p. 30) has sought to include the Dorset heads in the Thule group:

> With the occurrence of these harpoon heads in the Thule finds, with their wide spread from King William's Land to North Greenland and with the occurrence of their prototype by the Bering Strait, ... we can no longer look upon these harpoon heads as a local phenomenon; they must be regarded as a link in the Thule culture and must, like many of its other elements, be presumed to have originated in the west.

It is difficult to see why the inclusion of a few Dorset harpoon heads among the Thule finds should invalidate them as a type and place them in a group to which they are structurally unrelated; for with the exception of the one Dorset form which has an open socket and single spur like the Thule type 1, the others stand entirely apart from the Thule heads. Furthermore, as Jenness has already observed (1933, p. 394), the single harpoon head from Siberia which Mathiassen regards as the prototype of the Dorset heads is not at all closely related to these. As Jenness has most convincingly shown (1933, p. 389-395), the Dorset culture cannot be regarded as merely a phase of the Thule. It was an independent culture, extending from north Greenland to south Labrador, antedating the Thule culture in parts of these regions, contemporaneous with it in others and finally no doubt extinguished by it. Under such conditions it is natural that Dorset objects should sometimes be found at Thule sites and also that both cultures should have been affected by the contacts thus indicated. Until the Dorset culture is more thoroughly elucidated, we cannot know the full part it may have had in the formation of the present Eskimo culture, but the evidence at hand suggests that at least some of the most characteristic forms of Eastern harpoon heads may be traced back to this source.

We will return now to Bering Strait and see what relation if any exists between the older forms of harpoon heads there and those found to the southward. Archeological data are lacking for the mainland of Alaska from Norton Sound to Bristol Bay, so that we know nothing as to the cultural developments that have taken place in that region. The modern harpoon heads of southwest Alaska—from the mouth of the Yukon to the Alaska Peninsula—are rather distinctive in appearance, as are so many other cultural features in this region, but as yet there is nothing to throw light upon their origin. It cannot be known, for instance, whether the trifurcated spurs sometimes found on small closed socket harpoon heads on Nunivak Island and the adjoining mainland represent a continuation of this tradition from Old Bering Sea times. The harpoon heads from the Aleutian Islands figured by Jochelson (1925, pl. 27, *b*) probably do not include any very old types. They have closed sockets and apparently an end blade at right angles to the line hole. The systematic excavations of de Laguna have shown that at Cook Inlet this form of harpoon head is later than the bladeless form with open socket. The latter form de Laguna calls Thule type 1 and thinks (1934, p. 187) that it "offers the strongest proof yet advanced in favor of Mathiassen's hypothesis of an Alaskan Thule culture antedating the Birnirk and Old Bering Sea stages." It should be recognized, however, that these Cook Inlet heads, simple though they are and therefore inevitably close to any other open socketed, bladeless form, are by no means identical with the Thule heads. The lateral position of some of the line holes, the unusual breadth and tapering shape of the socket, and the form of the spur, which is sometimes median, sometimes lateral and flaring, are all features which give these heads a local stamp and readily distinguish them from all others, even though under a broad definition they would be included with the Thule heads. To understand the relation of these old south Alaskan heads to those of the Arctic we would need to know something of the archeology of the extensive stretch of coast intervening. In view of the fact that this south Alaskan culture has in so many respects developed along special lines and that it shows so few significant resemblances to northern Eskimo culture, particularly in its Arctic phases, it seems rather hazardous to postulate an underlying cultural connection on the basis of the harpoon heads alone. It is true that the excavations in northern Alaska have thrown little light on the origin of the Thule type 1 head; we only know that it appears suddenly, and very late, at Gambell. However, the conditions are somewhat clearer with regard to the still more important Thule types 2 and 3, for, as pointed out above, these are found at Gambell, at Bering Strait, and at Barrow, but in no case have they appeared at the lowest levels; on the contrary, the available evidence points rather to their having developed from the preceding Old Bering Sea and Birnirk forms. In view of these conditions, it seems highly improbable that these harpoon heads could also have belonged to a "Thule" phase of culture in Alaska which antedated the Old Bering Sea and Birnirk phases.

The composite toggle harpoon heads found along the Northwest Coast from southeast Alaska to California are so fundamentally different from the Eskimo forms that an immediate relationship seems out of the question. In fact these southern composite heads are structurally further removed from the Eskimo types than are a number of Old World forms including some from as far away as Scandinavia or even New Zealand (Edge-Partington and Heape, "Ethnographical Album of the Pacific Islands", 3d series, pl. 179, figs. 3-5).

Although systematic excavations have not been made in northeastern Siberia, a number of old type harpoon heads have been reported. Those in Rasmussen's collection from East Cape, figured by Mathiassen (1927, vol. 2, fig. 11, *1-6*) belong for the most part to the late Punuk stage; except for *6*, which appears to be a local form, the others conform to types which at Gambell were found only at the three later sites. Bogoras (1904-09, vol. 1, p. 117, fig. 33) illustrates several harpoon heads excavated from old Eskimo and Chukchee villages (probably only Eskimo) which appear to be older; two of these, *c* and *d*, are probably early Punuk. Sverdrup obtained several Old Bering Sea harpoon heads from sites on the Siberian side of Bering Strait and the writer has described another from Plover Bay (Collins, 1929, pp. 4, 5, fig. 1). The indications are, therefore, that the Old Bering Sea and Punuk harpoon heads will prove to have about the same distribution on the Siberian side of Bering Strait as they have on the Alaskan side.

Some of the simpler harpoon heads of the modern Chukchee are very similar to some modern Eskimo forms, as might be expected. Those of the Koryak and Gilyak appear to be somewhat more specialized, and their affiliations uncertain (Jochelson, 1905-08, vol. 1, figs. 87, 92; Schrenck, 1881, pl. 42, figs. 3, 4). It might be mentioned that the Koryak use the same method of line attachment as do the Eskimos of the Kuskokwim region, the head being fastened to a short loop of seal or walrus hide to which the foreshaft is also attached (cf. Jochelson, fig. 87, and Mason, 1902, fig. 84).

Jochelson does not mention finding toggle harpoon heads at the Kamchatkan sites he excavated, but this is no doubt accidental, as they occur in kitchen middens on the Kurile Islands and in Japan. The old Kurilian heads are simple bladeless forms, some having no line hole at all, others one or two holes (Torii, 1919, pl. 30, figs. 8-11; Baba, 1934, fig. 13, *6*). They have a bifurcated basal spur recalling the Dorset type, but the sockets are invariably open; this bifurcated spur is a feature which has been retained on the harpoon heads of the modern Ainu (Hitchcock, 1891 b, p. 470, fig. 85; Batchelor, p. 154). One of the harpoon heads illustrated by Torii (pl. 30, fig. 10) has the general shape of the Thule type 2 head, but with two line holes, one above the other.

Except for the double line holes, the old Kurilian harpoon heads have little in common with those of the Old Bering Sea culture. In the kitchen middens of Japan, however, harpoon heads have been found which have trifurcated symmetrical spurs, which otherwise are known only from Alaska. One of these, from the province of Rikuzen, Island of Hondo, described by S. Yagi (1899, pl. 8) has a round closed socket, a prominent trifurcated spur which is lateral and symmetrical, a single line hole in the plane of the spur, a wide slit for an end blade also in the plane of the line hole and spur, and below the blade slit two pairs of small opposite barbs. An almost identical specimen, with one of the three basal spurs broken off, is figured by Kishinouye (1911, pl. 22, fig. 59). Although the combination of features shown on these Japanese heads has not been found on any from the Eskimo region, the general appearance is strikingly suggestive of some of these. Another Japanese example from a shell mound in Hokkaido (Yezo) presents an even closer parallel to some of the Old Bering Sea heads; it has a double line hole, one above the other, an open rectangular socket (spur broken), a blade slit parallel with the line holes, and traces of decoration (Yonemura, 1935, fig. 5).[16]

We may now observe the distribution of the toggle harpoon head in northern Eurasia. First of all, we must note the presence of old harpoon heads of Eskimo type as far west in Siberia as the Kolyma River. Two of these, along with fragments of pottery and stone blades, were excavated from old house ruins by Prof. H. U. Sverdrup and have been described by Mathiassen (1927, vol. 2, p. 180). Both have open sockets with lashing slots, an irregular spur, and one prominent barb with an opposite side blade; they are therefore identical with one of the most characteristic Birnirk types (not Thule as stated by Mathiassen). These harpoon heads, being specifically Eskimo in type, afford strong confirmation of the theory that the ruins of underground houses found along the Arctic coast of northeastern Siberia are actually those of Eskimos who formerly occupied the region. It would be all the more interesting, therefore, if information were available concerning the ruins of underground houses reported still farther to the west along the stretch of Arctic coast now occupied by the Yukaghir (Jochelson, 1910-26, pp. 346-348); for if an Eskimo

[16] With regard to these old harpoon heads from Japan it should be mentioned that a striking parallel is found in the iron toggle heads of the harpoon-arrows which the Philippine Negritos use in hunting land mammals. These have been described by Schadenberg (1880, pl. 7, figs. 8, 9); Meyer (1893, p. 14. figs. 1, 2; pl. 6, figs. 2, 3; pl. 8, fig. 2); Mason (1902, p. 236); and Krieger (1926, pl. 4, figs. 11, 13). The similarity between the two forms is truly remarkable. Thus one of the examples illustrated by Meyer, figure 1, page 14, has the same trifurcated, lateral form of spur as the above mentioned Japanese heads. The other Negrito specimens resemble the Japanese type illustrated by Kishinouye in plate 22, figure 60. This is a bladeless head with a closed socket, a single, rather flaring spur, line hole parallel with spur, and two pairs of opposite barbs between line hole and tip. All of the Philippine examples mentioned have this general shape, the only difference being that the line hole is at right angles to the spur; one of them (Krieger, pl. 4, fig. 11) has even the two pairs of barbs between line hole and tip. All of the toggle heads have closed sockets which fit on to a loose wooden foreshaft very much like the Eskimo form; this is attached to the line by means of a cord wrapping; the base of the foreshaft rests in a squarish socket, an enlargement of the shaft. The structural agreement between the two forms is so close that one is led to suspect that the Negritos, in making the iron heads for their harpoon arrows, have had in mind a bone prototype like the Japanese heads. It is a point that might have some bearing on the prehistory of the Negrito, especially in view of the strong probability that a Negroid element was present in the Japanese archipelago in Neolithic times and because of the cultural parallels known to exist between Neolithic Japan and southeastern Asia where the earliest population seems to have been predominantly Negroid.

population existed along the Arctic coast from Bering Strait to the mouth of the Kolyma, it would be reasonable to expect that its influences might be traced even farther. It is significant in this connection that there has recently been discovered an old Eskimo-like culture on the Ya-mal Peninsula at the mouth of the Ob River, at the westernmost extremity of Arctic Siberia. This old culture, which seems to have differed in many respects from that of the Samoyed, the present occupants of the region, is described as having made use of earthenware pottery, baleen, bone and ivory implements, toggle harpoon heads, and the kayak (Cernecov, 1935). This isolated discovery, far to the west of the present Eskimo domain, leads one to expect that future excavations may reveal a similar stage of culture in other parts of Arctic Siberia, where in earlier times there may have lived groups of sedentary maritime peoples who hunted sea mammals with the toggle harpoon and whose culture in other respects conformed to the general Eskimo pattern.

There are few references to the use of the toggle harpoon head in northern Europe; here, as is so often the case elsewhere, this form is subordinated to the barbed head. However, the toggle form is reported from old sites in Norway (Solberg, 1909, p. 40, figs. 39-42; Bøe, 1934, pl. 2, figs. 14-16); Kola Peninsula (Schmidt, 1930, pl. 1, figs. 6, 7); and also from Yugoslavia (Čurčič, 1912, pp. 505, 507, figs. 14, 15, 17). They have also been found in Lake dwelling sites in France—Lake of Bourget,—and Austria—Laibach-Moor (Keller, 1878, pls. 161, fig. 6, 168, figs. 14, 20). Most of the examples illustrated are simple bladeless heads which in a very general way resemble some of the simpler Dorset and Thule types. Two of those figured by Solberg have double line holes like some of the old Japanese types; figure 43 has a bifurcated basal spur, also a Japanese feature. These simple European toggle harpoon heads are no doubt related in some way to the Asiatic-American forms, but until more information is available on the extensive intervening area it will hardly be possible to form any clear idea as to just what the relationship has been. It would also appear probable, as the writer has suggested (Collins, 1935, p. 467), that some significance should be attached to the fact that both the Old Bering Sea and Birnirk harpoon heads are often equipped with small stone side blades, a technique which was also common in northern Europe during the Maglemose period.

The ultimate origin of the toggle harpoon head is apparently to be sought in northern Eurasia. In America, where the greatest development has occurred, it is confined to the Eskimo territory and to adjacent regions where Eskimo influence has probably been exerted.

In the Old World toggle harpoon heads are far more widely, though sporadically, distributed, being found in northeastern and northwestern Siberia, northwestern and central Europe. They have also extended down the east Asiatic littoral to the Kurile Islands and Japan, and it is probably significant that in the Japanese examples referred to above, from the Neolithic, we have the closest approach to some of the elaborate Old Bering Sea forms.

Foreshafts

The harpoon foreshafts of the Old Bering Sea period do not differ significantly from those of the Punuk, but both are readily distinguished from the modern type (pl. 73, fig. 3). All of these foreshafts are of the movable variety; fixed foreshafts, which are characteristic of the Thule culture and of the modern Central and Eastern Eskimo, were entirely lacking at Gambell.

Socket Pieces

All of the socket pieces belong to the first type described by Mathiassen, the heavy, solid type (1927, vol. 2, pp. 33, 34); but whereas the Thule examples may have tangs which are hollow, pyramid-shaped, or with two flanges (bifurcated), those from St. Lawrence are less variable. The Old Bering Sea socket pieces have tangs of two kinds, conical or bifurcated whereas those of the Punuk period have wedge-shaped tangs like the modern Alaskan examples. In the older types of socket pieces the upper end is straight; in some of the Punuk and modern examples (pl. 73, fig. 7) and in the dart foreshaft shown in plate 33, figure 26, the end is enlarged and rounded like some of the Thule pieces (Mathiassen, 1927, vol. 1, pl. 3, figs. 9, 10).

Finger Rests

The Old Bering Sea finger rests for the harpoon shafts were either low with a sloping top (pl. 32, figs. 9-12) or high with a rounded end and a large circular hole for the lashing (pl. 32, figs. 7, 8). The latter is somewhat similar to one of the Punuk types (pl. 73, fig. 14); the other Punuk type (pl. 73, fig. 13) has sharply incurving sides and resembles certain Thule and modern Alaskan examples (Mathiassen, 1927, vol. 1, pl. 5, figs. 1, 2; Nelson, 1899, pl. 57, *b*, 30).

Ice Picks

The Old Bering Sea ice picks all have a roughened conical tang (pl. 32, figs. 1-6) and in general are conformable to the Thule types

(Mathiassen, vol. 1, pl. 4, figs. 2-4). The smooth, beveled tang is typical of the Punuk period (pl. 73, fig. 8), though the conical form has also been carried over (pl. 73, fig. 4). The modern St. Lawrence form with its abrupt, prominent shoulder and beveled lower end (pl. 73, fig. 9) is a further specialization of the Punuk type (pl. 73, fig. 8).

Ice Creepers

Old Bering Sea ice creepers are made of bone or baleen and have inserted pegs (pl. 37, figs. 3-5); those of the Punuk stage (pl. 75, figs. 23-25) have a different outline and have the pegs either inserted or carved in relief like the modern type (pl. 75, fig. 26). Ice creepers have not been reported from other ancient sites in Alaska, but since full information on the excavations is lacking, this should not be regarded as conclusive. However, they were not found at any of the Thule sites. They are used by the Labrador Eskimos (Turner, 1894, p. 217, fig. 43) in the form of crimped strips of sealskin sewed to the sole of the boot. The Point Barrow Eskimos use two crescent-shaped strips of skin for this purpose (Murdoch, 1892, p. 135, fig. 82). The Alaskan Eskimo and Chukchee ice creepers (Nelson, 1899, pp. 215, 216; Bogoras, 1904-09, vol. 2, p. 263, fig. 195) are all similar to the modern St. Lawrence type, whereas those of the Koryak (Jochelson, 1905-09, vol. 2, p. 605, fig. 130) are of iron with only two spikes. Ice creepers are also used in Kamchatka and China (Mason, 1896, p. 411), Afghanistan (Zarubin, 1916, pl. 7, *b*) and Finland (Sirelius, 1934, p. 116, pl. 55, fig. 244). It is interesting to observe that the type used in Scandinavia during the Viking period was introduced into Greenland, one of them having recently been excavated at the old Norse settlement of Brattahlid (Norlund and Stenberger, 1934, fig. 100, *D*).

Sealing Scratchers

The sealing scratcher seems not to have been known during the Old Bering Sea period. The Punuk type (pl. 75, fig. 17) differs from those of the Thule culture and most of the modern Alaskan examples in being longer and narrower and in having only two prongs. The specimen from Birnirk, figured by Mason (1930, pl. 1) resembles the Thule type more than it does the later Alaskan forms.

Throwing Boards and Bird Darts

The Old Bering Sea throwing boards (pl. 37, figs. 1, 2) are unlike any of the modern types (Nelson, p. 154; Murdoch, p. 217), but resemble the old Birnirk type in general contour and in the form of the grip (Mason, 1930, pl. 1).

Side prongs for bird darts (pl. 33, figs. 1-9; pl. 74, figs. 1, 2) have barbs on both the inner and outer side, like those of the Thule culture. The Old Bering Sea type is somewhat more rounded in cross-section than that of the Punuk.

Bows and Arrows

The Gambell finds have provided little information as to the exact nature of the Old Bering Sea bow. Small bows of baleen were used (pl. 55, fig. 1; pl. 56, fig. 15), but apparently only as toys. The larger bows were of wood, but it is not certain that they were provided with any heavy reinforcement of sinew or baleen. Bow braces and sinew twisters, which are always associated with the modern type of sinew-backed bow in Alaska, were not found at the Hillside site or in the southeastern section of Miyowagh, though they occurred in the northwestern section of Miyowagh and were common at the later sites (pl. 74, figs. 16-20). The toy bow with heavy reinforcements of baleen (pl. 60, fig. 8), from the early Punuk section of Miyowagh, is the earliest example of the backed bow from Gambell. The compound wooden bow is characteristic of the Thule culture, and the presence of sinew twisters indicates that they were reinforced with a sinew cable (Mathiassen, 1927, vol. 2, pp. 43, 44).

The Punuk arrowheads, as a group, are so distinct from those of the Old Bering Sea that we would seem justified in regarding them as later importations. The Old Bering Sea types (pl. 29, figs. 6, 7; pl. 34, figs. 1-6) are more or less rounded in cross-section and have a conical tang which is either smooth or roughened by hacking; the characteristic form of barb is one that is placed rather low, near the tang, and close to the body with very little flare; associated with this type of barb is a wide slit for an end blade. The Punuk arrowheads, on the other hand (pl. 74, figs. 6-10) are for the most part triangular in cross-section, in this respect resembling some of the modern St. Lawrence and Chukchee forms (Nelson, pl. 61 a, figs. 1, 2; Bogoras, 1904-09, fig. 74, *d;* Oukhtomsky, 1912, fig. 6, *e, g*). Most of them have a single prominent barb; others have two or more barbs, and still others none. The tangs are either plain and conical, like the earlier type, or have a shoulder (pl. 74, figs. 6, 8, 14). Only one of the large number of Punuk arrowheads had a blade slit.

Turning to the arrowheads collected by Stefansson at old sites on the Arctic coast (Wissler, 1916), it seems that none of these were triangular in cross-section like many of the Punuk specimens, but were relatively flat, like plate 74, figure 8. Most of them were barbed, a few of the older ones, from Birnirk (Wissler, fig. 24, *a;* also Mason, 1930, pl. 3), having sharp, oblique barbs like the Old Bering Sea specimen shown in plate 34, figure 6. Mostly, however, they have heavier barbs like plate 74, figures 8-10. The form of the tang provides a more significant basis of comparison. As mentioned above, the tangs of the Old Bering Sea arrowheads were conical, with no shoulders of knobs of any kind, whereas the Punuk specimens were either conical or provided with a shoulder. The Birnirk type, if we may judge from Wissler (fig. 24, *a, c*) and Mason (p. 386 and pl. 3) were either conical or shouldered. However, at the later sites—Cape Smythe and Franklin Bay—the tangs were usually provided with small knobs (Wissler, figs. 26, 27, 36).

These same knobs are present on the conical tangs of many of the Thule arrowheads, though the shouldered tang and the obliquely cut tang are also typical. With regard to the distribution of the various forms of tangs, Mathiassen (1927, vol. 2, p. 46) says:

> Thus the conical tang with two knobs is apparently an old form which has once been generally in use from Alaska to Greenland; in the eastern parts of the central territory it was supplanted by the obliquely cut tang, which spread from there to the Polar Eskimos; in Greenland it was superseded by the screw-thread; but in Alaska and in the other western regions, as also among the western Central Eskimos, who in this for once hold together with the Western Eskimos, the old form continued to prevail.

From the distribution in Alaska, it would now seem possible to differentiate also between the Thule forms with a shoulder and those with knobs, the shouldered tang being the original Thule form, derived from Alaska, and the knobs a later feature which appeared after the Thule culture had become established in the Central regions. The predominance of knobbed tangs at the later sites in North Alaska would be explained as being one of the numerous elements introduced into that region by a late return migration of Thule peoples from the eastward.

Blunt-Pointed Bird Arrows

Blunt points for bird arrows do not seem to have been used by the Old Bering Sea Eskimos. The earliest form at Gambell is the conical flat based type (pl. 74, fig. 13) which appeared in the Punuk stage. The more common ovoid form (pl. 74, fig. 12) is characteristic of the later Punuk, and is the form still used on St. Lawrence Island. Blunt-pointed bird arrows were known to some extent to the Thule culture, also to the modern Eskimos of the Central regions, Greenland, and Alaska, and to a number of Indian tribes. They are likewise widely distributed in northern Eurasia, being found for instance among the Chukchee (Bogoras, 1904-09, fig. 74, *f, h, n*); Koryak (Jochelson, 1905-08, fig. 96, *c, d*) Ostiak and Samoyed (Sommier, 1885, pp. 364, 366; Karutz, 1925, p. 91, fig. 18), and Finns (Sirelius, 1934, pl. 7, fig. 18). The practically uninterrupted distribution of the blunt bird arrow throughout the circumpolar zone is similar to that of such elements of the inland culture as snowshoes, the carrying cradle, bear ceremonialism, etc; and since it seems to have been unknown to the Old Bering Sea culture, we would probably be justified in regarding it as one of the elements belonging to the inland culture complex.

Wrist Guards

I am inclined to think that the same explanation might be applied to the bone or ivory wrist guard, which has a distribution somewhat similar to that of the blunt-pointed bird arrow. It was absent in the Old Bering Sea culture, and also in the Thule culture, although it is characteristic of the Punuk stage and of modern Eskimo culture generally. In boreal Eurasia this particular form of wrist guard as distinguished from the leather band, seems to be especially characteristic of those groups whose culture is most typical of the inland stage, as for instance the Chukchee (Bogoras, 1904-09, p. 155), Tungus (Karutz, p. 43, fig. 10), Ostiak (Sommier, p. 365), and Vogul (Karutz, p. 87, fig. 2).

Bird Bolas

The bird bola was another element which was introduced on St. Lawrence Island during the Punuk stage. No less than 256 bola balls, mostly of ivory, were found at the Punuk sites, but none at the Hillside site or the old section of Miyowagh. The bola is evidently older on the Arctic coast than on St. Lawrence, for Mason reports it from the Birnirk stage at Point Barrow (1930, p. 386). It is also a characteristic feature of the Thule culture (Mathiassen, 1927, vol. 2, p. 54). and the comparatively few groups of Central Eskimos who use it have no doubt derived it from this source.

Plate Armor

Plate armor is another characteristic St. Lawrence element that makes its appearance during the Punuk stage. The plates are all made of bone and in form are identical with those used on St. Lawrence Island in the nineteenth century. The distribution of bone (or ivory) armor in Alaska is limited to the Bering Strait area where it was used by the Eskimos at Wales, on the Diomede and St. Lawrence Islands, and by the Eskimos, Chukchee, and Koryak in northeastern Siberia (Nelson, 1899, p. 330; Bogoras, 1904-09, pp. 162-168; Jochelson, 1905-08, pp. 562-563).

In approaching the question of the origin and relationships of Eskimo armor it will be necessary to consider the types occurring in other parts of America and Asia. Fortunately for our purpose, aboriginal American armor has been subjected to a careful study by Hough (1895), whose valuable paper provides detailed information on armor types from Bering Strait southward, while Laufer's scholarly treatise (1914) has thrown a flood of light on the important problem of Chinese armor in relation to that of other Asiatic peoples.

Hough (1895, pp. 631-632) lists six types of armor used by the American Indians:

Plate armor.—Rows of overlapping plates, perforated and lashed. Eskimo and Chukchis.

Slat armor.—Wooden slats twined together. Sitkans, Shastas, Iroquois, Virginia Indians.

Rod armor.—Wooden rods twined together. Aleuts, Sitkans, Columbia River tribes, Klamaths, Hupas, Iroquois, Virginia Indians, etc.

Band armor.—Bands of skin arranged in telescoping fashion. Chukchis.

Skin armor.—Coats of hardened hide. Tlingits, Haidas, Hupas, Chinooks, Navajoes [traditional], Mohawks, Shoshones, Pawnees [traditional,] Comanches, etc.

Cotton-padded armor.—Mexicans, Isthmians, and Peruvians.

In the distribution of North American armor types Hough recognizes three well-defined areas, (1) Bering Strait; (2) Western, extending from southeastern Alaska to northern California, the Central basin and Mexico; and (3) Eastern, extending from southeastern Canada to Virginia.

The Bering Strait area is characterized by the use of two types, the plate armor of bone, ivory, and occasionally iron, and the banded armor of skin. The Diomede and Wales Eskimos use only the plate armor; the Chukchee, Siberian and St. Lawrence Eskimos use both types.

In the Western area we find four types—skin, rod, slat, and in Mexico and Central America, padded cotton. These were not mutually exclusive as both the skin and wooden types—rod and slat—were often used by the same tribe. The skins employed were those of elk, bison and bear, and the form was usually that of a sleeveless coat or jacket. The slats or rods of the wooden armor, except in the Aleutian Islands, were fastened together and often completely covered over with fine cords of sinew or fiber. The Aleutian armor consisted of rows of long wooden rods lashed together at the ends.

The rod and slat types are mixed, in the method of twining together the elements they are identical. In some localities the broad band of rods is alone found, while among the Tlingits, or around Sitka, occur rod armor, slat armor, and a combination of both types in the same piece, as well as skin armor.

In form the Aleut armor, instead of following the Eskimo type, belongs with the rod type of the Indians. The perforation of the rods, however, and the method of lashing, show Eskimo handiwork. [Hough, 1895, p. 638.]

Information on the armor of the Eastern area is derived from historical sources, no actual specimens having been preserved. It is described as having been made of wooden rods or slats which, just as in the west, were sewed or lashed together with cords. There is but a single reference to the use of skin armor in the northeast, but it may have been more widespread. Armor was also known in the southeast, as we see from Swanton's reference (1928, p. 438-439) to the effect that De Soto found " breastplates like corselets and head pieces made of rawhide " in a mortuary temple of the Carolina Indians.

Hough's conclusions (p. 651) regarding the origin and relationship of North American armor types are as follows:

The coat of thick skin which has appeared at all times and places may have arisen independently, following the prime idea of the concomitance of weapon and anti-weapon, but . . . . plate armor in America is a clear case of the migration of invention, its congeners having been traced from Japan northeastward through the Ainos, Giliaks, and Chukchis, across Bering Strait by the intervening islands to the western Eskimo. Here the armor spread southward from the narrowest part of the strait, passing into the slat armor of the Northwest Coast, which is possibly a development of the plate idea. The plate armor also may have spread to the eastern coast of North America. Hence it appears to be conclusive that plate armor in America had Asiatic origin.

As Laufer has shown (1914, p. 262 *et seq*) plate armor cannot be assigned to either the Ainu or the Giliak, nor can the Japanese be regarded as the inventors of this particular type of armor. However, from a technological viewpoint, Hough is undoubtedly correct in assuming a relationship between the plate armor of the Bering Strait region and that of eastern Asia.

According to Laufer metal armor and helmets did not exist in China prior to the Ts'in dynasty (255-206 B.C.). The defensive armor of the archaic period was made of rhinoceros hide and in form was probably not unlike the hide armor worn by certain American tribes. As Laufer has demonstrated, the art of warfare in China, including cavalry tactics, weapons, armor, and various other items of military equipment underwent radical and revolutionary changes during the Han dynasty (B.C. 206-A.D. 220). These innovations were consciously adopted by the Chinese in imitation of the superior methods and equipment of their inveterate enemies, the warlike Huns, or Hiung-nu, who in turn had derived their mode of warfare from the Iranians. Among the innovations introduced during the Earlier Han dynasty (206-23 B.C.) was leather armor reinforced with rows of copper scales or laminae, which in the Later Han was replaced by similar armor with iron scales. Plate armor, the subject of our present inquiry, seems to have developed from these earlier types, the assumption being that gradual changes in shape and manner of attachment of the iron scales resulted finally in rectangular plates, which were lashed together in rows. Such armor represented an advance over earlier types in that it was not only light and flexible but strong enough to be worn alone, thus making it possible to dispense with the heavy and cumbersome foundation garment of stiff hide (Laufer, 1914, pp. 211-214).

Laufer shows that plate armor was known in ancient Egypt, and also in Assyria during the reign of King Sargon (B.C. 722-705). In later times it was in general use among the Scythians, Mongols, Tibetans, and other tribes of western, central, and eastern Asia. Recent evidence indicates an extension of this essentially Asiatic form of armor even to Scandinavia. This is shown by the discovery in Gotland of a suit of iron plate mail enclosing the skeleton of a warrior who fell at the battle of Visby in 1361 and of similar plates from a tenth century site in Sweden (Thordeman, 1933, pp. 117-150). Thordeman, who has given an excellent summary of the technical and historical aspects of the problems connected with Asiatic splint (plate) armor, concludes that it had more than a sporadic distribution in the Baltic region in the tenth to the fourteenth centuries.

Plate armor reached its highest development in Japan and it was here that both Ratzel and Hough sought the origin of the similar armor of the Eskimos and Chukchee. From a purely comparative point of view, such a theory seemed entirely plausible, for as Hough pointed out, the form of the plates, their arrangements, and the method of lashing were identical in the two areas. Laufer (1914, pp. 262, 264, 265) has shown, however, that in view of certain historical considerations, the theory of a Japanese origin is untenable, as will appear from the following illuminating passage:

In the north-east of China, beyond the boundaries of Korea, in the east conterminous with the ocean, the northern limit being unknown, we find from very remote ages the habitat of a most interesting people, the Su-shên, who have greatly stirred the imagination of Chinese and Japanese chroniclers. They were the Vikings of the East, raiding on several occasions the coasts of northern Japan, and fighting many a sea-battle with the Japanese in the seventh century. For a thousand years prior to that time, the Chinese were acquainted with this tribe and its peculiar culture: even Confucius is said to have been posted in regard to them, and to have been aware of the fact that they availed themselves of flint arrowheads, usually poisoned, which were then preserved as curiosities in the royal treasury of China. From Chinese records we can establish the fact that the Su-shên lived through a stone age for at least fifteen hundred years down to the middle ages, when they became merged in the great flood of roaming Tungusian tribes. They had also stone axes, which played a role in their religious worship. A mere supposition is that they belonged to the Tungusian stock of peoples; yet this remains to be ascertained. They may as well have been related to one of the numerous groups of tribes occupying ancient Korea, or, which is still more likely, to the so-called Palae-Asiatic tribes of the North-Pacific region; but the whole ancient ethnology of north-eastern Asia remains as yet to be investigated.

Under the year 262 A. D. it is on record in the Annals of the Three Kingdoms that the Su-shên presented to the Court of China a tribute of a mixed lot of harness, altogether twenty pieces, including armor made of leather or hide, of bone, and of iron, with the addition of four hundred sable-skins.

. . . . If as early as 262 the Su-shên were in possession of bone plate armor, this type of harness cannot be explained as having been made in imitation of Japanese plate armor—for the plain reason that Japanese plate armor was at that time not in existence. Metal armor in Japan cannot be pointed out before the close of the eighth century.

. . . . It is therefore clear that at the time, when our Su-shên account of bone armor is at stake, the Japanese did not possess any metal or any plate armor, and that it is even questionable whether they then availed themselves of defensive armor at all. We are hence prompted to the conclusion that bone plate armor, being at least from six to eight hundred years older than Japanese plate armor, cannot have been made as a reproduction of the latter, and that Japan cannot be made responsible for it. Thus the whole theory of a connection of American and Northeast-Asiatic plate armor with Japan must naturally collapse.

The fact that the Su-shên were already in possession of plate armor of bone at a time when the Chinese were apparently just beginning to employ iron plate, leads Laufer (1914, p. 266) to assume that "bone armor in north-eastern Asia is as old as, or even older than, any iron plate armor in China or Korea." If plate armor of bone is to be derived from some foreign source, Laufer points to inner Siberia as the most likely place of origin, but on the whole is inclined to the view that the development of bone armor in northeastern Siberia and northwestern Alaska has been for the most part independent of influences from other parts of Asia. The comparative cultural isolation of the northeastern Siberian tribes from the rest of Asia and their closer relationship to America is thought to point to such a conclusion. Furthermore, from a technological standpoint, Laufer considers that the Eskimo-Chukchee plate armor may have been but the culminating stage in a developmental sequence that in America began with simple skin armor, and from that passed to a secondary stage in which wood was covered with elk hide or in which strengthening elements were attached to the outside or inside of the skin cuirass. Such a development would be analogous to but independent of the similar development in China where the original skin armor was succeeded by types in which the skin was reinforced with scales of copper and iron, and these in turn by rectangular plates of iron (Laufer, 1914, p. 269). While admitting that the problem of the American-Siberian plate armor is not susceptible of a definite solution, Laufer concludes (1914, pp. 269-270):

No fundamental difference can be found in the employment of wood and bone, or ivory, which simply present purely technical changes of material; and American-Asiatic bone plate armor, after all, might be conceived as quite a natural development, which may have arisen independently, without the contact of an outside culture. Its coming into existence could be explained by the trend of indigenous thought and the inventiveness of the aborigines, which may have resulted in a large variety of ingenious armor spread over an extensive area.

There remain other considerations to be made which would seem to confirm this impression. The cut, the style, and the mode of wearing armor in the North-Pacific region are different from those in eastern Asia. The peculiar Chukchi fashion of having the left side covered up and the left arm and hand hidden in the armor, while only the right arm remains free for action, is a striking feature, which is entirely lacking in any other part of Asia. At any rate, I am inclined toward the opinion that the type of bone plate armor under consideration is not exclusively due to an impact of foreign influence. In some form unknown to us it may have pre-existed, before any metal plate armor had reached the Far East; while I am quite willing to admit that at some later period the regular, rectangular shapes of the ivory plates, and the peculiar method of lashing them together, may be the outcome of an adaptation of some imported model.

We may now consider what bearing the archeological finds may have on the problem. We observe first of all that plate armor does not appear on St. Lawrence Island until the Punuk stage. It is unquestionably an importation from the Asiatic mainland, where identical forms are not only found at present but where, as Laufer's researches have shown, the type has existed from early times. On the other hand, the modern Alaskan Eskimos between Bering Strait and the Aleutian Islands seem to have been unacquainted with armor of any kind and the excavations of Jochelson, Hrdlička, and de Laguna have revealed no evidence of its existence in prehistoric times in the Aleutians, on Kodiak Island or at Cook Inlet.

In view of the fact that wrist guards, new types of ivory arrow heads, and bow braces and sinew twisters—adjuncts of the sinew-backed bow—also appear for the first time in the Punuk stage, it would seem that we have to deal here with the introduction of a complex of elements connected with warfare, the most important of which was plate armor. The sudden appearance of these elements might indicate either the intrusion into northeastern Siberia of a hostile group or a gradual northward diffusion of armor and improved means of warfare.

The fact that the Eskimo armor of the Punuk period seems to have been identical with the modern Eskimo-Chukchee-Koryak type, which in its essential features so closely resembles Japaneses armor, points to the conclusion that armor did not reach Bering Strait until after this particular type had developed. This would mean either a time subsequent to its certain appearance in China and Japan around the seventh or eighth centuries A.D. or an earlier time, from the third century, when the Su-shên had armor which at least was of the same general type. I am inclined to believe that the later date is more probable, even though the cultural impetus did not originate in Japan.

The immediate origin of the Siberian-Eskimo plate armor should probably be sought in Manchuria or eastern Mongolia, and the armor of the Su-shên and perhaps of other east Siberian tribes was in all probability the ancestral type. However, there seems no particular reason for assuming that plate armor had already reached Bering Sea by the third century A.D., when it was still apparently unknown in China. Laufer's argument to the effect that plate armor is older in northeastern Siberia than in China seems to be based on the assumption that it is one of a number of deep-rooted traits of a culture complex possessed in common by the Palae-Asiatics of northeast Siberia and the tribes of northwest America. Because the culture types in this part of Siberia " have strong and pronounced characteristics which have hardly any parallels in the rest of the Asiatic world ", and because " the entire area has remained purer and more intact from outside currents than any other culture group in Asia ", Laufer (1914, pp. 267, 268), while maintaining an attitude of reserve, is inclined to doubt that the plate armor of this area was derived from the southward. However, it is difficult to reconcile the theory of the independence of plate armor in the far northeast with the fact that it was this same kind of armor that was eventually adopted in China and Japan and that earlier had been widespread among the Turkish and Iranian tribes of central and western Asia. The evidence seems clearly to indicate that plate armor originated among the warlike tribes of central Asia whence it spread southward and eastward into China and gradually northward toward Bering Sea. It seems incredible that it should have penetrated to far northeastern Siberia and been adopted by the primitive hunting and fishing tribes around Bering Strait before it was adopted in China. Though not by nature a warlike people, the Chinese have always been faced with the necessity of protecting their lands from invasion and more than once have found it expedient to adapt their own mode of warfare to that of their enemies. China, with its fertile valleys and rich civilization, was a constant temptation to the restless barbarian hordes, and the effects of repeated foreign invasion must have been felt there centuries earlier than in the barren regions to the northward. Indeed, it would seem reasonable to suppose that the primitive tribes around Bering Strait would be the last to have been affected, even indirectly, by such movements, in which case the seventh or eighth centuries A.D., or later, would appear as a more probable date for the introduction of plate armor than the third century.

The conclusion seems unmistakable that plate armor whether of bone, ivory, or iron, is peripheral at Bering Strait, the center lying somewhere to the southward in Asia. This being the case, how are we to explain the occurrence of armor elsewhere in America? Since wooden slat armor, the American type closest to the plate armor of the north, has its center in the North Pacific area, it would seem plausible to assume, as has generally been done, that the two types were related in origin. There is some question, however, whether this is actually true. Technically there is as great a discontinuity between Eskimo and Northwest Coast armor as there is a continuity between the former and that which is found widespread in Asia. The manner of lashing together the individual rectangular plates and the imbricated arrangement of these in parallel and somewhat overlapping rows are features which are exhibited in practically identical form from Bering Strait to Central and Eastern Asia, but which are lacking completely in America south of Bering Strait. If, in spite of what seems to have been a fundamental difference in construction, we are still to regard the slat armor of the Pacific region as derived from the plate armor of Bering Strait, we are faced with the further difficulty that the latter type does not appear until the Punuk stage. Although conceivable, it would seem rather unlikely that the history of armor in America is to be encompassed in so short a period, particularly if the rod and slat armor of the Atlantic seaboard was related to that of the Pacific region. There seems no reason why skin armor in America should not have developed independently and the same could have been true of rod and slat armor, although the possibility of a connection between the latter and that of the Eskimo cannot be denied. In other words, this aspect of the problem remains to be solved.

Men's Knives

The form of knife most common to both the Old Bering Sea and Punuk stages is that with a short, wide wooden handle and an end blade of rubbed slate (pl. 38, fig. 1; pl. 78, fig. 8), a type which has continued in use in Alaska until recent times (Murdoch, fig. 99; Nelson, pl. 47, figs. 2, 3). In addition to this type, others with side blades were used during the Old Bering Sea period (pl. 38, figs. 2-4). The small bone whittling knife or "antler chisel", which Murdoch describes from Point Barrow (figs. 143, 144) and which is so characteristic of the Thule culture is also an old element on St. Lawrence, where it belongs to both the Old Bering Sea and Punuk stages (pl. 38, figs. 5-7; pl. 78, figs. 4, 5). Mason also reports it from the Birnirk (1930, p. 386). The knife with slightly curved bone handle and small narrow blade set in one edge near the tip (the prototype of the modern "crooked knife") was unknown during the Old Bering Sea period. It was present, however, in the Punuk (pl. 78, figs. 1-3) in a form which is similar to the slightly curved Thule type (Mathiassen, 1927, vol. 1, pl. 18, figs. 2-4; pl. 83, fig. 10).

The knife sharpeners made of very small walrus tusks (pl. 38, figs. 11-14) seem to be a local type on St. Lawrence Island, known to all culture stages.

The bone knife or dagger (pl. 79, figs. 4-6) is another element which indicates relationship between the Punuk stage on St. Lawrence Island, modern Point Barrow, and the Thule culture. Knives of this kind do not seem to have been used during the Old Bering Sea period, and Mason does not mention them as occurring in the old material from Barrow. The modern Point Barrow type (Murdoch, figs. 174, 175) is rather heavy and clumsy, but another specimen from Barrow, figured by Mathiassen (1930 a, pl. 8, fig. 8) and one from Naujan (Mathiassen, 1927, vol. 1, pl. 13, fig. 15) are very similar to the Punuk knives.

Adz Heads

The elaborate and highly specialized adz heads of the Old Bering Sea and Punuk cultures present a marked contrast to the rather simple and uniform types known from other parts of the Eskimo territory.

Most of the Old Bering Sea and Punuk heads have had the stone blade lashed on instead of set in a socket (pl. 46, figs. 3-5; pl. 60, fig. 2; pl. 78, figs. 17, 18, 20, 21). They are carefully made in every feature: a smooth concavity for the blade; an opposite lip to hold the lashing on; an oval or rectangular socket for the end of the handle; and a groove, knobs, or " ears " for the handle lashing. The " shoe-shaped " adz heads of the Punuk period (pl. 78, figs. 20, 21) are apparently a local form, a specialized development from the flatter types such as plate 78, figures 17, 18, and plate 46, figure 4.

A less common Old Bering Sea type was that with a socket at the end for an inserted blade (pl. 46, figs. 6, 7). In this respect these resemble the modern Alaskan type, which has the blade set in the end, but to obtain a really close parallel to the modern Alaskan type we must turn to one of the latest Gambell specimens (pl. 78, fig. 19). The adz heads of the Thule culture, however, are even closer to the modern Alaskan forms, most of them being exactly similar in shape, with the same inserted blade and the same methods of handle attachment as the examples illustrated by Murdoch (cf. Mathiassen, 1927, vol. 1, pl. 20, with Murdoch, figs. 133-138). Until we know what kind of adz head was characteristic of the Birnirk culture, the history of this type must remain in doubt. Perhaps, as de Laguna has suggested (1934, p. 173), the modern Barrow type is a late importation brought into Alaska by a back wash of Thule culture.

Stone Implements

One of the most striking differences between the two culture stages on St. Lawrence Island is the extensive use of chipped stone implements during the Old Bering Sea period and their scarcity in the Punuk. At the Hillside site 242 artifacts of chipped slate, chert, jasper, chalcedony, etc., were found, in addition to large quantities of rejectage. The rubbing technique was also fully developed, for 140 artifacts and innumerable fragments of rubbed slate were found at the Hillside site. In contrast to this condition, implements of chipped stone were rarely found at the three later sites and were only fairly common at Miyowagh. At these sites rubbed slate was used almost entirely. Since all of the other sites are within three-quarters of a mile of the Hillside site, it is obvious that the rarity of chipped implements at the later sites is a strictly cultural phenomenon and not the result of a lack of suitable material.

When we turn to South Alaska we observe a similar condition, archeological investigations having shown that the older culture layers are characterized by a more extensive use of chipped stone than are the later. At Cook Inlet this was definitely so, as stated by de Laguna (1934, p. 129): "The stone industry of the earlier times is characterized by the greater relative importance of chipping, including even the chipping of slate." The same seems to be true of Kodiak, for Hrdlička (1935, p. 48) states that at the lower levels of the middens there was a "prevalence of chipped, with rarity of polished, large points and knives."

Jochelson does not differentiate between the material from different levels in the Aleutian middens, but since many of the Cook Inlet and Kodiak types of stone implements are found there, the chances are that similar conditions prevail.

In the eastern Arctic the Dorset culture is distinguished from the Thule by a preponderance of chipped stone implements:

> Implements of ground slate, which are so common in Thule remains, are comparatively scarce compared with the number of chipped implements made from chert, chalcedony, and quartz. . . . . [Jenness, 1933, p. 392.]

The fact that the older stages of Eskimo culture are characterized by a more extensive use of chipped stone implements than are the later stages would seem to indicate the retention of a stone technique characteristic of the Mesolithic and Neolithic horizons of central and eastern Asia.

Among the chipped stone implements from the Hillside site the most common forms of knife blades and arrow points are those with tang, although the tangless leaf-shaped form is also represented (pl. 40). These are types of such very wide distribution both in America and the Old World that their presence here is to be expected. The same is true of the small end scrapers (pl. 42, figs. 4-10), which are characteristic of Eskimo culture generally, and of many other culture phases in America and the Old World.

This is not altogether true of some of the other Old Bering Sea types, particularly gravers and the various types of side scrapers; for although these occur sporadically elsewhere in America, it is rarely that we find an assemblage of such types at one site. This may be explained partly by the fact that in many cases little attention may have been paid to the simpler forms of stone implements, such as retouched flakes, scrapers, etc. For this reason it is hardly possible to draw comparisons. It should be observed, however, that within the Eskimo area the nearest approach to the Old Bering Sea assemblage of chipped stone implements seems to be found in the Disko Bay region of west Greenland (Solberg, 1907; Mathiassen, 1934), though it must be remembered that the Dorset and Birnirk types have not yet been fully described. In all likelihood a number of forms corresponding to those of the Old Bering Sea culture will be found when the Dorset and Birnirk collections are examined in detail. Meanwhile we may point out the following types that are common to Disko Bay and the Old Bering Sea stage on St. Lawrence Island: convex end scrapers of chipped stone (Solberg, taf. 1), cf. plate 42, figures 4-10, 16; side scrapers (Solberg, taf. 2), cf. plate 41, figures 15-26; chipped knife blades with tang (Solberg, taf. 3), cf. plate 40, figures 18, 19; knife blades of rubbed slate, with tang (Solberg, taf. 4, figs. 3-6), cf. plate 39, figures 14-18; adzlike scrapers with abruptly beveled edge (Solberg, taf. 8), cf. plate 42, figures 12-15 and text figure 16; tanged projectile points of rubbed slate (Solberg, taf. 10, figs. 1-10), cf. plate 39, figures 6-12; the small slate implements with rubbed edges shown in plate 39, figures 19-22, resemble to a certain extent some of the "drill points" figured by Solberg (taf. 5; taf. 6, figs. 1-6, 9-12).

In his systematic excavations at Inugsuk and at various sites in the Disko Bay district, Mathiassen found that stone implements were not especially abundant. As to Solberg's "Stone Age", Mathiassen felt that this was not in the proper sense a cultural entity but merely a part, a late phase, of the Thule culture, of which only the stone implements themselves were known. Although it is true that a culture can hardly be established on the basis of stone implements alone, particularly in the Eskimo area, it seems to me that in this particular instance the typology of the forms may be of significance. If th implements of the "Stone Age" belong to a comparatively late, special Greenland phase of the Thule culture, it is strange that they should show such close resemblances to those of the Old Bering Sea culture, whereas the Canadian Thule culture itself, which was ancestral to the Greenland phase, shows no such resemblances. It would seem to point to contemporaneity in this respect between the Old Bering Sea culture and a late phase of the Thule, but this can hardly be the case, for as we shall see presently the Canadian Thule culture in its entirety is far more closely related to the Punuk phase on St. Lawrence Island that it is to the Old Bering Sea. It would seem that there is still some factor which has not been taken into account. When we consider that the Dorset culture is characterized by the extensive use of chipped stone implements, and that evidences of this culture are found in North Greenland, might it not be possible that some of the non-Thule types of the "Stone Age" were derived from this source? If this were the case, then the "Stone Age" as described by Solberg would represent a mixture of Dorset types—or special Greenland variants of these—and of later Thule types.

Outside of the Eskimo area we find a close resemblance to the Old Bering Sea end scrapers, side scrapers, retouched flakes, and gravers (pl. 41) at two recently discovered ancient sites in the west: the Folsom culture site in northern Colorado and the lower levels of the Signal Butte site in western Nebraska (Roberts, 1935; Strong, 1935). The Old Bering Sea blades do not in any way resemble the characteristic " Folsom " point, but with this single exception, there seems no doubt that the chipped stone artifacts from these two ancient sites in Colorado and Nebraska conform more closely to the above-mentioned Old Bering Sea types than does any later material from the same region. However, there is little point in speculating as to the possible significance of this fact until we know whether the concentration of these particular types is in itself indicative of antiquity or whether the same combination of types might also be found at later sites if more complete information were available.

The five-sided rubbing stones of coarse materials (pl. 43, figs. 1-5) and those of greenish prase with several smoothed edges (pl. 42, figs. 17-19) seem to be local Old Bering Sea types.

With regard to the various types of rubbed slate blades (pl. 39), these are so generally distributed among all the Eskimos that detailed comparisons are hardly necessary. It should be observed, however, that the triangular-shaped blades of the Old Bering Sea culture for the most part differ from those of the Thule culture in that they have tangs; we also note the absence of the long and narrow barbed slate blades which are so characteristic of the Kachemak Bay culture of Cook Inlet (de Laguna, 1934, pl. 31).

Rubbed slate weapon or knife blades have been found on the lower Fraser River and around Puget Sound (Smith, 1903, fig. 11; 1907, fig. 102, *b, c*, figs. 120, 121, 133). On the Atlantic side rubbed slate implements are frequently found at archeological sites in the St. Lawrence Valley region and New England; they are especially characteristic of the old " Red Paint " culture (Moorehead, 1900, figs. 111; 113, *h, i;* 146).

In the Old World polished slate points are found at late Stone Age horizons in Scandinavia (Brøgger, 1909, pp. 61, 62, 85; Nihlén, 1927, fig. 105; Menghin, 1931, pl. 30, figs. 11, 12, 15, 18) and in northeastern Siberia, Kamchatka, the Kurile Islands, Japan, Manchuria, Formosa, North and South China, and Indo-China (Torii, 1915; Mansuy, 1920, pl. 4, figs. 4-6; Andersson, 1923 a, p. 6, figs. 8-11; Umehara, 1927, pl. 1-3; Jochelson, 1928, p. 41; Menghin, 1931, pl. 33, figs. 7-10; Bishop, 1933, p. 397; Finn, 1934, pp. 291-301). In a general way the distribution of slate blades in Eurasia follows that in America. It is essentially a boreal distribution and only in the marginal areas have the forms penetrated very far to the southward—to New England and southern British Columbia in America and to Indo-China in Asia. The fact that slate blades, even though later than those of chipped stone, have been in use among the northern peoples since Neolithic times suggests that they are one of the specific elements of the " coast " culture—perhaps one of the later elements—the southward diffusion of which was limited either to those coastal regions where, just as in the north, a maritime form of culture prevailed, or to interior regions like Manchuria and China to which northern culture influences have manifestly extended. Nowhere, however, has slate entirely supplanted the harder varieties of stone; the original chipping technique has been retained, even by the modern Eskimos, though not to the same extent as by such earlier Eskimo cultures as those of South Alaska, the Old Bering Sea, Dorset, etc.

Sledges and Toboggans

One of the most surprising results of the Gambell excavations is the disclosure that dog traction seems to have been unknown on St. Lawrence Island until about the eighteenth century. We should not have been unprepared to find that dog traction was relatively recent, for scarcely any evidence of it had appeared at the old sites around Barrow (Mason, 1930, p. 385; Mathiassen, 1930 a, pp. 84-88). Furthermore, Birket-Smith (1929, vol. 2, p. 169) has shown that it could hardly have been known to the northern Indians in pre-Columbian times; and Hatt (1934, pp. 2761-2762), pointing out that it is a specific Eskimo element, unknown originally from other parts of America, feels that it must therefore have reached America at a comparatively late period. However, it is surprising that dog traction should prove to be so very recent on St. Lawrence Island. Mason thought that the absence of any evidence of dog traction at the old Barrow sites was purely accidental. Mathiassen (1930 a, p. 88) was likewise inclined toward this view.

> Having regard to the geographical distribution and great age of dog traction in Eurasia and the Central Eskimo region, we must take it as being quite precluded that the Western Eskimos did not know it in some form or other in olden times; but it does not seem to have played any prominent part in the culture.

Dog traction is such an important feature of Eskimo life, that, as Hatt has observed, it is difficult to imagine an Eskimo culture without it. And yet, if our interpretation is correct, we now see that for many centuries there existed on St. Lawrence Island and apparently to the northward an Eskimo culture highly specialized in many respects, but having no knowledge of this particular feature. This deduction, as regards St. Lawrence Island, is based on the fact that at none of the four old Gambell sites was there found any object that could be recognized as having been used in connection with a dog sledge or harness—no flat bone sledge shoes, trace buckles, swivels, or whip ferrules. Objects of this nature were found only at the latest site, the old section of Gambell, in association with metal and the latest types of implements. It might be argued that the Old Bering Sea and Punuk Eskimos had used some other method of harnessing the dogs; but even so it would have been necessary to use toggles or buckles of some kind, and a few of these would surely have been included among the thousands of specimens found at the four old sites. Since nothing of the kind was found we can only conclude that dogs were not used as draught animals and that the baleen toboggans and small flat sledges of the Old Bering Sea and Punuk Eskimos were pulled by hand, just as at the present time. As a matter of fact, even after the introduction of dog traction on St. Lawrence Island, the small hand sledge for hauling umiaks and loads of meat over the ice has continued to hold as important a place as the dog sledge used for winter travel. This is because the umiak has always been the principal means of transportation, and the summer the time for making long journeys. It would appear, therefore, that the sledges of the Western Eskimo have from the earliest times been connected with hunting on the sea ice, whereas those of the Central and Eastern Eskimos have been used more for traveling. It is, of course, natural enough that the Central Eskimo should have possessed a sledge suitable for long winter journeys, for without it they could hardly have spread as they have over the interior regions.

Along with the baleen toboggan, the earliest sledge used on St. Lawrence Island seems to have been a very simple type consisting of nothing more than two walrus tusks as runners and only two slats, one at either end (pl. 44, figs. 3-5). This type was found only at the Hillside site. A larger sledge of this same primitive form was made of two whale ribs. At the Hillside site and also at Miyowagh were found ivory runners of a somewhat different type, 5 to 6 cm high and about 1.2 cm thick (pl. 44, figs. 1, 2; pl. 45, fig. 3). These were for small sledges of the same general type as those used by the modern St. Lawrence and Siberian Eskimos (Nelson, 1899, pl. 76, fig. 1; Bogoras, 1904-09, fig. 22 *a*). This sledge had a greater number of slats, as shown by the notches on the runner, and a single large hole beneath each notch for the lashing that held the slat in place. Either one long runner or two short ones were used to a side, the entire length of the sledge probably not exceeding 50 cm. In addition to these runners there were also heavy ivory shoes (pl. 45, figs. 4-9), but their exact manner of attachment is unknown. They were probably fastened to low wooden runners of a sledge not unlike the type just mentioned; the wooden runners of the toy sledge shown on plate 59, figures 8, 9, may afford a clue as to its appearance. In the Punuk stage there was a development from this type of wide heavy *shoe* into a later form of *runner,* a transition which was brought about when the shoe became gradually narrower and higher. These changes in the forms of sledge runners and shoes are as yet of only local significance since there is no evidence that such a range of forms is found elsewhere. The significant fact, for the present, is that a small, low sledge, with heavy ivory runners, or shoe-runners, appears to have been the only form (except the baleen toboggan) known to the St. Lawrence Eskimos until quite recently, when the modern built-up type of sledge was introduced along with dog traction. The thin, narrow bone shoes, with the numerous round peg holes, which were used on the latter type of sledge, were found only at the latest of the five Gambell sites; apparently this type has been in use on St. Lawrence Island for less than 200 years. On the other hand, the small, low sledge has been in use continuously from the Old Bering Sea period to the present time, and it was no doubt used then as now mainly as an adjunct of hunting, for hauling loads of meat and umiaks over the ice by hand. In its essential features, this sledge is related to the simple runner sledge of the Central Eskimos which Mathiassen, Birket-Smith, and Hatt regard as the earliest developed form of the Eskimo sledge. In the Gambell excavations we now have proof of the antiquity of this type, and of the toboggan, among the Eskimos, but beyond this our finds contribute little to the solution of the problems concerning the origin and relationship of the various types of sledges and toboggans.

Because the simple runner sledge and the use of dog traction were originally unknown in America outside of the Eskimo area, Hatt is inclined to think that they were introduced into America at a comparatively late period. However, now that the archeological finds seem to indicate a dissociation of the two elements, the question appears in a somewhat different light. For the small, simple runner sledge such as described above might well be a very ancient type, but being designed only to haul loads by hand over the sea ice, it would not, in that particular form, have been useful away from the coasts or as a vehicle of travel. It would not be likely, therefore, to spread beyond the limits of the permanent Eskimo settlements along the coasts. Only after it had been altered in form—made longer and provided with lighter runners—would it have been thoroughly adapted to land travel; and one might reasonably suppose that this change was made at the time when dogs were first utilized as draught animals. Mathiassen (1930 a, p. 88) visualizes some such transformation taking place as the Eskimos of the Thule culture left their settled homes in the west and migrated eastward.

> . . . . when the Thule Culture Eskimos during their movement eastwards came to regions where the big aquatic mammals were less abundant, drift-wood more scarce and with less open water, it was . . . . then that the dog sledge attained the dominating position in the culture that it still has in these regions, whereas on the other hand the importance of the umiak diminished until it entirely disappeared; it now became necessary to make long winter journeys, and for this purpose the dog sledge was indispensable.

Mathiassen does not suppose that it was during this eastward migration that dogs were first employed by the Eskimos in hauling sledges; in his opinion they had known dog traction earlier but in their settled life along the coasts it had been of little importance. On the other hand, as we have seen, the archeological evidence seems to indicate that in early times dog traction was entirely unknown at least on St. Lawrence Island and at Point Barrow. It must be admitted that it is difficult to think of this being a universal condition in the west, for in view of the known antiquity of dog traction and sledges in the Old World (Birket-Smith, 1929, vol. 2, p. 169; Hatt, 1934, pp. 2758, 2759), it would mean that the complex had been invented independently by the Thule Eskimos, presumably after they had penetrated east of Barrow. Mathiassen's view that the ancestors of the Thule Eskimos possessed a latent knowledge of dog traction would certainly provide a better explanation. It may be that definite evidence of the early use of dog traction may yet appear around Bering Strait, possibly on the Siberian side. This would not be so very surprising, as there are several features—lamps, the Thule type 3 harpoon head, and lashing holes around the sockets of harpoon heads—which link the Thule culture with Bering Strait more closely than with Barrow or St. Lawrence Island.

Lamps and Cooking Pots

The Gambell excavations have shown conclusively that the particular forms of pottery lamps, lamp rests, and cooking pots described from St. Lawrence Island by Hough and Nelson have been in use there for only a relatively short time. From the old section of Gambell, from the upper levels of Seklowaghyaget, and from houses 8, 9, and 10 we obtained quantities of fragmentary pottery of this kind—pieces of flat-bottomed lamps, oval to rectangular in shape, with two high parallel ridges extending along the inside, like the modern specimen shown in plate 84, figure 4; and of flat-bottomed, thin-walled cooking pots, rectangular in shape with rounded corners and with suspension lugs on the outside or holes through the rim (pl. 84, fig. 5). But the far more extensive excavations at Ievoghiyoq, Miyowagh, and the Hillside site revealed no trace of this kind of pottery; the sherds indicated that there had been no lamps with ridges, no pots with suspension holes or lugs. Instead the lamps were shallow, conical, and thick-walled, and the cooking pots deep and circular with rounded or flat bottoms and thin walls. Although no complete vessels were found, the many hundreds of sherds indicate that the forms of both lamps and cooking pots remained constant throughout the Old Bering Sea period and the greater part of the Punuk.

Unlike the modern St. Lawrence lamp, which is peculiar to the island, the older rounded form seems to have been rather widely distributed in northern Alaska. I found a number of them when excavating old burials at Kowieruk, in the western part of Seward Peninsula and also at Wales; one of the Kowieruk lamps is illustrated in plate 53, figure 2. These lamps do not conform exactly to any modern type, though the rounded shape indicates a general relationship to the saucer-shaped lamps of the Yukon-Kuskokwim region. Mason states that round, flat pottery lamps and round earthenware pots were excavated by Van Valin at Barrow (1930, p. 386). Stefansson also found pottery fragments to be abundant at old ruins in the Horton River district between the Mackenzie and Coronation Gulf (1913, pp. 327-329; 1914, pp. 312-314, 332, 348), and Jenness found fragments in the Coronation Gulf region (1923, p. 541). Soapstone vessels seem to have been absent at all of the old Alaskan sites (Stefansson, 1914, p. 394; Jenness, 1928 a, pp. 74, 75; Mason, 1930, p. 386; Mathiassen, 1930 a, p. 53; Collins, 1934, p. 311, and 1935, p. 463).

The archeological evidence clearly indicates, therefore, that pottery lamps (and also cooking pots), instead of being restricted to the Yukon-Kuskokwim region and St. Lawrence Island, were until quite recently uniformly distributed throughout northern Alaska as well. In fact I do not know of an abandoned Eskimo site from Norton Sound to Point Barrow at which pottery fragments cannot be found in large numbers. According to all indications, pottery persisted in most places up to a few generations ago. The old lamps did not disappear immediately upon the importation of soapstone lamps from the east, and the old cooking pots were retained until supplanted by vessels of copper and iron.

The fact that a rounded pottery lamp is the characteristic form of the Old Bering Sea culture, stone lamps being entirely absent, lends strong support to Mathiassen's theory (1930 c, p. 598) that this was the original form of the Eskimo lamp:

. . . . the lamp is an Asiatic element introduced into America by the Eskimo, probably at first as a round or oval clay lamp, later on made of soapstone.

It is of interest in this connection to observe that Mathiassen has recently demonstrated that oval earthenware lamps, apparently used for illumination only, were characteristic of the Danish Ertebølle culture (Mathiassen, 1935). With earthenware lamps being thus characteristic of prehistoric culture stages in northwestern Europe as well as at Bering Strait and on the Ya-mal peninsula in northwestern Siberia (Cernecov, 1935) it would seem reasonable to anticipate that fuller knowledge will close in the gaps and reveal a uniform boreal distribution of pottery lamps, as distinguished from those of stone, from the Baltic eastward across Siberia to Bering Strait and Alaska.

Birket-Smith, however, views the question differently. The fact that stone lamps are found both to the north and south of the pottery lamp in Alaska indicates that the latter is intrusive, "a later, perhaps original Asiatic form, which among the Eskimos has especially adapted itself locally to the delta country where stone is extremely scarce" (Birket-Smith, 1929, p. 102). Furthermore, the fact that the Eskimos of northern Alaska import soapstone lamps from east of the Mackenzie indicates "that the people in Alaska have brought with them an ancient preference for stone lamps from elsewhere." (1929, p. 102). As to the original form of the Eskimo lamp, Birket-Smith points to the naturally hollow stone used by the Caribou Eskimo, and since unmodified stones were used in the same way on the Aleutian Islands he feels (1929, p. 103) that "the lamp of the Caribou Eskimos is no local, degenerate form, but a really constant, though extremely primitive type which it is also justifiable to regard as being the oldest."

Like everyone else, Birket-Smith (1929, p. 192) recognizes the antiquity of the lamp in the Old World:

It is to me probable that the bowl-shaped lamp for illumination—not for heating—is an extremely old culture element which with the earlier layer of hunting culture in the circumpolar region has been diffused over the greater part of boreal Eurasia and North-America, but which through the greater mobility which has accompanied snowshoe hunting and reindeer nomadism has for the greater part again disappeared. Only in those places where the later culture did not obtain a firm footing did the lamp remain in use, i. e., by the northern Pacific and among the Eskimos, among the latter in a further developed form as a source of heat as much as a source of light, and likewise in a specialised form among the large number of civilized peoples from the Mediterranean over South Asia to East Asia.

Although there seems little basis for the assumption that the lamp was once more widely spread in North America, having disappeared over large areas with the advent of the snowshoe hunting stage, there is no reason to doubt that it was one of the original elements of the coast culture or ice-hunting stage. However, it is difficult to see how Birket-Smith's theory of the ancestral status of the Caribou Eskimo lamp can be reconciled with the fact that in the Old World the lamp is a very ancient culture element, one which goes back to Paleolithic times. Hatt (1934, pp. 2762, 2763) has recognized this discrepancy, pointing out that the lamp is a specific Eskimo trait which could not have been borrowed from any other American culture and which must therefore have been brought over from Asia. If the simple hollow stone lamp of the Caribou Eskimo and the similar stone or shell lamps of other peoples are to be regarded as primitive, original forms that have persisted unchanged for thousands of years it would be necessary to know something of the history of the element in each particular case so as to avoid accepting as primitive some forms which might be only degenerate. Thus, according to Jochelson (1928, p. 68), the Kamchadal who formerly used stone lamps now make use of various improvised forms: "The present Kamchadal sometimes still use stone lamps for lighting, but often a tin box, iron frying pan, or a clam shell substitutes for the stone lamp." Whatever may have been the history of other simple Old World lamps mentioned by Birket-Smith, such as the hollowed-out stone of the Mongols, or the shells used in remote parts of Scotland, the Orkneys, Lapland, etc., there is no archeological evidence that any of the Eskimo lamps have developed from such simple local forms. Jochelson found both crude and finished types on the Aleutians, and while he states that "polished stone lamps and adzes were . . . . discovered chiefly in the upper layers" (1925, p. 122), he also found some well-made specimens in the lower levels. De Laguna found both crude and finished lamps at Cook Inlet but no evidence that one type had preceded the other. During three seasons of work at a single large site on Kodiak Island, Hrdlička found a large number of stone lamps, and observes (1935, p. 48) that the earlier forms were the more elaborate.

The culture of the oldest occupants of the site was in the main superior to that of the same people of later time and differed from this in several marked respects. It shows a superior art in lamp sculpture. . . . . As times go on . . . . their habits and culture change. The old lamp art fades away gradually.

The clearer perspective provided by the archeological investigations in the west leads one to question the correctness of Birket-Smith's view of the origin of the Eskimo lamp. The assumed relationship between the stone lamps of the northern Eskimo and those of the Aleut and Pacific Eskimo is based only on the fact that they are made of the same material. Structurally, the forms in the two regions are quite distinct. And since it now appears that in all of Alaska above Norton Sound, and very likely for some distance below, there were originally no stone lamps of any kind, there seems to be no reason why the structurally dissimilar forms to the eastward and southward should be considered as closely related. On the other hand, as de Laguna has already pointed out (1934, p. 180), there is undoubtedly a genetic relationship between the stone lamps of south Alaska (Cook Inlet, Kodiak, the Aleutian Islands) and those of Kamchatka; the latter in turn are related to Kurilian forms (Torii, 1919, p. 201; Nakayama, 1934—illustration of a small "sad-iron" shaped stone lamp from Shimushu, Kurile Ids.). In addition to the common feature of the suspension hole on the small hunter's lamp in the Aleutian Islands, Kamchatka, and the Kuriles, which de Laguna has pointed out, there is also a general similarity in size, shape, and treatment of the rim that unites the south Alaskan and Kamchatkan-Kurilian lamps and sets them apart as a regional group distinct from the crescent-shaped lamps of the Central and Eastern Eskimos.

It was the latter type of lamp that was introduced into northern Alaska as far west as Bering Strait, and this Birket-Smith would interpret as an indication that the Alaskan Eskimos "have brought with them an ancient preference for stone lamps from elsewhere." The present evidence, however, shows conclusively that these stone lamps have been imported only within the last few centuries. As has been pointed out earlier, there are strong indications of a late return movement of Thule peoples into northern Alaska, and herein apparently lies the explanation of the soapstone lamps which in recent times have supplanted the older pottery forms. These late migrants from the east did, indeed, bring with them a preference for this superior type of lamp, and later, with no local soapstone available for their manufacture, continued to obtain them through trade. The original absence of stone lamps in this region is clearly part of a cultural pattern and in no way the result of a lack of suitable material; for although there are some localities between the Yukon and Kuskokwim where stone is not immediately available, there is everywhere else an abundant supply of the same kinds of stone that the Aleuts and Pacific Eskimos have always used in the manufacture of their lamps.

From Mathiassen's investigations it appears highly probable that the earlier form of the soapstone lamp was the rounded crescent-shaped form of the Thule culture, which had its prototype in the rounded pottery lamp of the West. The long crescent-shaped modern form, which was introduced into Alaska, would then be a late specialization, a lamp which, as Hough has said (1898, p. 1038), is adapted to the high and rigorous north and which has arisen as "the result of an attempt to devise a vessel with a long, nearly straight wick edge combined with a reservoir."

The origin of the modern St. Lawrence lamp is somewhat uncertain. The rounded-rectangular shape and the two parallel ridges distinguish it from all other Eskimo lamps save the related forms from adjacent northeastern Siberia (e. g., Bogoras, 1904-09, p. 186, fig. 103). However, the position of the ridges, close to the rim, suggests a relationship with the Thule lamps (Mathiassen, 1927, vol. 2, p. 101). This becomes more apparent when we consider that stone and clay lamps closely related to the Thule type are found among the neighboring Siberian Eskimo and Chukchee (Hough, 1898, pl. 17; Nelson, 1899, pl. 28, fig. 3; Bogoras, 1904-09, fig. 102); and according to Nelson similar lamps are used on the Diomede Islands (p. 63). Mathiassen comments upon the fact that the Thule lamp, although present in Siberia, does not occur in Alaska even at Point Barrow, where so many Thule traits are to be found. As we have already observed, a similar condition is found with regard to the Thule type 3 harpoon head, drilled lashing holes around the socket, and small ivory bird figures.

On the whole, the present evidence points to the modern St. Lawrence clay lamp as being a local specialization, the immediate prototype of which is the more rounded Siberian form, also of clay but with a single wick ledge. This, in turn, appears to be either a copy, in pottery, of the stone Thule lamp or the prototype from which the Thule form was derived. The former explanation would appear the more reasonable in view of the fact that wick ledges in general seem to be a late feature, but the alternative explanation should not be ruled out until archeological data are available for northeastern Siberia.

The exact form of the Old Bering Sea cooking pot is unknown; we only know that it was a steep-sided pottery vessel with rounded, or very rarely, a flat bottom, probably resembling the ancient Koryak type (Jochelson, 1905-08, fig. 165) which, like the Neolithic pots in other parts of Siberia, also had a rounded bottom (Jochelson, 1928, p. 30). The Siberian and modern Alaskan pots of round shape but with flat bottoms are no doubt later.

The modern St. Lawrence cooking pot—flat-bottomed, rectangular in shape and with suspension lugs or holes at the rim—is an entirely different form, which makes its appearance at about the close of the Punuk period. It is an unusual and impractical form for a pottery vessel to take, and since it is unrelated to the earlier local form but very close to some of the eastern soapstone pots (e. g., the rounded-square Thule type and the Greenland type described by Hough, pl. 9, fig. 4), it seems impossible to avoid the conclusion that it is a pottery imitation of a soapstone vessel, a view which has already been expressed by Birket-Smith (1929, vol. 2, p. 104) and Mathiassen (1930 a, p. 92).

The relation between the pottery and stone cooking pot presents a similar problem to that of the lamp. Mathiassen (1927, vol. 2, p. 105) thinks that the rounded pottery form is the older:

> The round or oval soapstone cooking pots of the Thule culture are presumably copies of the rounded form of the clay vessel transferred to soapstone; later on, the suitable oblong shape for soapstone (but not for clay) has made its appearance in the central regions and superseded the round form from these regions and later, through purchase, transplanted itself to North Alaska.

Birket-Smith (1929, vol. 2, p. 104) agrees that the oval form is older than the rectangular but contends that

> . . . . it by no means follows from this that the stone pot has been derived from a clay pot . . . . the distribution of the stone cooking pot in North America is a powerful argument in favor of the earliest cooking pot of the Eskimos being of stone.
>
> The absence of soapstone cooking pots in the west is naturally explained by the fact that soapstone . . . . does not occur west of Coronation Gulf. All soapstone cooking pots and lamps at Mackenzie River and in Alaska are imported. That they were nevertheless in regular use means obviously, as in the case of stone lamps, a holding on to old custom.

However, now that recent investigations have shown that the stone pots and lamps in northern Alaska are all recent importations from the east, the problem appears in an entirely different light. We see that there is a wide break in the line of continuity that Birket-Smith would trace from the Central regions to Alaska, thence down the North Pacific coast to California, across to the Great Basin and finally to the middle and north Atlantic region. The presence of pottery and the absence of stone vessels is no local peculiarity of the Old Bering Sea culture. On the contrary it is conformable to conditions in northeastern Siberia where pottery was formerly widespread, as in the territory of the Koryak, Kamchadal, Chukchee, and Yakut, to say nothing of Eurasia generally. We may safely say, therefore, that pottery, instead of being intrusive among the Eskimo, was one of their original possessions. In this sense pottery should no doubt be considered as one of the elements of the coast culture or ice-hunting stage.

Excavations in Kamchatka and the Kurile Islands have revealed both pottery vessels (cooking pots) and stone lamps. They seem to have been contemporaneous at the Kamchatkan sites where Jochelson excavated, so that we have no way of knowing which of them had appeared first. However, in view of the greater abundance of pottery and its undoubted antiquity in Japan and on the mainland where it was part of a widespread Neolithic complex, it would seem probable that pottery had preceded stone lamps in this region. If this were so, then the stone lamps, closely related as they are to those of the Aleutian Islands, might reasonably be regarded as having been introduced into Asia by way of the Aleutian chain. The presence of pottery at all of the known prehistoric sites in Kamchatka and its absence in the Aleutian Islands would itself tend to preclude the idea of a west to east movement (from Kamchatka to the Aleutians), for if this had occurred, it would seem that pottery would have been introduced into the latter region.

The relationship between the stone lamps of the two regions can hardly be doubted; and since the Aleutian forms connect with those of Kodiak Island and Cook Inlet and these in turn probably with the stone vessels (mortars, etc.) in the nonpottery area extending from the North Pacific coast down to California, we seem to have a continuous distribution of stone vessels from Asia to America. It should be emphasized, however, that the cultural continuity thus indicated is strictly north Pacific—northward to and including the Aleutian chain on the American side, then westward to Kamchatka and the Kuriles in Asia. There is no evidence that the Eskimos north of Norton Sound (probably even north of the Kuskokwim) or the Asiatic tribes north of Kamchatka, were in any way affected. Here, on both sides of the Bering Sea, was an extensive area where stone vessels were unknown and where pottery was the important material. Since the Thule culture in all probability originated in this region, there is every reason to believe that Mathiassen is correct when he says that the Thule lamp and the more rounded type of cooking pot both had their prototypes in the rounded clay lamps and pots of the Bering Sea region. This does not mean necessarily that the Thule Eskimos were the first to make lamps and pots of soapstone. These may have been in use in the eastern Arctic before the Thule peoples arrived, for Jenness presents evidence which seems to show that the Dorset Eskimos in at least some places manufactured pots out of soapstone (Jenness, 1933, p. 392).

Ornamentation on the pottery from the Old Bering Sea and Punuk sites at Gambell was meager, being restricted to indentations, corrugations, and other surface irregularities produced by the application of a paddle with a roughened or carved surface. Sherds thus marked were found at the Hillside site, Miyowagh, and Ievoghiyoq; however, they were decidedly in the minority, most of the sherds showing no decoration of any kind. The most interesting exception was the single large sherd bearing a check-stamp design picked up on the surface of the Miyowagh midden (text fig. 17). Pottery decorated in this manner has thus far been reported in the Eskimo area only from Norton Sound and Nunivak Island (Collins, 1928). A fragment of check-stamped pottery from a Neolithic kitchen midden in Japan is illustrated by Kishinouye, plate 24, figure 85; it occurs also in southeastern Asia, having been described from Siam, Perak, and Annam (Sarasin, 1933, fig. 23 *a*; Goloubew, 1930, pl. 24). Its principal center, however, seems to have been southeastern China, to judge from the finds on Lamma Island, near Hong Kong (Finn, 1932, 1935). From this site Finn has excavated quantities of check-stamped pottery which he dates as 500-200 B.C. The peculiarly Chinese character of this pottery is shown by the accompanying scroll-like designs which are stamped on the same vessels. These are various forms of the decorative motive so characteristic of the earliest Chinese dynastic art, that of the Shang period, and which Finn very appropriately calls the "Double-**F**" design.

It is of interest to observe that the check-stamp pattern, though essentially a ceramic decoration may be applied at times even to bronze. An example is afforded by a bronze mirror in the possession of Dr. E. W. Kirk, of Washington, D. C. This mirror is reported to have been excavated from a tomb in Manchuria and probably dates from the T'ang dynasty (618-906 A. D.) or possibly somewhat later. The entire inner surface, except for a scrolled border design and two large dragons, is covered with very small indented squares forming a uniform check-stamp background, the squares having been stamped on the original mold from which the mirror was cast.

On the whole it seems that the technique of stamping in the decoration of pottery vessels was widely practiced in eastern Asia; a plain gridded or checkered design might, therefore, have appeared independently at a number of localities. Whether, with regard to the St. Lawrence and Asiatic examples mentioned, this was the case, or whether there was a closer connection, it is perhaps too early to say. If similar ware should later be found in northeastern Siberia a genetic relationship might well be claimed. Another, and more distant parallel is afforded by a check-stamped sherd, identical with the St. Lawrence example, reported from an Iron Age site on Kola Bay, northern Russia (Schmidt, pl. 6, fig. 4).

Baleen Vessels

Baleen vessels (pl. 53) are among those elements that have been present from the Old Bering Sea period to the present time. They are in general use from Greenland to Alaska and are evidently an old element in Eskimo culture (Mathiassen, 1927, vol. 2, p. 107). Relationship between the baleen vessel, which is found only among the Eskimos, and the birch bark and wooden vessels, which have a much wider distribution in northern America and northern and central Asia, is clearly indicated by similarities in the stitching along the sides, by the method of attaching the bottom to the sides, and by the shape. The technique of fastening the sides together by stitching and of attaching a separate bottom would seem especially designed for pliable materials like baleen and birch bark; the wooden vessels of the Alaskan Eskimos and Indians which are made in the same way might therefore be regarded as imitations of these forms. As to which of the two forms—the birch bark or the baleen—is the older, there is no clear evidence, although it would seem plausible to suppose that the birch bark vessel was the original form and the baleen vessel a substitute employed only by the Eskimos.

Women's Knives

The Old Bering Sea ulus have slate blades which are more or less oval in shape with a straight or curving edge. The handles, of wood or ivory, are either straight, rounded or crescent shaped (pl. 51, figs. 1-7). Two of them are decorated (pl. 12, fig. 12; pl. 14, fig. 6). Some, from the Hillside site, had no handles at all, the slate blade having been held directly in the hand (pl. 39, fig. 3). The prevailing form of the Punuk stage (pl. 78, figs. 9, 10, 12, 13) is very similar to the Old Bering Sea type; but a new form has appeared (pl. 78, fig. 11; pl. 82, fig. 30) which is pointed at one end, squarish at the other, with a large hole in which is hung an ornamental link. An earlier Punuk form is even more elaborate, with a wide ringlike opening at one end for the index finger and grooves on the sides for the thumb and other fingers (pl. 22, fig. 1). One of the Old Bering Sea handles also has a groove for the index finger (pl. 51, fig. 5).

Most of the modern Alaskan ulus have plain handles like the prevailing Old Bering Sea and Punuk forms but there are some which have openings (Mason, 1891, pls. 63, fig. 4; 65, fig. 4; 67, figs. 2, 3; Nelson, 1899, pl. 47, fig. 4); and the same is true of some slightly older specimens from the Arctic coast (Mathiassen, 1930 a, pl. 4, fig. 10; pl. 5, fig. 16; pl. 10, figs. 9, 10). Turning to the Thule culture, we find both the plain handle and the handle with large central openings (e. g., Mathiassen, 1927, vol. 1, pls. 23, 24). As Mathiassen has pointed out (1927, vol. 2, p. 87), the form with the hole is very likely the prototype of the two-armed eastern type, whereas the more widely spread tanged form has probably been derived from the Thule type with thickened overhanging grip (Mathiassen, 1927, vol. 1, pl. 24, fig. 2). The earliest form of all is undoubtedly the plain handle without a hole, the type that has been in use in Alaska from the Old Bering Sea period up to the present time. The later North Alaskan type with central hole is presumably one of the Thule elements introduced within the past few centuries.

Fat Scrapers

The Gambell finds show the antiquity of the cup-shaped fat scraper of ivory which is such a characteristic implement of the modern Alaskan Eskimos. The Old Bering Sea types, however, exhibit a wide range of variation and include no examples exactly similar to the modern type, although the prototype of the latter is no doubt represented by the shallow but rounded form illustrated in plate 51, figures 9, 11. The oldest form is rather long and narrow; it has a flat or rounded bottom, upright or slightly flaring walls and is open at both ends (pl. 13, fig. 8; pl. 17, figs. 1, 2; pl. 30, figs. 5-7; pl. 51, fig. 8). It is a type which has not been reported from any other locality. The Punuk type (pl. 78, fig. 14) which is slightly curved and has only one edge sharpened, has likewise not been found elsewhere. In the east the cup-shaped fat scraper is known from a single example from one of the Thule sites (Mathiassen, 1927, vol. 1, pl. 53, fig. 1) in a form more like the modern Alaskan examples than the older ones from St. Lawrence. Archeological information from northern Alaska will be necessary in order to determine the exact relationship between the Thule and Western types.

Needle Cases

The needle cases of the Old Bering Sea period (pl. 13, fig. 5; pl. 17, figs. 4-9) are of interest because of the light they throw on the problem of the original form of the needle case and of the relationship between the various modern forms, questions concerning which there has been considerable discussion.

In his study of Alaskan needle cases, Boas (1908, p. 327) came to the conclusion that the flanged form characteristic of the Norton Sound region and the winged form of the east were related in origin:

> It seems to me very plausible that the Alaskan type and the Eastern type represent specialized developments of the same older type of needlecase, and that the flanges and diminutive knobs of the Alaskan specimens are homologous to the flanges and large wings of the Eastern specimens.

Thalbitzer described a needle case from an old site at Scoresby Sound which resembles rather closely two old specimens later found at Point Barrow and described by Mathiassen. Thalbitzer (1909, pp. 476, 477) considered that this Greenland needle case was intermediate between the typical winged form and the Western Eskimo type:

> Its form diverges a little from that of the latter [the fully developed winged type] which was seen to be particularly typical of the Greenland fashion of needle-case; but the divergence rather goes to lend support to the view, that this somewhat slenderer form, which in Greenland is only found in the north-east, and only in this one specimen, really constitutes a transition form which fills up the gap between the Greenland and the West Eskimo type of this implement.

Mathiassen, on the other hand, thought that the prototype of the winged needle case of the east was to be found in the Alaskan needle case carved in human form and pointed to two old specimens from Point Barrow of modified winged type which had oblique lines on the sides which he regarded as stylized representations of "the hands bent in front of the body." (1927, vol. 2, p. 94.) As for the flanged Alaskan type, Mathiassen thought this to be a local, special form which had no relation to the winged type. Hatt (1928, p. 12) questioned the validity of Mathiassen's theory of a relationship between the winged case and the Alaskan case in human form, as did also the writer, who pointed out that the old Point Barrow specimens were in fact intermediate between the winged eastern form and the flanged Alaskan type and therefore in themselves constituted evidence of the relation between the two forms as postulated by Boas (Collins, 1929, p. 33). In 1930 Mathiassen (1930 a, pp. 62-63) returned to a consideration of this problem and pointed to several examples from Alaska which in his opinion showed further evidence of the transition from the human "arms" to the modified "wings" of the Barrow type. In a later publication (1931, p. 96) this view was abandoned.

If we now consider the Old Bering Sea needle cases, it will be seen that although they display considerable variability as to shape, none of them have any suggestion of a human form; neither do they have flanges of the modern Alaskan type nor " wings " of the older Point Barrow type, although one of them (pl. 17, fig. 5) has the same general outline as an old specimen from Barrow (Mason, 1930, pl. 4, fig. 8). The most common Old Bering Sea type is a rounded or somewhat flattened tube. Two of them (pl. 17, figs. 4, 8) are ornamented with pairs of the characteristic Old Bering Sea " animal heads ", and in figure 8 these have an appearance somewhat suggestive of " wings." Plate 17, figure 9, with a surface ornamentation which embodies certain Punuk features, has the upper end somewhat flanged and the sides expanded into small " wings." It would appear, therefore, that in the variable forms of the Old Bering Sea needle cases we have the first faint beginnings of the " flanges " and " wings " which later became more and more pronounced in the north, resulting finally in the standardized flanged type of western and northern Alaska and the winged type of the Central regions. The needle cases of southwest Alaska, on the other hand, have retained the more primitive tubular form of the Old Bering Sea culture.

The Punuk specimens (pl. 65, figs. 1, 2) are characterized by an enlarged upper end which is distinctly reminiscent of the modern Alaskan " flange ", even though it lacks the conventional fluting and decoration of the latter. Plate 65, figure 2, has, in addition, very distinct " wings " somewhat below the center so that on the whole it is quite conformable to the two old Barrow specimens figured by Mathiassen (1927, vol. 2, p. 95). We would be justified in assuming, therefore, that these Punuk and Barrow specimens, combining as they do both the " flange " and " wing " concept, represent the immediate prototype of both the flanged Alaskan needle case and the winged form of the east; and that Boas was therefore correct in considering that the diminutive knobs on the Alaskan specimens were homologous to the enlarged wings of the eastern specimens. Now that we have these older Alaskan specimens, we can see that the little knobs below the flanges on the modern Alaskan cases are survivals of the small wings, which in one instance at least (pl. 65, fig. 2) are themselves hardly more than knobs; and that the flanges are merely a later form of the expanded upper end to which in the course of time decorative treatment of a conventional nature has been applied. In Alaska, therefore, the later emphasis has been upon the enlarged upper end which has been retained and elaborated while the small " wings " have been reduced to nothing more than vestigial knobs. In the east, it is the wings that have been selected for special treatment, as a result of which there has appeared finally the exaggerated modern form; the

Thule type (Mathiassen, 1927, vol. 2, fig. 1, *28*) and the modified type described by Thalbitzer (1909, pp. 476, 477) represent intermediate stages between the older Alaskan form and the specialized form of the east, just as Thalbitzer had recognized.

As to the place of origin of the flanged-winged type of needle case the present evidence points to the Arctic coast of Alaska, probably around Barrow, rather than St. Lawrence Island; for it is on the Alaskan mainland that the type has centered, and furthermore the Punuk examples (pl. 65, figs. 1, 2) are almost certainly later than those excavated from the old Barrow sites. On the other hand the tubular type with neither wings nor flanges appears to be the oldest of all. It is this type which is characteristic of the Old Bering Sea culture, and which, as Thalbitzer has pointed out, is widely diffused over northern Eurasia, where it is found among the Lapps, Samoyed, Tungus, Gilyak, Ainu, etc. (Thalbitzer, 1924, p. 285.) In Europe the tubular needle case goes back to Paleolithic times. It is evident, as Thalbitzer has remarked, that the needle case is an old element in the circumpolar regions, and one indicative of far flung cultural relationships. In this connection it should be noted that in one instance at least there is a surprisingly close resemblance, to some extent even in decoration, between one of the old Ainu needle cases from the Kuriles (Torii, 1919, p. 32, fig. 3) and two recently excavated from the Kola Peninsula in northern Russia (Schmidt, 1930, pl. 4, figs. 2, 3). That the needle case in Asia goes back at least to Neolithic times is shown by the discovery of a specimen in a cave deposit of that age at Sha Kuo T'un, in southwestern Manchuria (Andersson, 1923 b; 1934, p. 195) and another at a Neolithic site on the Angara River, Irkutsk, Siberia (Menghin, 1931, pl. 21, fig. 17). The needle case discovered by Andersson was made from a fox humerus, and that from Siberia of a bird bone; in both instances the bone needles were found inside.

Jumping Stones

The presence of " jumping stones " on St. Lawrence Island is interesting and not a little puzzling, as these rows of spaced stones, or *nangissats,* have not been previously reported outside of Greenland (Porsild, 1920, pp. 297, 304. Thalbitzer, 1925, p. 245). They are found at a number of places on St. Lawrence Island: at Gambell; about 12 miles south of Gambell (pl. 1, fig. 2); at Kitneapalok; at Cape Kialegak, and doubtless at other places also. I have been told by the Eskimos that they also occur in Siberia.

There are three rows of these jumping stones on the top of the Gambell plateau. The principal one is something over 100 yards long and is evidently very old, as the stones are deeply embedded in the ground and covered over with moss and lichens. The ground all around has been cleared of stones, some of which have been placed in two piles about 5 feet high, on either side of the row at about the center. The line of stones curves somewhat but extends in a general north and south direction. The stones are closely spaced, some being hardly more than a foot apart.

These stone rows are not used at the present time and the Eskimos do not know when they were made. According to my informants they were used by young men who were training to be runners or strong men. While carrying a heavy log, they would jump over and between the stones, not on them as in Greenland. The only name given to the stone rows, as far as I could learn, was " kitphakiltut " which means simply " jumping rapidly." There can be no doubt that they had the same function as those in Greenland (Disko Bay) described by Porsild (1920, p. 300):

> Nowadays the game of hopping on stone rows is never played either by children or by adults. When accompanying travelers, however, our Greenlanders will, just for fun, hop over some of the stones, so as to demonstrate the knowledge of their meaning. In old times, however, the game belonged to the rather large number of sports and contests engaged in either as a pastime among the villagers, or as challenges to strangers, or during the annual feasts when controversies were settled by juridical drum songs.
>
> . . . . My informants relate that the player also had to carry a weight in his arms, such as a bundle of sealskins, the dead body of a small seal, or a live dog.

As Thalbitzer has pointed out, there are numerous Eskimo games, contests, festivals, etc., which can be traced in practically identical form from Alaska to Greenland and which denote a psychical homogeneity no less remarkable than that to be observed in other aspects of their culture (1925). These jumping stones provide another striking example of this widespread uniformity. It seems strange that they should have been found thus far only at the two extremes of the Eskimo territory, but later, no doubt, they will be found in the intervening areas. There is at present no way of knowing whether on St. Lawrence Island they belong to the Old Bering Sea, the Punuk, or the modern culture, for they are found near sites where at least two, if not all three, of the stages are represented. In all likelihood, however, they will be found to belong to a later stage of culture than the Old Bering Sea, for the latter, as far as we know, did not extend beyond

Alaska and Siberia. It would not be surprising if it should turn out that jumping stones, like a number of other widely diffused traits among the Eskimo, were originally connected with the Thule culture.

Summary

It will not be necessary, for our present purpose, to analyse the simpler, more common elements in the Old Bering Sea and Punuk cultures. These, as well as the special local types, have been illustrated and described in the preceding pages, and it will be sufficient here to include them in the following general categories into which the material may be divided:

Elements known only from the Old Bering Sea culture:

- Winged objects (pl. 12, figs. 1-4; pl. 20; pl. 21)
- Ivory object (pl. 12, fig. 14)
- Decorated ivory gorgets (?) (pl. 13, fig. 2; pl. 15, fig. 1; also early Punuk—pl. 22, fig. 4)
- Decorated ivory ornaments with slotted base (pl. 15, figs. 3, 4, 6; pl. 19, fig. 6)
- Harpoon heads (open socket types Ix, Iy, I(a)y, I(b), IIx, IIy; closed socket types Ix, IIx, IIIx, IIIy, IVy; pl. 23; pl. 24, figs. 1-18; pl. 26, figs. 1-5, 11-20; pl. 27, figs. 5-7)
- Arrowheads with low-lying barbs (pl. 29, fig. 6; pl. 34, figs. 2-6)
- Wedge-shaped ivory objects (pl. 29, fig. 17; pl. 47, figs. 12, 13)
- Dog femur scrapers (pl. 30, figs. 12-14)
- Heart-shaped ivory objects (pl. 30, figs. 18-20)
- Slate implement with straight, rubbed edges (pl. 39, figs. 19-22)
- 5-sided rubbing stones (pl. 43, figs. 1-5)
- Heavy sledge runners of whole walrus tusks (type 1, pl. 44, figs. 3-5)
- Heavy sledge runners of whale ribs
- Heavy ivory sledge shoes (types 1, 2, 3, pl. 45, figs. 4-9)
- Pottery paddle (pl. 47, fig. 17) probably also Punuk
- Small ivory vessel (pl. 51, fig. 12)
- Wooden shovels (?) (pl. 54, figs. 6-8)
- Drum handle and rim in one piece (pl. 55, fig. 5)
- Wooden handle (pl. 57, fig. 6)

Western Eskimo elements which occur in special forms in the Old Bering Sea culture:

- Decorated ivory ulu handles (pl. 12, fig. 12; pl. 14, fig. 6)
- Ulu handle with ivory inset in top (pl. 51, fig. 7)
- Ulu handle with finger rest on top (pl. 51, fig. 5)
- Decorated ivory drum handle (pl. 14, figs. 3-4)
- Decorated ivory fat scrapers (pl. 13, fig. 8; pl. 17, figs. 1, 2)
- Decorated ivory needle cases (pl. 13, fig. 5; pl. 17, figs. 4-9)
- Decorated ivory harpoon socket pieces (pl. 13, fig. 1; pl. 27, fig. 8)
- Decorated adz handles (pl. 17, fig. 3; pl. 46, fig. 1)

Finger rest for harpoon shaft (pl. 32, figs. 9-12)
Side prongs for bird darts (types 1, 1a, pl. 33, figs. 1-4)
Meat hooks (pl. 35, figs. 1-5) (rare in Punuk)
Ice creepers (pl. 37, figs. 3-5)
Throwing board (pl. 37, figs. 1, 2)
Wooden knife handles for side blade (pl. 38, figs. 2-4)
Chipped stone knife and arrow blades (pl. 40)
Adz heads (pl. 46, figs. 3-7)
Small ivory shuttle (pl. 58, fig. 11)

Elements common to Old Bering Sea and Punuk cultures:

Brow bands (pl. 15, fig. 11; pl. 58, figs. 6-9)
Ivory buttons with slotted base (pl. 22, fig. 7; pl. 58, figs. 3-5)
End ferrules for dart shaft (pl. 33, fig. 25; pl. 73, fig. 18)
Light pick handles (pl. 46, figs. 2, 8; pl. 79, figs. 1, 2)
Heavy ivory drill rests (pl. 46, fig. 13)
Wooden objects with concavity at end (pl. 47, fig. 11)
Bone drill points and reamers (pl. 48, figs. 1-4, 14)
Hand drills (pl. 48, figs. 5-8)
Bone rubbing tools (pl. 48, figs. 10-13)
Bone awls (pl. 48, figs. 15-17, 21-23)
Baleen ice scoop (pl. 55, fig. 7)
Small squares of plaited baleen (pl. 56, figs. 8, 9)
Small wooden cylinders, painted red (pl. 57, figs. 18, 19)
Toys of wood—kayaks, umiaks, dolls, whales, bows (pl. 59, figs. 1, 6, 7, 13, 14, 16, 17, 26, 27)
Toy harpoon heads of ivory (pl. 59, figs. 18-21)
Long wooden vessels (pl. 80, fig. 1)
Conical earthenware lamps (pl. 53, fig. 2; pl. 84, fig. 3)

Elements common to Old Bering Sea, Punuk and modern Western Eskimo culture:

Ivory chain (pl. 12, fig. 10; pl. 82, fig. 34)
Movable foreshafts for harpoons (pl. 29, figs. 1-4; pl. 73, figs. 1, 2)
Ice picks (pl. 29, fig. 14)
Wooden mouthpieces for floats (pl. 32, figs. 13-15)
Wooden wound plugs (pl. 35, figs. 11-14; pl. 75, fig. 11)
Fishline sinkers of ivory (pl. 36; pl. 75, figs. 12, 13)
Wood and bone knife handles for end blades (pl. 38, figs. 1, 8-10; pl. 78, figs. 6, 8)
Compound knife handles of ivory or bone (pl. 38, figs. 5-7; pl. 78, figs. 4, 5)
Knife sharpeners of young walrus tusks (pl. 38, figs. 11-14)
Heavy ivory sledge runners (pl. 45, figs. 1-3)
Baleen toboggans
Ivory bases for spindle buzzes (pl. 46, figs. 9, 10; pl. 67, fig. 2)
Pail handles (pl. 47, figs. 2-4)
Bow drills (pl. 47, fig. 1)
Wedges (pl. 47, figs. 8, 9)
Stone flakers of bone (pl. 48, figs. 18-20)

Heavy ivory picks (pl. 49)
Boat paddles (pl. 50, fig. 1; pl. 84, fig. 2)
Bone mattock blades (pl. 50, fig. 2; pl. 80, fig. 2)
Snow shovel of walrus scapula (pl. 50, fig. 6)
Plain ulu handles (pl. 51, figs. 1-4, 6; pl. 78, figs. 9, 10, 12, 13)
Wooden ladles (pl. 51, figs. 13, 16)
Baleen vessels (pl. 53, fig. 1)
Drying racks (pl. 57, fig. 22)
Snow goggles (pl. 58, figs. 1, 2)

Elements known only from the Punuk culture:

Ivory engraving tools with iron points (pl. 60, figs. 10, 11; pl. 81, figs. 17-20)
Ivory ulu handle with opening on top for index finger (pl. 22, fig. 1)
Ivory object (pl. 66, fig. 8)
Ivory object (pl. 67, fig. 6)
Ivory object (pl. 67, fig. 8)
Ivory objects—tridents, turret-shaped, etc. (pls. 68 and 69)
Harpoon heads (pl. 70, figs. 19, 20, 22, 23; pl. 71, figs. 1-14)
Walrus lance heads (?) (pl. 72, figs. 8, 9)
Ivory and baleen objects (pl. 75, figs. 20-22)
Heavy sledge runners (pl. 77, figs. 1-5)
Ivory ulu handle with link at end (pl. 78, fig. 11; pl. 82, fig. 30)
Fat scraper (pl. 78, fig. 14)
Adz heads, with knobs, and "shoe-shaped" (pl. 78, figs. 17, 18, 20, 21)
Ivory object (pl. 79, fig. 9)
Drum handles and combs with link at end (pl. 81, figs. 4, 11)
Ivory object (pl. 81, fig. 13)
Ivory objects (pl. 82, figs. 27-29)

Western Eskimo elements which occur in special forms in the Punuk culture:

"Winged" needle case (pl. 65, fig. 2) similar to old type around Barrow
Wrist guard (pl. 65, figs. 9-11; pl. 67, fig. 7; pl. 74, figs. 21-23)
Tubular needle case (pl. 66, fig. 7)
Ornamented ivory bodkin (pl. 67, fig. 4)
Whaling harpoon heads (pl. 72, figs. 1-7)
Ice pick for harpoon (pl. 73, fig. 8)
Side prongs for bird darts (pl. 74, figs. 1, 2)
Arrowheads (pl. 74, figs. 6-10, 14, 15)
Sealing scratcher (pl. 75, fig. 17)
Heavy ivory net sinker (pl. 75, fig. 16)
Ice creepers (pl. 75. figs. 23-25)
Barbs for salmon spear (pl. 75, fig. 19)
Bone knife handles, slightly curved (pl. 78, figs. 1-3)
Bone spoons (pl. 78, fig. 16)
Bone and ivory knives (pl. 79, figs. 4-6)
Boat hooks (pl. 79, figs. 12, 13)
Throwing board (pl. 80, fig. 3)

Drum handles (pl. 81, figs. 2-6)
Combs (pl. 81, figs. 7-10)
Ivory objects (pl. 82, figs. 19, 20)
Ivory ear ornament (pl. 82, fig. 18)
Drill cord handles (?) (pl. 82, figs. 25, 26)

Western Eskimo elements like those of the Punuk culture:

Ivory mouthpieces for floats (pl. 73, figs. 10-12)
Ivory finger rests for harpoon shafts (pl. 73, fig. 13)
Ivory mouthpiece (pl. 73, fig. 15)
Bone braces for sinew-backed bow (pl. 74, figs. 16-18)
Sinew twisters for sinew backed bow (pl. 74, figs. 19, 20)
Compound fish hook (pl. 75, figs. 4-9) St. Lawrence Island only
Fish hook in one piece (pl. 75, fig. 10) St. Lawrence Island only
Bola weights (pl. 76, figs. 1-19)
Plates of bone armor (pl. 76, figs. 20-24)
Heavy ivory sledge runners (pl. 77, figs. 6-8)
Adz head (pl. 78, fig. 19)
Harpoon rest for umiak (pl. 79, fig. 10)
Stone sinker for tom cod net (pl. 80, fig. 4)
Ear ornaments with insets of pyrites (pl. 82, fig. 16)
Thimble guard (pl. 82, fig. 23)
Harpoon or dart rest for kayak (pl. 82, fig. 36)
Drill mouthpieces (pl. 82, figs. 37-40)

Analysis of the material excavated at Gambell shows that the Old Bering Sea culture is essentially an Eskimo culture, and in certain respects a more highly specialized Eskimo culture than any existing today. The great number and variety of harpoon heads alone, their complicated forms and their artistic embellishment, show the important role that the hunting of sea mammals—seals and walrus—held in the culture of the Old Bering Sea Eskimos. Whaling, however, seems not to have been practiced; at any rate no whaling harpoon heads or foreshafts of definite Old Bering Sea age have been found, though the former are common enough in the Punuk and modern deposits. The picture that we obtain of the Old Bering Sea culture is that of a highly developed maritime culture which possessed the umiak, kayak, harpoon, and float, the throwing board and bird dart, bow, small hand-drawn sledge, and many other elements suitable to a settled life along the coasts. The most outstanding characteristic of the Old Bering Sea culture is its elaborate and sophisticated art style. Many implements such as knife handles, fat scrapers, harpoon socket pieces, and adz handles, which in other parts of the Eskimo territory are left perfectly plain, are here elaborately carved and ornamented. But however exotic Old Bering Sea art may appear, analysis shows it to have contained the basic elements of modern northern Eskimo art, to which it was no doubt ancestral; whereas Punuk art seems to represent the style from which Eskimo art south of Norton Sound was derived.

The general Eskimo character of the Old Bering Sea culture is shown (1) by the large number of basic elements which, along with the Punuk, it possesses in common with modern Alaskan Eskimo culture; (2) by the number of western elements which it exhibits in special (usually more elaboratae) form; and (3) by the fact that most of the elements peculiar to it are themselves of an essentially Eskimo character.

There are, however, many elements of modern Alaskan Eskimo culture that are lacking in the Old Bering Sea: mauls; mallets; wooden dishes with separate bottom; wooden boxes for blades; whale bone shaves; sealing scratchers *[17]; sealing indicators; whaling harpoon heads *; curved handles for flint flakers; bent scraper handles with finger grips; salmon spears *; jade whetstones, adz blades, etc.; crooked knives *; arrow shaft straighteners; blunt bird arrows *; bird bolas *; strengtheners for quivers; wrist guards *; sinew twisters and bow braces *; thimble guards *; trinket boxes; work bag fasteners; cord attachers, for fastening lines together; crotch harpoon rest for umiak *; net sinkers,* floats, and gages; snowshoes; armor *; built-up sledge and evidences of dog traction; torsion fox traps; pictographic art; small ivory bird figures for games; masks; labrets; soapstone lamps, etc. As we have already seen, a number of these elements (those marked by an asterisk) are present in the Punuk stage, and since the Punuk contains still other elements of Western Eskimo culture (those listed on pp. 357-8), it represents a much closer approach to the modern Alaskan culture than does the Old Bering Sea. Two of the elements listed above—masks and labrets—were no doubt derived originally from the Northwest Coast. The St. Lawrence Eskimos and their Siberian kinsmen were the only groups of Western Eskimo who failed to adopt these features.

Until we have further knowledge of archeological conditions in northeastern Siberia it will not be possible to know definitely whether certain Old Bering Sea and Punuk elements thus far known only from St. Lawrence Island are of local origin or whether like many others, they were introduced from Siberia. In view of its peripheral location and partial isolation, it would seem reasonable to suppose that numerous local traits might have developed and become established on St. Lawrence Island. However, the information at our disposal, scant though it is, indicates a remarkable uniformity of culture

[17] Elements marked with an asterisk are present in the Punuk stage.

throughout the whole Bering Strait area during the Old Bering Sea and Punuk stages and points to the tentative conclusion that cultural developments elsewhere in the region were approximately similar to those we have observed on St. Lawrence. Regional variations within established lines, rather than clear cut local patterns, seems to have been the usual condition. On the whole it would seem that there was as close a relationship between St. Lawrence Island and northeastern Siberia during the Old Bering Sea and Punuk periods as there is at the present time. Direct influences from the Alaskan mainland, on the other hand, seem to have been negligible. We know that both the Old Bering Sea and Punuk cultures were established in northeastern Siberia but there is as yet no evidence that the former extended as far south as Norton Sound or the Yukon delta—the sections of the Alaskan mainland nearest St. Lawrence. There are numerous resemblances between the Punuk and modern Alaskan culture (art, the elements in the preceding paragraph marked with an asterisk, and others listed on pp. 358-9), but since these same elements also occur in Siberia it would seem reasonable to suppose that they reached St. Lawrence Island from that direction. As far as I am aware, the rectangular ivory ear ornaments with insets of pyrites which have been found on Punuk Island and at Kukuliak (see p. 243) constitute the only evidence of direct contact with southwest Alaska; these objects, foreign as they are to St. Lawrence culture as a whole, are no doubt sporadic importations. It seems fairly certain that just as at the present time, there was never any regular contact with the Alaskan mainland, the nearest point of which was more than 100 miles away, whereas there has apparently always been constant communication between the St. Lawrence Islanders and their neighbors in Siberia.

CONCLUSION

In his classic monograph " The Archeology of the Central Eskimos " Mathiassen has demonstrated conclusively that the Thule culture must have had its origin in the west, along the Alaskan or Siberian coasts north of Bering Strait. As we have seen, these regions are included in the range of the Old Bering Sea culture and apparently also of the Punuk culture. It will now be possible, on the basis of the St. Lawrence finds and the scattered information available from other sites, to determine with a fair degree of certainty the position of the Thule culture in relation to the prehistoric and modern phases of culture in the west. In the foregoing pages we have had occasion to refer to a number of Old Bering Sea and Punuk types that corresponded to those of the Thule culture. If we examine the material which has been described and illustrated by Mathiassen (1927) we find that the following characteristic Thule types are likewise characteristic of the Old Bering Sea and Punuk cultures on St. Lawrence Island:

Side and end prongs for bird darts (Mathiassen, 1927, pl. 2, figs. 9-12)
Loose harpoon foreshafts (pl. 3, fig. 1)
Slate harpoon and knife blades (pl. 7)
Float bars (pl. 14, fig. 9)
Kayak models (pl. 14, figs. 10, 11)
Wedges (pl. 16, fig. 7)
Knife handles for end blade (pl. 17)
Mattocks (pl. 21)
Whetstones (pl. 16, figs. 11-14)
Compound knife handles (pl. 22, figs. 1-4)
Handles for drill cords (pl. 22, figs. 6, 7)
Plain ulu handles (pl. 23)
Pottery (pl. 27, figs. 1-3)
Baleen vessels (pl. 28, fig. 10)
Snow goggles (pl. 29, fig. 3)
Wooden dolls (pl. 32, fig. 8)
Chain (pl. 33, fig. 1)
Brow bands (pl. 51, figs. 6-9)
Stone drill points (pl. 49, fig. 16)
Ivory fat scraper (pl. 53, fig. 1)
End ferrule of bird dart (pl. 58, fig. 11)
Awls (pl. 16, figs. 15-17)
Baleen knots, etc. (pls. 35, 36)
Baleen toboggans
Umiaks

Thus there are 25 important elements that are common to all three cultures; doubtless there are others also, but I have preferred to list only those typical forms of which the identification is certain.

The following Thule features are present in the Old Bering Sea, absent in the Punuk:

Socket piece with bifurcated tang (Mathiassen, 1927, vol. 1, pl. 3, fig. 11)
Knobbed grip on bone knife (pl. 13, fig. 14)
Knife blades of chipped stone (pl. 44, fig. 1)

To this list might be added ice picks, for the Thule type with the conical tang is closer to the Old Bering Sea form than to the usual Punuk form, although the conical tang is also present in the Punuk.

The following Thule types are present in the Punuk but absent in the Old Bering Sea culture:

Thule types 1, 2, and 3, harpoon heads (Mathiassen, 1927, vol. 1, pl. 1)
Socket piece with knobbed end (pl. 3, figs. 9, 10)

Whaling harpoon heads (pl. 4, fig. 8)
Finger rests with constricted sides (pl. 5, figs. 1, 2)
Arrowheads with shouldered or knobbed tangs (pl. 8, figs. 1-7)
Arrowheads with single barb (pl. 9, figs. 3, 4, 7)
Blunt pointed bird arrows (p. 37)
Sinew twisters for bow (pl. 8, figs. 8, 9)
Bola weights (pl. 11, figs. 1-8)
Barbs for salmon spears (pl. 12, figs. 10, 11)
Bone knives (pl. 13, fig. 15)
Knife handles approaching the "crooked" shape (pl. 18, figs. 2, 3)
Wedge-shaped adz heads with inserted blade and roughened groove for lashing (pl. 20, figs. 1, 3, 10)
Drop pendants of ivory (pl. 30, figs. 1-17)
Sealing scratchers (pl. 41, figs. 9, 10)
One bird bone inserted in another (pl. 43, fig. 10)
"Wings" on needle cases (pl. 52, fig. 2)
Bear tooth amulets (pl. 57, figs. 2, 3)
Thimble holder (pl. 63, fig. 6)

The following Thule elements are characteristic of modern St. Lawrence Island culture but are lacking in both the Old Bering Sea and Punuk:

Flat bone sledge shoes (Mathiassen, 1927, vol. 1, pl. 13, figs. 1, 2)
Trace buckles for dog harness (pl. 14, figs. 3-9)
Dog tooth pendants (pl. 29, figs. 9-14)
Ivory bird figures (pl. 32, figs. 1-6)
Wick ledges in lamps
Rivet and lashing holes on harpoon heads

From this comparison it appears that the Thule culture is much more closely related to the Punuk and even to modern St. Lawrence culture than it is to the Old Bering Sea culture. In addition to the features cited above, it will be recalled that Thule art belongs also to the modern or late Punuk phase on St. Lawrence Island; and that the St. Lawrence houses which show the closest resemblance to the stone and whale bone houses of the Thule culture are also relatively recent, belonging to the late Punuk stage. Examining the list of elements which are common to the Thule and both of the prehistoric culture stages on St. Lawrence Island, we see that these are for the most part simple, fundamental elements of wide distribution, most of which are also characteristic of the modern St. Lawrence Eskimos. This list could be extended considerably if we were to disregard specific differences and include such general features as open socket harpoon heads, socket pieces, finger rests, the bow, throwing board, adzes, etc. But these, added to the list as given, would be only a further indication of the fundamental, general relationship between the Thule culture and Western Eskimo culture as a whole. On the other hand, when we take into account the specific aspects of those features which exhibit variability, we see that in almost every instance the immediate resemblances are between the Thule culture and the Punuk or modern phases of St. Lawrence culture. The fact that most of the Thule features at Gambell appear suddenly, with no indication of connection with earlier local forms, points to their having been introduced. For this reason the St. Lawrence finds themselves throw no direct light on the problem of the origin of the Thule culture. In seeking the solution of this problem, we must turn to the Arctic coast, as Mathiassen has pointed out.

Mathiassen (1927, vol. 2, pp. 174, 175, 176) has shown how in a great many respects the Thule culture is very close to that of the modern Point Barrow Eskimos:

> . . . . we find that of the 152 unquestionable Thule elements we recognise no fewer than 94 in the Pt. Barrow district, and, what is more, they are for the most part types which belong to the most characteristic in the Thule culture, as for instance 22 of the 31 "representative forms" of the Thule culture. . . . . All in all, one must say that the likeness between the Thule culture and the Pt. Barrow culture is exceedingly great; and in respect to these it is not nearly so necessary, as in West Greenland, to turn to old finds for the purpose of finding parallels to the Thule culture. The greater part of the elements mentioned above are in use among the Pt. Barrow Eskimos to this day, or at any rate they were when Murdoch visited them in the 1880's, and for the most part these are elements which play a predominating part in their culture . . . . There is hardly any doubt that the Pt. Barrow Eskimos are the Eskimo tribe living to-day that most closely approaches the Thule culture.

In two subsequent publications (1929, 1930 a) Mathiassen has turned to the archeological material from this area and has sought to identify the Thule culture with the early stage of culture represented in the Van Valin finds. While the modern Point Barrow culture contains a great many Thule elements (94), the Van Valin material is thought to represent a still closer approach to the Thule culture because it contains scarcely any of the local forms which are so prominent in the modern culture and which must be presumed to have developed since the Thule culture spread to the eastward. This, however, is hardly sufficient. While we may safely disregard these special later Alaskan features, which have no bearing on the Thule problem, the important question to be answered is whether the archeological material excavated by Van Valin contains either a greater number of Thule elements than does the modern culture, or elements which, in their particular forms, show a closer resemblance to the Thule elements than do those of the modern culture. In other words, what Thule features does the Van Valin material include that are not also to be found in the modern Point Barrow culture? This aspect of the problem has not been considered by Mathiassen, nor by Mason, but obviously it is highly important, and failure to observe it has led to a certain amount of confusion and to a one-sided presentation of the problem. As a matter of fact, as the writer has pointed out (Collins, 1934, pp. 310, 311), 11 of the 13 Thule elements which Mason lists as occurring in the Van Valin collection are elements which also occur in the modern culture; furthermore, most of them are also to be found in the Old Bering Sea culture (the exceptions are bola weights, sealing scratchers, ivory pendants)—in other words they are generalized types which are characteristic of all culture stages in the west, and consequently are of value only as indicating a relationship between the Thule culture and Western Eskimo culture in general. There are still many features of the prehistoric Point Barrow, or Birnirk, culture concerning which we have no information, so that its exact relationships cannot for the present be determined. However, the Birnirk harpoon heads alone are sufficient to show the close relationship to the Old Bering Sea culture. It is true that Mason has included these among the typical Thule forms in the Van Valin collection, and Mathiassen has done likewise when he refers to the two harpoon heads excavated by Sverdrup at the mouth of the Kolyma River in Siberia as Thule heads (Mason, 1930, pp. 386, 387; Mathiassen, 1927, vol. 2, p. 180; 1929, p. 54). This, however, is clearly not correct, except under a terminology so loose as to be almost meaningless; for although these old Alaskan and Siberian heads possess the general features of the Thule heads—a "thin" shape and an open socket—they possess in addition the specific features which characterize the Birnirk type—asymmetrical spurs that are bifurcated, trifurcated, or otherwise irregular and two stone side blades or one side blade with an opposite barb—features that remove them specifically from the Thule heads and bring them into direct relationship with those of the Old Bering Sea culture. Relationship with the Old Bering Sea culture is also indicated by the fact that Old Bering Sea art is found at the old Barrow sites (Wissler, 1916, fig. 6; Mason, 1930, pl. 5, fig. 1; Collins, 1935, p. 463), and by the further fact that the needle cases figured by Mason (pl. 4, figs. 6-8) are closer to the rather variable Old Bering Sea and Punuk forms than to the stylized winged form of the Thule culture, which differs little from the modern Central form. The small antler scoop or ladle figured by Mason is also an Old Bering Sea type (pl. 47, fig. 16), and as pointed out previously (p. 324), the few arrowheads that have been described from the old Barrow sites have conical tangs which are either plain or provided with a shoulder, like the Old Bering Sea specimens, whereas the later Barrow specimens have small knobs on the tang, a feature which is also characteristic of many of the Thule arrowheads. On the whole, therefore, the available evidence points clearly to the Birnirk culture being in part, at least, contemporaneous with the Old Bering Sea culture. It shows also that there is no basis for the assumption that it is the prehistoric rather than the modern phase of Eskimo culture at Barrow that is especially close to the Thule culture. On the contrary, the modern Point Barrow culture appears to be much closer to the Thule than is the Birnirk.

The fact that the modern or protohistoric phases of north Alaskan culture possess a number of important Thule elements that are lacking in the older cultures—Birnirk, Old Bering Sea, Punuk—is a crucial point with regard to the status of the Thule culture in Alaska. These elements are: soapstone lamps, objects connected with dog traction, small ivory bird figures, drilled lashing holes on harpoon heads and rivet holes for the blade. How are we to account for the fact that these typical Thule elements are prominent in the later culture of the northern Alaskan Eskimo but are not found at any of the older sites? If the Thule culture has an antiquity even approaching the thousand years assigned it by Mathiassen, the only satisfactory explanation would seem to be that already suggested by the writer (Collins, 1929, pp. 43, 44; 1934 b, pp. 310, 311; 1935, pp. 463, 464), namely, that these elements, and doubtless others also, were introduced into northern Alaska within the past few centuries by a late return migration of Thule Eskimos subsequent to the original eastward spread of the Thule culture.[18]

As was pointed out earlier, there is a strong probability that the modern Point Barrow type of house is also one of these later intrusive elements, for the very features that set it apart from other Alaskan houses—a gabled roof and a single wide rear platform—are those that connect it with the houses of the east. Furthermore, the Point Barrow house in its most typical form is restricted to the Arctic coast of Alaska, the region where the greatest number of these supposed Thule traits have found lodgment.

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[18] In the previous publications above referred to I included pictographic art as one of the elements introduced into northern Alaska by a late return flow of Thule culture. However, in the summer of 1936 I found several examples of this art at the old mound site at Wales, a site which definitely antedates the postulated reflex movement of Thule culture.

Boas has called attention to the fact that the folklore of the Western Eskimos points to an eastern origin. This fact, and conditions with regard to linguistics, seems to provide further evidence of a relatively late wave of migration entering northern Alaska from the eastward. The linguistic evidence is particularly striking, for according to Jenness the Eskimo dialects in Alaska north of Norton Sound are closer to those of Greenland and Labrador, more than 2,000 miles to the eastward, than they are to those of the Yukon-Kuskokwim region immediately to the south. Jenness (1933, pp. 379-380) says:

. . . . it is a remarkable fact that a Greenlander can still travel from his own country right across Arctic America as far as Bering Strait and make his dialect understood everywhere with little difficulty. Such changes in speech as he would encounter throughout this immense stretch of coast-line are of a minor character only, easily surmountable after a few hours' acquaintance. South of Bering Strait, however, with the exception of one or two oases like Inglestat, at the head of Norton Bay, where the dialect differs but little from that of Barrow, the dialects change rapidly, so that a Greenlander would probably require three different interpreters to converse with the Eskimo of St. Lawrence Island, of the Kuskokwim River, and of Cook Inlet.

From the evidence afforded by skeletal remains it would appear that actual movements of peoples were responsible for the dissemination of these various features of eastern culture into northern Alaska. From 1917 to 1919 W. B. Van Valin carried on excavations for the University of Pennsylvania at two old Eskimo sites near Point Barrow, a preliminary report of which has been published by Mason (1930). Both Mason and Mathiassen (1930 a) have identified the material from these old sites as Thule, although as I have attempted to point out above, the modern Point Barrow culture is actually much closer to the Thule than is this prehistoric material. One of the most interesting results of Van Valin's excavations was the discovery of 83 human skeletons, constituting probably the most important and significant lot of skeletal material from the Eskimo area. From Hrdlička's description (1930), the old Point Barrow crania are shown to have been very different from those of the modern Point Barrow Eskimos. They were extremely long and narrow, high and keel-shaped, and closely resembled the highly specialized Greenland type of Eskimo skull:

The "igloo" crania, while plainly pure Eskimo, proved to be of a decidedly exceptional nature for this location. The skulls, in brief, were not of the general western Eskimo type, but reminded at once strongly of the skulls from Greenland and Labrador. And they were exceptionally uniform, showing that they belonged to a definite and distinct Eskimo group. (Hrdlička, 1930, p. 318.)

A comparison of the Igloo and Greenland series shows striking similarities; hardly any two geographically separate groups originating from a single source could reasonably be expected to come nearer. The igloo skulls are even narrower in the vault than the Greenlanders, which means so much farther away from the southwestern, midwestern, and Asiatic Eskimo. . . . . [Hrdlička, 1930, p. 325.]

Mason, commenting on the results of Hrdlička's studies on the old Barrow crania, called attention to the apparently contradictory fact that the physical type of this supposed ancient Thule group was entirely different from that of the other Eskimo groups that were known to have possessed a Thule type of culture, namely the modern Point Barrow Eskimos, the recently extinct Sadlermiut of Southampton Island and the Polar Eskimo of Smith Sound in northwest Greenland. However, in spite of this, the old Barrow skeletons were accepted as exemplifying the physical type associated with the Thule culture.

In 1934 I questioned this interpretation on the ground that the cultural material excavated by Van Valin was pre-Thule and in part contemporaneous with the Old Bering Sea culture; I suggested, therefore, that since the modern Point Barrow Eskimos—the western group closest to the Thule culture—were physically related to the Southampton Island and Polar Eskimo groups, it seemed more reasonable to suppose that the physical type of the Thule culture was exhibited by these three modern groups than by Van Valin's pre-Thule group from Barrow.

The cultural evidence, therefore, points to the modern north Alaskan Eskimos and their immediate predecessors as the most likely "bearers of the Thule culture" in Alaska. In the Van Valin skeletons, on the other hand, we have a sample of an earlier population, the age of which is not known, although it was in part contemporaneous with the Old Bering Sea culture, the oldest thus far known from Alaska. [Collins, 1934 b, p. 311.]

The determining factor was the skeletal material excavated by Mathiassen from the prehistoric Thule sites in the Hudson Bay region, and as long as this was unpublished the question of the physical type associated with the Thule culture remained in doubt. This important material has now been published by Fischer-Møller and the results are entirely confirmatory of the above view. The physical type of the Thule Eskimos, as revealed by the skeletal remains from Naujan, the most important of the Thule sites in the Central region, is seen to have been practically identical with that of the modern Point Barrow Eskimos and entirely distinct from the "old igloo" or pre-Thule remains at Barrow. Fischer-Møller's conclusions are as follows:

If from similarity of culture we had expected to find agreement between the skulls from the old graves at Point Barrow and those from Naujan, we should be disappointed. Even taking into account the relatively small number of skulls, the similarity between the last groups in the table [i. e. between Naujan, modern Point Barrow, and Southampton Island] is decidedly greater than that between the first two [Naujan and the "old igloo" crania]; in particular the skulls from Naujan and from recent graves at Point Barrow exhibit great similarity—almost identical figures as regards the cranial measurements—whereas the old Point Barrow skulls are considerably longer, narrower and higher.

As regards the build of the nose, too, the identity between the recent Point Barrow skulls and the Naujan skulls is almost complete, whereas there is a great difference between the nasal measurements of these two groups and of the old Point Barrow skulls. There is also a pronounced difference between the nasion-basion measurements, and doubtless the other length measurements: glabella-lambda and glabella-inion, as well as the frontal measurements will exhibit differences. There can scarcely be any near relationship between the Naujan group and those from the old Point Barrow graves—the differences in the above important measurements are too considerable, especially having regard to how closely related most Eskimo tribes are. [Fischer-Møller, 1937, pp. 65-66.]

The evidence of physical anthropology, therefore, is hardly less striking than that afforded by linguistics. Taking all of the evidence—physical, linguistic, and cultural—there seems ample ground for assuming a close relationship between modern Point Barrow and eastern Eskimo culture, a relationship which apparently can be best explained by postulating a re-entry of Thule peoples into northern Alaska within the past few centuries. Such a return movement could most readily account for the observed conditions with regard to linguistics, where we find that the dialects of northern Alaska are more closely related to those of Greenland and Labrador than to those of neighboring groups south of Bering Strait. With regard to somatology the practical identity of the prehistoric Thule and the modern Point Barrow Eskimos and the corresponding dissimilarity between these and the prehistoric population at Point Barrow is a condition pointing in the same direction and indicating closer contacts within the past few centuries than during the time when the Birnirk and Old Bering Sea cultures were established along the northern shores of Bering Sea and the Arctic coast of Alaska. As for culture, the evidence is even more compelling, for the absence at the prehistoric Alaskan sites of such characteristic Thule elements as soapstone lamps and vessels, small ivory bird figures, objects connected with dog traction, drilled lashing and rivet holes on harpoon heads, and the common occurrence of these same elements in the culture of the modern Eskimos of northern Alaska can apparently be explained only on the basis of a relatively late east to west movement.

The hypothesis that the north coast of Alaska has been subjected to a relatively late wave of migration from the eastward would serve to explain in large part the rather sharp line of demarcation between Alaskan Eskimo culture north and south of Norton Sound. A more important implication, but one that would naturally follow, would be that we are here provided with at least a partial explanation of one of the most striking phenomena of Eskimo culture, namely, its remarkable uniformity. This homogeneity, both with regard to language and culture, which has been so often remarked upon and interpreted as indicating the recency of Eskimo culture, may instead be itself a recent condition, brought about through the leveling influences of a late wave of Thule culture from the eastward. Prior to this there was probably greater diversity of culture in the American Arctic; this would be true particularly of the earlier period when the Old Bering Sea and Dorset cultures occupied the regions of Bering Strait and Hudson Bay, respectively.

If such a leveling influence was exerted in the manner suggested it would vitiate completely, for this particular area, the method of approach that seeks to determine the age of an element on the basis of its geographical distribution; for in this instance, as indeed may often be the case, the more localized elements must be regarded as older than the more widespread, superimposed elements. (Collins, 1932, pp. 118-119).

It might also be inquired whether the postulated late flow of Thule culture into northern Alaska might not be responsible in large measure for the conditions that led to the formulation of the theory that the Eskimos coming from the eastward in relatively recent times, had entered as a wedge at Bering Strait, breaking off an earlier connection between the Palae-Asiatic tribes of Siberia and the Indian tribes of the Northwest Coast (Boas, 1905). Mythology furnishes the principal evidence of such a former relationship. In material and social culture the Chukchee are very close to the Eskimos, and a strong Eskimo influence can also be detected among the Koryak (Jochelson, 1905-08, vol. 1, p. 359). With regard to mythology, however, the Eskimo influence is practically restricted to the Chukchee, the mythology of the Koryak and Kamchadal being very close to that of the Northwest Coast Indians (Bogoras, 1902, pp. 637, 669, 670, 683). In summarizing the results of the Jesup expedition, Boas (1905, pp. 97-99) cites the following evidence as pointing to such a conclusion:

The culture of the Chukchee, who inhabit the extreme eastern part of [North Asia], is quite similar to that of the Eskimo, with the important exception that the Chukchee are reindeer-breeders, while the Eskimo are purely hunters. The similarity between the life of the Chukchee and that of the neighboring Koryak is great, although the characteristic Eskimo features tend to disappear. An analysis of the religious ideas and of the folk-lore of these tribes gives us the unexpected result that among the Chukchee we have not only a great number of Eskimo stories, but also a considerable number of Raven myths, which show a striking analogy to Raven traditions of the Indians of the North Pacific coast. Among the Koryak and Kamchadal the Eskimo elements become much fewer in number, while the relative proportion of Raven myths which show similarity to Raven tales of America is much larger. This feature is so striking that Mr. Bogoras and Mr. Jochelson have independently reached the conclusion that a close affiliation exists between eastern Siberian folk-lore and that of southern Alaska and British Columbia. Mr. Jochelson finds that the Koryak have many incidents in their tales in common with the Old World and with the North American Indians, and quite a number which are common to the Koryak, the Eskimo and the Indians, but none that belong to the Koryak and to the Eskimo alone. This is clear evidence that contact between Koryak and Eskimo is more recent than that between Koryak and Indian.

This clew once given, we investigated the cultural similarities in this whole area, and found ample evidence that there must have been, at an early period, an intimate relationship between the Indian tribes of the Pacific coast and the peoples of eastern Siberia. The peculiar fact that this relationship comes out much more clearly some distance to the west of Bering Strait, particularly among the Koryak, proves that the similar traits of culture cannot have been transmitted indirectly through the Eskimo.

. . . . So far as the available material allows us to judge, it would seem that the similarities between the Eskimo and the North Pacific Coast Indians are unimportant as compared to the similarities between the Koryak and Chukchee and these Indians. We must infer from these facts that the Eskimo are new arrivals on the Pacific side of America, that their original home was somewhere near, or east of the Mackenzie River, and that they interrupted, at an early period, the communication between the Siberian and Indian tribes, which left its trace [?] in many cultural traits common to the peoples on both sides of the Bering Sea.

The possibility suggests itself that the Thule Eskimos may have brought with them from the central regions not only eastern dialects and culture but also the Eastern Eskimo pattern of folklore, and that it was the introduction of the latter that produced the break at Bering Strait. This, of course, is only a supposition, which would be difficult either to prove or disprove. However, since the effects of the presumed late wave of Thule culture seem to have been felt to some extent by the Chukchee, it would appear as by no means improbable that their mythology, along with that of the Western Eskimos, had been influenced in the same way. The Koryak and Kamchadal, on the other hand, would not have been affected to the same degree, and consequently the Indian elements in their mythology would have remained prominent.

Although we have been led to conclude that the Thule culture, in its known aspects, is to be identified with the modern or protohistoric stages of culture in northern Alaska rather than with the Birnirk or Old Bering Sea phases, we have still to account for its origin. In seeking this origin in northern Alaska Mathiassen has arrived at what seems to be the only possible solution; it remains to be determined from just what region and what culture stage. Our knowledge of archeological conditions in this region is insufficient to permit of a definite answer, but according to present indications, when the Thule left the western regions it must have been at a stage somewhat later than that of the Birnirk culture. The fairly large number of basic common elements in the two cultures attests their general relationship, but there is still a wide gap between the oldest of the Eastern Thule sites—Naujan and Malerualik—and the two old Barrow sites. This suggests that somewhere in the intervening area there are to be found older Thule sites than those excavated by Mathiassen, sites that will show a more pronounced resemblance to Birnirk, such as possibly in a more general use of earthenware pottery and of harpoon heads closer to the Birnirk types. At the same time one would expect that these intermediate sites would not reveal in fully developed form those Thule features which were later introduced into Alaska.

The Birnirk culture itself must presumably be regarded as a direct outgrowth of the Old Bering Sea culture, a somewhat specialized phase that became established at the eastern periphery. A basic relationship with the Old Bering Sea culture is shown by the considerable number of implement types common to the two stages (many of those which are mentioned by Mason, p. 386), by the sporadic occurrence of Old Bering Sea art, and by the harpoon heads, which, like some of the earliest Old Bering Sea types, have side blades and prominent asymmetrical divided spurs. However, the particular forms of these Birnirk heads are closer to some of the early Punuk than to the Old Bering Sea types. It would appear that they represent a special line of development from the general Old Bering Sea pattern. According to the list of features given by Mason (1930, p. 386) there are several others which denote a closer relationship with the Punuk than the Old Bering Sea: bola weights, sealing scratchers, ivory pendants, wrist guard.

One of the most important problems of Arctic archeology is that of the origin and relationships of the Dorset culture. Originally described by Jenness (1925) from Cape Dorset and Coats Island in the northern part of Hudson Bay, it is now known to have extended from north Greenland to Newfoundland (Jenness, 1933, pp. 390-395). In his last publication Jenness has shown conclusively that the Dorset must be recognized as a cultural entity, and not, as Mathiassen had believed, as a locally stamped, late phase of the Thule culture. In the general range of its forms it is quite different from the Thule and other phases of Eskimo culture. As was pointed out earlier, its peculiar art is to a certain extent suggestive of the earliest phase of Old Bering Sea art, and it likewise resembles the old Alaskan culture in its highly developed stone chipping technique. It cannot have been derived from the Old Bering Sea culture as we know it, however, for the latter is already in many respects a highly developed Eskimo culture, possessing numerous important features of which the Dorset culture had no knowledge.

As Jenness has pointed out, the Dorset culture shows unmistakable Indian affinities, particularly with the Beothuk and the prehistoric "Red Paint" culture. Jenness has suggested that since the Dorset culture preceded the Thule, it may have been derived from that of the Caribou Eskimos. In view of the divergence of the Dorset culture from Eskimo culture generally and its rather close relationship to that of the Indians, it would seem that its origin might with equal propriety be sought in the latter direction; in which case we would suppose the Dorset to have been an originally Indian culture, which before the spread of the Thule culture to the central regions, had gradually worked northward; later, with the advent of the Thule Eskimos, the Dorset peoples would be forced to give way, and gradually succumb to the better equipped and more aggressive newcomers from the west. This, of course, is only speculation; the problem is one of complexity, involving numerous factors the full significance of which is not yet apparent. I think we may safely say that it will not be possible to arrive at a real understanding of archeological conditions in the eastern Arctic until the Dorset culture has been fully revealed and its origin and relationships determined.

The excavations of Jochelson on the Aleutian Islands and of de Laguna at Cook Inlet have provided detailed information on the early forms of culture which prevailed in these regions. The material from the Aleutians shows a somewhat closer approach to the northern forms of Eskimo culture than that from Cook Inlet, which is almost at the extreme southern limit of the Eskimo territory. In neither case, however, is there more than a general resemblance to northern Eskimo culture. Speaking of the Kachemak Bay, Cook Inlet, culture, de Laguna (1934, p. 217) says:

The basis seems to have been a fairly generalized type of Eskimo culture, which itself included a number of elements common to the Arctic and North

Pacific areas. It is, however, the style of workmanship, especially the finish of the bone and antler specimens, and certain stylistic features, difficult to describe and impossible to enumerate, that most clearly show the Eskimo character of the Kachemak Bay culture.

The general Eskimo character of the Aleutian and Cook Inlet cultures is shown by the presence of such types as chipped stone and rubbed slate blades, flakers, adzes, whetstones, rubbing stones, pottery (rare), drill points, toggle harpoon heads, foreshafts, socket pieces, barbed dart points, awls, needles, needle cases, spoons, shovels, wedges, float mouthpieces (Aleutian), side prongs for bird darts or fish spears, drum handles, pendants. In only a few instances, however, are there specific resemblances to the northern types; the southern forms are often distinctive in appearance and rather far removed from these.

De Laguna lists a large number of Thule elements occurring in the Kachemak Bay culture, which leads her to believe that a basic Thule or proto-Thule culture will eventually be found in Alaska:

> Lastly, I suggest that on the Alaskan mainland, north of the Peninsula, traces of a Thule or proto-Thule culture should be found, correlated both with the Canadian Thule culture and with the First Period of the Kachemak Bay culture. From a chronological point of view, the proto-Thule stage must have been pre-Punuk. It was, therefore, contemporaneous with the old Bering Sea culture on St. Lawrence Island; or, if it existed on St. Lawrence Island, it was older than the Old Bering Sea culture. [de Laguna, 1934, pp. 219, 220.]

It must be observed, however, that almost all of the Thule elements assigned to the Kachemak Bay culture are simple, widely distributed types that would be included in a comprehensive collection from almost any Eskimo site. Practically all of them are found on St. Lawrence Island, in either or both the Old Bering Sea or the Punuk material, and with hardly an exception they occur also among the modern Alaskan Eskimos. In other words, the Kachemak Bay culture appears to be no closer to the Thule culture than to that of the intervening sections of Alaska. I do not see, therefore, how the occurrence of these simple, common Eskimo elements at Cook Inlet can mean more than that the culture there was basically Eskimo. On the other hand, as might be expected from its geographical position, the Cook Inlet culture diverges considerably from the general northern pattern. This is shown by the fact that there is a far closer relationship between the two prehistoric culture stages on St. Lawrence Island and the Thule or for that matter between these and any other adequately known eastern form of Eskimo culture than there is between the Kachemak Bay, or the Aleutian, and any other Eskimo culture to the northward. This becomes increasingly apparent when we take into account the special forms of the two southern cultures which give them their individual stamp and which for the most part also show their close relationship to the general pattern of culture prevailing in the North Pacific region. Of elements of this nature in the Kachemak Bay culture we observe the following: Dismembered burials; burial on top of refuge island; wooden masks for the dead; trophy heads; artificial eyes on trophy skulls; utilized human bones; notched and grooved stones in large numbers; the splitting adze; pestles; grinding slabs and stones; slate "awls"; stone clubs; stone saws; elaborate stone lamps of special form; slate ulus or scrapers with chipped edge; slate and shale mirrors; beds or grooves on dart heads for the blade; dart heads with wide, flattened tangs; harpoon socket piece in two parts; foreshafts with wide flattened tangs; compound fish hooks, with bone barbs; cut animal bones—articulations; labrets; fish vertebra rings; nose pins.

These elements, which are so characteristic of the culture at Cook Inlet and for the most part of south Alaska generally, are with the exception of a few grooved stones, fish hooks and the labret (which first appears at the Thule stage at Wales—Jenness, 1928 a, p. 75) all foreign to northern Eskimo culture. With the latter region there has evidently been a basic, early relationship, but the development of south Alaskan culture has been virtually independent of influences from the northward. On the other hand there is unmistakable evidence of cultural relationship between south Alaska and a fairly restricted area along the east Asiatic coast.

De Laguna lists a number of Kachemak Bay types which are found in Kamchatka and in Neolithic Japan. In Kamchatka, in addition to some of the more widespread types like stone blades, dart points, etc. are found the following typical Kachemak Bay elements: refuge island; notched and grooved stones; stone with hole; grinding stone and slab; oval stone lamp; lamp with ring; labret; large bone arrowhead with blade but no barbs. In Japan there is a larger number of the simple, more widespread types, and fewer of the special Kachemak Bay types. Among the latter are notched and grooved stones, large arrowhead with blade but no barbs, and broken and cut human bones. As to the possible significance of these Asiatic resemblances, de Laguna (1934, p. 218) remarks: "The hunter's lamp with ring and the roof entrance to the house show a cultural relationship between the Aleutian Islands and Kamchatka; while at Port Moller, and nowhere else in Alaska, is found the Japanese type of harpoon head [toggle harpoon head with closed socket and line hole in plane of the spur]."

In our discussion of houses and lamps it was stated that the distribution seemed to point to these having been introduced into Kamchatka by way of the Aleutian Islands rather than from Kamchatka to the Aleutians. The presence of the above-mentioned additional elements of south Alaskan culture in Kamchatka strengthens this view. If we are to assume a genetic relationship—and the resemblances in some cases are so close that we can hardly do otherwise—it is difficult to see how the connection could have been established other than by way of the Aleutian chain. Most of the elements (refuge island, notched and grooved stones, stone with hole, grinding stone and slab, oval and " sad iron " shaped stone lamp, stone lamp with ring) are among the most characteristic forms of south Alaskan culture, particularly that of the Aleutians, Kodiak Island, and Cook Inlet, but are lacking in the north; therefore, they could hardly have passed over at Bering Strait. As for their occurrence in Asia, it seems that just as in the case of the roof entrance they are practically restricted to that part of the east Asiatic littoral lying closest to the Aleutians.

Jochelson seems to attach no importance to the finding of what seems to have been a labret at an old site in Kamchatka. He does not illustrate the specimen and merely lists it as follows (1928, p. 43): "A polished marble object resembling a labret (2163), but it must be noted that no labrets were used as personal ornaments by the ancient Kamchadal." However, as de Laguna has observed, the statements of the natives as to what elements may or may not have been used in ancient times are hardly conclusive (de Laguna, 1934, p. 206). Furthermore, a labret has recently been reported from an ancient site on the Kurile Islands (Baba, 1934, pl. 1, fig. 12), so that there is no reason to doubt its occurrence in Kamchatka as well.

The list of characteristic south Alaskan elements occurring also in Kamchatka, could be extended considerably by including other elements of wider distribution in both America and Asia. The special forms, however, are those which have significance in this connection; and in view of the fact that in general these have a much wider and usually a more sporadic distribution in America than in Asia—where they are confined to the areas nearest the Aleutians—it seems reasonable to assume that they were originally American elements which were introduced into Kamchatka.

Most of the more recent writers who have discussed the problem of Asiatic and American relationships have felt that the Aleutian Islands were not a migration route into America. This view, it would seem, is entirely correct, for it is difficult to imagine Asiatics leaving the mainland in Kamchatka and setting out eastward over the open sea where there was no land visible. And even if they had reached the Commander Islands they would have had before them the still greater stretch of open water to Attu, the westernmost of the Aleutians. Improbable as such a theory would appear from a geographical standpoint, the strongest evidence against it is cultural. The fact that the known cultural remains on the Aleutians are of an essentially Eskimoid or American character, as demonstrated by both Dall and Jochelson, shows that the islands must have been peopled from the Alaskan mainland. As was pointed out previously, the presence of pottery in Kamchatka and its absence in the Aleutians is in itself an argument against a west to east movement, for if such had occurred, it would seem that pottery would have been introduced into the Aleutians. When we consider, on the other hand, that the early Aleuts must have been expert navigators to have settled and maintained contacts between the widely separated islands, it would have been by no means an insuperable feat for them to have pushed on and reached the Commander Islands and then the Kamchatka peninsula. The Commander Islands were uninhabited when discovered by Bering in 1741, and no traces of kitchen middens or aboriginal house ruins have ever been reported. It is a question, however, whether these have been really searched for. Some of the Aleutian middens, even the largest, are at the present time very inconspicuous, appearing either as grass-covered knolls along a hill slope or as natural ridges along the shores. The obliterating effects of time are still better illustrated by the Old Bering Sea site at Gambell, which was so completely merged into the hillside that the present Eskimos had no knowledge of its existence. The indications of cultural connections between the Aleutians and Kamchatka are so clear as to lead to the expectation that evidences of aboriginal occupancy will eventually be discovered on the Commander Islands.

If the hypothesis of a westward migration from the Aleutian Islands to Kamchatka should be borne out we would seem to have at least a partial explanation of the cultural resemblances between the Northwest Indians and the Palae-Asiatic tribes of Siberia which were revealed through the investigations of the Jesup Expedition. As pointed out above, it seems by no means improbable that the late wave of Thule culture which penetrated into northern Alaska as far west as Bering Strait might have introduced, among other eastern culture traits, an eastern form of folklore which blended with and to a certain extent supplanted a mythology in which Indian-Siberian elements had been more prominent. Whether the Indian elements in Siberian mythology had been transmitted directly across Bering Strait or over the Aleutians to Kamchatka would remain an open question. The fact that these elements are strongest among the Kamchadal and Koryak would seem to favor the southern route, but an adequate explanation would require a more thorough analysis of Alaskan mythology than has as yet been made. Whatever the conditions may have been with regard to mythology, there seems little likelihood of Indian elements of material culture having been carried back into Siberia by way of Bering Strait after the Eskimos had become established there, for the Old Bering Sea culture, elaborate though it is, is in every sense Eskimo and, with the possible exception of art, shows few significant resemblances to Northwest Indian culture. In the Aleutians, on the other hand, we find an aberrant form of Eskimo culture which embodied a number of important elements characteristic of south Alaskan culture generally, and when we observe that some of these have succeeded in gaining a foothold in Kamchatka and the regions immediately adjacent, it seems plausible to regard them as American elements which drifted into Asia over the Aleutian chain.

Although on theoretical grounds we are forced to assume that man originally entered the American continent at Bering Strait, it must be emphasized that archeological work in this region has revealed as yet no trace of these earliest migrants. The excavations at St. Lawrence Island and Bering Strait have pushed the Eskimo far back into the past, but they have revealed no evidence of any pre-Eskimo cultural remains. We have seen that changes in shore line topography have taken place within the past few centuries; through subsidence of the coast line at the eastern end of St. Lawrence Island some Eskimo sites of the intermediate or Punuk period now lie as much as 6 feet below sea level, whereas on the other hand there is evidence of a rather extensive building up of the coast line at the northwestern end of the Island since the time of the Old Bering Sea culture. When we consider that the oldest site at Gambell was so completely hidden from view that the modern Eskimos did not suspect its existence, even though they had walked over it countless times, we realize that the discovery of still older sites will be no simple matter. At the same time, the knowledge which has been gained of these relatively recent physiographic changes and of the conditions under which the oldest Eskimo remains are found, provides a necessary background for a systematic approach to the more fundamental problem of pre-Eskimo migrations.

The investigations at Gambell have provided full confirmation of the chronological position of the Old Bering Sea culture as originally expressed by Jenness on the basis of his pioneer investigations at Wales and the Diomede Islands. We have seen that on St. Lawrence the Old Bering Sea culture gave rise to the Punuk; that on the Arctic coast it was apparently ancestral to the Birnirk, the stage from which the Thule, the dominant prehistoric culture of the central regions, was derived. The Dorset and Cook Inlet cultures differ in so many respects from the Old Bering Sea that we can say little as to what relationship may have existed between them and the latter. Neither of them, however, are Eskimo cultures in the same sense as is the Old Bering Sea culture, which in spite of its specialized development in certain directions is fundamentally Eskimo, and basic, apparently, to the existing phases of northern Eskimo culture from Siberia to Greenland.

But what bearing have the Alaskan investigations on the theory of the central origin of Eskimo culture, or more specifically on the theory that the Caribou Eskimos possess a Proto-Eskimo form of culture like that from which all subsequent forms have been derived? This view, which has been propounded and elaborated with such erudition by Birket-Smith, is worthy of a more extended theoretical discussion that can be given here. We may, however, indicate very briefly what bearing the Alaskan finds seem to have on this problem.

Birket-Smith's explanation of why the Caribou Eskimos remained in their Proto-Eskimo condition for perhaps thousands of years while all around them other Eskimos were undergoing cultural change is that these Central Eskimos had never gone down to the coast as did first the Palae-Eskimos and later the Eschato-Eskimos, but had remained in the interior. Hence there was no impelling motive for culture change. Implicit in this explanation seems to be the idea that all significant changes in Eskimo culture have come about through radical, dynamic movements: the Palae-Eskimo culture came into being when a group of Proto-Eskimos, following the caribou in their migrations, left the interior and took up the hunting of sea mammals on the coasts; the Neo-Eskimo culture arose when the Palae-Eskimos arrived in Alaska and came into contact with alien cultures, those of the Northwest Coast of America and of northeastern Asia. We thus have a very definite picture of the development of Eskimo culture, but one which to only a very limited extent calls in the explanation of anything like a normal, slow growth of culture. But of course the very idea that such internal culture growth should have taken place among the Caribou Eskimos would vitiate completely the theory of their all important role in the origin of Eskimo culture, for the theory demands that they remain absolutely static through centuries—not to say millenniums—while all other Eskimo cultures of which we have knowledge were undergoing marked cultural evolution. Even the Thule culture of the Central regions, although known from only a few sites which apparently were not occupied for any very great length of time, is seen to have undergone certain modifications. In Greenland this is still more evident, for Mathiassen's painstaking excavations have shown that Eskimo culture there has been undergoing constant change from about the twelfth century up to the present time. In the west the evidence for cultural change is even greater. Wherever excavations have been made—in Cook Inlet, on Kodiak and St. Lawrence Islands, at Bering Strait, and at Barrow—far-reaching changes are found to have occurred in prehistoric times, and there is no reason for believing that all of them were by any means due primarily to stimulus from outside sources.

In the light of recent archeological discoveries, therefore, it would appear that prehistoric Eskimo culture everywhere has exhibited a marked mutability; there has been found no instance of a culture remaining stationary over any long period of time. If we accept Birket-Smith's theory, however, we must seek the origin of Eskimo culture in the one group that is held up as an example of cultural stability perhaps without parallel anywhere, in the group that in some almost miraculous manner is supposed to have frozen its culture to the point where it continued century after century as if in a changeless vacuum. And yet the theory possesses an innate plausibility from the very fact that the Caribou Eskimos possess a simple culture; and since the first Eskimo culture must also have been simple there would be a certain logic in assuming that this existing simple culture might, after all, in spite of serious obstacles to such a view, represent the original condition. Obviously, the test of this assumption lies with archeology. If the Caribou Eskimos do represent the ancestral type from which all others have sprung, we should expect that the farther back into Eskimo prehistory we go the more we would find the culture approaching the original Caribou pattern. We should expect that the oldest Eskimo culture that could be determined archeologically would show strong resemblances to the supposed prototype. This, of course, is not the case. On the contrary, the oldest form of Eskimo culture that has yet appeared in the Western regions is further removed from the Caribou Eskimo culture than is that of many modern groups. It is difficult to see, therefore, how the data of archeology can be brought to support the theory of the central origin of Eskimo culture. The Old Bering Sea is, of course, no simple or primitive culture, but an already highly specialized Eskimo culture. This being the case it is obvious that we have not yet by any means solved the problem of the origin of Eskimo culture. On the contrary, the archeological investigations in the West have added to its complexity. At the same time they have cleared the ground, and, in revealing the oldest stage of Eskimo culture in the Bering Strait region, have provided a new point of departure from which the problem may be approached.

The high development of Eskimo culture around Bering Strait in prehistoric times cannot in any way be regarded as the result of contact with the Northwest Coast. The influences from this direction that have been so often remarked upon and which are so prominent in modern Alaskan Eskimo culture seem not to have been exerted until relatively recent times. Not only does the Old Bering Sea culture reveal no trace of these late Indian features, but there is no evidence that primary Indian elements have had any important part in the formation of the culture. On the other hand, it is significant that some of the most important and fundamental elements of the Old Bering Sea culture—such as the toggle harpoon head, skin boats of the umiak or kayak type, sledges and toboggans, the lamp, and rubbed slate implements—are widespread Old World elements, which in America are found only among the Eskimo or in areas where Eskimo influence has probably extended. Since these elements could hardly have originated in America they must have been introduced from Asia. It follows, therefore, as both Mathiassen and Hatt have contended, that the ultimate origin of Eskimo culture is to be sought in the Old World.

The excavations on St. Lawrence Island, which have made it possible to distinguish between certain older and younger elements in Eskimo culture, seem also in a way to have added something to Hatt's concept of a " coast " and an " inland " culture. Hatt's theory, based originally on an exhaustive study of clothing types, was of two great culture waves or strata in the northern parts of Eurasia and America. The older stratum—the coast culture—is " now most fully represented and highest developed in the culture of the Eskimo tribes "; the later stratum, or the inland culture " is found fullest and most unmixed in the culture of the Tungusians, although its influence is felt from Lapland to Labrador " (Hatt, 1916 b, pp. 248-249). The inland culture is characterized particularly by the moccasin and snowshoe, the conical lodge, the birch bark canoe, the cradle board, the two-handed skin scraper, the smoking of skins, and the tanning of skins by the use of fat.

Hatt's hypothesis later received support from Hallowell's investigation of bear ceremonialism in the northern hemisphere:

It seems to me that the "inland culture" concept has gained in substance and reliability through Hallowell's investigations. Hallowell has shown that a distinct set of religious ideas and hunting rites, "bear ceremonialism," has a circumpolar distribution very nearly corresponding to what I have called "inland culture". Hallowell adds also to the "inland culture" the following traits: the tambourine as an essential item of a shaman's equipment, scapulimantia, the "soul kidnapping theory" of disease, game drives, the earth diver motif in folklore, hunting territories, bloody animal sacrifices. [Hatt, 1933, pp. 2759, 2760.]

It would now seem that to the inland culture we might also attribute blunt bird arrows and wrist guards, and possibly also the sinew-backed bow, the bird bola, and the crooked knife. All of these elements make their appearance in the Punuk stage and their distribution outside of the Eskimo area is suggestive of an "inland" status. On the other hand, the St. Lawrence investigations have revealed the antiquity of the Western form of Eskimo culture which Hatt had already recognized as being more or less typical of the coast culture. We would seem justified in assigning to the coast culture the following widespread Old Bering Sea elements: the square earth-covered wooden house with entrance passage, the umiak and kayak, toggle harpoon heads, the lamp, earthenware pottery, the simple runner sledge, toboggan, throwing board and bird dart, needle case, chipped stone and probably rubbed slate implements.[19] As Hatt has observed, the coast culture is something of a medley and is much less clearly defined than the inland culture. This is a condition that might be expected, not only because of the greater age of the coast culture and its more stationary character, but also because it will probably be found eventually to consist in part at least of local elements. Lacking a means of travel and ready communication such as the inland peoples possessed in snowshoes and later in reindeer sledges, the older coastal groups would have remained more or less isolated and hence there would have been opportunity for the development of local traits. Just as the somewhat circumscribed Old Bering Sea culture, with its rather numerous local elements, is of considerably greater antiquity than the much more widespread Thule culture, it will doubtless be found that other relatively local cultures—but probably of a generalized Eskimo character—formerly existed along the northern coasts of Eurasia before these regions were subjected to the leveling influences of the more mobile inland groups. Evidence of such an old coast culture in extreme

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[19] In view of the finding of a two-handed skin scraper at Miyowagh and several similar small scrapers at the Hillside site (p. 166), it would seem that this element should also be attributed to the coast culture.

western Siberia seems to have been provided in the recent excavations on the Ya-mal Peninsula, at the mouth of the Ob River, where there has been revealed an old Eskimo-like culture which made use of pottery, baleen, bone and ivory implements, toggle harpoon heads, and the kayak (Cernecov, 1935).

The recent excavations in nothern Alaska have thrown considerable light on the problems of Eskimo prehistory, but they have by no means provided the final solutions thereto. They have revealed an ancient Eskimo culture which is seen to have been ancestral to the existing phases, and yet, paradoxically enough, this Old Bering Sea culture is in many respects a more highly developed, a more specialized Eskimo culture than any other known. This can only mean that we must extend our search still farther into the past if we are to find the simple beginnings of this old culture and presumably, therefore, of Eskimo culture generally.

Although we are unable to say just where and when the Old Bering Sea culture arose, there can be no doubt as to the general direction in which we must turn in seeking its origin. This is northern Eurasia, the region in which we find numerous striking parallels to Eskimo culture, and the only region where we find on the one hand the geographical conditions essential to the establishment of a settled maritime culture based on the hunting of sea mammals, and on the other hand, either existing today or having existed in former times, such basic Old Bering Sea elements as the square wooden earth-covered house with entrance passage, skin boats, sledges and toboggans, the harpoon with toggle head, throwing board and bird dart, lamps, pottery vessels, chipped stone and rubbed slate implements. These elements are found widely distributed throughout northern Eurasia, and we may assume that they formed a part of the culture of those first peoples who followed the rivers to the Arctic coasts and who somewhere between Bering Strait and the Kara Sea developed a culture which embodied the general features of Eskimo culture as we know it in its earliest western form. As to the immediate origin of the Old Bering Sea culture, the present indications point to northeastern Siberia, somewhere between the mouths of the Anadyr and Kolyma Rivers, as the area in which the culture in the specific form that we know it came into being.

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EXPLANATION OF PLATES

Plate 1

1. Kitchen midden at Kitneapalok, old Eskimo site on west end of St. Lawrence Island.
2. Two rows of "jumping stones" at old village on west end of St. Lawrence Island.
3. Meat cache made of stones and whale bones. Mirrukta, northwest end of St. Lawrence Island.

4, 5. Views of the large midden at Kukuliak, north coast of St. Lawrence Island.

Plate 2

1. Remains of old house entrance at base of 16-foot midden on Punuk Island, off the southeast end of St. Lawrence Island.
2. View of the Punuk midden.
3. Ruins of underground house on Punuk Island, abandoned about 40 years ago.

Plate 3

1. View of the 18-foot midden marking the site of the old village of Kialegak, at southeastern end of St. Lawrence Island.
2. Taking down sections along the exposed vertical face of the Kialegak midden.
3. View of the smaller midden at Kialegak.
4. Ruins of wood and whale bone house at Kialegak, abandoned about 50 years ago.

Plate 4

1. View of the Gambell cape, Chibukak (Sevuokok) from the east.
2. Gravel foreland extending westward from the Gambell cape or plateau, showing old beach lines, the modern village at the extreme end, lake at the left, and old site of Miyowagh in right foreground.
3. View of the west slope of the plateau; the two dark areas on the lower slope are the excavations at the Old Bering Sea "Hillside site."
4. The rocks on the lower slope of the plateau among which were found the first traces of the Old Bering Sea village.
5. Beginning of the excavation at the Hillside site.

6, 7. Remains of two old floors (house no. 1) at the Hillside site.

8. Fallen stones at north end of house no. 1.

Plate 5

1. Smaller stones supporting a huge stone at south end of house no. 1.
2. Rotted mass of timbers being uncovered at house no. 2, Hillside site.

3, 4. Later views of the same.

Plate 6

Excavations at Miyowagh

1. Beginning the excavation of cut 4, with cut 1 in the foreground.
2. Cuts 1 and 4 at a later stage of excavation.
3. Cut 2, showing a baleen toboggan *in situ* beneath stones and whale bones.
4. North side of cut 19.
5. Another view of cut 19, with remains of wooden structure at base; cut 27 in background.

Plate 7

Excavations at Miyowagh

1. Cut 27, showing projecting ends of four corner posts of house; cut 19 in background.
2. View of the same at later stage, with the horizontal wall timbers exposed; strings in cut 19 indicate the slope of the refuse.
3. View of cut 27 from the opposite direction, showing the superimposed horizontal wall timbers.

Plate 8

Excavations at Miyowagh

1. View of cut 9 a, in background, at an early stage of excavation.
2. Later view of the same, with the floor and part of rear wall of house no. 3 at the left, and house no. 4 at right.
3. View of house no. 3, with the long entrance passage, facing NW., shown in the background.
4. The timbers of the inner end of the entrance passage to house no. 3.

Plate 9

Excavations at Miyowagh

1. Ruins of house no. 4, at left, shown partly underlying the walls of house no. 3, at right.
2. View of house no. 3, with the older house, no. 4, shown at a lower level in the background.
3. Uncovering the entrance passage to house no. 4.

4, 5. Views of the stone flooring and remaining wall pieces of house no. 4.

Plate 10

Excavations at Miyowagh

1. Remains of a cache and house walls in cuts 21 and 26.
2. The same at a later stage.
3. Beginning excavation of cuts 18, 23, 24, and 25.
4. The same at a later stage, with timbers and whale bones beginning to appear.

Plate 11

Excavations at Miyowagh (cuts 18, 23, 24, and 25)

1. View of cuts 18, 23, 24, and 25 after stone flooring and upright timbers of entrance passage have begun to appear.

2, 3. Views of the same at a later stage of excavation.

4. Small storage pit at center of stone flooring; small "winged" object shown *in situ*.

Plate 12

Hillside site, Old Bering Sea culture

1. Ivory winged object, between floor stones, house no. 1, U.S.N.M. no. 352,654.
2. " " " , house no. 1, U.S.N.M. no. 352,829.
3. " " " , " " 2, " " 352,490.
4. " " " , first (upper) level of midden, U.S.N.M. no. 352,699.

5. Human figure, ivory, below floor stones, house no. 2, U.S.N.M. no. 352,544.
6. " " , " , " " " " " 1, " " 352,653.
7. Human head, " , house no. 1, U.S.N.M. no. 352,597.
8. Fragment of harpoon head, ivory, house no. 1, U.S.N.M. no. 352,595.
9. Broken ivory object, house no. 1, U.S.N.M. no. 352,953.
10. Ivory chain, third level of midden, " " 352,743.
11. Ivory harpoon foreshaft, between floor stones, house no. 2, U.S.N.M. no. 352,542.
12. Ivory ulu handle, beneath floor stones, house no. 2, U.S.N.M. no. 352,540.
13. Fragment of ivory fat scraper, beneath floor stones, house no. 2, U.S.N.M. no. 352,543.
14. Ivory object, beneath floor stones, house no. 2, U.S.N.M. no. 352,541.

Plate 13

Hillside site, Old Bering Sea culture

1. Harpoon socket piece, ivory, house no. 1, U.S.N.M. no. 352,788.
2. Ivory ornament, upper level of midden, U.S.N.M. no. 352,701.
3. Polar bear, ivory, second level of midden, U.S.N.M. no. 352,722.
4. Bird, ivory, upper (first) level of midden, " " 352,700.
5. Needle case, ivory, second level of midden, " " 352,742.
6. Animal carving, ivory, " " " " , " " 352,722 a.
7. Broken ivory object, beneath floor stones, house no. 1, U.S.N.M. no. 352,652.
8. Fat scraper, ivory, house no. 1, U.S.N.M. no. 352,601.

Plate 14

Hillside site and Little Diomede Island, Old Bering Sea culture

1, 2. Drawings of ivory ornament shown on pl. 13, fig. 2.
3, 4. Ivory drum handle, Little Diomede Island, U.S.N.M. no. 349,519.
5. Dart socket piece, ivory, Little Diomede Island, U.S.N.M. no. 344,674
6. Ulu handle, ivory, Little Diomede Island, U.S.N.M. no. 347,942.

Plate 15

Miyowagh, Old Bering Sea culture

1. Ivory ornament, cut 19, depth 79 in., U.S.N.M. no. 371,929.
2. Decorated ivory fragment, cut 23, depth 18 in., U.S.N.M. no. 371,969.
3. Ivory ornament, cut 23, depth 72 in., U.S.N.M. no. 371,978.
4. Ivory pendant, cut 18, depth 18 in., " " 371,823.
5. Fragment of harpoon head, ivory, cut 3, depth 54 in., U.S.N.M. no. 353,272.
6. Ivory ornament, cut 19, depth 63 in., U.S.N.M. no. 371,923.
7. Ivory plug, cut 19, depth 34 in., U.S.N.M. no. 371,898.
8. Ivory object, cut 18, depth 48 in., " " 371,842.
9. " " , " 19, " 17 in., " " 371,887.
10. Ivory hook, " 19, surface, U.S.N.M. no. 371,865.
11. Ivory brow band, cut 27, depth 42 in., U.S.N.M. no. 372,026.
12. Cord handle, ivory, cut 24, depth 54 in., " " 371,996.

Plate 16

Miyowagh, Old Bering Sea culture

1, 2, 3. Decorated ivory object, cut 16, depth 30 in., U.S.N.M. no. 354,237.

Plate 17

Miyowagh, Old Bering Sea culture

1. Fat scraper, ivory, cut 9a, depth 50 in., U.S.N.M. no. 354,368.
2. " " , " , " 10, " 54 in., " " 354,015.
3. Adz handle, " , purchased, U.S.N.M. no. 354,493.
4. Needle case, " , cut 9a, depth 24 in., U.S.N.M. no. 354,344.
5. " " , " , " 7, " 33 in., " " 353,674.
6. " " , " , " 9, " " 354,444.
7. " " , " , " 9a, " 13 in., " " 354,445.
8. " " , " , " 9a, " 20 in., " " 354,343.
9. " " , " , " 4, " 55 in., " " 353,439.

Plate 18

Miyowagh, Old Bering Sea culture

1, 2, 3, 4, 5. Drawings of needle cases shown on pl. 17, figs. 4, 8, and 9.

Plate 19

Miyowagh, Old Bering Sea culture

1. Pail handle, ivory, cut 19, depth 51 in., U.S.N.M. no. 371,914.
2. " " , " , " 7, " 67 in., " " 353,765.
3. " " , " , " 15, " 44 in., " " 354,186.
4. Animal figure, " , " 23, " 80 in., " " 371,983.
5. Ivory object, cut 18, depth 48 in., U.S.N.M. no. 371,841.
6. Walrus, ivory, cut 9, U.S.N.M. no. 354,447.
7. Fragment of harpoon head, ivory, cut 9, depth 20 in., U.S.N.M. no. 354,336.
8. " " " " , " , " 25, " 48 in., " " 372,010.

Plate 20

Miyowagh, Old Bering Sea culture

1. Winged object, ivory, cut 15, depth 28 in., U.S.N.M. no. 354,148.
2. " " , " , " 7, " 80 in., " " 353,800.
3. " " , " , " 8, " 23 in., " " 353,847.
4. " " , " , " 6, " 36 in., " " 353,577.
5. " " , " , " 9a, " 38 in., " " 354,379.

Plate 21

Miyowagh, Old Bering Sea culture

1, 2, 3, 4, 5. Reverse of the winged objects shown on pl. 20.

Plate 22

Miyowagh, Punuk culture

1. Ulu handle, ivory, depth 36 in., U.S.N.M. no. 372,130.
2. Ivory object, cut 24, depth 18 in., " " 371,988.
3. " " , purchased, U.S.N.M. no. 372,035.

4. Ivory ornament, cut 19, depth 12 in., U.S.N.M. no. 371,875.
5. Bird figure, ivory, U.S.N.M. no. 372,032.
6. Small winged object, bone, cut 2, depth 20 in., U.S.N.M. no. 353,093.
7. Ivory ornament, purchased, U.S.N.M. no. 372,033.
8. Reamer, ivory, cut 20, depth 12 in., U.S.N.M. no. 371,942.
9. Ivory object, purchased, U.S.N.M. no. 372,036.
10. Wrist guard, ivory, cut 27, depth 9 in., U.S.N.M. no. 372,015.

Plate 23

Hillside site, Old Bering Sea culture

1. Harpoon head, ivory, among rocks, U.S.N.M. no. 352,845.
2. “ “ , “ , “ “ , “ “ 352,850.
3. Unfinished harpoon head, ivory, second layer of midden, U.S.N.M. no. 352,736.
4. Harpoon head, ivory, among rocks, U.S.N.M. no 352,846.
5. “ “ , “ , house no. 1, U.S.N.M. no. 352,594.
6. Unfinished harpoon head, ivory, first (upper) layer of midden, U.S.N.M. no. 352,696.
7. Harpoon head, ivory, house no. 1, U.S.N.M. no. 352,784.
8. “ “ , “ , “ “ 2, “ “ 352,481 a.
9. “ “ , “ , among rocks, “ “ 352,583.
10. “ “ , “ , second level of midden, U.S.N.M. no. 352,721.
11. “ “ , “ , house no. 1, U.S.N.M. no. 352,592.
12. “ “ , “ , collected by Riley D. Moore, U.S.N.M. no. 280,309.
13. Broken harpoon head, ivory, among rocks, U.S.N.M. no. 352,848.
14. Harpoon head, ivory, among rocks, U.S.N.M. no. 352,695.
15. Toy harpoon head, ivory, among rocks, “ “ 352,851.
16. “ “ “ , “ , house no. 1, “ “ 352,786.

Plate 24

Miyowagh, Old Bering Sea and early Punuk cultures

1. Harpoon head, ivory, cut 7, depth 75 in., U.S.N.M. no. 353,782.
2. “ “ , “ , “ 23, “ 65 in., “ “ 371,977 a.
3. “ “ , “ , “ 18, “ 78 in., “ “ 371,859.
4. “ “ , “ , “ 23, “ 81 in., “ “ 371,982.
5. “ “ , “ , “ 9a, “ 24 in., “ “ 354,436.
6. “ “ , “ , “ 29, “ 25 in., “ “ 372,029.
7. “ “ , “ , “ 23, “ 14 in., “ “ 371,966.
8. “ “ , “ , “ 4, “ 36 in., “ “ 353,376.
9. “ “ , “ , “ 23, “ 58 in., “ “ 371,974.
10. “ “ , “ , “ 9, “ 36 in., “ “ 354,437.
11. “ “ , bone, “ 7, “ 92 in., “ “ 353,823.
12. “ “ , ivory, “ 27, “ 29 in., “ “ 372,023.
13. “ “ , “ , “ 7, “ 96 in., “ “ 353,830.
14. “ “ , “ , “ 9a, “ 26 in., “ “ 354,435.
15. “ “ , “ , “ 9a, “ 48 in., “ “ 354,378 a.
16. “ “ , “ , “ 7, “ 67 in., “ “ 353,767.
17. “ “ , “ , “ 18, “ 48 in., “ “ 371,840.
18. “ “ , “ , “ 9a, “ 36 in., “ “ 354,352.
19. “ “ , “ , “ 3, “ 20 in., “ “ 353,192 (Punuk).
20. “ “ , “ , “ 7, “ 62 in., “ “ 353,755 “ .
21. “ “ , “ , “ 23, “ 14 in., “ “ 371,984 “ .
22. “ “ , “ , “ 1, “ 30 in., “ “ 352,956 “ .
23. “ “ , “ , “ 9, “ 24 in., “ “ 354,076 “

Plate 25

Miyowagh, Old Bering Sea and early Punuk cultures

1-23. Reverse of harpoon heads shown on pl. 24.

Plate 26

Miyowagh, Old Bering Sea and early Punuk cultures

1. Harpoon head, ivory, cut 9a, depth 36 in., U.S.N.M. no. 354,351.
2. " ", ", " 23, " 81 in., " " 371,981.
3. " ", ", " 24, " 54 in., " " 371,916 a.
4. " ", ", " 7, " 16 in., " " 353,643.
5. Unfinished harpoon head, ivory, cut 18, depth 48 in., U.S.N.M. no. 371,837.
6. Harpoon head, ivory, cut 6, depth 26 in., U.S.N.M. no. 353,575 (Punuk).
7. " ", ", " 9, " 48 in., " " 354,094 " .
8. " ", ", " 19, " 51 in., " " 371,912 " .
9. " ", ", " 19, " 24 in., " " 371,334 " .
10. " ", ", " 24, " 13 in., " " 371,985 " .
11. " ", ", " 18, " 48 in., " " 371,838.
12. " ", ", " 18, " 40 in., " " 371,831.
13. " ", ", " 13, " 60 in., " " 353,968.
14. " ", ", " 21, " 24 in., " " 371,956.
15. Fragment of harpoon head, ivory, cut 25, depth 39 in., U.S.N.M. no. 372,008.
16. Harpoon head, ivory, cut 18, depth 66 in., U.S.N.M. no. 371,854.
17. " ", ", " 25, " 61 in., " " 372,011.
18. " ", ", " 9a, " 38 in., " " 354,353.
19. " ", ", " 8, " 40 in., " " 353,876.
20. " ", ", " 24, " 13 in., " " 371,984.

Plate 27

St. Lawrence and Little Diomede Islands

1. Harpoon head, bone, Cape Kialegak, U.S.N.M. no. 346,804.
2. " ", ", " ", " " 346,802.
3. " ", ", " ", " " 346,801.
4. " ", ", " ", " " 346,805.
5. " ", ivory, Little Diomede Island, U.S.N.M. no. 347,940.
6. " ", ", " " ", " " 347,931.
7. " ", ", " " ", " " 372,164.

B. Harpoon socket piece, ivory, Kukuliak. Owned by Capt. E. D. Jones, U.S.C.G.S

Plate 28

Miyowagh, Punuk culture

1. Harpoon head, bone, cut 19, depth 24 in., U.S.N.M. no. 371,892.
2. “ “ , “ , “ 1, “ 12 in., “ “ 352,901.
3. “ “ , “ , “ 17, “ 20 in., “ “ 354,299.
4. “ “ , ivory, “ 1, “ 24 in., “ “ 352,945.
5. “ “ , bone, “ 20, “ 12 in., “ “ 371,935.
6. “ “ , “ , “ 6, “ 20 in., “ “ 353,557.
7. “ “ , “ , “ 2, “ 28 in., “ “ 353,107.
8. “ “ , ivory, “ 2, “ 24 in., “ “ 353,095.
9. “ “ , “ , “ 19, “ 17 in., “ “ 371,878.
10. “ “ , “ , “ 19, “ 12 in., “ “ 371,868.
11. “ “ , “ , “ 9, “ 12 in., “ “ 354,048.
12. “ “ , “ , “ 4, “ 31 in., “ “ 353,367.
13. “ “ , “ , “ 1, “ 24 in., “ “ 352,947.
14. “ “ , “ , “ 4, “ 25 in., “ “ 353,354.
15. “ “ , “ , “ 4, “ 43 in., “ “ 353,408.
16. “ “ , “ , “ 19, “ 38 in., “ “ 371,900.
17. “ “ , “ , “ 19, “ 45 in., “ “ 371,904.
18. “ “ , “ , “ 9, “ 24 in., “ “ 354,079.
19. “ “ , “ , “ 20, “ 12 in., “ “ 371,931.
20. “ “ , “ , “ 27, “ 16 in., “ “ 372,016.
21. “ “ , “ , “ 19, “ 48 in., “ “ 371,910.
22. “ “ , “ , “ 1, “ 30 in., “ “ 352,955.
23. “ “ , bone, “ 27, “ 22 in., “ “ 372,019.
24. “ “ , ivory, “ 20, “ 12 in., “ “ 371,932.
25. “ “ , “ , “ 2, “ 28 in., “ “ 353,108.
26. “ “ , “ , “ 1, “ 30 in., “ “ 353,956 a.
27. “ “ , “ , “ 19, “ 59 in., “ “ 371,920.
28. “ “ , “ , “ 20, “ 12 in., “ “ 371,933.

Plate 29

Hillside site, Old Bering Sea culture

1. Harpoon foreshaft, ivory, upper level of midden, U.S.N.M. no. 352,714.
2. “ “ , “ , among rocks, U.S.N.M. no. 352,862.
3. “ “ , “ , house no. 1, “ “ 352,830.
4. “ “ , “ , second layer of midden, U.S.N.M. no. 352,733.
5. Dart point, ivory, upper level of midden, U.S.N.M. no. 352,713.
6. Arrowhead, bone, among rocks, U.S.N.M. no. 352,585.
7. “ , ivory, house no. 2, “ “ 352,486.
8. Peg for end of throwing board, ivory, among rocks, U.S.N.M. no. 352,875.
9. “ “ “ “ “ “ , “ , “ “ , “ “ 352,874.
10. Stone flaker, bone, among rocks, U.S.N.M. no. 352,870.
11. Knife, wooden handle, stone blade, between floor stones of house no. 1, U.S.N.M. no. 352,670.
12. Knife handle, wood, house no. 2, U.S.N.M. no. 352,489.
13. Harpoon ice pick, ivory, lower level of midden, U.S.N.M. no. 352,754.
14. “ “ “ , “ , among rocks, U.S.N.M. no. 352,852.
15. “ “ “ , “ , below floor stones, house no. 1, U.S.N.M. no. 352,659.
16. Adz handle, wood, house no. 2, U.S.N.M. no. 352,504.
17. Wedge, ivory, among rocks, U.S.N.M. no. 352,865.

Plate 30

Hillside site, Old Bering Sea culture

1. Drill shaft, wood, below floor stones, house no. 1, U.S.N.M. no. 352,664.
2. Drill mouthpiece, ivory, house no. 1, U.S.N.M. no. 352,616.
3. " " , walrus tooth, among rocks, U.S.N.M. no. 352,868.
4. Ivory tube, second level of midden, U.S.N.M. no. 352,740.
5. Fat scraper, ivory, house no. 1, " " 352,602.
6. " " , " , " " 1, " " 352,600.
7. " " , " , third level of midden, U.S.N.M. no. 352,745.
8. Ivory object, below floor stones, house no. 2, U.S.N.M. no. 352,545.
9. Stone flaker, bone, among rocks, U.S.N.M. no. 352,587.
10. " " , " , " " , " " 352,890.
11. " " , ivory, third level of midden, U.S.N.M. no. 352,766.
12. Scraper of dog femur, first (upper) level of midden, U.S.N.M. no. 352,716.
13. " " " " , fourth (lowest) level of " , " " 352,782.
14. " " " " , house no. 1, U.S.N.M. no. 352,639.
15. Reamer, ivory, house no. 1, U.S.N.M. no. 352,837.
16. Bone awl, among rocks, U.S.N.M. no. 352,578.
17. Ivory awl, house no. 1, " " 352,834.
18. Ivory object, " " 2, " " 352,480.
19. " " , between floor stones of house no. 1, U.S.N.M. no. 352,660.
20. " " , " " " " " " 1, " " 352,660 a.
21. " " , among rocks, U.S.N.M. no. 352,589.
22. " " , " " , " " 352,876.
23. " " , house no. 1, " " 352,839.
24. Toy kayak, wood, beneath floor stones of house no. 2, U.S.N.M. no. 352,552.
25. Toy umiak, " , house no. 2, U.S.N.M. no. 352,507.
26. Piece of brow band, ivory, third level of midden, U.S.N.M. no. 352,746.
27. Ivory object, fourth (lowest) level of midden, U.S.N.M. no. 352,781.
28. " " , house no. 1, U.S.N.M. no. 352,640.
29. " " , third level of midden, U.S.N.M. no. 352,757.

Plate 31

Miyowagh, Old Bering Sea culture

1. Harpoon foreshaft, ivory, cut 9, U.S.N.M. no. 354,400.
2. " " , " , " 9, " " 354,400 a.
3. Broken harpoon foreshaft, ivory, cut 27, depth 26 in., U.S.N.M. no. 371,043.
4. End of harpoon " , " , " 18, " 27 in., " " 369,728.
5. " " " " , " , " 4, " 40 in., " " 353,383.
6. " " " " , " , " 19, " 51 in., " " 371,915.
7. Harpoon foreshaft, ivory, cut 7, depth 75 in., U.S.N.M. no. 353,778.
8. " " , " , " 9, " 24 in., " " 354,069.
9. " " , " , " 24, " 13 in., " " 370,712.
10. End of harpoon foreshaft, ivory, cut 7, depth 51 in., U.S.N.M. no. 353,735.
11. Harpoon socket piece, ivory, cut 16, depth 26 in., U.S.N.M. no. 354,229.
12. End of harpoon socket piece, ivory, cut 27, depth 52 in., U.S.N.M. no. 371,161.
13. " " " " " , " , " 19, " 79 in., " " 370,275.
14. " " " " " , " , " 27, " 9 in., " " 370,989.
15. Tang of " " " , " , " 24, " 54 in., " " 371,993.

16. Harpoon socket piece, ivory, cut 17, depth 27 in., U.S.N.M. no. 369,638.
17. Broken harpoon socket piece, ivory, cut 9, depth 24 in., U.S.N.M. no. 354,446.
18. Harpoon socket piece, ivory, cut 13, depth 14 in., U.S.N.M. no. 353,938.
19. Tang of harpoon socket piece, ivory, cut 23, depth 25 in., U.S.N.M. no. 370,567.

Plate 32

Miyowagh, Old Bering Sea culture

1. Harpoon ice pick, ivory, cut 21, depth 56 in., U.S.N.M. no. 370,464.
2. " " ", " , " 7, " 80 in., " " 353,815.
3. " " ", " , " 27, " 22 in., " " 371,023.
4. " " ", " , " 23, " 64 in., " " 370,640.
5. " " " , bone, " 1, " 63 in., " " 353,064.
6. " " " , ivory, " 13, " 54 in., " " 353,970.
7. Finger rest for harpoon shaft, ivory, cut 22, depth 46 in., U.S.N.M. no. 370,525.
8. " " " " ", " , " 18, " 32 in., " " 369,732.
9. " " " " ", " , " 7, " 62 in., " " 353,759.
10. " " " " ", " , " 27, " 38 in., " " 371,096.
11. " " " " ", " , " 7, " 37 in., " " 353,688.
12. " " " " ", " , " 27, " 16 in., " " 371,009.
13. Float mouthpiece, wood, cut 18, depth 44 in., U.S.N.M. no. 369,844.
14. " " , " , " 18, " 48 in., " " 369,822.
15. " " , " , " 25, " 55 in., " " 370,978.
16. Float plug, ivory, cut 9, depth 48 in., U.S.N.M. no. 354,089.
17. " ", " , " 2, " 12 in., " " 353,082.
18. " ", " , " 22, " 41 in., " " 370,512.
19. " ", " , " 25, " 18 in., " " 370,837.
20. Float bar, " , " 4, " 25 in., " " 353,313.
21. Stopper for float mouthpiece, wood, cut 18, depth 41 in., U.S.N.M. no. 369,823.
22. " " " " , " , " 19, " 56 in., " " 370,165.

Plate 33

Miyowagh, Old Bering Sea and Punuk cultures

1. Side prong for bird dart, ivory, cut 23, depth 8 in., U.S.N.M. no. 370,536.
2. " " " " ", " , " 27, " 29 in., " " 371,069.
3. " " " " ", " , " 7, " 75 in., " " 353,783.
4. " " " " ", " , " 18, " 66 in., " " 369,914.
5. " " " " ", " , " 20, " 12 in., " " 370,315 (Punuk).
6. " " " " ", " , " 2, " 24 in., " " 353,099 " .
7. " " " " ", " , " 2, " 24 in., " " 353,100 " .
8. " " " " ", " , purchased, U.S.N.M. no. 354,466.
9. " " " " ", " , cut 19, depth 24 in., U.S.N.M. no. 370,002.
10. End point for bird dart, " , " 19, " 34 in., " " 370,040.
11. " " " " ", " , " 9, " 24 in., " " 354,402.
12. " " " " ", " , " 20, " 30 in., " " 370,367.
13. " " " " ", " , " 18, " 18 in., " " 369,687.
14. " " " " ", " , " 9, " 24 in., " " 354,402.
15. " " " " ", " , " 19, " 38 in., " " 370,058.

16. Point for fish spear, ivory, cut 19, depth 12 in., U.S.N.M. no. 369,961.
17. " " " " , " , " 19, " 51 in., " " 370,135.
18. " " " " , " , " 1, " 30 in., " " 352,957.
19. " " " " , " , " 20, " 22 in., " " 370,341.
20. " " " " , " , " 17, " 26 in., " " 354,315.
21. " " " " , " , " 1, " 18 in., " " 352,939.
22. " " " " , " , " 27, " 32 in., " " 371,084.
23. Peg for end of throwing board, ivory, cut 24, depth 39 in., U.S.N.M. no. 370,762.
24. " " " " " " , " , " 1, " 24 in., " " 352,949.
25. Peg for butt end of dart, ivory, cut 27, depth 16 in., U.S.N.M. no. 371,003.
26. End of dart socket piece, " , " 19, " 12 in., " " 369,952.
27. " " " " " , " , " 19, " 24 in., " " 369,996.
28. Dart socket piece, ivory, cut 7, depth 37 in., U.S.N.M. no. 353,683.
29. " " " , " , " 10, " 40 in., " " 354,001.

Plate 34

Miyowagh, Old Bering Sea and Punuk cultures

1. Arrowhead, bone, cut 27, depth 26 in., U.S.N.M. no. 372,020.
2. " , " , " 18, " 36 in., " " 369,751.
3. " , " , " 18, " 44 in., " " 371,833.
4. " , " , " 18, " 60 in., " " 369,897.
5. " , " , " 27, " 26 in., " " 371,038.
6. " , " , " 19, " 34 in., " " 370,040.
7. " , " , " 17, " 20 in., " " 354,292 (Punuk).
8. " , " , " 19, " 42 in., " " 370,079.
9. " , ivory, " 20, " 12 in., " " 370,326 (Punuk).
10. " , bone, " 19, " 12 in., " " 369,963.
11. " , " , " 25, " 61 in., " " 372,012.
12. " , " , " 22, " 30 in., " " 370,489.
13. " , ivory, in wooden shaft, cut 9, depth 24 in., U.S.N.M. no. 354,451.

Plate 35

Miyowagh, Old Bering Sea and Punuk cultures

1. Meat hook, ivory, cut 7, depth 37 in., U.S.N.M. no. 353,684.
2. " " , " , " 2, " 48 in., " " 353,152.
3. " " , " , " 19, " 56 in., " " 370,161.
4. " " , " , " 22, " 36 in., " " 370,497.
5. " " , " , " 7, " 85 in., " " 353,835.
6. " " , " , " 20, " 26 in., " " 370,355 (Punuk).
7. " " , " , " 3, " 24 in., " " 353,203.
8. " " , " , " 17, " 20 in., " " 354,288 (Punuk).
9. Small ivory hook, " 5, " 32 in., " " 353,501.
10. " " " , " 23, " 78 in., " " 370,676.
11. Wound plug, wood, " 19, " 45 in., " " 370,075.
12. " " , " , " 19, " 86 in., " " 370,290.
13. " " , " , " 25, " 72 in., " " 370,929.
14. " " , " , " 19, " 59 in., " " 370,192.

Plate 36

Miyowagh, Old Bering Sea and Punuk cultures

1. Fishline sinker, ivory, cut 18, depth 59 in., U.S.N.M. no. 369,889.
2. “ “ , “ , “ 18, “ 51 in., “ “ 369,865.
3. “ “ , “ , “ 7, “ 46 in., “ “ 353,709.
4. “ “ , “ , “ 24, “ 36 in., “ “ 370,735.
5. “ “ , “ , “ 13, “ 20 in., “ “ 353,945.
6. “ “ , “ , “ 4, “ 48 in., “ “ 353,399.
7. “ “ , “ , “ 9, U.S.N.M. no. 354,405.
8. “ “ , “ , “ 18, depth 27 in., U.S.N.M. no. 369,712.
9. “ “ , “ , “ 19, “ 38 in., “ “ 370,059.
10. “ “ , “ , “ 18, “ 12 in., “ “ 369,679.
11. “ “ , “ , “ 19, “ 5 in., “ “ 369,958.
12. “ “ , “ , “ 3, “ 16 in., “ “ 353,117.
13. “ “ , “ , “ 7, “ 75 in., “ “ 353,779.
14. “ “ , “ , “ 1, “ 38 in., “ “ 352,974.
15. “ “ , “ , “ 19, “ 34 in., “ “ 370,038.
16. “ “ , bone, “ 4, “ 43 in., “ “ 353,404.
17. “ “ , ivory, “ 18, “ 36 in., “ “ 369,755.
18. “ “ , “ , “ 6, “ 12 in., “ “ 353,539.
19. “ “ , “ , “ 23, “ 79 in., “ “ 370,693.
20. “ “ , “ , “ 1, “ 30 in., “ “ 352,961.
21. “ “ , “ , “ 15, “ 40 in., “ “ 354,174.
22. “ “ , (unfinished harpoon head), ivory, cut 15, depth 40 in., U.S.N.M. no. 354,173.

Plate 37

Miyowagh, Old Bering Sea culture

1. Fragmentary throwing board, wood, cut 28, depth 37 in., U.S.N.M. no. 371,192.
2. Lower end of “ “ , “ , “ 18, “ 53 in., “ “ 369,877.
3. Ice creeper, bone, cut 18, depth 81 in., U.S.N.M. no. 369,945.
4. “ “ , baleen, “ 19, “ 51 in., “ “ 370,127.
5. “ “ , “ , “ 23, “ 58 in., “ “ 370,610.
6. Ivory object, cut 24, depth 80 in., U.S.N.M. no. 372,003.
7. Scraper (?), wood, cut 8, depth 32 in., U.S.N.M. no. 353,861.
8. Wooden object, purchased, U.S.N.M. no. 372,038.
9. Cross brace for kayak frame, wood, cut 19, depth 59 in., U.S.N.M. no. 370,193.

Plate 38

Miyowagh, Old Bering Sea and Punuk cultures

1. Knife, slate blade, wooden handle, cut 26, depth 55 in., U.S.N.M. no. 370,976.
2. “ , “ “ , “ “ , “ 13, “ 29 in., “ “ 353,964.
3. “ , “ “ , “ “ , “ 23, “ 64 in., “ “ 370,641.
4. Knife handle, wood, cut 24, depth 36 in., U.S.N.M. no. 370,739.
5. “ “ , ivory, “ 19, “ 32 in., “ “ 370,029.
6. “ “ , “ , “ 18, “ 30 in., “ “ 369,731.
7. “ “ , “ , “ 7, “ 46 in., “ “ 353,710.
8. “ “ , “ , “ 19, “ 73 in., “ “ 370,236.
9. “ “ , bone, “ 25, “ 72 in., “ “ 370,928.
10. “ “ , “ , “ 18, “ 48 in., “ “ 369,843.

11. Knife sharpener, young walrus tusk, cut 19, depth 76 in., U.S.N.M. no. 370,246.
12. " " , " " " , " 18, " 27 in., " " 369,713.
13. " " , " " " , " 18, " 36 in., " " 369,750.
14. " " , " " " , " 18, " 36 in., " " 369,750 a.

PLATE 39

Hillside site, Old Bering Sea culture

1. Tip of harpoon blade, slate, house no. 1, U.S.N.M. no. 352,673.
2. " " " " , " , " " 1, " " 352,673.
3. " " " " , " , " " 1, " " 352,673.
4. " " " " , " , among rocks, " " 352,888.
5. " " " " , " , " " , " " 352,566.
6. Harpoon or knife blade, " , house no. 1, " " 352,792.
7. " " " " , " , among rocks, " " 352,562.
8. " " " " , " , house no. 2, " " 352,444.
9. " " " " , " , " " 1, " " 352,672.
10. " " " " , " , " " 1, " " 352,792.
11. " " " " , " , among rocks, " " 352,882.
12. " " " " , " , house no. 1, " " 352,672.
13. Knife or lance blade, " , " " 1, " " 352,672.
14. " blade, slate, house no. 1, U.S.N.M. no. 352,672.
15. " " , " , first (upper) level of midden, U.S.N.M. no. 352,704.
16. " " , " , house no. 2, U.S.N.M. no. 352,439.
17. " " , " , " " 2, " " 352,440.
18. " " , " , " " 2, " " 352,438.
19. Implement with rubbed edges, slate, between houses no. 1 and 2, U.S.N.M. no. 369,622.
20. Implement with rubbed edges, slate, third level of midden, U.S.N.M. no. 352,752.
21. " " " " , " , second " " " , " " 352,725.
22. " " " " , " , among rocks, U.S.N.M. no. 352,888.
23. Ulu blade, slate, house no. 1, U.S.N.M. no. 352,683.
24. " " , " , " " 1, " " 352,683.
25. " " , " , " " 2, " " 352,458.

PLATE 40

Hillside site, Old Bering Sea culture

1. Knife blade, chipped slate, house no. 2, U.S.N.M. no. 352,675.
2. " " , " " , " " 2, " " 352,450.
3. " " , " " , among rocks, " " 352,881.
4. " " , " " , " " , " " 352,889.
5. " " , " " , house no. 2, " " 352,675.
6. " " , " " , third level of midden, U.S.N.M. no. 352,748.
7. " " , " " , house no. 1, U.S.N.M. no. 352,675.
8. " " , " " , among rocks, U.S.N.M. no. 352,560.
9. " " , " " , third level of midden, U.S.N.M. no. 352,749.
10. " " , " " , fourth (lowest) level of midden, U.S.N.M. no. 352,771.
11. " " , chipped chert, house no. 2, U.S.N.M. no. 352,448.
12. " " or arrow point, chipped chert, house no. 2, U.S.N.M. no. 352,803.

13. Arrow point, chipped jasper, house no. 2, U.S.N.M. no. 352,674.
14. " " , " " , among rocks, " " 352,566.
15. Blade, chipped quartz, among rocks, U.S.N.M. no. 352,881.
16. " , " jasper, " " , " " 352,881.
17. Knife blade, chipped jasper, below floor stones, house no. 1, U.S.N.M. no. 352,656.
18. " " , " " , house no. 2, U.S.N.M. no. 352,449.
19. " " , " " , " " 2, " " 352,447.
20. Unfinished blade, chipped slate, house no. 1, " " 352,675.
21. " " , " " , among rocks," " 352,884.

Plate 41

Hillside site, Old Bering Sea culture

1. Drill point, slate, among rocks, U.S.N.M. no. 352,890.
2. " " (?) quartz, among rocks, U.S.N.M. no. 352,890.
3. " " or scraper, slate, fourth (lowest) level of midden, U.S.N.M. no. 352,773.
4. " " , slate, among rocks, U.S.N.M. no. 352,569.
5. Hand drill, " , " " , " " 352,890.
6. Hand drill, chert, house no. 1, " " 352,676.
7. Drill point, slate, " " 1, " " 352,797.
8. Graver, chert, house no. 1, U.S.N.M. no. 352,677.
9. " , jasper, among rocks, " " 352,570.
10. " , " , " " , " " 352,570.
11. " , " , first (upper) level of midden, U.S.N.M. no. 352,707.
12. " , " , house no. 2, U.S.N.M. no. 352,456.
13. " , quartz, second level of midden, U.S.N.M. no. 352,727.
14. " , chalcedony, house no. 1, U.S.N.M. no. 352,678.
15. Side scraper, jasper, among rocks, " " 352,570.
16. " " , quartz, first (upper) level of midden, U.S.N.M. no. 352,707.
17. " " , jasper, among rocks, U.S.N.M. no. 352,570.
18. " " , " , between houses no. 1 and 2, U.S.N.M. no. 369,625.
19. " " , " , house no. 2, U.S.N.M. no. 352,463.
20. " " , " , " " 1, " " 352,808.
21. " " , chalcedony, house no. 1," " 352,806.
22. " " , jasper, house no. 2, " " 352,455.
23. " " , " , below floor stones, house no. 2, U.S.N.M. no. 352,525.
24. " " , " , house no. 1, U.S.N.M. no. 352,809.
25. " " , " , third level of midden, U.S.N.M. no. 352,751.
26. " " , chert, fourth (lowest) level of midden, U.S.N.M. no. 352,777.
27. " " , jasper, house no. 2, U.S.N.M. no. 352,454.
28. " " , " , fourth (lowest) level of midden, U.S.N.M. no. 352,776.
29. " " , " , house no. 1, U.S.N.M. no. 352,802.
30. " " , chalcedony, house no. 1, " " 352,790.
31. " " , jasper, house no. 1, " " 352,674.

Plate 42

Hillside site, Old Bering Sea culture

1. Side scraper, silicious slate, house no. 1, U.S.N.M. no. 352,817.
2. " " , prase, house no. 1, U.S.N.M. no. 352,682.
3. " " , jasper, " " 1, " " 352,800.
4. End " , " , " " 1, " " 352,682.
5. " " , " , second level of midden, U.S.N.M. no. 352,727.
6. " " , " , house no. 2, U.S.N.M. no. 352,452.
7. " " , " , between houses no. 1 and 2, U.S.N.M. no. 369,625.
8. " " , " , among rocks, U.S.N.M. no. 352,889.
9. " " , " , house no. 1, " " 352,793.
10. " " , " , fourth (lowest) level of midden, U.S.N.M. no. 352,774.
11. Scraper, slate, fourth (lowest) level of midden, U.S.N.M. no. 352,770.
12. Adzlike scraper, chert, among rocks, U.S.N.M. no. 352,568.
13. " " , prase, " " , " " 352,567.
14. " " , chert, house no. 1, " " 352,681.
15. Scraper, prase, house no. 1, U.S.N.M. no. 352,677.
16. " , " , " " 2, " " 352,451.
17. Scraper with smoothed edges, prase, house no. 1, U.S.N.M. no. 352,817.
18. " " " " , " , among rocks, " " 352,568.
19. " " " " , " , house no. 1, " " 352,794.
20. Rubbing tool, carbonaceous slate, house no. 1, " " 352,680.
21. Adz blade, basalt, house no. 1, U.S.N.M. no. 352,791.

Plate 43

Hillside site, Old Bering Sea culture

1. Rubbing stone, basalt, house no. 1, U.S.N.M. no. 352,690.
2. " " , vesicular besalt, house no. 1, U.S.N.M. no. 352,812.
3. " " , sandstone, second level of midden, " " 352,726.
4. " " , basalt, below floor stones, house no. 1, U.S.N.M. no. 352,657.
5. " " , vesicular basalt, house no. 2, U.S.N.M. no. 352,460.
6. " " , scoria, house no. 1, U.S.N.M. no. 352,687.
7. Whetstone, basalt, house no. 1, U.S.N.M. no. 352,689.
8. " , sandstone, " " 1, " " 352,692.
9. " , " , " " 1, " " 352,815.
10. " , diorite, " " 1, " " 352,689.
11. Rubbing stone, scoria, house no. 1, " " 352,461.
12. " " , " , " " 1, " " 352,686.
13. " " , basalt, " " 1, " " 352,685.
14. Hammer stone, diabase, " " 1, " " 352,811.

Plate 44

Hillside site, Old Bering Sea culture

1. Sledge runner, ivory, house no. 1, U.S.N.M. no. 352,615.
2. " " , " , " " 1, " " 352,615 a.
3. " " , " , " " 2, " " 352,471.
4. " " , " , " " 1, " " 352,615 b.
5. " " , " , " " 2, " " 352,490.

Plate 45

Miyowagh, Old Bering Sea culture

1. Sledge runner, ivory, cut 22, depth 46 in., U.S.N.M. no. 370,522.
2. " " , " , " 27, " 32 in., " " 371,085.
3. " " , " , " 7, " 46 in., " " 353,664.
4. Sledge shoe, " , " 2, " 43 in., " " 353,151.
5. " " , " , " 2, " 28 in., " " 353,110.
6. " " , " , " 15, " 14 in., " " 354,148 a.
7. " " , " , " 27, " 9 in., " " 370,986.
8. " " , " , " 18, " 44 in., " " 369,807.
9. " " , " , " 7, " 75 in., " " 353,791.

Plate 46

Miyowagh, Old Bering Sea culture

1. Adz handle, ivory, cut 19, depth 76 in., U.S.N.M. no. 371,925.
2. " " , " , " 9, U.S.N.M. no. 354,443.
3. " head, ivory, purchased, " " 354,464.
4. " " , " , cut 18, depth 25 in., U.S.N.M. no. 369,701.
5. " " , wood, " 25, " 84 in., " " 370,940.
6. " " , bone, " 15, " 33 in., " " 354,157.
7. " " , " , " 24, " 52 in., " " 370,768.
8. Pick handle, wood, cut 27, " 46 in., " " 371,150.
9. Base of spindle buzz, ivory, cut 9, depth 48 in., U.S.N.M. no. 354,090.
10. " " " " , " , " 27, " 22 in., " " 371,022.
11. Handle of " " , " , " 24, " 64 in., " " 370,801.
12. Rod of " " , " , " 19, " 24 in., " " 370,001.
13. Drill rest, ivory, cut 21, depth 42 in., U.S.N.M. no. 370,439.
14. Part of umiak keel, wood, cut 23, depth 44 in., U.S.N.M. no. 369,827.
15. End of harpoon shaft, " , " 18, " 44 in., " " 369,821.

Plate 47

Miyowagh, Old Bering Sea culture

1. Drill bow, wood, cut 19, depth 45 in., U.S.N.M. no. 370,103.
2. Pail handle, bone, " 23, " 72 in., " " 371,980.
3. " " , " , " 25, " 89 in., " " 370,953.
4. " " , wood, " 2, " 40 in., " " 353,143.
5. Wooden handle, cut 27, depth 26 in., U.S.N.M. no. 371,048.
6. Ivory handle, " 16, " 60 in., " " 354,252.
7. " " , " 9, U.S.N.M. no. 354,399.
8. Ivory wedge, " 9, " " 354,395.
9. Wedge, used secondarily as drill rest, cut 13, depth 60 in., U.S.N.M. no. 353,959.
10. Scraper (?), wood, cut 27, depth 46 in., U.S.N.M. no. 371,154.
11. Scraper handle (?), " 27, " 42 in., " " 371,117.
12. Wedge, ivory, cut 25, depth 48 in., U.S.N.M. no. 370,886.
13. " , " , " 19, " 76 in., " " 370,250.
14. Hook, wood, " 22, " 41 in., " " 370,517.
15. Carving of human head, wood, cut 10, depth 54 in., U.S.N.M. no. 353,963.
16. Ladle, bone, cut 23, depth 81 in., U.S.N.M. no. 370,697.
17. Pottery paddle, cut 9, U.S.N.M. no. 354,414.

PLATE 48

Miyowagh, Old Bering Sea culture

1. Drill point, bone, cut 22, depth 30 in., U.S.N.M. no. 370,487.
2. “ “ , “ , “ 27, “ 44 in., “ “ 371,131.
3. “ “ , “ , “ 18, “ 27 in., “ “ 369,720.
4. “ “ , “ , “ 18, “ 63 in., “ “ 369,906.
5. Hand drill, “ , “ 29, “ 20 in., “ “ 371,213.
6. “ “ , “ , “ 24, “ 36 in., “ “ 370,734.
7. “ “ , ivory, “ 19, “ 63 in., “ “ 370,207.
8. Reamer, bone, cut 29, depth 17 in., U.S.N.M. no. 371,205.
9. “ , ivory, “ 23, “ 22 in., “ “ 370,558.
10. Rubbing tool, bone, cut 23, depth 58 in., U.S.N.M. no. 370,629.
11. “ “ , “ , “ 23, “ 72 in., “ “ 370,666.
12. “ “ , “ , “ 22, “ 36 in., “ “ 370,496.
13. Reamer, bone, cut 18, depth 59 in., U.S.N.M. no. 369,890.
14. “ , “ , “ 24, “ 18 in., “ “ 370,718.
15. Awl, bone, “ 23, “ 58 in., “ “ 370,621.
16. “ , “ , “ 19, “ 51 in., “ “ 370,128.
17. “ , “ , “ 18, “ 25 in., “ “ 369,700.
18. Flaking tool, bone, cut 1, depth 12 in., U.S.N.M. no. 353,915.
19. “ “ , “ , “ 18, “ 12 in., “ “ 369,683.
20. “ “ , “ , “ 18, “ 72 in., “ “ 369,932.
21. Awl, ivory, cut 7, depth 62 in., U.S.N.M. no. 353,781.
22. “ , “ , “ 24, “ 54 in., “ “ 370,784.
23. “ , “ , “ 25, “ 61 in., “ “ 370,906.
24. Implement, ivory, cut 18, depth 27 in., U.S.N.M. no. 369,719.

PLATE 49

Hillside site, Old Bering Sea culture

1. Ivory pick, house no. 2, U.S.N.M. no. 352,466.
2. “ “ , “ “ 1, “ “ 352,818.
3. “ “ , “ “ 2, “ “ 352,467.
4. “ “ , “ “ 1, “ “ 352,605.
5. “ “ , “ “ 1, “ “ 352,612.
6. “ “ , “ “ 1, “ “ 352,604.
7. “ “ , “ “ 1, “ “ 352,610.

PLATE 50

Miyowagh, Old Bering Sea culture

1. Wooden paddle, cut 23, depth 81 in., U.S.N.M. no. 370,699.
2. Mattock blade, bone, cut 24, depth 25 in., U.S.N.M. no. 370,729.
3. Sledge cross bar, cut 9a, depth 36 in., U.S.N.M. no. 354,349.
4. Knife, bone, cut 19, depth 67 in., U.S.N.M. no. 370,230.
5. Ajagaq, bone, cut 7, “ 37 in., “ “ 353,690.
6. Snow shovel, bone, cut 18, depth 49 in., U.S.N.M. no. 369,860.

Plate 51

Miyowagh, Old Bering Sea culture

1. Ulu, wooden handle, stone blade, cut 22, depth 86 in., U.S.N.M. no. 370,286.
2. “ , “ “ , “ “ , “ 18, “ 59 in., “ “ 369,887.
3. Ulu handle, wood, cut 9, depth 20 in., U.S.N.M. no. 354,417.
4. “ “ , “ , “ 19, “ 86 in., “ “ 370,289.
5. “ “ , “ , “ 25, “ 33 in., “ “ 370,860.
6. “ “ , “ , “ 19, “ 45 in., “ “ 370,094.
7. “ “ , “ , “ 27, “ 36 in., “ “ 371,100.
8. Fat scraper, ivory, cut 12, depth 25 in., “ “ 353,932.
9. “ “ , “ , U.S.N.M. no. 354,476.
10. Scraper, bone, cut 10, depth 22 in., U.S.N.M. no. 353,978.
11. Fat scraper, ivory, cut 10, depth 22 in., U.S.N.M. no. 353,979.
12. Ivory vessel, cut 16, depth 23 in., U.S.N.M. no. 354,222.
13. Ladle, wood, “ 23, “ 72 in., “ “ 370,670.
14. “ , ivory, “ 19, “ 30 in., “ “ 370,016.
15. Spoon, antler, “ 19, “ 67 in., “ “ 370,224.
16. Ladle, “ , “ 18, “ 48 in., “ “ 369,845.

Plate 52

Hillside site, Old Bering Sea culture

1. Potsherd, first (upper) level of midden, U.S.N.M. no. 352,702.
2. “ , among rocks, U.S.N.M. no. 352,880.
3. “ , “ “ , “ “ 352,559.
4. “ , “ “ , “ “ 352,880.
5. “ , “ “ , “ “ 352,880.
6. “ , “ “ , “ “ 352,880.
7. “ , “ “ , “ “ 352,880.
8. “ , house no. 1, “ “ 352,789.
9. “ , “ “ 1, “ “ 352,789.
10. “ , “ “ 1, “ “ 352,671.
11. “ , “ “ 1, “ “ 352,671.
12. “ , among rocks, “ “ 352,559.
13. “ , first (upper) level of midden, U.S.N.M. no. 352,702.
14. “ , below floor stones, house no. 1, “ “ 352,655.

Plate 53

1. Baleen vessel, below floor stones of house no. 2, U.S.N.M. no. 352,515.
2. Pottery lamp, from old grave at Kowieruk, east of Teller, Seward Peninsula, U.S.N.M. no. 347,877.

Plate 54

Hillside site, Old Bering Sea culture

1. Bottom of baleen vessel, wood, beneath floor stones, house no. 2, U.S.N.M. no. 352,536.
2. Bottom of baleen vessel, wood, beneath floor stones, house no. 2, U.S.N.M. no. 352,516.

3. Bottom of baleen vessel, wood, house no. 1, U.S.N.M. no. 352,627.
4. Fragment of wooden vessel, beneath floor stones, house no. 2, U.S.N.M. no. 352,538.
5. Fragment of wooden vessel, house no. 1, U.S.N.M. no. 352,638.
6. Wooden shovel (?), house no. 1, U.S.N.M. no. 352,627.
7. " " ", " " 1, " " 352,628.
8. " " ", " " 1, " " 352,627.

Plate 55

Miyowagh, Old Bering Sea culture

1. Toy bow, baleen, cut 19, depth 51 in., U.S.N.M. no. 370,133.
2. Part of a baleen snare, cut 23, depth 39 in., U.S.N.M. no. 370,592.
3. Piece of knotted baleen, cut 25, " 33 in., " " 370,863.
4. Ventilator rim (?), cut 23, depth 32 in., U.S.N.M. no. 370,578.
5. Drum handle and part of rim, cut 16, depth 23 in., U.S.N.M. no. 354,224.
6. Wooden shaft with baleen wrapping, cut 9, U.S.N.M. no. 354,420.
7. Ice scoop, baleen, cut 18, depth 44 in., " " 369,814.
8. Ring of baleen, cut 9, depth 48 in., U.S.N.M. no. 354,088.
9. Fishline, " , " 26, " 39 in., " " 370,971.

Plate 56

Miyowagh, Old Bering Sea culture

1. Engraving tool, wooden handle, jasper point, cut 19, depth 38 in., U.S.N.M. no. 370,059.
2. Engraving tool, wooden handle, jasper point, cut 19, depth 67 in., U.S.N.M. no. 370,223.
3. Fishhook (?), cut 9, U.S.N.M. no. 354,474.
4. Toy knife, baleen, cut 19, depth 45 in., U.S.N.M. no. 370,099.
5. Toy, baleen, cut 19, depth 38 in., U.S.N.M. no. 370,069.
6. Toy paddle, baleen, cut 27, depth 26 in., U.S.N.M. no. 371,052.
7. Toy, baleen, cut 19, depth 42 in., U.S.N.M. no. 370,081.
8. Plaited object, baleen, cut 18, depth 27 in., U.S.N.M. no. 369,725.
9. " " , " , " 23, " 22 in., " " 370,560.
10. Pieces of wood lashed with baleen, cut 18, depth 40 in., U.S.N.M. no. 369,783
11. Roll of baleen, cut 18, depth 32 in., U.S.N.M. no. 369,744.
12. Part of snare (?), cut 18, depth 32 in., " " 369,746.
13. Sliver of bone attached to wooden shaft, cut 27, depth 16 in., U.S.N.M. no. 371,000.
14. Bundle of grass, wrapped with baleen, cut 27, depth 26 in., U.S.N.M. no. 371,053.
15. Toy bow, baleen, cut 18, depth 32 in., U.S.N.M. no. 369,742.
16. Human hair tied to piece of wood, cut 21, depth 24 in., U.S.N.M. no. 370,403.

Plate 57

Miyowagh, Old Bering Sea culture

1. Lance foreshaft, wood, cut 23, depth 81 in., U.S.N.M. no. 370,701.
2. Part of drill shaft, wood, cut 23, depth 81 in., " " 370,705.
3. " " " " , " , " 18, " 36 in., " " 369,767.
4. End of arrow " , " , " 19, " 32 in., " " 369,916.
5. " " " " , " , " 18, " 66 in., " " 370,034.

6. Handle of engraving tool (?), cut 19, depth 79 in., U.S.N.M. no. 370,263.
7. Part of snare (?), wood, cut 9, U.S.N.M. no. 354,422.
8. Section of drum rim, wood, cut 16, depth 46 in., U.S.N.M. no. 354,255.
9, 10. Fragmentary wooden rods, painted red, cut 23, depth 81 in., U.S.N.M. no. 370,700.
11. Wooden object, cut 24, depth 68 in., U.S.N.M. no. 370,816.
12. " " , " 18, " 36 in., " " 369,759.
13. " " , " 18, " 36 in., " " 369,767.
14. " " , " 18, " 49 in., " " 369,861.
15. " " , painted red, cut 18, depth 59 in., U.S.N.M. no. 369,893.
16. " " , cut 28, depth 31 in., U.S.N.M. no. 371,178.
17. " " , " 23, " 81 in., " " 370,703.
18. Wooden cylinder, cut 23, depth 32 in., " " 370,579.
19. " " , painted red, cut 23, depth 45 in., U.S.N.M. no. 370,596.
20. Piece of drying rack slat, wood, cut 23, depth 81 in., " " 370,705.
21. Wooden object, cut 18, depth 40 in., U.S.N.M. no. 369,782.
22. Part of drying rack frame, cut 19, depth 45 in., U.S.N.M. no. 370,108.

Plate 58

Miyowagh, Old Bering Sea culture

1. Snow goggles, wood, cut 19, depth 54 in., U.S.N.M. no. 370,150.
2. " " , " , " 24, " 39 in., " " 370,753.
3. Bone button, cut 24, depth 64 in., U.S.N.M. no. 370,794.
4. Ivory button, " 19, " 30 in., " " 370,017.
5. " " , " 24, " 25 in., " " 371,990.
6. Piece of brow band, ivory, cut 18, depth 81 in., U.S.N.M. no. 369,947.
7. Brow band, ivory, cut 7, depth 75 in., U.S.N.M. no. 353,780.
8. Piece of brow band, ivory, cut 23, depth 72 in., U.S.N.M. no. 370,663.
9. Brow band, ivory, cut 27, depth 52 in., U.S.N.M. no. 371,159.
10. Comb, ivory, cut 7, depth 67 in., U.S.N.M. no. 353,766.
11. Shuttle, ivory, cut 7, depth 67 in., " " 353,775.
12. Piece of brow band, ivory, cut 3, depth 60 in., U.S.N.M. no. 353,291.
13. Ivory object, cut 23, depth 58 in., U.S.N.M. no. 370,625.
14. Potsherd with human figure decoration, cut 9 a, depth 60 in., U.S.N.M. no. 354,369.
15. Small bone plaque, cut 5, depth 32 in., U.S.N.M. no. 353,503.
16. Fused walrus teeth, used as drill rest, cut 16, depth 36 in., U.S.N.M. no. 354,243.
17. Ivory object, cut 7, depth 67 in., U.S.N.M. no. 353,772.
18. " " , " 8, " 20 in., " " 353,843.

Plate 59

Miyowagh, Old Bering Sea culture

1. Toy kayak, wood, cut 18, depth 44 in., U.S.N.M. no. 369,828.
2. Cross piece of toy umiak, wood, cut 13, depth 54 in., U.S.N.M. no. 353,960.
3. Keel piece " " " , " , " 18, " 32 in., " " 369,746.
4. Figure of man in toy kayak (?), wood, cut 18, depth 44 in., U.S.N.M. no. 369,829.
5. Figure of man in toy kayak (?), wood, cut 6, depth 42 in., U.S.N.M. no. 369,596.
6. Toy umiak, bark, cut 19, depth 54 in., U.S.N.M. no. 370,149.
7. End seat for toy umiak, bark, cut 18, depth 32 in., U.S.N.M. no. 369,741.

8, 9. Toy sledge runner, wood, cut 25, depth 43 in., U.S.N.M. no. 370,878.
10. Cross bars of toy sledge, wood, cut 25, depth 43 in., " " 370,878.
11. Toy sledge runner, ivory, cut 18, depth 12 in., U.S.N.M. no. 369,681.
12. Ivory top (?), cut 18, depth 12 in., U.S.N.M. no. 369,683.
13. Toy whales, bark, U.S.N.M. no. 354,481.
14. Toy whale, " , cut 7, depth 75 in., U.S.N.M. no. 353,785.
15. Wooden object with spiral groove, cut 10, depth 54 in., U.S.N.M. no. 354,023.
16. Doll, wood, cut 19, depth 34 in., U.S.N.M. no. 370,043.
17. " , bark, " 9, " 48 in., " " 354,092.
18. Toy harpoon head, ivory, cut 24, depth 54 in., U.S.N.M. no. 371,995.
19. " " " , " , " 18, " 59 in., " " 371,845.
20. " " " , " , " 19, " 56 in., " " 371,917.
21. " " " , " , " 7, " 75 in., " " 353,784.
22. Toy winged object, " , " 18, " 60 in., " " 371,850.
23. " " " , " , " 27, " 46 in., " " 371,144.
24. " " " , " , " 5, " 23 in., " " 353,486.
25. Toy polar bear, " , " 24, " 54 in., " " 370,779.
26. Toy bow, wood, cut 19, depth 34 in., U.S.N.M. no. 370,047.
27. " " , " , " 24, " 54 in., " " 370,789.

Plate 60

Miyowagh, early Punuk

1. Circular dish, whale bone, cut 17, depth 34 in., U.S.N.M. no. 369,655.
2. Adz head, ivory, cut 19, depth 42 in., U.S.N.M. no. 371,903.
3. Ivory object, cut 9, depth 36 in., U.S.N.M. no. 354,083.
4. Cord handle (?), ivory, cut 19, depth 17 in., U.S.N.M. no. 369,977.
5. " " " , " , " 23, " 24 in., " " 370,548.
6. Broken snow goggles, ivory, surface of midden, " " 354,478.
7. Ornamental plug, ivory, cut 2, depth 28 in., " " 353,116.
8. Toy bow, reinforced with baleen, cut 19, depth 42 in., U.S.N.M. no. 370,081.
9. Drill shaft, wood and ivory, purchased, U.S.N.M. no. 354,495.
10. Engraving tool, ivory, cut 27, depth 22 in., " " 371,025.
11. " " , " , " 3, " 20 in., " " 353,209.
12. Bone shovel, cut 4, depth 15 in., U.S.N.M. no. 353,310.

Plate 61

1. View of Ievoghiyoq, on the gravel plain, with Miyowagh in foreground.
2. Excavations at house no. 7, Ievoghiyoq; stone entrance passage in foreground.
3. House no. 7 at a later stage of excavation, showing the mass of fallen wall and roof timbers, and stone walled entrance in foreground.
4. View of the same looking in opposite direction, toward the south.

Plate 62

1, 2. Views of the fallen wall and roof timbers of house no. 7, Ievoghiyoq.
3. Ruins of house no. 6, a stone-walled house of later type at Ievoghiyoq.
4. Round antechamber at end of entrance passage to house no. 6.

Plate 63

1. Piece of blubber-soaked walrus skin in one of the cuts at Seklowaghyaget.
2, 3. House no. 8, Seklowaghyaget.
4. Oval enlargement of the entrance passage to house no. 8.
5. View of same before the fallen roof material—whale ribs—had been removed.

Plate 64

1. Oval annex to passage of house no. 9, with stone walls and floor and roof of whale ribs.
2. Uncovering the wooden floor of house no. 10, the latest house excavated at Gambell; abandoned about 50 years ago.
3. Underground cache made of whale bones, Gambell.
4. Small underground house of whale bones and stones at Naskok, east of Gambell; abandoned about 50 years ago.
5. Ruins of square stone house at Mirrukta, east of Gambell.

Plate 65

Ievoghiyoq, Punuk culture

1. Broken needle case, ivory, cut 5, depth 43 in., U.S.N.M. no. 355,461.
2. Needle case, ivory, cut 9, depth 12 in., U.S.N.M. no. 372,080.
3. Knife handle, " , " 1, " 28 in., " " 354,610.
4. Fragmentary dart socket piece, ivory, cut 1, depth 31 in., U.S.N.M. no. 354,649.
5. Fragmentary dart socket piece, ivory, cut 5, depth 24 in., U.S.N.M. no. 355,259.
6. Link ornament, ivory, cut 8, depth 8 in., U.S.N.M. no. 372,052.
7. Ivory object, cut 1, depth 42 in., U.S.N.M. no. 354,744.
8. " " , " 5, " 31 in., " " 355,339.
9. Wrist guard, ivory, cut 1, depth 36 in., U.S.N.M. no. 354,702.
10. " " , " , " 1, " 44 in., " " 354,760.
11. " " , bone, " 1, " 36 in., " " 354,703.

Plate 66

Ievoghiyoq, Punuk culture

1. Fragment of wrist guard, ivory, purchased, U.S.N.M. no. 372,100.
2. Wrist guard, ivory, purchased, U.S.N.M. no. 355,767.
3. Harpoon socket piece, ivory, purchased, U.S.N.M. no. 354,496.
4. Ivory object, cut 1, depth 42 in., U.S.N.M. no. 354,743.
5. " " , " 5, " 14 in., " " 355,181.
6. " " , " 8, " 44 in., " " 372,072.
7. Needle case, purchased, U.S.N.M. no. 372,144.
8. Ivory object, " , " " 355,775.

Plate 67

Seklowaghyaget and old section of Gambell, Punuk culture

1. Ulu handle, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 372,743.
2. Base of spindle buzz, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 372,138.
3. Broken dart socket piece, ivory, " , " , " " 364,124.

4. Bodkin, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 356,125.
5. Wrist guard, ivory, old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,192.
6. Ivory object, Seklowaghyaget, purchased, U.S.N.M. no. 364,180.
7. Wrist guard, Seklowaghyaget, cut 3, depth 20 in., U.S.N.M. no. 355,952.
8. Ivory object, " , purchased, U.S.N.M. no. 356,131.

Plate 68

Ievoghiyoq and Seklowaghyaget, Punuk culture

1. Ivory trident, Ievoghiyoq, cut 4, depth 31 in., U.S.N.M. no. 355,064.
2. " " , " , " 4, " 31 in., " " 355,065.
3. " " , Seklowaghyaget, purchased, U.S.N.M. no. 356,126.
4. " " , " , " , " " 355,202.
5. " " , Ievoghiyoq, cut 5, depth 24 in., U.S.N.M. no. 356,127.
6. Ivory object, Seklowaghyaget, purchased, U.S.N.M. no. 372,140 a.
7. " " , " , " , " " 356,128.
8. " " , " , " , " " 356,129.

Plate 69

1-8. Reverse of objects illustrated on pl. 68.

Plate 70

Ievoghiyoq, Punuk culture

1. Harpoon head, ivory, cut 1, depth 12 in., U.S.N.M. no. 354,560.
2. " " , bone, " 5, " 18 in., " " 355,179.
3. " " , " , " 1, " 22 in., " " 354,970.
4. " " , ivory, " 1, " 22 in., " " 354,593.
5. " " , " , " 5, " 24 in., " " 355,252.
6. " " , bone, " 8, " 28 in., " " 372,060.
7. " " , ivory, " 1, " 44 in., " " 354,762.
8. " " , " , " 4, " 59 in., " " 355,110.
9. " " , " , " 6, " 36 in., " " 355,645.
10. " " , " , " 5, " 33 in., " " 355,356.
11. " " , " , " 6, " 30 in., " " 355,596.
12. " " , " , " 6, " 22 in., " " 355,557.
13. " " , " , " 6, " 5 in., " " 355,471.
14. " " , " , " 6, " 5 in., " " 355,139.
15. " " , " , " 8, " 44 in., " " 372,068.
16. " " , " , " 9, " 12 in., " " 372,073.
17. " " , " , " 9, " 31 in., " " 372,093.
18. " " , " , " 5, " 12 in., " " 355,173.
19. " " , " , " 1, " 50 in., " " 354,779.
20. " " , " , " 1, " 40 in., " " 354,717.
21. " " , " , " 4, " 42 in., " " 355,060.
22. " " , " , " 6, " 9 in., " " 355,530.
23. " " , " , " 2, " 22 in., " " 354,859.

Plate 71

Seklowaghyaget and old section of Gambell, Punuk and modern

1. Harpoon head, ivory, Seklowaghyaget, cut 2, depth 22 in., U.S.N.M. no. 355,863.
2. " " , " , " , " 2, " 49 in., " " 355,903.
3. " " , " , " , " 3, " 18 in., " " 355,942.
4. " " , " , " , " 4, " 18 in., " " 356,039.
5. " " , " , " , " 2, " 18 in., " " 355,842.
6. " " , " , " , " 2, " 12 in., " " 355,822.
7. " " , bone, " , " 2, " 28 in., " " 355,879.
8. " " , ivory, " , " 2, " 12 in., " " 355,821.
9. " " , " , " , " 2, " 22 in., " " 355,863.
10. " " , " , " , " 2, " 18 in., " " 355,841.
11. " " , " , " , " 2, " 22 in., " " 355,868.
12. " " , " , " , " 2, " 18 in., " " 355,843.
13. " " , bone, " , " 7, " 12 in., " " 372,113.
14. " " , ivory, " , " 4, " 12 in., " " 356,029.
15. " " , bone, house no. 8, U.S.N.M. no. 356,337.
16. " " , " , " " 8, " " 356,335.
17. " " , " , " " 8, " " 356,322.
18. " " , " , " " 8, " " 356,333.
19. " " , " , " " 8, " " 356,336.
20. " " , ivory, " " 8, " " 356,323.
21. " " , bone, exact provenience unknown, purchased, U.S.N.M. no. 356,713.
22. " " , ivory, old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,180.
23. Harpoon head, bone, old section of Gambell, cut 1, depth 16 in., U.S.N.M. no. 356,203.
24. Harpoon head, ivory, old section of Gambell, cut 2, depth 20 in., U.S.N.M. no. 356,311.
25. Harpoon head, ivory, old section of Gambell, cut 2, depth 10 in., U.S.N.M. no. 356,298.
26. Harpoon head, ivory, house no. 10, U.S.N.M. no.356,372.
27. " , " , St. Lawrence Island, collected by E. W. Nelson, U.S.N.M. no. 126,915.
28. Harpoon head, ivory, old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,178.
29. Harpoon head, ivory, St. Lawrence Island, collected by Riley D. Moore.

Plate 72

Various localities, Punuk culture

1. Whaling harpoon head, ivory, Miyowagh, cut 18, depth 60 in., U.S.N.M. no. 371,846.
2. Whaling harpoon head, ivory, Miyowagh, cut 12, depth 27 in., U.S.N.M. no. 353,928.
3. Whaling harpoon head, ivory, Kitneapalok, 20 miles south of Gambell, U.S.N.M. no. 371,705.

4. Whaling harpoon head, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 356,121.
5. " " " , " , old section of Gambell, cut 1, depth 16 in., U.S.N.M. no. 356,201.
6. Whaling harpoon head, ivory, old section of Gambell, cut 1, depth 8 in., U.S.N.M no. 356,175.
7. Whaling harpoon head, ivory, Kukuliak, purchased, U.S.N.M. no. 356,576.
8. Lance head, ivory, Seklowaghyaget, purchased, " " 371,802.
9. " " , " , Kukuliak, purchased, U.S.N.M. no. 356,715.

Plate 73

Various localities, Punuk and modern

1. Harpoon foreshaft, ivory, Seklowaghyaget, cut 2, depth 28 in., U.S.N.M. no. 355,878.
2. Harpoon foreshaft, ivory, Seklowaghyaget, surface, U.S.N.M. no. 371,639.
3. " " , " , modern, Punuk Island, " " 342,791.
4. Harpoon ice pick, bone, Ievoghiyoq, cut 5, depth 24 in., U.S.N.M. no. 355,282.
5. Toy harpoon socket piece, ivory, Ievoghiyoq, cut 6, depth 22 in., U.S.N.M. no. 355,572.
6. Harpoon socket piece, ivory, Seklowaghyaget, surface, U.S.N.M. no. 371,631.
7. " " " , house no. 9, U.S.N.M. no. 356,356.
8. Harpoon ice pick, house no. 8, U.S.N.M. no. 356,348.
9. " " " , bone, modern, collected by E. W. Nelson, U.S.N.M. no. 126,912.
10. Mouthpiece for bladder float, ivory, Ievoghiyoq, cut 6, depth 30 in., U.S.N.M. no. 355,592.
11. Mouthpiece for bladder float, ivory, Miyowagh, cut 4, depth 20 in., U.S.N.M. no. 355,322.
12. Mouthpiece for bladder float, ivory, Ievoghiyoq, cut 6, depth 40 in., U.S.N.M. no. 355,656.
13. Finger rest for harpoon shaft, ivory, Ievoghiyoq, cut 5, depth 18 in., U.S.N.M. no. 355,159.
14. Finger rest for harpoon shaft, ivory, old section of Gambell, cut 1, depth 16 in., U.S.N.M. no. 356,223.
15. Mouthpiece for water bag, ivory, Seklowaghyaget, surface, U.S.N.M. no. 371,641.
16. Mouthpiece for seal skin float, ivory, Ievoghiyoq, cut 9, depth 19 in., U.S.N.M. no. 371,381.
17. Spur for end of throwing board, ivory, Ievoghiyoq, cut 5, depth 12 in., U.S.N.M. no. 355,128.
18. Peg for end of dart shaft, ivory, Ievoghiyoq, cut 1, depth 50 in., U.S.N.M. no. 354,778.
19. Wooden plug for seal skin float, Ievoghiyoq, cut 5, depth 31 in., U.S.N.M. no. 355,324.
20. Float bar, wood, Ievoghiyoq, cut 4, depth 53 in., U.S.N.M. no. 355,098.

Plate 74

Various localities, Punuk and modern

1. Side prong for bird dart, ivory, Ievoghiyoq, cut 4, depth 45 in., U.S.N.M. no. 355,076.
2. Side prong for bird dart, ivory, Ievoghiyoq, cut 1, depth 28 in., U.S.N.M. no. 354,623.

3. End prong for bird dart, ivory, Ievoghiyoq, cut 5, depth 12 in., U.S.N.M. no. 355,194.
4. End prong for bird dart, ivory, Ievoghiyoq, cut 8, depth 29 in., U.S.N.M. no. 371,277.
5. End prong for bird dart, ivory, Ievoghiyoq, cut 1, depth 44 in., U.S.N.M. no. 354,764.
6. Arrowhead, ivory, Ievoghiyoq, cut 5, depth 24 in., U.S.N.M. no. 355,277.
7. " , " , " , U.S.N.M. no. 355,738.
8. " , bone, " , cut 1, depth 12 in., U.S.N.M. no. 354,537.
9. " , " , " , " 9, " 12 in., " " 371,356.
10. " , " , " , " 6, " 22 in., " " 355,567.
11. Blunt arrow tip, ivory, Seklowaghyaget, cut 2, depth 12 in., U.S.N.M. no. 355,829.
12. Blunt arrow tip, ivory, Seklowaghyaget, cut 8, depth 60 in., U.S.N.M. no. 371,603.
13. Blunt arrow tip, ivory, Seklowaghyaget, cut 8, depth 67 in., U.S.N.M. no. 371,620.
14. Arrowhead, bone, Ievoghiyoq, cut 5, depth 39 in., U.S.N.M. no. 355,379.
15. " , " , " , " 1, " 28 in., " " 354,616.
16. Bow brace, bone, " , " 6, " 5 in., " " 355,485.
17. " " , " , old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,171.
18. Bow brace, bone, Ievoghiyoq, cut 8, depth 44 in., U.S.N.M. no. 371,341.
19. Sinew twister, ivory, " , " 9, " 31 in., " " 371,388.
20. " " , " , " , " 5, " 18 in., " " 355,164.
21. Wrist guard, ivory, old section of Gambell, surface, " " 372,141.
22. " " , " , Ievoghiyoq, purchased, U.S.N.M. no. 355,768.
23. " " , " , " , " , " " 357,769.
24. " " , " , modern St. Lawrence form, purchased, U.S.N.M. no. 371,814.

Plate 75

Various localities, Punuk and modern

1. Prong for fish spear, Ievoghiyoq, cut 1, depth 9 in., U.S.N.M. no. 355,150.
2. " " " " , " , " 1, " 9 in., " " 355,194.
3. " " " " , " , " 1, " 9 in., " " 355,194.
4. Fishhook shank, ivory, old section of Gambell, cut 2, depth 10 in., U.S.N.M. no. 356,297.
5. Fishhook shank, bone, old section of Gambell, cut 1, depth 24 in., U.S.N.M. no. 356,251.
6. Fishhook barb, ivory, Ievoghiyoq, cut 5, depth 12 in., U.S.N.M. no. 355,194.
7. Fishhook barb, ivory, old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,188.
8. Fishhook barb, ivory, old section of Gambell, cut 1, depth 24 in., U.S.N.M. no. 356,252.
9. Fishhook barb, old section of Gambell, cut 1, depth 32 in., U.S.N.M. no. 356,290.
10. Fishhook, ivory, old section of Gambell, cut 2, depth 10 in., U.S.N.M. no. 356,297.
11. Wound plug, wood, Ievoghiyoq, cut 1, depth 31 in., U.S.N.M. no. 354,651.
12. Fishline sinker, ivory, Ievoghiyoq, cut 9, depth 34 in., U.S.N.M. no. 371,402.
13. " " , " , " , " 1, " 31 in., " " 354,642.
14. " " , " , Seklowaghyaget, cut 7, depth 42 in., " " 371,529.
15. " " , " , " , " 2, " 49 in., " " 355,901.
16. Net sinker, ivory, Ievoghiyoq, cut 5, depth 28 in., U.S.N.M. no. 355,278.
17. Sealing scratcher, wood, Ievoghiyoq, purchased, U.S.N.M. no. 364,203

18. Meat hook, bone, Seklowaghyaget, cut 2, depth 61 in., U.S.N.M. no. 355,917.
19. Barb for salmon spear, Cape Kialegak, U.S.N.M. no. 346,451.
20. Baleen object, Ievoghiyoq, cut 1, depth 40 in., U.S.N.M. no. 354,712.
21. Ivory object, Miyowagh, " 1, " 12 in., " " 352,922.
22. " " , " , " 17, " 12 in., " " 354,270.
23. Ice creeper, ivory, Miyowagh, cut 19, depth 24 in., U.S.N.M. no. 369,993.
24. " " , " , Seklowaghyaget, purchased, " " 364,160.
25. " " , bone, Miyowagh, cut 19, depth 5 in., " " 369,954.
26. " " , ivory, modern type, Punuk Island, " " 342,785.

Plate 76

Various localities, Punuk culture

1. Bola weight, ivory, Ievoghiyoq, cut 1, depth 22 in., U.S.N.M. no. 354,568.
2. " " , " , " , " 4, " 26 in., " " 355,021.
3. " " , " , " , " 6; " 22 in., " " 355,535.
4. " " , " , " , " 5, " 12 in., " " 355,116.
5. " " , " , " , " 6, " 22 in., " " 355,535.
6. " " , " , " , " 6, " 36 in., " " 355,625.
7. " " , " , " , " 5, " 39 in., " " 355,377.
8. " " , " , " , " 5, " 31 in., " " 355,308.
9. " " , " , " , " 1, " 22 in., " " 354,568.
10. " " , " , " , " 5, " 33 in., " " 355,345.
11. " " , bone, " , " 1, " 12 in., " " 354,516.
12. " " , ivory, " , " 1, " 40 in., " " 354,710.
13. " " , " , " , " 1, " 36 in., " " 354,690.
14. " " , " , Miyowagh, " 4, " 15 in., " " 353,311.
15. " " , " , Seklowaghyaget, cut 4, depth 12 in., " " 356,051.
16. " " , " , Ievoghiyoq, cut 6, depth 22 in., " " 355,535.
17. " " , " , " , " 8, " 18 in., " " 371,255.
18. " " , " , " , " 6, " 5 in., " " 355,467.
19. " " , " , Seklowaghyaget, cut 7, depth 4 in., " " 371,626.
20. Piece of plate armor, bone, Ievoghiyoq, cut 5, depth 24 in., U.S.N.M. no. 355,225.
21. Piece of plate armor, bone, Ievoghiyoq, cut 5, depth 28 in., U.S.N.M. no. 355,281.
22. Piece of plate armor, bone, Seklowaghyaget, cut 3, depth 38 in., U.S.N.M. no. 355,982.
23. Piece of plate armor, bone, Seklowaghyaget, cut 3, depth 38 in., U.S.N.M. no. 355,982.
24. Piece of plate armor, helmet, bone, house no. 8, U.S.N.M. no. 356,330.

Plate 77

Various localities, Punuk culture

1. Piece of sledge runner, ivory, Ievoghiyoq, cut 6, depth 30 in., U.S.N.M. no. 355,609.
2. Piece of sledge runner, ivory, Ievoghiyoq, cut 5, depth 12 in., U.S.N.M. no. 355,115.
3. Piece of sledge runner, ivory, Ievoghiyoq, cut 6, depth 9 in., U.S.N.M. no. 355,519.

4. Piece of sledge runner, ivory, Ievoghiyoq, depth unknown, U.S.N.M. no. 355,726.
5. " " " " , " , " , cut 5, depth 18 in., U.S.N.M. no. 355,156.
6. Sledge runner, ivory, Seklowaghyaget, cut 7, depth 28 in., U.S.N.M. no. 371,514.
7. " " , " , house no. 9, U.S.N.M. no. 356,350.
8. " " , " , " " 10, " " 356,375.

Plate 78

Various localities, Punuk culture

1. Knife handle, bone, Seklowaghyaget, cut 7, depth 4 in., U.S.N.M. no. 371,627.
2. " " , " , old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,183.
3. Knife handle, bone, Ievoghiyoq, cut 7, depth 8 in., U.S.N.M. no. 355,670.
4. " " , " , " , " 8, " 13 in., " " 371,246.
5. " " , " , old section of Gambell, cut 1, depth 32 in., U.S.N.M. no. 356,286.
6. Knife handle, wood, Ievoghiyoq, cut 5, depth 33 in., U.S.N.M. no. 355,353.
7. " " , " , " , " 8, " 37 in., " " 371,309.
8. " " , " , " , " 8, " 39 in., " " 371,322.
9. Ulu handle, ivory, " , " 6, " 5 in., " " 355,480.
10. Ulu, wooden handle, slate blade, Seklowaghyaget, cut 3, depth 48 in., U.S.N.M. no. 355,997.
11. Ulu handle, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 356,731.
12. " " , " , Ievoghiyoq, " , " " 372,099.
13. " " , " , Seklowaghyaget, " , " " 356,008.
14. Fat scraper, bone, Ievoghiyoq, cut 2, depth 26 in., U.S.N.M. no. 354,866.
15. Scraper, bone, Ievoghiyoq, cut 5, depth 12 in., U.S.N.M. no. 355,218.
16. Bone spoon, Ievoghiyoq, cut 3, depth 12 in., " " 354,985.
17. Adz head, ivory, Ievoghiyoq, cut 1, depth 50 in., " " 354,769.
18. " " , " , Seklowaghyaget, cut 6, depth 12 in., U.S.N.M. no. 371,417.
19. " " , bone, " , " 7, " 36 in., " " 371,521.
20. " " , ivory, Punuk Island, U.S.N.M. no. 343,373.
21. " " , " , house no. 8, " " 356,319.

Plate 79

Various localities, Punuk culture

1. Pick handle, wood, Seklowaghyaget, cut 8, depth 52 in., U.S.N.M. no. 371,598.
2. " " , ivory, " , surface, U.S.N.M. no. 356,087.
3. Adz handle, wood, house no. 7 (Ievoghiyoq), " " 355,825.
4. Knife, ivory, Seklowaghyaget, cut 2, depth 12 in., U.S.N.M. no. 355,825.
5. " , bone, house no. 3 (Miyowagh), U.S.N.M. no. 354,104.
6. " , ivory, Ievoghiyoq, cut 5, depth 39 in., U.S.N.M. no. 355,401.
7. Ivory object, Miyowagh, " 2, " 28 in., " " 353,111.
8. Bone hook, Seklowaghyaget, cut 2, depth 3 in., " " 355,827.
9. Ivory object, old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,194.
10. Harpoon rest, bone, Seklowaghyaget, " 3, " 34 in., " " 355,972.
11. Snow goggles, Seklowaghyaget, surface, U.S.N.M. no. 371,636.
12. Boat hook, ivory, Ievoghiyoq, depth 12 in., U.S.N.M. no. 355,731.
13. " " , " , " , purchased, " " 355,766.

Plate 80

Various localities, Punuk culture

1. Wooden vessel, Ievoghiyoq, cut 1, depth 41 in., U.S.N.M. no. 371,327.
2. Mattock blade, whale rib, Ievoghiyoq, cut 8, depth 34 in., U.S.N.M. no. 371,294.
3. Throwing board, wood, unfinished, Punuk Island, U.S.N.M. no. 356,688.
4. Stone sinker for tom cod net, old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,166.
5. Drill rest, whale ear bone, Ievoghiyoq, cut 6, depth 22 in., U.S.N.M. no. 355,536.

Plate 81

Various localities, Punuk culture

1. Bone tube, Ievoghiyoq, cut 4, depth 24 in., U.S.N.M. no. 355,005.
2. Ivory drum handle, Seklowaghyaget, purchased, " " 344,579.
3. " " " , " , " , " " 356,136.
4. " " " , " , " , " " 356,137.
5. " " " , Ievoghiyoq, cut 1, depth 12 in., U.S.N.M. no. 354,558.
6. Wooden drum handle, " , house no. 7, U.S.N.M. no. 355,718.
7. Ivory comb, old section of Gambell, cut 1, depth 12 in., U.S.N.M. no. 356,210.
8. " " , Ievoghiyoq, purchased, U.S.N.M. no. 355,770.
9. " " , " , cut 6, depth 22 in., U.S.N.M. no. 355,546.
10. " " , " , " 5, " 12 in., " " 355,197.
11. " " , Seklowaghyaget, purchased, U.S.N.M. no. 369,550.
12. Bear tooth pendant, Ievoghiyoq, cut 9, depth 12 in., U.S.N.M. no. 371,352.
13. Ivory object, Seklowaghyaget, purchased, U.S.N.M. no. 356,147.
14. Sealing scratcher, Ievoghiyoq, cut 6, depth 22 in., U.S.N.M. no. 355,553.
15. Inserted bird bones, " , " 5, " 12 in., " " 355,127.
16. " " " , " , " 5, " 12 in., " " 355,196.
17. Engraving tool, Ievoghiyoq, ivory, cut 6, depth 22 in., " " 355,554.
18. " " , " , " , " 1, " 12 in., " " 354,528.
19. " " , " , wood, " 5, " 31 in., " " 355,319.
20. " " , ivory, old section of Gambell, cut 1, depth 16 in., U.S.N.M. no. 356,226.
21. Hand drill, bone, Miyowagh, cut 19, depth 24 in., U.S.N.M. no. 369,999.

Plate 82

Various localities, Punuk culture

1. Ivory pendant, Miyowagh, cut 20, depth 12 in., U.S.N.M. no. 370,325.
2. " " , Ievoghiyoq, " 1, " 12 in., " " 345,525.
3. " " , Miyowagh, " 1, " 8 in., " " 352,920.
4. " " , Ievoghiyoq, " 8, " 28 in., " " 371,281.
5. " " , " , " 6, " 22 in., " " 355,555.
6. " " , Punuk Island, U.S.N.M. no. 343,489.
7. " " , " " , " " 343,678.
8. " " , Seklowaghyaget, purchased, U.S.N.M. no. 356,140.
9. " " , Miyowagh, cut 20, depth 12 in., U.S.N.M. no. 370,324.
10. " " , Gambell, purchased, U.S.N.M. no. 347,570.
11. " " , Punuk Island, U.S.N.M. no. 343,487.
12. " " , Ievoghiyoq, cut 5, depth 24 in., U.S.N.M. no. 355,265.
13. " " , Gambell, purchased, U.S.N.M. no. 371,660.

14, 15. Dog tooth pendants, old section of Gambell, cut 1, depth 32 in., U.S.N.M. no. 356,272.
16. Ivory ear ornament, Punuk Island, U.S.N.M. no. 356,631.
17. " " " , unfinished, Punuk Island, U.S.N.M. no. 356,644.
18. " " " , old section of Gambell, cut 1, depth 16 in., U.S.N.M. no. 356,225.
19. Ivory object, Ievoghiyoq, cut 6, depth 22 in., U.S.N.M. no. 355,573.
20. " " , " , " 6, " 30 in., " " 355,604.
21. Ivory plug, old section of Gambell, cut 2, depth 20 in., U.S.N.M. no. 356,315.
22. Ivory ear ornament, Seklowaghyaget, cut 2, depth 22 in., " " 355,852.
23. Ivory thimble guard, house no. 8, U.S.N.M. no. 356,339.
24. " " " , Ievoghiyoq, cut 5, depth 24 in., U.S.N.M. no. 355,265.
25. Cord handle, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 356,730.
26. " " , " , Ievoghiyoq, depth unknown, U.S.N.M. no. 355,743.
27. Ivory object, Seklowaghyaget, purchased, U.S.N.M. no. 371,648.
28. " " , " , " , " " 364,190.
29. " " , " , " , " " 364,191.
30. Ulu handle, ivory, " , " , " " 364,157.
31. Link ornament," , " , " , " " 347,587.
32. " " ," , Cape Kialegak, U.S.N.M. no. 342,922.
33. " " ," , Punuk Island, " " 343,921.
34. " " ," , old section of Gambell, cut 1, depth 8 in., U.S.N.M. no. 356,189.
35. Trace buckle for dog harness, ivory, old section of Gambell, cut 1, depth 24 in., U.S.N.M. no. 356,255.
36. Ivory dart rest, for kayak, Ievoghiyoq, cut 5, depth 24 in., U.S.N.M. no. 355,263.
37. Mouthpiece for bow drill, ivory, Miyowagh, cut 20, depth 12 in., U.S.N.M. no. 370,317.
38. Mouthpiece for bow drill, ivory, Miyowagh, cut 6, depth 12 in., U.S.N.M. no. 353,535.
39. Mouthpiece for bow drill, ivory, Ievoghiyoq, cut 5, depth 33 in., U.S.N.M. no. 355,346.
40. Mouthpiece for bow drill, ivory, Mirrukta, U.S.N.M. no. 356, 486.

Plate 83

Various localities, Punuk and modern

1. Toy sledge, ivory, Gambell, purchased, U.S.N.M. no. 356,609.
2. " " , " , " , " , " " 356,721.
3. Toy sledge runner, ivory, Ievoghiyoq, cut 1, depth 31 in., U.S.N.M. no. 354,644.
4. Toy kayak, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 364,174.
5. " " , " , Ievoghiyoq, cut 5, depth 31 in., U.S.N.M. no. 355,338.
6. " " , old section of Gambell, cut 1, depth 16 in., U.S.N.M. no. 356,213.
7. Ivory bird figure, purchased, U.S.N.M. no. 355,778.
8. " " " , Seklowaghyaget, cut 7, depth 12 in., U.S.N.M. no. 371,488.
9. " " " , " , " 7, " 12 in., " " 371,488.
10. " " " , purchased, U.S.N.M. no. 356,141.
11. " " " , Seklowaghyaget, cut 7, depth 12 in., U.S.N.M. no. 371,488.
12. Ivory doll, Cape Kialegak, U.S.N.M. no. 343,004.

13. Doll head, ivory, Seklowaghyaget, purchased, U.S.N.M. no. 356,726.
14. " " , " , Punuk Island, U.S.N.M. no. 356,701.
15. Ivory top, Seklowaghyaget, cut 7, depth 36 in., U.S.N.M. no. 371,520.
16. Whale, ivory, Ievoghiyoq, " 7, " 8 in., " " 355,676.
17. " , " , house no. 9, U.S.N.M. no. 356,357.
18. " , " , " " 8, " " 356,325.

Plate 84

Various localities, Punuk and modern

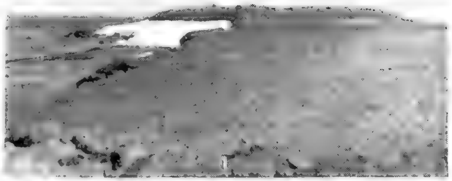
1. Wooden fire hearth, house no. 7, Ievoghiyoq, U.S.N.M. no. 355,722.
2. Boat paddle, house no. 7, Ievoghiyoq, U.S.N.M. no. 355,720.
3. Half of pottery lamp, Ievoghiyoq, cut 6, depth 5 in., U.S.N.M. no. 355,464.
4. Lamp, St. Lawrence Island, modern type, U.S.N.M. no. 342,736.
5. Cooking pot, modern type, house no. 9, U.S.N.M. no. 356,349.

VIEWS OF MIDDENS, "JUMPING STONES", AND MEAT CACHE, AT OLD ESKIMO SITES ON WEST AND NORTH COASTS OF ST. LAWRENCE ISLAND

(For explanation, see page 395.)

VIEWS OF MIDDENS AND HOUSE RUIN, PUNUK ISLAND, OFF SOUTHEASTERN END OF ST. LAWRENCE ISLAND

(For explanation, see page 395.)



VIEWS OF MIDDENS AND HOUSE RUIN, CAPE KIALEGAK, SOUTHEASTERN END OF ST. LAWRENCE ISLAND

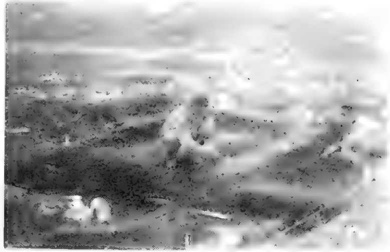
(For explanation, see page 395.)

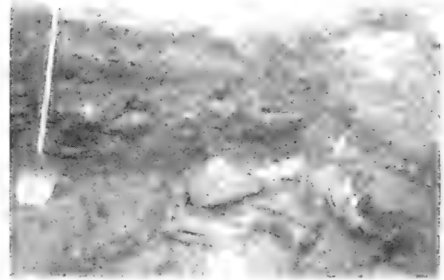
VIEWS AT GAMBELL, NORTHWESTERN END OF ST. LAWRENCE ISLAND

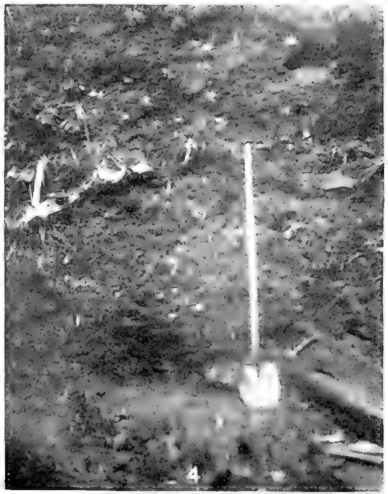
(For explanation, see page 395.)

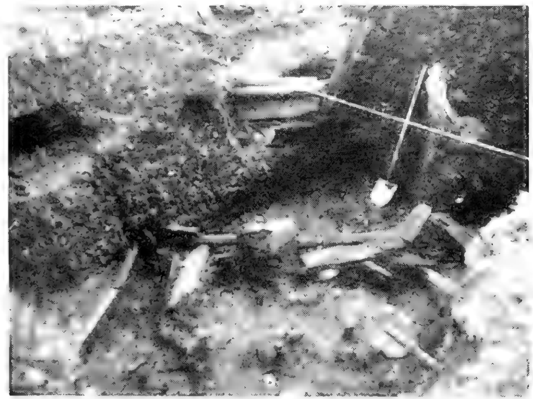
EXCAVATIONS AT HILLSIDE SITE, GAMBELL

(For explanation, see page 395.)









EXCAVATIONS AT MIYOWAGH, GAMBELL

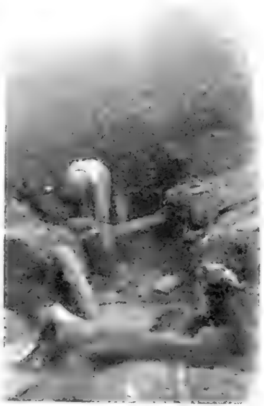
(For explanation, see page 395.)

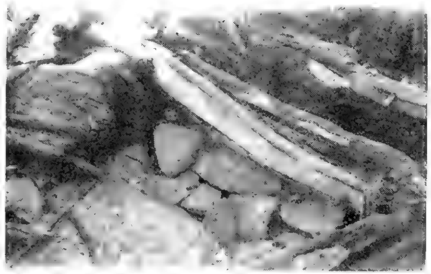
EXCAVATIONS AT MIYOWAGH, GAMBELL

(For explanation, see page 396.)

EXCAVATIONS AT MIYOWAGH, GAMBELL

(For explanation, see page 396.)



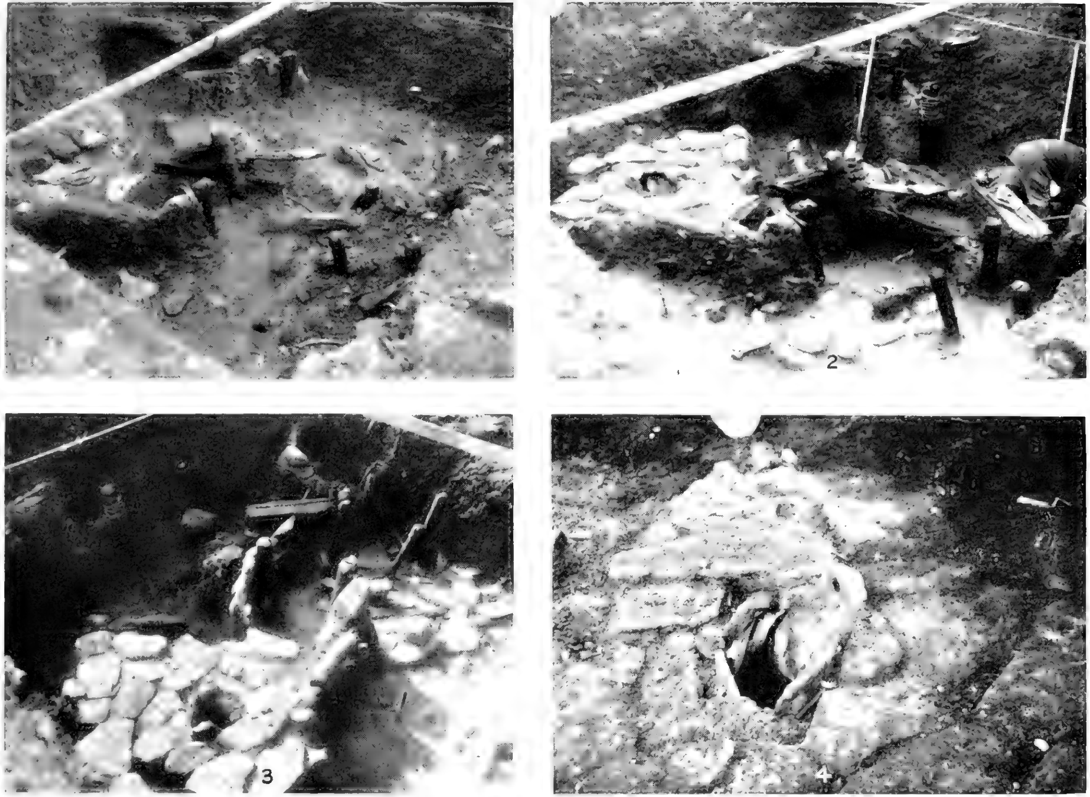


EXCAVATIONS AT MIYOWAGH, GAMBELL

(For explanation, see page 306.)

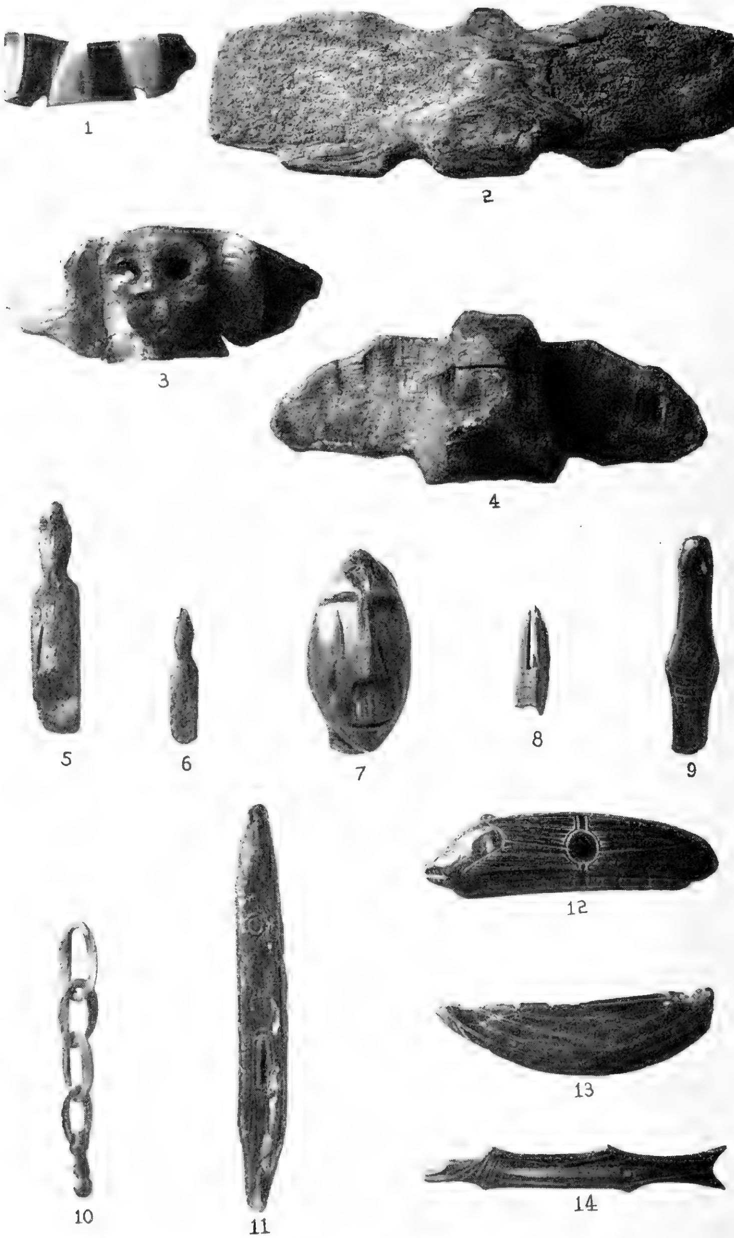
EXCAVATIONS AT MIYOWAGH, GAMBELL

(For explanation, see page 396.)



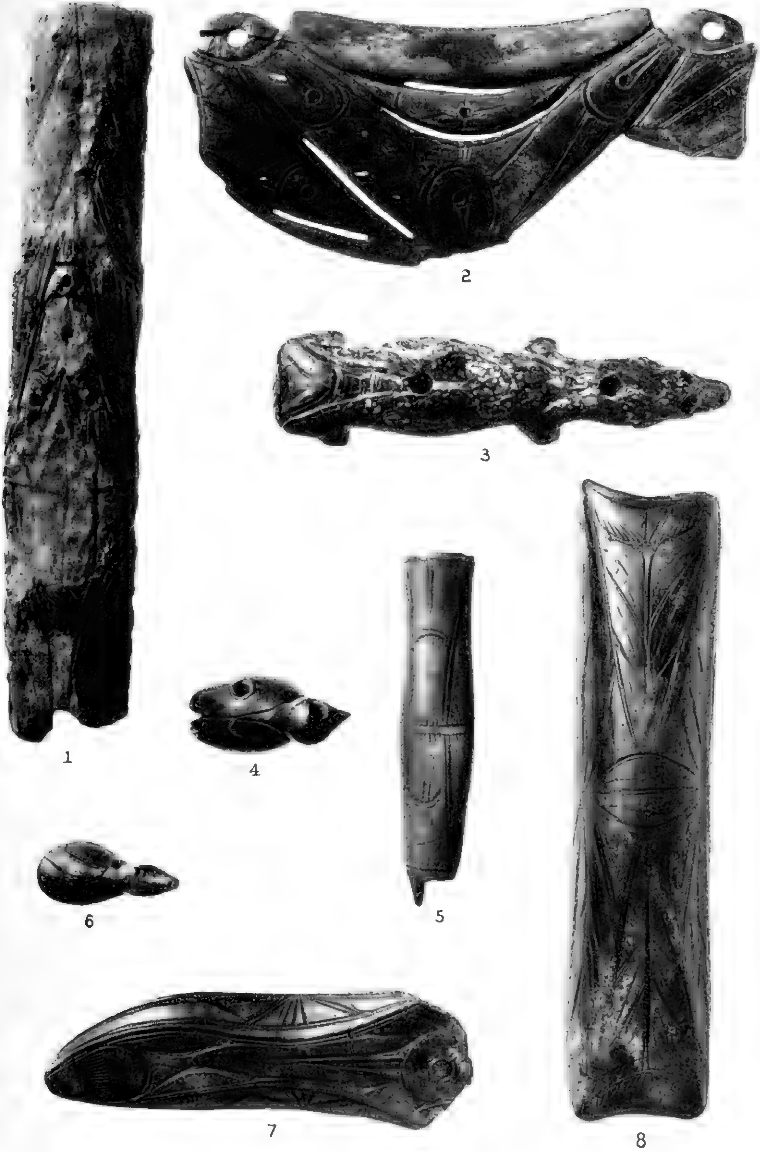
EXCAVATIONS AT MIYOWAGH, GAMBELL (CUTS 18, 23, 24, AND 25)

(For explanation, see page 396.)



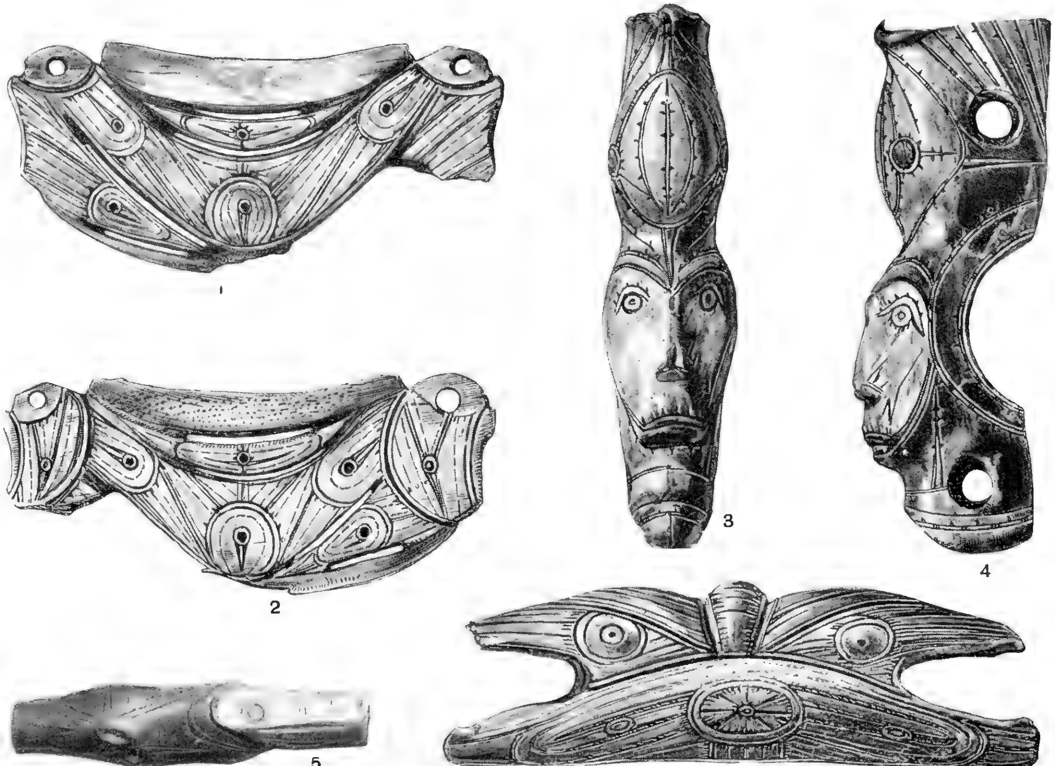
IVORY OBJECTS FROM THE HILLSIDE SITE, OLD BERING SEA CULTURE.
½ NATURAL SIZE.

(For explanation, see pages 396-397.)



DECORATED IVORY OBJECTS FROM THE HILLSIDE SITE, OLD BERING SEA CULTURE. APPROX. ⅔ NATURAL SIZE.

(For explanation, see page 397.)



1

2

3

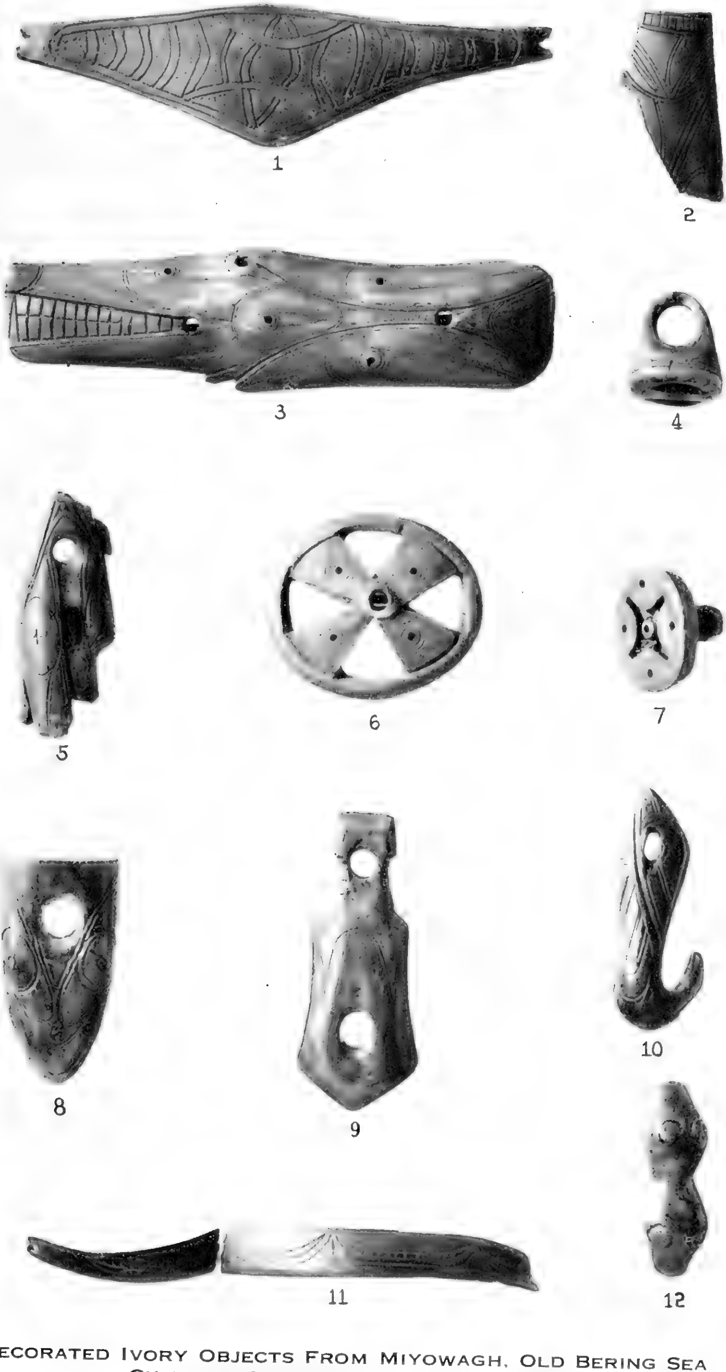
4

5

6

DECORATED IVORY OBJECTS, OLD BERING SEA CULTURE. 1, 2, FROM HILLSIDE SITE; APPROX. ½ NATURAL SIZE. 3-6, FROM LITTLE DIOMEDE ISLAND; 3, 4, NATURAL SIZE; 5, APPROX. 3/5 NATURAL SIZE; 6, APPROX. 4/5 NATURAL SIZE.

(For explanation, see page 397.)



Decorated Ivory Objects From Miyowagh, Old Bering Sea Culture. Approx. 3/5 Natural Size.

(For explanation, see page 397.)

DECORATED IVORY OBJECT FROM MIYOWAGH, OLD BERING SEA CULTURE. 5/6 NATURAL SIZE.

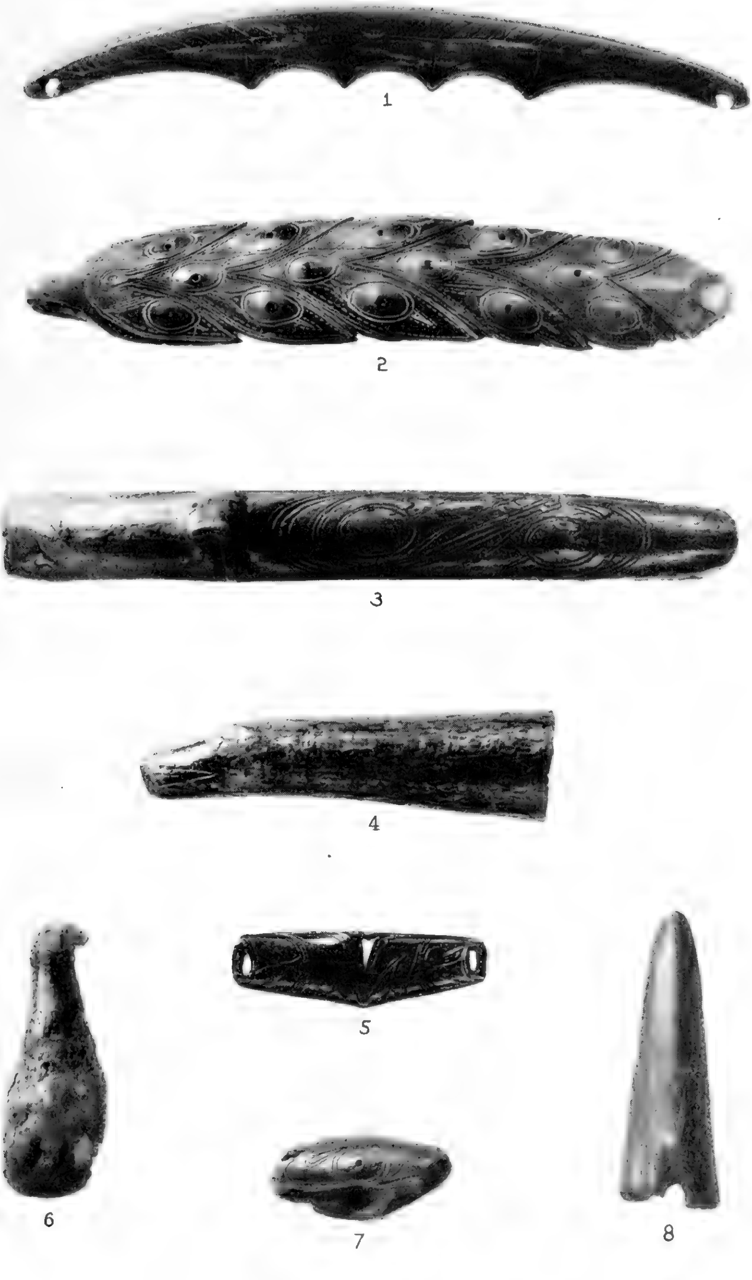
(For explanation, see page 398.)

DECORATED IVORY SCRAPERS, ADZ HANDLE, AND NEEDLE CASES FROM MIYOWAGH, OLD BERING SEA CULTURE. APPROX. 3/5 NATURAL SIZE.

(For explanation, see page 398.)

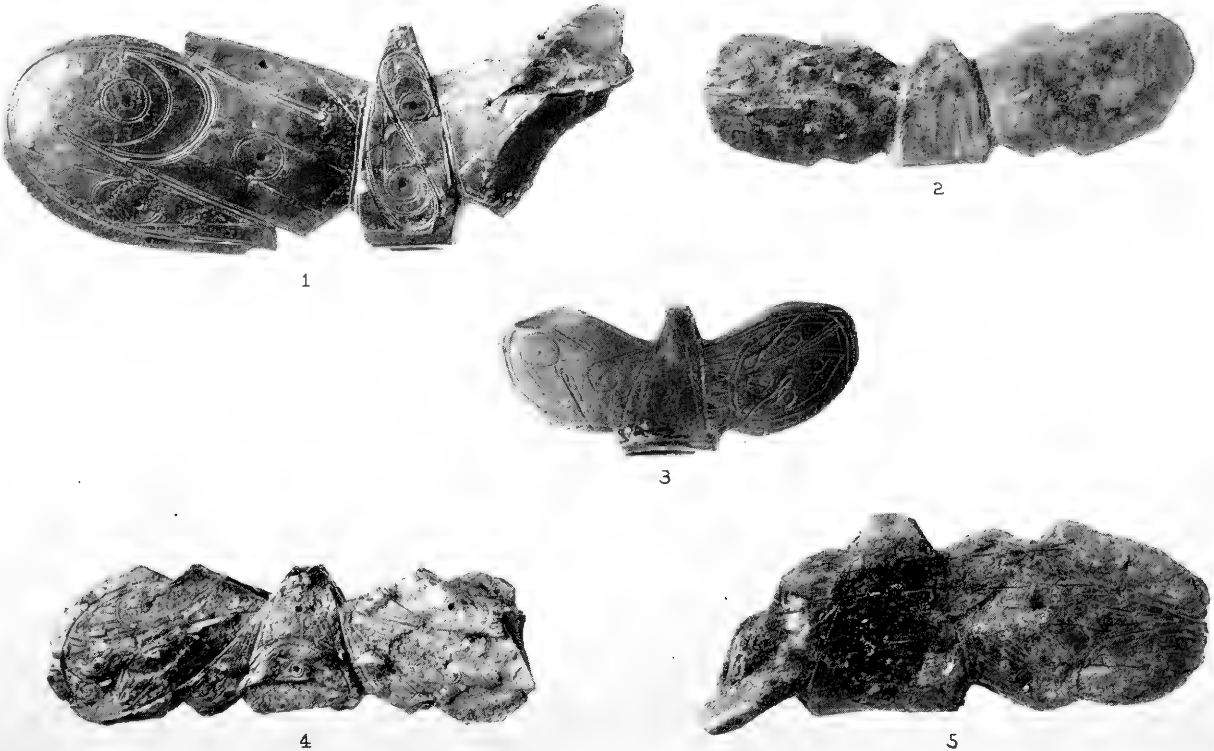
DECORATED IVORY NEEDLE CASES FROM MIYOWAGH, OLD BERING SEA CULTURE. ENLARGED 1/5.

(For explanation, see page 398.)



IVORY OBJECTS FROM MIYOWAGH, OLD BERING SEA CULTURE. APPROX. 3/5 NATURAL SIZE.

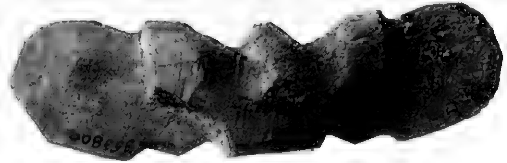
(For explanation, see page 398.)



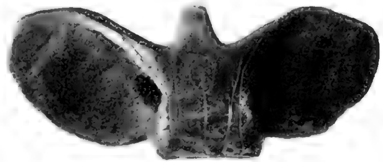
IVORY WINGED OBJECTS FROM MIYOWAGH. OLD BERING SEA CULTURE. APPROX. ½ NATURAL SIZE.

(For explanation, see page 398.)

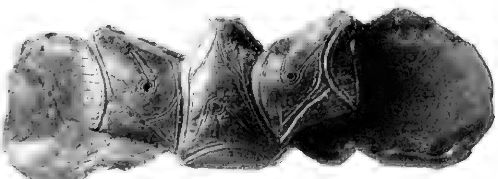
1



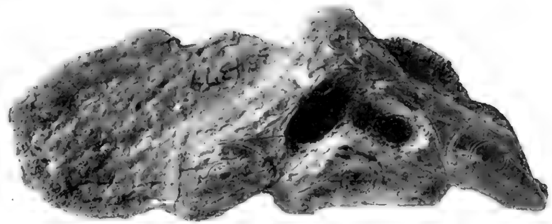
2



3



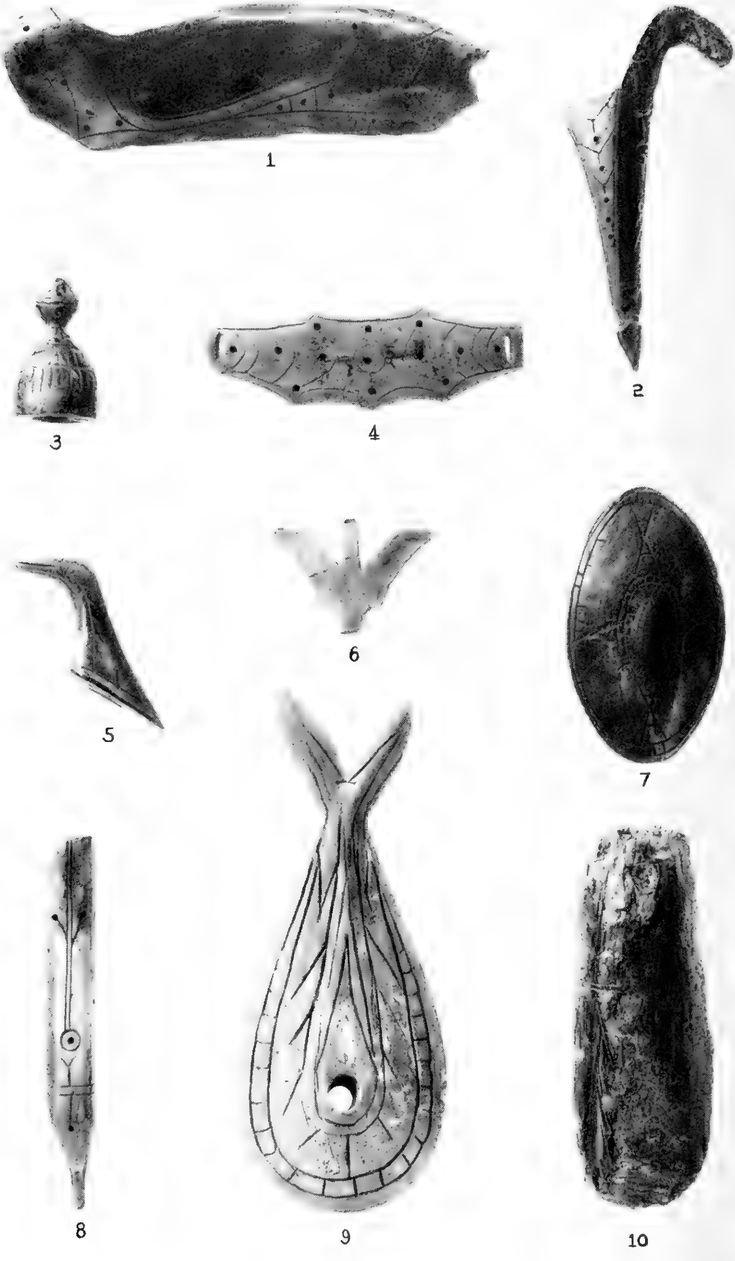
4



5

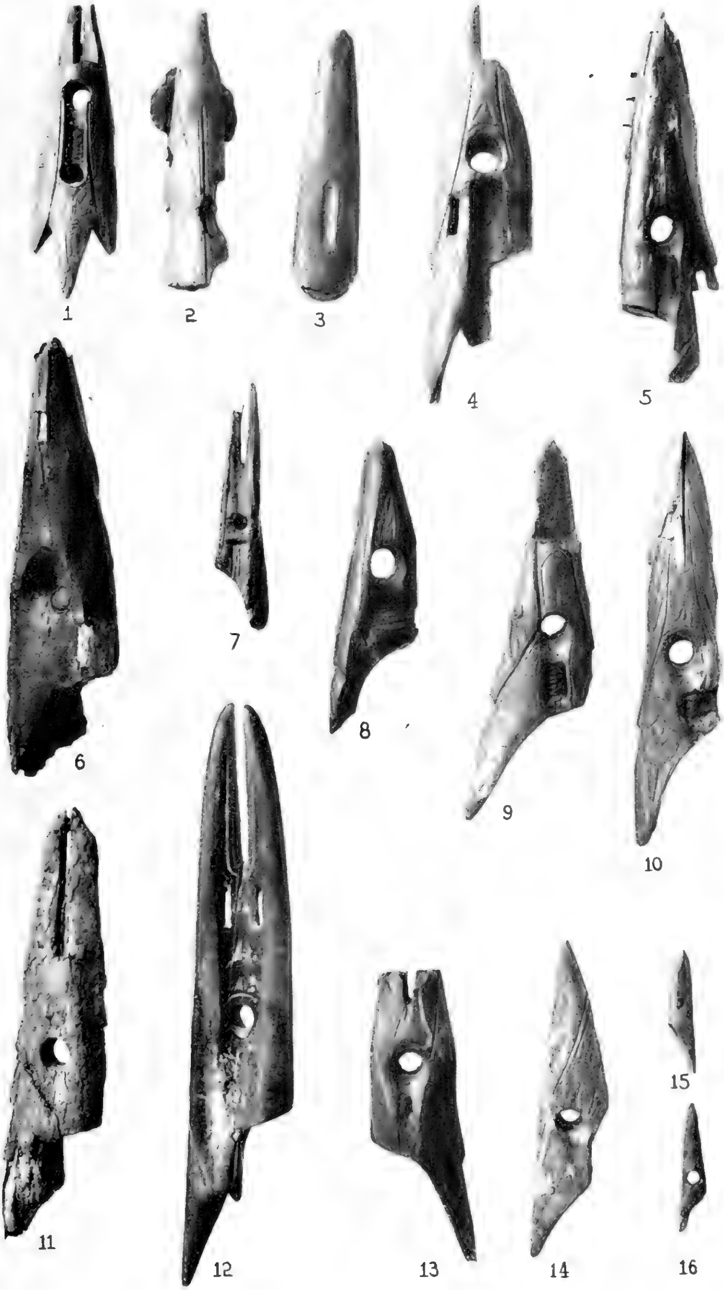
REVERSE OF OBJECTS SHOWN ON PLATE 20. APPROX. ½ NATURAL SIZE.

(For explanation, see page 398.)



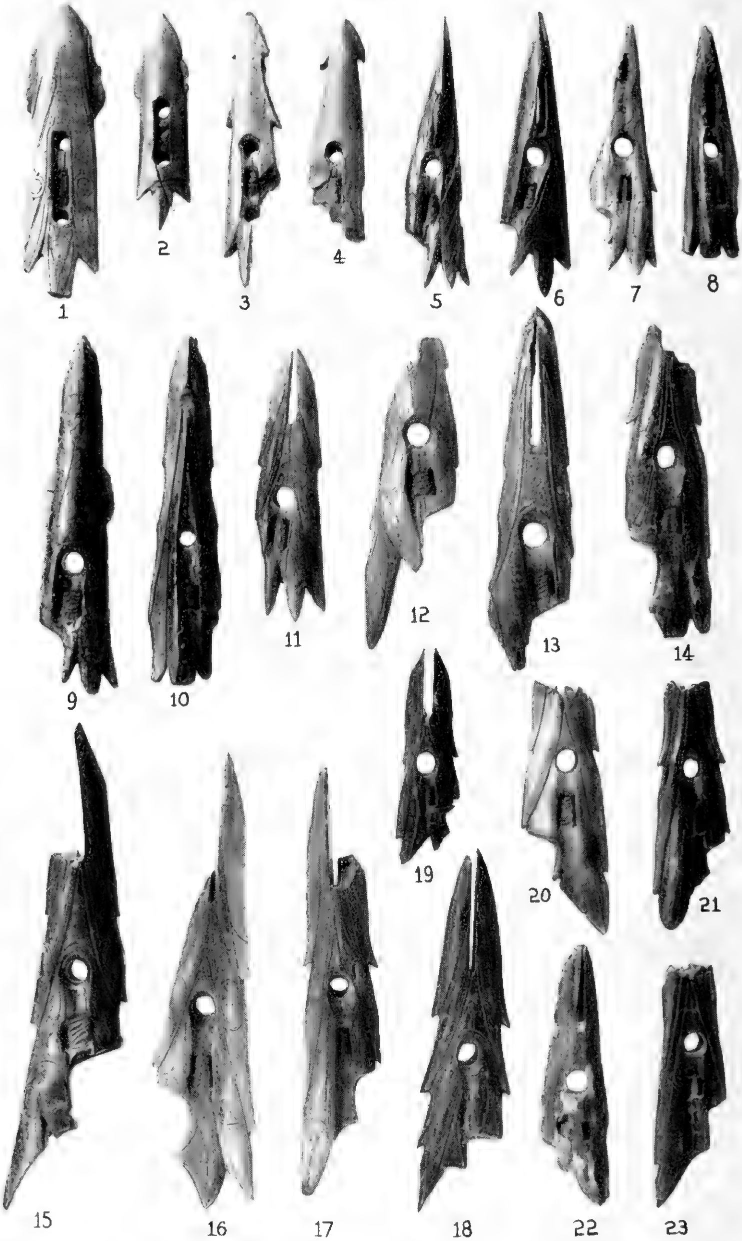
EXAMPLES OF EARLY PUNUK ART FROM MIYOWAGH.
APPROX. ⅔ NATURAL SIZE.

(For explanation, see pages 398-399.)



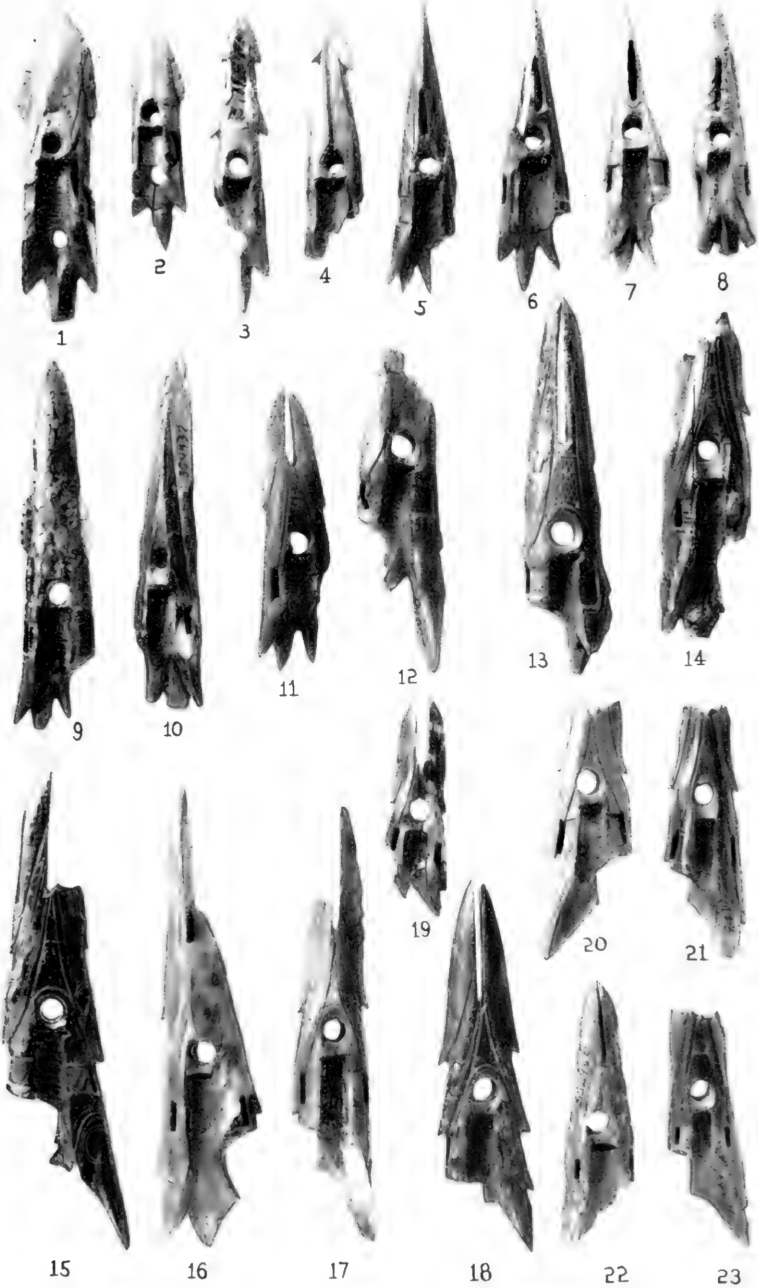
IVORY HARPOON HEADS FROM HILLSIDE SITE, OLD BERING SEA CULTURE.
APPROX. ½ NATURAL SIZE.

(For explanation, see page 399.)



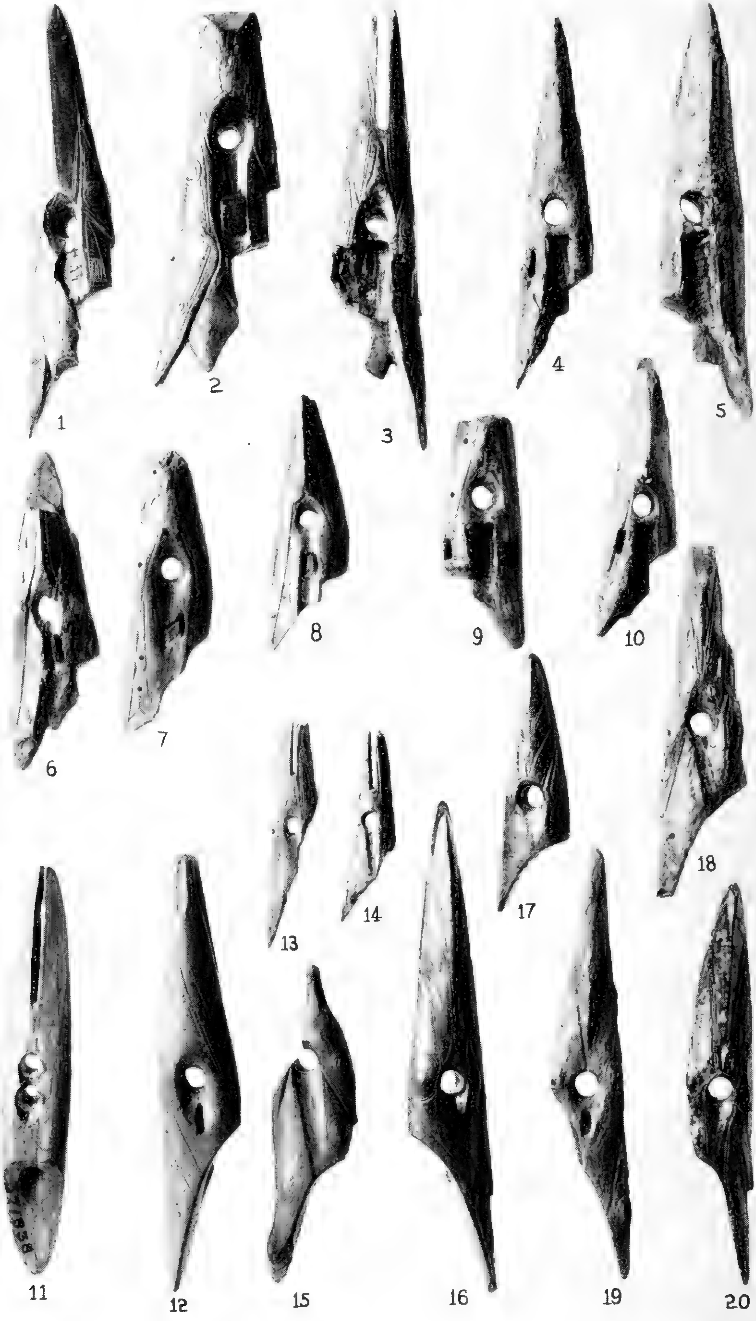
Harpoon Heads from Miyowagh, Old Bering Sea and Early Punuk Cultures. Approx. ½ Natural Size.

(For explanation, see page 399.)



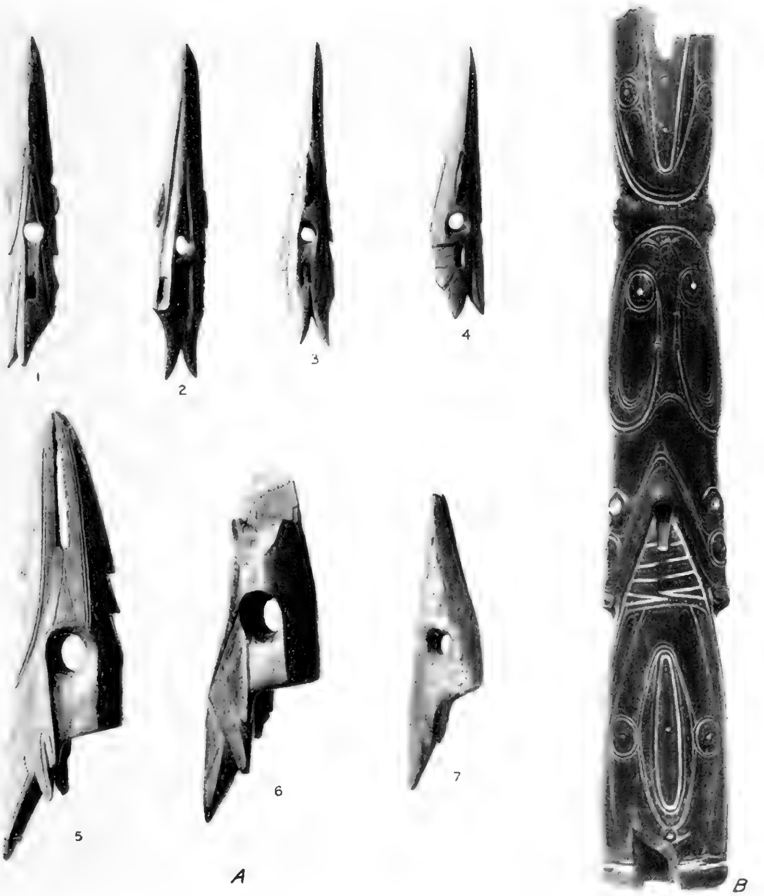
REVERSE OF HARPOON HEADS SHOWN ON PLATE 24.
APPROX. ½ NATURAL SIZE.

(For explanation, see page 400.)



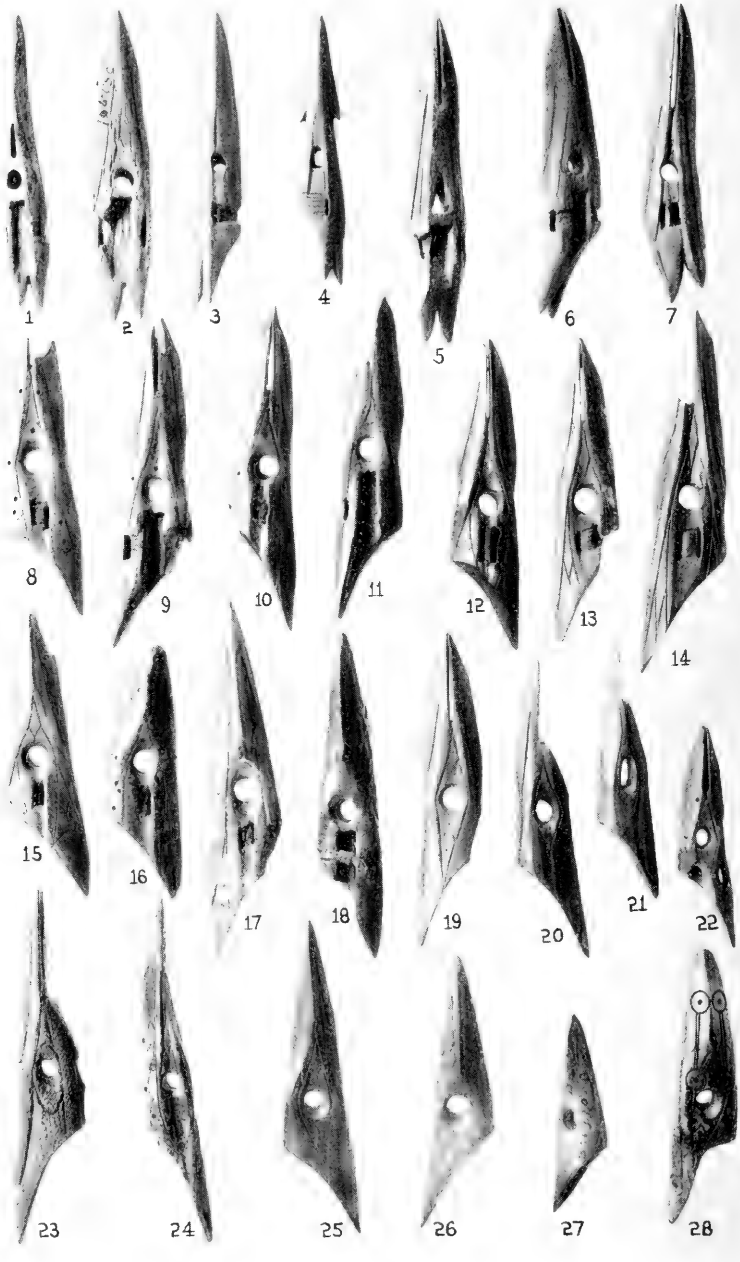
IVORY HARPOON HEADS FROM MIYOWAGH, OLD BERING SEA AND EARLY PUNUK CULTURES. APPROX. ½ NATURAL SIZE.

(For explanation, see page 400.)



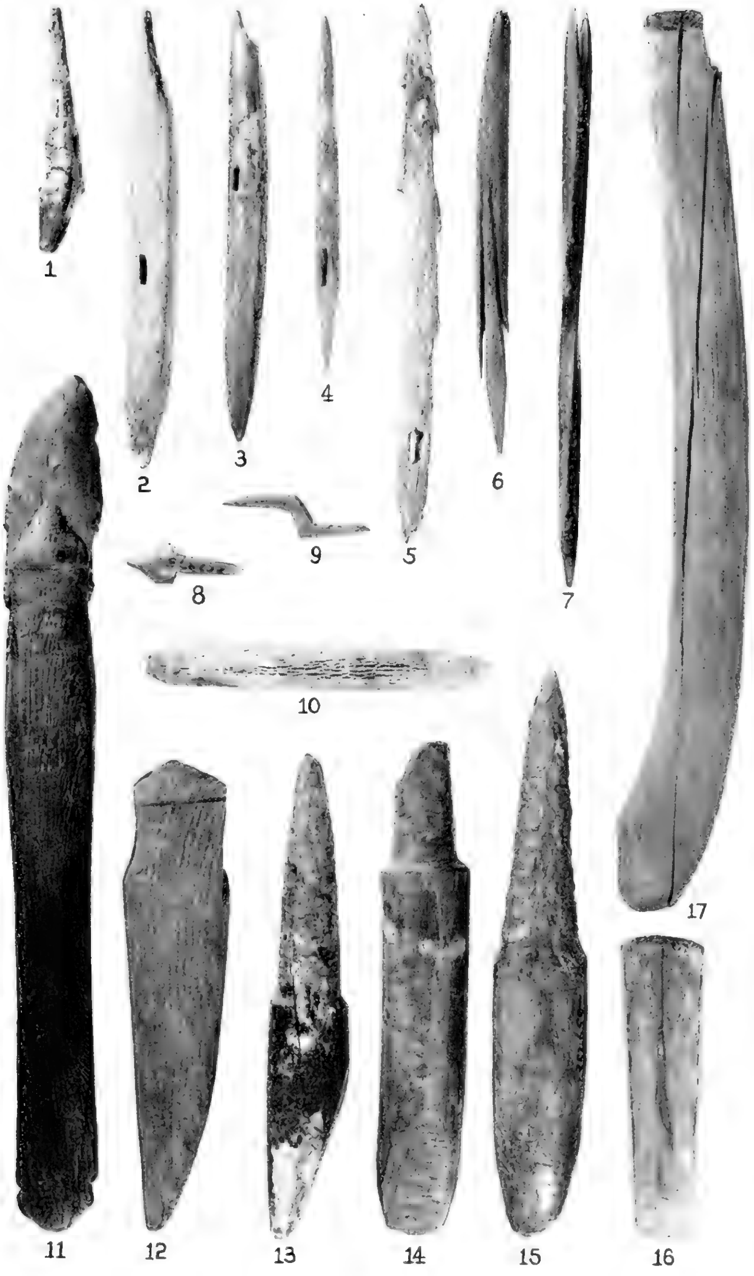
HARPOON HEADS AND SOCKET PIECE, ST. LAWRENCE AND LITTLE DIOMEDE ISLANDS. APPROX. ½ NATURAL SIZE.

(For explanation, see page 400.)



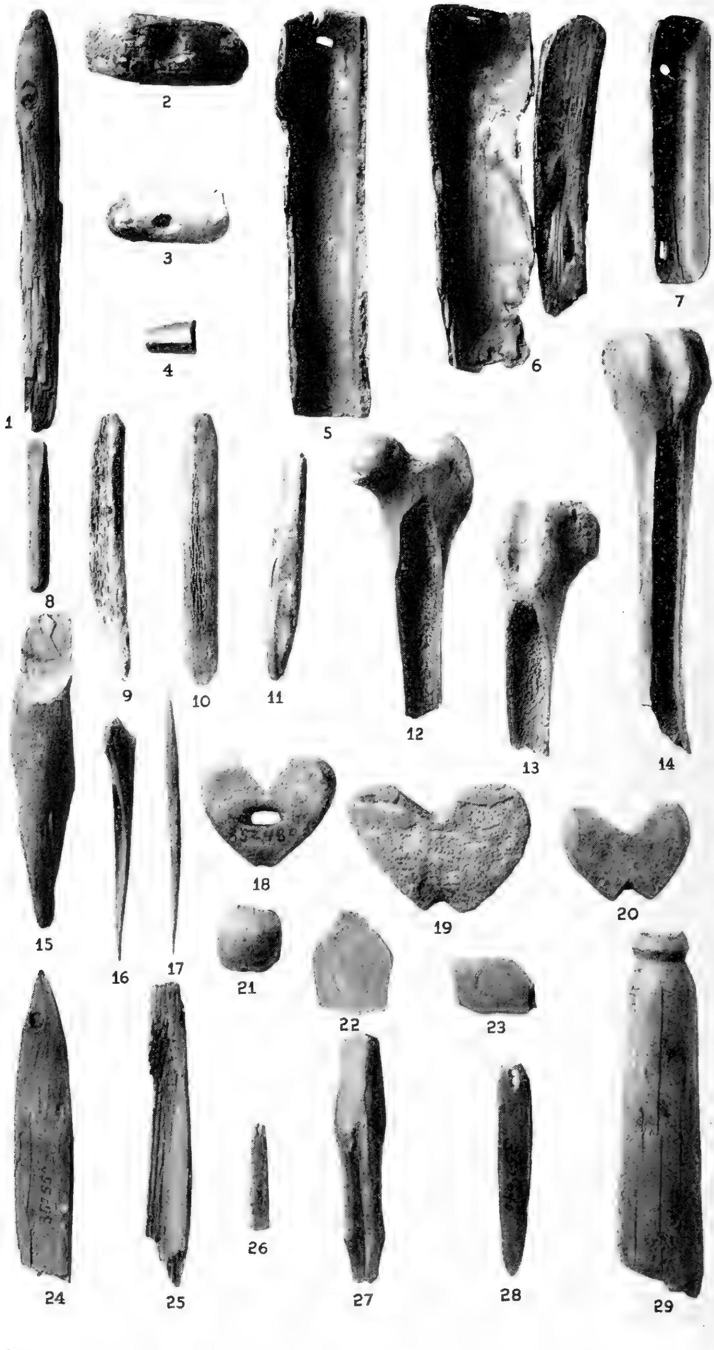
HARPOON HEADS OF EARLY PUNUK TYPE FROM MIYOWAGH.
APPROX. ½ NATURAL SIZE.

(For explanation, see page 401.)



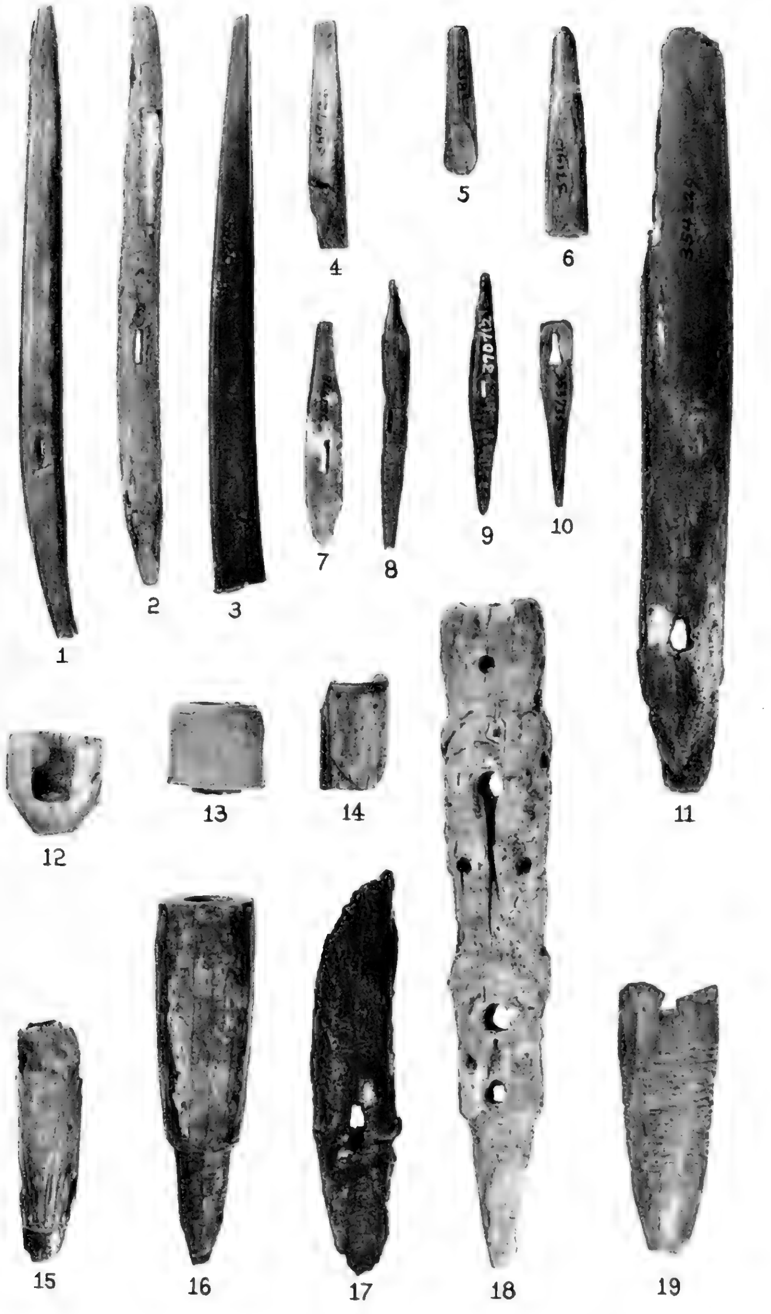
IMPLEMENT TYPES OF OLD BERING SEA CULTURE, FROM THE HILLSIDE SITE. APPROX. ½ NATURAL SIZE.

(For explanation, see page 401.)



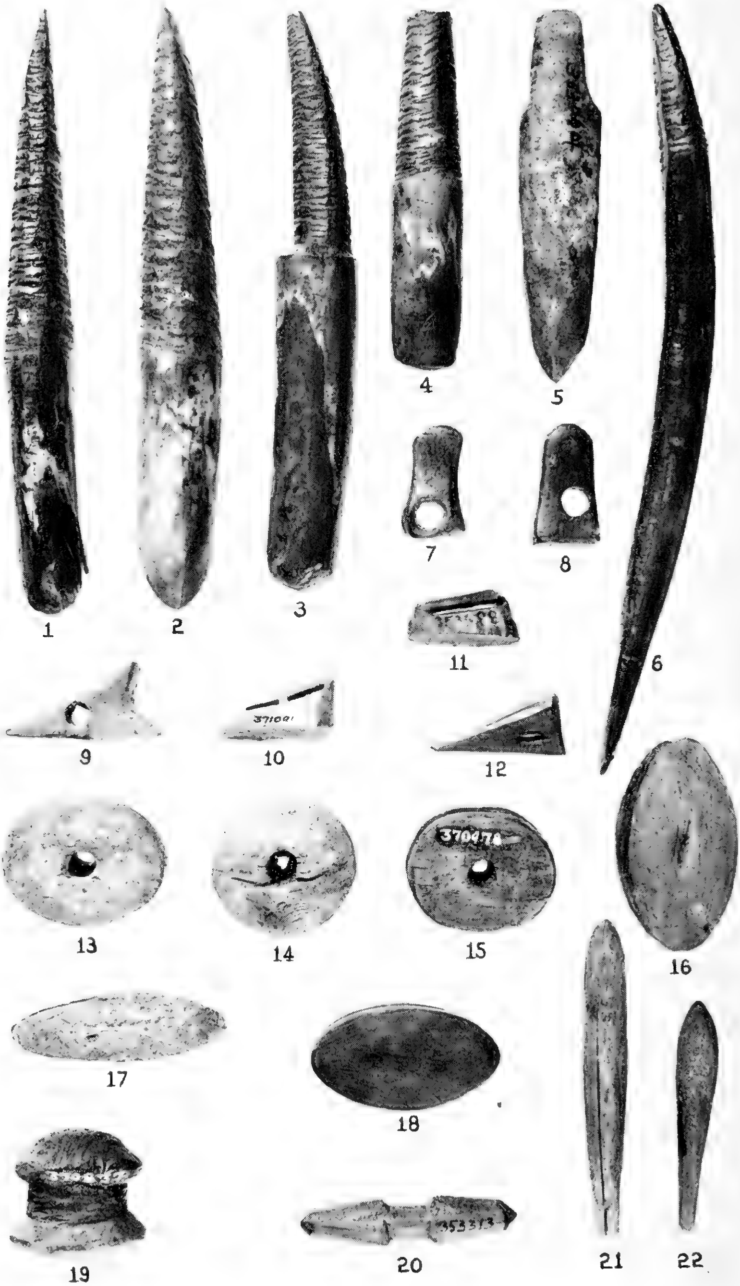
IMPLEMENT TYPES OF OLD BERING SEA CULTURE, FROM THE HILLSIDE SITE. APPROX. 2/5 NATURAL SIZE.

(For explanation, see page 402.)



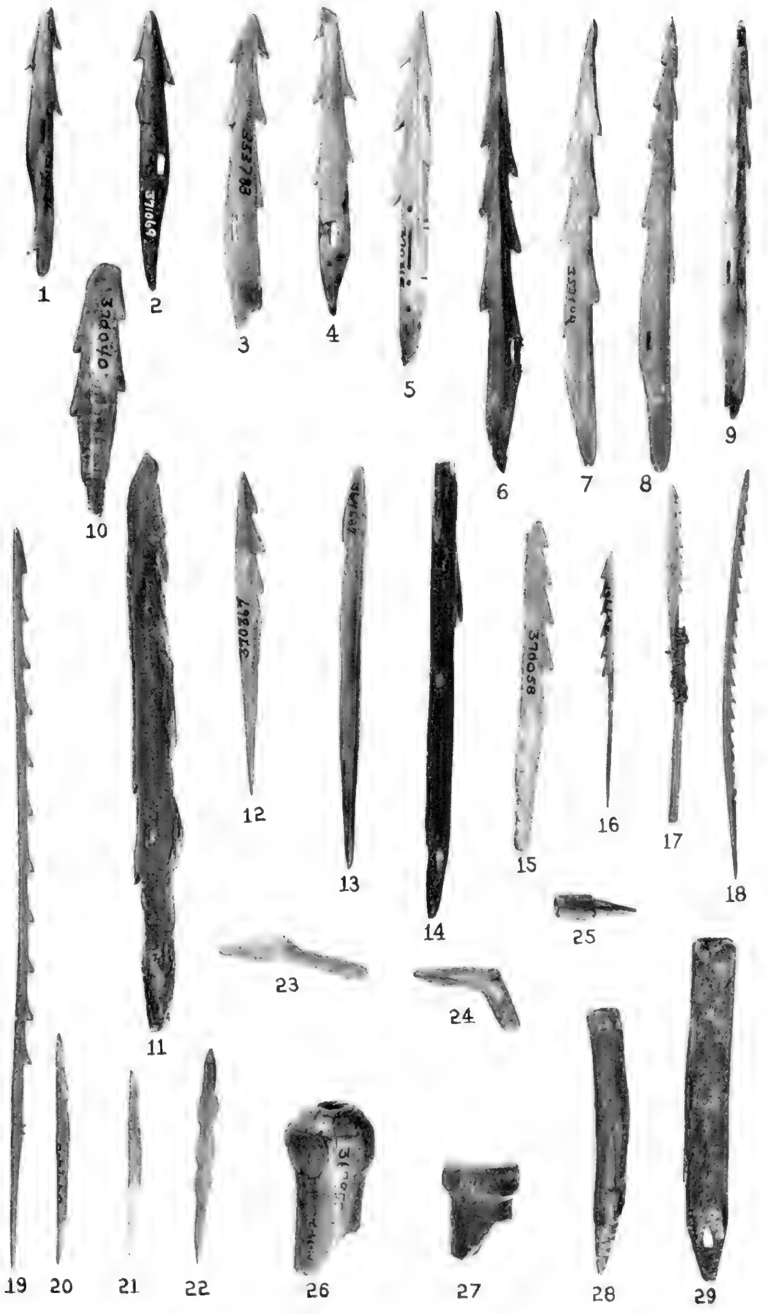
HARPOON PARTS, OLD BERING SEA CULTURE, FROM MIYOWAGH.
APPROX. ½ NATURAL SIZE.

(For explanation, see pages 402-403.)



HARPOON PARTS, OLD BERING SEA CULTURE, FROM MIYOWAGH.
APPROX. ½ NATURAL SIZE.

(For explanation, see page 403.)

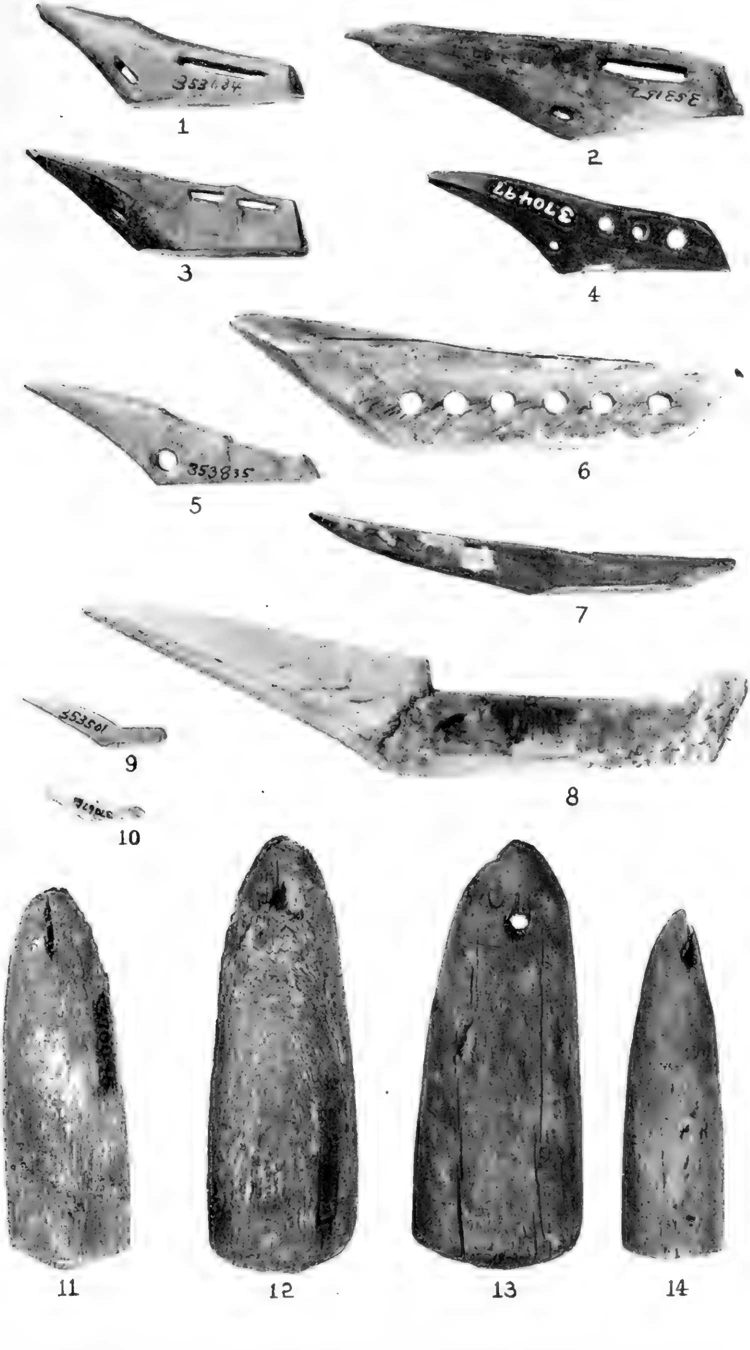


Dart Points, Etc., Old Bering Sea and Punuk Cultures, From Miyowagh. Approx. ½ Natural Size.

(For explanation, see pages 403-404.)

BONE AND IVORY ARROWHEADS, OLD BERING SEA AND PUNUK CULTURES, FROM MIYOWAGH. APPROX. ½ NATURAL SIZE.

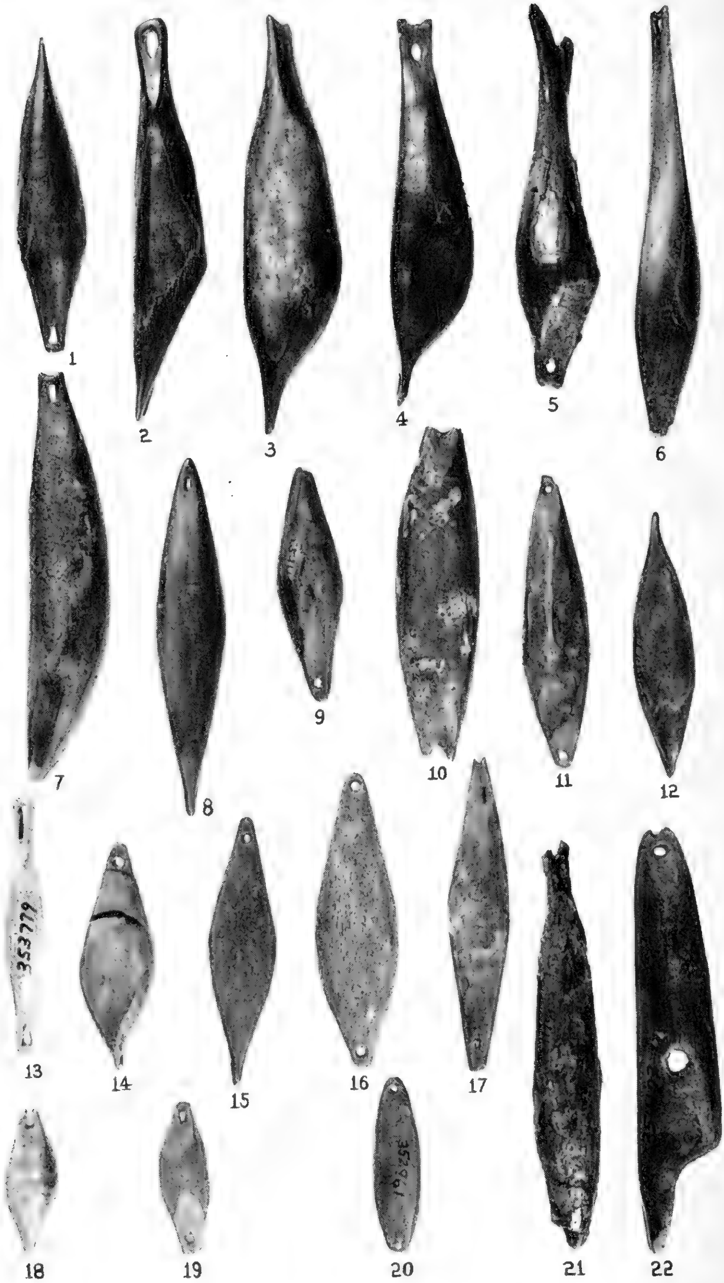
(For explanation, see page 404.)



1 2 3 4 5 6 7 8 9 10 11 12 13 14

MEAT HOOKS AND WOUND PLUGS, OLD BERING SEA AND PUNUK CULTURES, FROM MIYOWAGH, APPROX. ½ NATURAL SIZE.

(For explanation, see page 404.)

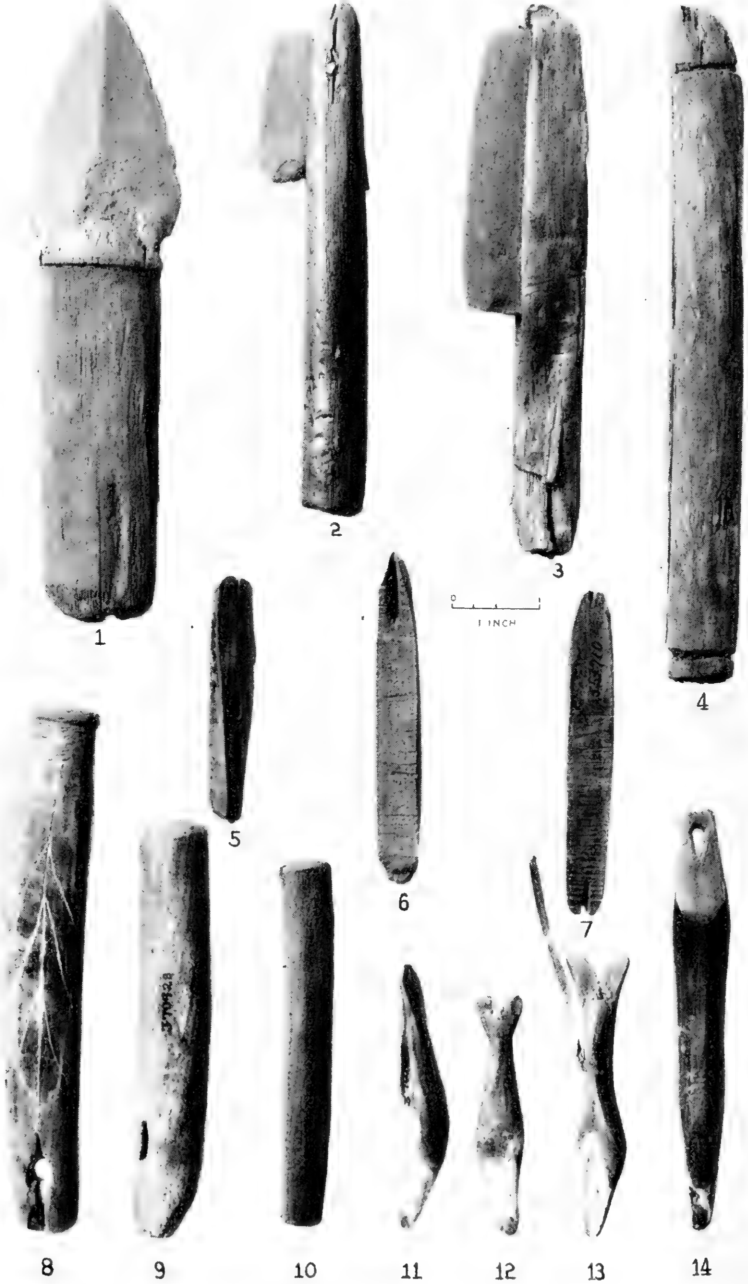


FISHLINE SINKERS, OLD BERING SEA AND PUNUK CULTURES, FROM MIYOWAGH. APPROX. ½ NATURAL SIZE.

(For explanation, see page 405.)

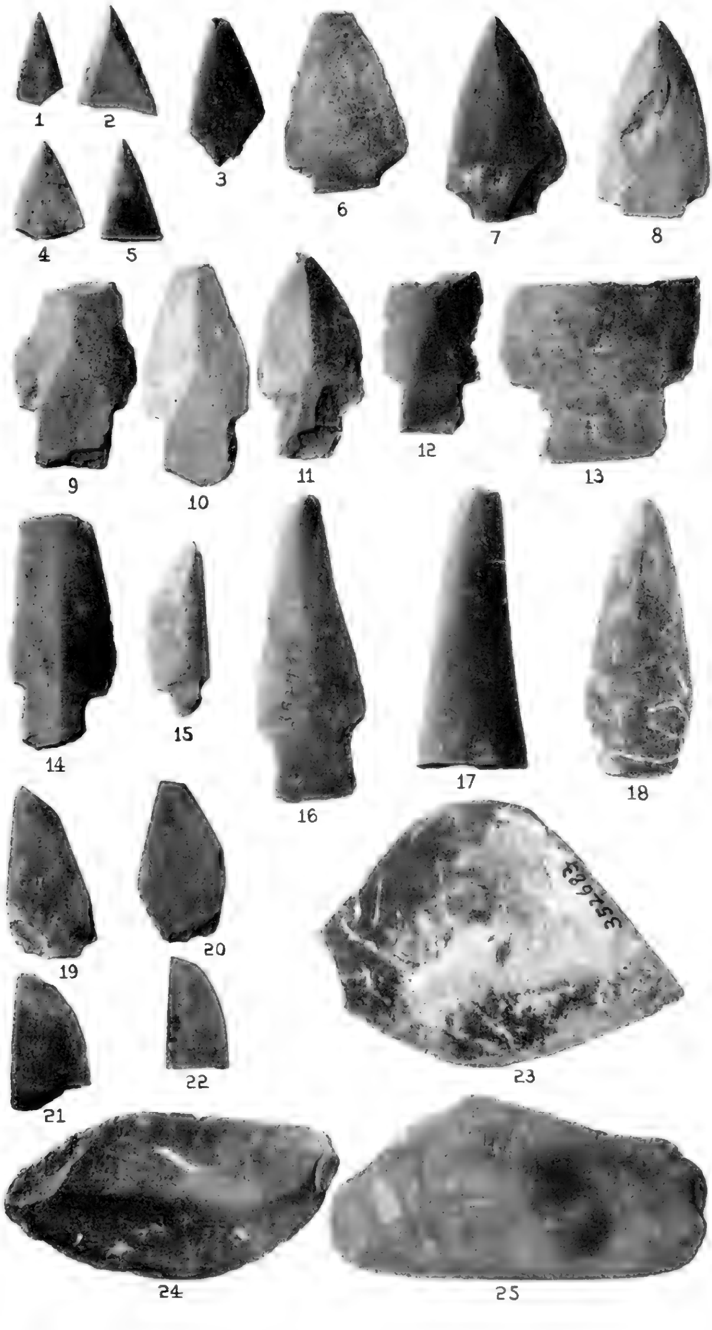
THROWING BOARDS, ICE CREEPERS, ETC., OLD BERING SEA CULTURE, FROM MIYOWAGH. APPROX. ½ NATURAL SIZE.

(For explanation, see page 405.)



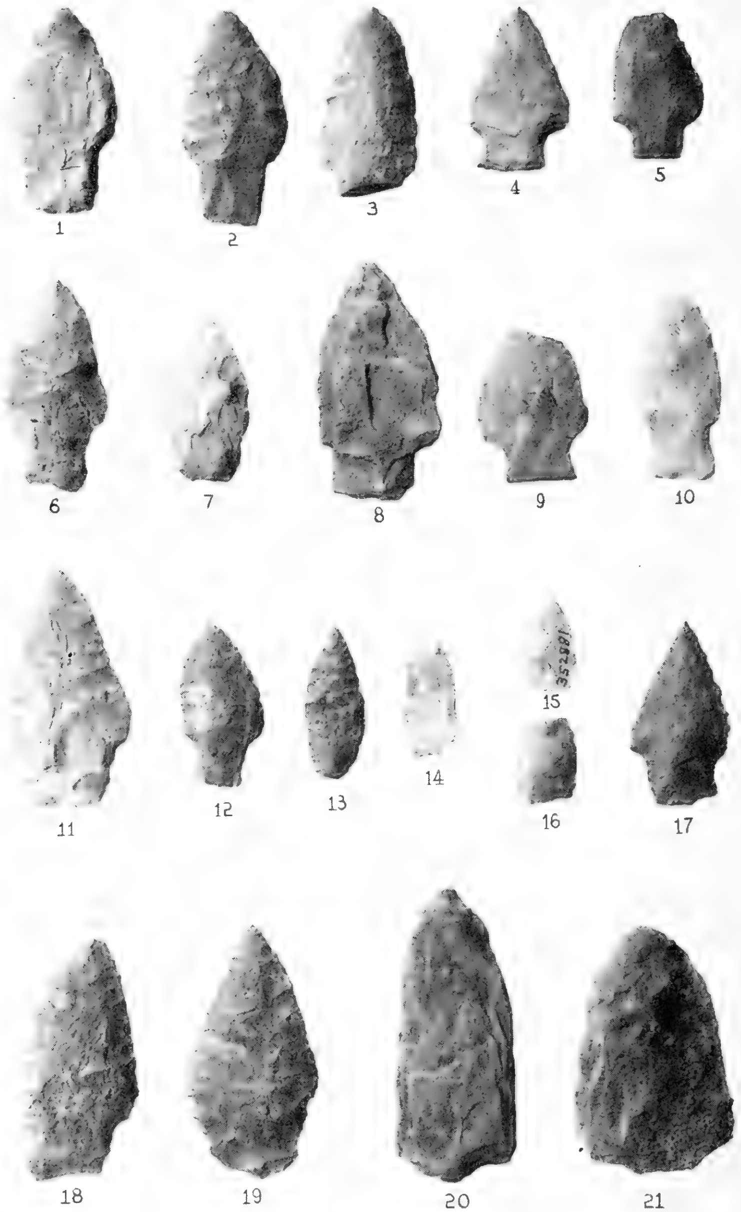
KNIVES AND KNIFE SHARPENERS, OLD BERING SEA AND PUNUK CULTURES, MIYOWAGH

(For explanation, see pages 405-406.)



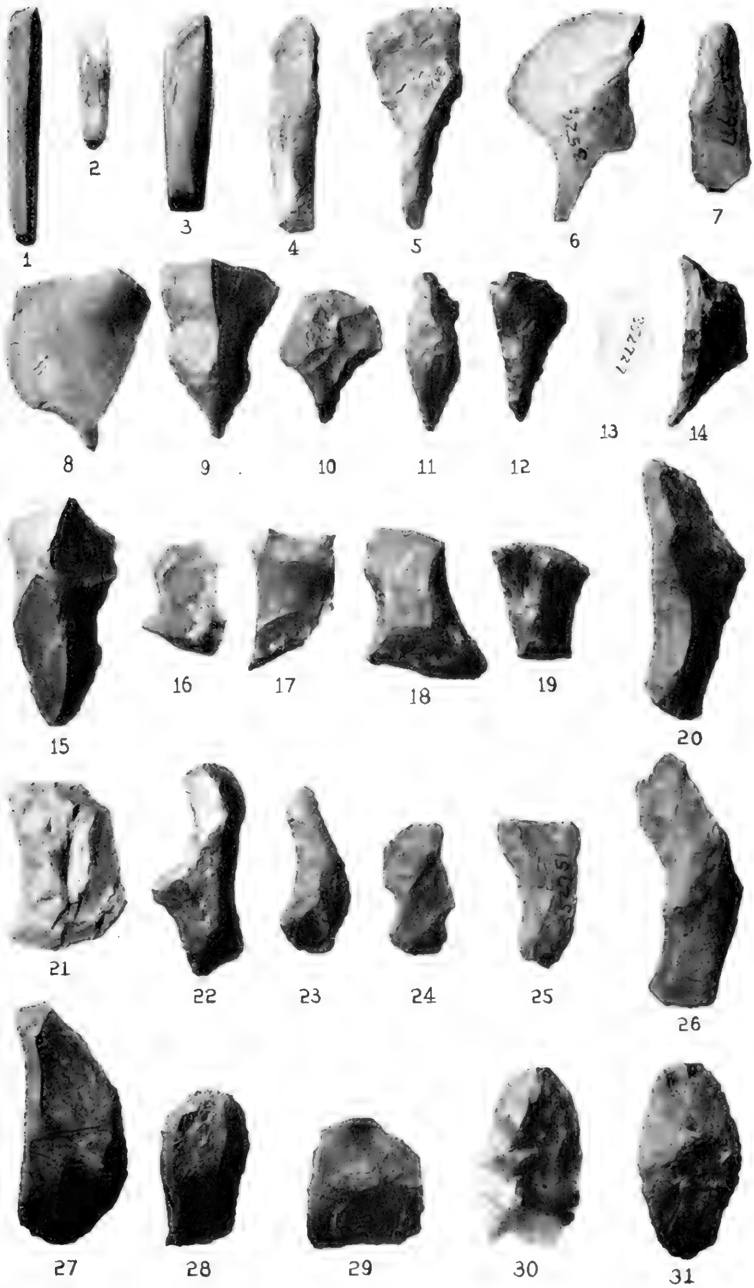
IMPLEMENTS OF RUBBED SLATE FROM HILLSIDE SITE, OLD BERING SEA CULTURE. APPROX. ½ NATURAL SIZE.

(For explanation, see page 406.)



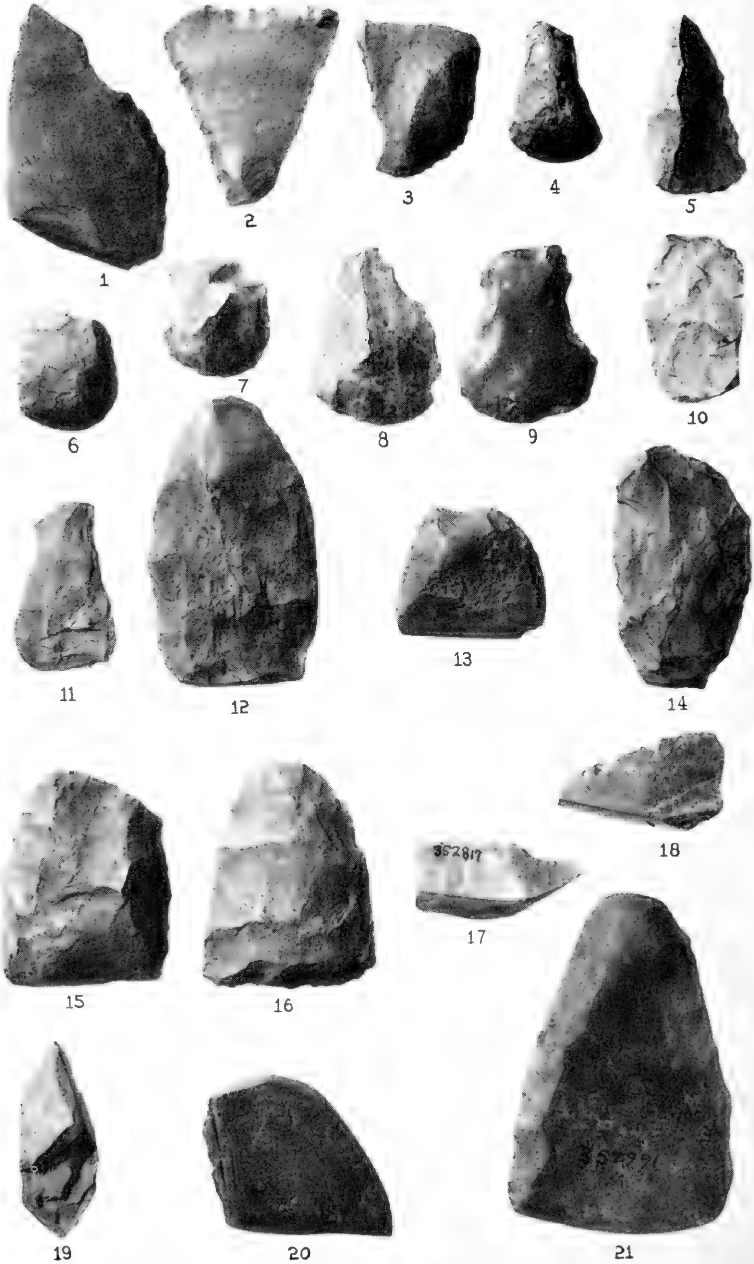
IMPLEMENTS OF CHIPPED STONE FROM THE HILLSIDE SITE, OLD BERING SEA CULTURE. ½ NATURAL SIZE.

(For explanation, see pages 406-407.)



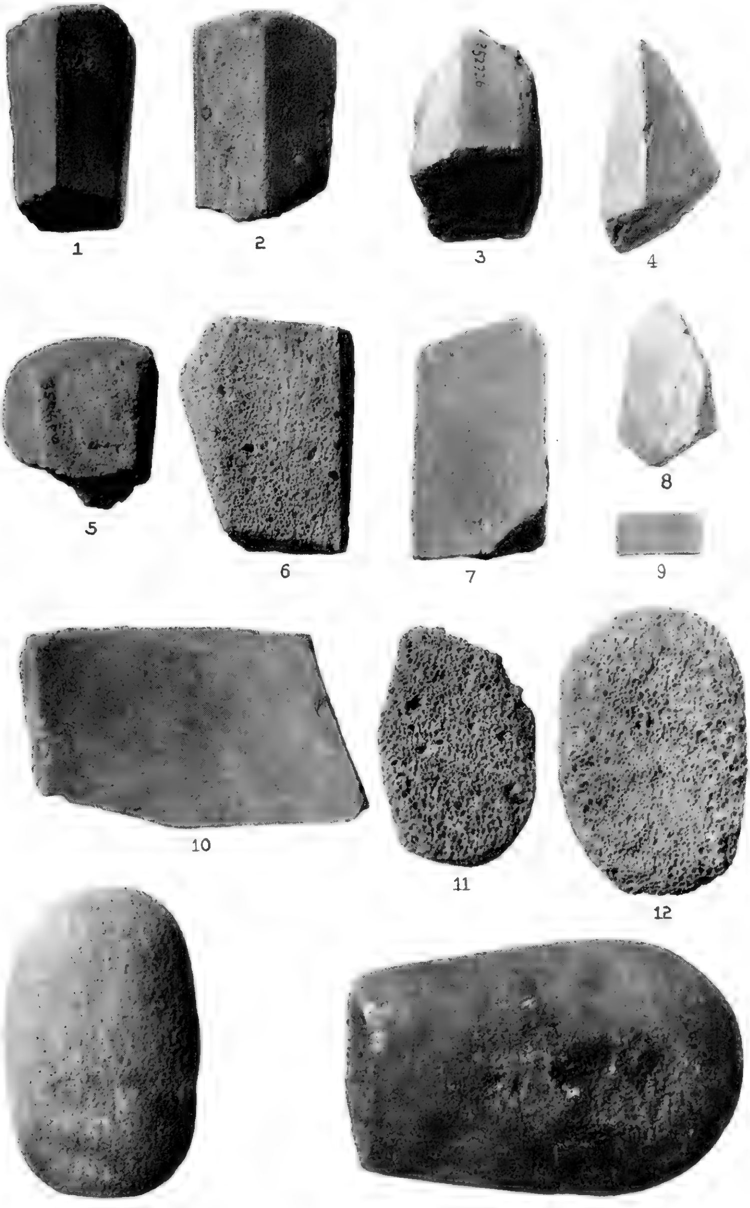
DRILL POINTS, GRAVERS, AND SIDE SCRAPERS FROM HILLSIDE SITE, OLD BERING SEA CULTURE. APPROX. ½ NATURAL SIZE.

(For explanation, see page 407.)



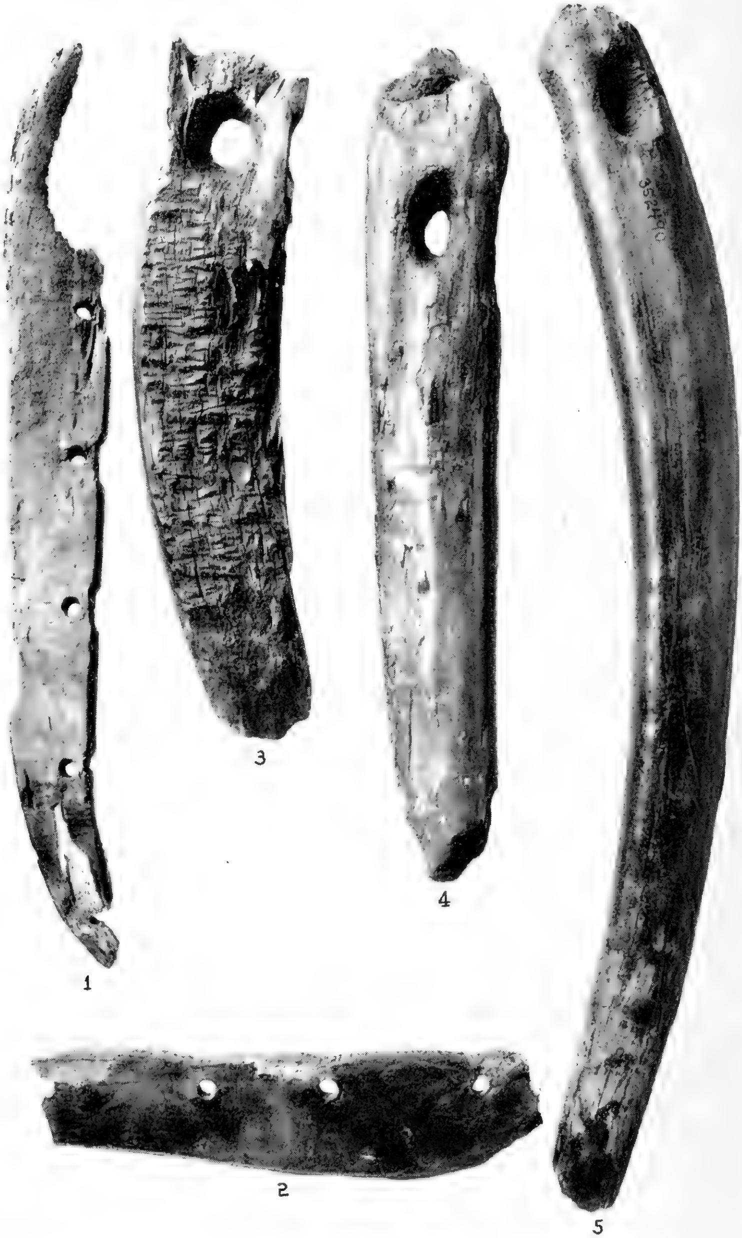
SIDE AND END SCRAPERS, RUBBING TOOLS, ETC., FROM HILLSIDE SITE, OLD BERING SEA CULTURE. ½ NATURAL SIZE.

(For explanation, see page 408.)



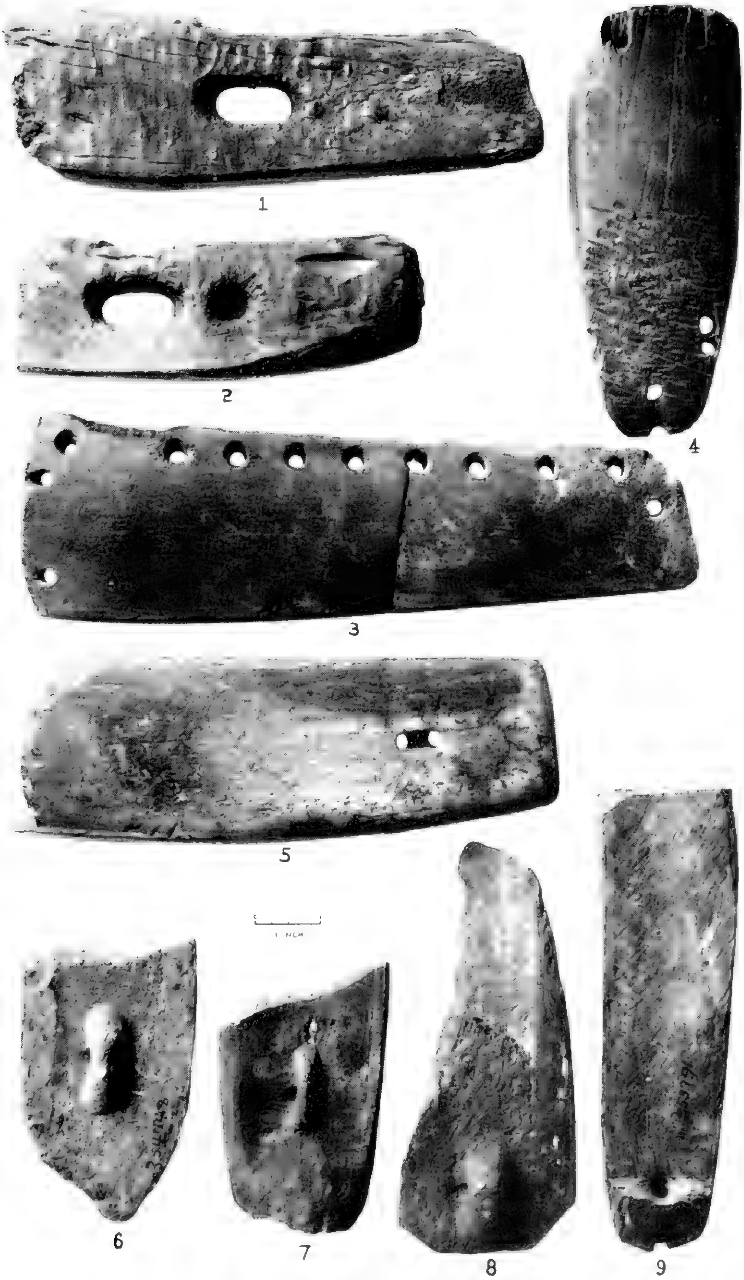
RUBBING STONES, WHETSTONES, ETC., FROM HILLSIDE SITE, OLD BERING SEA CULTURE. APPROX. ⅓ NATURAL SIZE.

(For explanation, see page 408.)



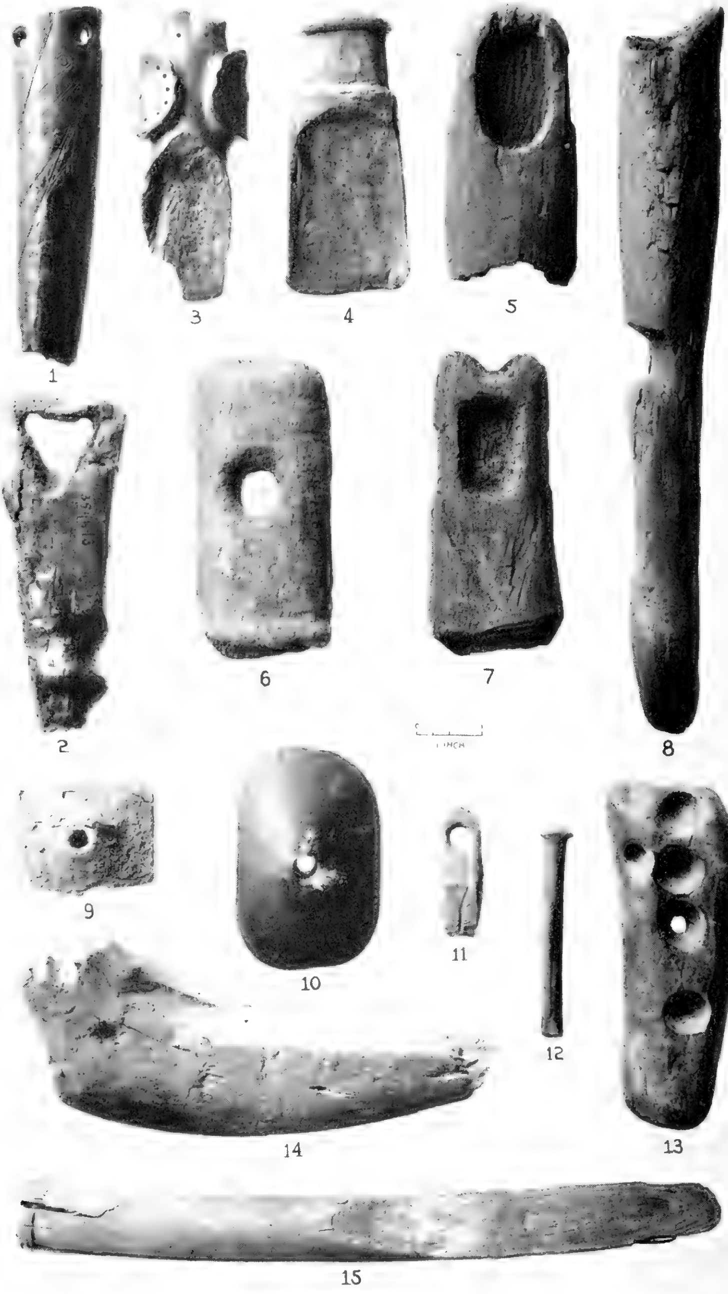
IVORY SLEDGE RUNNERS FROM HILLSIDE SITE, OLD BERING SEA CULTURE. APPROX. ¼ NATURAL SIZE.

(For explanation, see page 408.)



IVORY SLEDGE RUNNERS AND SHOES, MIYOWAGH, OLD BERING SEA CULTURE

(For explanation, see page 409.)

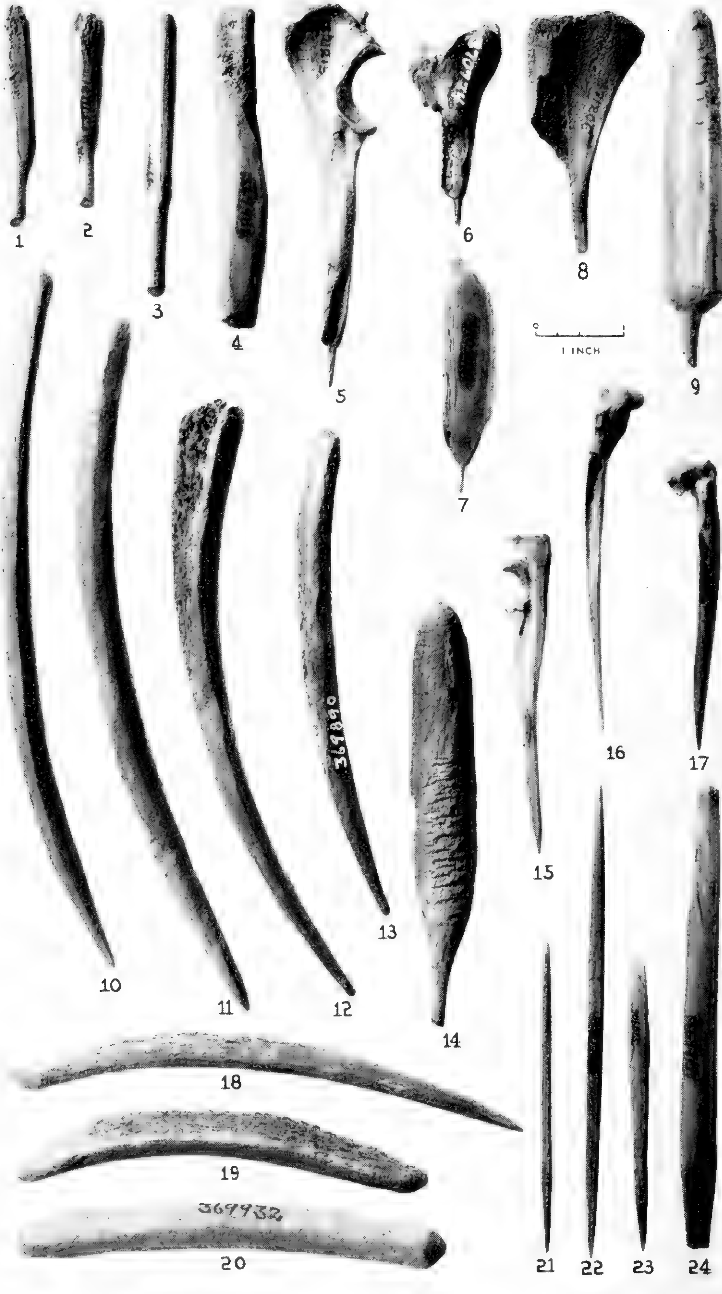


IMPLEMENT TYPES OF THE OLD BERING SEA CULTURE, MIYOWAGH

(For explanation, see page 409.)

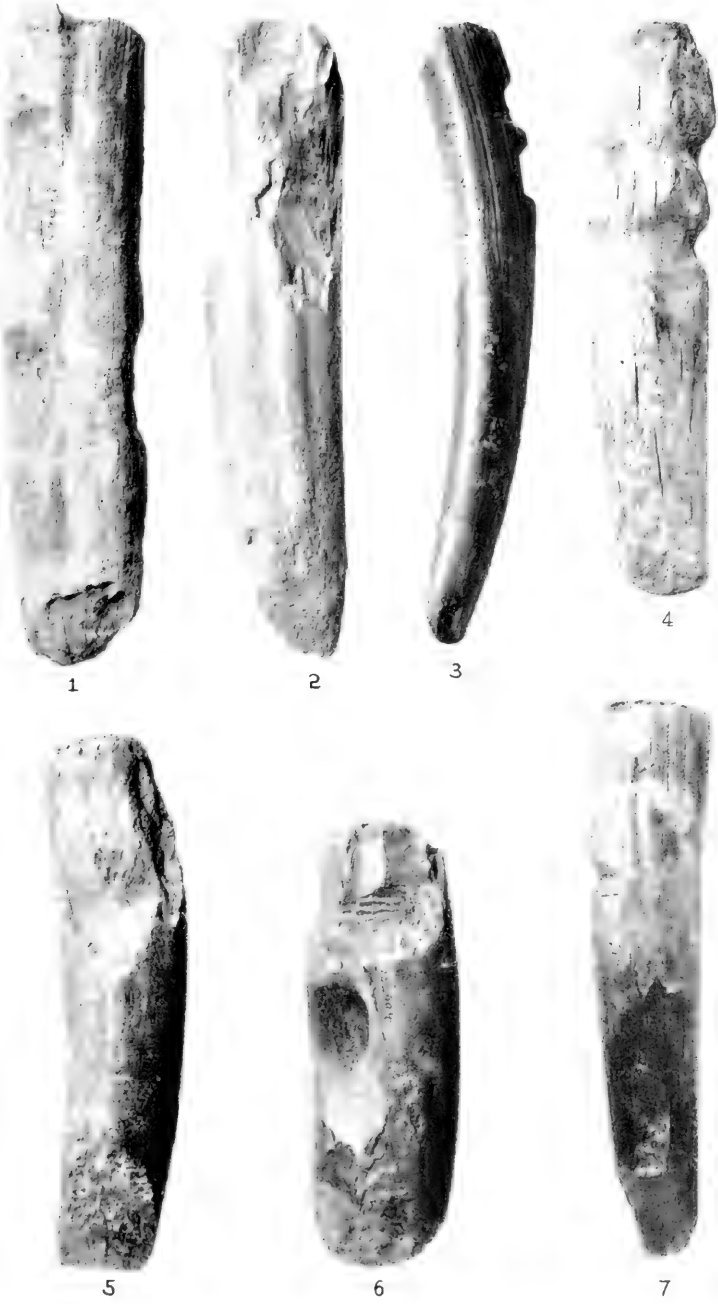
IMPLEMENT TYPES OF OLD BERING SEA CULTURE, MIYOWAGH. APPROX. ⅓ NATURAL SIZE.

(For explanation, see page 409.)



IMPLEMENT TYPES OF OLD BERING SEA CULTURE, MIYOWAGH

(For explanation, see page 410.)

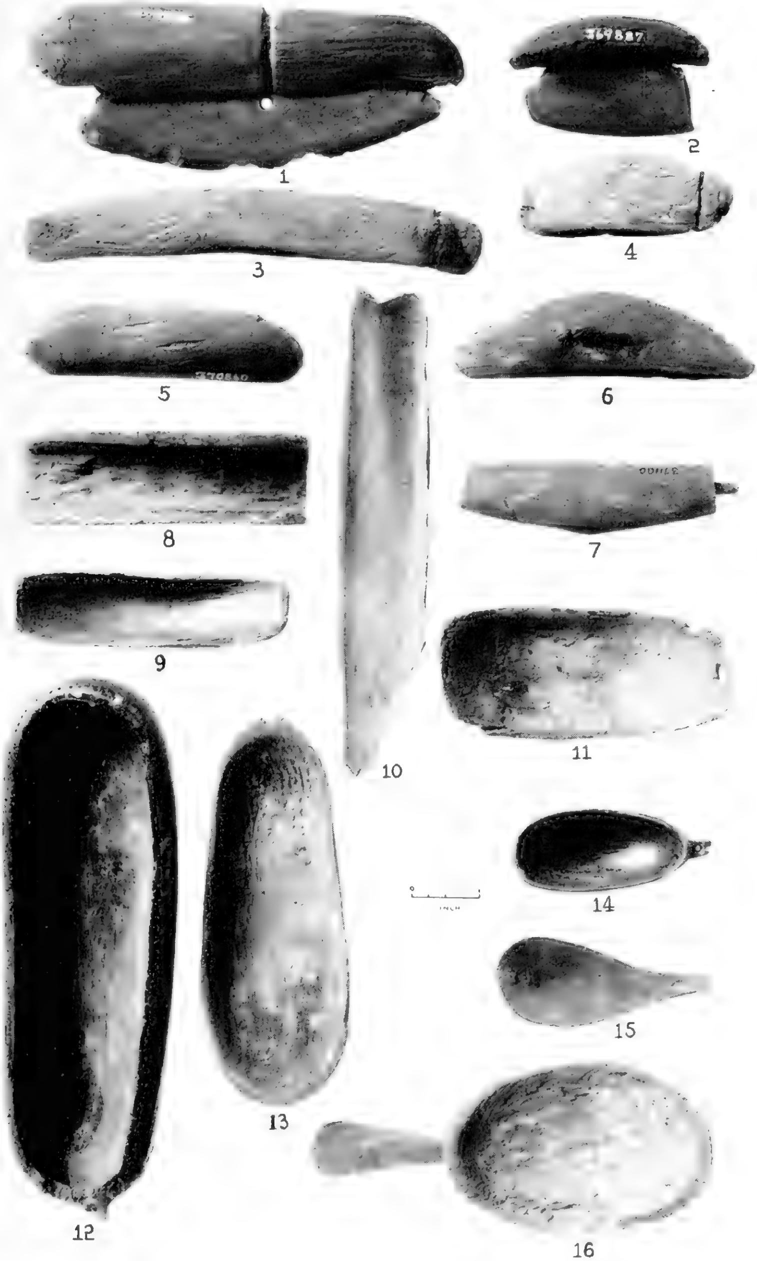


IVORY PICKS, OLD BERING SEA CULTURE, HILLSIDE SITE
APPROX. ⅓ NATURAL SIZE.

(For explanation, see page 410.)

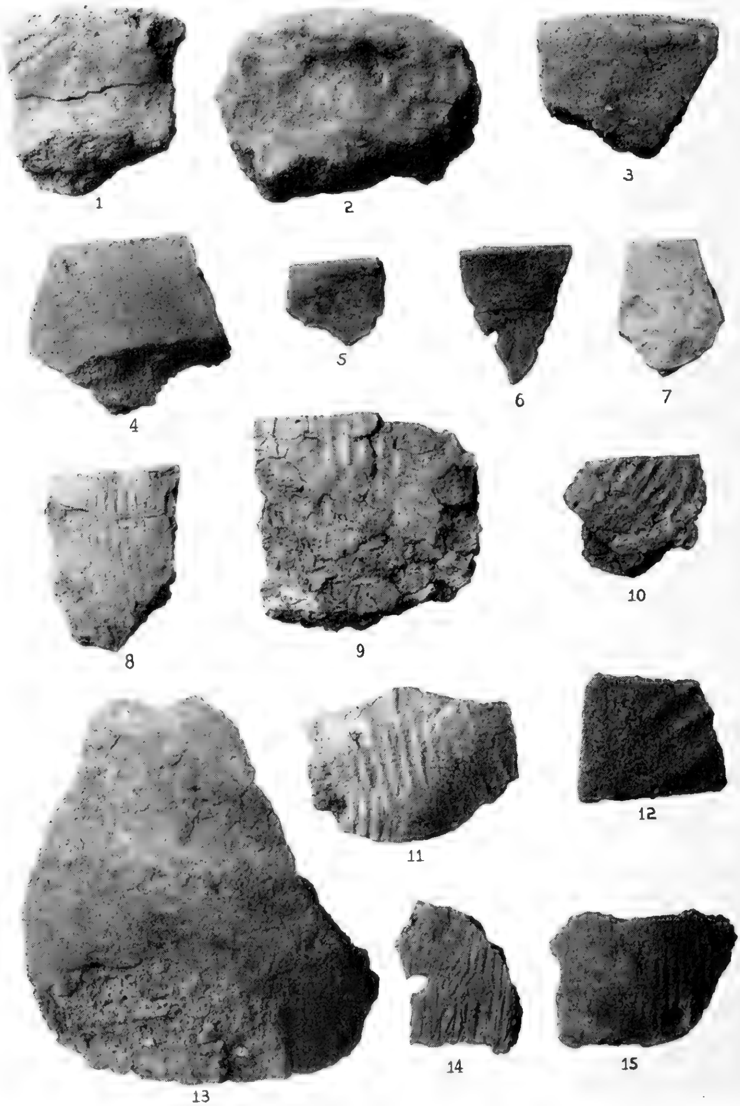
Implement Types, Old Bering Sea Culture, Miyowagh

(For explanation, see page 410.)



IMPLEMENT TYPES, OLD BERING SEA CULTURE, MIYOWAGH

(For explanation, see page 411.)



POTSHERDS, OLD BERING SEA CULTURE, HILLSIDE SITE.
APPROX. ⅓ NATURAL SIZE.

(For explanation, see page 411.)

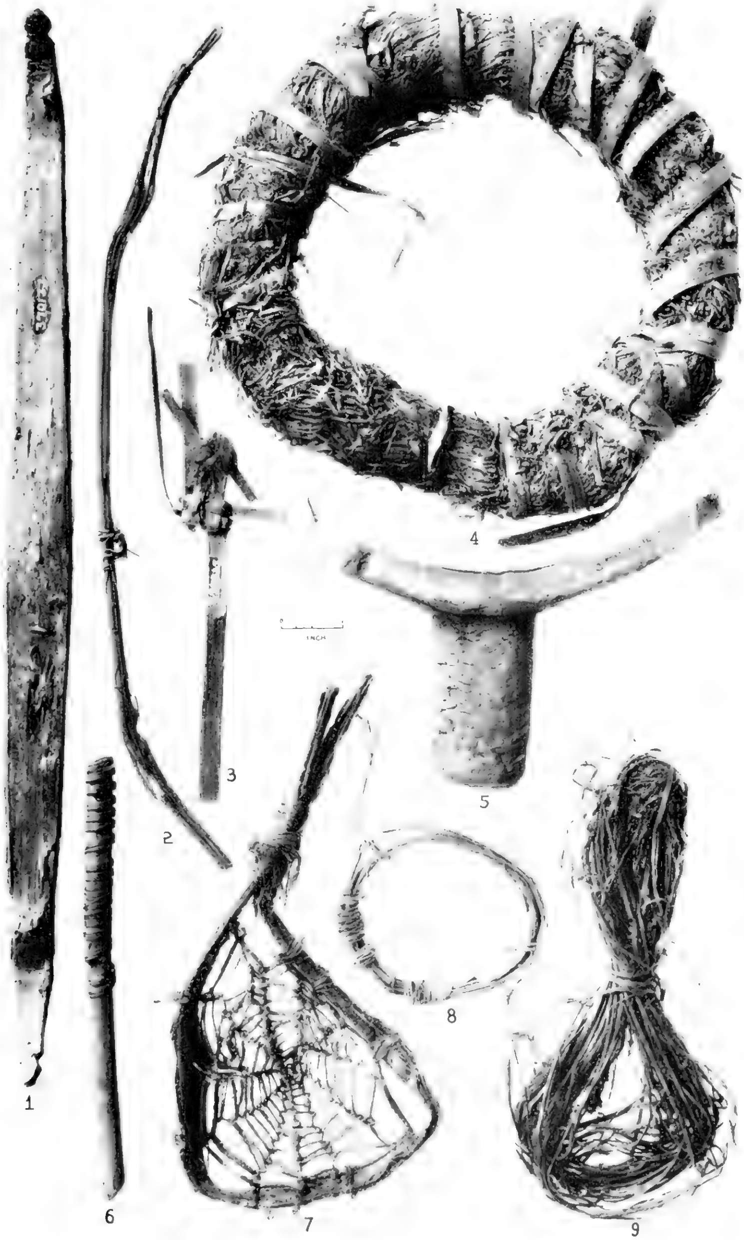
1. BALEEN VESSEL, OLD BERING SEA CULTURE, HILLSIDE SITE. ¾ NATURAL SIZE.

2. POTTERY LAMP, KOWIERUK, SEWARD PENINSULA. ⅓ NATURAL SIZE.

(For explanation, see page 411.)

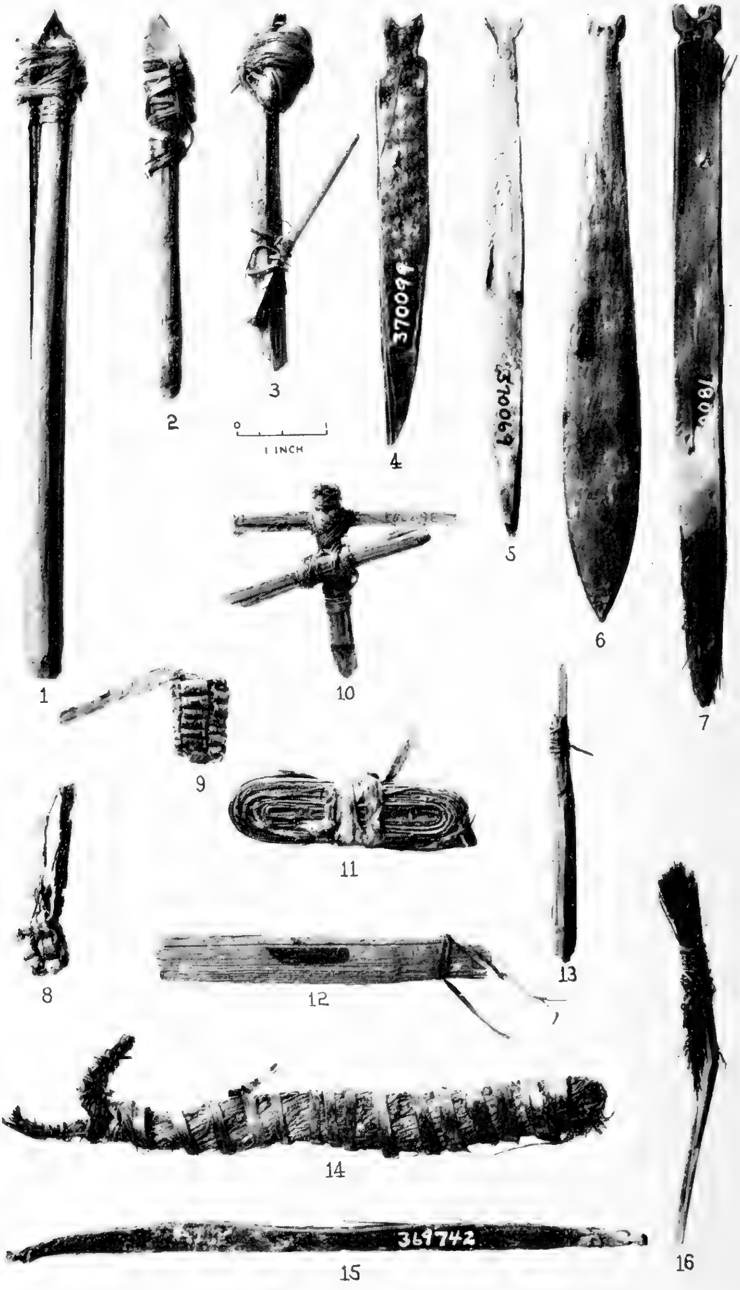
WOODEN BASES FOR BALEEN VESSELS, ETC., OLD BERING SEA CULTURE, HILLSIDE SITE. APPROX. 1/3 NATURAL SIZE.

(For explanation, see pages 411-412)



IMPLEMENT TYPES OF OLD BERING SEA CULTURE, MIYOWAGH

(For explanation, see page 412.)

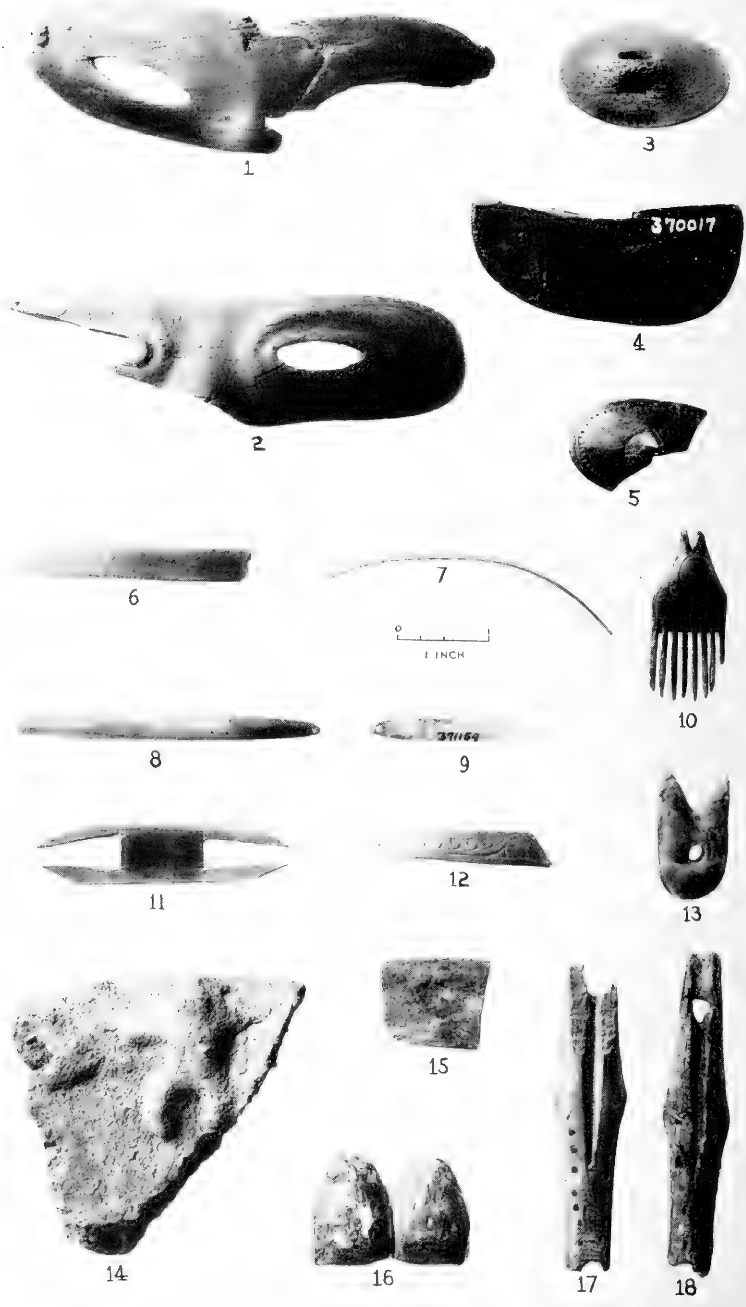


BALEEN OBJECTS, ETC., OLD BERING SEA CULTURE, MIYOWAGH

(For explanation, see page 412.)

Wooden Objects and Fragments, Old Bering Sea Culture, Miyowagh

(For explanation, see pages 412-413.)

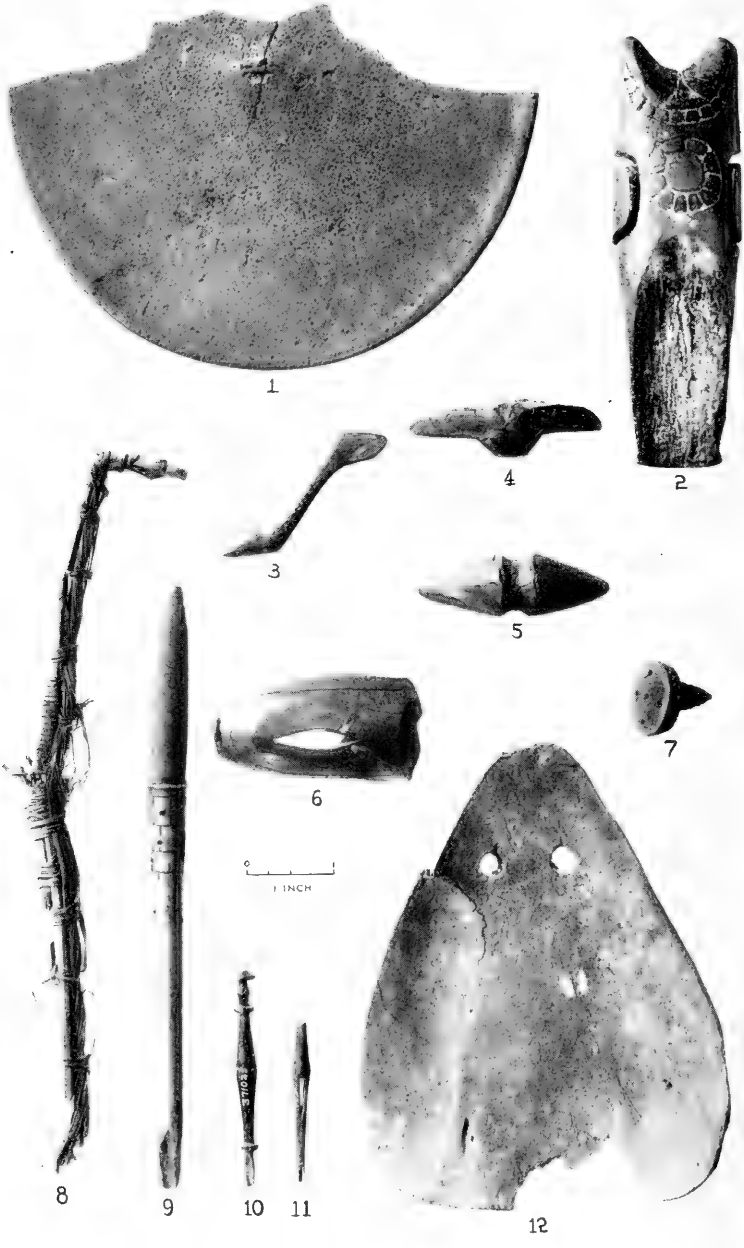


SNOW GOGGLES, BUTTONS, BROW BANDS, ETC., OLD BERING SEA CULTURE, MIYOWAGH

(For explanation, see page 413.)

TOYS, OLD BERING SEA CULTURE, MIYOWAGH. APPROX. ½ NATURAL SIZE.

(For explanation, see pages 413-414.)



IMPLEMENT TYPES OF EARLY PUNUK CULTURE, MIYOWAGH

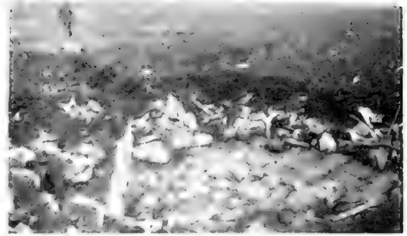
(For explanation, see page 414.)

EXCAVATIONS AT IEVOGHIYOQ, GAMBELL

(For explanation, see page 414.)

EXCAVATIONS AT IEVOGHIYOQ, GAMBELL

(For explanation, see page 414.)



EXCAVATIONS AT SEKLOWAGHYAGET, GAMBELL

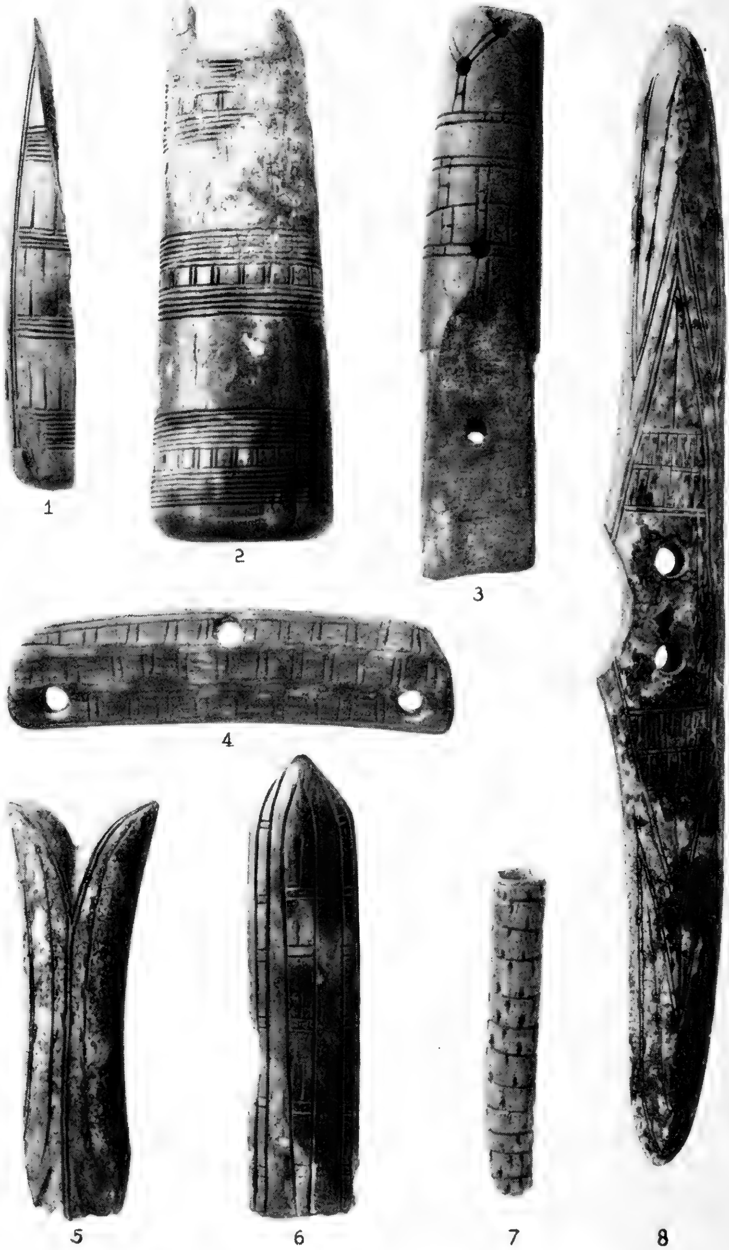
(For explanation, see page 415.)

HOUSE RUINS AT OLD SECTION OF GAMBELL, AND AT NASKOK AND MIRRUKTA, EAST OF GAMBELL

(For explanation, see page 415.)

DECORATED OBJECTS FROM IEVOGHIYOQ, PUNUK CULTURE.
APPROX. 3/5 NATURAL SIZE.

(For explanation, see page 415.)



DECORATED OBJECTS FROM IEVOGHIYOQ, PUNUK CULTURE.
APPROX. 3/5 NATURAL SIZE.

(For explanation, see page 415.)

Decorated Objects From Seplowaghyaget and Old Section of Gambell, Punuk Culture. Approx. 3/5 Natural Size.

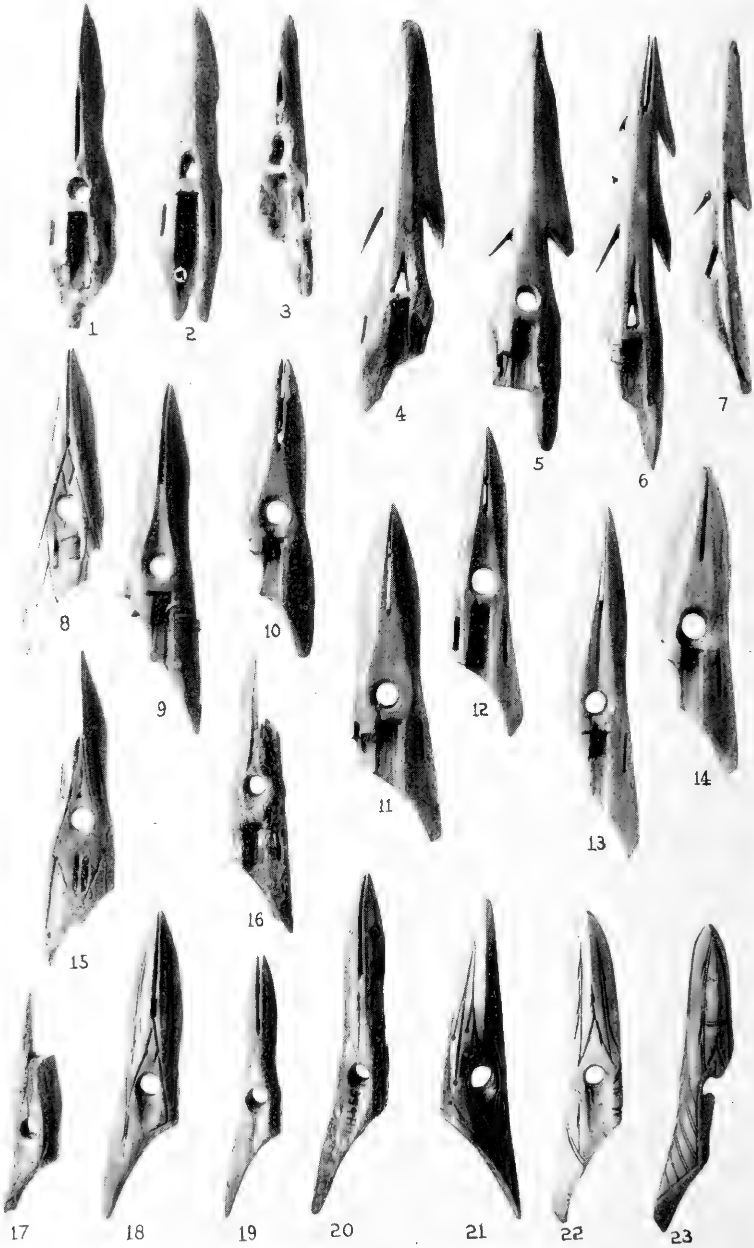
(For explanation, see pages 415-416.)

IVORY OBJECTS FROM IEVOGHIYOQ AND SEKLOWAGHYAGET, PUNUK CULTURE. APPROX. ½ NATURAL SIZE.

(For explanation, see page 416.)

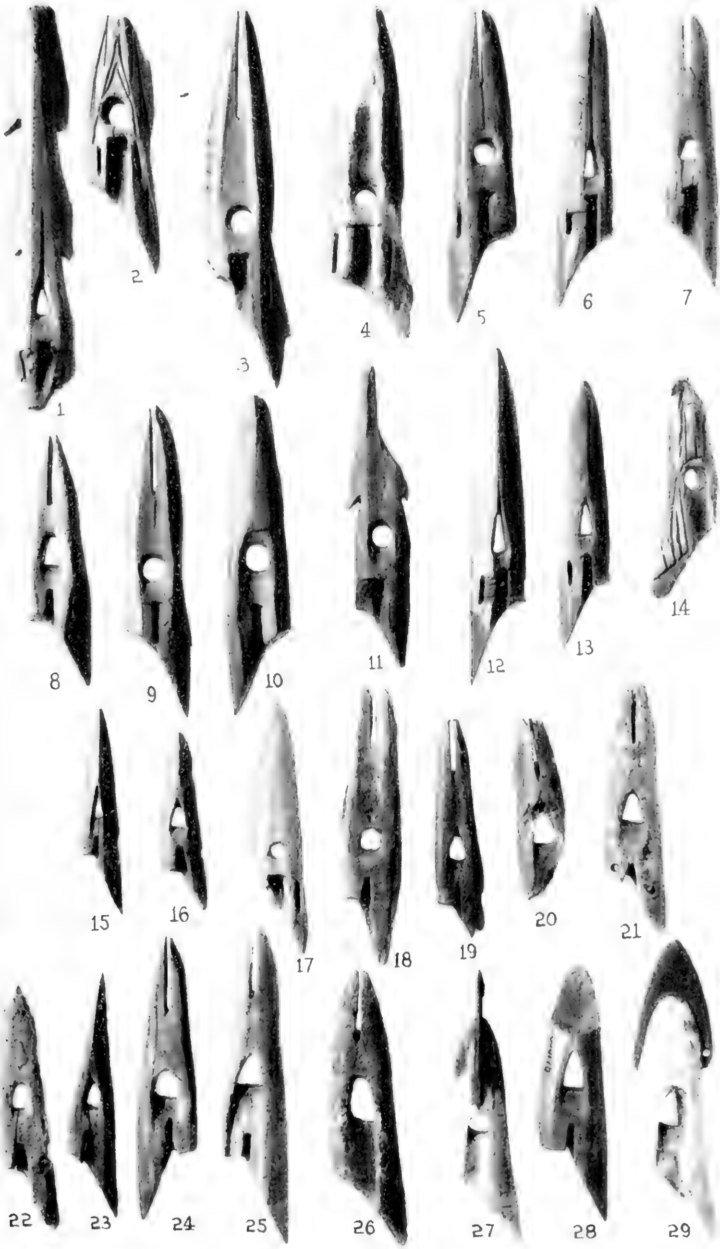
REVERSE OF THE OBJECTS SHOWN ON PLATE 68

(For explanation, see page 416.)



HARPOON HEADS FROM IEVOGHIYOQ, PUNUK CULTURE.
APPROX. ½ NATURAL SIZE.

(For explanation, see page 416.)



HARPOON HEADS FROM SEKLOWAGHYAGET AND THE OLD SECTION OF GAMBELL, PUNUK CULTURE AND MODERN. APPROX. ½ NATURAL SIZE.

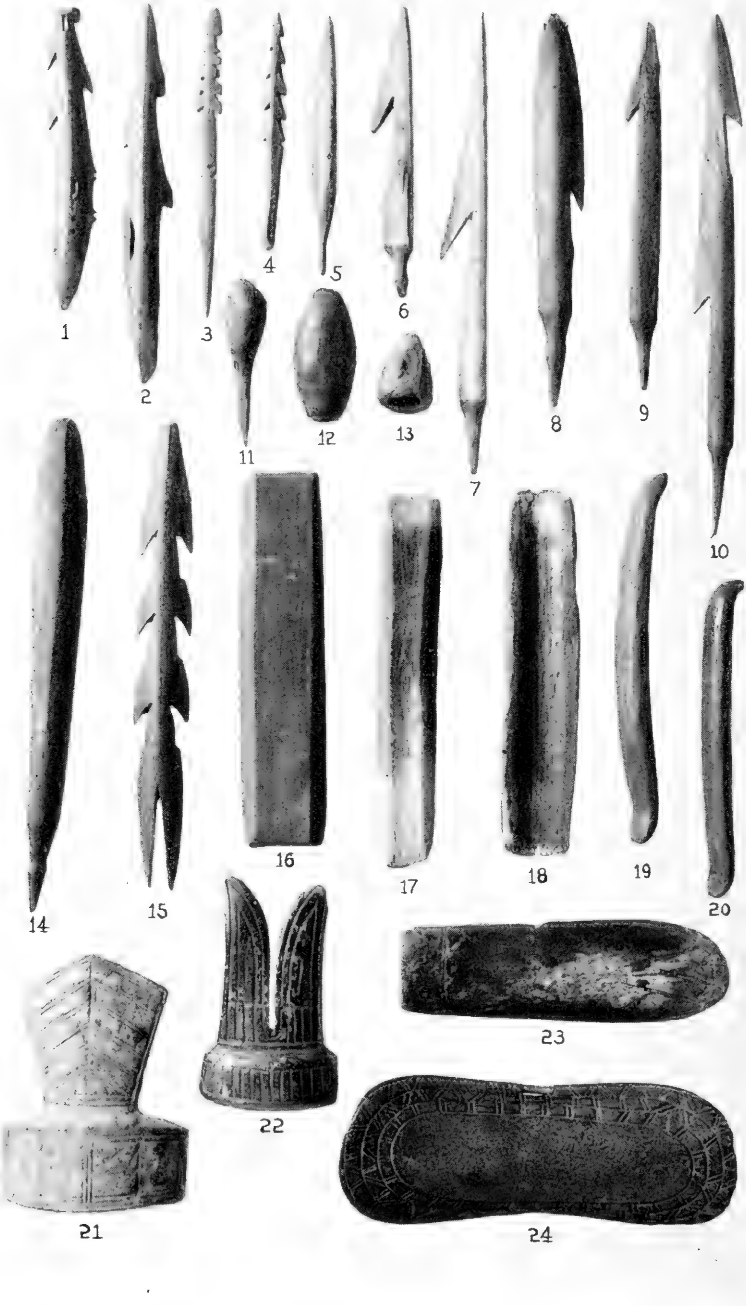
(For explanation, see page 417.)

Whaling Harpoon Heads From the Punuk Sites.
Approx. ½ Natural Size.

(For explanation, see pages 417-418.)

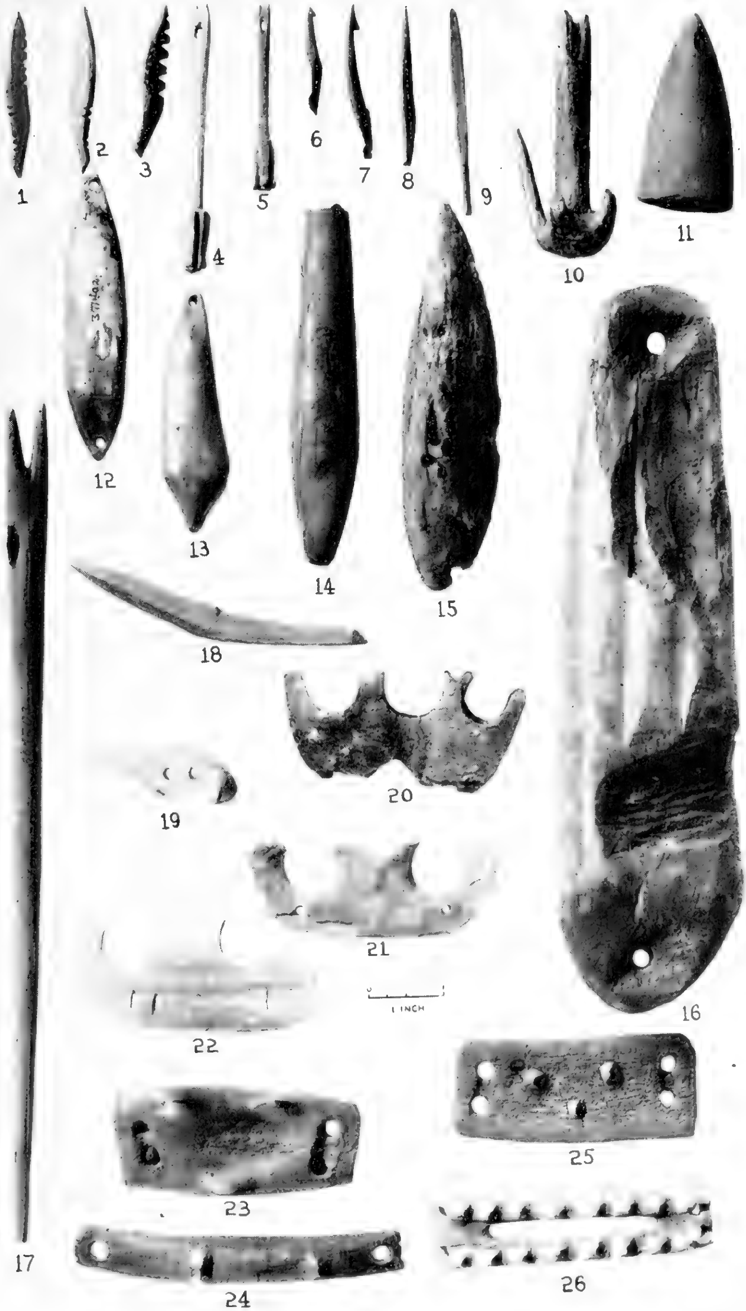
IMPLEMENT TYPES, PUNUK AND MODERN.
APPROX. ½ NATURAL SIZE.

(For explanation, see page 418.)



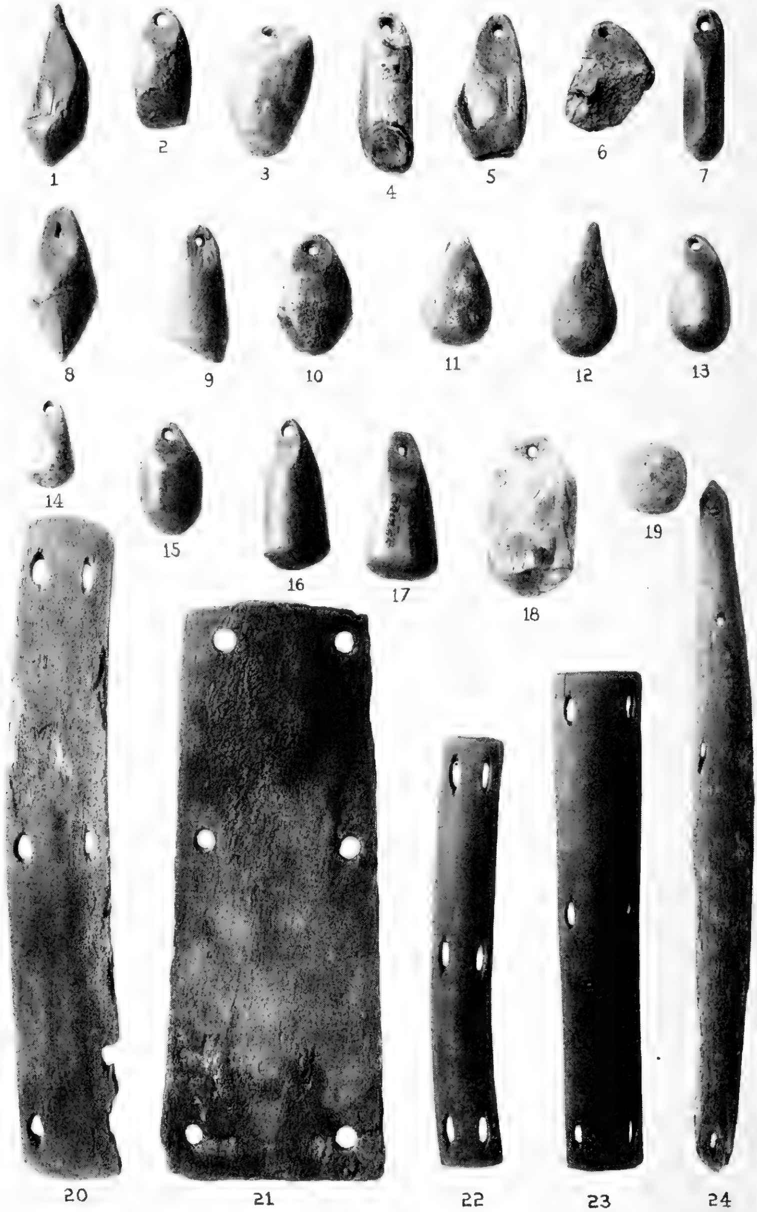
IMPLEMENT TYPES, PUNUK AND MODERN.
APPROX. ½ NATURAL SIZE.

(For explanation, see pages 418-419.)



IMPLEMENT TYPES, PUNUK AND MODERN

(For explanation, see pages 419-420.)



BOLA WEIGHTS AND PIECES OF PLATE ARMOR, PUNUK CULTURE.
APPROX. 2/5 NATURAL SIZE.

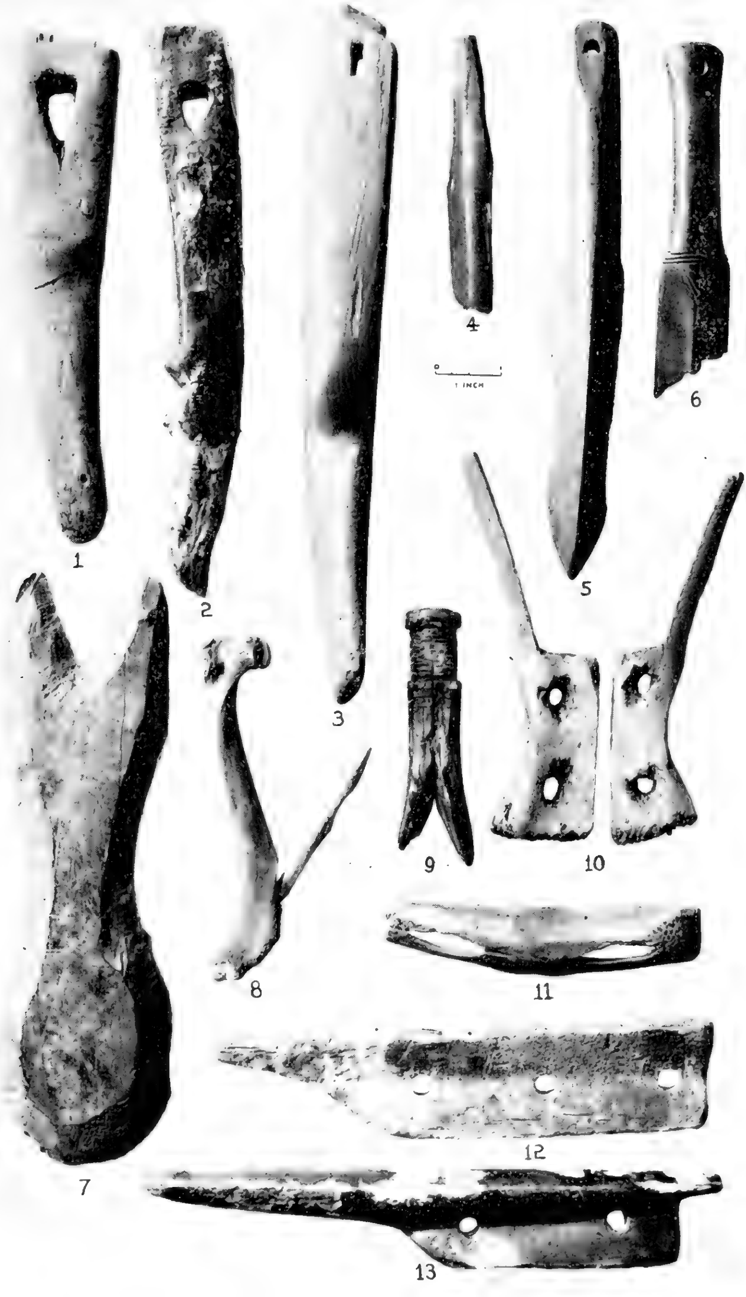
(For explanation, see page 420.)

SLEDGE RUNNERS OF THE PUNUK CULTURE

(For explanation, see pages 420-421.)

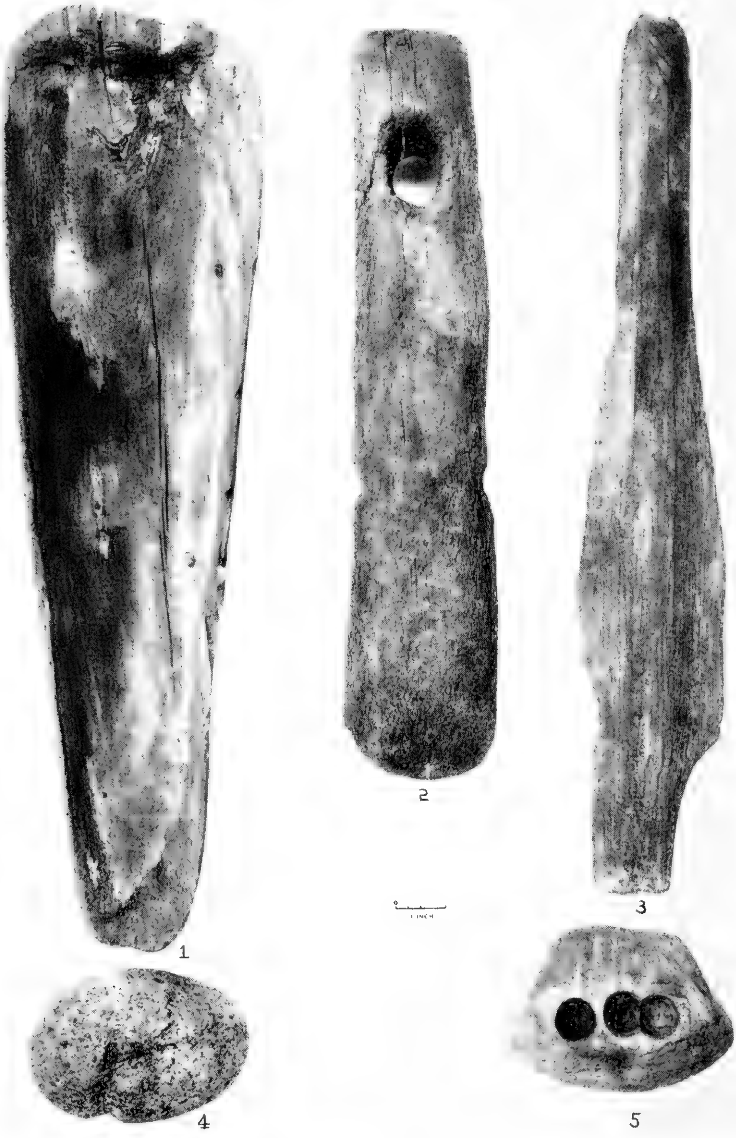
IMPLEMENT TYPES OF THE PUNUK CULTURE

(For explanation, see page 421.)



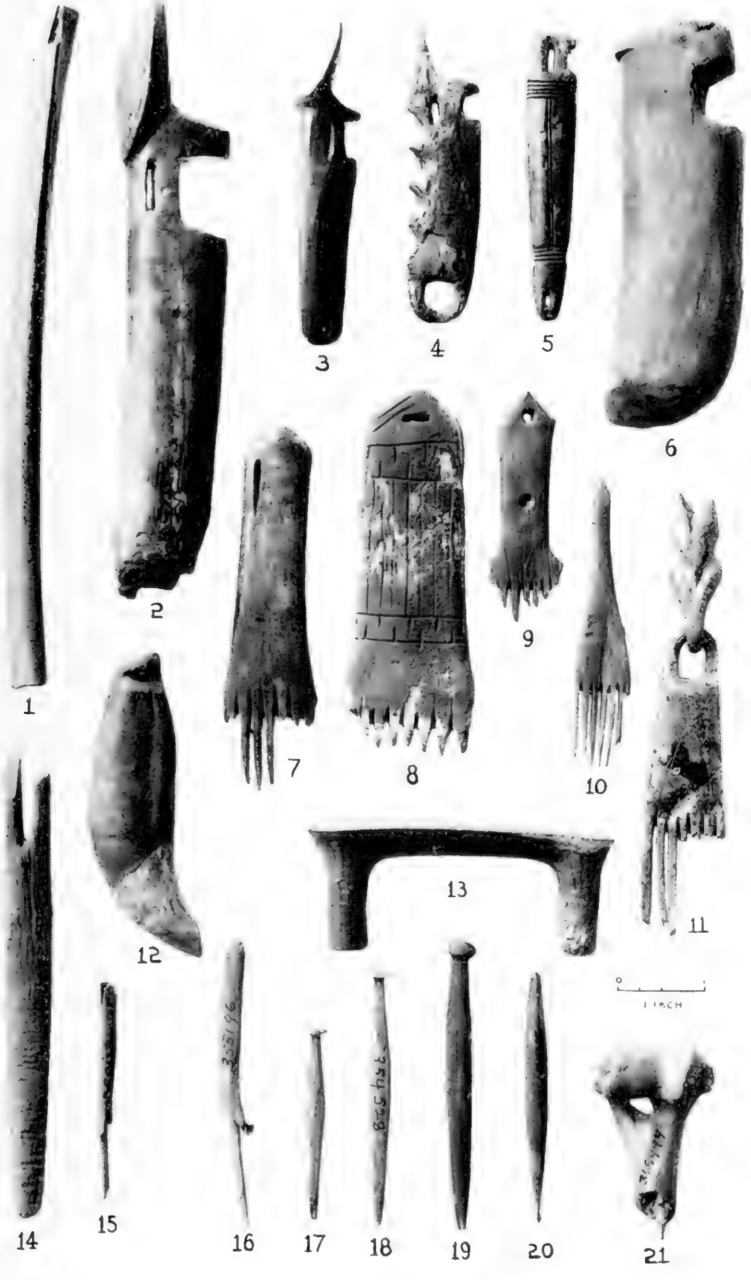
IMPLEMENT TYPES OF THE PUNUK CULTURE

(For explanation, see page 421.)



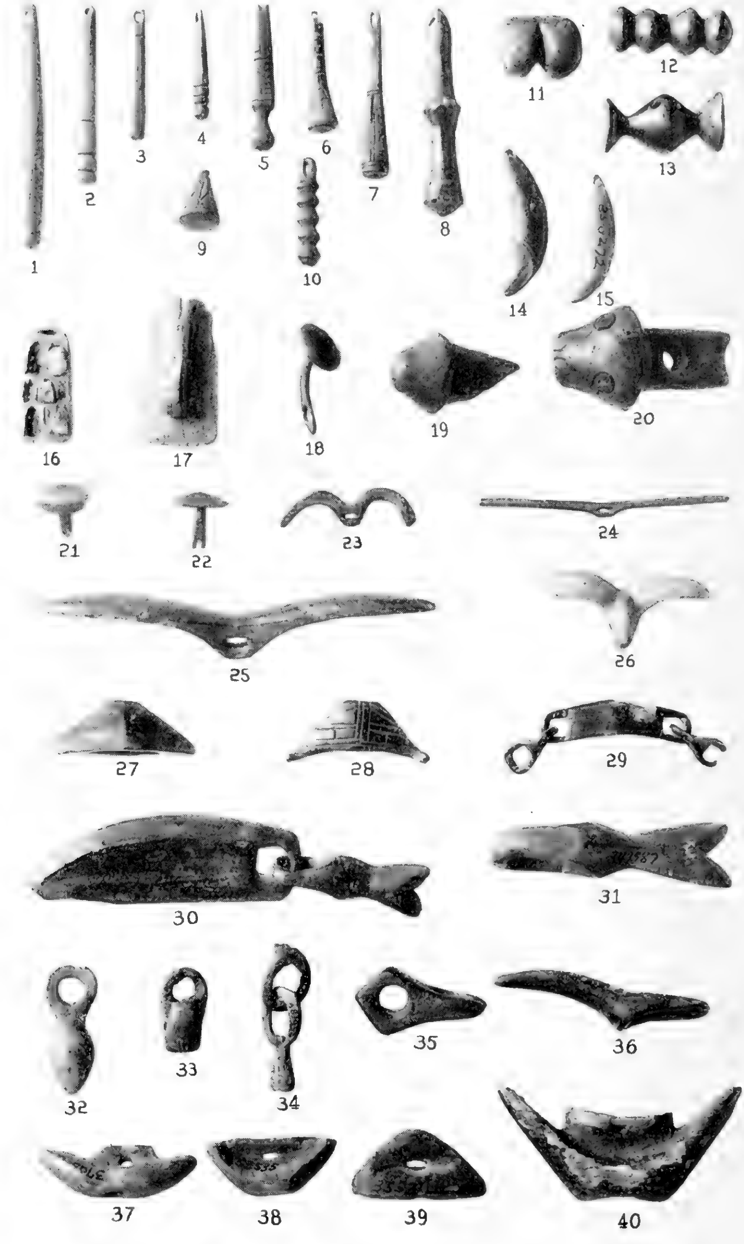
IMPLEMENT TYPES OF THE PUNUK CULTURE

(For explanation, see page 422.)



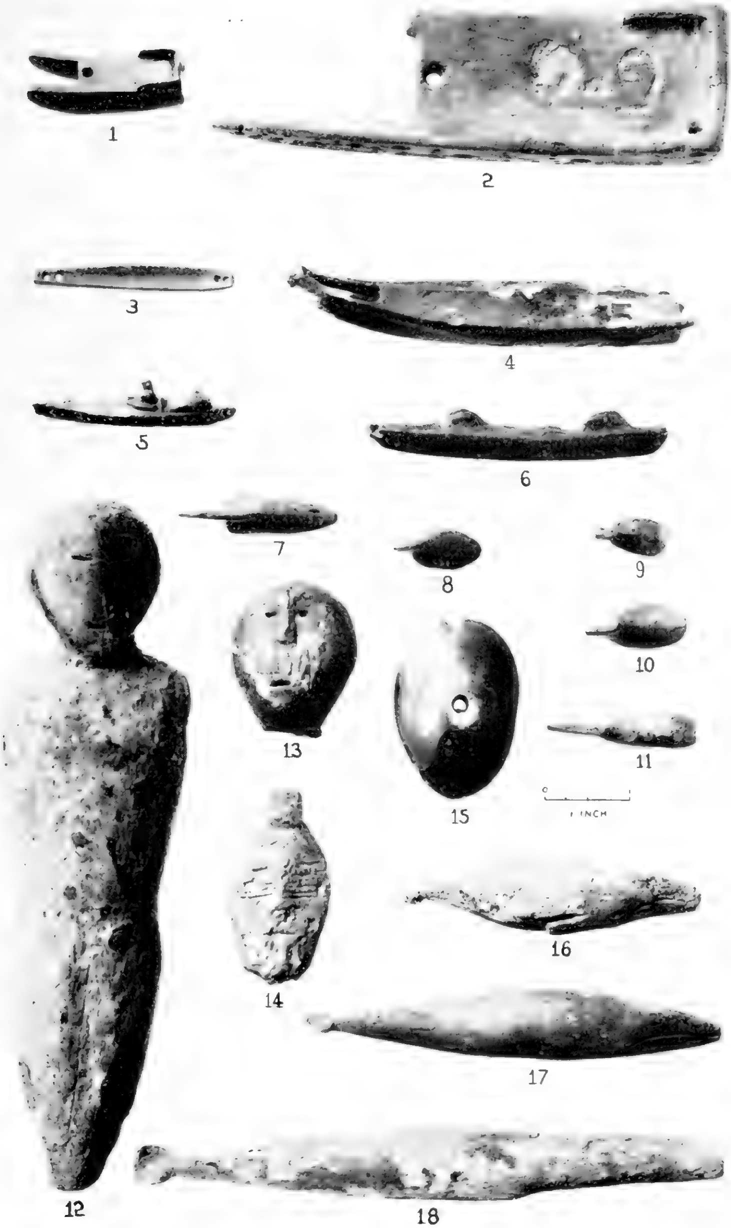
IMPLEMENT TYPES OF THE PUNUK CULTURE

(For explanation, see page 422.)



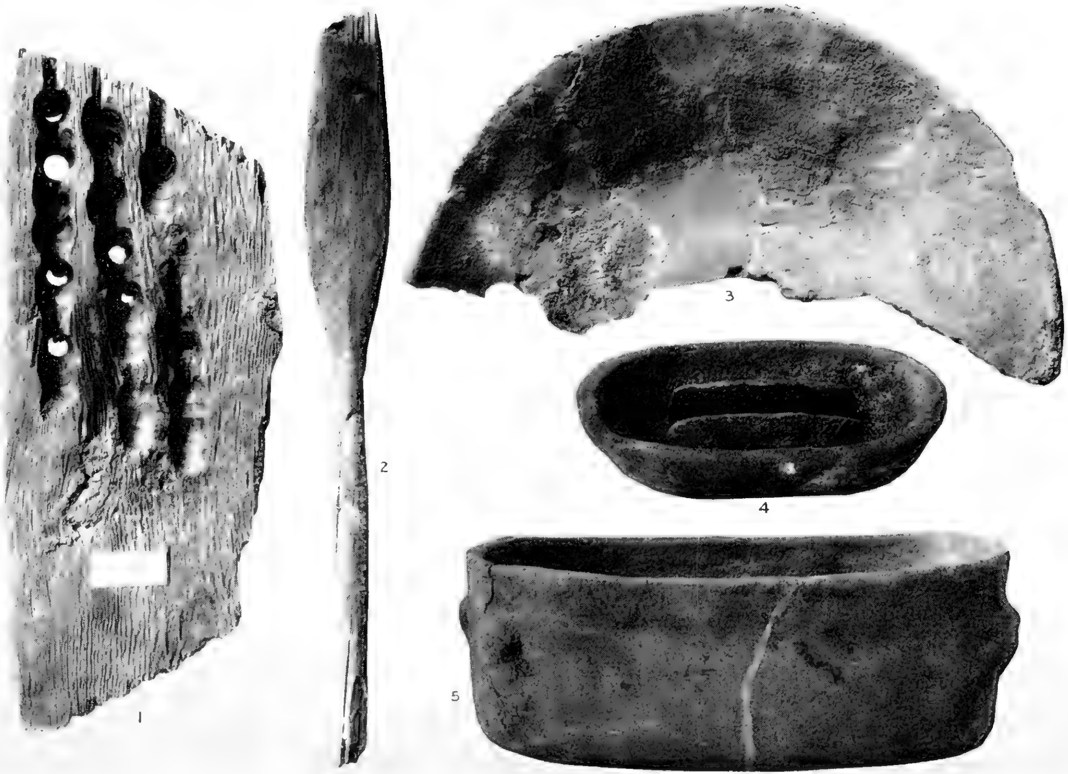
ORNAMENTS, ETC., OF THE PUNUK CULTURE. APPROX. ½ NATURAL SIZE.

(For explanation, see pages 422-423.)



TOYS, PUNUK AND MODERN

(For explanation, see pages 423-424.)



POTTERY VESSELS, BOAT PADDLE, AND FIRE HEARTH, PUNUK AND MODERN.
1, 3-5, APPROX. ¼ NATURAL SIZE; 2, 1/6 NATURAL SIZE.

(For explanation, see page 424.)

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SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 96 NUMBER 2

WAVE LENGTHS OF RADIATION IN THE VISIBLE SPECTRUM PROMOTING THE GERMINATION OF LIGHT-SENSITIVE LETTUCE SEED

(WITH ONE PLATE)

BY
LEWIS H. FLINT
Boyce Thompson Institute for Plant Research, Inc.
AND
E. D. McALISTER
Division of Radiation and Organisms,
Smithsonian Institution

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WAVE LENGTHS OF RADIATION IN THE VISIBLE SPECTRUM PROMOTING THE GERMINATION OF LIGHT-SENSITIVE LETTUCE SEED

By LEWIS H. FLINT,[1]
Boyce Thompson Institute for Plant Research, Inc.

AND

E. D. McALISTER,
Division of Radiation and Organisms, Smithsonian Institution

(With One Plate)

INTRODUCTION

The purpose of this investigation is to fix definitely the wave lengths of radiation which maximally promote the germination of light-sensitive lettuce seed[2] and to study their relationships to the wave lengths of radiation most effective in other fundamental plant phenomena.

In a previous publication (Flint and McAlister, 1935) the wave lengths of radiation in the visible spectrum inhibiting the germination of light-sensitive lettuce seed were reported as occurring in two regions: one in the violet-blue-green region (with principal maxima at about 4400 and 4800 angstroms), and the other in the red-to-near-infrared region (with one maximum, at about 7600 angstroms). The earlier work of Flint (1934, a, b) had indicated the general range of the radiation promoting germination as 5200 to 7000 A, but the curve of relative effectiveness of the radiation within this range was unknown. The accompanying graph (fig. 1), reproduced from a recent paper by Flint and McAlister (1936), illustrates the state of the study of radiation in relation to the germination of this particular seed at the beginning of the researches here reported for the same material.

It may be noted from figure 1 that at the intensities of radiation applied in the region 5200-7000 A a germination of 100 percent was secured at the longer wave lengths. It follows that differences in the

[1] Formerly of the Division of Seed Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

[2] Light-sensitive Arlington Fancy lettuce seed was used throughout the cooperative researches.

effectiveness of one part of this region over another were masked by the completeness of the germination.

In the study of the effectiveness of radiation in the violet-blue-green region it had been found that the principal critical wave lengths in the regions 4400 A and 4800 A were identical (within the range of experimental error) with those reported by Johnston (1934) and others for the phototropic response of oat coleoptiles. This analogy suggested that similar pigments were involved in the absorption in both instances, and that the results thus might well be of significance beyond their immediate application to the problem of dormancy in a particular kind of seed. This possibility has been made more prob-

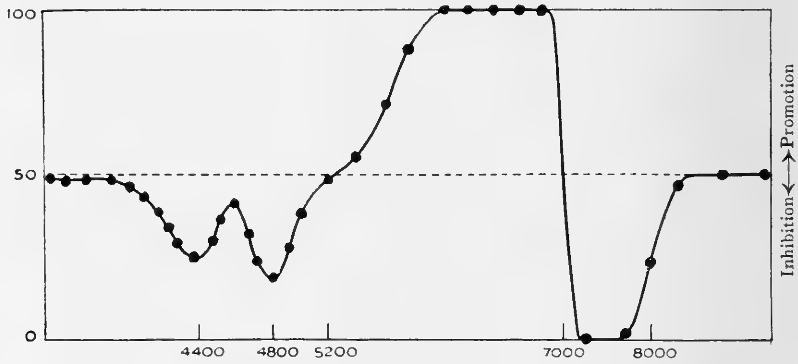

Fig. 1.—The action of radiation of specific wave-lengths in relation to the germination of light-sensitive lettuce seed. The percentages of germination in the spectrum (immediately following an exposure to red light sufficient to effect 50% germination) are indicated as ordinates, the wave-lengths of the spectral light being indicated as abscissae.

able through the recent work of Burkholder and Pratt (see Burkholder, 1936, p. 46), who found not only that radiation in the violet-blue region influenced the movement of *Mimosa,* but also that a band of radiation in the 7600 A region had a similar effect.

In view of the foregoing the study of the relative effectiveness of the wave lengths of visible radiation promoting the germination of light-sensitive lettuce seed seemed to warrant the continuation of this work, which led to the results here reported.

REVIEW OF LITERATURE

Cieslar (1883) reported that yellow light favored the germination of certain seeds, whereas violet light retarded it. In later years the phraseology became more precise, with " yellow to red " or " yellow, orange, and red " light as the promoting radiation, yet neither the wave length range nor the relative effectiveness of bands of radiation within the range were established. Flint (1934) reported that the upper limit of the radiation inhibiting germination was at about 5200 A, while the upper limit of the seemingly analogous phototropic response was set as about 5400 A by Johnston (1934). The curves of the absorption spectra of carotin and xanthophyll as reported by McNicholas (1931) reach low points in the region 5000 A to 5500 A, with principal critical wave lengths of maximum absorption at about 4400 A and 4800 A (when allowance is made for the shift in wave length associated with the solvent). These correspond closely with the regions of maximum effectiveness of this radiation in inhibiting germination and inducing phototropism. The curves of the absorption spectra of the chlorophylls as given by Zscheile (1934) are uniformly low in the green region and Shuck (1935) has held that there was a band of this radiation which had no effect on germination. On the other hand the curve of the action of radiation of specific wave lengths in relation to the germination of light-sensitive lettuce seed as developed in the work of Flint and McAlister (see fig. 1) indicates an immediate transition of reaction in this region, though not as abrupt a change as that taking place at the long wave length end of the promoting influence at about 7000 A.

Kommerell (1927), in studying quality of light and germination, had concluded that at any specified wave length the effectiveness of the radiation was proportional to the energy falling upon the surface of the seed. The work of Flint and McAlister, on the other hand, indicated that the effectiveness of the radiation was proportional to its absorption by the seed pigments. The investigations of Meischke (1936) support the latter viewpoint.

METHODS

The procedure and apparatus used in this investigation was essentially that described in detail in a previous paper (Flint and McAlister, 1935) except that blue light of controlled intensity was superimposed uniformly over the spectral region in which the seeds were being treated. By the well-known system of trial and error, using constant continuous spectral illumination, the blue light was so regulated in intensity that the maximum germination throughout the set of compartments in 24 hours was precisely 100 percent in some one compartment. With compartments 0.4 inch wide as used in the experiments previously reported, the conditions were then such that any increase in the intensity of the blue radiation gave less than 100 percent germination in this compartment. All experiments reported were at room temperature less than 29° C., for at higher temperatures the Arlington Fancy lettuce seed used in these experiments would not germinate, irrespective of the light conditions. On account of the narrow range of wave lengths represented by the critical maxima obtained, no correction for relative energy was applied to the graphic representation of the data.

In the data as given in table 1, it may be noted that there was a more or less progressive falling off in the peak germination and that there was some variation between the different series. Under the conditions of the experiments, with continuous operation of the spectral and superimposed light sources, a differential reduction in the efficiencies of the lights was to be expected.

RESULTS

A large number of experiments were carried out incidental to the attainment of the prescribed conditions. Under conditions such that an additional intensity of blue, when superimposed upon the spectral light, would reduce the percentage germination in the compartment yielding 100 percent germination, the following results in table 1 were obtained:

In conjunction with the results obtained as given in table 1, an examination of the absorption spectra of lettuce seed extract in acetone was undertaken. The results of this study are given in plate 1.

The foregoing results establish the critical wave lengths of the radiation promoting the germination of the seed used in these trials and appear to indicate the nature of the material responsible for the reaction. The relative effectiveness of radiation with wave lengths within

Table 1.—*Percentage germination of light-sensitive lettuce seed in spectral green to infrared radiation with superimposed blue light. Compartment width 0.4 inch.*

Series	Percentage germination at approximate wave lengths at center of compartments														
	4950	5080	5180	5300	5440	5650	5710	5850	6000	6210	6400	6700	7050	7500	8200
A	0	0	0	0	0	0	0	0	0	5.9	27.3	100.0	64.0	2.1	0
B	0	0	0	0	0	0	0	0	0	0	30.7	73.3	77.8	0	0
C	0	0	0	0	0	0	0	0	0	0	0	85.2	14.3	0	0
D	0	0	0	0	0	0	0	0	0	0	0	80.0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	65.0	0	0	0
Average	0	0	0	0	0	0	0	0	0	1.18	11.6	80.7	32.03	0.42	0

the 5000-6000 A range has not been established in these trials, but in its entirety this radiation is obviously far less effective than that in the 6700 A region.

DISCUSSION

The results given in table 1 have been averaged and represented graphically as the full line curve in figure 2.

It is obvious from this diagram that the radiation most effective in promoting the germination of the seed had a wave length of the order of 6700 A. The nature and position of this curve invites comparison

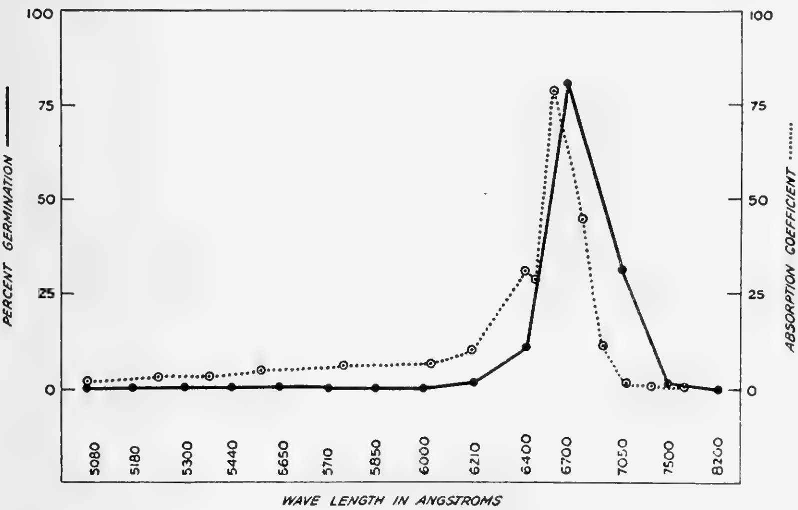

FIG. 2.—Curves of seed response and chlorophyll absorption.

with the curve of the absorption spectrum of the chlorophylls in this region, and the analogy is impressive. Here is an instance, then, in which, within the limits of experimental error, the apparent critical wave length of radiation promoting germination coincides with the major absorption in this region by a pigment common to all green plants. The approximate order of correspondence is indicated in figure 2. In Zscheile's work the leaf pigments were extracted with ether. In the germination study the seed pigments were acting in their natural environment, which was an aqueous solution. Under these circumstances the wave length shift apparent in figure 2 is about the amount to be expected.

In plate 1 the upper spectrogram is taken from Willstätter and Stöll and represents the absorption of an acetone extract of leaf pigments.

The center spectrogram represents the absorption of an acetone extract of seed pigments. The lower spectrogram represents the emission of the mercury arc, and provides a wave-length scale for the center spectrogram. It is apparent from this plate that the pigments absorbing the longer wave lengths of visible radiation in the seed are similar to those pigments found in the leaf by Willstätter and Stöll.

Since the leaf pigments absorbing the longer wave lengths of visible radiation are for the most part identified as chlorophyll, it follows from the data represented in figure 2 and plate 1 that (within the limits of experimental error) the radiation most effective in promoting germination in the seed is that most effectively absorbed by chlorophyll in the same region.

Unfortunately, these experiments were terminated before it was possible to make a positive identification of the pigments responsible for the relatively intense absorption for wave lengths of radiation shorter than 5400 A that is apparent on plate 1. It is certain that this is not due to the blue absorption of chlorophyll alone, for it is too intense compared to the red absorption and also extends too far toward the longer wave lengths. Thus, the presence of a yellow pigment is indicated, and the close agreement between the critical wave lengths of radiation inhibiting germination and those absorbed by the carotenes is impressive. However, a more extensive study of the absorption spectrum of the yellow pigment found in these seeds is necessary before more can be said.

The close analogy between the critical wave lengths of radiation influencing seed germination and the critical wave lengths of radiation absorbed by plant pigments places a distinct emphasis upon what is perhaps a new and promising viewpoint. In the seeds the violet-blue light promotes a set of physiological responses quite different from the set which is promoted by orange-red light. It follows that in green plants the physiological response to violet-blue light may be quite different from the response to orange-red light. If such is the case, the study of quality of light offers increasing promise in relation to the problems of photosynthesis, photoperiodism, seed maturation, seed germination, plant distribution, and so on.

In conjunction with an increasing interest in qualitative light effects the results here reported obviously emphasize the desirability of a more adequate knowledge of the quality of light at the earth's surface and of the modification of that quality with time of day and year, with latitude, with altitude, and with water vapor in the earth's atmosphere.

SUMMARY

Radiation of wave lengths ranging from about 5200 A to about 7000 A characterizing the colors yellow, orange, and red, promotes the germination of light-sensitive lettuce seed; but within this range the longer wave lengths are by far the most effective.

The critical wave length of the radiation promoting germination within the most effective range is approximately 6700 A.

Within the limits of experimental error the radiation most effective in promoting germination is that most abundantly absorbed by chlorophyll in the same region.

The absorption characteristics of an acetone extract demonstrate the presence of chlorophyll in the seed.

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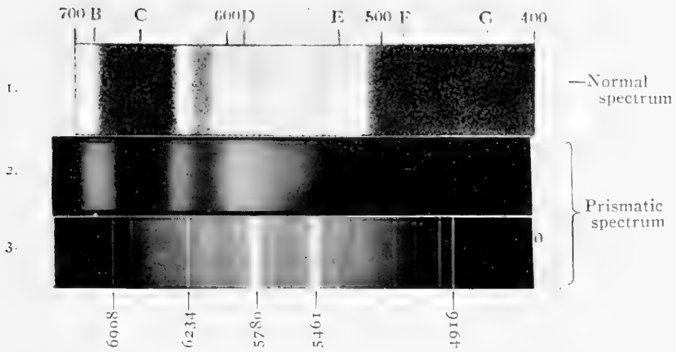

COMPARISON OF LEAF AND SEED PIGMENTS

1. Spectrogram of acetone extract of leaf pigments. (Willstätter and Stoll.)
2. Spectrogram of acetone extract of seed pigments.
3. Mercury comparison spectrogram.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 96, NUMBER 3

PHOTOTROPIC RESPONSE AND CO_2 ASSIMILATION OF PLANTS IN POLARIZED LIGHT

BY
EARL S. JOHNSTON
Division of Radiation and Organisms, Smithsonian Institution

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By EARL S. JOHNSTON
Division of Radiation and Organisms, Smithsonian Institution

From time to time articles both scientific and popular appear on the effects of polarized light on plants. Some years ago Semmens (1923) reported an increased velocity of seed germination in moonlight and suggested that the plane polarization of moonlight affected the diatase activity. Baly and Semmens (1924) reported an increased rate of hydrolysis of starches in plants exposed to polarized light. In a later paper Semmens (1930) characterizes plants grown in successive periods of darkness and polarized light by a disappearance of starch and other reserve products, such as glucosides, a temporary phototropism due to increased stem turgor, and a leaf fall with other signs of starvation. On the other hand, du Buy and Nuernbergk (1935) mention some unpublished experiments in which they found no difference in the bending of *Avena* coleoptiles toward polarized and nonpolarized light. Furthermore, Dastur and Asana (1932) indicate that the process of photosynthesis goes on as vigorously and regularly in polarized light as in ordinary light. Macht (1926) reports evidence of better growth of *Lupinus,* wheat, squash, and *Helianthus* seedlings in polarized light of a Mazda lamp than in his controls. Dastur and Gunjikar (1935) report that leaves of 12 different species clearly show a larger amount of energy absorbed from polarized light than from normal light of equal intensity. May (1924) conducted a number of experiments over a year to determine if there was a basis of fact regarding the seeding of crops during different phases of the moon. He found there was not enough difference in the general growth to be noticeable to the eye, certainly not enough upon which to found a theory. There is no evidence, as pointed out by Garner (1937), to show that the moon is capable of exerting any effect on crop plants other than those due to its action on illuminating conditions.

In a number of plant growth studies conducted at the Smithsonian Institution it has been necessary to direct beams of light on the plants by means of mirrors. Judging from some of the discussions in the literature one might raise the question as to the effect of polarized light on growth processes. Especially is this applicable to our studies on the growth of the oat coleoptile in monochromatic light reflected by a mirror, and to CO_2 assimilation studies of wheat plants in which light intensities are increased by mirrors. The present paper discusses the phototropic response of the oat coleoptile and the CO_2 assimilation of young wheat plants in polarized light.

The general method of illuminating the plant by two opposing beams of light was used in the phototropic experiments. This balancing

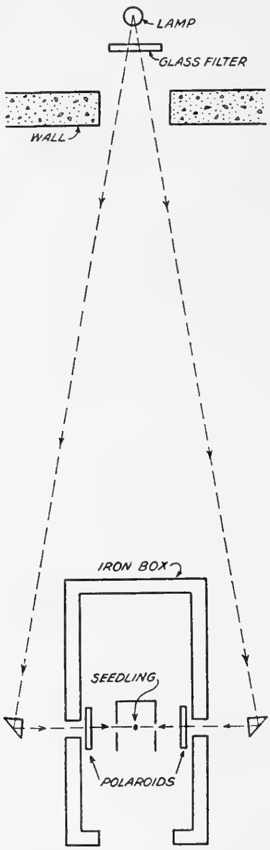

Fig. 1.—Diagram showing position of *Avena* coleoptile between two opposing beams of light which originate from a single source and are polarized at right angles to each other.

action of light on phototropic response has been discussed by Johnston (1934) and by Castle (1931). In the experiments here discussed a single light source was used. Two beams were reflected by right-angle prisms in such a manner that the first 0.5 to 1.0 mm of the tip of a coleoptile was illuminated from opposite sides. The general arrangement of apparatus is illustrated in figure 1.

The light source was a 1,000-lumens, 1.6-amperes street series lamp with a heat-resisting, heat-absorbing extra light shade Corning filter (2.75 mm). After being reflected by the prisms two beams of light entered an iron box ($34.5 \times 18.5 \times 30$ cm high) through two oppositely located side windows. In each window was fitted a Polaroid disk (4 cm diameter). Each beam of light then passed through a horizontal 0.5-mm slit in a brass shield and fell on the tip of a coleoptile placed midway between these shields. These shields were 4 cm apart. The small Erlenmeyer flask (50 ml) in which the oat seedling was growing rested on a small shelf which could be raised or lowered by means of a worm gear. With this arrangement the tip of a seedling could be accurately placed in the path of the narrow opposing beams of light. The total length of each light beam from the lamp to the mid point between the brass shields was 107 cm.

The oats, *Avena sativa* Markton, were germinated at approximately 25° C. between glass plates covered with moist filter paper. The plates were so placed in a moisture chamber that the seedlings grew vertically. A careful selection of the seedlings was made for straightness when they had attained a length of 1 to 2 cm. One was then transferred to the small Erlenmeyer flask fitted with a cork stopper. It was supported by means of a little cotton in a small hole of the stopper. The flask was filled with distilled water so that the roots were entirely immersed. The seedlings were always handled in darkness or photographically red light. One Polaroid disk was so placed that the plane polarized light was parallel to the axis of the seedling. The other Polaroid was placed to give a beam of light polarized at right angles to this. The setting at right angles could easily be accomplished by observing the lamp filament through the two prisms and two Polaroids and rotating the one Polaroid until the transmitted light reached its minimum visibility. At this point the filament appeared a dark purple red in color.

By means of a specially constructed photocell a point was located between the slits of the two shields where the two beams were equally intense. At this point the seedlings either showed no phototropic bending or a very slight one after 2 to 3 hours. No change so far as the reactions of the coleoptile were concerned were noted when the Polaroids were rotated through an angle of 90° in order to reverse the polarity of the light striking the two sides of the tip. The difficulty in this procedure was to locate accurately the mid point of equal intensities. The seedling was more sensitive to small differences of light intensity than the photocell.

In order to overcome this difficulty, a slightly different method was used. The mid point of equal intensities was approximately located with the photocell and the seedling placed slightly to the left of this point. A distinct phototropic bending then occurred toward the left. Another seedling was placed to the right of the mid point and the bending then occurred toward the right. The right or left displacements were never greater than 0.75 cm. Consistent results were obtained in a series of such experiments in which a fresh seedling was used each time, no matter whether the light was polarized parallel or at right angles to the axis of the plant. No difference could be detected in the phototropic response of the seedling in regard to the plane of polarization of the light impinging on its tip when the Polaroids were placed in the two positions mentioned.

Calculations of intensities based on the lengths of light paths at points of maximum displacement of seedlings give a difference of slightly less than 3 percent as the maximum range. This clearly shows that if polarized light had a different effect on phototropism in one plane than in the other, as here used, such an effect is less than 3 percent. Crozier and Mangelsdorf (1924) found no difference in the phototropic efficiency of plane polarized and nonpolarized light of equal intensity on arthropods. The difference in phototropic effect of light depending on the plane of polarization which Castle (1934) found for the cells of *Phycomyces* is shown by him to be due to differences in the reflection losses at the cell surface. What Castle concludes for the growth of *Phycomyces* is undoubtedly true for the coleoptile of *Avena,* namely, that plane polarized light has no specific effect on its growth processes.

The disappearance of starch and signs of starvation of plants grown in polarized light, as reported by Semmens, would indicate serious disturbances in the photosynthetic mechanism of such plants. This would undoubtedly involve the CO_2 assimilation process. Because of the disagreement between the results of Semmens and those of Dastur and Asana it was thought worth while to determine the CO_2 uptake of wheat plants in polarized and nonpolarized light, especially since this was the experimental plant used by Hoover, Johnston, and Brackett (1933) and by Hoover (1937) in their CO_2 absorption studies.

In a series of experiments carried out by McAlister in which his recently described spectrographic method (1937, 1937 a) for CO_2 determination was used, little or no evidence was obtained that indicated a different rate of photosynthesis of wheat plants in polarized and nonpolarized light from a Mazda lamp.

Young wheat seedlings were grown under controlled conditions in the growth tube and exposed first to nonpolarized and then to polarized light. The light source was a 1,000-watt Mazda projection lamp used with a suitable water filter. Light polarized parallel to the plant axis was obtained by inserting a Polaroid disk between the plant and the lamp.

The Polaroid greatly reduced the light intensity and in order to reduce the intensity of the nonpolarized light to that of the polarized, a 200-mesh screen was inserted between the plant and the lamp. A small G. E. photocell foot-candle meter was used to approximate the intensities. Data from two such experiments are presented in table 1.

TABLE 1.—*Carbon Dioxide Assimilation of Young Wheat Seedlings in Nonpolarized and Polarized Light*

Date 1937	Light: Character	Light: Intensity: Foot-candles	Light: Intensity: Thermocouple reading with filter [a]	CO_2 assimilation: (mm³ 10 min.)	CO_2 assimilation: Corrected
May 4	Nonpolarized	250	...	482	588
	Polarized	260	...	574	586
May 5	Nonpolarized	273	8.2	565	689
	Polarized	282	9.8	670	684

[a] With a Corning Aklo heat-resisting, heat-absorbing medium (2.46 mm) filter together with a 10-cm water filter, the wave-length distribution was restricted to about 3800-7800 A, which includes the major portion of the spectrum active in photosynthesis. These thermocouple readings were used in obtaining the corrected CO_2 assimilation.

In such experiments it is important that light and not the CO_2 of the air surrounding the plants be the limiting factor. In order to make sure this was the case, additional readings of CO_2 uptake were taken on May 5 at higher intensities in nonpolarized light. The CO_2 uptake at 700-800 foot-candles was found to be 1060 mm^3 per 10-minute interval. It therefore appears certain that at the lower intensities used in these experiments light and not CO_2 was the limiting factor.

Although the experiments on this phase of the work were not many and for 10-minute intervals, yet because of the extreme accuracy and quickness of this optical method of determining the CO_2 absorption by plants, it may safely be concluded that polarized light has no effect upon the uptake of CO_2. There is the possibility, although it does not seem probable, that if the plants were grown for long periods in polarized light some secondary effects on the CO_2 assimilation might appear. The measurements indicate a difference of approximately 1 percent, but since it is assumed that the thermocouple-filter system measures the light effective in photosynthesis equally accurately in the two cases, it is well to bear in mind that a greater photosynthetic efficiency may exist in one light than in the other. This may be the case because of the difference in color of the light after it passes through the Polaroid. Pollard (1936) has noted the wave-length distribution characteristics of the Polaroid. Because the light transmitted is somewhat different in wave-length distribution from the screened Mazda light, accurate comparisons are exceedingly difficult.

In summarizing, it may be concluded from the experimental evidence here presented that polarized light has no effect other than that of ordinary light in phototropism of *Avena* Markton. If there is a difference it is less than the 3 percent accuracy of the experimental technique. Also, there is little evidence that polarized light acts any differently from nonpolarized light of equal intensity and similar wave-length distribution in the process of CO_2 assimilation.

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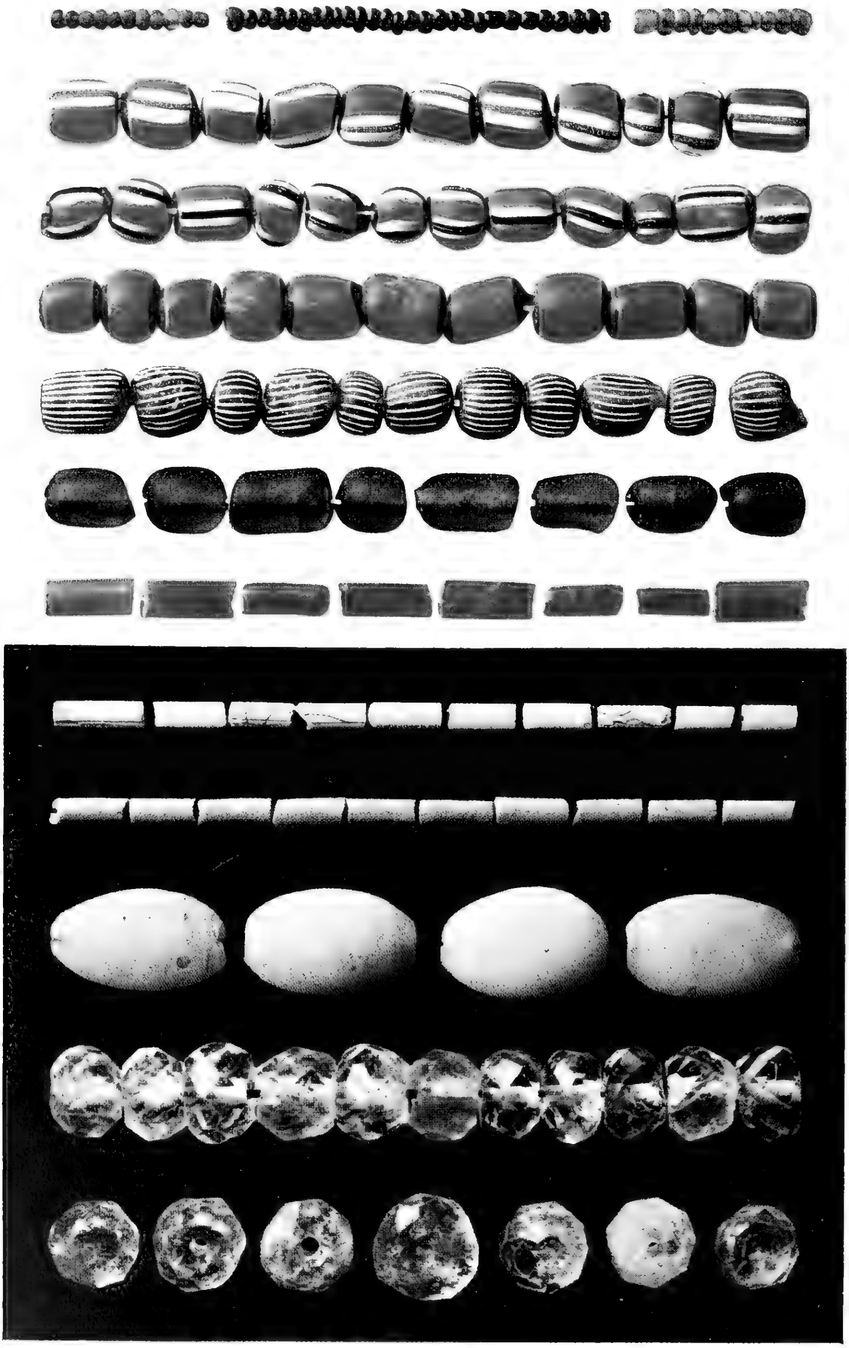

TRADE BEADS FOUND AT LEEDSTOWN. NATURAL SIZE

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 96, NUMBER 4

INDIAN SITES BELOW THE FALLS OF THE RAPPAHANNOCK, VIRGINIA

(With 21 Plates)

BY
DAVID I. BUSHNELL, JR.

(Publication 3441)

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(With 21 Plates)

INTRODUCTION

During the summer of 1608, the year following the settlement of Jamestown, parties of the colonists made two successful and, considered in retrospect, very important expeditions along the shores of Chesapeake Bay. They discovered many streams that flow into the bay and came in contact with the natives who occupied the territory. The second party left Jamestown July 24 and returned late in August, after having explored the country to the northward, to the mouth of the Rappahannock. They entered the river and continued up the stream to the large island at the falls, near the present city of Fredericksburg, as far as their boat could be taken. The valleys beyond were occupied by the Manahoac tribes, a Siouan group ever enemies of their Algonquian neighbors; many camps and villages of the latter were then standing on the banks of the Rappahannock below the island and had been passed by the English when they ascended the stream. However, no villages were encountered within a distance of 10 or 12 miles of the falls; that part of the valley appeared to have been recently abandoned by the Algonquian tribes.

The country claimed and occupied by the Manahoac tribes in 1608 has already been described,[1] together with examples of material from various localities, and consequently, it is now thought desirable to present, for comparison, a brief description of sites that have been discovered on the banks of the river, beginning at Leedstown, the early colonial settlement some 40 miles below the falls, and continuing up the valley.

I am again indebted to Capt. H. K. Baisley, United States Army Air Corps, for aerial photographs of the areas described; and to F. M. Aldridge, of Fredericksburg, and R. G. Paine and E. G. Cassedy, of the Smithsonian Institution, for assistance in locating sites and material.

[1] Bushnell, David I., Jr., The Manahoac tribes in Virginia, 1608. Smithsonian Misc. Coll., vol. 94, no. 8, 1935.

DISCOVERY OF THE RAPPAHANNOCK

At the time of the establishment of Jamestown, May 1607, many settlements of Algonquian tribes stood on the banks of the Rappahannock, from the mouth of the stream far inland to the vicinity of the falls or rapids near the present city of Fredericksburg. Some were comparatively large villages with smaller camps nearby.

The river was first explored by the colonists late in the summer of the following year, 1608, when they penetrated the wilderness as far as the falls and there came in contact with the Manahoac tribes who claimed the lands to the westward.

As the English advanced up the Rappahannock from the Chesapeake, they saw many native villages, and when near the settlement of the Rapahanock, probably in the present Richmond County, opposite the town of Tappahannock, they were treacherously attacked by the Indians but escaped injury. A short time before reaching the Rapahanock village the English were joined by the friendly Indian Mosco, who later served them as guide and interpreter. They continued up the river and discovered other Algonquian camps and villages, and to quote from the narrative (p. 426):[2] "The Kings of *Pissassack, Nandtaughtacund,* and *Cuttatawomen,* used us kindly, and all their people neglected not any thing to *Mosco* to bring us to them." The three villages will again be mentioned, and the sites described.

The brief accounts that have been preserved of the encounter of the English with the Manahoac, who had gathered just above the large island, are of the greatest interest and importance. And as related by the Manahoac Indian from Hassininga, through the Algonquian interpreter, while in the vicinity of the falls they were near "the bounds betwixt the Kingdome of the *Mannahocks* and the *Nandtaughtacunds*." Thus it appears that the latter name was applied to the Algonquian group that occupied the country along the Rappahannock just below the falls, and therefore nearest neighbors of the Siouan or Manahoac tribes. Again when referring to the Rappahannock (p. 348):

> Upon this river on the North side are the people *Cuttatawomen,* with 30 fighting men. Higher are the *Moraughtacunds,* with 80. Beyond them *Rapahanock* with 100. Far above is another *Cuttatawomen* with 20. On the South is the pleasant seat of *Nantaughtacund* having 150 men. This river . . . is replenished with fish and foule.

[2] Smith, Capt. John, The generall historie of Virginia, 1624. All references to Smith's writings are quoted from the English Scholar's Library edition, edited by Edward Arber, Birmingham, England, 1884.

Many additional names appear on the Smith map, a section of which is reproduced in figure 1. Of the five groups mentioned in the preceding quotation the last two were within the limits of the region

FIG. 1.—Section of the Smith map, 1624, showing the many native villages that stood on the banks of the Rappahannock from the vicinity of Leedstown to the falls at Fredericksburg.

now being considered, which extends from Leedstown, on the left bank of the Rappahannock in Westmoreland County, up the river to the falls at Fredericksburg.

ACTS RELATING TO THE INDIANS PASSED BY THE GENERAL ASSEMBLY DURING THE SECOND HALF OF THE SEVENTEENTH CENTURY

Great changes necessarily occurred among the native tribes of Virginia after the English entered the wilderness and occupied much of their land. Unrest developed, and it is evident that soon after the middle of the century the native tribes whose villages stood on the banks of the Rappahannock, beyond the English plantations, were regarded with grave apprehension.

In November 1654, among "Orders of Assembly", as transcribed by Hening,[3] is one "Concerning the March against the Rappa' Indians." This reads in part (p. 389): "Whereas divers complaints have bin made by the inhabitants of the counties of Lancaster, Northumberland and Westmoreland concerning divers injuries and insolencyes offered and done by the Rappahannock Indians, unto them." The order then states the number of men to be furnished by each county, "with armes, amunition and provisions, with boates and other necessaries for their voyage to the said Rappahannock townes." But it is not known to which villages this referred.

Late in the spring of 1656 occurred the sanguinary encounter between colonists and Indians, the latter thought to have been a Siouan tribe from farther up the Rappahannock, who had moved to the vicinity of the falls of the James. It was a period of much concern to the frontier settlements of Virginia where the native tribes were being harassed by their enemies from far northward.

Many laws affecting the Indians were enacted and enforced in Virginia during the succeeding years. Some made specific reference to the people of the Rappahannock valley, others were more general and applied to all tribes alike. Trade was frequently the subject of the acts, and these now shed light on the economic problems with which the colonists were then confronted. Brief quotations from Hening should prove of interest:

Act CXXXVIII of the "Grand Assembly Held at James City March the 23d 1661-2" was a digest of earlier laws relating to the Indians some of which reveal facts of historical importance.[4]

First concerning food:

And be it further enacted that for the better releife of the poore Indians whome the seating of the English hath forced from their wonted conveniencies

[3] Hening, William Waller, The Statutes at Large; being a collection of all the Laws of Virginia, from the first session of the Legislature, in the year 1619, vol. 1, New York, 1823.

[4] Hening, op. cit., vol. 2, p. 140.

of oystering, ffishing and gathering tuckahoe,[5] cuttyemnions [5a] or other wild fruites by which they were wonted for a greate parte of the yeare to subsist, Be it therefore granted, enacted and confirmed that the said Indians upon

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[5] Smith wrote in 1612, when referring to the food of the Virginia Indians with whom he had come in contact (op. cit., p. 58): "The chiefe roote they have for foode is called *Tockawhoughe.* It groweth like a flagge in low muddy freshes. In one day a *Savage* will gather sufficient for a weeke. These rootes are much of a greatnes and taste of *Potatoes.* They use to cover a great many of them with oke leaves and ferne, and then cover all with earth in the manner of a colepit; over it, on each side, they continue a great fire 24 houres before they dare eat it. Raw it is no better then poison, and being roasted, except it be tender and the heat abated, or sliced and dried in the sun, mixed with sorrell and meale or such like, it will prickle and torment the throat extreamely, and yet in summer they use this ordinarily for bread." This was undoubtedly the same plant that was gathered by the Indians a generation later, and to which reference was made in the Act just quoted. But it is evident that in later years many, if not all, edible roots became known as tuckahoe to the English colonists, although they may never have been known as such to the Indians.

A century later, in 1749, Peter Kalm (Travels into North America, second edition, London, 1772) mentioned several plants to which the name tuckahoe was then applied. He wrote (pp. 387-388): "*Taw-ho* and *Taw-him* was the Indian name of another plant, the root of which they eat. Some of them likewise call it *Tuckah;* but most of the Swedes still knew it by the name *Taw-ho.* It grows in moist ground and swamps . . . Nor did the Indians ever venture to eat them raw, but prepared them in the following manner: They gathered a great heap of these roots, dug a great long hole, sometimes two or three fathoms and upwards in length, into which they put the roots, and covered them with the earth that had been taken out of the hole; they made a great fire above it, which burnt till they thought proper to remove it; and then they dug up the roots, and consumed them with great avidity. These roots, when prepared in this manner, I am told, taste like potatoes. The *Indians* never dry and preserve them; but always take them fresh out of the marshes when they want them. This *Taw-ho* is the *Arum Virginicum,* or *Virginian* Wake-robin."

The following note by Dr. Frederick V. Coville tends to identify the plant first called Tockawhoughe by the Virginia colonists: "*Peltandra virginica.* The old Indian name, tuckahoe, appears never to have been adopted by botanists as the common name of this important Indian food plant. It has been called Virginia wakerobin because of its close relationship to *Arum maculatum,* the wakerobin of England. It has also been called by botanists arrow-arum, because of its arrow-shaped leaves." Dr. Coville was convinced of the correctness of the conclusion, but desired to determine for his own satisfaction the edibility of the roots before the statement should appear in print. In the endeavor to collect roots of the plant, *Peltandra virginica,* we visited Hunting Creek, on the Virginia side of the Potomac just below Alexandria, Dec. 29, 1936, but were unsuccessful as the leaves had disappeared because of the lateness of the season, and the roots could not be identified. Dr. Coville was taken ill a few days later and died on Jan. 9, 1937, and thus the work remained unfinished.

[5a] The wild fruit to which the name cuttyemnions was applied has not been identified, but the etymology of the word has been determined by John P. Har-

addresse made to two of the justices of that county they desire to oyster or gather wild fruite in, as aforesaid, they the said justices shall grant a lycense to the said Indians to oyster or gather fruites as aforesaid.

But the time was to be limited, and the Indians were to have with them "only such tooles or implements as serve for the end of their comeing." No guns were to be carried.

The use of badges in identifying Indians when they visited the English settlements is mentioned in the same act. It was stated in part:

. . . because an intervall betweene the Indians and English cannot in the present neernesse of seating be soe laid out as may wholly secure the English from the Indians comeing in and pilfering things from them if a free intercourse be admitted, *Be it therefore enacted* for the prevention thereof and to the end that the nations may be distinguished and soe if they are taken in the manner of doing any injuryes the sufferers know to what kings to addresse themselves for remedy, that badges (vizt.) silver plates and copper plates with the name of the towne 'graved upon them, be given to all the adjacent kings within our protection. And that all the said kings give it in charge to their people that none of them presume upon what occasion soever to come within the English bounds without those badges upon them or one with a badge in their company, and if any damage or injury be done to any Englishman by them or any of them, that then the king or greate man of the place the badge denote shalbe answerable for itt; and if any shall notwithstanding this injunction be found in our bounds without any such badge[6] or not accompanied with one that shall have them, that then it shall be lawfull for any Englishman to apprehend and carry him or them before any justice of the peace who shall keepe him or them in safe custody untill their king or greate man ransome them by paying one hundred armes length of rohonoake[7] for each Indian soe taken . . .

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rington, of the Bureau of American Ethnology, who states: "The name 'cuttyemnions' evidently refers to some small black or dark-colored berry, the species of which has not been determined. The name is to be analysed as follows: cutty-, black, phonetically kate or makate; -min, berry of any kind; -an or -in, suffix denoting plural of inanimate objects, pluralizing the element -min. The name therefore means small black colored fruits or berries."

[6] Certain of the large metal plates discovered by Judge Graham in burials on the banks of Port Tobago River, Maryland, may have been used as badges; however, the surfaces of the specimens are greatly corroded, and if names had been engraved on them as mentioned in the Act, all traces have disappeared.

[7] The writer is of the belief that this referred specifically to the small shells, *Marginella virginiana* Conrad, which occur in vast quantities in the waters of the Chesapeake. The shells were perforated and strung on threads of sinew to serve as ornaments. The belief is suggested by a brief reference found in the small printed catalog of the Museum Tradescantianum, published in London, 1656. On p. 47 of the catalog is mentioned: "Pohatan, King of Virginia's habit all embroidered with shells, or Roanoke." This was one of the pieces associated with the famed coronation of Powhatan during the autumn of 1608, when the

The reply to a question submitted to the Governor of Virginia, by the Lords Commissioners of Foreign Plantations in 1670 was: "The Indians, our neighbours are absolutely subjected, so that there is no fear of them."[8] This referred to the Indians within the colony. However, if peace prevailed within the colony, there was always much to fear from beyond the frontiers.

The Assembly of March 1675-6, anticipating an invasion of the colony and attacks on the outlying settlements, passed "An act for the safeguard and defence of the country against the Indians." This act, after mentioning the garrison to be located on the Potomac in Stafford County, continued: "one hundred and eleven men out of Glocester county to be garrisoned at one ffort or place of defence at or neare the ffalls of Rapahanack river, of which ffort major Lawrence Smith to be captain or cheife comander."[9]

The acts passed "At a Grand Assemblie, Holden at James Cittie the fifth day of June, 1676", included much of importance concerning the Indians of the colony and others who lived beyond the bounds. This assembly was held while the colony was dominated by Nathaniel Bacon and his followers, and consequently the acts became known as Bacon's Laws. Act I was "An act for carrying on a warre against the barbarous Indians", which referred to the Conestoga, who had harassed the Virginia frontiers and had later sought refuge near the Occaneechi far south in the present Mecklenburg County, Va. The act mentioned the number of troops to be raised in the several counties, supplies to be collected, and other questions relating to the proposed campaign.

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latter "gave his old shoes and his mantle to Captain Newport" (Smith, op. cit., p. 125). The remarkable specimen is now in the Ashmolean Museum, Oxford, England. The ornamentation was formed by attaching great numbers of the shells, *Marginella virginiana,* to the deer skins of which the "habit" or "mantle" was made. As defined in the Handbook of the American Indians (Bureau of American Ethnology, Bull. 30): "Roanoke. A name applied, with several variants, by the Virginia colonists, to the shell beads employed by the neighboring Indians as articles of personal adornment or media of exchange; a case of substitution of a familiar word for one that was ill understood and probably more difficult to pronounce. Capt. John Smith (1612 and 1624) gives the Powhatan name for shell beads in the form of *rawrenock* and *rawranoke,* and William Strachey defines *rarenaw* as 'a chain of beads.' The root *râr* means to 'rub', 'abrade', 'smooth', 'polish.' The original word may have been *rârenawok,* 'smoothed shells', pl. of *rarenaw.*"

[8] Hening, op. cit., vol. 2, p. 513.

[9] Hening, op. cit., vol. 2, p. 327.

Act II was "An act concerning Indian trade and traders." This prohibited trade with the Indians and then continued:

Provided nevertheless that it shall and may be lawfull that such Indians who shall serve the English in the warr, and onely such be supplied to the vallue of their wages and pay for the takeing prisoners in such necessary things as they shall want, armes and ammunition wholy excepted, and it is hereby intended that our neighbour Indian ffriends bee not debarred from fishing and hunting within their owne limmits and bounds, useing bowes and arrowes onelie. *Provided also* that such neighbour Indian ffriends who have occasion for corne to releive their wives and children, it shall and may be lawfull for any English to employ in fishing or deale with fish, canooes, bowles, matts or basketts, and to pay the said Indians for the same in Indian corne, but noe other commodities . . .[10]

This is of the greatest interest in proving that the English made use of dugout canoes obtained from the Indians, and also pottery vessels, rush mats, and baskets made in the Indian villages. The use by the colonists of such material of Indian make was probably general throughout the English settlements. It is likewise evident that fish were obtained by the English from the Indians, and much game may have been procured from the native hunters, who continued to use their bows and arrows.

During the meeting of the assembly, June 1676, when forces were being gathered for the intended expedition against the "barbarous Indians", it was ordered that "the forte in Rappahannack countie commanded by major Lawrence Smith, which was settled or intended to be settled by vertue of a late act of assembly, be forthwith deserted . . . " The troops were to be ordered to other posts on the frontier where conditions were more serious. This was only 3 months after the order had been given for the erection of the frontier "ffort or place of defence", and if ever erected, which is doubtful, it would probably have resembled the palisaded structures so characteristic of the wilderness far beyond the mountains a century later.

By the autumn of 1677 the growing importance of trade with the neighboring Indians was acknowledged by the burgesses, and acts were passed setting forth the manner in which it was to be conducted. On October 10, 1677, the Grand Assembly met at the house of Capt. Otho Thorpe, at Middle Plantation. Act III of that date, "An act lycensing trading with Indians", was of great importance. It read in part:

Forasmuch as the totall prohibition of tradeing with Indians is experimented and found hurtfull and prejudiciall to his majesties colony and the inhabitants

[10] Hening, op. cit., vol. 2, p. 350.

thereof; *Bee it therefore enacted by the governour, councell and burgesses of this present grand assembly, and the authority thereof, and it is hereby enacted,* that all Indians whatsoever being in amity and ffriendship with us from henceforth shall have free and full liberty to come in amongst us and bring in any comodities whatsoever to the severall places and at the severall tymes hereafter sett downe, and mentioned, and to trade with, sell or truck, for the same with the English, resorting thither, but noe where else for any comodityes whatsoever, and that such marts of ffaires continue fforty dayes and noe longer, (that is to say) . . . the place for the marte or ffaire in Rappahanock river to be appointed and set downe by the justices of the peace in Lancaster county, being mett and satt in the court, the begining of which marte or ffaire to be yearely the twentyeth day of Aprill and the twentyeth of September . . .

A similar "marte or ffaire" was to be held in Stafford County, beginning on April 30 and September 30 each year.[11]

A description of a gathering at a "marte or ffaire", with Indians and colonists coming together to trade, would be of the greatest interest, but none is known to have been preserved. Nor is there any known record of when or where such a gathering took place.

Two years later the protection of the outlying settlements again caused anxiety. The first act of the Grand Assembly "begunn at James Citty the 25th of April, 1679" was "for the defence of the country against the incursions of the Indian enemy." This provided "that fower houses for stores or garrisons be erected and built at the heads of the ffower greate rivers." The Rappahannock was one of the four. Two structures were to be erected at each chosen site, of the same dimensions, described as "one store house to be strongly built, and well covered to be sixty foot long, and twenty two foote broad, and one small house of tenn foot square to be strongly built for ammunition." Maj. Lawrence Smith of Gloucester County was in command at the falls of the Rappahannock. The frontier posts were maintained until the autumn of 1682, when it was ordered "that the said severall forts and garrisons be dismantled . . ."[12] The Indians were no longer feared as formerly, and to supply the garrisons proved a burden to the colony.

Thus, just three-quarters of a century after Captain Smith had been conducted by his Indian captors to their settlements on the banks of the Rappahannock, the native population of the entire valley had been dispersed and the sites of many of their villages, with the surrounding cornfields, had become plantations of the English colonists.

[11] Hening, op. cit., vol. 2, p. 410.

[12] Hening, op. cit., vol. 2, p. 498.

MOVEMENT OF TRIBES INDICATED BY NAMES ON THE AUGUSTINE HERRMAN MAP, 1673

The history of the Indians of the Rappahannock valley during the years from 1650 to 1670 would undoubtedly reveal a movement and shifting of many tribes from the localities in which they were encountered in 1608 and prove that others from a distance had entered the region.

Although no references to the actual migration of native tribes from Maryland across the Potomac to Virginia have been discovered, it is evident that soon after the middle of the seventeenth century such movements did occur and that tribes or parts of tribes crossed to the right bank of the stream and thence continued to the Rappahannock, where they established new homes. This alone would explain the occurrence of certain names on the Herrman map, which was issued in 1673. A section of the map, representing that part of the Rappahannock valley now being considered, is reproduced in figure 2. The names that were recorded on that part of the river in 1608 have disappeared and have been replaced by some that were at that time applied to villages beyond the left bank of the Potomac.

The official records of Maryland are replete with references to the native tribes with whom the settlers came in contact. Many lived within the Province, others came from beyond the bounds. Brief quotations from the records will make clear the causes which are thought to have led, ultimately, to the removal of many tribes from their earlier habitat. But such movements had continued through the centuries.

On March 24, 1652, just 20 years after Cecil, Lord Baltimore, had received from Charles I the charter for Maryland, it was stated that:[13] "Whereas there is Great Suspicion that the Indians intend Some Mischeife to the Inhabitants of this Province", for which reason Thomas Gerrard was ordered to raise a sufficient force and "repaire to Portoback or Choptico and (if he think fitt) either disarme or Secure the persons of any of the Said Indians till Examinacon had touching the premisses or further Order."

Later in the same year a document of importance was recorded, being: "Articles of Peace and freindshipp treated and agreed upon the 5th day of July 1652 Betweene the English Nation in the Province of Maryland on the one party, And the Indian Nation of Sasquesahanogh on the other partie . . ." But this was not concluded for

[13] Archives of Maryland. Proceedings of the Council of Maryland, 1636-1667. Maryland Hist. Soc., Baltimore, 1885.

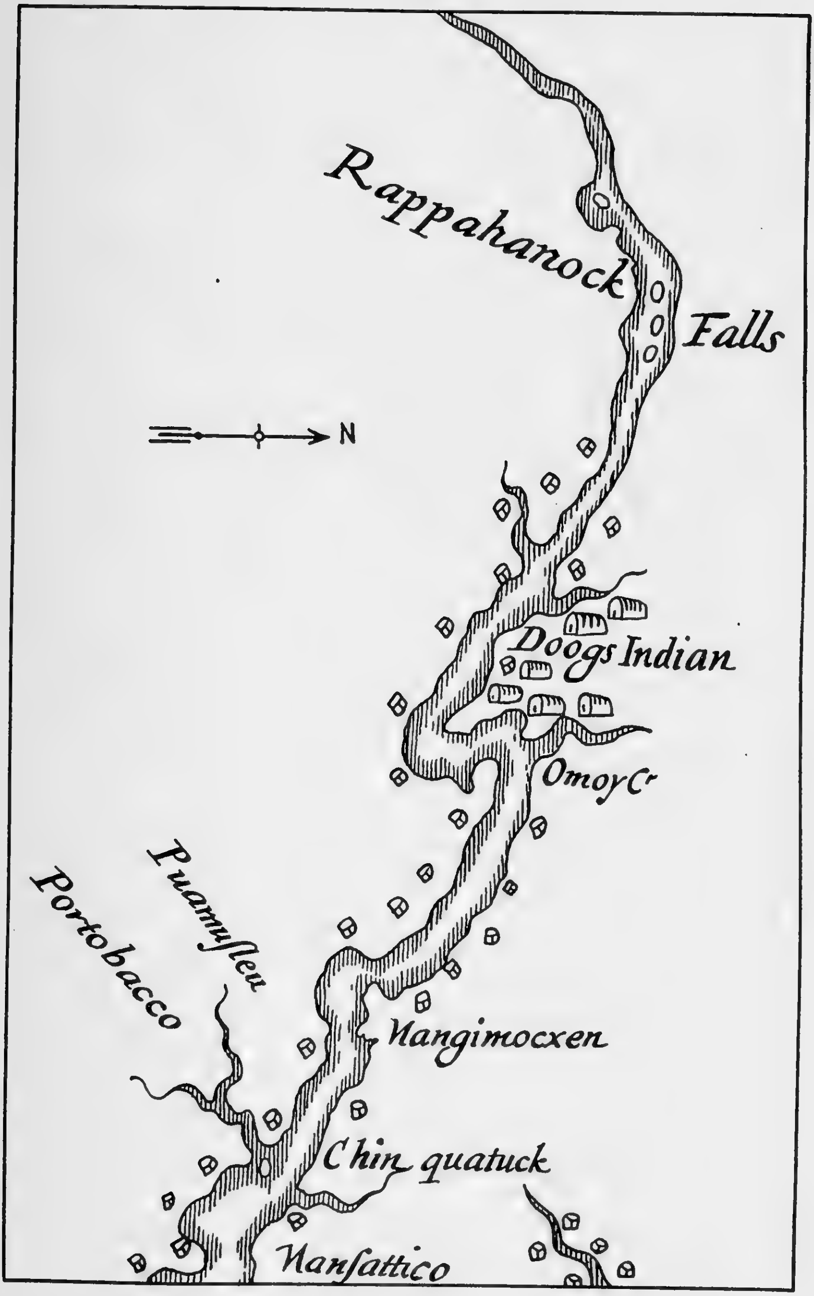

FIG. 2.—Section of Augustine Herrman map, 1673. The Rappahannock from below Leedstown to the falls.

some years (not until September 16, 1664), after other questions had been decided.[14] " Then was taken into Consideracon the Articles of peace with the Sasquesahanough Indians dated fift of July 1652."

During the same year that peace was made with the " Indian Nation of Sasquesahanough " trouble developed with the natives on the Eastern Shore, across Chesapeake Bay.

As recorded in the Proceedings of the Council, on November 25, 1652, at a Court held at St. Marys, an expedition was planned against the Indians of the Eastern Shore. It was that day " ordered and appointed that Sufficient forces be Speedily raised for a march against the Said Easterne Shore Indians, and for that purpose every Seventh man throughout the province is to be pressed for this Service . . . " Such an expedition was considered of the utmost importance for the safety of the people of the Province, but it was soon ascertained that the Indians on the Eastern Shore against whom the expedition was directed, as well as others living west of the Chesapeake, had knowledge of the proposed invasion. Consequently, on December 18, 1652, " with divers other very Materiall reasons as the danger of being frozen in and otherwise ", it was decided to defer " the designe till a more Seasonable time and opportunity."

On May 2, 1661, the General Assembly, as recorded in the Proceedings, feared the invasion by Indians from the north. Both houses assented to—

> An acte Impowring the Governor and Councell to Rayse forces and mayntayne a warre without the Province and to ayde the Sasquehannough Indians. Whereas it doth appeare to this prsent Generall Assembly that this Province is in Eminent danger by a warre begun in itt by some forreigne Indians as it hath been made appeare by credible informacon given of a person lately killd and of others that are probably cutt off by these forreign Indians. And that in humane probabillity our neighbour Indians the Sasquehannoughs are a Bullwarke and Security of the Northerne parts of this Province. And that by former treatyes with that nacon they have very much assured us of their affeccons and friendship And that they expected the like from us . . .

That same month peace was renewed between the people of Maryland and the Indians, but this was distinct from the document dated July 1652 and again September 16, 1664. It is presented in the Proceedings of the Council, and reads in part: " Articles of peace and amity concluded on the behalfe of the Lord Proprietary of the Province of Maryland and the Sasqsahannough Indians at a treaty begun at Spes Utia the 16th Day of May 1661 . . . "

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[14] Archives of Maryland. Proceedings and Acts of the General Assembly of Maryland, 1637-1664. Maryland Hist. Soc., Baltimore, 1883.

The agreement was for mutual help and understanding. The fifth article reads: "That the Sasquesahannoughs shall finde the English Souldiers with sufficient fish and flesh, and bread ready beaten." The last item is thought to have been tuckahoe, as described on page 5.

Trouble continued within the Province and on November 17, 1663, the following statement was made to the Council:

Whereas Sundry Complaints have been made unto mee by the Queene of Portaback in behalfe of her Selfe and Indians undr her, Intimating how that they have not only left their Towne standing by the water, but have removed themselves farther of even to their utmost bownds of their land—Leaving place to the English to Seate on theire ancient plantacons by the River side the English not being (as they informe mee) contented with what Land is allready freely granted Doe still take up land and Seate themselves very nigh unto the said Indians whose stocks of Cattle and hoggs doe and will yearely destroy theire Corne fields by which meanes they must of necessity come to ffamine they not knowing the way and meanes to fence in theire Corne ffeilds as the English doe will soon come to destruccon . . .

The English were then ordered to remain away from the Indian lands.

The northern Indians again invaded the Province and soon reached the banks of the Potomac and the shore of Chesapeake Bay. As recorded in the Proceedings of the Council:

Att a Councell held the 27th June 1664: Then was taken into Consideracon the prservacon of the province agt the incursion of the Cinego Indians[15] who lately killed some English in Ann Arundell County & alsoe entred the County of St Marys, Ordred tht Warr be pclaimed agt the Cinego Indians tht a Reward of a hundred Armes lenght of Roan Oake be given to evry pson whether Indian or English tht shall bring in a Cinego prisonr or both his Eares if he be slayne . . .

Many Maryland Indians may at this time have crossed the Potomac to seek new homes in Virginia, where they became established on more ancient sites that had been seen by the English in 1608 and which were shown on the 1624 map. However, it is evident that all did not abandon their lands beyond the Potomac in Maryland, and the names of many tribes were joined in a treaty made 2 years later. This was recorded in the Proceedings of the Assembly:

Articles of peace & amity concluded agreed upon between the Rt. honoble Caecilius Lord & Propr. of the Province of Maryland & Avalon Lord Barron, of Baltemore & the Indians of Pascattoway Anacostanck, Doags, Mikikiwomans, Manasquesend, Mattawomans, Chingwawateick, Hangemaick, Portobackes, Sacayo, Panyayo, & Choptico the 20th day of Aprill 1666.

The treaty contains many interesting references to conditions and customs, and to the privileges accorded the Indians.

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[15] The Seneca Indians; the name Seneca, however, was usually applied to all members of the Five Nations.

Augustine Herrman finished gathering data for his map during the year 1670 and then forwarded it to London, where the plates were engraved by William Faithorne and where the map was issued in 1673.[16] Consequently, the names that appear on that part of the map which is reproduced in figure 2 were the names of villages then inhabited—comparatively recent settlements which occupied more ancient sites. The different tribes or groups whose names they bore were not encountered on the banks of the Rappahannock by the first party of English from Jamestown, who ascended the stream in 1608.

Portobacco and Doogs Indian, names on the map, are obviously the Portobackes and Doags mentioned in the treaty of 1666. The former was one of the best-known tribes of Maryland, and when the English ascended the Potomac in 1608, their village was mentioned as " Potapaco with 20 [men]." This was in the present Charles County, Md. The name which in English is bay or cove later became corrupted into Port Tobacco.[17] True, the name would have been applicable to the great bay, now known as Port Tobago or Port Tobacco, on the south side of the Rappahannock, but it does not appear to have been so designated in 1608, certainly not on the 1624 map.

Beverley,[18] writing after 1692, referred to the scattered tribes then living in different parts of Virginia. He said in part: " In Richmond Port-Tobago, bout five Bow-men, but Wasting." This was Richmond County, on the left bank of the Rappahannock adjoining Westmoreland. The small remnant probably numbered about 20 individuals and was decreasing. This particular group may never have lived south of the river, in which event they had retained the name by which they were known in 1608, when living on the Maryland side of the Potomac, although they had become separated from other members of the tribe.

The identity of the tribe or tribes known as the Dogue or Doag Indians has not been clearly determined. The name does not occur in early records of Virginia and evidently does not appear until after the middle of the seventeenth century. The tribe is believed to have been part of the Nanticoke, on the Eastern Shore of Maryland,

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[16] Phillips, P. Lee, The rare map of Virginia and Maryland, by Augustine Herrman. Washington, 1911.

[17] Judge William J. Graham, Washington, D. C., who examined many sites on both sides of the Port Tobacco River, described them in a paper: The Indians of Port Tobacco River, Maryland, and their burial places, n.p., n.d. [1935].

[18] Beverley, Robert, The history and present state of Virginia, book 3, p. 62, London, 1705.

whence they may have removed, some having crossed the Potomac and continued to the banks of the Rappahannock. The tribal name is found in Maryland on early land grants and surveys:[19] "Doegs Point in Mattawoman Creek", Prince Georges County, 1699; and "Doags Neck", Charles County, 1657, both counties bordering on the Potomac. Also several references to tracts in Kent County, on the Eastern Shore, dated 1704 and 1705: "On a branch called Dogue Branch and on the north side of Chester River", and again "on the north side of a Branch called Dogue Branch just below a meadow called Chester Meadow."

The latter references are interesting as they apply to places within the region still occupied at that time by the Nanticoke.

Chinquatuck[20] of the Herrman map may be the Chingwawateick of the 1666 treaty.

The occurrence of the names on the Rappahannock should be accepted as proof that at some time before 1670, when northern Indians were invading Maryland and harassing the English settlements and native villages alike, many of the Indians whose lands had thus been invaded sought refuge across the Potomac in Virginia. The different groups may have been rather small, but of sufficient size to cause their old tribal names to become identified with the sites they occupied.

SITES OF ANCIENT SETTLEMENTS

The locations of many native settlements are shown on the Smith map of Virginia, often referred to as the 1624 map. These differed greatly in size and importance, and some were the villages of chiefs whose influence may have extended to the smaller groups outside the principal settlement. The names of such villages are accompanied on the map by a small representation of a habitation, the "Kings howses" as they were described in the legend. Three such relatively important towns stood on the banks of the Rappahannock within approximately 40 miles of the falls. The first of these settlements to be reached in ascending the river was Pissaseck, on the left or north

[19] I am indebted to William B. Marye, Baltimore, Md., for the references quoted.

[20] According to information furnished by Judge Alvin T. Embrey, Fredericksburg, Va., this small stream, which enters the left bank of the Rappahannock and which bounds Woodlawn, the old Turner plantation, was formerly known by the name Chingoteague, and was so recorded on several deeds, as in Deed Book 1, p. 620, and Deed Book 1A, p. 147, King George County, Va. The name at once suggests Chincoteague Bay on the Eastern Shore, being part in Virginia and part in Maryland.

bank; next above was Nandtanghtacund, on the shore of a deep bay on the opposite side of the stream; and far above was Cuttatawomen, on the left bank. Other settlements, evidently of less importance, are indicated on both banks of the river, but none is shown within about 10 miles of the falls. It appears that in 1608 there were no Algonquian camps on the Rappahannock for some distance below the great island, westward from which the country was dominated by Siouan tribes, whose steady movement down the valley may have caused the abandonment of the Algonquian villages.

It is thought that some sites indicated on that part of the 1624 map, figure 1, have been identified. These will now be briefly described, beginning with Pissaseck, thence up the river, thus approaching the "bounds betwixt the Kingdome of the *Mannahocks* and the *Nandtaughtacunds*." All are shown on the map, figure 3.

Pissaseck

This large settlement stood on the left or north bank of the Rappahannock, and although not specifically mentioned in the early narratives as being one of the native villages encountered in 1608, during the exploration of the river, its position, as well as its importance, is shown on the 1624 map by a "Kings howse." It occupied a level area high above the river, below and adjoining an extensive marsh, known as Drakes Marsh, where even now much game and wild fowl is killed each year. It was an ideal site for a native village, and the vast amount of broken pottery and innumerable objects of stone that are and have been recovered from the surface prove it to have been one of great extent and one that had been frequented through generations. The position of the village agreed with the general description of the environment of native settlements as presented by Strachey.[21] He wrote (p. 70):

> Theire habitations or townes are for the most part by the rivers, or not far distant from fresh springs, comonly upon a rice of a hill, that they may overlooke the river, and take every small thing into view which sturrs upon the same. Their howses are not many in one towne, and those that are stand dissite [dispersed] and scattered without forme of a street, farr and wyde asunder.

The site of the ancient village is shown in the aerial photograph reproduced in plate 2. It stood on the far or left bank of the river —now expanded and assuming the appearance of a lake—above the

[21] Strachey, William, The historie of travaile into Virginia Britannia. Hakluyt Society, London, 1849.

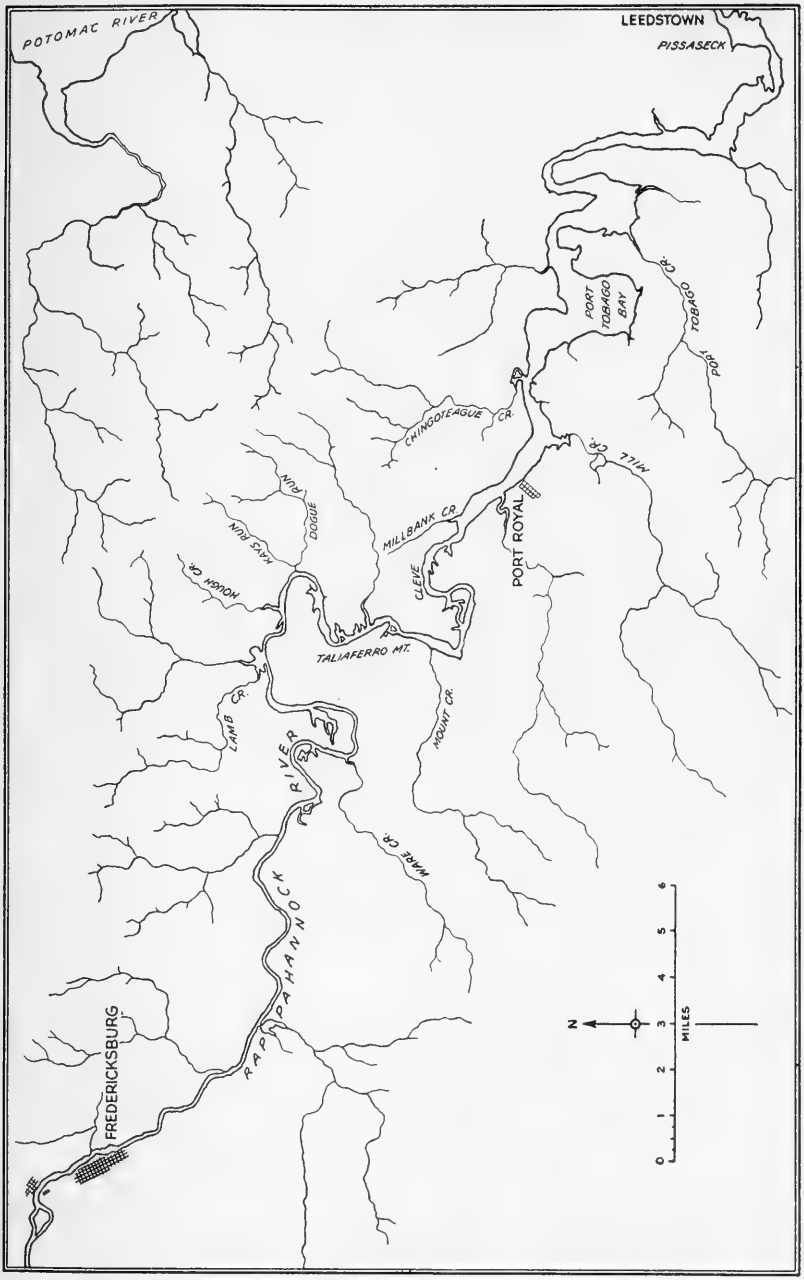


FIG. 3.—The Rappahannock from Leedstown to the island at the falls above Fredericksburg.

small white arrow which points with the current. The few houses just within the cloud-shadowed area to the right are all that remain of Leedstown. During the days of Indian occupancy the greater part of the land was covered with forests which extended to the edge of the water, and here, not far distant from the river, were the scattered habitations with the fields and gardens nearby.

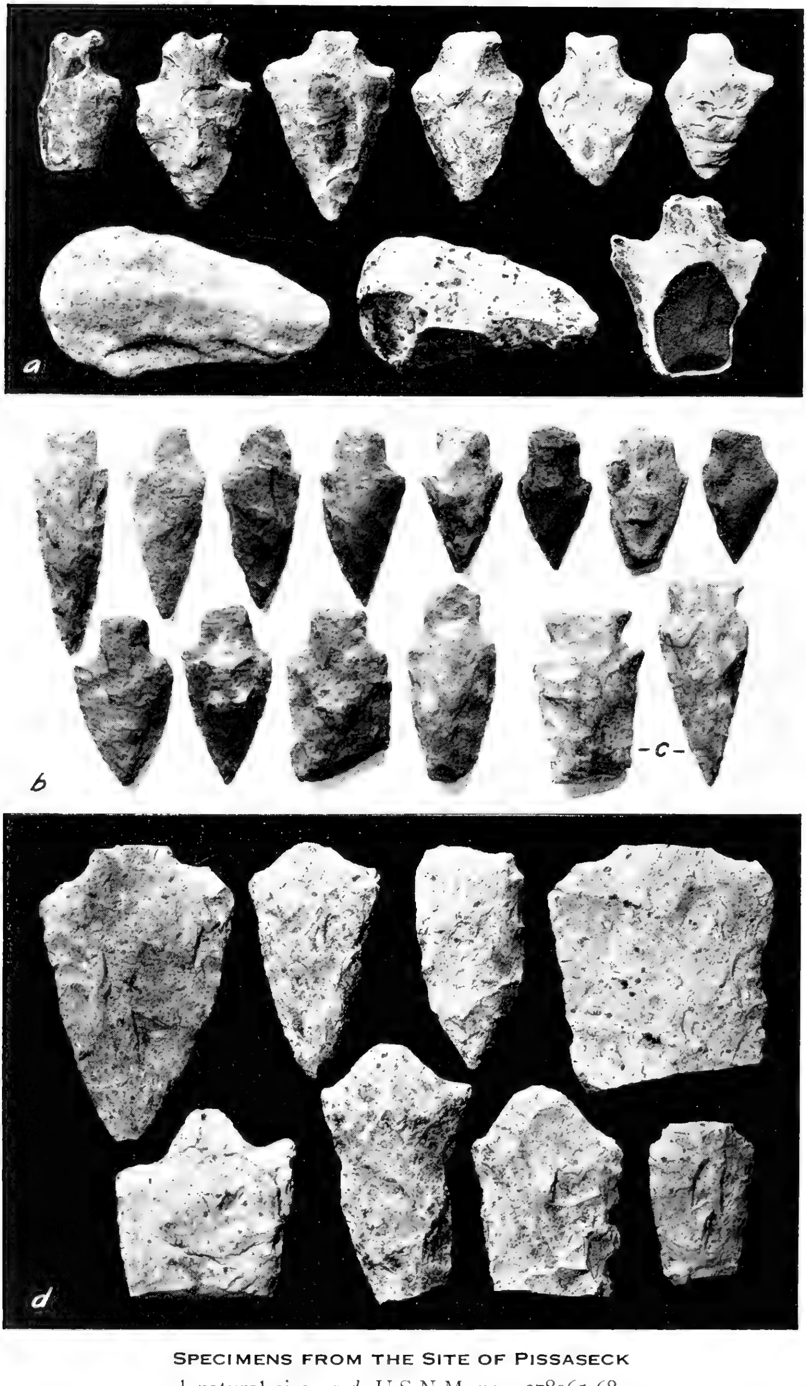
English traders were probably established at or near Pissaseck by the latter part of the seventeenth century, and a "marte or ffaire" may have been conducted in the vicinity. The old road leading to the Potomac undoubtedly follows the route of a more ancient trail that led to the native settlements. The region continued to become of greater importance to the colony and was more thickly settled with the building of warehouses on the bank of the river. Here was soon to be reared the town of Leeds.[22] Scant traces of the colonial town remain, and these are now encountered intermingled with the stone implements and bits of earthern vessels made and used by the earlier occupants of the region. However, the brick structures erected in the town covered only part of the land that had formerly been included in the native settlements, assuming the site to have been occupied and reoccupied through generations, long before the coming of the English.

Again referring to the aerial photograph: A triangular tract is visible immediately above the white arrow. This is 15 acres in extent and is bordered by the river for more than 1,200 feet. The material now illustrated and described came from the surface of this tract, the greater part of it having been found in the extreme western part—the left as shown in the photograph—a short distance back from the river. Although having been discovered on the surface, exposed by the plow and erosion, it is within reason to believe it is material that had accumulated in refuse heaps, overgrown with vegetation, later to become scattered and spread as the ground was cleared and cultivated. This hypothesis alone would explain the great variety of flaked objects, believed to indicate different periods of occupancy,

[22] The General Assembly, convened at Williamsburg, May 1742, passed an act for the establishment of a town "on the north side of Rappahannock river, in the County of King George, where the church and public warehouses are built . . . The said town shall be called by the name of Leeds." (Hening, op. cit., vol. 5, pp. 193-197). The area to be occupied, with the placing of streets and buildings, was described. Later, it was known as Leedstown, which became an active center of trade, with wharves and warehouses, whence quantities of tobacco and other products of the colony were sent to England, and where sailing vessels landed supplies for the rich plantations on the Northern Neck.

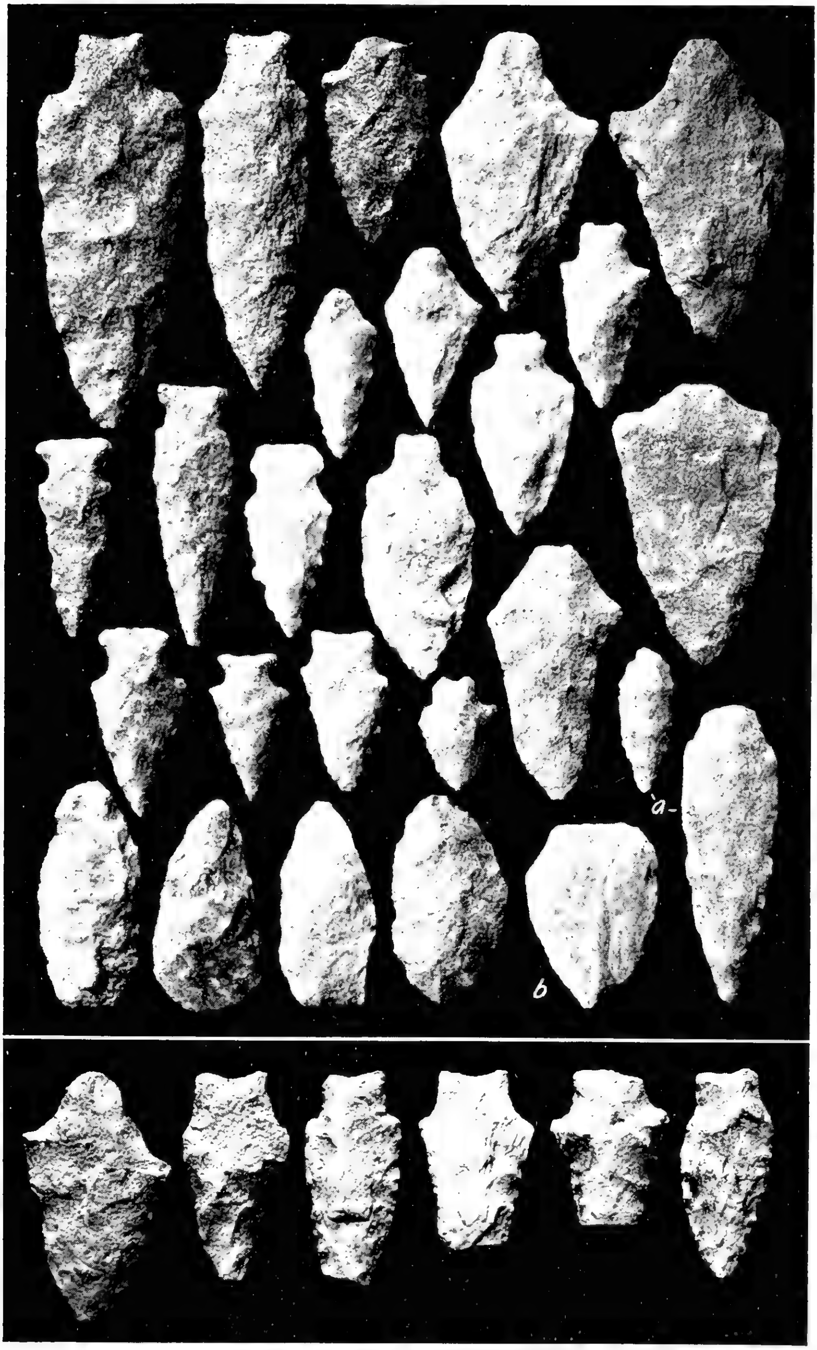
Photograph U. S. Army Air Corps.

North over the Rappahannock, Showing Leedstown and the Site of Pissaseck



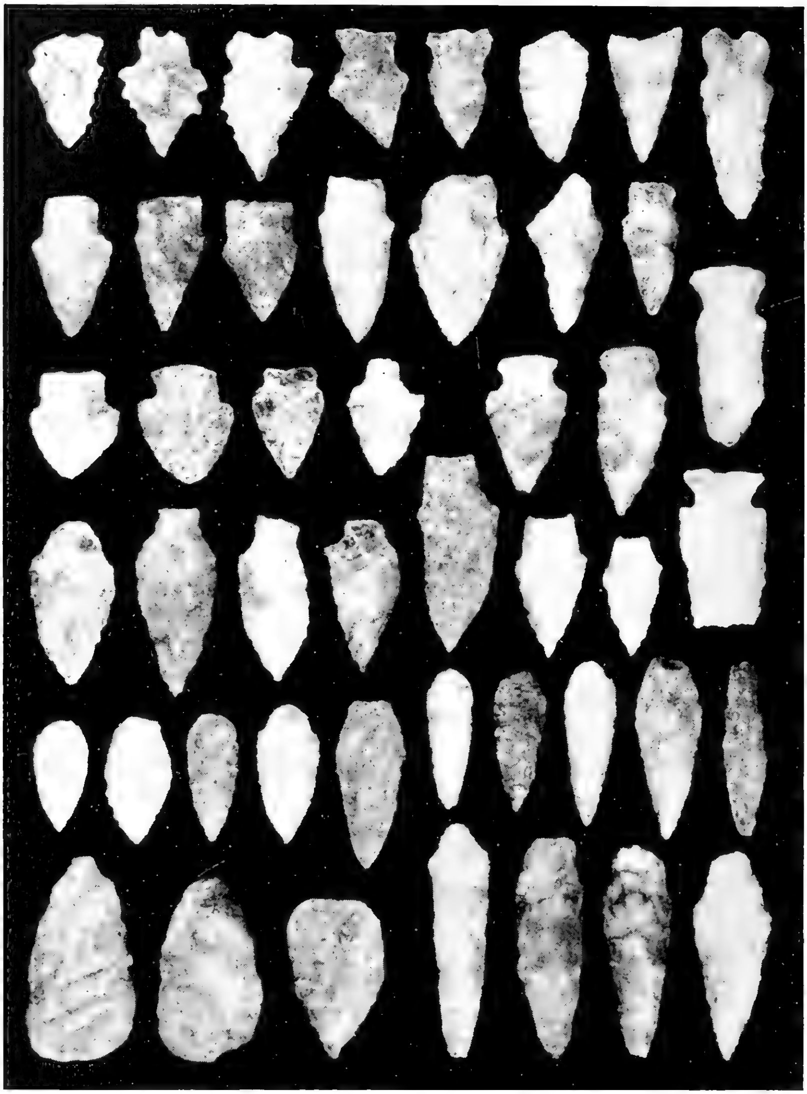
SPECIMENS FROM THE SITE OF PISSASECK

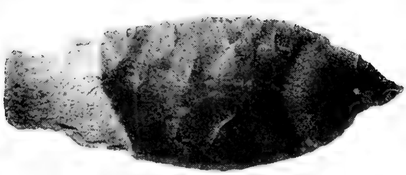
½ natural size. *a-d*, U.S.N.M. nos. 378065-68.



SPECIMENS FROM THE SITE OF PISSASECK

½ natural size. Above, U.S.N.M. no. 378069; below, U.S.N.M. no. 378070.





SPECIMENS FROM THE SITE OF PISSASECK

½ natural size. Above, U.S.N.M. no. 378071; below, U.S.N.M. no. 378072.

and the vast amount of fragmentary pottery, now recovered from the site. And, of course, the variety of objects, rather than the quantity, is of the greater interest.

To describe the material briefly:

Plate 3.—Specimens *a*. Seven examples of projectile points or knives, and two side scrapers, made of dark brown argillite, now weathered and bleached to a light yellowish color. The large broken blade in the lower right corner has recently been fractured, thus revealing the natural shade of the argillite and the extent to which the surface has been altered through long exposure. The condition and appearance of the specimens suggest great age. The specimens closely resemble certain material recovered from sites in the Delaware valley, artifacts belonging to the so-called argillite culture, which have been discovered in the yellow sand or soil below a stratum of black surface soil.[23]

Specimens *b*. Twelve projectile points made of dark, very compact, argillitic slate. These also resemble specimens from the Delaware valley figured and described in the works just cited.

Specimens *c*. Two specimens made of rhyolite of a light bluish-gray color, showing flow structure and slightly altered. A cache of 32 pieces, of the same form and material, many of which are in the United States National Museum (U.S.N.M. no. 756), were found in 1861 on the farm of Joshua Pierce, on Rock Creek, Washington, D. C. The farm surrounded the old Pierce Mill, on the bank of Rock Creek, where it is now crossed below Tilden and Upton Streets.

Specimens *d*. Eight examples of comparatively large blades made of rhyolite. The majority are broken, but the portions remaining reveal the characteristic features. All are very thin and are beautiful examples of flaking. These are altered to a greater degree than are the two specimens *c*. The stone, containing crystals of feldspar, was evidently derived from quarries in South Mountain, " a high group of ridges extending from near the Potomac at Harpers Ferry to the southern side of the Susquehanna at Harrisburg, Pennsylvania." The quarries were discovered by Holmes in 1892,[24] one, very extensive, " is 75 miles northwest of Washington, and was readily accessible to the inhabitants of Potomac and Patuxent rivers." Numerous scat-

[23] Compare Hawkes, E. W., and Linton, Ralph, A pre-Lenape site in New Jersey. Anthropol. Publ. Univ. Pennsylvania, vol. 6, no. 3, pl. 17, Philadelphia, 1916. Also illustrations in Spier, Leslie, The Trenton argillite culture, Anthropol. Papers Amer. Mus. Nat. Hist., vol. 22, pt. 4, New York, 1918.

[24] Holmes, W. H., Stone implements of the Potomac-Chesapeake Tidewater Province. 15th Ann. Rep. Bur. Amer. Ethnol., pp. 73-77, Washington, 1897.

tered specimens and caches of blades have been found in the surrounding country.

Plate 4.—Above, several types of projectile points, knives, scrapers, and drills, made of quartzite. The material was obtained in the form of boulders and pebbles, so plentiful in the region, and is of various colors and degrees of coarseness. The two specimens *a* are drills which had evidently been inserted in shafts. The points are smoothed and rounded, the effect of the rotary movement of the drill when in use. The point of *b* is likewise worn from use. This and the four specimens to the left in the same row may be classed as scrapers.

At the bottom of the plate are six examples of projectile points, or blades, made of diabase. No other similar pieces were found on the site. All are greatly weathered, including the fractured surfaces of the four broken specimens. The great similarity of form and size of the latter is remarkable. These have been altered to a greenish-brown color, are very rough, and resemble certain of the large implements shown in plate 8.

Plate 5.—A very large proportion of all the small flaked objects found on the site are made of white quartz, all of which had been derived from water-worn pebbles. Such pebbles occur here in vast quantities; the majority are small and so provided an unlimited supply of pieces of suitable size for the making of arrowpoints and of a variety of small implements such as scrapers, drills, and knives. Examples of all are illustrated. Some forms are far more numerous than others, and although a great quantity of broken pieces has been recovered from the site, together with many entire specimens, only one example of the triangular type of point has been obtained. Several varieties occurring on sites farther up the valley, beyond the falls, have not been found here.

A single specimen of much interest is shown at the bottom of the plate. It was found a few inches under the surface, some 50 feet back from the brow of the bank that slopes to the river about 15 feet below. It is made of gray flint [25] which is unaltered. The flaking is

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[25] The specimen was examined by E. P. Henderson, of the Department of Geology, U. S. National Museum, who described the material thus: "This is a gray flint-like material showing banding due to the arrangement of small cavities rather than to a difference in composition of the flint. There are a few brown inclusions of limonite in the gray flint. A light brown siliceous area at one end has not been altered to the flint. In this there are also some brown limonitic inclusions. It appears that the original mass was a nodule of flint with a surface of this light brown material inclosing the gray flint. Since there is a similar inclusion in both portions, it is likely that both have formed at the same time; consequently, the difference is not due to weathering."

clearly defined, and the edges are sharp. A characteristic feature of the type is the increase in the width of the blade near the middle, and in many examples a few flakes are removed from one edge near the point evidently in the endeavor to make the latter sharper. Specimens resembling this from Michigan, Illinois, Indiana, and Kentucky are preserved in the collections of the United States National Museum. The specimen from Kentucky deserves special mention. It is made of a dark brown flint, so plentiful through parts of Kentucky and Tennessee, and was found in a cave a short distance northeast of Bowling Green, Warren County, Ky. It was found in 1888 and was sent to the museum at that time (U.S.N.M. no. 1062, loan). The specimen is embedded for a distance of about three-quarters of an inch in a fragment of human pelvic bone, which it had entered from the front through the body. Thus it had served as a weapon and had undoubtedly been attached as a point of a spear. This discovery suggests the manner in which all similar pieces may have been used. Nevertheless, if mounted as knives or daggers they would have been serviceable in many ways.

The specimen from the site of ancient Pissaseck was undoubtedly made west of the Ohio.

POTTERY

A vast amount of fragmentary pottery has been recovered from the site. It is of a brownish color, often with coils clearly defined, and for the most part containing a tempering of crushed quartz or sand, some of which may have occurred naturally in the clay. With few exceptions the fragments bear on the outer surface the impressions of nets or single cords; a few reveal the use of closely woven fabrics. A single shard appears to have been decorated with straight, very regular lines, which had been made by impressing some hard material into the clay when the latter was in a plastic state. One fragment, appearing to be older than the majority, bears the impression of basketry.[26]

Plate 6.—The nine specimens forming the three upper rows are bits of rims of vessels and show several forms of impressions. The large piece on the top row is part of a rim that measured about 8 inches in diameter. It is coiled ware, and the difference in height of the two ends of the specimen represents the height of one coil of clay

[26] I am indebted to E. G. Cassedy, by whom all drawings were made, for assistance in determining the nature of the textiles which were impressed on the pottery vessels.

used in building up the wall of the vessel. The fracture has followed the line of contact of two coils. On the right may be seen the bottom of a coil of clay which had been worked down over the one below, but which had not become closely combined.

The triangular fragment in the top row shows very deep, sharply defined impressions of single cords which continued over the top of the vessel. The cords passed at an angle over the rim, forming a very rough surface. It is flat and does not have the usual curved surface of a rim, which suggests a vessel with a square opening.

The large, worn fragment on the left end of the second row is the only piece found on the site that bears the impression of what is believed to be basketry. The texture of the ware differs from that of the majority of specimens. It is more porous, and on the surfaces are many small cavities caused by the leaching away of the tempering material, thought to have been crushed shells. The rim was indented in a manner somewhat similar to *a,* next to be described, but had become smoothed from use. The vessel was evidently large.

The two forms of rim decoration mentioned are found more clearly defined on other specimens.

Specimen *a*. Coiled ware, with surface greatly weathered and now bleached to a light brownish color. On the surface are many very faint impressions of fine, twisted cords which may have been part of a net. The clay evidently contained a small amount of shell tempering which has decayed, resulting in the few cavities which are now visible on the surface and on the fractured edges. The rim is decorated as shown, exact size, in *a,* figure 4.

Specimen *b*. Very hard, compact ware, which does not show any evidence of coils of clay in forming the vessel. Tempering very coarse sand, two pieces of which project from the right side of the fragment and are visible in the photograph. The surface bears the impression of a net which had been carried over the top and impressed on the rim. This is drawn, natural size, in *b,* figure 4. Many specimens found on the site were similarly decorated.

As previously mentioned, many fragments of earthenware bear the impressions of nets. The meshes of some were small and regular, others were much coarser and made of heavier cords.

Specimen *c*. A very hard ware that contains much sand, some of which is very coarse; one piece of quartz, being as thick as the wall of the vessel, is exposed on both the inside and outside. The surface of this bit of pottery reveals the impression of a beautiful example of net making. The cords are finer than the great majority, and the

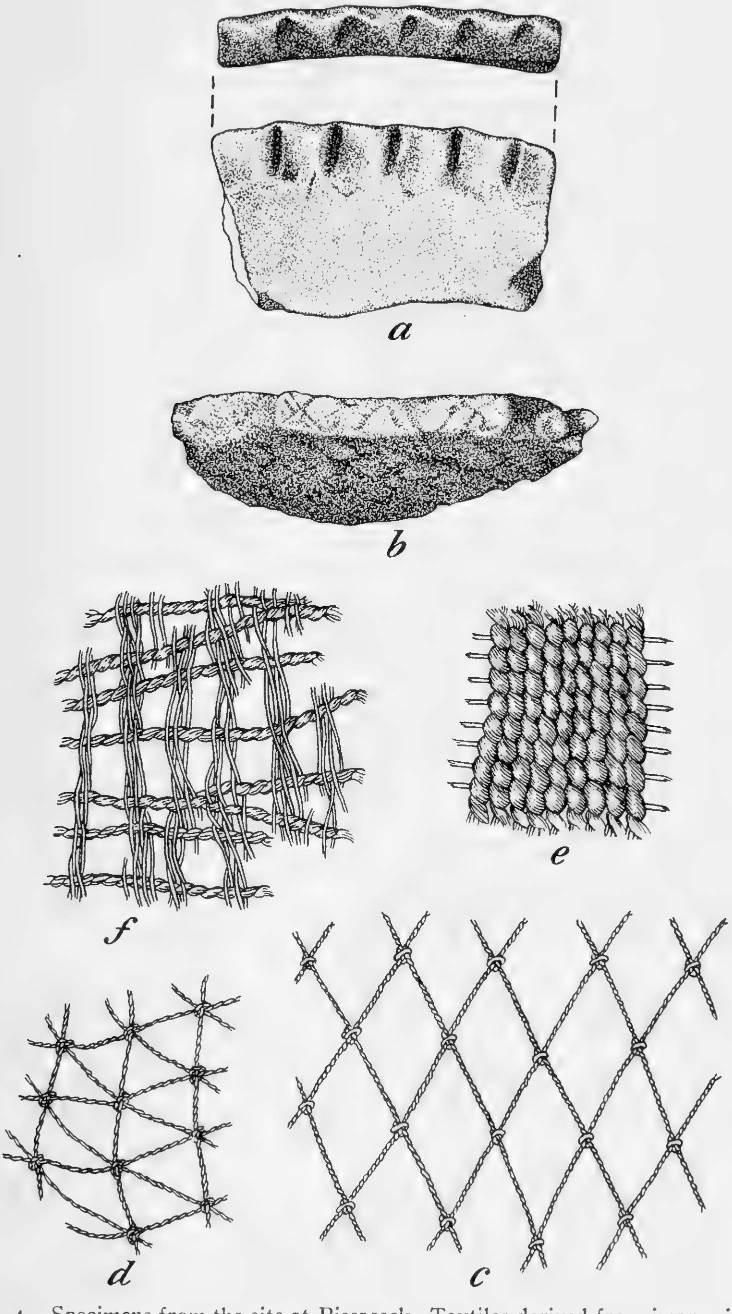

FIG. 4.—Specimens from the site at Pissaseck. Textiles derived from impressions on fragments of pottery. Natural size.

knots are more evenly placed. The net, restored, and drawn natural size, is shown in *c,* figure 4.

Specimen *d.* Coiled ware, porous but very hard. There are numerous small cavities caused by the leaching away of the tempering material, probably crushed shells. The impression on the surface was formed by a net in which apparently an extra series of small cords had been knotted across the original meshes, thus dividing each of the latter into two triangular sections. This unusual feature is more clearly shown in the drawing of the restored material, reproduced natural size in *d,* figure 4.

Specimen *e.* A hard, compact ware, very dark in color, with no indications of a tempering material. The impression on the outer surface was made by a closely woven fabric. The warp elements were very slight when compared with the thickness of the woof. The latter had probably been made of the hair or wool of some animal—possibly the bison. Drawn and reproduced natural size in *e,* figure 4.

Specimen *f.* Coiled ware, compact, with no trace of tempering. This differs from the preceding specimen in that the warp elements are very coarse, appearing to be twisted cords, possibly a vegetal substance. The woof is composed of many small strands. This is restored and drawn exact size in *f,* figure 4.

Plate 7.—Specimen *a.* The ware is very hard and has weathered to a light brown color. It is extremely porous, containing many cavities caused by the leaching away of the tempering material, probably crushed shells. The deep, sharply defined lines on the surface were formed by impressing some hard, rigid object in the clay while the latter was still in a plastic state. This is the only example of this form of decoration encountered on the site.

Specimen *b* is a small knob which appears to have projected from the side of a vessel. The ware is hard, of a reddish color, and contains a small amount of crushed quartz as tempering. The surface bears the impression of twisted cords, evidently a piece of cloth or net which had been pressed against the mass of clay. Nothing similar is known to have been found on the site.

Specimens *c, d,* and *e* are three fragments, each showing the edge or beginning of the bottom of the vessel, with a small part of the wall attached. All are of a reddish brown color and contain a tempering of coarse sand. The two pieces *c* and *d* may be parts of the same vessel. On the surfaces are the impressions of cords and nets, the latter being clearly shown in the photograph of *c.*

Specimen *f.* An example of the curious disks, of unknown use, made of bits of pottery vessels and found widely distributed, although no similar specimen was found on the sites examined along the Rappahannock. Much crushed quartz had been added as a tempering. The impression of tightly twisted cords remains on the outer surface. It is of a very bright, reddish color, different from that of any other specimen found on the site.

The large fragment to the right is part of a massive vessel. It is coiled ware and in places is more than one-half inch in thickness. The surface is hard and slightly pitted, indicating the leaching away of part of the tempering material, although some small pieces of quartz remain exposed. Tightly twisted cords crossed and recrossed the surface, the impressions of which are clearly defined. The lower edge, as viewed in the photograph, is the bottom of a coil or band of clay which had separated from the one against or upon which it had been placed. This parting had occurred while the vessel was still in use, when, it is evident, the parts had been perforated and fastened together by means of a cord or thong. Perforations made for this purpose are frequently found in bits of pottery as well as in fragments of soapstone vessels.

The specimens of earthenware just described are considered typical examples from the site of Pissaseck.

SOAPSTONE

The discovery of many fragments of soapstone vessels proves that at some time in the past much of the material was used by the occupants of the ancient site. The rather small pieces differ in texture and degree of purity, and consequently could have been derived from more than one quarry. Some may have been carried down the Rappahannock from the quarries far up the valley, well within the bounds of the territories dominated by the Manahoac tribes in 1608; other pieces were probably obtained from the extensive outcroppings in Amelia County, or from other sources in the tidewater region which have remained undiscovered.

There are no known references by the early writers to the actual use of soapstone by the native tribes of Virginia at the beginning of the seventeenth century, but it may have been used to a limited extent by some in conjunction with the far more numerous pottery vessels. This condition appears to have prevailed among certain related Algonquian tribes farther north in New Jersey and possibly elsewhere. Peter Kalm, the Swedish scientist, who wrote while in New Jersey in January 1749, mentioned the use of pottery and soapstone vessels by the Indians of the region at the time of the earliest European contact during the seventeenth century. He wrote[27] (vol. I, pp. 343-344):

The old boilers or kettles of the *Indians,* were either made of clay, or of different kind of pot-stones, (*Lapis ollaris*). The former consisted of a dark clay, mixt with grains of white sand or quartz, and burnt in the fire. Many of these kettles have two holes in the upper margin, on each side one, through which the *Indians* put a stick, and held the kettle over the fire, as long as it was to boil. Most of the kettles have no feet. It is remarkable that no pots of this kind have been found glazed, either on the outside or the inside. A few of the oldest *Swedes* could yet remember seeing the *Indians* boil their meat in these pots. They are very thin, and of different sizes; they are made sometimes of a greenish, and sometimes of a grey pot-stone, and some are made of another species of apyrous stone; the bottom and the margin are frequently above an inch thick. The *Indians,* notwithstanding their being unacquainted with iron, steel, and other metals, have learnt to hollow out very ingeniously these pots or kettles of pot-stone.

Four fragments of soapstone vessels, recovered from the site of Pissaseck, are shown in plate 7. The specimen in the upper right corner is a bit of a rim, worn smooth from use; it closely resembles the example from Nandtanghtacund, figure 8. The period of occupancy to which the specimens from the Rappahannock sites should be attributed has not been determined, but the statements by Kalm, although treating of the country farther north, suggest the possibility that soapstone may have been used in the Rappahannock villages as late as the beginning of the seventeenth century.

Many of the heavier, cruder forms of implements are still to be found scattered over the site of the ancient village. Typical examples are illustrated in plates 8 and 9.

Plate 8.—Specimen *a.* An implement made of diabase, surface slightly weathered, and resembling many specimens found on sites above the falls. The groove had been formed by pecking and is smooth from long use.

Specimen *b.* Axe made of diabase, so greatly altered that it is not possible to distinguish the flaked from the natural surface of the stone.

Specimen *c.* Pestle, made of diabase, with condition of surface similar to that of *b.* This was evidently a natural boulder which had been shaped by pecking rather than by flaking. Both sides are roughly pitted.

Specimen *d.* Hammerstone; a natural quartzite pebble with the greater part of the surface showing effect of use.

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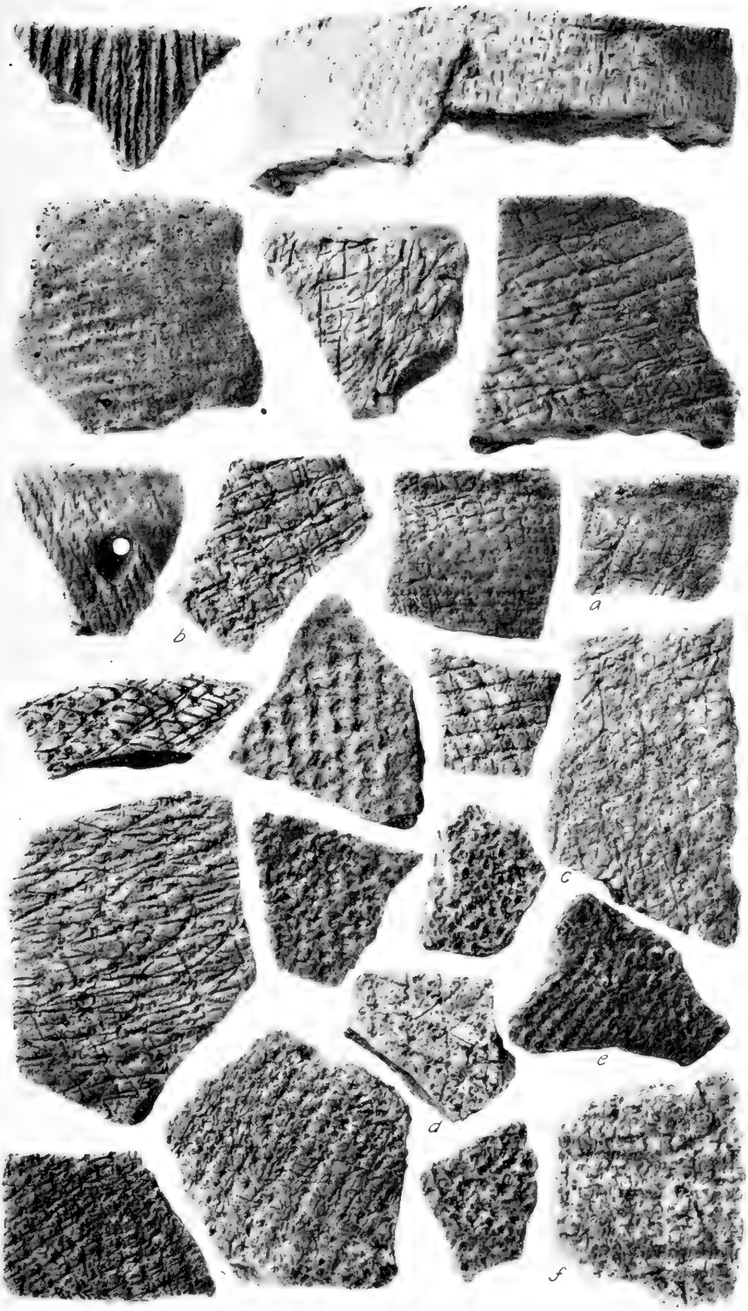
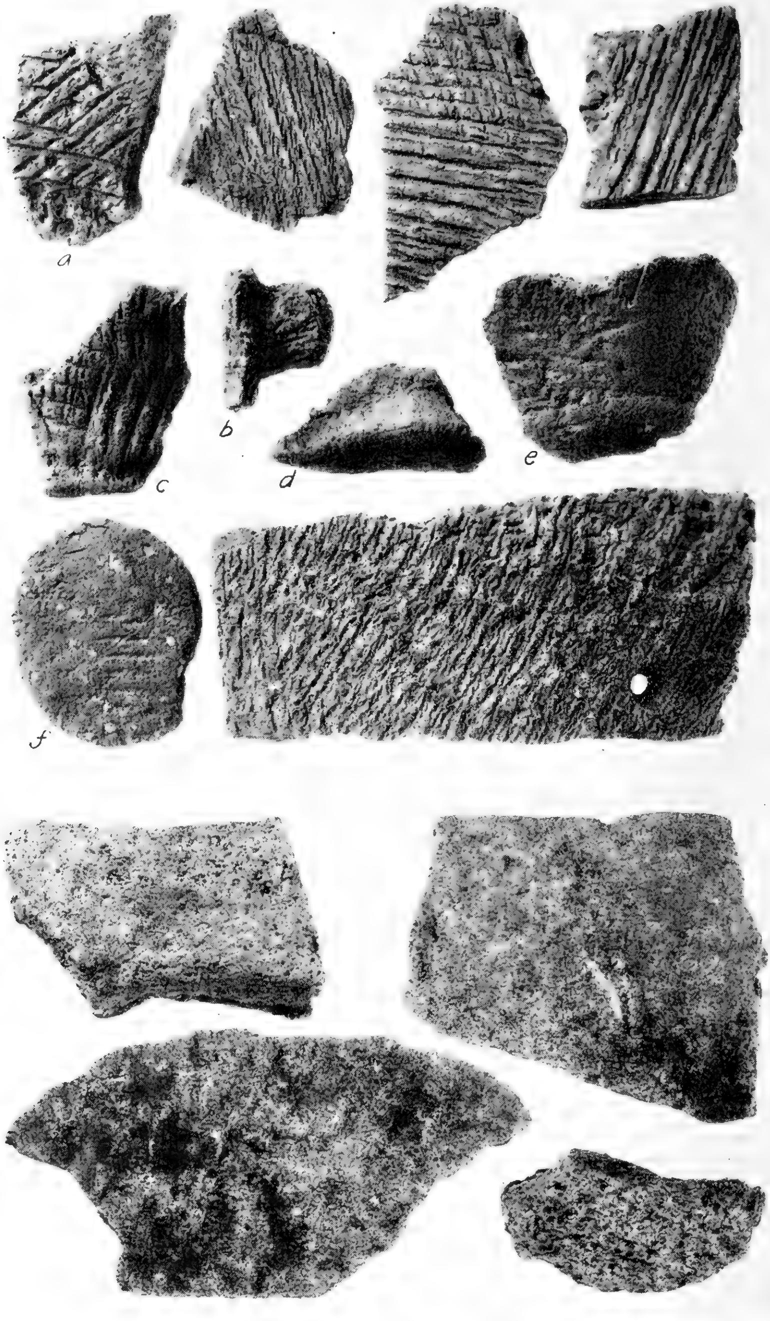
[27] Kalm, Peter, Travels into North America. 2d ed., 2 vols. London, 1772.

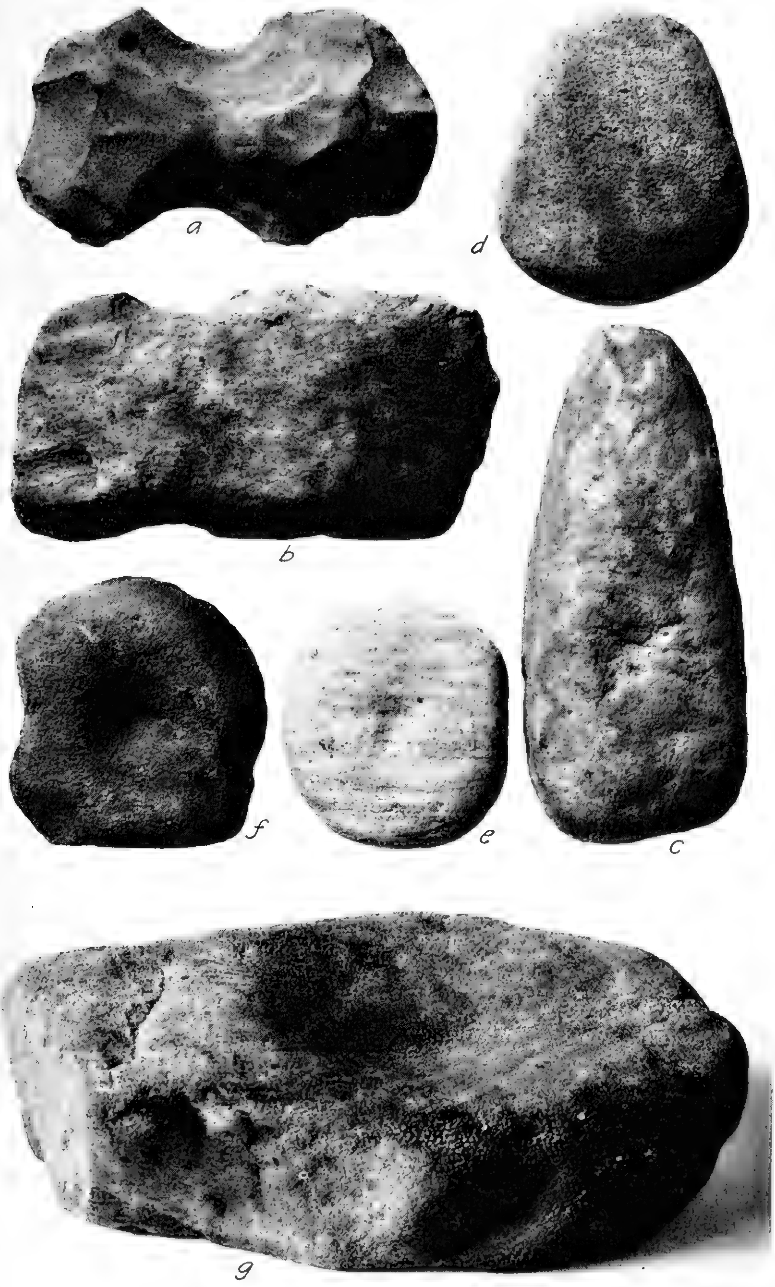


SPECIMENS FROM THE SITE OF PISSASECK
$\frac{1}{2}$ natural size. U.S.N.M. no. 378073.



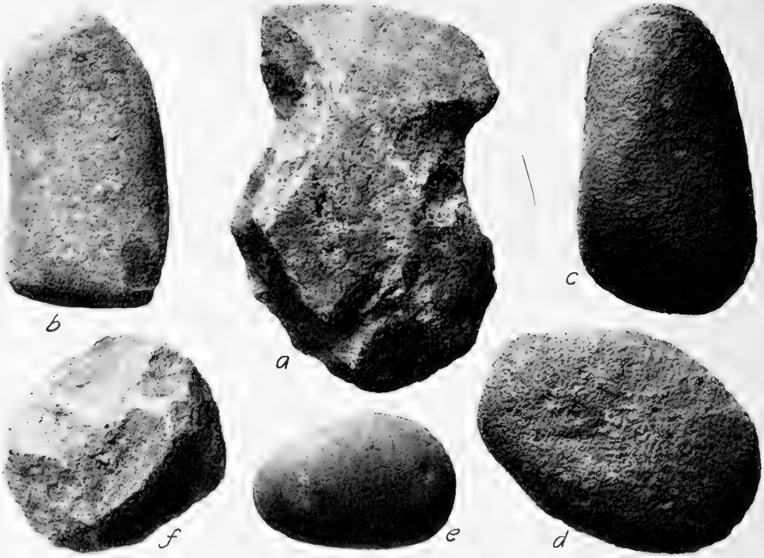
Specimens from the Site of Pissaseck

½ natural size. Above, pottery, U.S.N.M. no. 378073; below, soapstone, U.S.N.M. no. 378074.



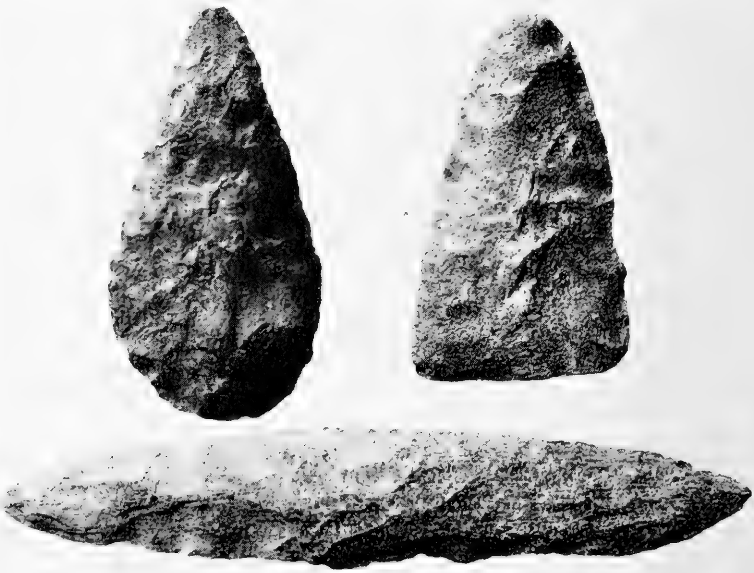
SPECIMENS FROM THE SITE OF PISSASECK

$\frac{1}{3}$ natural size. *a-f*, U.S.N.M. nos. 378075-80; *g*, U.S.N.M. no. 378080a.



1. SPECIMENS FROM THE SITE OF PISSASECK

⅓ natural size. *a*, U.S.N.M. no. 378081; *b-f*, U.S.N.M. no. 378082.



2. SPECIMENS FROM NEAR LEFT BANK OF THE RAPPAHANNOCK ABOVE GREENLAWS WHARF

½ natural size.

Specimen *e*. Hammerstone; a quartzite pebble, about 2 inches thick. Deeply pitted on the two opposite surfaces.

Specimen *f*. Hammerstone formed of a piece of coarse sandstone. Both surfaces deeply pitted.

Specimen *g*. Mortar made of an irregular block of coarse, dark brown sandstone.

Plate 9 (upper part).—Specimen *a*. Massive implement formed of a piece of coarse quartzite which had been struck from a boulder. It appears to have been attached to a handle and used as a hoe.

Specimens *b, c,* and *d*. Three hammerstones made of diabasic rocks, with surfaces showing different degrees of weathering.

Specimen *e*. Small quartzite pebble which had been used as a hammerstone.

Specimen *f*. A very roughly chipped implement made of diabase, with surface deeply weathered.

CACHE OF TRADE BEADS

A cache of trade beads found at Leedstown a few years ago proved to be of great interest. Examples of the beads are shown in plate 1, but before describing them in detail and telling of the locality and manner in which they were encountered, it will be well to refer briefly to the manufacture and use of glass beads by the early colonists at Jamestown.

Beads of many sorts were known to the Virginia Indians in prehistoric times; consequently, those brought by the first settlers—being of a new and unknown material and often of a brilliant color—became of the utmost importance when trading with the natives. So important were they that it was soon decided to manufacture some in the colony, rather than to import all from Europe, and it is evident that quantities were thus produced at a house erected for that purpose not far from Jamestown.

On April 30, 1607, before arriving at the site of future Jamestown, some of the English landed and visited the Indian village of Kecoughtan, about the position of the present Hampton, where they were treated kindly by the natives. The English were offered food and, so the narrative continues (p. lxiv):[28] "After we were well satisfied, they gave us of their Tobacco, which they tooke in a pipe made artificially of earth as ours are, but far bigger." A dance followed and when it had ended " the Captaine gave them Beades and other trifling Jewells."

[28] Percy narrative in Smith, op. cit.

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When trading with the Indians, during the summer of 1608 at a time when Powhatan was present, the colonists received a large quantity of corn in exchange for "a pound or two of blew beads." About this time the first glass was made at Jamestown.

The spring of 1609 found the colonists engaged in many endeavors; houses were being erected, a well was dug, and they "produced a tryall of Glasse." This was done at "the Glasse-house, a place in the woods neare a myle from James Towne",[29] which had probably been erected during the preceding year. To what extent beads were then made, or were produced during the years that immediately followed, is not known.

The second attempt to establish glass making in the colony was a more serious consideration. On June 11, 1621, at a Court held for Virginia,[30] "Intelligence was given y^t one Cap^t: Norton made an offer & would undertake to pcure 6 straungers skillfull in makinge of Glasse and Beads to goe over to Virginia to be imployed in the saide worke for the Company for no other consideracion then onely the halfe profitts of their labo^rs . . ." The proposition was accepted by the Company on June 13, and Norton agreed to "carry over with him 4 Itallyans and two servants of his owne . . . which six psons shall within three moneths after their Arivall in Virginia sett upp a Glass ffurnace and make all manner of Beade & Glasse . . ."

But it soon became known that the cost of the undertaking would be greater than anticipated and that the Company "were not able to goe through wth itt." It was then deemed best to let it be "free to pryvate Adventurers to undertake the same . . ." And so Captain Norton was released from his agreement. This was on July 16, 1621, and as stated by "certaine adventurers now present they did now acquainte this Courte that itt was not their intent therby utterly to exclude the Company from a buisiness of this speciall consequence unto them all (seeinge the Comoditie of Beads was like to prove the Verie Coyne of that Country) . . ."

In the "Instructions to the Governor and Council of State in Virginia,[31] dated July 24, 1621, is included the following: "Item whereas Cap^t William Norton and certaine Itallians now by the general Company and other worthy mynded adventures att a verie

[29] Smith, op. cit., p. 467.

[30] *In* The Records of the Virginia Company of London, vol. 1, p. 484. Library of Congress, Washington, 1906.

[31] *In* The Records of the Virginia Company of London, vol. 3, p. 477. Library of Congress, Washington, 1933.

great charge sent for the erecting of a glasse furnace in Virginia wee hartylie desire yow to afford them all favor possible."

It is evident the Company in London feared that bartering too many beads with the Indians would lessen their relative value, and in a letter to the Governor and Council in Virginia, dated August 12, 1621, stated (op cit., p. 495): "The makinge of beade is one of Cap^{t} Nortons cheife employmente w^{ch} beinge the mony you trade wth the natives we would by no meanes have through to much abundance vilified or the Virginiane at all pmitted to see or und^{r}stand the manufacture of them: wee therefore pray you seriously to consider what proportion of beade can be vented and their worth not abated, and intimate the proportion to Cap^{t} Norton and his Italians, and certifie the same to us in yo^{r} next letters, that accordingly we may limitt the quantitie that shall from time to time be made."

The importance of beads, and of blue glass beads in particular, was thus acknowledged,[32] and it is evident that vast quantities were made and traded to the Indians.

The use of beads was frequently mentioned in the early records of the colony. One such account of more than usual interest forms part of the Minutes of the Council and General Court.[33] At a court held at Jamestown, November 8, 1624, Robert Poole told that while on a trading voyage, "wherein he was ymployed for Mr Thresurer," he had bought corn from the Indians, and had exchanged "thirteene armes length of some beades for Another Tubb [of corn]." "Further he sayeth y^{t} Capt Croshow gave for a great Canoe w^{ch} he bought 10000 of blew beades, saying y^{t} he would give Mr Thresurer satisfaction for the beds.

"Also he sayeth y^{t} he paide for matts 20000 of blew beads, of w^{ch} matts there was used to seele ye shipp 20, *and*

"Further he sayeth that he gave to the great man of Potuxsea to be their guid to Pocotonck 6 or 800 of blew bead."

From this it may be assumed that innumerable blue glass beads, made at Jamestown, served the treasurer of the Colony as a medium of exchange when dealing with the Indians.

Happenings in England during the early years of the seventeenth century undoubtedly led to the endeavor to establish a glasshouse in

[32] Strachey, in his "Dictionarie of the Indian Language," gave "Blew beades, vnetagwushomon."

[33] The Virginia Magazine of History and Biography, vol. 21, p. 46, Virginia Hist. Soc., Richmond, 1913.

Virginia. In 1615[34] the importation of foreign glass into England was prohibited, but 5 years later permission was granted to import "rare and curious glasses." About that time, 1620, "an attempt was made to set up glass works in Scotland," with workers from Venice. If beads were included among the articles that were not to be imported from a foreign country, which would have included Venice, it became necessary to make all that were required for the Indian trade. Such may have been the reason for the establishment of the industry at Jamestown in 1621.

DISCOVERY OF THE BEADS

Just east of the triangular tract, within the shadowed area in the aerial photograph (pl. 2), the river bank rose normally some 6 or 8 feet above the gravelly beach. At some time in the past the bank had been cut away for a distance of more than 150 feet, and the surface for a like distance back from the water had been graded, thus forming a level area approximately 150 feet square sloping gradually to the edge of the water. In the middle of the far boundary of the graded area, facing and paralleling the river and 8 or 10 feet higher than the beach, are the remains of an ancient brick foundation, and about midway between this and the river are other bricks which appear to be part of a wall. Locally, and traditionally, this graded square is known as the Old Arsenal, a term which during the seventeenth and eighteenth centuries would have applied to a place where boats were built, also where arms and all military equipments were manufactured or stored. Such was probably the site at Leedstown, with the customhouse nearby.

The graded square has long been cultivated. When the ground was plowed early in the spring of 1925, a few beads were found on the surface near the center of the area. That night, as related by an old negro who lives nearby, a heavy rain fell and the following morning many beads were scattered over a very limited space. This caused a search for more, and soon great numbers of beads were encountered a few inches below the soil that had been disturbed by the plow.

The 13 varieties of beads illustrated in plate 1 are thought to include examples of all that were discovered in the cache. There may have been others, but if so, they have not been traced. Their history is not known, nor has it been possible to determine when or for what reason

[34] Nesbitt, Alexander. Glass. New York, 1879. This is one of the South Kensington Museum Art Handbooks.

they were placed as found. All may have been contained in a wooden keg or box which decayed and disappeared, thus allowing the beads to remain closely embedded in the surrounding earth.

The beads will be described and references made to identical or similar specimens from other localities that are now preserved in the collections of the United States National Museum, and to some that have been received at the Museum during the past 2 years for study or identification, but which have not remained in the collections. Many other kinds of beads occur on the sites, but only those resembling the specimens from Leedstown will now be considered.

Two of the 13 varieties found in the cache prove to be of the greatest interest and later will be described in detail. The first three, top row of the plate, are types that were widely distributed by the traders; they have been made for centuries and may still be obtained. As they are so numerous and so scattered, no specific references will be made to sites where they have been discovered.

Top row.—Left, transparent or translucent glass, light green; middle, opaque glass, black; right, transparent or translucent glass, medium shade of blue.

Second row.—Core transparent or translucent green glass, with thin glaze [35] of red glass covering entire surface. Over the surface of the red glaze are three groups of parallel lines, each group consisting of three lines, alternating white, blue, white.

Similar beads: Tennessee, Sullivan County, U.S.N.M. no. 136810; Alabama, Madison County, Hobbs Island in Tennessee River; Georgia, Bibb County, Macon; Pennsylvania, Bainbridge County, burial, U.S.N.M. no. 35773.

Third row.—Core transparent or translucent green glass, with thin glaze of red glass covering entire surface. Over the surface of the red glaze are four groups of parallel lines, each group consisting of three lines, alternating white, black, white. No other examples traced.

Fourth row.—Core translucent or transparent green glass, with thin glaze of red glass covering entire surface.

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[35] Beck, Horace C., Classification and nomenclature of beads and pendants. In Archaeologia . . . Published by the Society of Antiquaries of London. 2d ser., vol. 27, Oxford, 1928.

P. 55: " Glaze is a form of glass. It can vary very much in its composition, but it always contains silica and an alkali."

P. 56: " When a bead has been covered with a thin layer of vitreous enamel or glaze, it is called a *Glazed bead.*"

Similar beads: Tennessee, Sullivan County, U.S.N.M. no. 136810; North Carolina, Mecklenburg County, burials, U.S.N.M. no. 138808; Georgia, Bibb County, Macon, 1935, burials on plateau, also from surface of Mound D; Florida, Pinellas County, Maximo Point, Tampa Bay, beads somewhat smaller, U.S.N.M. no. 35775; Maryland, Prince Georges County, burial near Piscataway, U.S.N.M. no. 5839; New York, Monroe County, near Brockport, U.S.N.M. no. 16685.

Fifth row.—Translucent or transparent dark blue glass, longitudinally striped with fine lines of opaque white glass.

Similar beads: California, Santa Barbara County, Santa Rosa Island, U.S.N.M. no. 20236.

Sixth row.—Translucent or transparent dark blue glass.

Similar beads: Tennessee, Sullivan County, U.S.N.M. no. 136810; Alabama, Cherokee County, site on Coosa River, U.S.N.M. no. 99217; Alabama, Elmore County, near junction of Coosa and Tallapoosa Rivers, site of Fort Jackson, earlier old French Fort Toulouse, U.S.N.M. nos. 91557 and 91564; Alabama, Madison County, Hobbs Island in Tennessee River; Georgia, Bibb County, Macon, burial on the plateau, 1935; North Carolina, Mecklenburg County, burials, U.S.N.M. no. 138808; Florida, Hillsborough County, near Tampa Bay, U.S.N.M. no. 35335; Florida, Orange County, mound, U.S.N.M. no. 150100; Louisiana, Avoyelles Parish, U.S.N.M. no. 331724; Pennsylvania, Lancaster County, on Susquehanna River, U.S.N.M. no. 27048.

Seventh row.—Cane or tubular beads.[36] Core translucent or transparent green glass, with thin glaze of red glass over entire surface.

Similar beads: Tennessee, Sullivan County, U.S.N.M. no. 136812; Alabama, Madison County, Hobbs Island in Tennessee River; Virginia, Stafford County, average smaller, burial from site of Potomac village, at mouth of Potomac Creek.

Eighth row.—Cane or tubular beads, opaque white glass.

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[36] Beck, op. cit., p. 60, described this type of bead:

"*Cane beads.* To make these the glass was made into a rod or tube which was called a cane. These canes were sometimes made of one glass only; at other times they were made of different coloured glasses arrangd in a pattern.

"To make a bead, a cane, usually tubular, was selected of approximately the same diameter as the bead required. A piece the length of the bead was cut off this cane. In some cases this was used as a bead without any further work on it. In other cases it was finished by either grinding or reheating. Beads made in this manner are called *Cane beads.*"

Similar beads: Tennessee, Sullivan County, U.S.N.M. no. 136812; Alabama, Madison County, Hobbs Island in Tennessee River; Louisiana, Avoyelles Parish, U.S.N.M. no. 369258.

Ninth row.—Cane or tubular beads, opaque light blue glass. No other examples traced.

Tenth row.—Wire-wound beads,[37] opalescent white glass.

Similar beads: Tennessee, Sullivan County, average smaller, U.S.N.M. no. 136812; Georgia, Bibb County, Macon, 1935, from surface of Mound D; Georgia, Whitfield County, U.S.N.M. no 15539; Alabama, Talladega County, U.S.N.M. no. 364574; Mississippi, Lee County, more globular, U.S.N.M. no. 209619; Louisiana, Avoyelles Parish, average smaller, U.S.N.M. no. 331724.

Two bottom rows.—Cut rock crystal, with eight facets on perimeter.

Similar beads: Florida, Pinellas County, Maximo Point, facing Tampa Bay, U.S.N.M. no. 35775; Florida, Hillsborough County, 14 beads from burials near Tampa Bay, U.S.N.M. nos. 35334-35344; Florida, Orange County, U.S.N.M. no. 150100.

The references in the preceding lists often apply to a single bead, seldom to more than two or three, which had been found with many others of different types. Some had been discovered in burials, others had been recovered from the surface of village or camp sites. In two instances no examples of similar beads have been traced in the collections of the United States National Museum, although it is to be expected that some are preserved in other collections, both public and private. The relatively few specimens recorded may indicate the range of the several forms, rather than the frequency with which they have occurred.

The history of the remarkable cache is not known, nor has it been determined from what country or countries the material may have come. It is doubtful if any of the beads were made at Jamestown; consequently very little can now be added to the brief descriptions already given. Two of the types (fifth row and two bottom rows) present problems which may be difficult to solve, but the solution of which would undoubtedly aid in determining the place of origin of other beads encountered with them in the cache.

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[37] Beck, op cit., p. 60, referred to beads of this type:

"*Wire-wound beads.* A thin stick of glass heated until it had much the consistency of toffee was wound round a wire. During the process the glass was pulled out into a thread, and there is frequently a projection on the bead showing where this thread was broken off. When, however, as often happens, the bead has been reheated for subsequent decoration, this projection generally disappears. Beads made in this manner are called *Wire-wound.*"

Aside from the specimens from the Leedstown cache, the collections of the National Museum contain only one series of the transparent blue glass beads with longitudinal stripes of fine threads of opaque white glass paralleling the perforation. These were recovered from an ancient Indian burial on Santa Rosa Island, Santa Barbara County, Calif., by Stephen J. Bowers in 1876 (U.S.N.M. no. 20236). The islands were discovered by the Spaniards under Cabrillo in 1542 and were visited frequently thereafter by ships under the same flag. Although the beads from the bank of the Rappahannock are corroded, with their surfaces roughened, those from California appear as fresh and smooth as when placed in the graves. This contrast in condition of the two groups may be attributed to the difference in the amount of moisture, the variation of temperature, and the composition of the earth by which they were surrounded. All are thought to be of the same age and to have come from the same source—some glasshouse in Spain.

Cut rock crystal beads, similar to those recovered from the Leedstown cache, have been discovered on the west coast of Florida, but are not known from any other part of the United States. They have been found in mounds and burials within a limited area extending southward from the north shore of Tampa Bay to the vicinity of Key Marco, a distance of about 175 miles. Other forms of beads and pendants, likewise made of rock crystal, have been discovered in Florida associated with the type occurring at Leedstown, but only the latter will now be considered.

The specimens mentioned as having come from Pinellas and Hillsborough Counties were collected by S. T. Walker in 1879.[38] Many others were found during the progress of recent archeological explorations under the direction of the Bureau of American Ethnology, supervised by M. W. Stirling. They were encountered in several localities, within the bounds previously designated, and all came from burials thought to have belonged to the years following soon after the first contact of Spaniards and Indians about the last half of the sixteenth century. Whether they had been traded or given to the Indians, or had been recovered by the natives from a Spanish wreck on the Gulf coast, may never be known; however, they were undoubtedly brought to America in a Spanish ship.

The crystal beads from the cache on the Rappahannock and those from the west coast of Florida are identical in form and size. They

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[38] Walker, S. T., Preliminary explorations among the Indian mounds in southern Florida. *In* Ann. Rep. Smithsonian Inst. for 1879, Washington, 1880.

have the same number of facets on the perimeter. On all, the plane surface from which the perforation was begun is rough, suggesting the use of a saw in preparing the mass, and the opposite end of the perforation emerges in a distinct concavity which was made when the drill broke through the thin wall of crystal.

The two distinct types of beads found in the Virginia cache—the blue glass with fine white lines and the cut rock crystal—should, with a degree of certainty, be attributed to a Spanish source, and this suggests that all beads in the Leedstown cache were of Spanish origin.

During the sixteenth and seventeenth centuries Spain produced glass equal to that made in other parts of Europe; consequently, it is inconceivable that beads required for trade in foreign lands would have been brought from other countries. Barcelona was the center of the glass industry, which would undoubtedly have included the manufacture of beads. Thus it had been for centuries, and in the words of Señor Juan F. Riano, in a catalogue of Spanish objects in the South Kensington Museum: [39]

> Jeronimo Paulo, who wrote in 1491 a description in Latin of the most remarkable things at Barcelona, says they also send to Rome and other places many glass vessels of different sorts and kinds, which may well compete with those of Venice. Marineus Siculus, who writes at the beginning of the sixteenth century, says that the best glass made in Spain is that of Barcelona; and Gaspar Baneiros in his chronographia, published at Coimbra in 1562, mentions that excellent glass was made at Barcelona, almost equal to the Venetian.

These were the years during which Spanish vessels so frequently touched the coast of Florida and had intercourse with the native tribes. Although it has not been possible to trace definitely the source of the crystal beads, it is believed they were cut in Spain and brought to America during the latter half of the sixteenth century.

The beads, crystal as well as glass, found in the cache on the bank of the Rappahannock, may have been carried to Virginia in a ship under the English flag, but when, where, and how they had been obtained by the English would form an interesting bit of history.

Kerahocak

A village bearing the name of Kerahocak is shown on the 1624 map several miles above Pissaseck. It stood on the left bank of the Rappahannock opposite Port Tobago and Green Bays, probably about the position of Greenlaws Wharf, which is visible in the aerial photograph, plate 10, and is also indicated on figure 5. Here as elsewhere,

[39] Quoted by Nesbitt, op. cit., pp. 101-102.

fragmentary pottery, arrowpoints, and other artifacts have been collected.

Three specimens found a few years ago[40] a short distance above the wharf are illustrated in plate 9, figure 2. They were discovered several feet below the surface, not far from the river bank, and may have been associated with a burial. All are finished objects with edges smoothed from use.

Specimen at left is an unusual form and well chipped. The material is dark rhyolite with many small phenocrysts of quartz and feldspar.

Specimen at right is made of grayish quartzite, probably derived from a pebble found nearby. The edges are greatly worn, and the entire surface appears smooth from long use.

Specimen at bottom is a piece of exceptional interest. It is made of fine-grained rhyolite, with flow structure, of a grayish color. As viewed in the photograph the right lower edge, near the point, reveals the effect of much use, being worn to a greater degree than is any other part of the surface. It had evidently been mounted and used as a knife or dagger, with the left end, for a distance of several inches, inserted in a handle. Length 8 inches. The surface is only slightly altered and in this respect resembles that of the two specimens *c* shown in plate 3. The rhyolite was probably derived from a quarry in South Mountain, south of the Susquehanna, in Pennsylvania.

Nandtanghtacund

As previously mentioned, this is the name of a large village that appears on the 1624 map. It is placed on the right, or south, bank of the Rappahannock, on the shore of a large bay, the early Indian name of which has not been preserved but which is now known as Port Tobago or Port Tobacco Bay. Just below the site of the village, which is indicated by a "Kings howse", is the name of a smaller settlement which may have been part of the larger village.

Nandtanghtacund[41] was evidently seen by Captain Smith late in December 1607, or early in January 1608, while he was held captive by the Indians and before he was taken to Powhatan at Werowacomoco. He was conducted to many native villages and, as one narrative states (p. 398):[42]

they led him to the *Youthtanunds,* the *Mattapanients,* the *Payankatanks,* the *Nantaughtacunds,* and *Onawmanients* upon the rivers of *Rapahanock,* and *Pa-*

[40] Now in the private collection of F. M. Aldridge, Fredericksburg, Va.

[41] The spelling of names often differed in the text from the forms appearing on the map; the latter is followed in the present article unless quoted literally.

[42] Writings of Capt. John Smith. Arber ed.

tawomek; over all those rivers, and backe againe by divers other severall Nations, to the Kings habitation at *Pamaunkee:* where they entertained him with most strange and fearefull Conjurations.

This was before the exploration of the Rappahannock by the colonists during the summer of 1608 and may explain the presence of certain names on the map issued in 1624.

Traces of a very extensive settlement, a site that had been long frequented or often occupied, have been encountered on the eastern shore of Port Tobago Bay, where much material, including fragmentary pottery, is to be found scattered over the surface of a wide area extending eastward to the marsh bordering Green Bay. This was the site of ancient Nandtanghtacund, later occupied by the Porto-

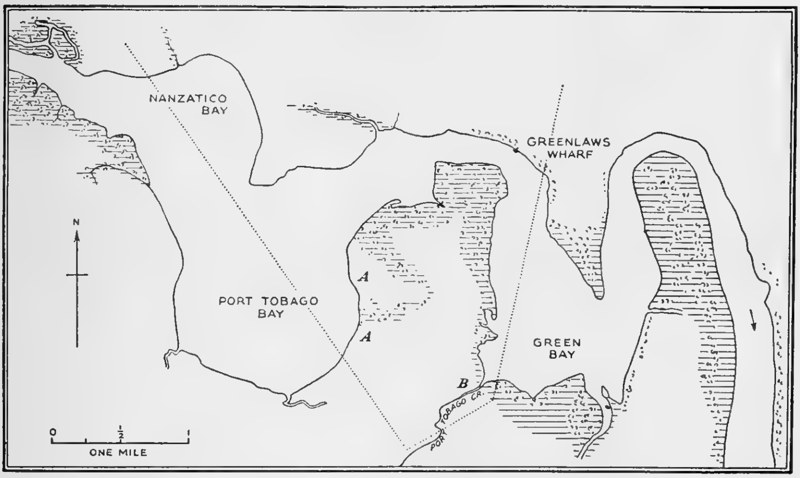

FIG. 5.—Map indicating position of Nandtanghtacund, later Portobago village. The area included within the dotted lines is shown in the aerial photograph, plate 10.

bacco, which is so clearly shown in the aerial photograph reproduced in plate 10, and indicated on the map, figure 5.

Nandtanghtacund was a settlement of importance during the days of Indian occupancy of the valley, but as it lay far beyond the frontier of the colony until after the middle of the seventeenth century it may have been seldom visited by the English before the native population had become greatly changed from what it was in 1608, at which time Smith referred to " Nantaughtacund having 150 men ", indicating a total population of approximately 700.

In October 1669 " An act ffor destroying Wolves " became necessary in the colony. This read in part:[43] " *It is enacted* that the Indian

[43] Hening, op. cit., vol. 2, p. 275.

tributaries be enjoyned and assessed to bring in a certaine number annually ", and in the list that followed, in Rapahanock County, were first the Portobaccoes having 60 " Bowmen or hunters ", who were assessed 12 heads; and secondly the Nanzcattico and Mattehatique who together had 50 men and were assessed 10 heads. The Portobaccoes are assumed to have occupied the site of ancient Nandtanghtacund, with the Nanzcattico living on the opposite side of the river. The position of the Portobacco village is shown on the Herrman map, issued in 1673, a detail of which is reproduced in figure 2.

Rappahannock County was created in 1656, at which time it extended on both banks of the river, but in the year 1692 it was divided, and that portion that stood on the right bank became Essex County and that on the north, or left, bank, Richmond County. Caroline County was formed in 1728 and included part of Essex County. Tobago or Tobacco Creek, from the southwest shore of Green Bay, became the boundary between Essex County on the east and Caroline County on the west; consequently the greater part of the site now being considered is just within Caroline County.

Another reference to the villages is found in a document that was prepared about 30 years after the appearance of the Herrman map. It occurs in a communication to the Board of Trade in London, dated Williamsburg, Virginia, July 18, 1702.[44] The principal rivers of the colony are mentioned, together with the names of the Indian tribes whose villages stood on their banks. Following Rappahannock River: " Indians and No. of.—Portobago or Nanzattico, 30 [men]; Wicocomoco." Thus at the beginning of the eighteenth century the remaining Portobago and Nanzattico were considered as one, and they probably occupied a single village.

Jefferson, in his references to the native tribes of Virginia,[45] included the Nantaughtacunds—thus following the spelling found in Smith's text—whose chief town had in 1608, so he believed, stood on Port Tobacco Creek in Essex and Caroline Counties. In this Jefferson clearly identified the ancient site with the association of the two names.

Being able to trace the settlement from the earliest days of the Colony, when primitive ways of life prevailed, it is gratifying to present a brief description of the village as it was in the year 1686, soon after contact with the English had caused many changes in the

[44] *In* The Virginia Magazine of History and Biography, vol. 1, no. 4, p. 363. Virginia Hist. Soc., Richmond, 1894.

[45] Jefferson, Thomas, Notes on the State of Virginia, Philadelphia, 1788.

customs of the native inhabitants. However, outwardly the group of bark-covered habitations, with their surrounding fields and gardens, and the dugout canoes drawn up on the sandy beach, did not differ in appearance from that of many small villages first seen by the colonists in 1607.

PORTOBAGO VILLAGE, 1686

A brief narrative of a visit to an Indian village on the bank of the Rappahannock, in Virginia, is contained in the journal of a young French Huguenot who traveled through the colony during the autumn and winter of the year 1686.[46]

Durand reached Virginia in October 1686 and, after varied experiences in a new country where he had difficulty in making himself understood, continued northward through Gloucester and Middlesex Counties to the right bank of the Rappahannock. He then crossed the Rappahannock to Lancaster County, thence up the left, or north, side of the stream, through a country sparsely settled and with roads that followed Indian trails.

" And so we entered into the county of Rappahannock. . . . We went the next day to Portobago, for so is called Mr. Wormeley's[47] rich plantations in this vicinity." This was an extensive tract, with 8 or 9 houses. " I perceived also that about two thirds of these lands were in timber, and others in prairies which I was told, were the plantations that the Savages occupied 5 or 6 years ago. Three of these Savages came to visit us as soon as we arrived, they brought him two large wild turkeycocks and one tame one, the wild ones weighed about 40 pounds apiece. We saw their village on the other side of the River, and the next day having expressed a wish to see them at home, Mr. Wormeley ordered three horses sent over the water." That afternoon they crossed the river to the south, or right, bank where the Indian village stood, and having mounted " rode

[46] The title page of the small book, in French, does not reveal the name of the author; however, it is stated in the text that he was a native of Dauphiné and a member of the Huguenot family of Durand. The title page reads: Voyages d'un Francois, Exilé pour la Religion, avec *Une Description de la* Virgine & Marilan dans L'Amerique. A La Haye, Imprimé pour l'Autheur, 1687.

The volume, with the exception of the part treating of the Indian village which is now translated and presented, was privately printed in English by Fairfax Harrison, 1923.

[47] Ralph Wormeley (1650-1701), of Rosegill on the lower Rappahannock, where Durand had remained a few days. He was a burgess from Middlesex in 1674, advanced to the Council in 1677, and Secretary of the colony from 1693 until his death.

through all lands on that side of the river, which were greater in extent than those on the north side where we were lodged . . . Having explored all of this region we went to the Indian village."

The Indian settlement which had been seen from the left bank of the river when looking across the stream is thought to have stood on the eastern shore of Port Tobago Bay, on the site of ancient Nandtanghtacund, from which it may not have differed greatly in appearance. Durand's brief description of the village and its people, as they were in December 1686, just two and one-half centuries ago, follows:

These Savages have rather pretty houses made of tree bark the walls as well as the roofs, so well put together with thongs of deerskin that neither rain nor wind disturb them at all. They are a people darker than the Gipsies (Egiptiens) we have in Europe. They mark their faces with cuts in the shape of a snail shell, in which they put powder, and thus they are marked for life.[48]

The women of the house wear only a deerskin to cover their least decent parts, in winter they wear the hairy side next the skin, and in summer put skin to skin. They build their fire in the middle of the house, their beds around it they inter-weave a certain strong grass which they find along the river resembling straw,[49] and they do it on four little forks (quatre petites fourches), these serve them for seats to sit upon.

In the village the men wear only a wretched shirt of white or blue cloth, and from the time they put it on they never take it off, it falls off of them in tatters, for they never wash anything. Aside from the deerskin the women are entirely naked the rest of their bodies, their little children completely naked, no matter how cold it is. The men do nothing except hunting and fishing, the women raise Indian corn (Bled Sarrasin) which is common among them, any one takes it who needs it.[50] They make also pots and vases from earth and pipes to smoke, the Christians buying their pots or vases fill them up with Indian Corn

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[48] This refers to tattooing, but to what extent it was practiced by the people of the Rappahannock is not known. From Durand's statement it may be inferred that he had seen both men and women who had followed the custom. But Smith did not mention men when he wrote some years before; he stated (op. cit., p. 66): "They adorne themselves most with copper beads and paintings. Their women some have their legs, hands, brests and face cunningly imbrodered with diverse workes, as beasts, serpentes, artificially wrought into their flesh with blacke spots."

[49] A sedge, *Scirpus americanus* Pers. Quantities of this grow in shallow water near the banks of the river.

[50] This is rather vague. Adair (History of the American Indians, London, 1775), who wrote of the tribes farther south, stated that (p. 430): "Formerly, the Indian law obliged every town to work together in one body, in sowing or planting their crops; though their fields are divided by proper marks, and their harvest is gathered separately . . ." William Bartram (Travels through North and South Carolina . . . London, 1792), referred to the same customs in these words (p. 510): "In the spring, the ground being already prepared, on one and the same day, early in the morning, the whole town is summoned, by the sound of a conch shell, from the mouth of the overseer, to meet at the

and that is the price,[51] they all smoke as well as the men, but they do not raise any tobacco, it is given them in exchange for game or fish.[52]

They marry among themselves but it is only to avoid confusion among the children, for as soon as a young man takes a wife he builds a little house, leaves his father and mother and retires to it. They have some knowledge, but a very imperfect knowledge, of the true God, they believe that he is creator of all that they see, and of the growth of what is necessary to life, but that he does not lower himself so far; that the demons which are inferior to him were created for that purpose, and so they fear them because they are from time to time tormented by them. They have no other ceremony in their marriages unless it be the assembling of the village, and the man having chosen she whom he wishes to take gives her a roe's foot or a deer's, and she gives him an ear of corn, which signifies that the husband will keep the house provided with meat and the woman with corn.[53]

The Ministers of this region take no pains to convert them to Christianity and instruct them, although the greater part of them know how to speak English. When we left them they made a present to Mr. Wormeley of a dozen deerskins, and to Mr. Parker and to me a handful of pipes each.

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public square, whither the people with their hoes and axes; and from thence proceed to their plantation, where they begin to plant, not every one in his own little district, assigned and laid out, but the whole community united begins on one certain part of the field, where they plant on until finished; and when their rising crops are ready for dressing and cleansing, they proceed after the same order, and so on day after day, until the crop is laid by for ripening. After the feast of the busk is over, and all the grain is ripe, the whole town again assemble, and every man carries off the fruits of his labour, from the part first allotted to him, which he deposits in his own granary; which is individually his own." But a large crib was provided in the town in which grain was placed, voluntarily, and in such quantity as the individual chose, which served as "a public treasury . . . and to which every citizen has the right of free and equal access, when his own private stores are consumed." Durand may have known of a similar custom prevailing at Portobago village.

[51] Evidently the value of the corn that a vessel would hold was the accepted value of the vessel itself. As previously recorded, an act passed the Assembly in June 1676 that allowed the English to obtain various articles from the Indians, mentioning "canooes, bowles, matts or basketts, and to pay the said Indians for the same in Indian corne, but noe other commodities."

[52] *Nicotiana rustica* has been identified as the plant formerly raised by the Indians of Virginia. Discussed by W. A. Setchell in Amer. Anthrop. vol. 23, no. 4, 1921.

[53] Adair (op. cit., pp. 139-140) referred to this ceremony: "When the bridegroom marries the bride, after the usual prelude, he takes a choice ear of corn, and divides it in two before witnesses, gives her one half in her hand, and keeps the other half to himself; or otherwise, he gives her a deer's foot, as an emblem of the readiness with which she ought to serve him: in return, she presents him with some cakes of bread . . . Formerly, this was an universal custom . . ." However, Adair was writing of conditions and customs in the country far south of Virginia and many years after Durand visited the village on the Rappahannock in 1686.

Since it was already dark we called the boat to take us away, because we needed considerable time, the River being very wide, for it carries even in this place vessels of six tons, although distant 30 leagues from the sea.

The small Indian village, occupied in December 1686, is thought to have stood on the eastern shore of Port Tobago Bay, the region designated A on the map, figure 5, and so clearly shown in the aerial photograph reproduced in plate 10.

MATERIAL FROM THE SITE OF NANDTANGHTACUND

It is known that during past years innumerable arrowpoints and other small flaked objects, stone implements and weapons of many forms, as well as quantities of fragmentary pottery, have been recovered from the site of the ancient village. But all does not belong to the same period of occupancy; some specimens are thought to be far older than others. Much may even now be found, revealed by the plow as the surface is gradually lowered or when the bank facing the water falls away. As a result of constant plowing and cultivation of the land through generations the pottery has been reduced to small fragments and many of the stone objects broken. Even in this condition, however, all prove to be of interest.

In the endeavor to show examples of different types of objects that have been recovered from the area, several specimens found some years ago[54] have been included and described with others collected during recent visits to the site. Nevertheless, it is realized that few of the many forms that would have been encountered in the village are included in the present sketch. Examples illustrated in plates 11, 12, and 13 will be briefly described:

Plate 11.—Specimen *a* is a small axe or weapon, chipped and deeply weathered. Material, a diabasic rock. This is attributed to an early period of occupancy that preceded, possibly by centuries, the historic village.

Specimen *b*. One of several similar celts found on the surface near Port Tobago Creek, area B on map, figure 5. Thick, oval in section, smoothed and polished through use. Material, a very dark, greenish diabase.

Specimen *c*. Double-edged implement, worn and polished. Material, diabase.

Specimen *d*. Grooved axe, found on the surface near shore of Port Tobago Bay.

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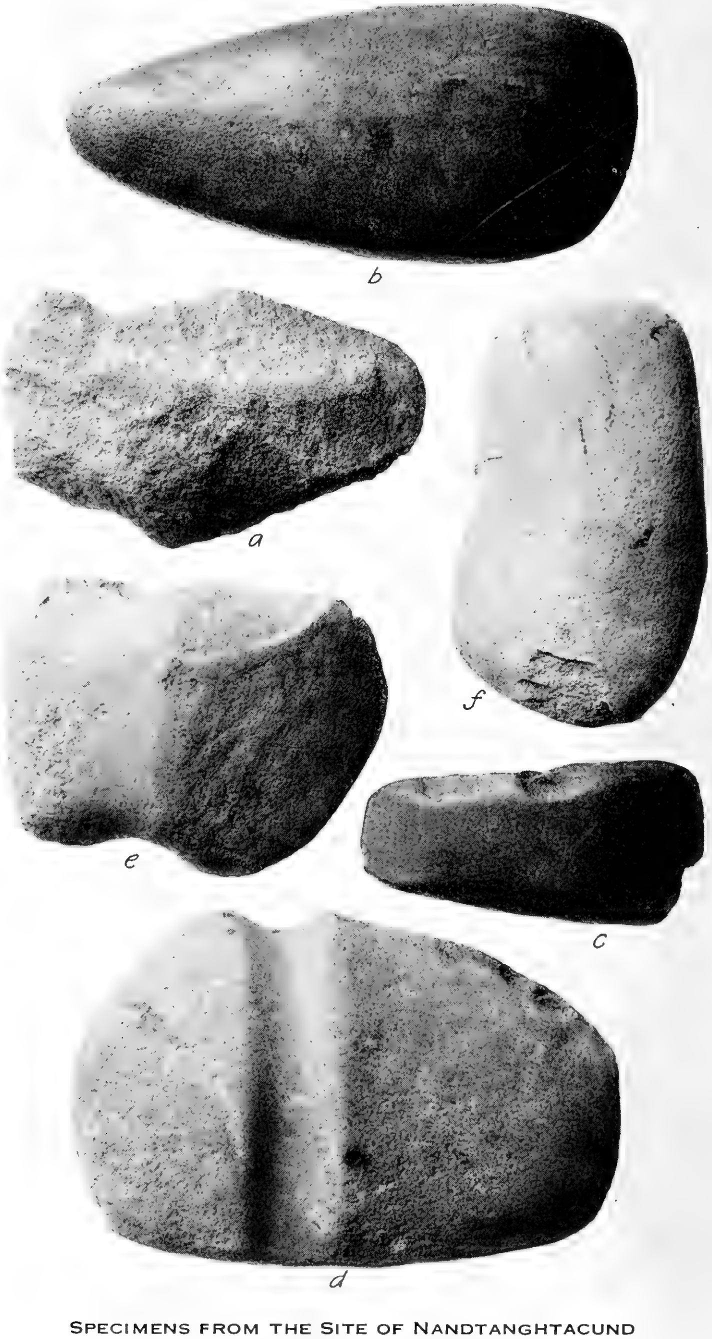
[54] Specimens *b* and *c*, plate 11, and *a*, plate 12, are in the collection of F. M. Aldridge, Fredericksburg, Va.

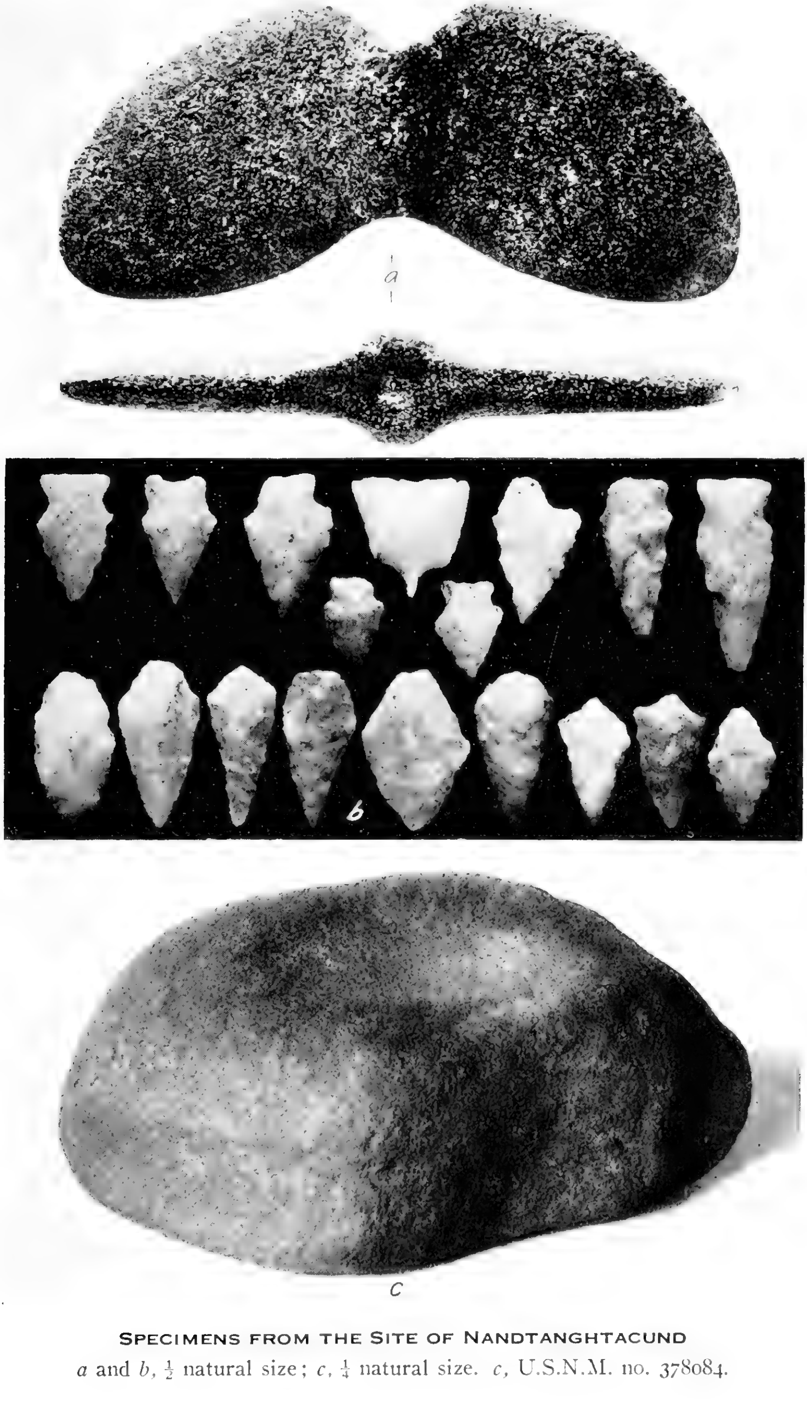
Photograph U. S. Army Air Corps.

SITE OF NANDTANGHTACUND WITH PORT TOBAGO BAY ON LEFT



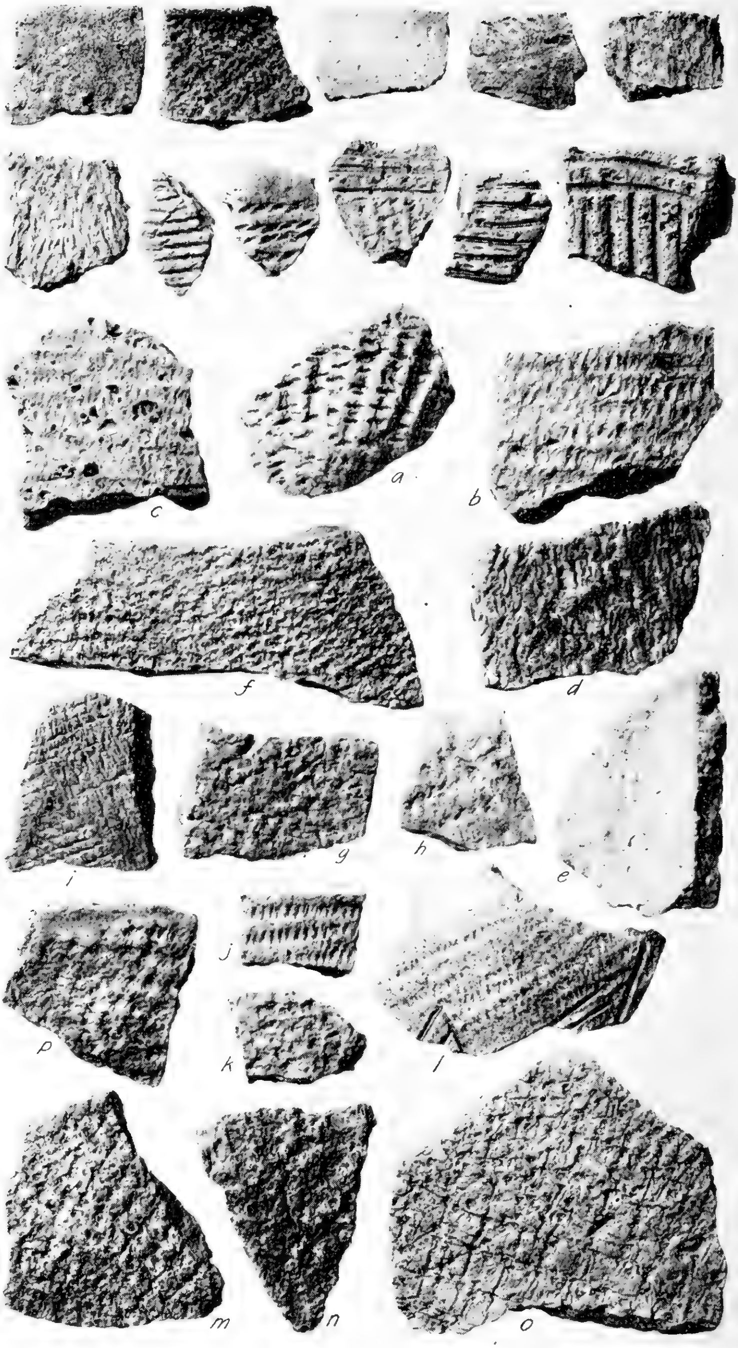
SPECIMENS FROM THE SITE OF NANDTANGHTACUND

½ natural size. *d,* U.S.N.M. no. 378083.



SPECIMENS FROM THE SITE OF NANDTANGHTACUND

a and *b*, ½ natural size; *c*, ¼ natural size. *c*, U.S.N.M. no. 378084.



FRAGMENTS OF POTTERY FROM THE SITE OF NANDTANGHTACUND

½ natural size. U.S.N.M. no. 378085.

Specimen *e*. Grooved axe, found on area B, near Port Tobago Creek. Fractured, but the edges were later worn smooth by use.

Specimen *f*. Hammerstone; a natural quartzite pebble with ends battered, showing evidence of use.

Plate 12.—Specimen at top is an unfinished banner stone of excellent workmanship. The surface, now greatly weathered, had been partly polished, and the perforation had been started. Material, a very hard greenish hornblende gneiss. Found on the surface near Port Tobago Creek.

The small white quartz objects shown in the plate include several characteristic forms, but the beautifully chipped specimen in the middle of the top row is unusual. It was found near the left bank of Port Tobago Creek, and within a short distance a similar specimen of the same size, made of a dark crystalline rock, was discovered.

A massive mortar, found on the surface near the shore of Port Tobago Bay, is shown at the bottom of the plate. Material, a dark, reddish brown coarse sandstone. It is between 4 and 5 inches in thickness and about 12 inches in length.

POTTERY

Twenty-seven fragments of earthenware are illustrated in plate 13, of which number 22 were discovered near the shore of Port Tobago Bay, many being found along the face of the bank that rises from 5 to 7 feet above the gravelly beach. The remaining 5 pieces, including the first, third, and fifth from the left in the top row, and specimens *c* and *g*, were found on the surface near the left bank of Port Tobago Creek, the area designated B on the map (fig. 5).

It is evident that the shoreline of the bay has changed during the two and one-half centuries that have elapsed since the site was visited by Durand. The waters of the bay have encroached upon the land then occupied by the village, and consequently the ground that now forms the shore may, in 1686, have been far back from the water.

Numerous pieces of pottery, stone implements, and other objects of Indian origin, have been found in the water some distance from the bank, and it is within reason to think that similar material occurs farther out, in deeper water, where it had been deposited when the soil was washed away. Therefore the 22 specimens shown in plate 13 came from a part of the settlement that had been many feet from the shore. The surface extending to the edge of the bank has been cultivated for generations, which readily explains the fragmentary condition of the pottery. The larger pieces, however, were found on the beach and in the face of the bank below the level where the earth had been disturbed by the plow.

The 11 specimens shown in the upper part of plate 13 reveal various kinds of surface decoration including the impression of a fabric, of twisted cords, and of another material, and deep lines. The fragments vary greatly in texture and are thought to have been made during different periods of occupancy. The five pieces forming the top row are bits of rims of vessels and may be described briefly, beginning at the left:

1. Coiled ware. Tempering, crushed quartz.
2. Coiled ware. Tempering, sand or crushed quartz.
3. No evidence of coils. Clay contains a quantity of fine sand which was probably natural. Vessel is a very light yellow with top or rim flat. Thickness at top 5/16 inch.
4. Coiled ware. Tempering, small amount of crushed quartz, and evidence of crushed shell which has decayed and disappeared, causing small cavities to remain.
5. No indication of coils. Much very fine sand mixed with the clay. Vessel of light color.

Second row, beginning at left:

1. No trace of coils. Clay contains much fine sand or crushed stone. Rather fragile with surface weathered a light gray.
2. No trace of coils. Tempering, sand or crushed stone.
3. No evidence of coils. Very dark inside with surface weathered light gray. Tempering, coarse sand.

4, 5, 6. Three pieces similar to others found higher up the Rappahannock opposite the large island at the falls.

When describing the specimens found opposite the island it was suggested that a vegetal substance had served as the tempering. This belief had been suggested by the presence in one piece of small cavities filled with particles of carbon which, when leached away, would have caused the porous condition of the ware. However, the occurrence of a piece of shell, $\frac{1}{4}$ inch in width, exposed in the middle of the edge of the largest of the 3 fragments, at right end of the second row, proves conclusively that crushed shell had been employed as a tempering material, either solely or in conjunction with some other substance, all traces of which have disappeared. The pitted surface, and the cavities throughout the ware, resulted from the disappearance of the tempering material, whatever it may have been.

The indented lines on the surfaces of the fourth and fifth specimens from the left were formed by some hard, smooth, and very regular object that was impressed upon the plastic clay before the vessel was fired. The lines on the fifth example are sharply defined and reveal a median ridge extending the entire length. Several fragments of pottery bearing the same impressions were found on sites above the falls of the Rappahannock; it therefore appears to be a recognized form of ornamentation practiced by the potters of the region.

The fragments of pottery illustrated in plate 13 have been chosen from many pieces discovered on the site. The 16 specimens designated by the letters from *a* to *p*, inclusive, have been selected to determine as far as possible, with a degree of certainty, the form of basketry or type of fabric that had been impressed upon the plastic clay when the vessel was made. The pottery is shown one-half size, but the fabric and basketry that is revealed by the impressions is restored and drawn exact size. The letters attached to the drawings reproduced in figures 6 and 7 are the same as those on the specimens in plate 13 from which the impressions were derived. They may be described as follows:

Specimen *a*. Coiled ware. Tempering crushed quartz. A piece of exceptional interest, as it proves the use of a rigid basket in shaping a pottery vessel. This fragment came from near the base of the vessel as is indicated by the convergence of the warp elements. This is clearly shown in the drawing at top of *a*, figure 6. As the basket widened, additional warp elements were inserted, to be held together by what may have been a continuous coil of a more pliable material. The inside of the fragment is next shown with the line of contact of two coils of clay indicated by the broken line. Below is sketched a view of the fragment from above, with a bit of the basket, restored, pressed against the outer surface of the vessel. The convex surface of a coil which is exposed in the fragment is indicated in the drawing, looking from above.

Specimen *b*. No evidence of coil. Tempering, crushed shell or vegetal substance, all of which has disappeared. The impression of coiled basketry is clearly shown on the surface.

Specimen *c*. No evidence of coil. Tempering leached away, causing the ware to be very porous. The surface bears the impression of coiled basketry.

Specimen *d*. Coiled ware. No trace of tempering. The impression suggests a coarsely made matting, having a foundation of flat splints

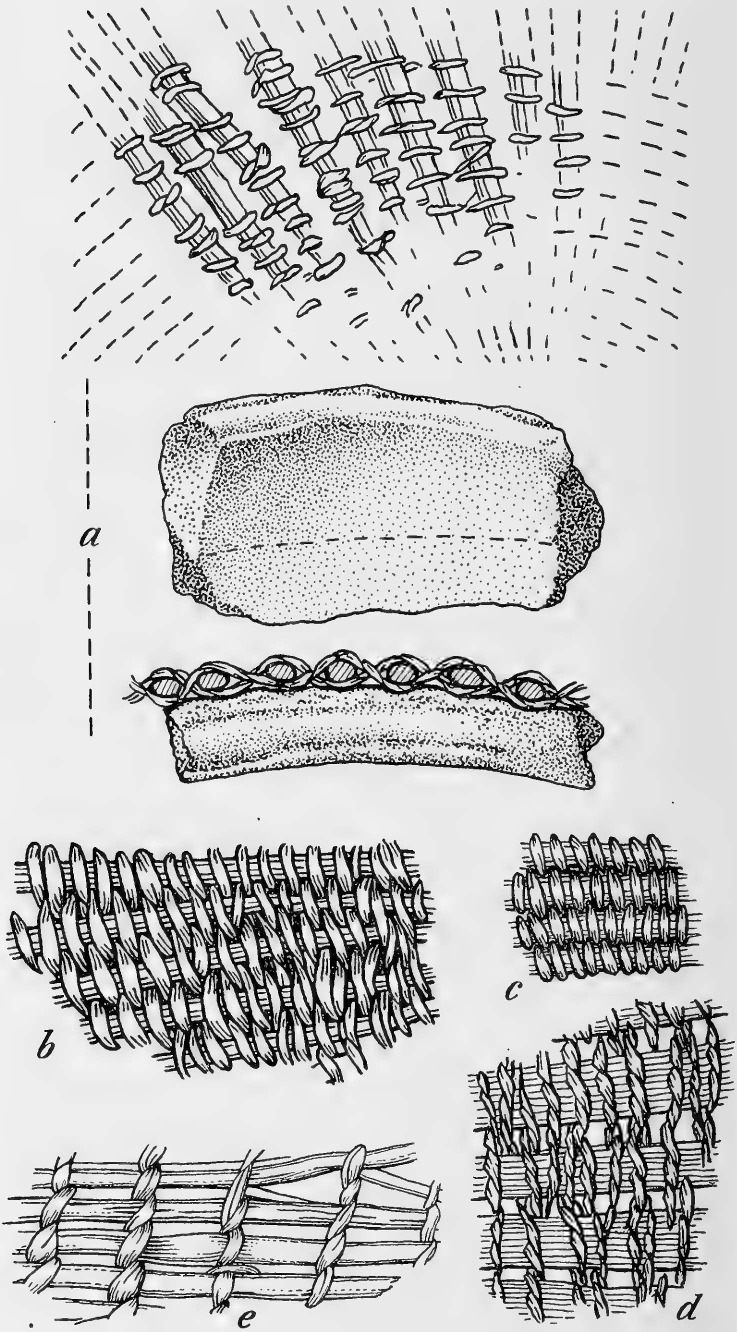


Fig. 6.—Specimens from the site of Nandtanghtacund. Textiles derived from impressions on fragments of pottery. Natural size.

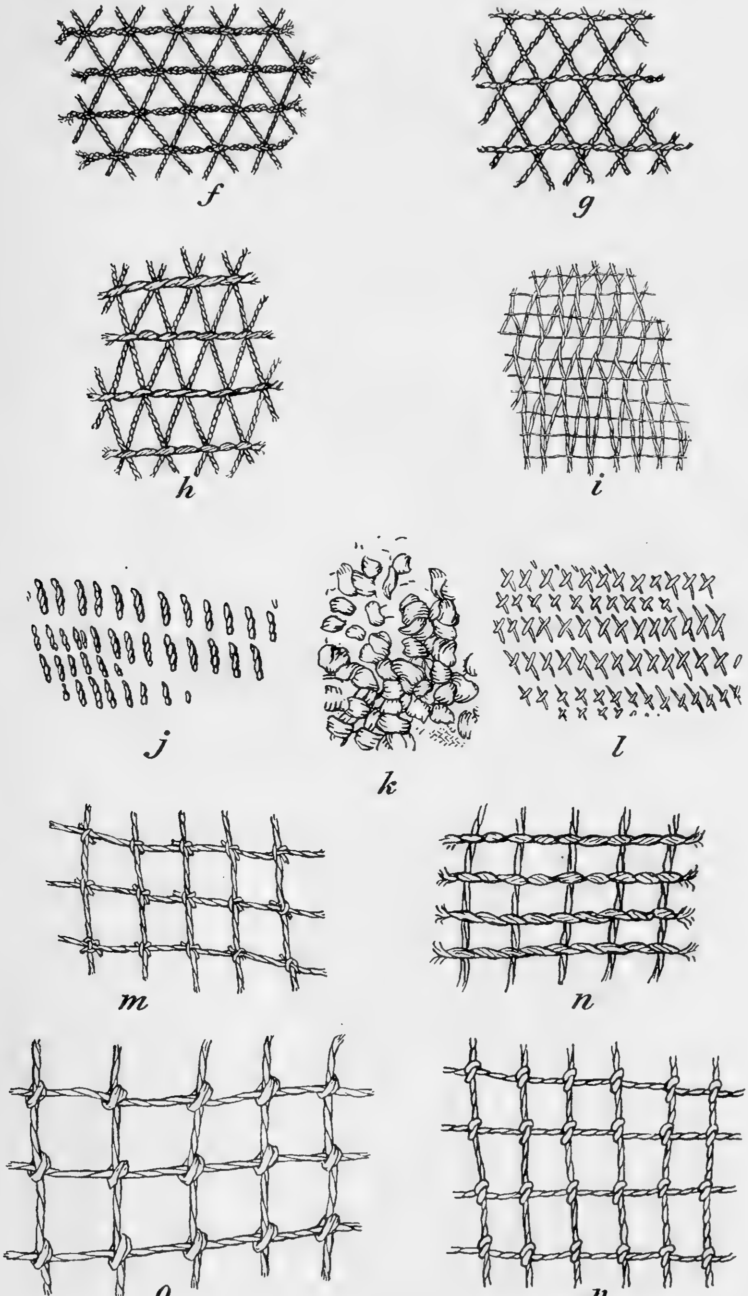


FIG. 7.—Specimens from the site of Nandtanghtacund. Textiles derived from impressions on fragments of pottery. Natural size.

or of reeds that had become crushed and flattened, held together loosely by twisted cords. An example of twined weaving.

Specimen *e*. No indication of coil. A small amount of fine sand mixed with the clay may be natural. It has not been possible to determine the type of vessel of which this is a fragment. The surface shown in the photograph is part of the inside of the vessel, and is very dark and smooth. On the right is the outer wall on which the impression appears. The outer surface is a yellowish brown color. Plain twine weaving.

Specimen *f*. Coiled ware. No evidence of tempering. Very hard. The impression on the surface was made by a piece of fabric of twined openwork weave, the unusual detail of which is that the horizontal cords appear to have been plaited rather than twisted.

Other examples of braiding or plaiting have been recorded. Holmes [55] illustrated a fragment of pottery from Georgia on which the decoration had been formed by impressing plaited cords upon the plastic clay, forming parallel straight lines. And during recent work in Manatee County, Fla, " charred fragments of braided and woven hair " of beautiful workmanship were found in a burial pit discovered in a mound not far from Little Manatee River.[56] Consequently, braiding such as is represented on the small piece of pottery from the Rappahannock site, although rarely encountered, is not unknown.

Specimen *g*. Coiled ware. Tempering, a small amount of crushed stone or sand. The surface bears the imprint of an example of twined openwork weave, having a crossed warp, differing in this respect from *f*.

Specimen *h*. Coiled ware. Clay impure and contains much fine grit. The impression of a fabric similar to that shown on *f* occurs on the surface, but the cords were twisted, not plaited.

Specimen *i*. No evidence of coil. Tempering, a quantity of fine sand or crushed quartz. The impression on the surface was formed by a piece of openwork fabric less regular in weave than the majority of examples and made of extremely fine threads.

Specimen *j*. Coiled ware. Much fine grit mixed with the clay. This is a fragment of the rim of a vessel. The impression on the surface suggests coiled basketry, with twisted cords forming the woof passing over and under a foundation made of some firm but flexible material.

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[55] Holmes, W. H., Prehistoric textile fabrics of the United States derived from impressions on pottery. *In* 3d Ann. Rep. Bur. Ethnol., p. 423, 1885.

[56] Stirling, M. W., Smithsonian archeological projects conducted under the Federal Emergency Relief Administration, 1933-34. *In* Ann. Rep. Smithsonian Inst., 1934, p. 381, 1935.

Specimen *k*. No indication of coil. No tempering. The impression on the surface was made by a rather closely woven fabric formed of coarse, loosely twisted cords, probably bison hair. In texture this resembles charred fabrics found in mounds in the Ohio valley, as well as work of historic tribes.[57]

Specimen *l*. Coiled ware. No evidence of tempering. The impression on the surface is very unusual and may have been made by either a basket or a piece of woven fabric. Two groups of woof elements, which may have been twisted cords, crossed as they passed over and under parallel warp. The straight lines, which were added after the impressions had been produced, are similar to those on the fourth and fifth specimens on the second row already mentioned.

Specimen *m*. Coiled ware. Tempering, small amount of sand or crushed quartz. At the crossing of many of the cords forming the net meshes there is a short depression in the clay, made when it was in a plastic condition. This is difficult to explain by any knot. It may not have been a part of the net proper but fragments of small feathers that had been attached to the meshes, an art practiced by the Indians of Virginia as well as by neighboring and related tribes both north and south. An account of the Delaware[58] and their native arts during the years 1654-1656 sheds light on customs that may not have differed from those practiced by the Indians of the Rappahannock during the same years. Lindeström wrote in part when referring to their use of feathers (p. 221): "They also make very fine and beautiful quilts of painted bird feathers. In the first place they tie them with meshes like nets, yet very fine; then they fasten the feathers in the meshes, so neat and strong that not one feather can come loose from it; it would sooner go clear off." This was also translated "The feather would sooner break off than come loose." Were small pieces of quill to remain in the knots of the net, the impression in clay would resemble that on the surface of *m*.

Specimen *n*. No evidence of coil. Tempering, crushed shell or vegetal substance, all traces of which have disappeared. Very hard. The impression on the surface was made by an open, netlike fabric. This was made by holding a single woof element between two strands

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[57] Compare Holmes, W. H., Prehistoric textile art of eastern United States. *In* 13th Ann. Rep. Bur. Ethnol., p. 36, pls. 6, 7, 1896.

[58] Lindeström, Peter, Geographia Americae with an account of the Delaware Indians, based on surveys and notes made in 1654-1656. Translated from the original manuscript with notes, by Amandus Johnson. The Swedish Colonial Society, Philadelphia, 1925.

of the warp which were twisted as they advanced with the woof between.

Specimen *o*. No indication of coil. Tempering, small amount of shell or vegetal substance, leached away, causing cavities. The very distinct impression of a coarse net appears on the surface.

Specimen *p*. Ware similar to *o*, but having the impression of a finer mesh. Part of the rim of a vessel.

Thus it has been possible, by means of impressions on bits of pottery, to gain some knowledge of the art of weaving and textile making as practiced by the inhabitants of the ancient village.

SOAPSTONE

Many fragments of soapstone vessels are encountered on the site, and it is evident that the material was used extensively by the people

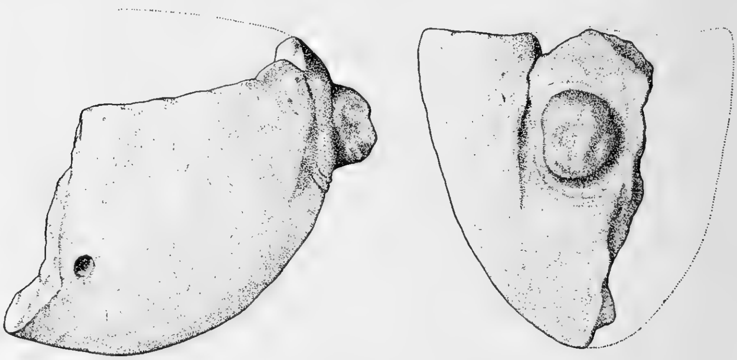


FIG. 8.—Fragment of a steatite vessel from site of Nandtanghtacund. $\frac{1}{3}$ natural size. U.S.N.M. no. 378093.

of the village. Here, as at Pissaseck, vessels made of soapstone may have been used as late as the beginning of the seventeenth century.

The most interesting piece of any sort found on the site is a fragment of a steatite vessel. This was discovered partly embedded in sand at the edge of the water of Port Tobago Bay, near the position of the upper A on the map, figure 5. Two views of the fragment are shown in figure 8, one-third natural size. The specimen appears to have had a very narrow base—so narrow that it could not have stood in an upright position without support. One conical perforation near the edge indicated that it had been broken and the parts held together by cords before being lost or discarded. But the most unusual feature is the knob in the middle of the narrow end, and this, although greatly worn, suggests a human face or head, with lines on the surface of the bowl both above and below. Undoubtedly, a similar ornament or handle was placed on the other end of the vessel in the same relative position. The greatest thickness of the wall is 1 inch, just below the knob. The entire surface, both inside and outside, is very smooth, resembling the surface of the rim fragment shown in plate 7, found at Pissaseck.

The villages of Pissaseck and Nandtanghtacund were important centers of population at the beginning of the seventeenth century and so continued for some years after the settlement of the colony. The sites of both native settlements are very extensive, and it is evident that they had existed through generations, although the entire area of each as now recognized may not have been occupied at any one time. From year to year, with the return of the people to the villages, different places would be selected for the erection of their habitations, a custom that resulted in a very extensive tract showing evidence of having been occupied, thus causing the sites to appear to be those of very large, widely dispersed settlements. Such a moving about over a restricted area may have continued for a long period and readily explains the occurrence of varied types of objects in many localities.

The material found on the two important sites just mentioned may be considered characteristic of the region. It is known, however, that certain forms of artifacts that would formerly have been encountered are not represented in the collections illustrated, but the deficiency will be partly supplied by showing specimens from sites farther up the river which will be briefly described. Nevertheless, were it possible to create large, representative collections from other places on the banks of the Rappahannock above Pissaseck, there would be a marked difference in the appearance of the material as a whole, and some types that are numerous on one site would be lacking or seldom encountered on others.

Above Port Tobago Bay

The right bank of the Rappahannock, at and immediately above the beginning of Port Tobago Bay, is bordered by an extensive marsh. That the high ground adjacent to the marsh was once occupied by a native settlement is indicated by the presence of pottery, now reduced to very small pieces, scattered over the surface. Various stone implements may also be found, together with a few pieces of soapstone vessels. The extent of the occupied area could not be determined, but it may have been comparatively small.

Many of the shards discovered on the surface of the site are smooth, others bear the impressions of cords and textiles, but the majority are so worn that it is not possible to identify the kind of material that had been impressed on the plastic clay. One fragment is a very hard, dark-colored coil ware, with no trace of tempering. The impression on this suggests that of a rather loosely woven basketry, with both warp and woof formed of firm material, not twisted cords. This is reproduced and drawn exact size in *a,* figure 9.

The wide mouth of Mill Creek is located on the right bank of the river about 2 miles above Port Tobago Bay. A mile or more from the river the creek is crossed by the main highway from Fredericksburg. A small camp site was discovered on the left bank of the creek immediately south of the road. Several argillite points and fragments of very coarse, net-marked pottery were found on the surface. The pottery appears to have belonged to not more than two vessels, and although worn and greatly disintegrated, several of the shards reveal

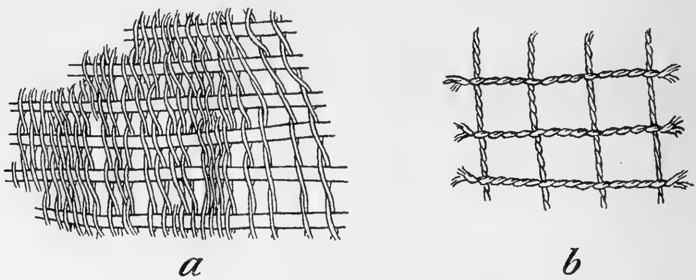


Fig. 9.—Textiles derived from impressions on fragments of pottery. *a,* from right bank of the Rappahannock near Port Tobago Bay. *b,* from camp site on Mill Creek 1 mile above its mouth. Natural size.

the impression of a net which resembles specimen *n* from Nandtanghtacund. This was made by the woof elements being held firmly between two strands which were twisted together as they advanced to form the warp. The net, as restored and drawn exact size is shown in *b,* figure 9. The argillite points are deeply weathered.

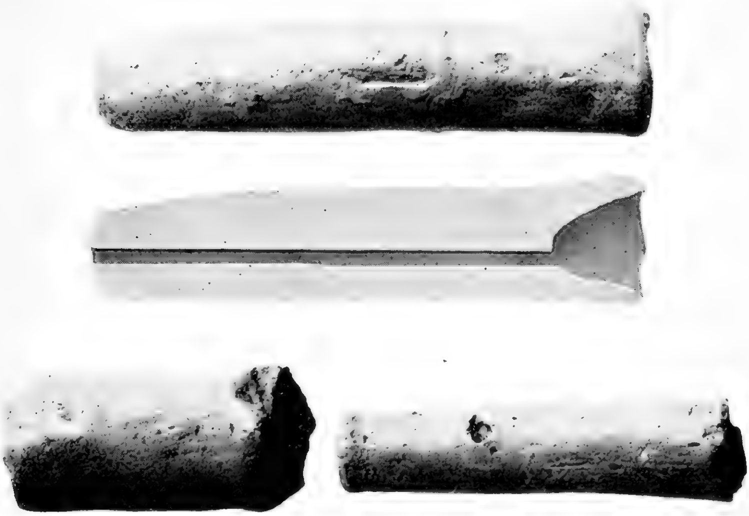
Traces of many small camps similar to the one just mentioned—camps of hunters away from the larger villages—could undoubtedly be discovered near springs and on the banks of streams throughout the wooded region.

Left Bank of the Rappahannock Above Port Tobago Bay

The names of two settlements appear on the 1624 map on the left bank of the Rappahannock a short distance above the deep bay later known as Port Tobago or Tobacco Bay. The first is Papiscone and just beyond is Assuweska. One of these is thought to have stood at the mouth of Chingoteague Creek, but it is not possible to determine

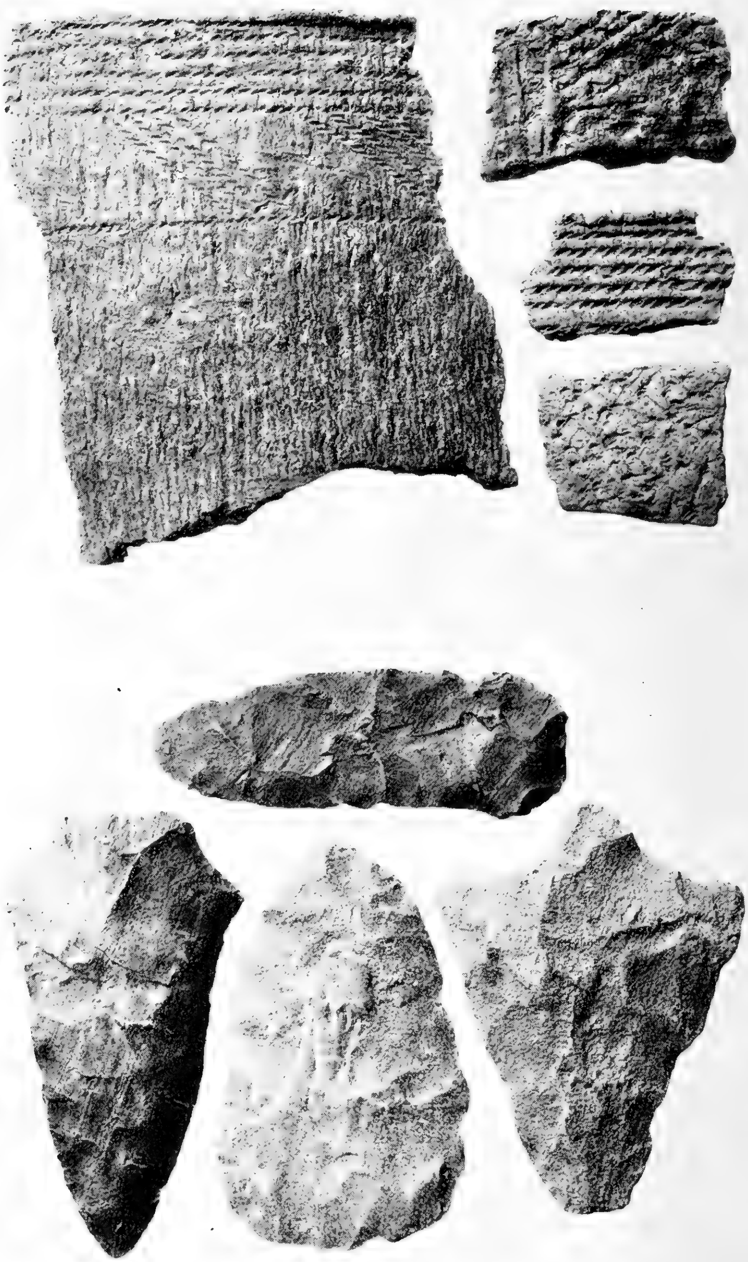
Photograph U. S. Army Air Corps.

1. NORTH OVER THE RAPPAHANNOCK SHOWING MOUTH OF CHINGOTEAGUE CREEK



2. PIPES FOR SMOKING. MADE OF CLAY. FROM SITE AT MOUTH OF CHINGOTEAGUE CREEK

Natural size. U.S.N.M. no. 378086.



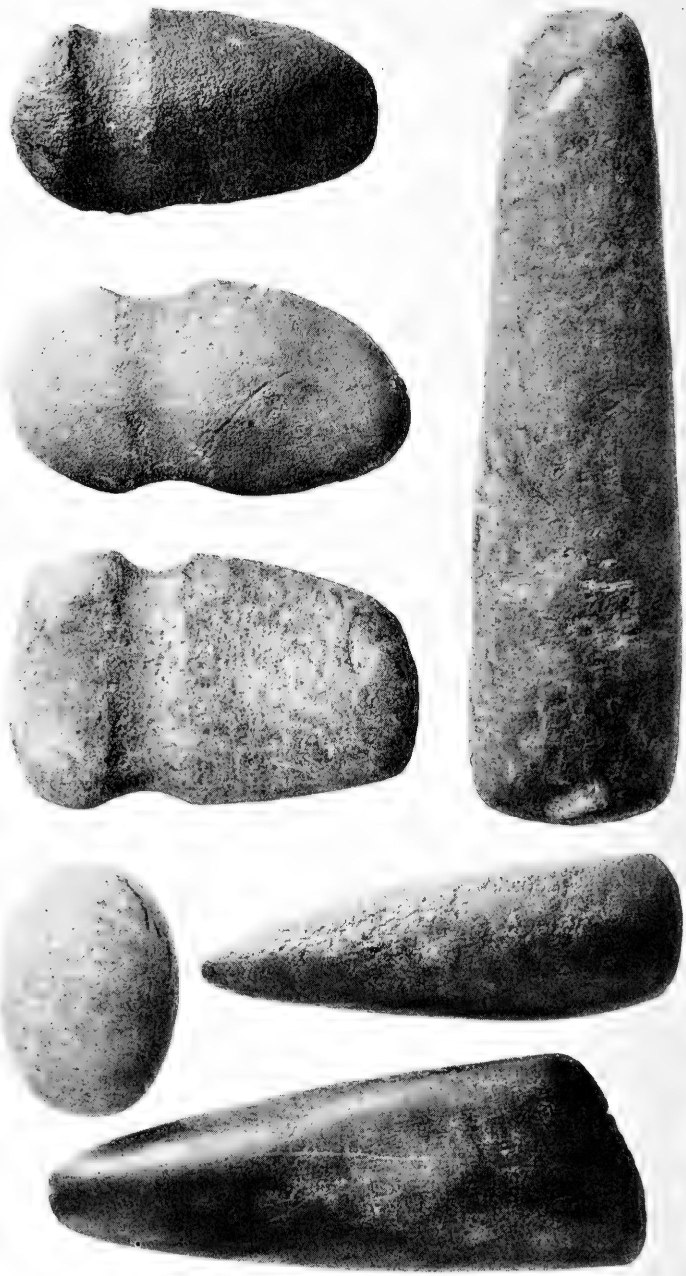
Specimens from Site at Mouth of Chingoteague Creek

$\frac{1}{2}$ natural size.

Photograph U. S. Army Air Corps.

NORTH OVER THE RAPPAHANNOCK

Cleve, on left bank, above arrow to right. Taliaferro Mount, on right bank, over arrow to left. Potomac River, near mouth of Potomac Creek, in upper right corner.



SPECIMENS FROM RAPPAHANNOCK SITES

Above, from Gay Mont. Below, from Cleve. ½ natural size.

the exact position of either. Traces of a village have been discovered on the narrow tongue of land which extends upward from the junction of the two streams and which is bordered by the left bank of the river and the right bank of the creek. This is visible in the aerial photograph, plate 14, figure 1. Several large springs issue from the river bank, which rises in places more than 20 feet above the gravelly beach. The site commands a beautiful view of the winding valley, and as evidences of occupancy are encountered for a distance of more than a quarter of a mile, it may have been occupied and reoccupied for many years. It is known that a vast number of small chipped objects, also many larger specimens and quantities of fragmentary pottery, have been recovered from the site of the ancient village. Much may even now be found on the surface, but as the area has been cultivated for many years, the pottery has been reduced to bits, and few entire arrowpoints or objects of any sort are to be discovered.

Small tubular clay pipes have been found within a rather restricted area—just above the small arrow shown on the aerial photograph. One perfect and two fragmentary examples are illustrated in plate 14. All are made of clay without tempering, are of a light brownish color and very hard. The perforation, made when the clay was in a soft condition, had been produced by the insertion of a comparatively rigid, firm substance, probably a slender twig or stem of some plant.

The discovery of pipes in considerable numbers at once recalls the statement made by Durand that when leaving the Indian village of Portobago, to return to the Wormeley house on the north side of the river, he and another member of the party had received as a gift "a handful of pipes each." He had previously told that the women of the village were then making "pots and vases from earth and pipes to smoke." This was during the autumn of 1686, and it is within reason to believe that the pipes to which he then referred were similar to those now being considered. Consequently, this primitive form of pipe was made and used in the Rappahannock villages just two and one-half centuries ago. The bowls are so small that it is difficult to understand how the pipes could have been used unless the leaves of the plants were rolled and inserted in the opening, rather than being crushed and employed in the usual manner.

Additional material from the site is shown in plate 15. Although the pottery now found scattered over the surface has been broken into small pieces by the constant cultivation of the land for many years, larger specimens have been encountered exposed on the face of the river bank below the upper stratum of soil that had been disturbed by the plow. One such piece is illustrated in plate 15. This large fragment is part of a vessel that measured approximately 11 inches across the rim, with the wall $\frac{1}{4}$ inch thick. The vessel had probably been about 15 inches in height, with a small, conical bottom. It is coiled ware, with a coarse sand tempering. The inner surface is crossed by many small, parallel grooves caused by the object or material used in smoothing the clay when the vessel was formed. The outer surface had first been marked by tightly twisted cords placed vertically, overlapping, and passing over the top of the opening, causing the edge to be very rough and irregular. Six single cords, parallel, form a band about 1 inch in width just below the rim. A single cord is placed parallel to these 1 inch below. Groups of four cords extend diagonally across the intervening space, the groups of four being about $1\frac{1}{2}$ inches apart. All had been impressed on the clay while it was in a plastic condition and before the vessel was fired. The impressions of the cords are easily distinguished in the photograph.

Three smaller fragments are shown to the right of the large specimen. The second bears the impressions of cords placed horizontally as on the large fragment, but the rim had been indented, or rather scalloped, by means of a heavy cord pressed at intervals into the clay. The ware is similar to the large fragment, and, like it, has a tempering of coarse sand. The specimen at the upper right bears the impression of a net over part of the surface, but on the left there are several vertical impressions that appear to have been made by matting or basketry. This combination suggests that a piece of net was placed against some rigid material before the impression was made in the clay.

The third of the small fragments bears the impression of a net, similar to specimens from Pissaseck and elsewhere.

A vast number of small shards were found scattered over the cultivated land, but only three were net-marked, the great majority being similar to the large piece first described.

Four examples of the larger chipped objects, found on the surface during past years,[59] are shown on plate 15. All are finished specimens with edges worn and smoothed from use. The knife, placed horizontally at the top of the group, is made of dark, brownish rhyolite as is also the large blade at the left. The second piece is made of yellowish quartzite, and that on the right is diabase with surfaces greatly altered. These were selected for illustration from a number of similar specimens as being typical examples of rather unusual material.

[59] Now in the private collection of A. J. Jones, of Jersey, King George County, Va.

At Mouth of Millbank Creek

Millbank Creek flows into the Rappahannock from the north between 3 and 4 miles above Chingoteague Creek. The present Millbank Creek is believed to have been shown on the Herrman map as Omoy Cr., the first large creek below the "Doogs Indian." Jiles Point, at the junction of the streams, extends between the right bank of the creek and the left bank of the river. The land facing the river is high, but on the other side it is lower and is bordered by a marsh through which the creek flows. The point of land, well protected by the water, is thought to have been occupied by one of the villages indicated on the 1624 map. Much fragmentary pottery and numerous arrowpoints may even now be collected from the surface, and mor-

Fig. 10.—Point resembling the Folsom type made of diabase. Found near mouth of Millbank Creek. Natural size. U.S.N.M. no. 378094.

tars, axes, and other large specimens are often found, all tending to indicate the location of an ancient settlement.

The most important piece known to have been discovered on the site is a Folsom point, made of dark gray flint, which has already been described.[60] It is a typical example of the eastern form and was found on the surface in a small field, at the extremity of the point of land, that slopes to the marsh bordering the creek. No similar specimen is known to have been found in the vicinity, but nearby, in the same field, was discovered a point made of diabase which closely resembles the Folsom type. This is shown, natural size, in figure 10. It is crude when compared with the first specimen, but, considering

[60] Literary Digest, June 9, 1934. Also in Bushnell, D. I., Jr., The Manahoac Tribes in Virginia, 1608. Smithsonian Misc. Coll., vol. 94, no. 8, pl. 13, Oct. 9, 1935.

the material of which it is made, it is doubtful if a better piece could have been produced. The surface is altered to a far greater degree than are the blades made of the same stone from Pissaseck illustrated in plate 4. The two specimens just mentioned are thought to have belonged to the same period of occupancy or to have been lost by the same nomadic bands.

The third field beyond the mouth of Millbank Creek is visible on the extreme right in the aerial photograph, plate 16. This is the lower part of Cleve, the old house having stood in the midst of the grove, near the river bank, a short distance to the left. Much broken pottery and innumerable objects of stone have been found on the surface of this field, which is just above the white arrow in the photograph. The two celts illustrated in plate 17 were found here. Both are oval in section, symmetrical, and are made of a hard, greenish diabase. The small hammerstone shown with the celts was found in the field nearer the mouth of the creek. It is a natural quartzite pebble battered at both ends.

The fragments of pottery are mostly small, few being more than an inch in length. One such piece bore the impression of a net, several were smooth, all others were cord-marked. The ware resembles in all respects that discovered near the mouth of Chingoteague Creek, on the same side of the Rappahannock several miles below.

Checopissowa

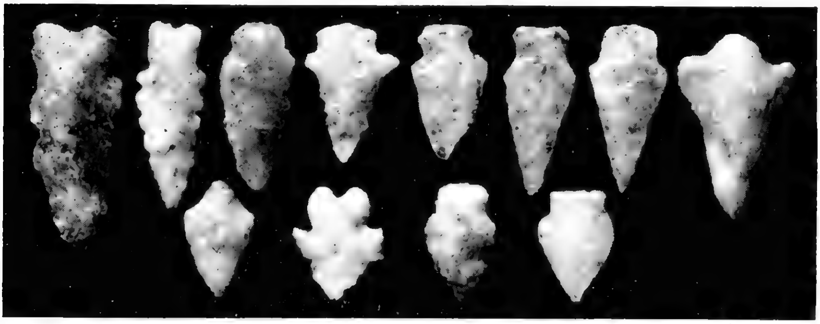
Much material has been collected from the surface of the fields bordering the right bank of the river, an area clearly shown in the lower left quarter of the aerial photograph reproduced in plate 16. It is part of Gay Mont. This was the locality of a large native settlement, and although it is not possible to be positive in the identification of the ancient sites, it may have been the village of Checopissowa, as indicated on the 1624 map.

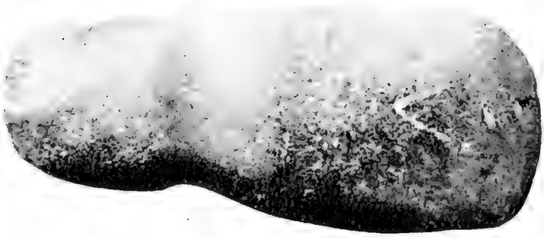
The three small grooved axes and the cylindrical pestle, the latter made of fine-grain quartzite, which are illustrated in plate 17, were found on this site near the river bank. Many of the smaller objects known to have been collected here, and which have been examined, are exceptionally well chipped and represent a variety of forms. The majority of the small pieces, including the projectile points, are made of white quartz.

Fragmentary pottery is plentiful, and many pieces bearing the impression of what is thought to have been rigid basketry are found intermingled with ware that obviously belonged to a recent period of

Photograph U. S. Army Air Corps.

1. East over the Rappahannock. Ancient village site to right of black arrow which points with the current. The Potomac River in the distance.





2. Above, from right bank of the Rappahannock north of Taliaferro Mount. U.S.N.M. no. 378087. ½ natural size. Below, axe from below mouth of Dogue Run. ½ natural size.

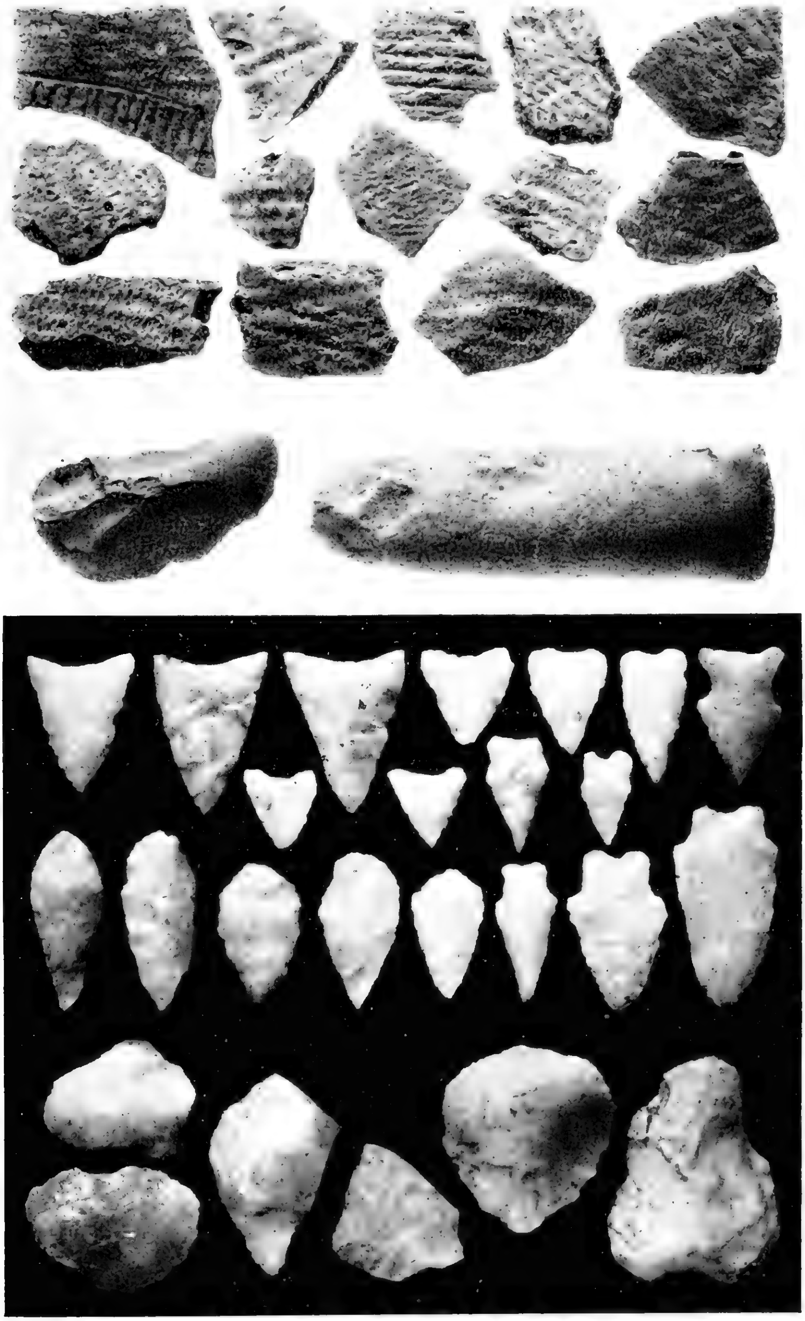
Photograph U. S. Army Air Corps.

1. Looking across the site, up the valley of the Rappahannock, with Lamb Creek in foreground.

Photograph U. S. Army Air Corps.

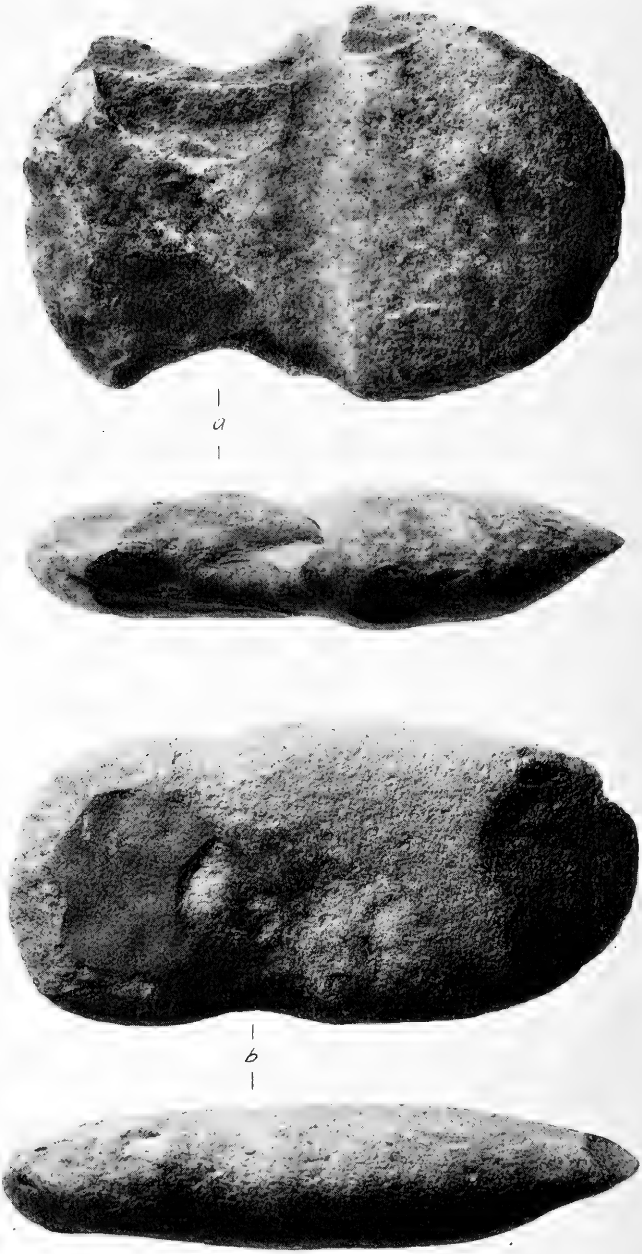
2. Junction of Lamb Creek and the Rappahannock.

SITE OF CUTTATAWOMEN



SPECIMENS FROM THE SITE CF CUTTATAWOMEN

½ natural size. U.S.N.M. nos. 378088-91.



Two Specimens, Showing Rechipping, from Site on Left Bank of the Rappahannock, 1 Mile above Mouth of Lamb Creek

⅔ natural size. *a*, U.S.N.M. no. 378092.

occupancy. Some vessels had been decorated with a roulette, and other shards are similar to the three illustrated on the right, second row, in plate 13. As a whole the pottery from this area differs from that discovered at Pissaseck, but resembles much of the ware found at Nandtanghtacund and at sites farther up the Rappahannock beyond the falls.

Taliaferro Mount

Again referring to the aerial photograph of the region, plate 16, Taliaferro Mount is on the right bank, heavily timbered, immediately above the white arrow which is pointing downstream. The mount rises abruptly from the water and is rather steep on the north, but slopes gradually to the south and west. This commanding spot was evidently occupied by the house of Robert Taliaferro, the same to which Lederer referred when he wrote:[61]

> On the twentieth of August 1670, Col. Catlet of Virginia and my self, with nine English horse, and five Indians on foot, departed from the house of one Robert Talifer, and that night reached the falls of Rappahanock river in Indian *Mantapeuck*.

A few years later Beverley mentioned[62] "*Tolivers* Mount, upon *Rappahannock* River", as one of the elevations from which he had "view'd the Country all around over the Tops of the highest Trees, for many Leagues together." It was evidently a place of renown and had been frequented by the Indians long before the coming of the colonists.

John Fontaine, who accompanied Governor Spotswood on his journey to the mountains during the summer of 1716, left Williamsburg November 9, 1715, for the German settlements on the Rappahannock above the falls.[63] Three days later they reached the home of Robert Beverley, "this Beverley is the same that made the History of Virginia." There they remained until the 19th, and that day, so the journal continued: "About three we came to a place upon Rappahannock River, called Taliaferro's Mount, from whence we had a feeble view of the Appalachian Mountains, and a fine view of the river, which is navigable for large ships and has several fine islands

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[61] Lederer, John, The discoveries of . . . Begun in March 1669, and ended in September 1670. London, 1672. Reprint 1902.

[62] Beverley, Robert, The history and present state of Virginia, book 2, pp. 11-12, London, 1705.

[63] Journal of John Fontaine. *In* Memoirs of a Huguenot family, by Ann Maury. New York, 1853.

in it . . . We saw upon the river abundance of geese, ducks, and water-pheasants."

Although a " feeble view " of the high ground and hills to the northwest may have been obtained, the Appalachian Mountains, as now designated, could never have been seen.

Much material of native origin has been recovered from the area bordering the right bank of the river and extending northward from the foot of Taliaferro Mount. Projectile points and other small chipped objects are plentiful, and typical examples are illustrated in plate 18, figure 2. All shown are made of white quartz. Small pieces of pottery may be found in the same fields near the river bank, indicating the site of a native settlement.

" Doogs Indian "

About 2 miles above Taliaferro Mount the Rappahannock makes a wide bend to the eastward, passing fertile fields which are frequently bordered by low marsh lands. This is shown in the aerial photograph reproduced in plate 18, figure 1, with the camera pointing east. Dogue Run, flowing between heavily timbered banks, joins the Rappahannock from the east (above the white arrow) opposite the end of the large marsh. The name of the run was derived from that of the Doeg tribe after they are thought to have come from Maryland and entered the valley of the Rappahannock. In 1673 this was the country of the " Doogs Indian " as indicated on the Herrman map, figure 2. It is a beautiful section of the valley and was once a vast forest where game abounded. Traces of Indian occupancy are encountered in all parts of the region, and some of the stone implements and weapons which have been found on the surface are unusual forms and many reveal superior workmanship.

The axe illustrated in plate 18, figure 2, was found in the field on the left bank of the river visible in the right center of the photograph. It is a natural pebble of diabase which had been slightly worked into shape. The shallow groove is very smooth, a condition which suggests considerable use. Larger, rather massive specimens of the same type have been found on the site.

Innumerable arrowpoints and other chipped objects have been found on the surface of the field. Some rather large specimens are often discovered. Typical examples are sketched in figure 11.[64] Of the five specimens shown, four are made of quartzite, and one, that

[64] These are in the private collection of William Howard, Fredericksburg, Va.

in the upper right, is made of diabase. All are well chipped and symmetrical, and resemble certain specimens from the site at the mouth of Chingoteague Creek, previously mentioned.

The small grooved axe shown second from top in plate 17, is similar to the specimens from the field on the left bank of the river

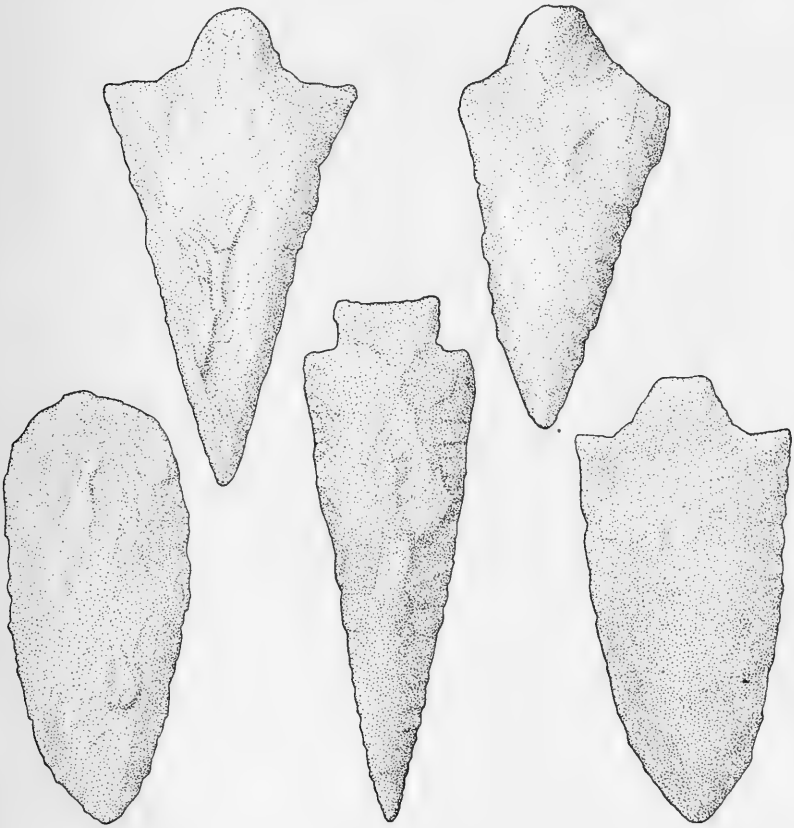

FIG. 11.—Specimens found near Dogue Run. ½ natural size.

below Dogue Run, just described. It likewise was fashioned from a natural pebble of diabasic rock, and the groove has become smoothed and worn from use. This distinctive type of weapon or implement was not encountered elsewhere on the Rappahannock sites. It is believed to have belonged to a late period of occupancy, as may also many of the projectile points, small chipped objects, and fragments of earthenware found in the vicinity.

Opposite the Mouth of Hough Creek

Hough Creek enters the left bank of the Rappahannock about 1 mile above Dogue Run. The Indian name of the creek is not known. The mouth of the creek, bordered by brush and timber, is visible in the aerial photograph, plate 18, figure 1, to the left of the black arrow which points with the direction of the current. On the opposite side of the river, to the right of the arrow, is the site of an ancient settlement which appears to have been abandoned before the coming of the English in 1608. No village is indicated in this locality on the 1624 map. The extent of the occupied area has not been determined. It was probably a permanent village as distinguished from a temporary camping ground. The land is comparatively low and during the freshet of April 1937 was under several feet of water.

The material discovered on the site includes many projectile points and several types of small chipped objects, the majority of which are made of white quartz; consequently, it is impossible to determine the relative age of a specimen by the condition of its surface. But other pieces formed of diabasic rock and a very fine-grain quartzite have become greatly altered and in this respect resemble the two axes found a short distance above on the opposite side of the river, shown in plate 21. A few bits of pottery that bear the impression of basketry, and several fragments of soapstone vessels found near the river bank, likewise suggest an early period of occupancy.

Cuttatawomen

The position of the village of Cuttatawomen, standing on the left bank of the Rappahannock, is indicated on the 1624 map by a sketch of one of the " Kings howses," proving it to have been the home of a chief. However, in 1608 it was not a large settlement, as it was then described as having but 20 bowmen. Mooney was of the belief that the ancient village stood at or near the mouth of Lamb Creek. Traces of a native settlement have been discovered at the junction of the creek and the Rappahannock and may indicate the location of Cuttatawomen. This beautiful site, on the left bank of the river just above the mouth of the creek, is shown in aerial photographs reproduced in plate 19.

The land has been cleared and cultivated for many years, much of it for two centuries or more, before which it had been occupied by native settlements with small clearings for gardens and cornfields. It is known that during past years large collections of stone implements and numerous artifacts of various forms have been recovered from the surface of the site. Some may even now be found, and specimens discovered during recent visits are illustrated in plate 20. All were collected in the fields bordering the left bank of the river, rising 20 feet or more above the water, extending to the vicinity of the old wharf which is visible in the lower of the two photographs (pl. 19).

The pottery found on the site has been reduced to small fragments; characteristic shards are shown in plate 20. Many of the fragments are believed to be ware that belonged to an early period of occupancy, preceding that of the historic villages of 1608. The impressions on the surface of some pieces appear to have been made by rigid basketry which had been used in shaping the vessels. Crushed shell had evidently served for a tempering material. No example of net-marked ware, so plentiful at Pissaseck and elsewhere, was found on this site.

The two specimens shown below the pottery are made of diabase. To the left is a knife or scraper, formed of a flake struck from a pebble and revealing secondary chipping. To the right is a well-made celt with a sharp cutting edge. The surface is slightly altered.

All pieces illustrated in the lower half of the plate are made of white quartz. The beautiful triangular points are of special interest, as few specimens have been found on other sites, a single example having been discovered at Pissaseck. At the bottom are six roughly formed scrapers or implements that had been used for different purposes, representing several types, all of which bear evidence of much use.

A short way above its junction with the Rappahannock, Lamb Creek makes a sharp bend to the left (pl. 19, lower figure). This is caused by a narrow tongue of land sloping down from the high ground, which rises some 20 feet above the water. The sloping ridge is covered with trees and brush. A large tree, standing separate and apart from others and with a very light spot on the ground to the left of it, at the edge of the cultivated land, may readily be distinguished in the photograph. This large tree is growing from an embankment and ditch which may be traced from the foot of the high ground at the beginning of the marsh bordering the river, over the ridge and down to near the edge of the marsh through which the creek flows. The embankment and ditch follow a straight course. As viewed in the photograph, the embankment is on the far side, facing the level, cultivated fields. The best-preserved section is near the large tree, on the highest part of the ground, where the embankment is approximately 18 inches in height and the ditch about the same in depth.

Nothing is known of the origin of the embankment and ditch. They are very old and may have been constructed during days of Indian occupancy, when the embankment would undoubtedly have been surmounted by a palisade. Nothing similar has been encountered on other Rappahannock sites.

Sockbeck

About 1 mile up the Rappahannock from the mouth of Lamb Creek, on the same side of the river, is the site of a settlement which gives the impression of being very old. It is near the river, on cultivated land just beyond the cloud-shadowed area shown in the upper of the two photographs reproduced in plate 19. It is a beautiful location which had probably been occupied and reoccupied through generations and may have been the position of Sockbeck as placed on the 1624 map, but, as previously mentioned, it is not possible to be certain of the identification of any site. The extent of the site was not determined.

Some very interesting materal was discovered on the surface, including arrowpoints and other small chipped objects, crude hammerstones and pestles, and two axes which are the most unusual specimens found on any site mentioned in the present work. A few bits of pottery are to be found scattered over parts of the site, being more plentiful near the river, but all have been reduced by the plow to very small pieces.

The two axes are shown two-thirds natural size in plate 21. They were found in the same field a short distance back from the river bank. Both are made of fine-grain, dark gray quartzite.

Specimen *a*. When originally made, this was a grooved axe, or axelike implement. It was probably a quartzite pebble that was shaped by pecking or battering the surface until it was reduced to the desired form and the groove made. Then it was lost or abandoned for a long period, during which time the surface became much altered. Later it was partly rechipped, but the groove no longer served its original function, although the implement was again hafted and used. The rechipped portion is slightly altered and is easily distinguished from the more deeply weathered surface of the original axe. A small portion of the natural surface of the pebble remains and is visible far to the left in the photograph of the side of the implement.

Specimen *b*. Made of a thin quartzite pebble. It had been formed by pecking, but part of the natural surface of the stone remains on both sides of the axe. The surface became greatly altered after having been unused for a long period. Evidently, it was later discovered and resharpened by the removal of several large flakes. The exposed surface thus produced is worn and smoothed from use, and even though it has been in this condition for three centuries or more, the surface remains unaltered, in strong contrast to the appearance of the older portion.

Quartzite weathers or alters so slowly that the present condition of the two specimens is suggestive of great age. But the surface of the secondary chipping of the two pieces has not altered to the same degree, and it is evident the first specimen has been exposed much longer than has the second. The surface of the later chipping on *a* has become altered, whereas that of *b* has remained unchanged. The first may be the older of the two, and both periods during which it was used may have preceded that represented by the historic Algonquian tribes, whose villages stood in the valley of the Rappahannock in 1608.

Beyond this site the left bank of the Rappahannock is bordered by an extensive marsh, and on the opposite side are cliffs rising nearly 100 feet above the water. From the brow of the cliffs it is possible, when conditions are favorable, to see the Blue Ridge Mountains far to the westward.

Evidence of Indian occupancy is encountered throughout the region, which had been occupied and reoccupied through centuries. But it is evident that the greater part of the valley from here to the falls had been abandoned by the Algonquian tribes before the summer of 1608, at which time the English from Jamestown entered the country.

CONCLUSIONS SUGGESTED BY CERTAIN SPECIMENS

Early in the seventeenth century, when the English ascended the Rappahannock, that part of the valley now being considered was comparatively thickly settled, with camps and villages standing on the banks of the river. But, as proved by the discovery of certain objects, the native tribes then encountered were not the first to inhabit the country. The specimens recovered from the sites vary in form and material, and obviously belonged to several distinct periods of occupancy.

The occurrence of a typical eastern Folsom point near the mouth of Millbank Creek, on the left bank of the Rappahannock, presents an interesting problem. It is a beautiful example of the type that has been discovered widely dispersed throughout the country east of the Mississippi, being more numerous in some localities than in others but all possessing the same characteristic features, similar in many details to the western points. It is a highly specialized form and one believed to have developed from a single center rather than to have arisen independently in different localities at different times.

The discoveries made by Roberts[65] at the Lindenmeier Site in northern Colorado during the past 2 years have established the great antiquity of the Folsom culture in that part of the country, placed by some at from 8,000 to 10,000 years; by others these figures are considered conservative. But not until a similar site has been uncovered in the eastern part of the country will it be possible to suggest, with a degree of certainty, the age of the eastern Folsom points, as represented by the example from the valley of the Rappahannock. It will be necessary to find specimens resting in an undisturbed, stratified deposit that will permit the geologist to determine the approximate age of the superimposed or surrounding mass. The discovery of such a deposit would be of the utmost value in the attempt to determine the antiquity of man in the eastern part of the continent.

Next in importance to the Folsom point are the two axes illustrated in plate 21. Both bear evidence of having been used during two long-separated periods, and in this respect they are similar to another specimen found some years ago on the bank of the Rapidan.[66] And as has been suggested in the description, both periods during which one of the specimens from the Rappahannock site was used may have preceded that represented by the tribes encountered by the first English colonists.

Some material recovered from the site of ancient Pissaseck may likewise have belonged to an early period, although this will be more difficult to prove. This refers in particular to the argillite points and scrapers illustrated in plate 3, which are similar to specimens recovered from the stratum of yellow sand, below black soil, in the Delaware valley.

The objects which have been mentioned—a Folsom point, the two axes, and the argillite material—afford conclusive evidence of the existence of several distinct periods of occupancy in the valley of the Rappahannock preceding the coming of the historic tribes, those whose villages stood on the banks of the river at the beginning of the seventeenth century.

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[65] Roberts, Frank H. H., Jr., Additional information on the Folsom complex. Smithsonian Misc. Coll., vol. 95, no. 10, 1936.

[66] Bushnell, David I., Jr., Evidence of Indian occupancy in Albemarle County, Virginia. Smithsonian Misc. Coll., vol. 89, no. 7, pl. 2, 1933.

Earthenware vessels continued to be made in the Rappahannock villages long after the arrival of the English colonists. There is a reference by the French traveler Durand to the making of "pots and vases from earth" at the Portobago village during the autumn of 1686, and the art may have been practiced into the eighteenth century. Much fragmentary pottery is found on all sites along the river, but it is difficult, often impossible, to distinguish the more recent from the early forms of ware. A few scattered pieces bear the impression of basketry. These are attributed to an early period of occupancy and may have been contemporaneous with the axes previously mentioned.

The impressions of textiles on fragments of pottery from Pissaseck, Nandtanghtacund, and other localities serve as a means of determining the kind of nets, mattings, and coarse fabrics made and used in the native villages. Much of the ware so marked and now encountered on the surface was made during the late period and indicates the skill of the people as weavers and potters.

All material described in the preceding pages was discovered on the surface, and the greater part of it may have accumulated in refuse heaps in and about the villages, later, when the land was cleared and cultivated, to be scattered by the plow. It is believed that much remains hidden beneath the surface, implements and ornaments, pottery vessels, fireplaces and traces of the habitations, and burials. The recovery of such material would make it possible to form a clearer conception of the manners and customs, the ways of life, of the inhabitants of the Rappahannock valley long before the settlement of Jamestown, and would aid in determining whence they came.

(From "Explorations and Field-Work of the Smithsonian Institution in 1937")

ANCIENT SITES ON THE BANKS OF THE RAPPAHANNOCK IN VIRGINIA

By DAVID I. BUSHNELL, JR.
Collaborator in Anthropology, U. S. National Museum

During the spring of 1937 a great freshet swept down the valley of the Rappahannock from the foot of the Blue Ridge, where heavy rains had fallen for several days. The low grounds were inundated, and when the waters had receded it was discovered that many areas had been greatly altered, gullies had been formed, banks of sand had been deposited and, in some instances, the surface soil for a depth of a foot or more had been washed away, causing the heavier masses to settle and remain exposed. Traces of ancient camps and villages were thus revealed.

The valley of the Rappahannock below Fredericksburg is more open, the low grounds more extensive, and the river is wider than above the falls; nevertheless, the force of the great flood was felt far down the stream.

On May 9, when the ground was becoming dry, several places below the falls were again visited to see the effect of the flood and to endeavor to recover some of the material thought to have been deposited by the swirling waters. Fortunately, a site of much interest was encountered. It is on the right bank of the Rappahannock in Caroline County, Va., a mile or more below the mouth of Lamb Creek on the opposite side of the river and is shown in the aerial photograph reproduced in figure 111, to the right of the black arrow which points with the current. This is now a rich and fertile section of the valley, but visualize the same region as it was in 1608, when first visited by English colonists from Jamestown—a dense forest with small groups of mat- and bark-covered lodges dotting the river banks, trails traversing the wilderness, game and wildfowl to supply the wants and requirements of the native hunters armed with bows and arrows, and streams teeming with fish. However, the earlier settlement, traces of which were uncovered by the freshet, is thought to have been abandoned before the year 1608.

When the site was visited on May 9, the surface for a distance of a hundred yards or more from the river bank, and extending to the beginning of the wooded area, was sand and gravel, all vegetation had been swept away, and in places it was deeply gullied. Fragments of pottery and objects of stone, some broken and others entire, were scattered over the surface, indicating the location of a native village which had been occupied centuries ago. Examples of the specimens collected at that time are shown in figure 112. Above are 15 objects made of white quartz, so plentiful in the valley. Projectile points, knives, and scrapers are included in the group. The four pieces to the left in the second row may have been mounted as knives and their simi-

FIG. 111.—Looking down the Rappahannock. Site of the ancient settlement to the right of the black arrow. (Photograph by U. S. Army Air Corps.)

larity in form and size is remarkable, but being made of quartz the condition and appearance of the surface does not aid in determining their relative age. Below are 9 pieces representing a variety of forms, all made of diabasic rock and with surfaces equally altered as a result of long exposure. At the bottom is a cylindrical pestle, with a short, shallow groove clearly shown in the photograph. Two forms of scrapers may be recognized. All specimens, quartz and diabase, are thought to be of approximately the same age. Some fragments of earthenware found on the site bear the impression of coiled basketry, and this is considered the oldest form of pottery occurring in the Rappahannock valley; other pieces are cord-marked and some are smooth, porous, and deeply pitted through the leaching away of the

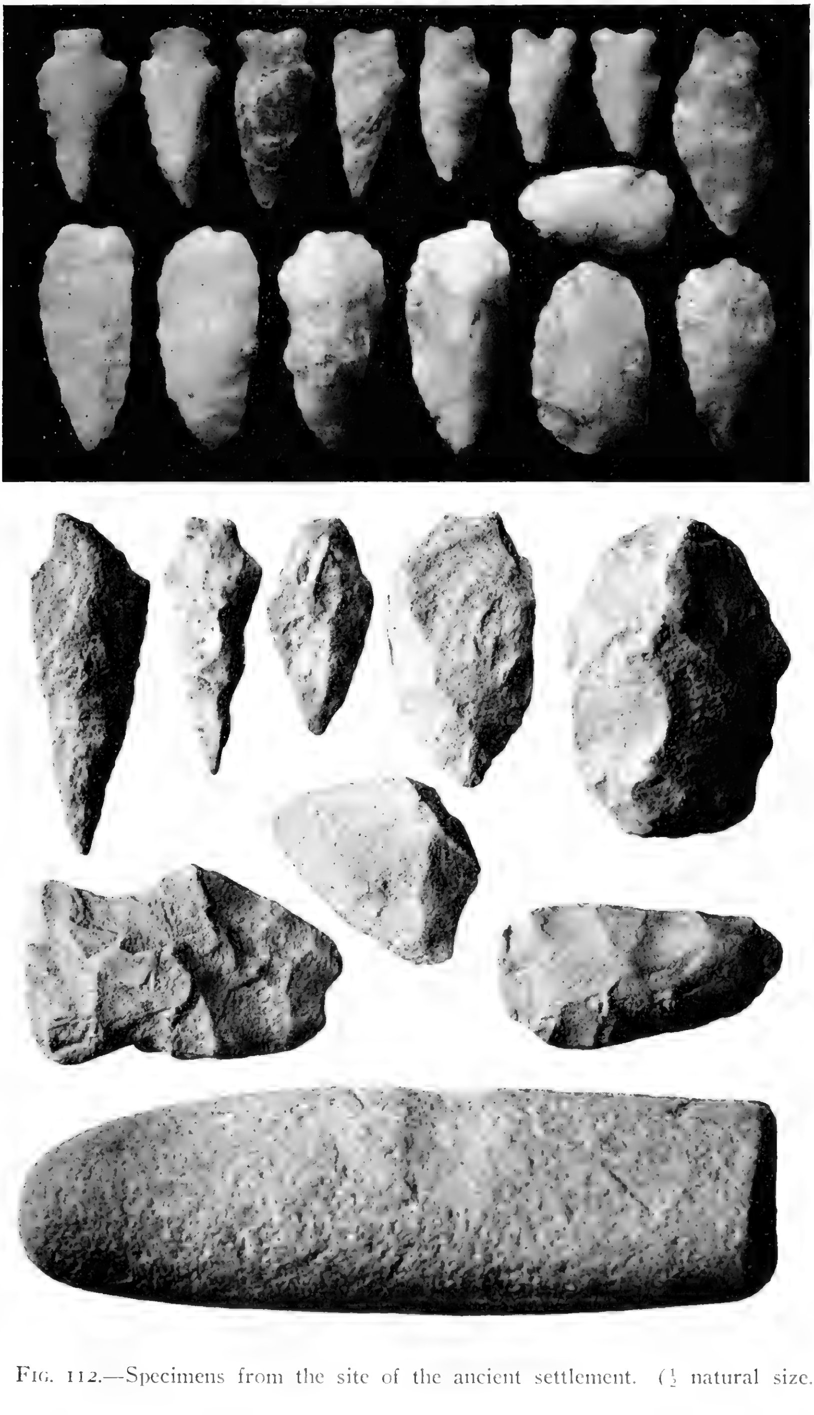

FIG. 112.—Specimens from the site of the ancient settlement. (½ natural size.)

crushed shell which had served as the tempering material. Bits of soapstone vessels were also found. The types and condition of the objects discovered suggest that this was a permanent village rather than a temporary camp, and the uniformity of the weathering makes it appear that all articles of stone were made and used about the same time.

Later in the year several sites farther up the river, which had likewise been exposed by the spring freshet, were visited and examined. The material discovered, much of which differs from that now figured, will be described and illustrated at another time.

Floods have been recorded ever since the country was settled by the English, when much of the heavy timber was cleared away and the ground was cultivated and leveled. The loosened earth was often inundated and gullied, as during the spring of 1937, and although the masses of refuse which had accumulated in and about the native villages during different periods of occupancy were once distinct and stratified or separated, all became intermingled by the force of the waters. This readily explains the variety of objects, made of various materials, often encountered on the same site. Such conditions prevailed not only on the Rappahannock but in the vicinity of other streams as well.

Some years ago a beautiful example of the eastern form of Folsom points was discovered near the left bank of the river a few miles below the site just described. Unfortunately, it was found on the surface, not beneath it, but this is not significant because, as explained above, the clearing and cultivating of the land enabled the periodic flood waters to change the contour of the land rapidly, and the Folsom point may therefore have once been well below the surface. The occurrence of the point in this region may be accepted as proof that man was here many centuries ago, although just how early he reached the country eastward from the mountains will be impossible to determine until more evidence is available.

During the year 1937, as for several preceding years, a superficial examination was made of many sites both above and below the falls of the Rappahannock. The results were interesting and satisfactory, and have led to the belief that an intensive investigation, including the excavation of certain areas, would prove of exceptional value and shed light on the manners and ways of life, and possibly reveal the identity, of the early inhabitants of the valley.

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THE MALE GENITALIA OF ORTHOPTEROID INSECTS

BY

R. E. SNODGRASS
Bureau of Entomology and Plant Quarantine
U. S. Department of Agriculture

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CONTENTS

I. INTRODUCTION

The order Orthoptera as here understood includes at least the Mantoidea, Blattoidea, Tettigonioidea, and Acridoidea. The group unity of these forms is attested in the structure of the male reproductive system by the compounding of the so-called accessory genital glands that appear, in the adult condition, to arise from the inner end of the ductus ejaculatorius, but which in their development are outgrowths of the mesodermal coelomic ampullae into which the vasa deferentia discharge. Closely associated with the true Orthoptera by the same feature of the male genitalia are the Termitidae, Embiidae, Grylloblattidae, Phasmatidae, and probably the Zorotypidae. On the other hand, the Plecoptera and the Dermaptera would appear to be distinct orders having no close relationship with the Orthoptera, since in each of these groups the male reproductive system is specialized in its own way, and shows none of the features characteristic of the orthopteroid insects. Concerning Dermaptera, Favrelle (1934) says, not only the structure of their reproductive organs, but also the cytology of their spermatogenesis shows that they are entirely distinct from Orthoptera.

Development of the male gonads.—The primary germ cells of Orthoptera, so far as their history is known, are differentiated from the somatic cells at a relatively late stage of development as compared with those of insects in which they appear at the time of blastoderm formation. In *Blatta, Blattella, Gryllus,* and *Melanoplus* the germ cells have been first recognized as such after the differentiation of the inner germ layer, but before the formation of the coelomic sacs (Heymons, 1895; Nelsen, 1934), in *Conocephalus* and *Locusta* not until the coelomic cavities have been formed in the mesoderm (Wheeler, 1893; Roonwal, 1937). The germ cells of *Melanoplus differentialis,* according to Nelsen (1934), are first distinguishable from the ectoderm of the germ band when metamerism is about to begin in the abdomen; they now appear as bands of weakly staining cells bordering the abdomen (fig. 1 A, *GCls*) from the region of the first to that of the ninth prospective somite, and are seen in sections (B, *GCls*) as masses of cells at the sides of the abdominal ectoderm projecting laterad of the bases of the ammotic folds (*Am*). The mesoderm rudiment (*Msd*) has already been formed as a solid band of cells lying above the midline of the ectoderm. During the subsequent growth of the embryo the mesoderm spreads laterally to the edges of the ectoderm (C), and the germ cell bands are now folded inward upon the mesoderm. When the coelomic sacs are later formed (D, *Coel*), the germ cells (*GCls*) have come to lie on their dorsal walls, and from this position they soon invade the mesoderm and intermingle with the mesoderm cells in the upper parts of the splanchnic

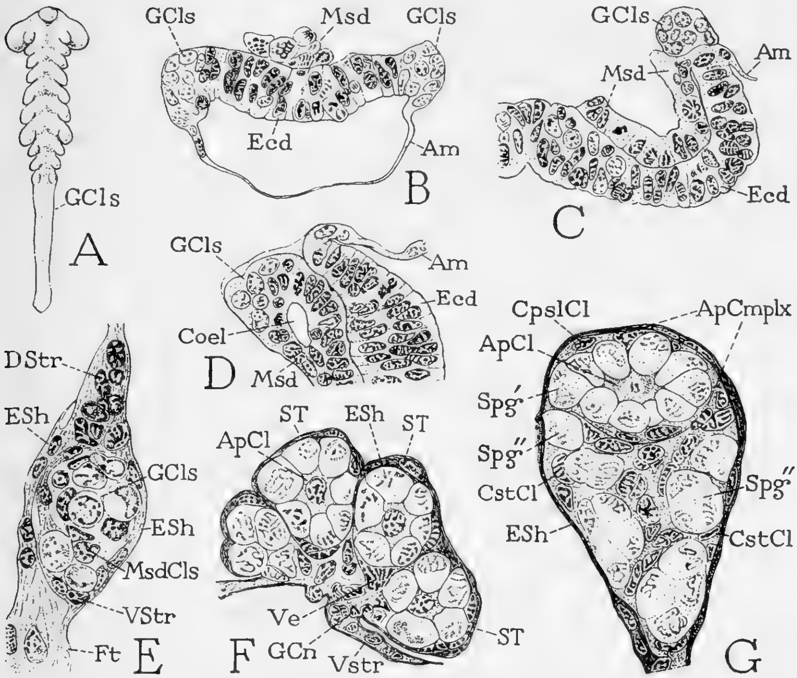

FIG. 1.—Development of the testis of *Melanoplus differentialis* (Thomas). (From Nelsen, 1931, 1934.)

A, an embryo at age when the germ cells are first distinguishable as such lying along sides of ectoderm of abdomen. B, transverse section of unsegmented part of abdomen at stage of fig. A, showing masses of germ cells (*GCls*) proximal to amniotic folds (*Am*) at sides of abdominal ectoderm (*Ecd*). C, transverse section of lateral half of germ band at later stage, with germ cells folded inward upon upper end of mesoderm. D, still later stage, germ cells now transferred to splanchnic wall of mesoderm. E, transverse section of testis just after revolution of embryo, showing group of germ cells (*GCls*) and undifferentiated mesoderm cells (*MsdCls*) in germinal area of gonad, with dorsal strand of mesoderm cells above (*DStr*) and ventral strand (*VStr*) below, the whole surrounded by a mesodermal epithelial sheath (*ESh*) continuous with a body of fat tissue (*Ft*) below. F, transverse section of testis near close of first postembryonic instar, showing rudiments of sperm tubes (*ST*), each containing an apical cell (*ApCl*) surrounded by primary spermatogonia, with vasa efferentia (*Ve*) forming from germinal center (*GCn*). G, section of young sperm tube during latter part of second instar, with apical complex (*ApCmplx*) in its distal end, and encysting spermatogonia (*Spg''*) in its proximal part.

Am, amnion; *ApCl,* apical cell; *ApCmplx,* apical complex; *Coel,* coelomic cavity; *CpslCl,* capsular cell; *CstCl,* cyst cell; *DStr,* dorsal strand; *Ecd,* ectoderm; *ESh,* epithelial sheath of testis; *Ft,* body of fat tissue; *GCls,* germ cells; *GCn,* germinal center; *Msd,* mesoderm; *MdsCls,* undifferentiated mesodermal cells of gonad; *Spg',* primary spermatogonia; *Spg'',* secondary spermatogonia; *ST,* rudiments of sperm tubes (testicular "follicles"); *Ve,* vas efferens; *VStr,* ventral strand.

layers. Roonwal (1937) questions whether Nelsen properly identified the supposed early germ cells of *Melanoplus,* and suggests that they are probably cardioblasts.

After the successive coelomic cavities have merged into a continuous coelome by the dissolution of the separating walls, the germ cell areas of the splanchnopleure form two long genital strands, or ridges. These ridges in the young embryo of *Melanoplus,* Nelsen says, extend from the first to the eighth abdominal segment; in *Conocephalus,* Wheeler (1893) observes, germ cells may lie as far back as the tenth segment, though ordinarily they extend only into the sixth, and in *Locusta,* according to Roonwal (1937), they can be traced back to the tenth segment. As each ridge enlarges it protrudes into the coelome and comes to have the form of a free fold suspended from the upper part of the splanchnopleure in the neighborhood of the cardiac rudiments; in *Melanoplus* (fig. 1 E) the fold supports ventrally a mass of fat tissue (*Ft*). A transverse section of the male gonad at this stage, as described by Nelsen (1931) in *Melanoplus,* shows the following elements (fig. 1 E): dorsally is the membranous attachment of the gonad to the splanchnopleure; below this runs a dorsal strand of mesodermal cells (*DStr*); next is a central mass of germ cells (*GCls*) and undifferentiated mesoderm cells (*MsdCls*); and finally, a ventral strand of mesodermal cells (*VStr*), which forms the lower wall of the gonadial rudiment and supports the mass of fat tissue (*Ft*) beneath it. The entire organ, from the suspensory membrane to the ventral fat body, is invested in a mesodermal epithelial sheath (*ESh*), the "outer limiting membrane" of Nelsen.

The later history of the male genital rudiment consists of a differentiation of the inner cellular elements, the formation of the definitive sperm tubes, or so-called testicular "follicles" (it should be noted that an ovarial follicle is a subdivision of an egg tube), the establishment of the sperm tube ducts (vasa efferentia), and the formation of the gonadial part of the vas deferens. The following account of the processes involved is a brief summary of the excellent description of the development of the testis in *Melanoplus differentialis* given by Nelsen (1931), which adds much in the way of concise information to our previous knowledge of the subject in other insects.

At the beginning of the post-revolution period in the development of the *Melanoplus* embryo, the genital rudiments have somewhat shortened, reaching now only to the end of the seventh abdominal segment. By the middle of this period, the indifferent mesodermal cells of each gonad begin to differentiate into connective tissue elements that form intratesticular partitions among the germ cells, thus segregating the latter into groups of one or more cells each (fig. 1 F). The partition-forming cells are probably generated from cells at the junction of the gonad proper with the ventral cell strand. The actively proliferating area here located is termed by Nelsen the "germinal center" (*GCn*). Each cell group, or cell nest, thus secondarily isolated, marks the nucleus of a definitive sperm tube, or "follicle."

By the time of hatching, the gonads have the form of two cords lying immediately below the heart, extending from the rear half of the third abdominal segment into the anterior half of the sixth. The germ cells have multiplied until there are about four or five cells in each group. Now an "indifferent mesoderm cell", Nelsen observes, leaves the periphery of the gonad and pushes into the center of each germ cell group, where it sends out cytoplasmic processes that fill the spaces between the germ cells. This interpolated cell becomes the apical cell of the group (fig. 1 F, G, *ApCl*); the entire nest of cells is surrounded by a capsule of connective tissue cells (G, *CpslCl*). The whole formation, which will be retained in the apex of each sperm tube, Nelsen calls the *apical complex* (*ApCmplx*).

The growth of the apical complexes causes a series of lobes to appear on the dorsal surface of the gonad, which are the beginnings of the definitive sperm tubes (fig. 1 F, *ST*). Undifferentiated cells now grow upward from the germinal center against the lower end of each apical complex (*Ve*), while at the same time the outer epithelial sheath grows inward between the dorsal lobes of the gonad until it invades the germinal center. In this manner the young sperm tubes are formed, each consisting of a germarium, which is the apical complex, and of a duct, or vas efferens (*Ve*), derived from the germinal center, the whole structure invested in a fold of the outer epithelial sheath (*ESh*).

The next phase of activity in the gonad, which begins during the second nymphal instar, is the formation of the sperm cysts, and the further differentiation of internal cellular elements. The germ cells surrounding the apical cell, and in immediate contact with it, are the primary spermatogonia (fig. 1 G, *Spg′*). During division, however, some of the germ cells are crowded away from the apical cell, or they are excluded from it by a tangential plane of division. These displaced cells become secondary spermatogonia (*Spg″*). As the latter leave the sphere of primary spermatogonia they take with them some of the capsular cells investing the apical complex, which, attaching themselves to the secondary spermatogonia, become the cyst cells (*CstCl*) that give rise to the sperm cysts. The encysted secondary spermatogonia by subsequent divisions produce the cell groups that eventually form the spermatocytes and spermatozoa. The formation of the cysts from mesoderm cells, as described by Nelsen, seems much more reasonable than the idea that the cyst cells are derived from the spermatogonia, as some writers have claimed. The cyst cells of the testis are thus seen to be entirely analogous in their origin to the follicle cells of the ovary. During the formation of the cysts the sperm tubes increase in size, and the interstices between the cysts become occupied by a continuously growing interfollicular framework of connective tissue cells derived mostly from the germinal center. A central core of cells also is produced from the same source. Since the cysts first formed lie between the apical complex and the rudiment of the outlet duct, these cysts remain in the neighborhood of the duct as younger ones are formed in the upper part of the tube, which later elongates in the apical direction to form a zone of growth to accommodate the increasing number of cysts.

Finally, there is formed from the ventral strand and the germinal center beneath the sperm tubes the gonadial part of the vas deferens, which is continuous with a cell strand proceeding posteriorly that becomes the free part of the duct. The lumen is formed as an internal cleavage space between the cells of the strand. The individual ducts of the sperm tubes, or vasa efferentia, which are connected with the vas deferens, Nelsen says, do not acquire distinct lumina until just before the last moult. The mature testis of *Melanoplus differentialis,* according to Nelsen, includes about 188 sperm tubes.

The mature testes of the Orthoptera in general vary in size and shape according to the number, form, and arrangement of the sperm tubes. In the more generalized condition the testicular tubes are small pear-shaped or oval bodies arranged in series on the gonadial parts of the ducts (figs. 7 B, 11 A, B, *Tes*); in *Blattella* (fig. 16 A) each organ is reduced to four globular bodies on the end of the duct. Generally, however, the testis is a large oval compact mass of elongate tubules enveloped in a common peritoneal sheath (figs. 9 A, 20 A, 34 A, 39 A). An exceptional condition occurs in some of the Phasmatidae, in which the testes are long cylindrical organs having no subdivision into sperm tubes (fig. 7 A, *Tes*).

The male genital ducts.—The embryonic vasa deferentia of Orthoptera (fig. 2 A, *Vd*) end posteriorly with hollow terminal enlargements, or *ampullae* (*Amp*), inserted into the appendage rudiments of the tenth abdominal somite (*XApd*). This condition has long been known from the work of Heymons and of Wheeler on *Periplaneta, Blattella, Gryllus,* and *Conocephalus,* and recently has been shown to occur in Acrididae by Else (1934) and by Roonwal (1937). The cavities are present in the ampullae long before the lumina appear in the other parts of the ducts. The ampullar cavities are ventral remnants of the coelomic sacs of the tenth abdominal somite, and similar though transient ampullae of coelomic origin may occur in the preceding abdominal somites. To the ampullae of the tenth segment of the male,

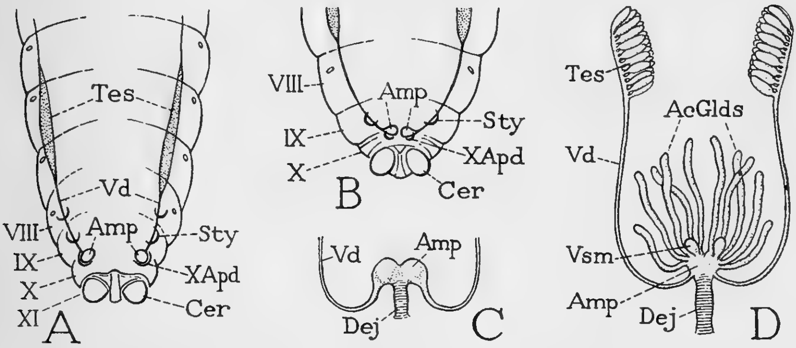

FIG. 2.—Development of the male genital ducts and accessory glands of Orthoptera. (A, B, simplified from Wheeler, 1893; C, D, diagrammatic.)

A, abdomen of embryo of *Conocephalus brevipennis* (Scudder) with vasa deferentia ending in ampullae contained in appendage rudiments of tenth abdominal segment (*XApd*). B, same, later stage, ampullae dislodged from appendages and approximated medially. C, diagram of usual condition of genital ducts in an orthopteran nymph, ampullae (*Amp*) united with each other and with anterior end of an ectodermal ductus ejaculatorius (*Dej*). D, diagram of typical structure of internal male genitalia of adult Orthoptera, in which the accessory glands (*AcGlds*) and vesiculae seminales (*Vsm*) are outgrowths of the united mesodermal genital ampullae (*Amp*).

AcGlds, accessory genital glands; *Amp,* coelomic ampullae of genital ducts; *Cer,* cercus; *Dej,* ductus ejaculatorius; *Sty,* stylus of ninth abdominal segment; *Tes,* testis; *Vd,* vas deferens; *Vsm,* vesicula seminalis: *VIII, IX, X,* eighth, ninth, and tenth abdominal segments; *XApd,* appendage rudiment of tenth abdominal segment.

however, are attached the posterior ends of the genital strands that become the vasa deferentia (fig. 2 A). The ampullae persist, first as terminal parts of the lateral ducts, but later united as an anterior part of the definitive median ejaculatory duct (C, D, *Amp*).

Inasmuch as the gonadial parts of the embryonic genital ridges shorten during their development, with a complemental lengthening of the parts forming the ducts, it seems very probable that each entire ridge was primarily a gonad, and that the terminal ampullae alone represent the primitive coelomic outlet ducts. If this is true, as the occurrence of germ cells as far back as the tenth abdominal somite would suggest, the primitive genital ducts of insects are then quite comparable with the outlet ducts of Onychophora and of those arthropods in which they are known to be of coelomic origin. The lumen of the gonad and of the definitive lateral genital duct of insects and of some other arthropods appears to be a secondary cleavage space formed in the originally solid genital ridge. However, the observation of Heymons (1892) that the embryonic germ cells of *Blattella* are overgrown by folds of the splanchnic mesoderm, might be interpreted as evidence of the closure of a dorsal gonadial compartment of the coelome, and thus give the insect gonad the same morphological status as that of Onychophora and Chilopoda (see Snodgrass, 1936, pp. 7-12).

The terminations of the embryonic genital ducts of the male in the appendage rudiments of the tenth abdominal segment (fig. 2 A) would seem to imply that the primitive ducts, represented by the coelomic ampullae, opened on the bases of these appendages when the latter had a more leglike form. The gonopores have a similar position in many other arthropods, though on different pairs of appendages. It might be assumed also that the ducts discharged through a pair of papillae or short tubular penes arising from the appendage bases, though such organs are not reproduced in the embryo; but it seems improbable that the appendages themselves containing the duct exits ever formed an intromittent organ, since in other arthropods the intromittent organs, if present, are formed from neighboring appendages that have no direct relation to the genital ducts.

As the development of the male exit system of the Orthoptera progresses toward the mature condition, the appendage rudiments of the tenth abdominal segment shift toward the median line (fig. 2 B), but the enlarging ampullae (*Amp*) leave the appendages and independently migrate forward and mesally into the posterior part of the ninth abdominal segment. Here the ampullae unite with each other to form a bilobed mesodermal vesicle into which open the two vasa deferentia (C, *Amp*). At the same time a median, tubular ingrowth of the ectoderm has formed between the ninth and tenth segments, which is the primary ejaculatory duct (*Dej*). The ectodermal duct unites with the mesodermal vesicle, and the lumina of the two organs eventually become continuous. The definitive median genital exit passage in the Orthoptera, commonly called the "ductus ejaculatorius", is therefore a composite structure formed of a posterior ectodermal part, and an anterior mesodermal part (D, *Dej, Amp*).

The outgrowth of numerous vesicular or tubular diverticula from the ampullar part of the definitive ductus ejaculatorius is a feature characteristic of all the true Orthoptera and of most of the orthopteroid insects (fig. 2 D). These structures, being produced from the mesodermal part of the median outlet duct, are necessarily themselves mesodermal, and are therefore to be classed as *mesadenia*. They include tubular *accessory glands* of various lengths (D, *AcGlds*), producing in most cases materials for the formation of spermatophores, and saclike or tubular *vesiculae seminales* (*Vsm*) serving for the storage of the spermatozoa. These organs do not usually appear until the adult moult, and sperm vesicles may not be formed at all in some families. The male accessory glands of insects of certain other orders appear, from ontogenetic and structural evidence, to be of ectodermal origin, and therefore properly classed as *ectadenia*.

The external genitalia.—The external genital structures of male orthopteroid insects are principally phallic organs. Accessory copulatory structures, or periphallic organs, are but little developed, and when present they are mostly secondary formations having no apparent relationships in the different groups. Appendage rudiments are commonly present on all the abdominal somites of the embryo, but in the male those of the somites anterior to the ninth disappear before hatching. The appendages of the ninth segment of the male, however, are retained in many families as a pair of small, nonmusculated styli borne on the posterior margin of the definitive ninth sternal plate, their coxopodites supposedly in most cases being incorporated in the sternal plate. According to Else (1934) the embryonic appendages of the ninth abdominal segment of the male of *Melanoplus differentialis* merge completely with the posterolateral parts of the primitive sternum of this segment, even the styli being thus obliterated in Acrididae. It is only in the Grylloblattidae that the ninth segment appendages retain a two-segmented structure, the coxopodites being here large, free lobes bearing the styli (fig. 6 A, B, C).

The phallic organs of the Orthoptera are highly variable and often very complex structures. In most cases their principal modifications are not adaptations for the direct intromission of the sperm, but for the production of spermatophores and the transfer of the latter to the genital chamber or the sperm receptacle of the female. The phallic structures of Blattidae, Tettigoniidae, and Acrididae can be traced in their nymphal development from small lobes that grow out around the mouth of the ejaculatory duct. These phallic lobes, or *phallomeres,* of Grylloblattidae, Blattidae, and Mantidae retain their independence and take on various forms in the adult; in the other families they unite to form a single phallic structure, or *phallus,* which contains an open endophallic cavity into which discharges the ejaculatory duct.

It should be observed that the median penis as formed in certain Ephemeroptera and some Dermaptera is quite a different structure from the median penis, or phallus, of Orthoptera, because it is clearly a product of the union of two separate penes each containing an outlet duct. A median penis of this type the writer (1936) has designated a *penis conjunctus;* it frequently recurs in Crustacea and Diplopoda. The median penis of Orthoptera, and probably that of most pterygote insects, on the other hand, is a *penis communis,* since, however formed, it is not produced by the union of two primary organs containing each the outlet of a primitive lateral duct. The definitive median duct, or ductus ejaculatorius, of the phallus is an independent structure, single in its origin—it is a *ductus communis,* not a ductus conjunctus, nor a persistent branch of conjoined ducts as in some Dermaptera.

Since in some cases there are only two primitive phallic lobes in the nymph, or a pair of lateral lobes take a predominant part in the formation of the adult phallic structure, it might be supposed that these lobes are derived from the segmental appendages of the tenth abdominal somite. According to Wheeler (1893) the embryonic tenth appendage rudiments of the male of *Conocephalus,* after the ampullae have withdrawn from them, disappear. It is claimed by Else (1934), however, that the appendage rudiments of the tenth segment in *Melanoplus* persist and continue their migration toward the median line until they take a position at the sides of the point where the ejaculatory duct invagination is being formed. Here, he says, they grow out into lobes that unite about the mouth of the duct, and eventually form the complex phallic organ of the adult, which contains the gonopore.

An origin of the acridid phallus from appendage rudiments is described also by Roonwal (1937) in *Locusta migratoria,* but Roonwal claims that the appendages both of the tenth and the ninth segments are involved. He says: "the tenth abdominal appendages shift forwards and fuse with the ninth, and together they form the aedeagus and its duct (ejaculatory duct) and associated structures." Inasmuch as the ninth segment appendages of most other orthopteroid families become the styli of the definitive ninth sternum, it seems hardly credible that they should take part in the formation of the phallus in an acridid, and, as above noted, the appendage rudiments of the ninth segment of *Melanoplus* are said by Else to disappear. Otherwise, the accounts of the development of the acridid phallus as given by Else and by Roonwal are in essential agreement.

If the acridid phallus is a direct product of the united appendages of the tenth abdominal segment, a similar origin for the organ has not been observed in any other insect. The embryonic appendages of the tenth segment are known otherwise to be retained only as larval " legs " in Neuroptera, Trichoptera, Lepidoptera, and lower Hymenoptera. The phallic rudiment of Lepidoptera is said by Mehta (1934) to appear during the fourth larval instar as a small conical outgrowth in the base of an ectodermal genital pouch formed earlier on the venter of the ninth abdominal segment. Toward the end of the larval period the single rudiment splits into a pair of phallic lobes, which, before pupation, come together and unite about a central depression of the integument that becomes the unpaired part of the ejaculatory duct. The final development of the phallus takes place in the pupal stage. In Mehta's account there is certainly nothing to suggest any possible relation of the primitive phallic lobes to the larval appendages of the tenth segment. In Blattidae, there may be three distinct phallic lobes (fig. 15 B), and in Tettigoniidae as many as six in a young nymph (fig. 23 B). We may question, therefore, whether the two primary phallic lobes of Acrididae are not independent outgrowths of the genital integument that might be confused with the simultaneously disappearing appendage rudiments of the tenth abdominal segment.

The phallic components have usually been attributed on theoretical grounds to the appendages of the ninth abdominal segment, supposedly endites or " endopodites " of these appendages, thus making the male organ partly equivalent to the female ovipositor; but of this there is certainly no evidence from ontogeny. It is shown by Mehta (1934) that the phallic lobes of Lepidoptera have no anatomical relation to the integumental outgrowths of the ninth segment that give rise to the clasping appendages, or valvae, of the adult genital apparatus. It seems most probable, therefore, that the insect phallus is either an independent product of the genital integument around the mouth of the ejaculatory duct, or a product of the tenth pair of abdominal appendages. If the primary phallic components really are lobes of the tenth abdominal segment that converge from a lateral position and join with each other, it might be supposed, judging from the facts in other arthropods, that these lobes are primitive paired penes derived from the limb bases, rather than that they are the appendages themselves, for in no case does a genital duct traverse an entire appendage. The original presence within the lobes of the terminal ampullae of the primary ducts would suggest such an interpretation, but in this case it is evident that the ampullae leave the penes, and that the definitive median outlet duct is a secondary invagination formed between the penes as the latter unite, and which makes a secondary connection with the conjoined ampullae.

The embryonic appendages of the eleventh abdominal segment (fig. 2 A, B, *Cer*) persist as the cerci of the adult. These organs are usually sensory in function, but in some of the Orthoptera they are modified for clasping or other copulatory purposes (fig. 8 K), and may be armed with basal lobes or hooks (fig. 4 G, *d,* 8 B, *a, b,* 17 C, *a, b*), or with processes of the distal parts (figs. 25 C, 26 B, 27 A, 28 A).

II. ISOPTERA

The reproductive system of the Isoptera is unquestionably of the orthopteroid type of structure. The internal genital organs have been described by Grassi and Sandias (1893, 1897-'98) in *Termes lucifugus,* by Bugnion and Popoff (1912) in *Termes obscuriceps,* by Imms (1920) in *Archotermopsis wroughtoni,* by Light (1934) in *Zootermopsis nevadensis,* and by Bonneville (1936) in *Neotermes aburiensis* and *Bellicositermes natalensis.* The testes consist each of a group of small digitate, fusiform, or pyriform sperm tubes (fig. 3 A, B, D, *Tes*), apparently not invested in a common peritoneal sheath, arising from the end of the vas deferens. The vasa deferentia (*Vd*) open into a short ductus ejaculatorius (*Dej*). In *Archotermopsis* and *Zootermopsis,* as shown by Imms and by Light, a group of glandular tubules (A, *AcGlds*) arises from the inner end of the ejaculatory duct anterior to the junction of the vasa deferentia. These tubules, though designated " vesiculae seminales ", are clearly the homologs of the accessory glands of Orthoptera, as stated by Imms, who observes that no spermatozoa are present in them. The tubules of *Archotermopsis* are separated into two lateral groups. A simpler condition appears to occur in *Termes,* since in *T. obscuriceps* Bugnion and Popoff find only a pair of small vesicular diverticula given off from the posterior ends of the vasa deferentia (fig. 3 B, *AcGld*), and in *T. lucifugus* Grassi and Sandias show but two large sacs (C) in a similar position. Grassi and Sandias note, as does Imms, that the " vesicles " do not contain spermatozoa. According to Bonneville (1936), however, a pair of similar vesicles in *Neotermes aburiensis,* consisting of pouchlike enlargements of the posterior ends of the vasa deferentia, are true vesiculae seminales, since they are filled with spermatozoa; in *Bellicositermes natalensis* the vesicles are reduced to simple enlargements of the ducts. In addition to the sperm vesicles, Bonneville says, *Neotermes aburiensis* has a median divertículum of the ejaculatory duct receiving a pair of united tubes, which are probably accessory glands. Hence it is evident that the Isoptera may have both accessory glands and seminal vesicles arising from the vasa deferentia, or from their conjoined ends united with the ejacula-

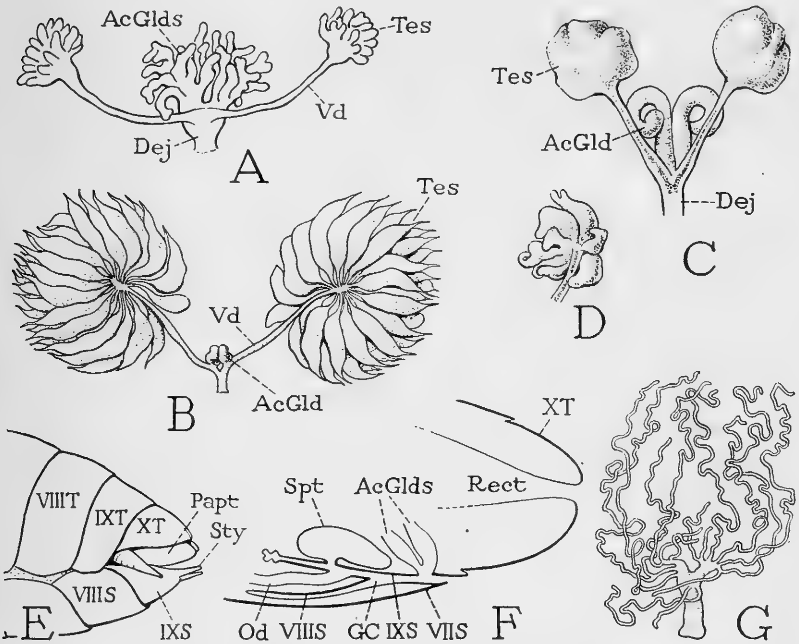

FIG. 3.—Isoptera: male and female genitalia.

A, *Archotermopsis wroughtoni* (Desneux), internal male reproductive organs of an adult soldier (from Imms, 1920). B, *Odontotermes obscuriceps* (Wasmann), internal reproductive organs of a king (from Bugnion and Popoff, 1912). C, *Reticulitermes lucifugus* Rossi, internal reproductive organs of a perfect male before loss of wings (from Grassi and Sandias, 1897). D, same, testis of perfect insect before loss of wings (from Grassi and Sandias, 1897). E, *Mastotermes darwinensis* Froggatt, end of abdomen of winged male (from Crampton, 1920). F, *Archotermopsis wroughtoni* (Desneux), diagrammatic median section of posterior part of abdomen of female soldier (from Imms, 1920). G, same, accessory genital glands of female soldier (from Imms, 1920).
AcGld, accessory gland; *Dej*, ductus ejaculatorius; *GC*, genital chamber; *Od*, oviduct; *Papt*, paraproct; *Rect*, rectum; *Spt*, spermatheca; *Sty*, stylus; *Tes*, testis; *Vd*, vas deferens.

tory duct. A phallic (" prostate ") gland, such as that present in Blattidae and Mantidae, has not been observed in the Isoptera.

The ovaries of Isoptera have the generalized type of structure that occurs also in some Orthoptera, in which the ovarioles arise serially from the distal parts of the lateral oviducts. The terminal filaments unite in a common median suspensory ligament. The accessory genital glands of the female of *Archotermopsis,* as shown by Imms (fig. 3 G), consist of two groups of long tubules arising from short lateral branches of a large common outlet duct opening on the venter of the ninth abdominal segment.

External genitalia appear to be nonexistent in male termites, and nothing has been recorded concerning the manner of sperm transfer. A complete ovipositor consisting of three pairs of small valvulae is present in *Mastotermes darwinensis* (see Crampton, 1920, 1923, and Browman, 1935), which closely resembles the ovipositor of nymphal blattids, except for the absence of styli on the third valvulae. In various other species apparent rudiments of first valvulae have been observed, but the valvulae of the ninth segment have been completely lost.

There is little ground for disputing the currently accepted view that the termites are closely related to the roaches and mantids, but the idea often expressed or implied that these three groups of insects are separated from other Orthoptera by having the female genital opening between the seventh and eighth abdominal segments clearly arises from an error of anatomical interpretation (see Snodgrass, 1933, p. 76). In the Isoptera the eighth abdominal sternum of the female, as shown by Imms (fig. 3 F, *VIIIS*), is concealed above the extended seventh sternum (*VIIS*), as it is in the blattids and mantids, in which the eighth sternum is much reduced. In all cases, however, the opening of the oviduct in the adult is morphologically *behind* the eighth sternum, since it is either on the reflected dorsal surface of the sternum (F, *Od*), or on a fold or lobe above the sternal rudiment. If, therefore, it is found that in a young termite nymph the median oviduct arises between the seventh and eighth abdominal sterna, such a condition would be but a recapitulatory stage of development common to various insects, including Orthoptera.

III. EMBIOPTERA

The Embiidae, in the structure of the internal reproductive organs of the male, resemble the Orthoptera, and have no characteristic feature of the Plecoptera. The male organs have been studied in three species, namely, *Haploembia solieri,* described by Grassi and Sandias (1897-'98), *Embia minor* by Mukerji (1928), and *Embia major,* illustrated in the present paper. The testes are soft elongate bodies (fig. 4 A, *Tes*) situated laterally in the anterior part of the abdomen. Each testis is composed of a large number of small vesicular bodies opening separately into the anterior part of the vas deferens.

The embiid testis thus resembles the testis of the primitive phasmid *Timema* (fig. 7 B) and the nymphal testis of *Blatta orientalis* (fig. 11 A, B). Grassi and Sandias, and Mukerji describe the testis of *Embia* as being imperfectly divided into five consecutive lobes; a

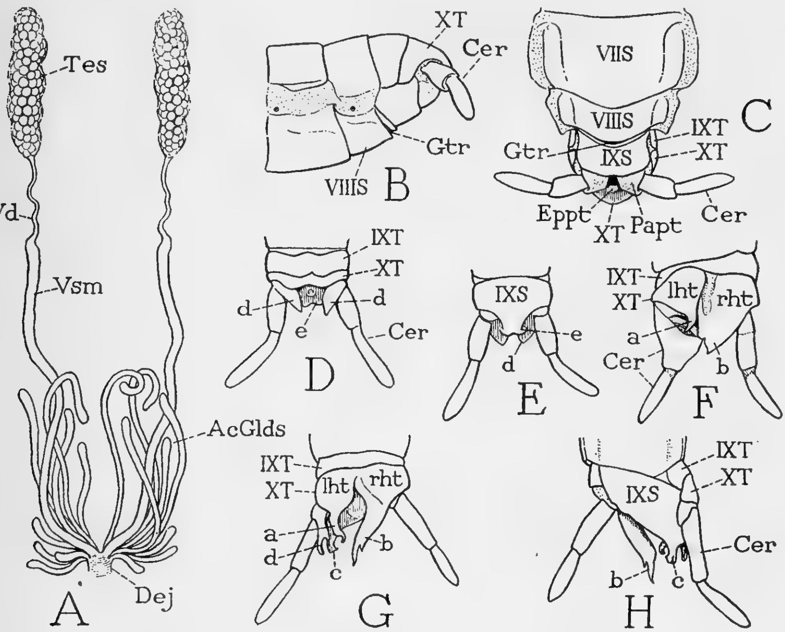

FIG. 4.—Embioptera: male and female genitalia.

A, *Embia major* Imms, internal organs of male, dorsal view. B, same, end of female abdomen, lateral view. C, same, end of female abdomen, ventral view. D, *Clothoda nobilis* (Gerstaecker), end of male abdomen, dorsal view (from Enderlein, 1912). E, same, end of male abdomen, ventral view (from Enderlein, 1912). F, *Embia major*, end of male abdomen, dorsal view (from Crampton, 1918). G, *Oligotoma saundersii* Westwood, end of male abdomen, dorsal view (from Walker, 1922). H, same, end of male abdomen, ventral view (from Walker, 1922).

a, distal process of left half of tenth abdominal tergum; *AcGlds*, accessory glands; *b*, distal process of right half of tenth tergum; *c*, distal process of ninth sternum; *Cer*, cercus; *d*, basal endite of cercus; *e*, terminal lobe of ninth sternum; *Eppt*, epiproct; *Gtr*, gonotreme; *lht*, left hemitergite of tenth segment; *Papt*, paraproct; *rht*, right hemitergite of tenth segment; *Tes*, testis; *Vd*, vas deferens; *Vsm*, vesicula seminalis.

distinct lobulation was not observed in *Embia major*, but the single specimen available for dissection had been long preserved in alcohol. Each vas deferens (fig. 4 A, *Vd*) is somewhat enlarged throughout most of its length to form a long slender " vesicula seminalis " (*Vsm*), and the two ducts unite posteriorly in a short ductus ejaculatorius

(*Dej*). From the anterior end of the last there are given off in *Embia major* about 16 slender accessory-gland tubules of different lengths (*AcGlds*) arranged in two lateral groups. In *Embia minor,* as shown by Mukerji, there is a similar number of tubules, but one tube on each side is particularly long and is much thickened in its anterior half. Grassi and Sandias find only four tubules in *Haploembia solieri,* which they describe as " glandular sacs." Though the number of accessory-gland tubules in *Embia* is thus variable and always small as compared with the usual number in Orthoptera, the number of tubules may be greater than in *Grylloblatta* (fig. 6 E) and in some of the Phasmatidae (fig. 7 A, C).

The external genital structures of male Embiidae are well known from the general works of Verhoeff (1904) and Enderlein (1912), and from the description of individual species by Grassi and Sandias (1893, 1897-98), Imms (1913), Crampton (1918), Walker (1922), and Mukerji (1928). A true phallic organ apparently is absent or but little developed. The eleventh abdominal segment is suppressed in the male, except for the large two-part cerci, which are generally asymmetrical, and may have large basal lobes (fig. 4 D-H). The external genital structures consist of asymmetrical modifications of the sternum of the ninth abdominal segment and the tergum of the tenth segment, and of lobes and processes developed from these parts and from the bases of the cerci. The least modified condition occurs in *Clothoda nobilis* (D, E), in which there is but a small degree of asymmetry. The ninth and tenth terga are narrow transverse sclerites (D), and the sternum of the ninth segment (E) is an entirely symmetrical plate extended posteriorly in a median lobe (*e*) beneath the genital opening. The bases of the cerci are produced mesally as large endite processes (D, E. *d*). In most other forms the tergum of the tenth segment is subdivided into two asymmetrical lateral plates, or hemitergites (F, G, *lht, rht*), bearing irregular apical processes (*a, b*), and the ninth sternum (H) is more or less asymmetrically produced to the left. In some forms the base of the left cercus is armed with a large irregular endite (G, *d*). It is to be noted that all the accessory genital structures converge to the left, and that it is the left cercus that bears a basal lobe or is otherwise modified. The sinistral development of the genital parts is an adaptation to the relative position of the male and female during copulation.

The mating habits of embiids have been noted by Melander (1903) in *Oligotoma texana,* and more fully described by Friederichs (1934) in *Oligotoma nigra* and *Monotylota ramburi.* The male of *Embia* or *Oligotoma* places himself on the back of the female, with his abdomen turned to the right and its apex bent to the left beneath the abdomen of the female (see figure by Friederichs). In the case of *Monotylota ramburi* the male grasps the fore part of the head of the female with his mandibles, curves his body to the right of the female, still holding the latter by the head, and directs the end of his abdomen to the left beneath that of the female to effect a union of the genital parts. The genital region of the female (fig. 4 B, C) is entirely unarmed. The gonotreme (*Gtr*) opens into a tubular genital chamber above the eighth sternum, which is continuous with the short median oviduct anteriorly, and has the aperture of the spermatheca in its dorsal wall just within the gonotreme. The male organs, therefore, are probably inserted into the genital chamber of the female in order to expose the mouth of the spermatheca. The presence of compound accessory glands in the male (fig. 4 A) would suggest the formation of a spermatophore, and Friederichs records that a male was observed a few minutes after copulation to double upon himself and eat something (possible a spermatophore) projecting from his genital opening. Copulation with *Monotylota ramburi,* Friederichs says, lasts about 15 minutes.

The question of the relationships of the Embiidae has given rise to much discussion, some writers holding that the embiids have affinities with the Plecoptera and others that they are related to the Isoptera. The structure of the internal genital organs of the male shows definitely that the Embiidae belong to the orthopteroid group of insects and not to the Plecoptera, but the embiids lack some of the characteristic features of the termites. The eighth abdominal sternum of the female, for example, is a well-developed external plate (fig. 4 B, C, *VIIIS*), and the genital opening (*Gtr*) is exposed behind it. Styli are never present on the ninth sternum of the male. On the other hand, the tenth tergum forms the apical dorsal plate of the abdomen (B, *XT*), as in Isoptera and Blattidae, and the epiproct is a rudimentary lobe, present in the female (C, *Eppt*), on its ventral surface. That the accessory genitalia of the male have been developed within the Embiidae is apparent from the relatively simple terminal parts in the primitive genus *Clothoda.*

IV. ZORAPTERA

The Zoraptera are here included with the orthopteroid insects, not implying that their relations to the Orthoptera can be demonstrated, but because the insects cannot be satisfactorily placed anywhere else. Crampton (1922) expressed the opinion that psocids, Zoraptera, and embiids have been derived from a common ancestral source, and

Imms (1934) associates the Zoraptera with the Psocida in a common order Psocoptera. Crampton (1922) points out a similarity in the wing venation between *Archipsocus* and *Zorotypus,* but in an earlier paper (1920 a) he regarded the Zoraptera as intermediate between Plecoptera and Isoptera, with perhaps closer affinities on the side of the Isoptera.

The general outlines of the body of a wingless *Zorotypus hubbardi* (fig. 5 A) suggest those of a newly hatched cockroach, and the aspect of the insect as a whole, especially when seen in side view,

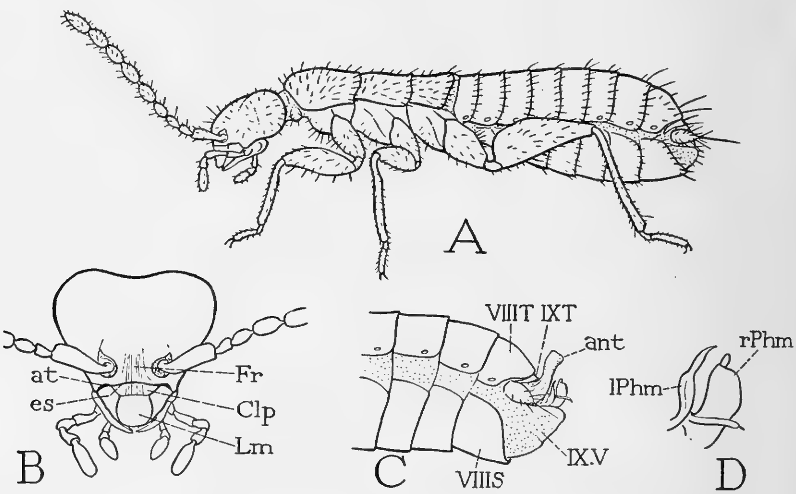

FIG. 5.—Zoraptera: *Zorotypus hubbardi* Caudell.

A, wingless adult (× 33). B, head, anterior view, showing orthopteroid type of structure in frons, clypeus, and labrum. C, posterior end of male abdomen. D, male genital lobes.

at, anterior tentorial pit; *ant,* anal tube; *Clp,* clypeus; *es,* epistomal suture; *Fr,* frons; *Lm,* labrum; *lPhm,* left phallomere; *rPhm,* right phallomere.

has a rather striking resemblance to that of a grylloblattid. The features of the head of *Zorotypus,* except for the specialized form of the antennae and palpi, and the absence of parietal sutures, are those of *Grylloblatta,* and have no likeness to the head characters of Psocidae. There is, for example, no upward enlargement of the postclypeus, a prominent characteristic of the psocid head, and the maxillary rods of the psocids are absent in *Zorotypus.* The only well-marked head suture in *Zorotypus hubbardi* is the epistomal suture (fig. 5 B, *es*); it cuts straight across the lower edge of the face below the antennal bases, and contains laterally the tentorial pits (*at*). Beyond the epistomal suture, as shown by Crampton, is a narrow clypeus (*Clp*) and a fairly large labrum (*Lm*). The labral muscles arise on the cranial area between the bases of the antennae, demonstrating that this area is the frons (*Fr*). In the Psocidae the enlarged postclypeus intervenes between a small anteclypeus and the reduced frontal region, and the labral muscles, as shown by Badonnel (1934), traverse the postclypeus from their dorsal origins on the frons.

The internal reproductive organs of *Zorotypus* are difficult to study, and the writer has not been able to make a satisfactory dissection of them. In mature males, however, there are always to be found three very delicate membranous sacs containing coiled bundles of enormous spermatozoa. The spermatozoa were observed by Silvestri (1913), and also by Crampton (1920 a), who refers to them as "wavy" or "crinkly" fibers. The bundles of spermatozoa are very similar to those of the mantid *Tenodera,* and when a single sperm thread is straightened out it is actually as long as or longer than the entire insect. In the psocid *Stenopsocus,* according to Badonnel (1934), there is a pair of huge sperm vesicles, each vesicle subdivided into two chambers with thick glandular walls. The testes of *Zorotypus,* Silvestri says, are situated dorsally in the third and fourth abdominal segments, and the vasa deferentia unite to form a long, variously folded ejaculatory duct.

The abdomen of the male of *Zorotypus hubbardi* has eight well-defined segments (fig. 5 C). The tergum of the ninth segment, however, is reduced to a narrow sclerite (*IXT*) with a small median tooth, and the venter of this segment is unsclerotized, though it forms a large subgenital lobe (*IX.V*). Dorsally the abdomen terminates with a small anal tube (*ant*), from beneath which projects a pair of genital lobes. The genitalia of *Zorotypus hubbardi* have been described by Crampton (1920 a) and by Walker (1922). The genital lobes (phallomeres) lie side by side, one right, the other left, but the position of the gonopore has not been determined. The left genital lobe (D, *lPhm*) tapers distally to a point; the right one (*rPhm*) is flattened, bears distally a small papilla, and proximally a slender process directed posteriorly.

V. GRYLLOBLATTOIDEA

The relationships of the grylloblattids has been a subject of discussion and difference of opinion ever since the insects have been known, and the very name of the first described genus and species, *Grylloblatta campodeiformis* Walker (1914), seems to provide for most any taxonomic eventuality. There is no question that the grylloblattids are orthopteroid insects; it is their position within this group that is uncertain. Crampton (1927), after several changes of opinion, finally settled to the conviction that the Grylloblattidae are related to the Tettigoniidae and Gryllidae, while Imms (1927) contended that the weight of evidence justifies their retention in the Cursoria, with which they were first associated. From a study of the general body musculature Ford (1923) concluded that *Grylloblatta* belongs to the blattid and mantid line of descent rather than to that of the saltatorial Orthoptera, though she showed that the musculature of the ovipositor is much like that of Tettigoniidae and Gryllidae. Walker (1933), however, finds that the musculature of the head and head appendages of *Grylloblatta* is also nearest that of the Saltatoria. The structure of the external male genitalia, on the other hand, clearly suggests a relationship with the mantids and blattids, while the internal genital organs, as here shown from sketches by Walker, undoubtedly present a very generalized type of orthopteroid structure.

The following brief description of the external and internal genitalia of *Grylloblatta campodeiformis* is to be accredited entirely to Dr. E. M. Walker, who has most generously sent the writer notes and sketches from his as yet unfinished work on the anatomy of the species.

The most evident generalized feature of the grylloblattids is the entire lack of union between the sternum and the appendages of the ninth abdominal segment of the male (fig. 6 A, B, C). This character is unique among the Orthoptera, though common in Thysanura and Ephemeroptera on the one hand, and in many holometabolous insects on the other. The genital coxopodites of the adult are large, free, triangular plates, asymmetrical in size and shape (B, C, *Cxpd*), each bearing a small apical stylus (*Sty*). The asymmetry of the coxopodites is less pronounced in younger instars (A). Though both coxopodites are freely hinged on the ninth sternum, only the right one, Walker says, is provided with a muscle, which arises on the ninth tergum. Neither stylus, however, is musculated.

The narrow tenth tergum is continued ventrally on the sides around the bases of the cerci into a pair of free asymmetrical processes (fig. 6 D) that nearly meet beneath the venter. The left tergal process (*tpl*) is a sclerotic arm terminating in a flattened disk; the right process (*tpr*) is of simpler form and is unsclerotized except at its base. The epiproct (*Eppt*) is small, entirely free from the tenth tergum, but concealed beneath the margin of the latter.

The external male genitalia of *Grylloblatta* consist essentially of two phallic lobes (phallomeres) arising from the genital surface, with the gonopore between them, or on the base of the right lobe.

In a young nymph, Walker (1922) says, the ventral intersegmental membrane between the ninth and tenth abdominal segments presents "two oval, slightly elevated areas (fig. 6 A, *r, l*), which are the rudiments of the genital lobes." In an older nymph "the genital lobes are much larger and are separated by an oblique fissure, as in the adult, but there are as yet no chitinous processes nor eversible sac." The genital lobes remain distinct in the adult (B, C, D, *rPhm, lPhm*),

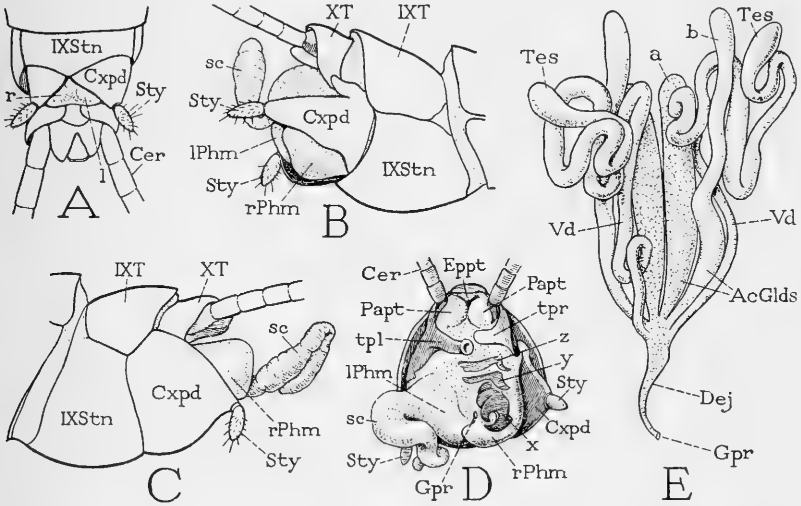

FIG. 6.—Grylloblattoidea: Male genitalia of *Grylloblatta campodeiformis* Walker. (A, B, C, from Walker, 1922; D, E, from unpublished sketches by Walker.)

A, half-grown male nymph, showing rudiments of phallic lobes, and approximate symmetry of coxopodites of styli. B, C, adult male, end of abdomen, right and left sides. D, adult male, end of abdomen, posterior view, showing genital structures. E, internal reproductive organs of adult male.

a, b, thick median, and more slender lateral accessory glands (*AcGlds*); *Cer,* cercus; *Cxpd,* coxopodite of stylus; *Dej,* ductus ejaculatorius; *Eppt,* epiproct; *Gpr,* gonopore; *l,* rudiment of left phallomere (*lPhm*); *Papt,* paraproct *r,* rudiment of right phallomere (*rPhm*); *sc,* saclike phallic lobe; *Sty,* stylus; *Tes,* testis; *tpl, tpr,* left and right ventral processes of tenth abdominal tergum; *Vd,* vas deferens; *x, y, z,* phallic sclerites.

and the gonopore now appears as a small aperture (D, *Gpr*) on the inner margin of the right lobe. The latter contains three prominent sclerites on its upper surface (*x, y, z*); the left lobe (*lPhm*) is unsclerotized except for a small setigerous area on its base, but it is produced into a long, twisted sac (B, C, D, *sc*).

The internal genital organs of the male are shown by Walker to have a very simple structure as compared with those of most other Orthoptera. "The testes", Walker writes, "are simple tubes (fig.

6 E, *Tes*), lying freely in the abdominal cavity on each side of the intestine, and are irregularly convoluted. They pass insensibly into thick vasa deferentia (*Vd*), which are coiled back and forth a few times. Their junction with the ejaculatory duct (*Dej*) occurs in the ninth segment, and at the point of union two pairs of accessory glands (*AcGlds*) are given off. The outer pair of glands (*b*) consists of long tubes extending forward almost as far as the testes, but are not coiled. They are thickened at their anterior ends, which are bluntly rounded. The inner pair (*a*) are much shorter and stouter than the outer glands and appear to have a lobulated inner structure." It is possible that one pair of these "glands" will be found to be sperm vesicles.

The structure of the genital organs of *Grylloblatta,* both external and internal, suggests that the grylloblattids are simply generalized Orthoptera. A generalized orthopteron should have a generalized ovipositor, such as that of the female of *Grylloblatta.* According to Ford (1926) *Grylloblatta* (in confinement) deposits its eggs in the soil, the ovipositor being held at right angles to the abdomen, and the eggs passed through it. This primitive egg-laying habit has been but little modified in Tettigoniidae and Gryllidae, and consequently the ovipositor in these families retains the generalized structure. In Mantidae and Blattidae, on the other hand, the ovipositor has acquired a specialized form in adaptation to the acquired habit of enclosing the eggs in a cocoon or ootheca. The external male genitalia of *Grylloblatta* are generalized in that they consist of separate phallic lobes; though they acquire a specialized structure in the adult, as they do in Mantidae and Blattidae, the lobes do not unite to form a composite phallic organ enclosing the terminus of the ejaculatory duct as in other Orthoptera. Ford (1926) says the type of spermatheca found in *Grylloblatta* indicates the formation of a spermatophore; but from what we now know it is probable that most Orthoptera produce spermatophores. The internal male genitalia of *Grylloblatta* are unquestionably generalized, and most closely resemble those of Phasmatidae, in which there is a relatively small number of accessory gland tubules (fig. 7 A, B, C, *AcGlds*) and the testes may be simple tubes (A, *Tes*). The freedom of the genital appendages of the male from the sternum of the ninth abdominal segment is a primitive feature found nowhere else in the Orthoptera. The reduction of the epiproct occurs in Embioptera and Phasmatidae as well as in *Grylloblatta,* and suggest an approach to the almost complete elimination of the epiproct in Mantidae and Blattidae.

VI. PHASMATOIDEA

The general structure of the reproductive organs of the Phasmatidae shows that the phasmatids are to be classed among the more generalized groups of orthopteroid insects. The external genitalia of the male consist either of irregular lobes surrounding the gonopore, or of a single phallic structure containing the genital opening, and thus resemble the nymphal organs of either Blattidae or Tettigoniidae. The female is provided with a small ovipositor, which differs but little from the ovipositor of Mantidae and Blattidae. Few studies have been made on the internal reproductive organs of the phasmatids, but the several examples here given show that the testes may have a generalized compound structure, though usually they are simple tubes without external subdivisions, and that the accessory glands consist of a group of tubules, though the latter are never so numerous as in Mantidae and Blattidae, or in the saltatorial Orthoptera.

The testes.—A generalized type of testicular structure occurs at least in *Timema californica,* in which each testis (fig. 7 B, *Tes*) consists of two long rows of small but distinct globular bodies opening serially into the anterior part of the vas deferens. Siebold and Stannius (1854) included the Phasmatidae among Orthoptera having a multitude of round testicular follicles, but they mentioned no particular species, and Suckow (1828), cited as authority in a footnote reference of the English translation, gives no examples of phasmatid genital organs. De Sinéty (1901), finding the testes to be simple continuous tubes in species studied by him, as in *Bacillus rossii* described by Heymons (1897), dismissed the earlier idea of a compound structure in the phasmatid testis as one of the " légendes traditionnelles" of entomology. However, if *Timema* is truly a phasmatid, there would appear to be in this case some basis for the legend.

With most of the Phasmatidae in which the internal reproductive organs have been examined, the testes are found to have the form of long tubes showing no subdivision into sperm tubules, or " follicles." Heymons (1897) described the testes of an immature male of *Bacillus rossii* as two long strands of genital and epithelial cells continuous posteriorly with the outlet ducts. Adult organs of the tubular form are described by De Sinéty (1901), particularly in *Leptyniella attenuata* (fig. 7 A, *Tes*), and by Pehani (1925) in *Carausius morosus.* The testes of *Anisomorpha buprestoides* are of the same type, as are probably also those of *Diapheromera femorata* in an active condition, but the specimens of this species examined by the writer had evidently passed the functional stage, for the testes consisted of long, delicate, threadlike tubes having no evident cellular structure.

The long tubular testis of *Leptyniella* (fig. 7 A), according to De Sinéty (1901), consists of a mass of cysts, containing spermatozoa in different stages of development, enclosed in a cellular envelope.

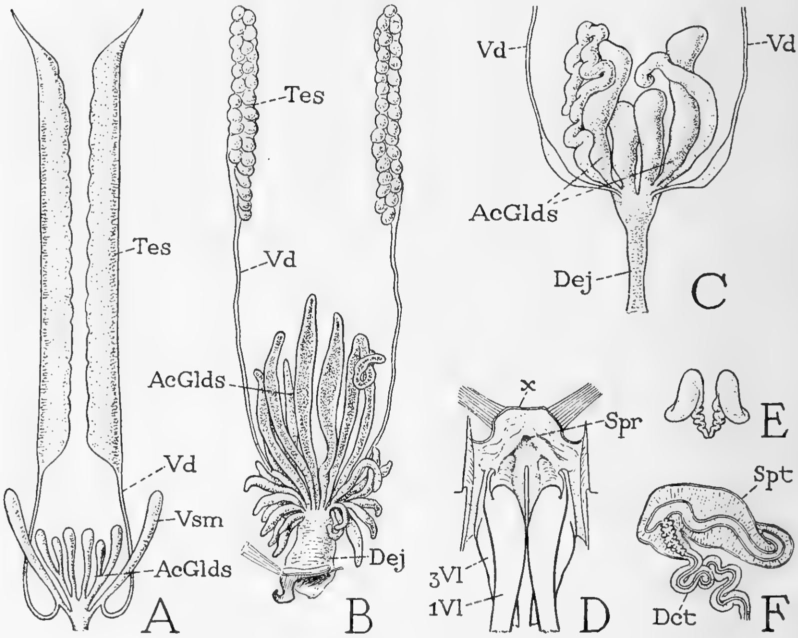

Fig. 7.—Phasmatoidea: male and female genitalia.

A, *Leptyniella attenuata* (Pantel), male internal reproductive organs (combined from De Sinéty, 1901). B, *Timema californica* Scudder, male, internal reproductive organs. C, *Diapheromera femorata* (Say), male, internal reproductive organs except testes. D, same, female, base of ovipositor and dorsal wall of genital chamber with spermathecal opening. E, same, spermathecae and ducts. F, same, single spermatheca and duct, optical section.

AcGlds, accessory glands; *Dej,* ductus ejaculatorius; *Dct,* duct of spermatheca; *Spr,* spermathecal aperture; *Spt,* spermatheca; *Tes,* testes; *Vd,* vas deferens; *1Vl, 3Vl,* first and third valvulae of ovipositor; *Vsm,* vesicula seminalis; *x,* cut edge of genital chamber wall.

The spermatogonial cysts lie along the dorsal crest of the testis, which presents a series of low elevations, while the cysts containing mature spermatozoa occupy the ventral part of the organ, which is traversed by the vas deferens. The testes of *Carausius* are said by Pehani (1925) to have the same structure as that described by De Sinéty for *Leptyniella.* The simple tubular form of phasmatid testis might be supposed to represent a primitive gonadial structure comparable with the testis of Chilopoda; but since the usual compound type occurs in *Timema*, it seems more probable that the common form of the testis in the Phasmatidae has been produced secondarily by an amalgamation of the primitive sperm tubes.

The accessory genital glands.—Tubular diverticula of the ejaculatory duct, most of which are probably genital accessory glands, are present in each of the several species of Phasmatidae that have been studied. In *Timema californica* the tubules are relatively numerous and of different sizes (fig. 7 B, *AcGlds*). In *Leptyniella attenuata* a pair of long lateral tubules (A, *Vsm*) are described by De Sinéty (1901) as vesiculae seminales, and a group of six median tubules (*AcGlds*) as accessory glands. A compact mass of tubules is present in *Diapheromera femorata* (C) lying against the ventral wall of the eighth abdominal segment. The individual tubes are difficult to separate, but careful manipulation reveals six of them. At least four are thick, orange-yellow sacs (*AcGlds*), but the tubule on the right is always longer and more coiled than the others, and has a pale pink color (in alcoholic specimens). The accessory tubules of *Carausius morosus* as shown by Pehani (1925) are similar to those of *Diapheromera;* two lateral tubules of the group are much larger than the others, and are regarded by Pehani as seminal vesicles. In a specimen of *Anisomorpha buprestoides* only two saclike diverticula were found (fig. 8 F) arising from the vasa deferentia, but the specimen may have been immature. A phallic gland corresponding with that present in Mantidae and Blattidae has not been observed in the Phasmatidae.

The external genitalia and associated structures.—The terminal parts of the male abdomen, as well as the phallic organs themselves, are highly variable in different species of the Phasmatidae. A relatively generalized structure of the abdomen is found in *Timema californica* (fig. 8 A, B), though associated here with a very specialized development of the cerci. In most of the phasmatids the first abdominal segment is as completely incorporated into the metathorax as it is in the higher Hymenoptera, but in *Timema* the tergum of this segment is entirely free from the metatergum, though the narrow sternum is united with the metasternum. The genital segments of *Timema* are not particularly modified (A, B); the ninth sternum is somewhat prolonged beneath the genital organs, but there is no distinct subgenital plate differentiated from it. In the typical phasmatid structure, the ninth abdominal sternum is completely divided into an anterior sternal plate (C, J, L, *IXS*) and a free posterior subgenital lobe (*IXSL*). The sternal plate is more or less displaced anteriorly, and may come to be associated with the eighth segment

(L, *IXS*); the venter of the ninth segment posterior to the sternum is mostly membranous, being formed possibly by an extension of the intersegmental membrane. The large subgenital lobe (C, J, L, *IXSL*) is scoop-shaped, its dorsal concavity forming the floor of the genital chamber, in which is lodged the phallic organ. An extreme development of this type of structure is seen in *Diapheromera* (L), in which the sternal plate (*IXS*) forms a small supporting stalk for the subgenital lobe (*IXSL*), and is provided with two pairs of large muscles arising on the tergal plates of the eighth and ninth segments.

The phallic organs of the Phasmatidae are said by Chopard (1920) to consist of several highly variable lobes, and of a very much reduced penis entirely concealed by the lobes. From a comparative study of the more simple types of phallic structures, and from a study of the development of the genitalia in *Cyphocrania gigas,* Chopard arrives at the following generalization: Fundamentally there are four very asymmetrical genital valves, but the upper two are often united in a single lobe; the valves in most cases are membranous, particularly the lower ones, containing only small sclerotic areas usually near their bases; sometimes, however, the valves are strongly sclerotized, and in such cases they have a tendency to unite in two large lobes, one dorsal, the other ventral, or rarely in a single structure.

The illustrations here given of the phasmatid intromittent organ include examples only of the type in which the phallic lobes are more or less united to form a single structure (fig. 8 G, H, I, M, N); the writer is not familiar with forms in which the lobes are entirely distinct. In an unidentified species (I) the phallus is a soft, ovate body composed of several irregular lobes of different sizes united only at their bases. In *Anisomorpha buprestoides* (G, H) the lobes are mostly united, being free only at their tips, which converge about the gonotreme on the ventral surface (H). In the dorsal wall of the phallus is a weak median sclerite (G, *e*) projecting distally in a small, free process on the left. The phallus of *Diapheromera femorata* (M, N) is a thick cylindrical structure, divided apically by a median cleft into short right and left lobes, between which is a third flat, median lobe. The ejaculatory duct opens here between the bases of the lobes; in *Anisomorpha* it opens on one of the lobes just within the lower lip of the gonotreme. The "penis," said by Chopard to be concealed within the phallic lobes, the writer has not observed.

Chopard points out that the lobiform structure and asymmetry of the phasmatid male genitalia give the organs a resemblance to the genital lobes of male Blattidae. The likeness is more particularly evident when the comparison is made with the simpler lobes of

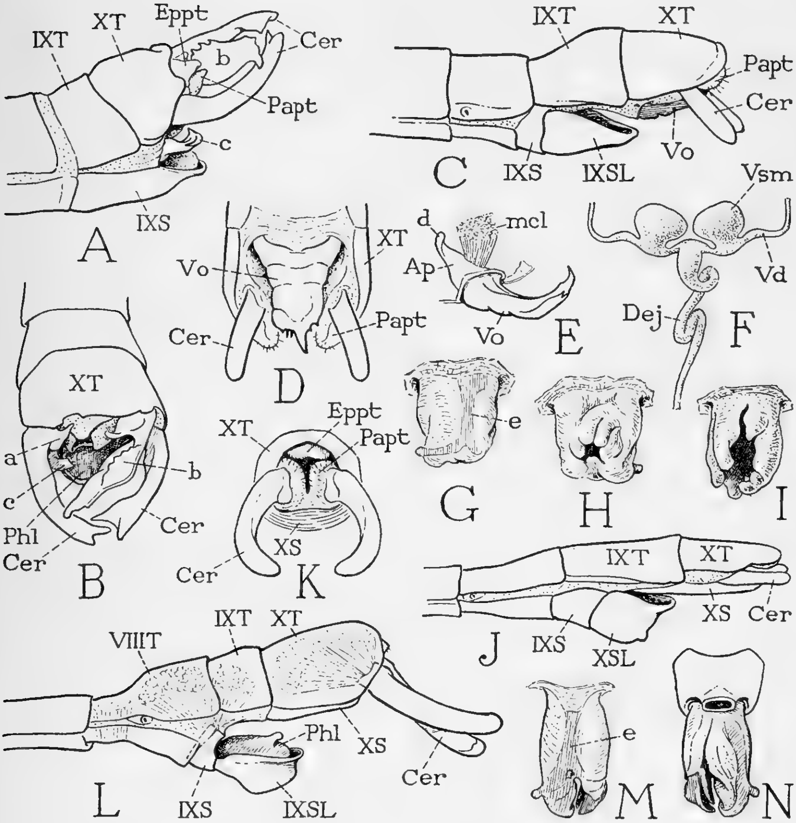

FIG. 8.—Phasmatoidea: male genitalia.

A, *Timema californica* Scudder, end of abdomen, lateral view. B, same, dorsal view. C, *Anisomorpha buprestoides* (Stoll), end of abdomen. D, same, ventral view of end of abdomen, showing vomer (*Vo*). E, same, lateral view of vomer with left apodeme and muscle. F, same, genital ducts and vesiculae seminales. G, H, same, phallus, dorsal and ventral views. I, unidentified species, ventral view of phallus. J, same, end of abdomen. K, *Diapheromera femorata* (Say), end of abdomen, posterior view. L, same, distal part of abdomen. M, N, same, phallus, dorsal and ventral views.

a, basal lobe of left cercus; *Ap,* apodeme of vomer; *b,* basal lobe of right cercus; *c,* left genital process; *Cer,* cercus; *d,* articular point of apodeme of vomer; *Dej,* ductus ejaculatorius; *e,* dorsal sclerite of phallus; *Eppt,* epiproct; *mcl,* muscle of vomer; *Papt,* paraproct; *Phl,* phallus; *Vd,* vas deferens; *Vo,* vomer; *Vsm,* vesicula seminalis.

nymphal blattids (fig. 12 E); but in the forms in which the lobes are partly united (fig. 8 H, I), the phallic organ of an adult phasmatid comes near being a replica of the nymphal organs in Tettigoniidae (fig. 23 E).

The tenth abdominal segment is always well developed and usually extends beyond the genital parts as a conical or oval end-segment of the body bearing the cerci and the anus (fig. 8 C, J, L, *X*), but in *Timema* (A) it is relatively short and the ninth sternum projects beneath it. The tenth sternum may be a simple plate extending backward to the anal region (J, L, *XS*); its posterior margin is sometimes cleft, the two points being continuous dorsally with the paraprocts. In many of the phasmatids, however, the venter of the tenth segment of the male abdomen bears a large sclerotic lobe extended horizontally backward from its anterior margin, and is otherwise membranous. This ventral lobe of the tenth segment is known as the *vomer* (C, *Vo*). The vomer varies greatly in size and shape in different species of phasmatids; an elaborate account of its numerous modifications is given by Pantel (1915), and both De Sinéty (1901) and Pantel show that the organ is developed during nymphal stages as a fold of the venter of the tenth abdominal segment. In the example here given, *Anisomorpha buprestoides,* the vomer is a broad, strongly sclerotic plate (D, *Vo*) armed distally with several small spines, and ending with an asymmetrical point curved upward between the paraprocts (C). Its basal angles are produced into inflections of the body wall as a pair of strong divergent apodemes (E, *Ap*), each provided with a thick muscle (*mcl*) arising on the tenth tergum. The ends of the apodemes appear to be fulcral points applied against the tergal walls. The vomer might be supposed to be an instrument for depressing the subgenital plate of the female, but its asymmetry and the spinous armature of its distal part do not appear to adapt it to such a purpose.

The eleventh segment is inconspicuous, though it bears the cerci, which are usually large and prominent. It consists of a small epiproct (fig. 8 K, *Eppt*) projecting above the anus from beneath the margin of the tenth tergum (*XT*), and of two soft paraproctial lobes (*Papt*) lying at the sides of the anus, either vertical or more or less horizontal in position. The cerci are generally of a simple cylindrical form (C, D, *Cer*), but they vary much in size, and may be long, falcate clasping organs (K, L), or sometimes foliaceous or branched structures. They are movable by large muscles arising on the tergum of the tenth segment (L). In *Timema californica* the cerci have an exceptional development, being strong, asymmetrical appendages curved toward each other distally (A, B, *Cer*); each cercus, moreover, has a mesal lobe arising from its base (*a*, *b*), the left one of which is a small recurved process (B, *a*), the right (A, B, *b*) a large irregular lobe larger than the cercus itself.

The females of most Phasmatidae, including *Timema,* have a small though fully developed ovipositor consisting of the usual three pairs of valvulae. The valvulae are weak and flexible, and enclose between them a cavity the size of an individual egg. The ovipositor is mostly concealed by the long subgenital eighth abdominal sternum, which forms the floor of an ample genital chamber extending anterior to the base of the ovipositor. The opening of the oviduct is a median cleft in the genital chamber floor below the base of the ovipositor, and the spermathecal opening is a small aperture in the dorsal wall of the chamber just anterior to the bases of the first valvulae (fig. 7 D, *Spr*). The sperm receptacle of *Diapheromera femorata* consists of two small spermathecal sacs (E) with convoluted ducts opening through the common exit. Each sac is a thick-walled structure having a tubular lumen connected with the duct near its anterior end (F). The histology of the spermathecae has been described by Marshall and Severin (1906).

During mating the male takes a position on the female's back and curves his abdomen downward and forward beneath that of the female (see Stockard, 1908; Grimpe, 1921). The exact use of the copulatory apparatus has not been recorded, and no observations suggest that the phasmatids produce spermatophores. Parthenogenesis is of common occurrence in the family. Each egg may be held for some time in the ovipositor before being liberated. Ordinarily the eggs are dropped casually, but according to Grimpe (1921), the female of *Phyllium bioculatum* by a strong swing of the abdomen throws each egg a considerable distance from her.

VII. MANTOIDEA

The male genitalia of the mantids are very similar in general structure to those of *Blatta* and *Periplaneta* among the Blattidae, and differ but little among the mantid genera. In *Tenodera sinensis,* the species here illustrated (fig. 10), the slender male abdomen tapers to the apex of the slightly asymmetrical sternum of the ninth segment (A, *IXS*), which bears two small terminal styli (*Sty*), and projects far beyond the cercus-bearing proctiger composed of the tenth and eleventh segments. Resting in the shallow cavity on the dorsal side of the large ninth sternum, fully exposed beyond the proctiger, are the external genital organs, consisting of three thick lobelike phallomeres with various accessory prongs (*lPhm, rPhm, vPhm*). The short tenth segment presents dorsally a small triangular tergum (*XT*) with lateral condyles on which articulate the bases of the long slender cerci (*Cer*). The venter of the tenth segment is membranous and forms the short dorsal wall of the genital chamber. The eleventh segment is much reduced; it consists principally of the two paraprocts (*Papt*), which are mostly concealed beneath the tenth tergum,

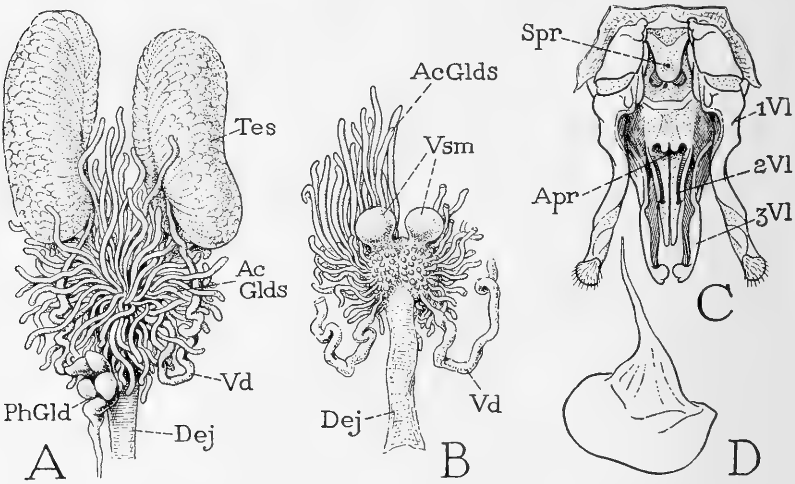

FIG. 9.—Mantoidea: male and female genitalia and a spermatophore.

A, *Tenodera sinensis* Saussure, male, internal genitalia, dorsal view. B, same, seminal vesicles exposed by removal of most of accessory glands. C, same, female, ventral view of ovipositor, spermathecal aperture, and opening of accessory glands. D, *Mantis religiosa* Linnaeus, spermatophore (from specimen furnished by K. D. Roeder).

AcGlds, accessory glands; *Apr,* aperture of accessory glands; *Dej,* ductus ejaculatorius; *PhGld,* phallic gland; *Spr,* aperture of spermatheca; *Tes,* testis; *Vd,* vas deferens; *1Vl, 2Vl, 3Vl,* valvulae of ovipositor; *Vsm,* vesiculae seminales.

but the epiproct is present as a soft median lobe projecting from the under surface of the tenth tergum. The tenth and eleventh abdominal segments thus have the same structure in the mantids as in the blattids.

The internal genitalia.—The internal male reproductive organs of *Tenodera* (fig. 9 A, B) include a pair of large testes (A, *Tes*), the vasa deferentia (*Vd*), a mass of tubular accessory glands (*AcGlds*), a pair of vesiculae seminales (B, *Vsm*) in which the spermatozoa are stored, the ejaculatory duct (*Dej*), and a phallic gland (A, *PhGld*). The testes, which lie laterally in the fifth, sixth, and seventh abdominal segments, consist each of numerous sperm tubes invested in a delicate peritoneal sheath. The vasa deferentia run caudad from the testes as simple tubes with a few convolutions, turn mesad beneath the cercal nerves, and then go forward to the ductus ejaculatorius, which they enter at the base of a bilobed anterior swelling of the latter (B). This anterior enlarged part of the ejaculatory duct probably represents the united mesodermal ampullae of the primitive exit system; from it are given off the tubules of the accessory glands (*AcGlds*), and the pair of globular sperm vesicles (*Vsm*), which normally are concealed among the gland tubules. The numerous tubules of the accessory glands are of different lengths, but are approximately of the same diameter, and appear to be all of a like nature functionally. The ectodermal part of the ductus ejaculatorius is a wide tube extending straight backward to the base of the ventral phallomere, on the dorsal surface of which it opens between membranous folds (fig. 10 F, *Gpr*). The phallic gland (A, *PhGld*) lies on the posterior part of the mass of accessory gland tubules, at the left of the ejaculatory duct; it is subdivided into several irregular lobules, but posteriorly is continued as a tapering duct into the left phallomere to open on the distal part of the latter.

The external genitalia.—The external genital organs of *Tenodera sinensis,* as already noted, consist of three large irregular genital lobes, or phallomeres (fig. 10 A, *lPhm, rPhm, vPhm*), which, as in *Blatta* and *Periplaneta*, enclose the gonopore between them but do not form a unified phallic structure. Two of the phallomeres arise respectively right and left above the genital opening, the third is median and ventral.

The right phallomere (fig. 10 B) is a wide flat appendage of triangular form with a long transverse base extending to the left above the base of the left phallomere in the anterior wall of the genital chamber. The distal margin is produced into a large lobe (*a*) on the right and a smaller lobe (*c*) on the left. On the under surface of the appendage, along the proximal part of the lateral margin of the ventral wall, is a slender, strongly sclerotized bar forming a serrated ridge (C, E, *d*), from the proximal end of which an arm (*e*) extends laterad and supports a large apodeme (B, C, E, *Ap*). The apodeme projects forward on the right into the body cavity of the ninth and eighth segments of the abdomen, and expands into a flat plate (E) over the anterior end of the eighth sternum. Just mesad of the proximal end of the serrated ridge there arises from the wall of the genital chamber a strong hooklike process (C, E, *f*) articulated basally on the ridge and having its apex opposed to the latter. The

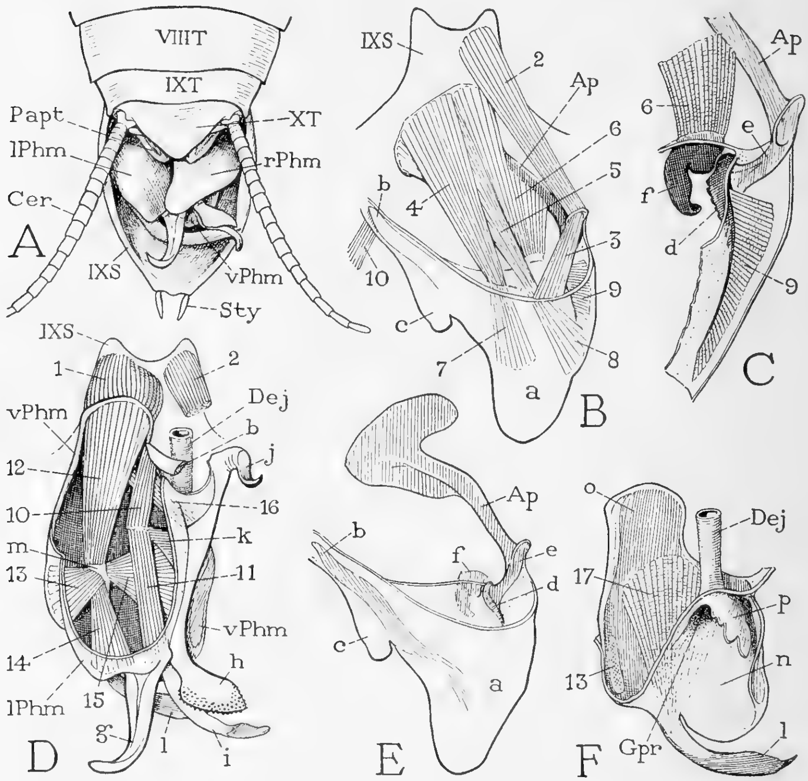

FIG. 10.—Mantoidea: external male genitalia of *Tenodera sinensis* Saussure.

A, end of abdomen, dorsal view, phallomeres in place within genital chamber. B, right phallomere and muscles, dorsal view. C, latero-proximal part of ventral wall of right phallomere, dorsal view, showing movable hook (*f*) beneath the phallomere. D, left phallomere and underlying ventral phallomere, dorsal view. E, right phallomere and its apodeme, muscles removed, dorsal view. F, ventral phallomere and terminus of ejaculatory duct, dorsal view.

a, dextral lobe of right phallomere; *Ap*, apodeme of right phallomere; *b*, left extremity of base of right phallomere; *c*, sinistral lobe of right phallomere; *Cer*, cercus; *d*, serrated ridge of ventral surface of right phallomere; *Dej*, ductus ejaculatorius; *e*, basal support of apodeme of right phallomere; *f*, movable hook beneath right phallomere; *g*, *h*, *i*, distal processes of left phallomere; *Gpr*, gonopore; *j*, proximal mesal process of left phallomere; *k*, mesal apodeme of left phallomere; *l*, distal arm of ventral phallomere; *lPhm*, left phallomere; *m*, ventral apodeme of left phallomere; *n*, exposed part of ventral phallomere; *o*, ventral plate of ventral phallomere; *p*, membranous fold enclosing gonopore; *Papt*, paraproct; *rPhm*, right phallomere; *Sty*, stylus; *vPhm*, ventral phallomere. *1-17*, muscles of phallomeres; for explanation, see text, pages 34, 35.

hook is movable by a large muscle (C, *6*) inserted on its base. This pincerlike structure is said by Walker (1922) to serve as a clasper in copulation, the remnant of a male abdomen of *Stagmomantis carolina* having been found attached by it to the female.

The left phallomere (fig. 10 D, *lPhm*) has a more complex structure than the right phallomere. It consists of a broad, thick basal lobe and of three large terminal processes (*g, h, i*). The dorsal wall of this appendage is derived directly from the anterior wall of the genital chamber, but its ventral wall is reflected into the dorsal wall of the ventral phallomere (D, *vPhm*), which lies beneath it. Of the terminal processes, one (D, *g*) is a strongly sclerotic arm extending posteriorly and ending in an upcurved hook, the second (*h*), arising from the distal end of a plate in the mesal wall of the appendage, is a broad flat lobe turned mesally, the third (*i*) is a weaker, slender process arising beneath the second and curving to the right and dorsally. Arising proximally from the mesal plate is a strong hooklike process (*j*) that normally lies in a pocket on the under surface of the right phallomere. A broad tapering apodemal inflection (*k*) extends inward from the dorsal margin of the mesal plate to give attachment to muscles within the appendage, but the left phallomere has no basal apodeme corresponding with that of the right phallomere (E, *Ap*). A short apodemal process from the floor of the left phallomere (D, *m*) gives insertion to several convergent muscles.

The ventral phallomere (fig. 10 F) is a flat appendage of irregular outline, bearing a large distal process (*l*) curved to the right. Its long, smooth under surface fits snugly upon the concave floor of the genital chamber; the shorter membranous dorsal wall is reflected into the ventral wall of the left phallomere (D), so that the basal parts of the two appendages have a common inner cavity. The ventral wall contains a large plate (F, *o*). The distal part of the ventral phallomere is expanded to the right, forming a large oval lobe with a smooth concave surface (*n*) lying usually to the right of the distal part of the left phallomere, where normally it is covered by the major lobe of the right phallomere (B, *a*). At the base of the concave dorsal surface of the ventral phallomere is the wide funnel-shaped opening (F*Gpr*) of the ejaculatory duct (*Dej*) beneath a large fimbriated membranous fold of the integument (*p*). At D of figure 10 the ventral phallomere is shown retracted to the left, in which position it is almost completely covered by the left phallomere, but ordinarily its distal lobe (F, *n*) is exposed on the right of the latter.

The phallic musculature of *Tenodera* is highly developed, as in *Blatta* and *Periplaneta,* but its chief interest from the standpoint of comparative anatomy lies in the fact that it has little in common with the phallic musculature of Blattidae. Aside from several sheets of muscle fibers inserted dorsally at the base of the right phallomere, which appear to arise on the tenth segment, the muscles of the three appendages are as follows:

1. Retractor of the ventral phallomere (fig. 10 D).—A short thick muscle arising to the left on the anterior lobe of the ninth abdominal sternum (*IXS*), inserted on the base of the ventral plate of the ventral phallomere.

2. Retractor of the right phallomere (fig. 10 B, D).—A corresponding but much longer muscle on the right from the anterior lobe of the ninth sternum to the base of the apodeme of the right phallomere (B).

3. Levator of right phallomere (fig. 10 B).—A short muscle from the base of the apodemal stalk to the dorsal margin of the base of the right phallomere.

4, 5. Depressors of the right phallomere (fig. 10 B).—Two flat sheets of fibers arising on the distal expansion of the apodeme, inserted ventrally on the base of the right phallomere.

6. Muscle of the ventral clasper of the right phallomere (fig. 10 B, C).—A broad flat muscle arising on the stalk and lobe of the apodeme (B), inserted on the base of the movable ventral hook (C, *f*) of the right phallomere.

7, 8, 9. Intrinsic muscles of the right phallomere (fig. 10 B).—Two of these muscles (*7, 8*) are divergent bundles of fibers on the ventral wall of the right phallomere, the third (*9*) is a lateral series of short fibers inserted on the serrated ridge (C, *d*) of the ventral wall of the phallomere.

10. A short muscle (fig. 10 B, D) from the mesal extremity of the base of the right phallomere (*b*) to the mesal apodeme (D, *k*) of the left phallomere.

11. An intrinsic muscle of the left phallomere (fig. 10 D) extending from the mesal apodeme of the latter (*k*) to the base of the apical process (*g*).

12, 13, 14, 15.—A group of four intrinsic muscles of the left and ventral phallomeres (fig. 10 D) converging upon the apodemal process (*m*) of the ventral wall of the left phallomere, one muscle (*12*) from the anterior end of the ventral plate of the ventral phallomere, another (*13*) from the distal lateral angle of the same plate (F, *13*), the third (*14*) from the base of the apical process (*g*), and the fourth (*15*) from the mesal plate of the left phallomere. Muscles *12* and *13* of this group evidently serve to move the left and ventral phallomeres on each other; muscles *14* and *15*, together with *11*, probably effect a change in the shape of the left phallomere that gives a movement to the distal processes.

16. An oblique muscle (fig. 10 D) from the mesal sclerite of the left phallomere to the ventral plate of the ventral phallomere.

17. Intrinsic muscle of the ventral phallomere (fig. 10 F).—A wide fan of fibers arising on the ventral plate of the ventral phallomere and converging to the base of the distal arm (*l*).

Mating habits and spermatophores.—The mating habits of the mantids is a subject on which writers seldom fail to become emotional; it furnishes the high point in the curve of literary entomology. The female mantis is frequently observed to attack and more or less completely devour the male before or during copulation, an act which, of course, can be made to seem highly sensational. A recent analysis of the sexual behavior of the mantis by Roeder (1935), however, puts the matter on a physiological basis. The principal sense organs of the mantids are the eyes, but the only visual perception is motion. Any moving object, therefore, is to the mantid an article of food and calls forth the attack response. The male mantis, preliminary to copulation, leaps upon the back of the female and normally grasps her by the mesothorax and the edges of the wings. If the male attains this hold at the first attempt, according to Roeder, the female is completely negative, giving no sign that she recognizes the presence of the male, and making no attack on him. In any other position, however, the male mantid is to the female only another insect. Thus, Roeder says, "if the male approaches the female from the side, landing on her back at right angles, or instead of clasping the mesothorax with his raptorial arms, grips her by the head or only by the tips of the wings, the female then immediately wheels and grabs him." The numerous records of cannibalism on the part of the female mantis, Roeder suggests, are largely the result of disturbance of the insects by the observer, or of the limited space in cages in which the insects are confined.

If, however, the female for any reason does attack and partially eat the male during copulation, the sexual act is not prevented or arrested, since, as Roeder demonstrates, the copulatory apparatus is controlled entirely by the last nerve ganglion of the abdomen. Furthermore, by decapitation the copulating movements are greatly increased because the activating mechanism is now released from the inhibitory stimulus that normally arises in the suboesophageal ganglion of the head. Decapitated insects, under any circumstances, Roeder shows, make continuously the copulating movements of the abdomen, which in the male are stimulated normally only by the contact of his body with the back of the female.

To effect copulation the male mantis, as described and shown in photographs by Roeder, lowers his abdomen on the right side of the female and bends the end around in an acute curve to the left beneath the female's wings, so that the phallic organs are directed forward toward the genital chamber of the female, into which eventually they are inserted between the ovipositor and the subgenital sternum. The exact use of the male organs has not been observed, but the only response of the female is an elevation of the ovipositor. Copulation, once effected, continues a varying length of time. Binet (1931) says that out of doors in an afternoon sun it is completed in about 15 minutes, according to Przibram (1907) it lasts usually about 2½ hours with specimens in cages, Roeder (1935) observes that it continues 4 or 5 hours. Insemination is finally accomplished by the transfer of a spermatophore, formed in the genital organs of the male, into the genital chamber of the female. The production of a spermatophore by mantids during copulation has been recorded by Przibram (1907) and by Gerhardt (1914). The spermatophore of *Mantis religiosa* here shown at D of figure 9 was furnished by Prof. K. D. Roeder, of Tufts College, who says it was produced by a male not in copulation with a female, but having the suboesophageal ganglion removed. The specimen when received projected from the right side of the male genitalia, but evidently it had been formed in the shallow dorsal cavity of the ventral phallomere, for the long tapering neck was still held in the end of the ejaculatory duct. The opening of the female spermatheca of *Tenodera sinensis* is a minute pore on the under surface of a large lobe of the body wall between the bases of the ventral valvulae of the ovipositor (fig. 9 C, *Spr*). Evidently the tip of the spermatophore neck, or duct, must be inserted into the spermathecal aperture.

VIII. BLATTOIDEA

The male genital organs of the cockroaches differ in no essential respect from those of the mantids. The external genitalia appear in an early nymphal stage as two or three small phallic lobes close to the gonopore, and the lobes retain their individualities in the adult stage. The mature phallomeres are either relatively simple structures, widely separated, or they form groups of highly complex processes, which in *Blatta* and *Periplaneta* are very similar to the phallic organs of Mantidae. A phallic gland is present, which in *Blatta* and *Periplaneta* opens as in the mantids on the left phallomere.

The testes.—The testes of Blattidae are of the compound type of structure, the sperm tubes being small globular or fusiform bodies, either projecting freely from the vas deferens, or enclosed in a common peritoneal sheath. In *Blattella* each testis consists of only four rounded or oval sacs placed radially on the end of the duct (fig. 16 A, *Tes*). In *Cryptocercus punctulatus*, Cleveland (1934) says, "the testis is composed of many rounded follicles or lobes attached by short tubes to the vas deferens" (in his figure the "follicles" are fusiforme tubes). The testes of *Blatta orientalis* are functionally mature at the end of nymphal life, when each consists of an elongate mass of small globular sacs arising from the axial duct (fig. 11 A, *Tes*, B). In the imago, however, the testes become degenerate (C, *Tes*) and are to be found only with much difficulty. For this reason some of the earlier students of roach anatomy mistook the mass of accessory genital glands for the testes; even Fénard (1896) fell into this error and asserted that the Blattidae differ from other Orthoptera in lacking accessory glands, though the true condition in *Blatta* had already been described by Miall and Denny (1886).

The genital ducts.—The vasa deferentia proceed posteriorly from the testes to the rear part of the abdomen, where they turn mesally *beneath the cercal nerves* (fig. 11 C, *CerNv*) and then go forward and dorsally to open into the upper surface of the ejaculatory duct at the base of the accessory glands (figs. 11 C, 15 D, 16 A, *Vd*). The vasa deferentia of *Blatta* divide and shortly reunite at two places in the course of each (fig. 11 A, C), but there are no permanent convolutions or dilatations of the ducts in any of the Blattidae that have been described. In nymphal instars, however, the vasa deferentia end in a pair of saclike ampullae broadly joined to each other and united with the inner end of the ejaculatory duct (figs. 11 A, 12 F, 15 C, *Amp*). Since these ampullae of the vasa deferentia later give rise to the tubular accessory glands, the ampullae themselves become functionally an anterior mesodermal part of the definitive ejaculatory duct. The distal ectodermal part of the latter (fig. 12 F, *Dej*) becomes a wide muscular tube (figs. 11 C, 15 D, *Dej*), which opens either between the bases of the phallomeres (fig. 15 D), or into an endophallic sac (fig. 16 A, C, E, *Enph*). In *Blattella* the anterior part of the ejaculatory duct forms a large pouch behind the bases of the accessory glands (fig. 16 A, C, *SP*).

The accessory genital glands.—The accessory glands of the male genital system of Blattidae consist of numerous tubules forming the characteristic oval mass of "utriculi" seated upon the anterior end of the ejaculatory duct (figs. 11 C, 15 D, 16 A, *AcGlds*). In *Blatta*

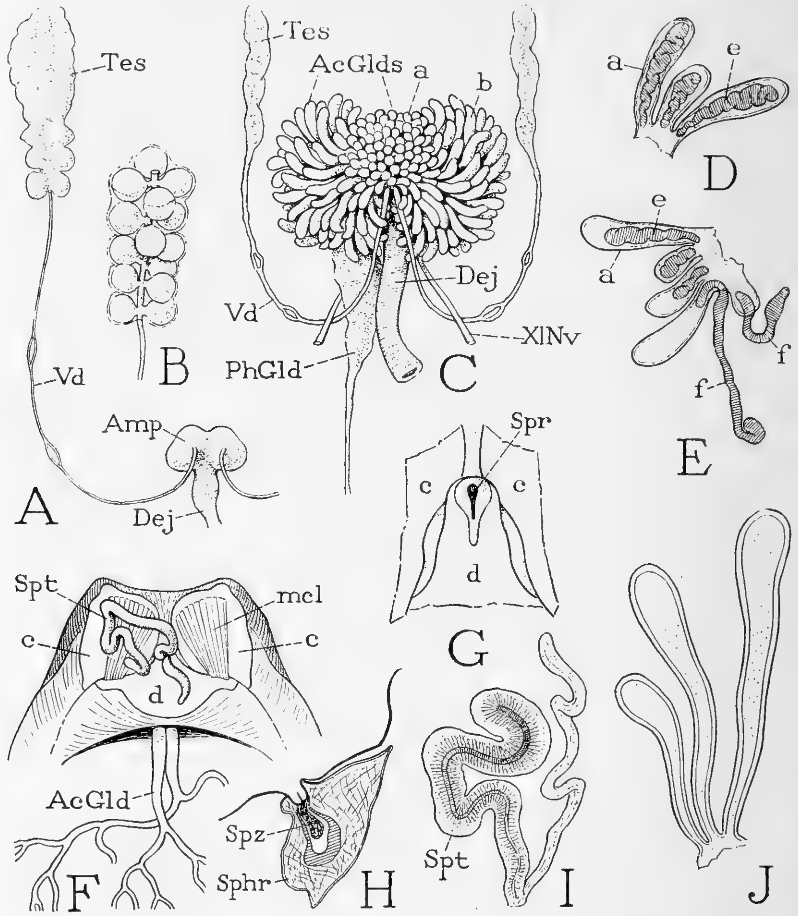

FIG. 11.—Blattoidea: male and female genitalia of *Blatta orientalis* Linnaeus.

A, male nymph, 22 mm long, internal genitalia. B, same, detail of testis, more enlarged. C, adult male, internal genitalia, dorsal view. D, small tubules of accessory glands, characteristic appearance. E, same, under pressure. F, adult female, floor of body cavity above ovipositor, showing spermatheca and accessory glands. G, same, external aperture of spermatheca. H, section of spermathophore attached to papilla of spermathecal aperture (from Zabinski, 1933 a). I, spermatheca, showing ductules in glandular wall of sperm-receiving tube. J, larger tubules of male accessory glands, same enlargement as D and E.

a, smaller tubules of accessory glands (utriculi breviores); *AcGld*, female accessory gland; *AcGlds*, male accessory glands; *Amp*, mesodermal ampullae of nymphal ejaculatory duct; *b*, larger tubules of accessory glands (utriculi majores); *c, d*, sclerites of dorsal wall of female genital chamber; *Dej*, ductus ejaculatorius; *e*, inner tube of smaller accessory gland tubules; *f*, same, extruded by pressure; *mcl*, muscle of spermathecal sclerite (*d*); *PhGld*, phallic gland; *Sphr*, spermatophore; *Spr*, spermathecal aperture; *Spt*, spermatheca; *Spz*, spermatozoa; *Tes*, testis; *Vd*, vas deferens; *XINv*, cercal nerve of eleventh abdominal segment.

(fig. 11 C) and *Periplaneta* (fig. 15 D, E) the glands are differentiated into a median group of short tubules (*a*) and lateral groups of longer tubules (b), the "utriculi breviores" and "utriculi majores" of Miall and Denny (1886). In *Blattella germanica* (fig. 16 A) and in *Cryptocercus punctulatus* (Cleveland, 1934) a group of tubules corresponding with the larger tubules of *Blatta* and *Periplaneta* forms the usual compact cluster on the end of the ejaculatory duct, but projecting forward far beyond the latter is a group of long, thick, chalky white tubes. In *Blattella* those long glands are usually six in number (fig. 16 A, C, *d*) though some are united at their bases, and they arise from the left branch of the bifurcate anterior end of the ejaculatory duct (C). These tubes lie in the ventral part of the abdomen, where in freshly killed specimens they show through the integument as a conspicuous white mass extending from the posterior part of the seventh segment to the anterior edge of the fourth.

The secretion of the male accessory glands of Blattidae has been but little studied, and the function of the secretion cannot be definitely stated until the method of insemination of the female is better known. Ito (1924) says the male accessory glands of *Blatta orientalis* form a spermatic fluid, which stimulates the activity of the spermatozoa. The corresponding glands of other Orthoptera furnish the material of the spermatophores. A spermatophore has been observed among the roaches only in *Blatta orientalis* (fig. 11 H), described by Zabinski (1933 a) as consisting of several layers, the first of which he believes must be formed by the small median tubules of the accessory glands, and the other outer coats by the larger tubules. The two sets of gland tubules of *Blatta* differ in appearance in a manner suggestive of a functional difference. The larger peripheral tubules (fig. 11 J) are turgid and opaquely white when freshly dissected in water, but they quickly become clear in glycerine. Most of the smaller tubules contain each a dark inner tube (D, *e*) compressed into irregular folds, which under pressure slides out of its sheath (E, *f*) and may expand to a length double or more that of the outer gland wall. When crushed, some of the inner tubes are seen to contain innumerable dark granules. The writer at first suspected that these inner tubes of the smaller glands might have some relation to the spermatophores, but no evidence of their nature or function was obtained. Miall and Denny (1886) say that in the adult of *Blatta orientalis* "the utriculi are usually distended with spermatozoa, and are of a brilliant opaque white." The writer has failed to discover spermatozoa in any of the glandular tubules of *Blatta, Periplaneta,* or *Blattella.*

The seminal vesicles.—The presence of special vesicles for the storage of the spermatozoa appears to have been overlooked by other students of the reproductive organs of the roaches. Ito (1924) states there are no seminal vesicles in *Blatta orientalis,* and that the sperm is stored in the anterior enlarged part of the ejaculatory duct. Miall and Denny, as above noted, believed that the accessory gland tubules

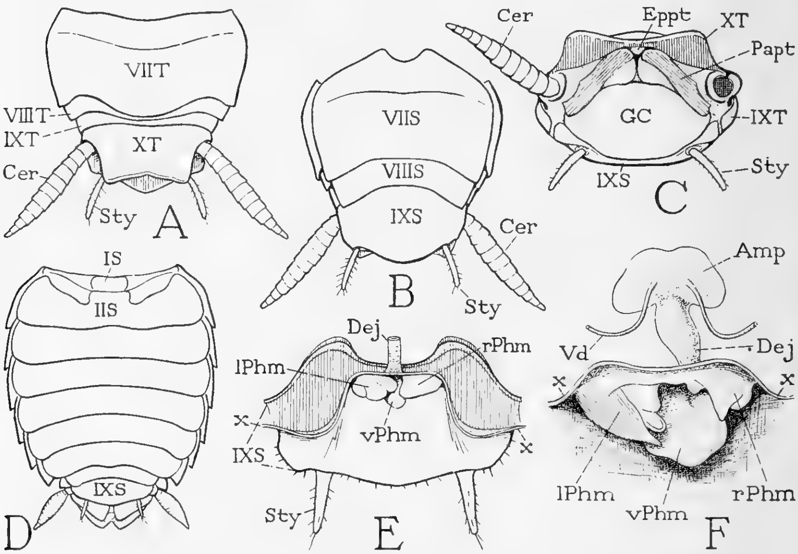

Fig. 12.—Blattoidea: adult and immature structure of the male abdomen, and nymphal genitalia of *Blatta orientalis* Linnaeus.

A, end of abdomen of adult male, dorsal view. B, same, ventral view. C, same, posterior view. D, nymph 11 mm long, ventral surface of abdomen. E, same, genital chamber exposed from above, showing three simple phallomeres arising from anterior wall around gonopore. F, nymph 22 mm long, showing later stage of phallomeres, and mesodermal ampullae united with anterior end of ectodermal ejaculatory duct.

Amp, mesodermal ampulla of ejaculatory duct; *Cer,* cercus; *Dej,* ductus ejaculatorius; *Eppt,* epiproct; *GC,* genital chamber; *lPhm,* left phallomere; *Papt,* paraproct; *rPhm,* right phallomere; *Sty,* stylus; *Vd,* vas deferens; *vPhm,* ventral phallomere; *x-x,* cut wall of genital chamber.

are filled with spermatozoa. However, in *Blatta, Periplaneta,* and *Blattella,* at least, there are special sperm-containing vesicles arising from the anterior end of the ejaculatory duct among the gland tubules. The seminal vesicles of *Blattella* are two small oval sacs arising close together from the end of the right branch of the ejaculatory duct (fig. 16 C, *Vsm*), where ordinarily they are concealed by the accessory gland tubules. They are filled with spermatozoa, and are similar to the sperm vesicles of the mantid *Tenodera* (fig. 9 B) except that both are dextral in position. In *Blatta* and *Periplaneta* the seminal vesicles consist of two groups of small pyriform sacs, six or seven on each side, arising from the ventral surface of the ejaculatory duct at the base of the area of the small median gland tubules (fig. 15 E, *Vsm*). The vesicles are distinguishable from the smaller glands by their slightly larger size and more opaque whiteness; they are clearly shown in *Blatta* by Miall and Denny (1886, fig. 99, 1), who did not recognize their function. The sacs are filled with spermatozoa, which must be stored in them by the time the testes go into a state of degeneration. The spermatozoa of Blattidae are very small as compared with those of Mantidae, and are not attached to one another in bundles.

The phallic gland.—A large gland of unknown function, the "conglobate gland" of Miall and Denny, or "prostate gland" of some other writers, is associated with the external genital organs of male Blattidae. It lies beneath the accessory glands and ejaculatory duct, and opens on the phallic region. The phallic gland of *Blatta orientalis* is an elongate sac (fig. 11 C, *PhGld*) tapering posteriorly into the base of the left phallomere (fig. 14 A), where it terminates in a duct that opens on a membranous space between the two middle distal lobes (*r, s*) of the appendage. Ito (1924) mistakenly says that the duct of the gland opens into the posterior extremity of the ejaculatory duct. The phallic gland of *Periplaneta americana* is similar to that of *Blatta* except that it is subdivided into several compact lobes. In *Blattella germanica* the phallic gland consists of a mass of coiled tubules (fig. 16 B); its long slender duct opens on the phallic integument mesad of the mouth of the sac containing the left phallomere (E, *z*).

The phallic organs.—The external genital apparatus of male roaches, as of the mantids, consists of genital lobes, or phallomeres, associated with the mouth of the ejaculatory duct, which do not unite to form a single phallic organ comparable with that of other Orthoptera. Two distinct types of phallic structure are found in the Blattidae; one is characteristic of the Blattinae; the other, judging from various published accounts, but principally from Chopard's (1920) comparative study of the blattid genitalia, would appear to occur, with various modifications, in most of the other subfamilies. Presumably intermediate forms are to be found between the two types, but it is not necessary to suppose that one has been derived from the other, since both types have a similar origin in nymphal instars. The descriptions of two representative species of each type here given can serve only as a basis for a more extensive study, which might lead to a better understanding of the natural classification of the blattid subfamilies.

The type of phallic structure pertaining to the Blattinae consists of a highly integrated complex of parts belonging to three phallic organs, which appear in the nymph as three simple lobes of the genital chamber wall immediately surrounding the gonopore. This type of structure is illustrated in the following descriptions of *Blatta orientalis* and *Periplaneta americana*.

The abdomen of an adult male of *Blatta orientalis* (fig. 12 A) ends with the broadly truncate and somewhat emarginate tenth tergum above (*XT*), and the large rounded ninth sternum below (B, *IXS*), which latter bears the elongate styli (*Sty*). Beneath the margin of the tenth tergum are the paraprocts (C, *Papt*), and a small membranous area or lobe (*Eppt*) representing the epiproct. Between the paraprocts and the ninth sternum is the mouth of a deep cavity, the genital chamber (*GC*), containing the phallic organs. In a nymphal male the abdomen is relatively short and broad (D) and the small ninth sternum does not completely conceal the paraprocts. If the genital chamber of a median-sized nymph is opened (E) there will be seen three small, soft lobes projecting from its anterior wall around the opening of the ejaculatory duct (*Dej*). These lobes are the left phallomere (*lPhm*), the right phallomere (*rPhm*), and the ventral phallomere (*vPhm*). In a later nymphal instar (F) the phallomeres have increased in size and the lateral ones show the development of accessory lobes. The ejaculatory duct (*Dej*) opens above the base of the broad ventral phallomere. From this simple beginning are evolved the extraordinarily complex genital organs of the adult roach.

The mature phallomeres of *Blatta orientalis,* as seen from above in their usual position within the genital chamber, are shown at A of figure 13. The right phallomere (*rPhm*) has taken a more median position above the genital opening, the elaborately subdivided left phallomere (*lPhm*) forms a group of lobes and horny processes on the right, and the broad ventral phallomere (*vPhm*) projects to the right from beneath the other two. The base of the right phallomere is produced forward on the right into a deep pocket (*y*) of the genital chamber wall, and the base of the left phallomere is sunken into a similar but shallower pocket on the left (*z*). Beneath the right phallomere is a deep, transverse, oval cavity (C) within a large, strongly convex capsular sclerite (A, B, C, *m*), which is normally closed from below by a flat valvular sclerite (C, *n*). Between the dorsal right phallomere and the left phallomere is an obliquely transverse fold, which, beginning on the left (A, *fd*), goes downward to the right and expands on the dorsal surface of the ventral phallomere (fig. 14 B, *fd*). Within the lower end of this fold above the base of the ventral

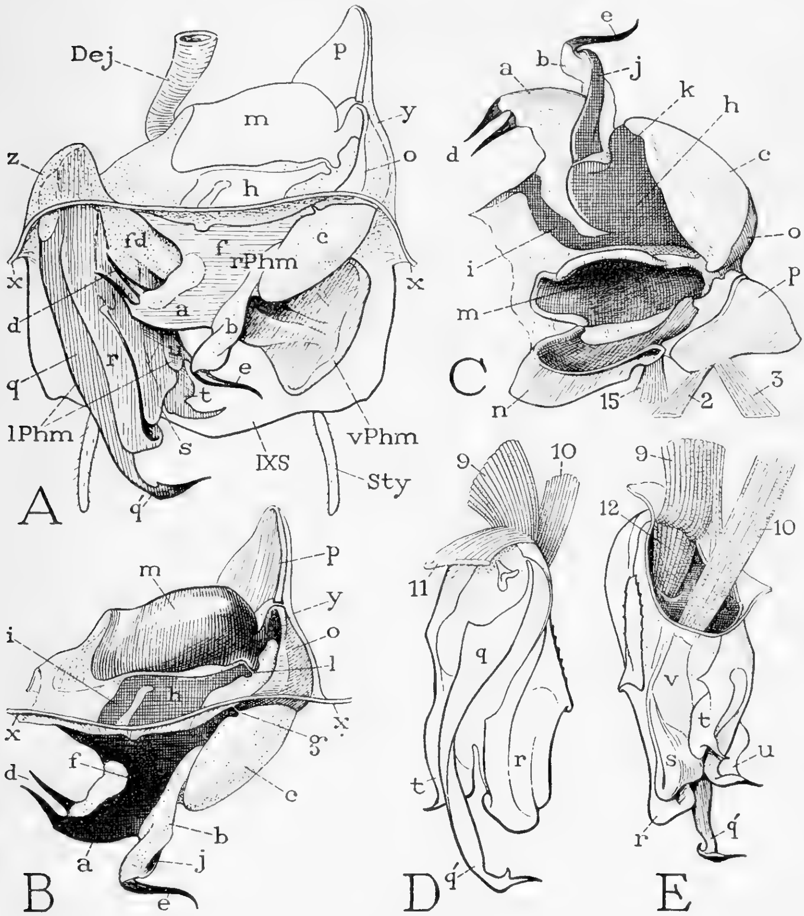

FIG. 13.—Blattoidea: external male genitalia of *Blatta orientalis* Linnaeus.

A, genitalia in place within genital chamber distal to anterior wall of latter (*x-x*), and parts invaginated into body cavity, dorsal view. B, right phallomere, dorsal view. C, same, posterior view with distal lobes turned dorsally. D, left phallomere, dorsolateral view. E, same, ventromesal view.

Parts of Right Phallomere.—*a, b, c,* left, median, and right lobules of free dorsal lobe; *d,* sinistral prongs; *e,* dextral hook; *f,* dorsal plate of dorsal lobe; *g,* articulation of dorsal plate with apodemal plate (*o*); *h,* ventral plate of dorsal lobe; *i,* left arm of ventral plate; *j,* distal arm of ventral plate; *k,* right lobe of ventral plate; *l,* articulation of ventral plate with capsular sclerite; *m,* capsular sclerite; *n,* ventral valvular plate; *o,* basal plate of apodeme; *p,* apodeme; *y,* pouch of genital chamber wall (*x-x*) containing base and apodeme of right phallomere.

Parts of Left Phallomere.—*q, q', r, s, t, u,* distal subdivisions and free processes; *v,* ventral sclerite; *z,* pouch of genital chamber wall containing base of left phallomere.

Other lettering as on preceding figures. For explanation of muscles, see fig. 14.

phallomere is the large genital opening, or phallotreme (*Phtr*). Since the terminal part of the genital exit passage contains a sclerotization (*es*) in its wall, it is probably a phallic invagination, or endophallic sac (*Enph*), rather than the end of the true ductus ejaculatorius (*Dej*), which is continuous with it.

The exposed part of the right phallomere comprises an oval membranous lobe on the right (fig. 13 A, B, *c*), and a flat extension on the left (*f*), which is subdivided into a sinistral lobe (*a*) bearing two strong prongs (*d*), and a dextral lobe (*b*) bearing a curved spine (*e*) turned to the right. From the base of the phallomere a basal plate (*o*) extends into the dextral pocket (*y*) of the genital chamber wall, where it becomes continuous with the capsular sclerite (*m*) of the ventral cavity, and supports an apodemal plate (*p*). The under surface of the right phallomere (C) contains an irregular sclerotization (*h, i, j, k*). Proximal to the latter is the cavity of the capsular sclerite (*m*), which is closed in the usual position of the right phallomere by the valvular sclerite (*n*) hinged to its lower lip.

The left phallomere (fig. 13 A, *lPhm*, D, E) is a fasces of irregular, elongate lobes (*q, r, s, t, u*), free at their extremities but having a common base sunken into the sinistral pocket (A, *z*) of the genital chamber. A large oval foramen opens into the base of the phallomere (E) from the body cavity. The outermost lobe (A, D, *q*) terminates in a strong spearhead-shaped process (*q'*) turned to the right, and two smaller more proximal prongs arise from the median lobes (*t, u*).

The ventral phallomere is a simple broad lobe projecting to the right from beneath the right phallomere (fig. 13, A, *vPhm*). The interphallic fold (*fd*) containing the phallotreme ends on its upper surface (fig. 14 B, *fd*); its lower surface is a flat plate (*w*) with a basal arm projecting to the left.

The phallic musculature of *Blatta* is quite different from that of the phasmid *Tenodera* (fig. 10), notwithstanding the evident identity of the phallomeres in the two genera. The muscles of the right phallomere of *Blatta* (fig. 14 C) include the following: *1*, a short thick muscle from the left side of the ninth abdominal tergum to the left extremity of the phallomere base; *2, 3*, right and left retractors of the phallomere, arising on the anterior lobes of the ninth sternum and converging to their insertions on the apodemal plate (fig. 13 A, *p*) near its mesal end; *4*, a muscle arising posteriorly on the ninth sternum, inserted anteriorly (fig. 14 C) on the apex of the apodemal plate; *5*, a large muscle from the apodemal plate to the capsular sclerite (*m*); *6*, a long muscle from the apodemal plate to the basal plate (*o*) of the phallomere; *7*, a long flat muscle, probably a levator of the phallomere, from the apodemal plate to the dorsal plate (*f*) of the free part of the phallomere; *8*, a thick mass of fibers in the right lobe (*c*), arising on the basal plate (*o*), and inserted on the distal process (fig. 13 C, *k*) of the ventral plate (*h*) of the phallomere.

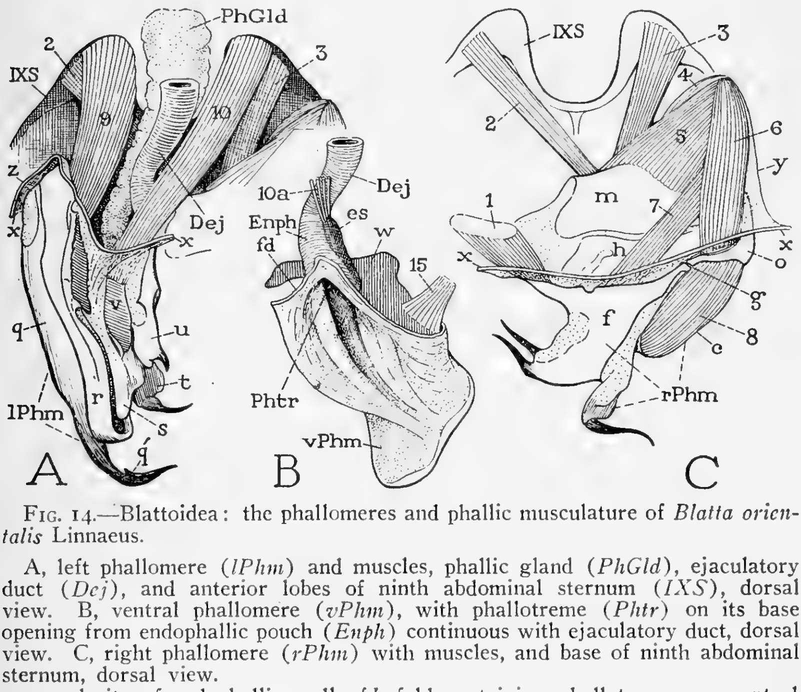

FIG. 14.—Blattoidea: the phallomeres and phallic musculature of *Blatta orientalis* Linnaeus.

A, left phallomere (*lPhm*) and muscles, phallic gland (*PhGld*), ejaculatory duct (*Dej*), and anterior lobes of ninth abdominal sternum (*IXS*), dorsal view. B, ventral phallomere (*vPhm*), with phallotreme (*Phtr*) on its base opening from endophallic pouch (*Enph*) continuous with ejaculatory duct, dorsal view. C, right phallomere (*rPhm*) with muscles, and base of ninth abdominal sternum, dorsal view.

es, sclerite of endophallic wall; *fd*, fold containing phallotreme; *w*, ventral plate of ventral phallomere; *x-x*, cut edge of anterior wall of genital chamber. Other lettering as on fig. 13.

1, tergal adductor of dorsal lobe of right phallomere; *2*, *3*, sternal adductors of right phallomere; *4*, sternal protractor of same; *5*, retractor of capsular sclerite; *6*, muscle of basal plate; *7*, apodemal adductor of dorsal lobe of right phallomere; *8*, dextral abductor of same; *9*, *10*, sternal retractors of left phallomere; *10 a*, branch of *10* inserted on endophallic sclerite; *11*, sternal protractor of left phallomere; *12*, inner muscle of left phallomere; *13*, *14*, internal mucles of left phallomere not shown in figures; 15, muscle of ventral phallomere. (See text, pages 44-46.)

The muscles of the left phallomere are as follows: *9*, *10*, two large retractors of the phallomere, arising right and left on the anterior lobes of the ninth sternum (fig. 14 A), extending into the basal foramen of the phallomere (fig. 13 E), where the right is inserted dorsally and the left ventrally; *10 a*, a few fibers from *10* inserted on the endophallic sclerite (fig. 14 B, *es*); *11*, a protracter of the phallomere arising posteriorly on the ninth sternum, inserted ventrally on the phallomere base (fig. 13 D); *12*, a large bundle of fibers within the left phallomere (fig. 13 E), arising in the base of the appendage and inserted distally in the lateral lobe (*q*), giving independent movement to the distal process of the latter; *13, 14,* two small muscles within the left phallomere (not shown in the figures).

The ventral phallomere has but one muscle attached upon it; this is a short muscle (fig. 14 B, *15*) attached to the right margin of the

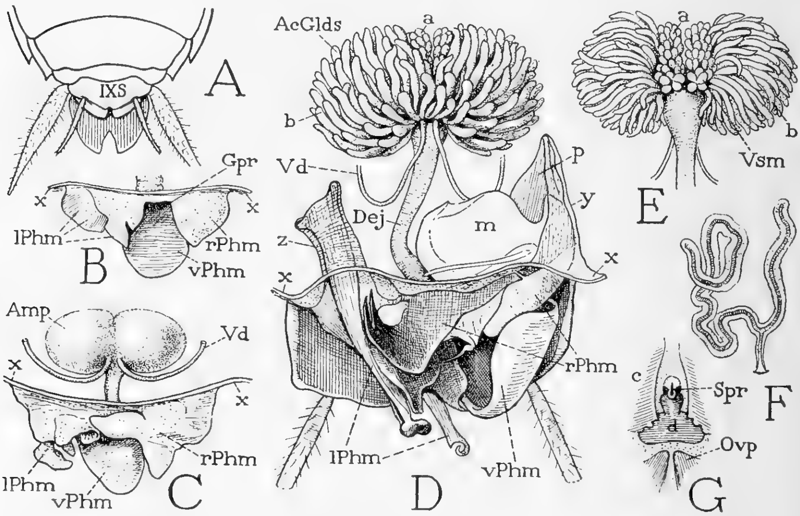

FIG. 15.—Blattoidea: male and female genitalia of *Periplaneta americana* (Linnaeus).

A, male nymph, 31 mm long, end of abdomen, ventral view. B, same, external genitalia, dorsal view. C, genitalia of following nymphal instar taken from within cuticle of B. D, adult male, external and part of internal genitalia, dorsal view. E, same, accessory glands and vesiculae seminales, ventral view. F, spermatheca. G, spermathecal aperture and surrounding structures in dorsal wall of female genital chamber.

a, b, smaller and larger tubules of accessory glands; *c, d,* sclerites in dorsal wall of female genital chamber associated with spermathecal aperture (*Spr*); *Ovp,* base of ovipositor; *Vsm,* vesiculae seminales. Other lettering as on fig. 13.

ventral plate (*w*), which extends downward from the right marginal angle of the valvular plate (fig. 13 C, *n*) beneath the right phallomere.

The external genitalia of *Periplaneta* (fig. 15 D) differ only in details from those of *Blatta*. The three phallomeres have essentially the same structure and the same relations to one another in the two genera, but in minor characters they present many differences. The left phallomere of *Periplaneta americana* is somewhat more deeply sunken into its basal pouch (*z*) than in *Blatta orientalis,* but the right phallomere has the same basal structure as that of *Blatta,* and beneath it is the same cavity within a large capsular sclerite (*m*). This interphallic cavity of the Blattinae, with its strongly developed walls and closing valve, must have some important function connected with the insemination of the female. According to Zabinski (1933 a) *Blatta orientalis* produces a spermatophore (fig. 11 *H*), though nothing is known of the place or manner of its formation. Structural details of the phallic organs in several species of *Periplaneta* are shown by Walker (1922), and Crampton (1925) gives a complete nomenclature for all the phallic parts of *P. americana.* The right and left phallic lobes are the "parameres" of Walker, who calls the ventral lobe the "penis." Crampton, however, designates as the "penis" a small lobe on the base of the ventral phallomere, which is evidently a part of the interphallic fold containing the phallotreme. *Eurycotis,* as described and figured by Chopard (1920), would appear to have the same type of phallic structure as *Blatta* and *Periplaneta,* and the same is true of *Blaberus atropos* described by Walker, though the phallomeres of this species are not of the typical blattine form.

The immature phallomeres of *Periplaneta americana* consist of three small lobes similar to those of *Blatta.* In a nymph 31 millimeters long (fig. 15 A) the left phallomere is already partly subdivided into accessory lobes (B). If a specimen of this instar is in a premoulting condition, the phallomeres of the next instar (C), contained within the loosened cuticula, will be found to have a shape more suggestive of that of the adult organs.

The second type of blattid phallic structure, which is well exemplified in *Blattella germanica,* is characterized by the absence of the ventral phallomere, by a simplification of the other two phallomeres, which are mostly invaginated into right and left pouches of the genital chamber wall, and by the development of an eversible median lobe containing the opening of the genital exit passage. The median lobe appears to be a secondary evagination at the mouth of an eversible endophallic sac; when protracted it forms an intromittent organ, and may therefore be termed the *penis,* in a functional sense.

In *Blattella germanica* the external genital organs and the proctiger are concealed between the long tenth tergum and the shorter, asymmetrical ninth sternum (fig. 17 A). The proctiger is a membranous cone (C, *Ptgr*) arising beneath the base of the tenth tergum; it bears the anus at its apex and a pair of lateral hooks (*a, b*) on its base, but it shows no differentiation into epiproct and paraprocts. The subgenital sternum (A, *IXS*) bears two small styli (*Sty*) on its distal margin, and has a pair of long apodemes (*IXSAp*) projecting into the body cavity from its concealed anterior margin. On the left side of its free part is a deep marginal notch. In some specimens there projects from this notch a long sclerotic process with a terminal hook and a membranous base (B, *lPhm*). This process is called the "penis" by Chopard (1920); it is the "titillator" of Wille (1920), the "left

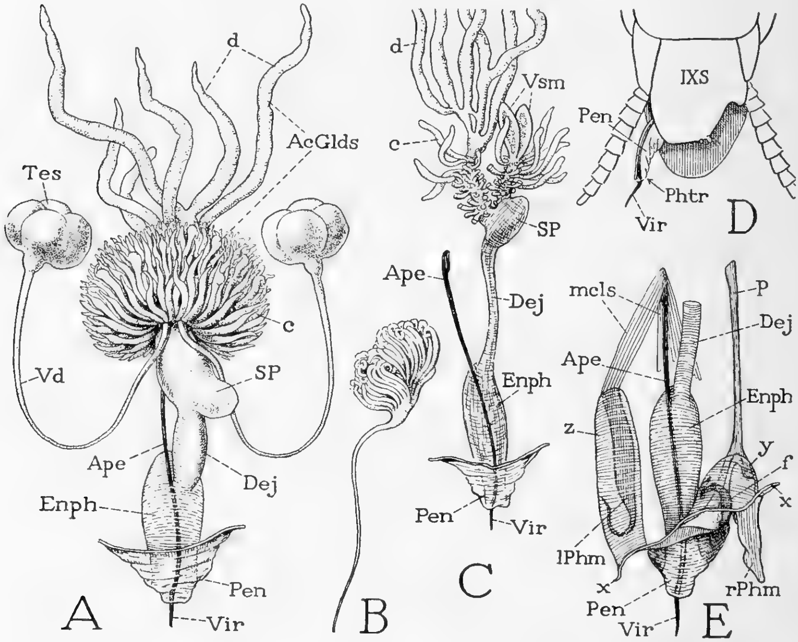

FIG. 16.—Blattoidea: male genitalia of *Blattella germanica* (Linnaeus).

A, internal reproductive organs, dorsal view. B, phallic gland. C, ejaculatory duct and associated structures, with most of smaller accessory gland tubules removed to expose the seminal vesicles. D, end of abdomen with penis projected, ventral view. E, external genitalia and endophallic pouch in retracted position, dorsal view.

AcGlds, accessory glands; *Ape,* endophallic apodeme; *c,* smaller tubules of accessory glands; *d,* long white tubules of accessory glands; *Dej,* ductus ejaculatorius; *Enph,* endophallus; *f,* sclerotic fold of wall of right phallic pouch; *lPhm,* left phallomere; *mcls,* muscles of endophallic apodeme; *p,* apodeme of right phallomere; *Pen,* penis; *Phtr,* phallotreme; *rPhm,* right phallotreme; *SP,* pouch of ejaculatory duct; *Tes,* testis; *Vd,* vas deferens; *Vir,* virga; *Vsm,* vesiculae seminales; *x-x* cut edge of anterior wall of genital chamber; *y,* right phallic pouch; *z,* left phallic pouch.

paramere" of Walker (1922), or the left phallomere according to the nomenclature here used. In other specimens, again, there is sometimes seen a conical or slender membranous organ terminating in a spine projecting from the right above the genital sternum (fig. 16 D, *Pen*). This is the penis, which is more usually concealed within the genital chamber.

The phallic organs of *Blattella* in the retracted state are shown as seen from above at E of figure 16. The anterior wall of the genital chamber (*x-x*) runs obliquely forward from left to right. On the left it is produced into a deep pouch (*z*) containing the hooked left phallomere (*lPhm*); on the right it forms a wider but shallower pocket (*y*) containing the right phallomere. The right phallomere consists principally of a flattened sclerotic arm (*rPhm*), which, though never seen projecting from the genital chamber, is evidently protractile, since it is provided with a long basal apodeme (*p*) on which muscles are inserted. The apodeme forks in the wall of the pouch, giving one branch to the base of the phallomere arm, and sending the other through the mesal wall of the pouch to an external sclerite above the base of the penis (*Pen*). On the inner wall of the pouch is a thick rounded fold (*f*) with a heavy, dark, crescentic, marginal sclerotization. The retracted penis appears as a conical, membranous lobe or fold (A, C, E, *Pen*) projecting from between the phallomere pouches, and bearing at its apex a free spine, or virga (*Vir*). Ventral to the base of the virga is an irregular opening, the phallotreme, leading into a large endophallic sac (*Enph*), which receives the ejaculatory duct (*Dej*) near its anterior end. The endophallic sac of *Blattella* apparently is equivalent to the terminal part of the genital exit passage of *Periplaneta* and *Blatta* (fig. 14 B, *Enph*) opening in the membranous fold on the dorsal side of the base of the ventral phallomere. The phallotreme of *Blattella* is on the ventral surface of the penis, which fact would make it seem improbable that the penis represents the ventral phallomere of the Blattinae. From the base of the virga a long slender apodeme runs forward through the dorsal wall of the endophallus and projects anteriorly as a free rod (fig. 16 A, C, E, *Ape*), on which protractor muscles (E, *mcls*) are inserted.

In a young male nymph of *Blattella germanica* the ninth abdominal sternum is a simple, symmetrical, narrow plate (fig. 17 D, *IXS*), bearing two widely separated styli (*Sty*). At a later stage (E) it is larger and produced posteriorly in a truncate extension on which the styli are closer together, but it still shows none of the irregular features of the adult subgenital plate (A). At this stage the phallic structures are distinct lobes (F) arising from the anterior wall of the genital chamber above the ninth sternum. The left lobe (*lPhm*) unquestionably represents the left phallomere of the adult because in the premoulting period a hooked structure (*G*) may be found within it, which is clearly the beginning of the mature form of the organ (H). The right phallomere is a small simple lobe (*rPhm*) on the right. Between the two phallomere lobes is a sclerotic point (*Vir*), which is the rudiment of the virga, and evidently cannot represent the median ventral phallomere of *Blatta* or *Periplaneta* because of its position dorsal to the genital opening.

The external genitalia of *Ectobius lapponicus* have the same type of structure as those of *Blattella,* but in most respects they are simpler. The exposed part of the ninth abdominal sternum of the adult male

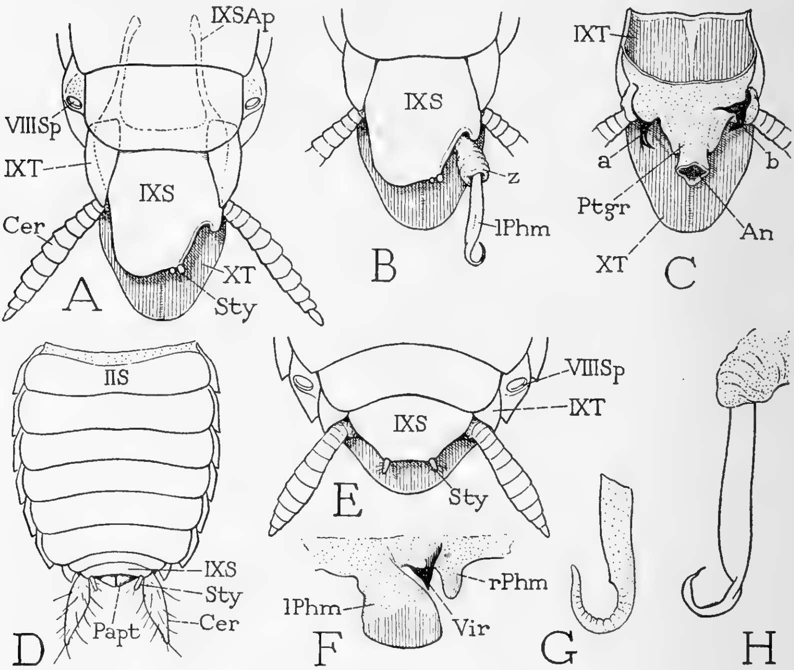

FIG. 17.—Blattoidea: abdomen and external male genitalia of *Blattella germanica* (Linnaeus).

A, adult male, end of abdomen, ventral view. B, same, with left phallomere projected. C, same, proctiger and basal hooks (*a, b*) beneath tenth tergum, ventral view. D, nymph 3 mm long, abdomen, ventral surface. E, nymph 22 mm long, end of abdomen, ventral view. F, same, phallic lobes removed from genital chamber, dorsal view. G, left phallomere of following nymphal instar taken from within cuticula of left lobe of F. H, left phallomere of adult.

For letter explanation, see preceding figures.

forms an asymmetrically triangular subgenital plate (fig. 18 A, B, *IXS*) projecting far beyond the short tergum of the tenth segment (A, *XT*), and bearing the coalesced rudiments of the styli (B, *Sty*) at its apex. The anterior invaginated part of the ninth sternum (E) is produced into two long apodemal arms (*IXSAps*) extending far forward in the abdomen, the left arm being longer than the right. Above the external part of the ninth sternum is the genital chamber, within which may be seen the short membranous penis (A, E, *Pen*), but the phallomeres are usually entirely concealed in their lateral pouches (E, *y*, *z*). The much-reduced right phallomere (D, E, *rPhm*) consists of two small superposed lamellae at the bottom of the right pouch (*y*), with a short apodeme (*p*) projecting from the wall of the latter. The left phallomere is a long, thick, strongly sclerotized rod with a hooked extremity (E, *lPhm*), contained in a correspondingly deep pouch (*z*). By the complete eversion of the pouch, however, the left phallomere can be protracted far beyond the end of

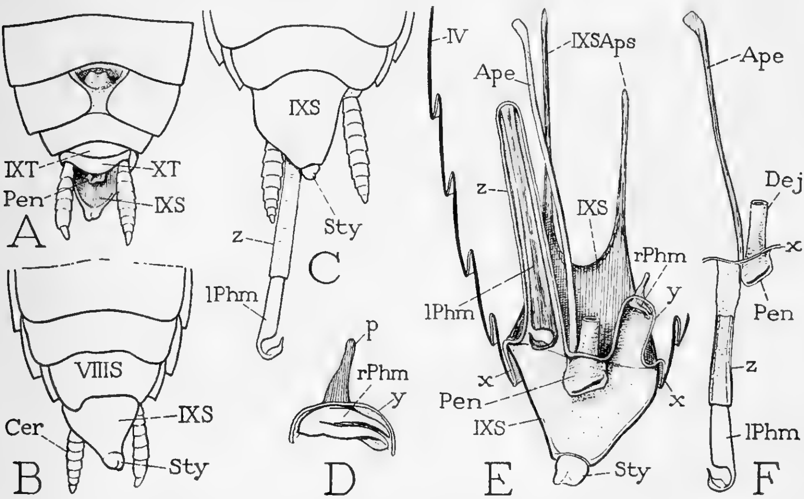

FIG. 18.—Blattoidea: abdomen and external male genitalia of *Ectobius lapponicus* (Linnaeus).

A, end of abdomen, showing penis (*Pen*) in base of genital chamber, dorsal view. B, same, ventral view. C, same, ventral view, with left phallomere projected on everted pouch (*z*). D, right phallomere in right phallic pouch (*y*). E, general view of retracted genitalia, somewhat diagrammatic, including ninth sternum and its apodemal arms (*IXSAps*), dorsal view. F, left phallomere projected, penis (*Pen*), and endophallic apodeme (*Ape*).

For letter explanation, see fig. 16.

the abdomen (C, F). The penis is a short membranous lobe (E, F, *Pen*) with a small endophallic cavity opening at its extremity. The penis is unarmed, but from the endophallic wall there arises a long apodeme (*Ape*), which extends forward and to the left into the fourth abdominal segment.

The type of phallic structure here shown in *Ectobia* and *Blattella,* representing the Ectobiinae and Pseudomopinae, occurs in many other forms, certainly including, as is evident from the descriptions and figures of Chopard (1920), the Nyctiborinae, Epilamprinae, Panchlorinae, and Perisphaerinae.

The female genitalia.—The external genital structures of female Blattidae include the opening of the median oviduct, the aperture of the spermatheca, the ovipositor, the opening of the accessory glands, and the oöthecal mold; they involve the seventh abdominal sternum and the ventral parts of at least the eighth and ninth abdominal segments. The genitalia are completely concealed in a large cavity above the seventh sternum, which latter is prolonged beneath the ventral parts of the succeeding segments. The short ovipositor arises (in the adult) from the venter of the ninth segment in the dorsal wall of the cavity. The small anterior part of the cavity lying before the ovipositor and above a fold representing the eighth sternum corresponds with the usual genital chamber of the eighth segment (see Snodgrass, 1933, fig. 23); the much larger posterior part, or vestibule, lying above the seventh sternum contains the ovipositor anteriorly, and forms distally a mold and container for the oötheca. The opening of the oviduct (gonopore) lies on a fold or lobe of the venter of the eighth segment, the spermatheca opens somewhere between the gonopore and the ovipositor, and the accessory glands discharge behind the base of the ovipositor.

The spermatheca of Blattidae is a two-branched structure (figs. 11 I, 15 F), one branch, which is usually thicker than the other or enlarged at the end, being the true sperm receptacle, the other apparently a glandular accessory. In *Blatta* and *Periplaneta* there is but one spermatheca; in *Blattella* there are two complete spermathecae (fig. 19 B), each with a separate opening and a glandular branch. According to Cleveland (1934) two spermathecae are present also in *Cryptocercus punctulatus.* The larger branch of the spermatheca of *Blatta orientalis* (fig. 11 I, *Spt*) is traversed by a narrow axial canal with strongly sclerotic walls, from which are given off numerous fine canaliculi into the cells of the thick glandular epithelium. In a preliminary study the writer mistook these threadlike ductules for spermatozoa, and made the foolish statement that the supposed spermatozoa are attached to a long spermatophore (Snodgrass, 1936, p. 90). Ito (1924), however, has shown the true nature of the structures radiating from the central canal. He says, moreover, that the lumen of the spermatheca, after copulation, is filled with spermatozoa and fine granules of secretion. The spermatheca of *Blatta* and of *Periplaneta* opens upon a small papilla on a median sclerite in the dorsal wall of the genital chamber (figs. 11 F, G, 15 G, *Spr*) proximal to the base of the ovipositor. In *Blattella* the spermathecae have quite a different position, as will be shown later, and their openings have a very special relation to the gonopore.

The structural details of the female genital region are well known in *Blatta* and *Periplaneta*; they have been but little studied in forms in which the male organs have the type of structure exemplified in *Blattella* and *Ectobia,* though Wille (1920) has given an account of the female genitalia in *Blattella germanica* that is deficient in only one essential point.

Most of the external genital organs of the female of *Blattella germanica* are exposed by depressing the seventh abdominal sternum. When the subgenital sternum is carefully cut away from its basal connections, it is to be seen that the lateral and anterior walls of the cavity above it (fig. 19 A) are formed by thick membranous folds (*VIIIV*) converging downward and forward from the spiracular plates of the eighth tergum (*VIIIT*). The folds, therefore, evidently represent the venter of the eighth segment, and the several asymmetrical sclerites contained in them (A, C, D, *h, i, j, k*), as well as a large crescentic sclerite (A, *l*) in the roof of the chamber before the ovipositor (*Ovp*), must be remnants of the eighth sternum. Immediately behind the crescentic dorsal sclerite (A, *l*) are the bases of the first, or ventral, valvulae of the ovipositor, with the accompanying first valvifers (*1Vlf*). The second and third valvulae arise from the venter of the ninth segment, in which are several small sclerites linked with the ninth tergum by a pair of long sclerotic bars (*o, o*) extending forward and mesally from the lateral extremities of the tergum. The area behind the ovipositor includes the venter of the tenth segment and the under surfaces of the paraprocts (*Papt*).

The mouth of the median oviduct of *Blattella* (fig. 19 A, *Gpr*) is situated on the end of a soft triangular lobe (*m*) projecting from the anterior wall of the genital chamber. The dorsal surface of this genital lobe is marked by a deep median groove (C, D, *sg*), in the anterior end of which are the apertures of the two spermathecae (D, *Spr, Spr*). Beneath the genital lobe is a flat fold of the integument (A, C, *n*) that contains the ventralmost sclerite (*h*) referable to the eighth sternum. Another sclerite (D, *k*) lies dorsally on the left side of the lobe, and two sclerites converge above it (A, *i, j*) from the lateral ventral folds of the eighth segment. The general conformation of the region of the genital opening is thus quite different in *Blattella* from that in *Blatta* and *Periplaneta,* in which the gonopore is on the dorsal surface of a simple fold of the venter of the eighth abdominal segment, and the spermathecal aperture is located on a small sclerite in the dorsal wall of the genital chamber immediately before the base of the ovipositor (figs. 11 G, 15 G, *Spr*). The two spermathecal apertures of *Blattella* are far in advance of the base of the ovipositor, and, as above noted, they lie in the anterior end of a groove (fig. 19 D, *sg*) on the dorsal surface of the genital lobe (*m*) that contains the gonopore (C, *Gpr*) in its free posterior margin. The groove of the genital lobe, therefore, is clearly a sperm conduit serving to convey the spermatozoa from the spermathecal apertures at its base (D, *Spr, Spr*) to the eggs issuing from the gonopore at its posterior end (C, *Gpr*).

The oötheca of *Blattella* is molded in the cavity of a large triangular,

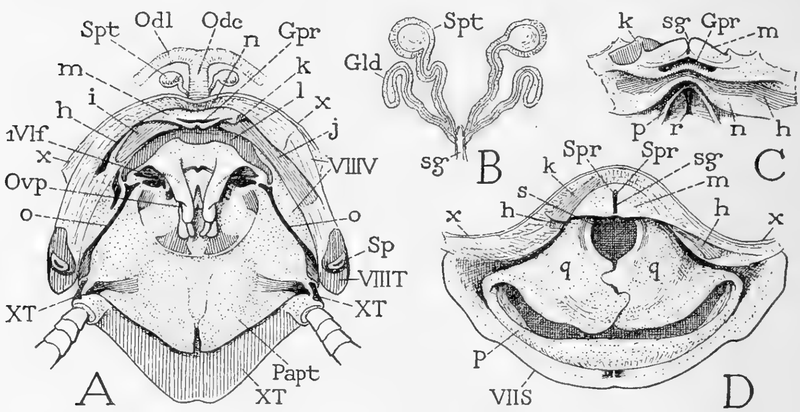

FIG. 19.—Blattoidea: female genitalia and associated structures of *Blattella germanica* (Linnaeus).

A, general view of external genitalia and associated inner structures exposed by removal of seventh abdominal sternum, ventral view. B, spermathecae. C, genital lobe (*m*) containing gonopore projecting from anterior wall of genital chamber, posterior view. D, genital lobe (*m*), and oöthecal fold (*p, q*) on floor of vestibulum.

Gld, spermathecal gland; *Gpr*, gonopore; *h, i, j, k*, sclerites in ventral folds (*VIIIV*) of eighth abdominal segment; *l*, transverse sclerite in roof of genital chamber proximal to ovipositor; *m*, genital lobe; *n*, subgenital fold; *o, o*, ventral arms of ninth tergum; *Odc*, oviductus communis; *Odl*, oviductus lateralis; *Ovp*, ovipositor; *p*, oöthecal fold on dorsal surface of seventh sternum; *Papt*, paraproct; *q, q*, lateral flaps of oöthecal fold; *r*, median anterior sclerite in floor of oöthecal chamber; *s*, foramen admitting end of ovipositor into oöthecal chamber; *sg*, spermatic groove; *Sp*, spiracle; *Spr*, spermathecal aperture; *Spt*, spermatheca; *VIIS*, sternum of seventh segment; *VIIIV*, venter of eighth segment; *VIIIT*, tergum of eighth segment; *x-x*, cut edge of anterior wall of genital chamber; *XT*, tergum of tenth segment.

calyxlike fold (fig. 19 D, *p, q*) arising submarginally on the floor of the vestibulum. The apex of this fold (C, *p*) lies anteriorly beneath the subgenital fold (*n*) of the eighth segment, and encloses a small median sclerite (*r*) of the vestibular floor. The lateral parts of the oöthecal fold are produced in two broad irregular flaps (D, *q, q*), which overlap medially, but leave between their bases a round foramen (*s*), through which the end of the ovipositor projects posteriorly and downward into the oöthecal chamber. The genital lobe of the eighth segment (A, *m*) evidently is protractile against the ovipositor base; the short ovipositor, therefore, serves as an egg conduct leading from the gonopore (*Gpr*) on the end of the genital lobe into the chamber of the oöthecal fold, and it also conveys into the latter the formative material of the oötheca discharged from the accessory glands opening between the bases of the second valvulae. With the formation of the oötheca, the lateral flaps of the oöthecal fold are pressed upward against the roof of the vestibulum, and thus shut off the oöthecal chamber from the cavity containing the ovipositor, except for the foramen that admits the end of the ovipositor.

Copulation and insemination.—There can be little doubt that many of the differences in the male genital structures between *Blatta* and *Periplaneta* on the one hand, and *Blattella* and related genera on the other are correlated with the differences in the genital apparatus of the females, but we have no exact information on the interrelated functions of the genital organs. Considering how intimate some of the cockroaches are with us, it is disconcerting to find how little we know of the private lives of cockroaches. Several investigators, however, have revealed something of their mating habits.

It has long been known that male roaches are provided with glands opening on the back of the abdomen; the secretion of some of these glands is attractive to the female at the time of mating, and assists the male in effecting a union with the female.

The first observation on dorsal abdominal glands in cockroaches was made by Gerstaeker (1861), who described two pairs of small, eversible, glandular vesicles found in a species of *Corydia* between the dorsal and ventral plates of segments *I* and *II,* present in adult males and females, but not in nymphal instars. The function of these glands is unknown, and the occurrence of similar glands in other species has not been determined. In *Blatta* and *Periplaneta* a pair of small glandular pouches occur in the infolded membrane between the tergal plates of segments *V* and *VI*. These glands were first described in *Periplaneta* by Minchin (1889, 1890), whose observations were confirmed by Haase (1889), and their histology has been further studied by Oettinger (1906), and by Konček (1924). The walls of the pouches contain glandular cells, and their inner surfaces are covered with small hairs. The dorsal glands of *Blatta* and *Periplaneta* are present in both sexes of the adult, and, according to Oettinger, in all stages of the nymph. They are regarded as odor-producing organs by Haase and Oettinger. It is possible that their secretion has a sex attraction during mating. In *Blattella* and related genera the back of the male abdomen is marked by two deep irregular depressions of the integument at the bases of the seventh and eighth tergal plates (see Oettinger, 1906; Wille, 1920). Into each of these depressions opens a pair of glands, the first between segments *VI* and *VII,* the second between segments *VII* and *VIII.* The glands of *Blattella,* according to Oettinger and Konček, are similar to those of *Periplaneta,* though located on different segments, but they are present only in adult males. The secretion of the male glands in *Blattella,* as suggested by Sikora (1918) and demonstrated by Wille (1920), is attractive to the females at the time of mating and induces the female to mount the back of the male preliminary to copulation. The glands thus have a function similar to that of the back glands of certain male crickets.

Wille (1920) describes the mating and copulation of *Blattella germanica* as follows: When a male encounters a prospective mate he takes a position either face to face with her or at her side. After a short interplay of the antennae, the male raises his wings at right angles to his body, turns himself about, and brings the end of his abdomen close to the head of the female. The depressions on the back of the male are thus exposed to the female, who, being soon attracted to them, first explores them with her palpi and then proceeds to lick them with her mouth parts. When the female becomes absorbed in this occupation, the male suddenly makes a backward movement, thrusting his abdomen under that of the female, until the female's head is almost against the bases of his upstanding wings. From the abdomen of the male, already extended at its tip, there is now projected the long, hooked left phallomere ("titillator") and the penis. The first grasps and pulls down the subgenital plate of the female, while the second is turned upward and forward and thrust into the female's genital chamber. In the following discussion of the act of insemination, Wille appears to assume that the spermatozoa are discharged into the oviduct; he describes the means by which the penis might be guided toward the "vaginal" orifice in such a manner that the genital openings of the two sexes would be pressed together; he makes only an incidental mention of a sperm receptacle, and does not observe the separate spermathecal openings in the spermatic groove above the gonopore. It would seem more probable, therefore, that the virga of the penis is laid in the seminal groove of the female genital lobe, and that the spermatozoa are thus guided from the exit orifice of the penis to the spermathecal apertures.

Zabinski (1933), who studied the mating habits of several common species of roaches, claims that the male, after having secured a hold on the genitalia of the female, turns end to end from her, and that insemination is normally completed in this position. Copulation in the reversed position, he says, continues about a half hour with *Blattella,* perhaps an hour with *Periplaneta,* and two or three hours with species of *Blaberus.* The preliminary mating of *Blatta orientalis,* as described by Rau (1924) and by Zabinski (1933), is accomplished in the same manner as with *Blattella germanica.* There appears, however, to be no positive evidence that the females of *Blatta* are attracted to the males by any gland secretion of the latter, though Rau says that when a male has partly inserted his body under the female, the latter " slowly walks on top of his back, touching and feeling the segments of his abdomen with her jaws and palpi."

Little is known of the exact function of the numerous phallic structures of the Blattinae. Rau (1924) observes that a male of *Blatta orientalis* attempting to copulate with a female opens and closes the genital claspers like a pair of tongs. Zabinski (1933 a) found that after removal of the long hooked process of the left phallomere (fig. 13 A, q′) the male of *B. orientalis* is entirely unable to copulate with the female, and likewise, after removal of the ventral valvulae of the female's ovipositor, a nomal male cannot retain his hold on the female. The curvature of the left phallomere hook to the right, Zabinski points out, must compel a grasping of the female on this side, and for this reason the male always turns to the right in taking the reversed position, in which insemination of the female is finally accomplished.

The method of sperm transfer in Blattidae has been but little studied. In most other Orthoptera the spermatozoa are enclosed in a spermatophore formed from the secretion of the male accessory genital glands, and the high development of these glands in the Blattidae would suggest that the glands have the same function in this family. Yet, Zabinski (1933 a) is the only observer who has reported the occurrence of a spermatophore among the roaches; his record pertains to *Blatta orientalis.* Copulation in this species, Zabinski says, results in the attachment of a spermatophore on the papilla of the female containing the spermathecal orifice (fig. 11 H). The spermatophore, about the size of pin head, is at first pear-shaped but later becomes deformed by pressure; when fresh it is white and has the consistency of hard butter. It consists of outer and inner walls with an intervening layer of vacuolated material. The inner wall, Zabinski believes, is formed by the secretion of the smaller tubules of the accessory glands, and the outer parts by that of the longer tubules. The spermatophore is carried by the female for 2 or 3 days, and is then rejected. Wille (1920) found no evidence of spermatophore formation in *Blattella germanica*. Free spermatozoa, he says, are present in the seminal receptacles of females examined the morning following mating that took place during the night, but no trace of spermatophore capsules is to be seen.

IX. TETTIGONIOIDEA

The external genital apparatus of the adult male of tettigoniid, gryllid, and acridid Orthoptera differs from that of the Blattidae and Mantidae in that it consists of a single phallic structure which encloses the opening of the ejaculatory duct. The organ is developed in the nymph, however, from primitive genital lobes (phallomeres) that grow out from the genital integument around the gonopore.

The mature phallus of the Tettigonioidea has a distinctive type of structure, which fact can leave no doubt of the close relationship of the several families included in this group (Tettigoniidae, Gryllidae, and related forms variously classified by taxonomists). Unquestionably a wider comparative study of the organ would give valuable evidence on the natural classification of the families. Since the structure of the phallus is adapted to the formation of a spermatophore, the nature of the spermatophore itself should be an index to relationships. Judging from what is known concerning the spermatophores of members of several families, it seems probable that the families will be found to fall into two series, according to whether the spermatophore contains a single sperm capsule, or two sperm capsules.

The internal reproductive organs of male Tettigonioidea exemplify the typical orthopteran structure of these parts in a highly developed condition (figs. 20 A, 27 C, 34 A, 39 A). The testes (*Tes*) are compact bodies, each composed of a large number of sperm tubes (fig. 27 D, *ST*) surrounded by a peritoneal sheath (*PSh*). The vas deferens (*Vd*) penetrates into the testis and the sperm tubes converge upon its anterior end, which may be much enlarged. Beyond the testis each vas deferens is thrown into numerous loops, forming an epididymis-like body (figs. 20 A, 27 C, 34 C, 39, *Epdm*) that attains a particularly large size in the Gryllotalpidae (fig. 39). Posteriorly the vasa deferentia turn mesad and ventrally, going beneath the large cercal nerves of the eleventh abdominal segment (figs. 20 A, 34 A, 39 B, *XINv*), and then forward to enter the anterior part of the ductus ejaculatorius.

The ejaculatory duct (if the name is given to the entire median genital exit passage of the adult) is clearly composed of both ectodermal and mesodermal parts. The mesodermal section is formed of the united embryonic ampullae of the vasa deferentia (figs. 21 E, 31 E, *Amp*), and gives rise to the accessory glands and seminal vesicles of the adult. From each ampulla in a late nymphal stage there may be a single diverticulum, but the great mass of tubules appears only in the imaginal stage. The ampullar part of the definitive ejaculatory duct may be bilobed (fig. 25 G) or single; in *Gryllotalpa* it forms a large median sac (fig. 39 A) from which the accessory gland tubules arise. The accessory glands always consist of numerous tubules (figs. 20 A, 27 C, 34 A, 39 A, *AcGlds*), which differ in length, and may be differentiated into several groups by differences in size and probably in the nature of their secretions. In *Phaneroptera furcata* (fig. 20 A) there are four distinct, paired groups of tubules, including two anterior groups of long thick tubes (*a*), lateral clusters of shorter and more slender tubules (*b*), a dense ventral mass of still smaller ones (*c*), and finally two large, compact bodies of fine, closely interwoven tubules (*d*) projecting laterally and posteriorly. Bodies of tubules similar to the last, but much smaller, are present also in *Gryllotalpa* (fig. 39 A, *d*). Sperm-containing vesicles comparable with those of Mantidae and Blattidae appear to be absent in Tettigoniidae and Gryllidae, but in *Gryllotalpa* two large tubular diverticula (fig. 39 A, *Vsm*) arise laterally from the ejaculatory duct near the terminations of the vasa deferentia, which, as noted by Ito (1924), are found to be filled with mature spermatozoa, their heads buried in the vesicular walls.

The posterior ectodermal part of the ejaculatory duct is wide and usually very short. Its walls are continuous posteriorly with those of the endophallus (figs. 25 F, 32 E), but the termination of the duct is always marked by the orifices of two globular vesicles (*ejv*) that open into it. These vesicles of the ejaculatory duct are characteristic features of the Tettigonioidea (figs. 20 A, 25 F, C, 27 C, 32 E, 34 A, 39 A). They have been termed " prostate glands ", and should have a better claim to this name than the phallic glands of Blattidae and Mantidae, but nothing is known of their function. According to Ito (1924) the lumen of each vesicle is lined by a thick chitinous intima and contains a granular mass with large globules. The vesicles usually have a pale yellow or orange color.

The accessory glands, the ejaculatory duct, and the phallic muscles are innervated by branches given off from the common basal trunks of the nerves to the tenth and eleventh segments (figs. 34 D, 39 B). This fact suggests that the ectodermal phallus and ejaculatory duct, as well as the mesodermal ampullar part of the latter, are derived from the tenth abdominal somite.

The female genital organs of the Tettigonioidea, aside from the ovipositor, are simple and of a generalized type of structure. The external genital opening, or vulva (female gonotreme), lies between the base of the ovipositor and the posterior margin of the eighth sternum, or a differentiated subgenital lobe of the latter (fig. 20 B, F, *Vul*). It leads into a small genital chamber into which open both the median oviduct and the spermatheca. The opening of the oviduct (female gonopore) lies ventrally, either in the anterior wall of the

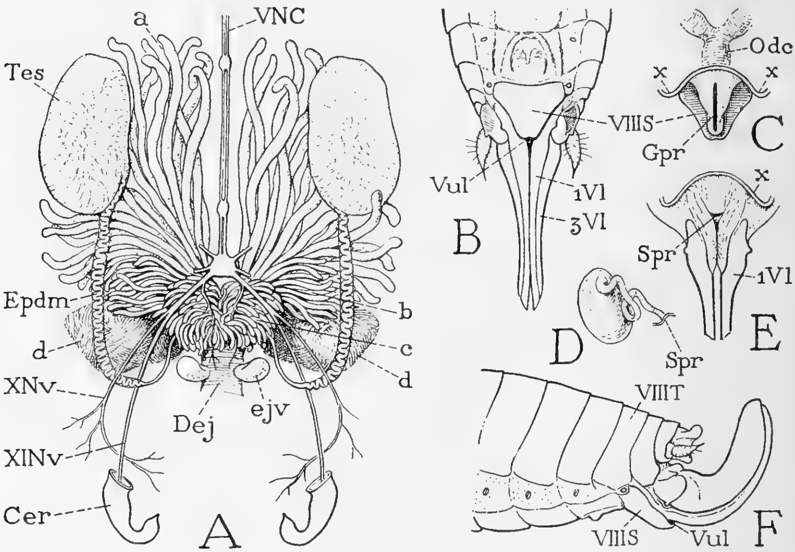

FIG. 20.—Tettigonioidea—Tettigoniidae: male and female genitalia of *Phaneroptera furcata* (Brunner).

A, internal reproductive organs of adult male, ventral view. B, end of abdomen of female, ventral view. C, opening of oviduct (*Gpr*) on fold of upper surface of eighth abdominal sternum. D, spermatheca. E, spermathecal aperture at base of ovipositor in dorsal wall of genital chamber. F, end of female abdomen, lateral view.

a, b, c, d, four paired groups of accessory gland tubules; *Cer,* cercus; *Dej,* ductus ejaculatorius; *ejv,* vesicle of ejaculatory duct; *Epdm,* epididymis; *Gpr,* gonopore; *Odc,* oviductus communis; *Spr,* spermathecal aperture; *Tes,* testis; *1Vl, 3Vl,* first and third valvulae of ovipositor; *VNC,* ventral nerve cord; *Vul,* vulva (female gonotreme); *x-x,* cut edge of anterior wall of genital chamber; *XNv, XINv,* nerves of tenth and eleventh abdominal segments.

genital chamber, or on a median fold of the floor (fig. 20 C, *Gpr*). The spermathecal aperture is in the dorsal wall of the chamber (E, *Spr*); it may be concealed in a pocket of the latter, or, as in *Gryllus,* it may be situated on a large spoutlike projection. The spermatheca is a single oval or elongate sac (figs. 20 D, 29 B), and its duct has no diverticulum. The short median oviduct (fig. 40 A, *Odc*) unites with the lateral oviducts (*Odl*) in the ventral part of the abdomen, the lateral ducts turning downward and mesally between the principal nerves of the seventh and eighth segments (B). Compared with the male, in which the vasa deferentia turn downward between the nerves of the tenth and eleventh segments, it is seen that the nerves of three segments intervene between the positions of the ends of the ducts in the two sexes, from which it is evident that two segments intervened between the primary female genital segment (*VII*) and the primary male genital segment (*X*).

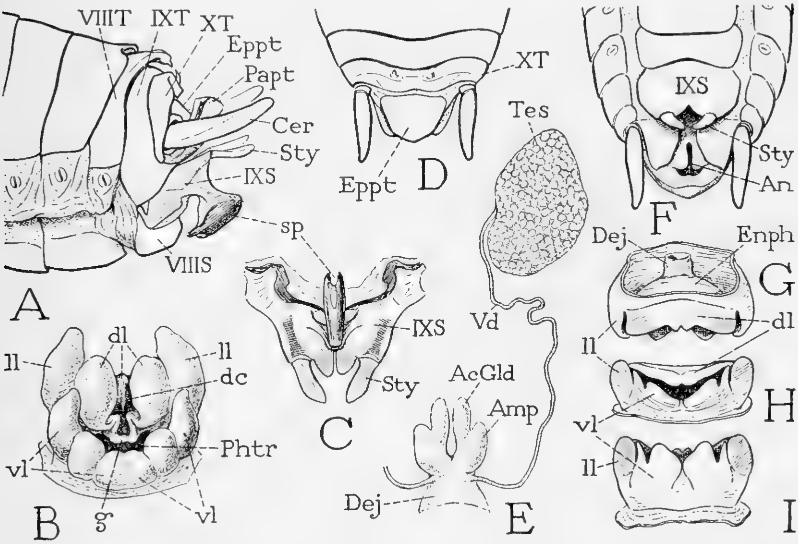

FIG. 21.—Tettigonioidea: male genitalia of *Cyphoderris monstrosa* Uhler.

A, adult male, end of abdomen, lateral view. B, phallus of adult, posterior view. C, ninth abdominal sternum, ventral view. D, male nymph, probably full grown, end of abdomen, dorsal view. E, same, internal reproductive organs. F, same, end of abdomen, ventral view. G, H, I, same, phallus, dorsal, posterior and ventral views.

AcGld, first rudiment of accessory glands; *Amp*, mesodermal ampulla; *dc*, dorsal cavity of phallus; *Dej*, ejaculatory duct; *dl*, dorsal lobe of phallus; *Enph*, endophallus; *g*, posterior margin of dorsal lobe of phallus; *ll*, lateral lobe of phallus; *Phtr*, phallotreme; *sp*, sternal process; *Sty*, stylus; *Tes*, testis; *vl*, ventral lobe of phallus; *Vd*, vas deferens.

Cyphoderris monstrosa.—This insect, of uncertain taxonomic status, would appear to belong to the Tettigoniidae because of the presence of well-developed styli on the ninth abdominal sternum of the male in both adult and nymphal stages (fig. 21 A, F, *Sty*), and because of the more complete separation of the epiproct from the tenth tergum (A, D) than is characteristic of the Gryllidae. The phallus, moreover, very well represents a generalized condition of the tettigoniid type of phallic structure, and certainly does not have the special features of the organ developed in Gryllidae and related families. The ninth sternum of the adult male has a very unusual form (A, C, *IXS*); it folds up against the end of the abdomen and bears a large hammer-shaped process (*sp*) on its under surface. Walker (1922) gives a good illustration of the terminal aspect of the abdomen of *Cyphoderris monstrosa,* and he says the only representative of the penis are the folded membranous lips of the genital passage. This statement is entirely true, but when the membranous folds are inflated, as shown at B of figure 21, drawn from a dried specimen boiled in water, they take the form of a definite organ, the lips of which are produced into a number of lobes surrounding the gonotreme, which opens from a spacious endophallic cavity.

The structure of the phallus of *Cyphoderris* is easily understood on examining the organ in a late nymphal stage. The nymphal phallus (fig. 21, G, H, I) is a broad, flat structure with weakly sclerotized walls, arising by a wide base from the wall of the genital chamber. It contains a large endophallic cavity, to the anterior wall of which is attached the ejaculatory duct (G, *Dej*). The lips of the phallotreme are subdivided into several distinct lobes; above is a broad dorsal lobe (G, H, *dl*), at the sides a pair of oval lateral lobes (*ll*), and below a pair of ventral lobes (H, I, *vl*), each subdivided into two parts. The structure of the nymphal phallus of *Cyphoderris* is typical of that of the Tettigonioidea in general (figs. 23 B-F, 31 F-H). The differentiation of the organ into its various adult forms takes place principally with the change to the imago.

In the phallus of the adult *Cyphoderris* (fig. 21 B) the various lobes of the nymphal organ (H) have expanded into large vesicular processes, which are probably distended by pressure from within the abdomen. The ventral lobes (*vl*) now include five subsidiary lobes, but the median one is evidently the small median part between the ventral lobes of the nymph (I). At the sides of the phallotreme are the greatly expanded lateral lobes (*ll*). The dorsal lobe (*dl*) carries two marginal vesicles, and its median part is deeply depressed, forming a dorsal cavity (*dc*), but its distal margin (*g*) is still the upper lip of the phallotreme. The latter leads into an ample endophallic cavity that receives the ejaculatory duct.

Tettigoniidae.—The phallus of the tettigoniids in its essential structure and immature form is identical with that of *Cyphoderris,* but in its adult development it is subject to greater modifications. The structural variations of the adult organ, however, are but little divergent and closely follow a single line of evolution.

The mature tettigoniid phallus in its usual retracted condition is mostly concealed within the genital chamber, where it appears as a large, thick, soft body arising from the anterior wall of the chamber. Its general structure may be represented diagrammatically as at C, figure 22. The posterior part of the organ presents ventrally a wide transverse opening, the phallotreme, which leads into a large ventral endophallic cavity (*Enph*) continuous anteriorly with the ejaculatory duct. The part of the organ above the phallotreme constitutes a large,

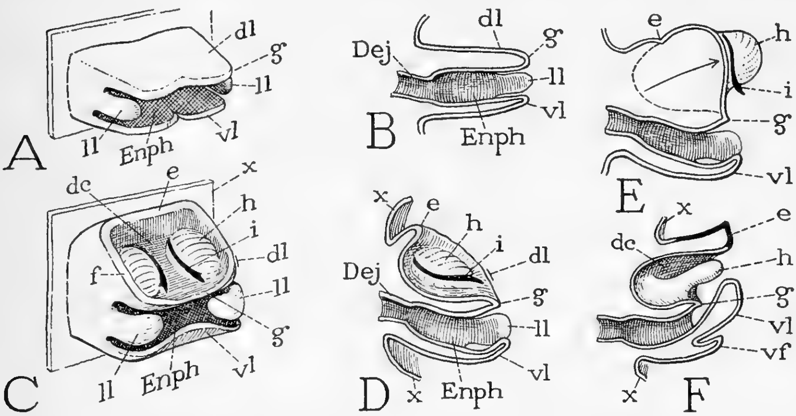

FIG. 22.—Diagrams showing the fundamental structure and the evolution of the tettigonioid type of phallus in Tettigoniidae and Rhaphidophorinae.

A, nymphal structure of the phallus, postero-lateral view. B, same, median section. C, adult structure of the phallus in Tettigoniidae, postero-lateral view. D, same, median section. E, same, dorsal cavity and its armature everted. F, adult structure of the phallus in Rhaphidophorinae, median section.

The following letter explanations apply to figs. 22 to 28, inclusive. *An*, anus; *AcGlds*, accessory glands; *Cer*, cercus; *dc*, dorsal cavity of phallus; *Dej*, ductus ejaculatorius; *dl*, dorsal lobe of phallus; *e*, anterior margin of dorsal cavity of phallus (produced posteriorly at F); *ejv*, vesicle of ejaculatory duct; *Enph*, endophallus; *Epdm*, epididymis; *Eppt*, epiproct; *f*, lateral margin of dorsal cavity of phallus; *g*, posterior margin of dorsal lobe of phallus; *h*, membranous lobe or fold on floor of dorsal cavity of phallus; *i*, sclerotic armature associated with *h*; *j*, dorsal fold of body wall above base of phallus; *k*, dorsal pouch of phallus formed by posterior reflection of anterior margin (*e*) of dorsal phallic cavity (*dc*); *ll*, lateral lobe of phallus; *mcl*, muscles; *Papt*, paraproct: *Phl*, phallus; *Phtr*, phallotreme; *PSh*, peritoneal sheath of testis; *rpd*, *rpv*, dorsal and ventral retractor muscles of phallus; *ST*, sperm tube of testis; *Sty*, stylus; *Tes*, testis; *Vd*, vas deferens; *vf*, ventral fold of phallus; *vl*, ventral lobe of phallus; *x-x*, cut edge of anterior wall of genital chamber; *X.V*, venter of tenth abdominal segment.

thick *dorsal lobe* (*dl*), the part beneath projects as a broad, flaplike *ventral lobe* (*vl*), while at each side of the opening is a *lateral lobe* (*ll*). The upper or posterodorsal surface of the dorsal lobe is usually depressed or deeply sunken, forming a *dorsal cavity* (*dc*), the margins of which (*e*, *f*, *g*) are often prominent folds. The distal margin (*g*) appears as a transverse septum between the dorsal cavity and the mouth of the endophallic cavity. The floor of the dorsal cavity is generally produced in a pair of soft lateral folds or rounded lobes (*h*), and associated with these structures is usually a pair of sclerotic bars or plates (*i*), the ends of which may project as free processes. The anatomical relations of the various parts of the phallus in the ordinary retracted state are best seen in a median longitudinal section (D), from which it becomes evident that the entire organ is merely an outgrowth from the genital chamber wall (*x-x*), enclosing a large endophallic cavity (*Enph*), into which opens the ejaculatory duct (*Dej*). Disregarding the modification of the dorsal lobe, therefore,

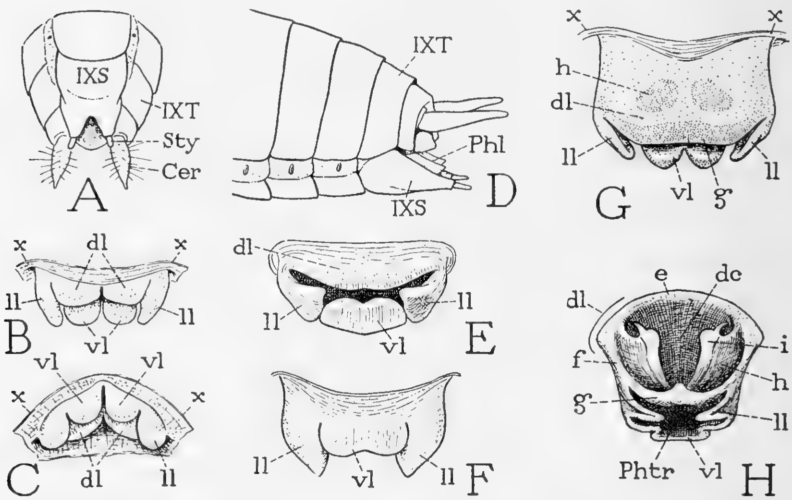

FIG. 23.—Tettigonioidea–Tettigoniidae: external male genitalia of *Conocephalus fasciatus* (Degeer).

A, nymph, 9 mm long, end of abdomen, ventral view. B, C, same, phallus in dorsal and ventro-posterior views. D, nymph, 11 mm long, end of abdomen. E, F, same, phallus in posterior and ventral views. G, nymph, 14 mm long, phallus, dorsal view. H, adult, phallus, posterior view.

For letter explanation, see fig. 22.

the essential structure of the phallus may be expressed as in the diagram at A, or in section as at B. This simplified concept of the adult phallic structure is the actual structure of the organ in late nymphal stages of its development (fig. 23 E, G).

The male organs of the Tettigoniidae have been well described by Walker (1922), though in terms somewhat different from those used here because based on a different idea concerning the origin and evolution of the phallus. The paired processes or armature of the dorsal phallic lobe Walker calls the "parameres", the dorsal cavity the "paramere sac", and the endophallic cavity the "spermatophore sac."

The so-called parameres of the Tettigoniidae are supposed to represent the paired right and left phallic lobes of Blattidae, but, as will presently be shown, the development of the tettigoniid phallus does not warrant the assumption of a close homology between any of its minor parts and the phallic structures of Blattidae.

Though the tettigoniid phallus is ordinarily concealed within the genital chamber, the entire organ is protractile. In the protracted condition (fig. 22 E) the dorsal cavity with its armature is everted, and all parts of the phallus may be so greatly distended by blood pressure that the organ assumes an entirely different appearance from that of its passive state. The principal muscles of the phallus are a pair of dorsal retractors (fig. 24 B, *rpd*) arising on the lateral parts of the tenth abdominal tergum, and a pair of ventral retractors (*rpv*) arising on the ninth sternum.

The development of the tettigoniid phallus in nymphal instars shows that the adult organ is a composite structure formed by the union of several primary lobes of the genital integument that grow out around the gonopore, or mouth of the invagination that gives rise to the ectodermal part of the ejaculatory duct. In a young nymph of *Conocephalus fasciatus,* 9 mm in length (fig. 23 A), the gonopore is surrounded by six small phallic lobes (B, C), two of which are dorsal, two lateral, and two ventral. These simple lobes, or phallomeres, enclose between them a shallow endophallic cavity, to the base of which is attached the ejaculatory duct. The early nymphal phallomeres of *Conocephalus* thus resemble the nymphal phallomeres of *Blatta* or *Periplaneta* (figs. 12 E, 15 C), except that there are six of them instead of three. At this stage, therefore, it is impossible to identify any particular pair of lobes in *Conocephalus* with any particular pair in *Blatta* or *Periplaneta.* At a later stage in the development of *Conocephalus,* in a nymph 11 mm long (fig. 23 D), the two primary dorsal phallomeres have united in a single broad dorsal lobe (E, *dl*), and the two ventral phallomeres have united in a single ventral lobe (E, F, *vl*), the lateral lobes (*ll*) retaining their independence. All the lobes, moreover, are now carried out on a common basal ring, and the endophallic cavity is correspondingly deepened. Thus is established the typical four-lobed structure of the adult phallus, but the special features of the dorsal lobe are not yet in evidence. At a still later stage, in a nymph 14 mm in length, the basal part of the phallus has greatly lengthened (G), so that the primary phallomeres now appear as relatively small terminal lobes, with the wide phallotreme between them. The dorsal lobe (*dl*) still presents a broad flat upper surface, but there are differentiated upon it two oval thickenings (*h*), which evidently are the rudiments of the adult armature (H, *h*, *i*). The mature structure of the phallus (H) apparently is attained at the last moult; it involves principally the thickening of the dorsal lobe, the invagination of the upper surface of the latter, and the development of the dorsal armature characteristic of the species.

The adult modifications of the tettigoniid phallus consist principally of variations in the relative size of the several terminal lobes, and in the form and development of the armature of the dorsal lobe. In the Decticinae, however, the cavity of the dorsal lobe becomes converted into a pocket by the posterior extension of its anterior margin, which condition leads into that characteristic of the Rhaphidophorinae (fig. 22 F), and finally to an extreme type of modification that distinguishes the Gryllidae from the Tettigoniidae.

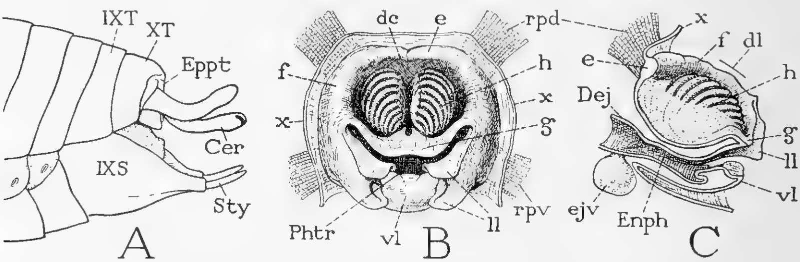

Fig. 24.—Tettigonioidea–Tettigoniidae: external male genitalia of *Microcentrum retinerve* (Burmeister).

A, end of abdomen, lateral view. B, phallus, posterior view. C, same, median longitudinal section.

For letter explanation, see fig. 22.

For a concrete example of a phallic structure that comes close to the hypothetical generalized structure shown at C of figure 22 we may select the genus *Microcentrum*. The phallus of *M. retinerve* (fig. 24 B) is a low, rounded organ with a basinlike cavity (*dc*) in the dorsal wall, a pair of folded lateral lobes (*ll*), and a thick, bifurcate ventral lobe (*vl*). The phallotreme (*Phtr*) is a wide, transverse opening between the distal lip (*g*) of the dorsal lobe above, and the lateral and ventral lobes below. The dorsal cavity contains two large, oval, strongly convex protuberances (*h*), transversely ribbed on their lateral surfaces with finely toothed ridges, but there is no other accessory armature. Attached on the inner surfaces of these dorsal organs are large masses of muscle fibers converging from the lateral parts of the base of the phallus. The dorsal and ventral retractor muscles (*rpd*, *rpv*) have the typical arrangement and are inserted on the phallic base. A median section of the organ (C) shows clearly the simple anatomical relations of its parts, including the endophallic cavity (*Enph*) that receives the ejaculatory duct (*Dej*). In the closely related *M. rhombifolium* the phallus has the same general structure as that of *retinerve,* but the organs of the dorsal cavity are absent.

A nymphal condition of the phallus appears to be retained in the adult of *Amblycorypha oblongifolia,* since the phallic organ is here a small, soft, compact body presenting a broad, flat dorsal surface without the usual dorsal cavity and armature. The endophallic cavity, however, contains a flat, tonguelike fold that divides it into a dorsal

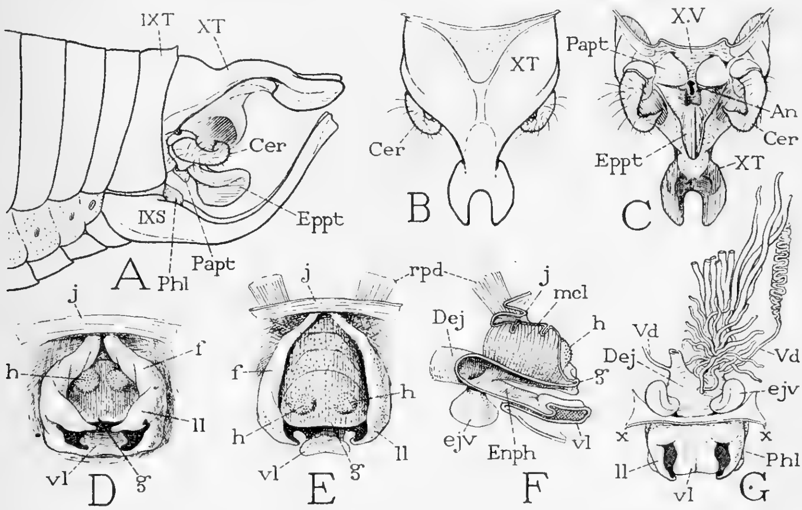

FIG. 25.—Tettigonioidea–Tettigoniidae: abdomen and genitalia of male of *Phaneroptera furcata* (Brunner).

A, end of abdomen, lateral view. B, tenth tergum and cerci, dorsal view. C, tenth and eleventh abdominal segments, ventral view. D, phallus, posterior view. E, same, dorsal view. F, same, median longitudinal section. G, phallus and associated internal organs, ventral view.

For letter explanation, see fig. 22.

and a ventral compartment. The fold arises by a narrowed base above the gonopore, and ends with two small divergent lobes projecting from the phallotreme.

In the genus *Phaneroptera* the male " terminalia " include numerous modifications of the ninth, tenth, and eleventh abdominal segments. In *S. furcata* (fig. 25 A) the tergum of the ninth segment resembles the tergal plates preceding it, but the ninth sternum (*IXS*) is produced posteriorly in a long, slender, tapering, trough-shaped extension, strongly curved upward, ending in a narrow truncate margin. Styli are absent unless they are represented by two small nodules on the distal angles of the sternal process. The concave dorsal wall of the ninth sternum becomes proximally a deep concavity in which the phallus (*Phl*) is lodged. The tenth tergum (A, B, *XT*) is a large triangular plate with its apex produced into a thick median stalk bearing two strong terminal lobes that embrace the process of the ninth sternum when the tenth tergum is depressed. The venter of the tenth segment is a narrow membranous area proximal to the paraprocts (C, *X.V*). The eleventh segment projects ventrally from beneath the broad basal part of the tenth segment (A, C); the epiproct is produced into a prominent, laterally compressed lobe (*Eppt*); the paraprocts (*Papt*) are two small, soft lobes at the base of the epiproct. The anus (C, *An*) lies in the anterior end of a deep depression on the under surface of the epiproct. The falciform cerci (A, B, C, *Cer*) are articulated by their basal sclerites to the proximal parts of the lateral margins of the tenth tergum (A).

The phallus of *Phaneroptera furcata* is a thick, padlike organ arising from the anterior wall of the genital chamber. In its usual condition it is contained in the dorsal concavity on the base of the ninth sternum (fig. 25 A, *Phl*), where it is concealed by the overhanging lobe of the epiproct. The broad, sloping posterior surface of the phallus (D, E) presents a median depression dorsally between prominent marginal folds (*f*) that terminate distally in the lateral phallic lobes (*ll*). The ventral lobe is a tonguelike extension of the ventral lip of the broad phallotreme (E, *vl*), which may be folded back into the latter (D). The floor of the dorsal cavity is roundly convex and is crossed by four, narrow, dark-lipped grooves. Distally, it bears a pair of prominent oval swellings (*h*), conspicuous by their darker color, which results from a dense covering of small spines such as are more sparsely distributed on the surrounding surface. The interior of the dorsal lobe of the phallus is occupied by two dense masses of muscle (F, *mcl*) the fibers of which arise laterally within the phallus and curve medially and dorsally to their insertions on the arched floor of the dorsal cavity. In the retracted condition the base of the phallus is covered dorsally by a transverse fold of the genital chamber wall (D, E, F, *j*).

The apparently abrupt change in the structure of the phallus from the simple nymphal condition to the complex adult form, as illustrated in *Conocephalus fasciatus* (fig. 23 G, H), is of course more gradual than it appears. The adult modifications take place during the last nymphal instar within the cuticula of the nymphal phallus, and are completed at ecdysis. The mature phallus of *C. fasciatus* (fig. 23 H) much resembles that of C. *brevipennis* described and figured by Walker (1922). In the retracted condition the phallus projects but little from the wall of the genital chamber. The upper surface of the dorsal lobe contains a wide, cuplike depression, the dorsal cavity (*dc*), from the lateral walls of which arise a pair of folds (*h*) with sclerotized margins (*i*) that end in free horny processes. The sclerotized parts are the " parameres " of Walker, the supporting folds the " bases of the parameres." The phallotreme (*Phtr*) is a large opening in the ventral part of the phallus between the thickened posterior margin of the dorsal lobe above (*g*), the lateral lobes at the sides (*ll*), and the ventral lobe below (*vl*). When the phallus is protracted the whole organ forms a grotesque vesicular body (fig. 26 B) projecting between the epiproct and the depressed ninth sternum (A). The cavity of the dorsal lobe is entirely everted (B, *dl*), and the folds of its floor are

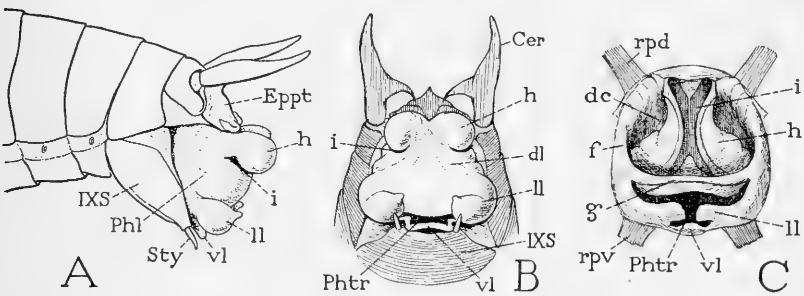

FIG. 26.—Tettigonioidea–Tettigoniidae: external male genitalia of *Conocephalus fasciatus* (Degeer) and *Neoconocephalus ensiger* (Harris).

A, *Conocephalus fasciatus*, end of abdomen with phallus everted, lateral view. B, same, posterior view. C, *Neoconocephalus ensiger*, phallus in retracted condition, posterior view.

For letter explanation, see fig. 22.

inflated to form two protruding dorsal vesicles (*h*), beneath which the sclerotic bars (*i*) curve to the sides. The lateral lobes likewise are distended as pair of vesicles (*ll*) at the sides of the phallotreme; but the ventral lobe (*vl*) is not changed from its usual form (fig. 23 H, *vl*).

The phallus of *Neoconocephalus ensiger* (fig. 26 C) resembles that of *Conocephalus fasciatus*. In the retracted condition the organ is scarcely more than a low, oval fold projecting from the genital chamber wall. The dorsal lobe is occupied by a deep, open cavity (*dc*), on the floor of which is a median X-shaped sclerotization (*i*) without projecting points, which is flanked by two large, soft folds (*h*). The phallotreme is a large transverse opening (*Phtr*). The lateral lobes (*ll*) and the ventral lobe (*vl*) are present as usual, but the ventral lobe is very small.

In *Orchelimum minor* the phallus is characterized by the great development of the ventral lobe (fig. 27 B, *vl*), which projects as a large flap from beneath the phallotreme. The shallow dorsal cavity (*dc*) contains two thick lateral folds (*h*), each of which is armed with a long, curved, sclerotic band (*i*) arising on the median side of the fold and curving laterally around its distal end. The sclerites are bifurcate at their terminations, but only the outer points project as

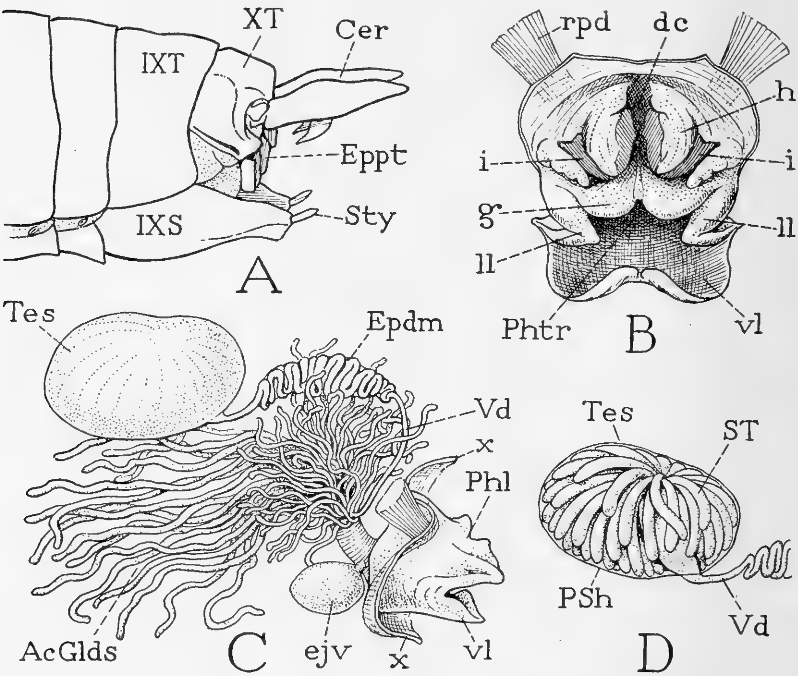

FIG. 27.—Tettigonioidea–Tettigoniidae: male genitalia of *Orchelimum minor* Brunner.

A, end of abdomen, lateral view. B, phallus, posterior view. C, internal genitalia and phallus, lateral view. D, testis and adjoining part of vas deferens. For letter explanation, see fig. 22.

free processes. The posterior margin of the floor of the dorsal cavity forms a wide, bilobed lip (*g*) above the phallotreme, at the sides of which project the triangular lateral lobes (*ll*).

The Decticinae present several important modifications of the phallic structure that are not found in the other tettigoniid families, but which prefigure some of the characteristic features of the phallus in Rhaphidophorinae and Gryllidae. The dorsal cavity of the phallus, for example, is converted into a deep pouch (fig. 22 F, *dc*), apparently by a posterior extension of its anterior margin (D, *e*), which latter thus comes to form a free dorsal fold (F, *e*) at the distal end of the phallus, where its upper surface is reflected into the genital chamber wall above (*x*). Furthermore, the armature of the dorsal cavity takes the form of two processes projecting from the mouth of the cavity.

The decticine type of phallic structure is illustrated by Walker (1922) from *Nebdula carinata.* Walker also regards it as intermediate between the ordinary tettigoniid structure and the rhaphidophorine structure, but he takes the latter to represent the more generalized form. Just the opposite view is adopted here, because there can be no question that the type of structure progressively developed through the Decticinae, Rhaphidophorinae, and Gryllidae

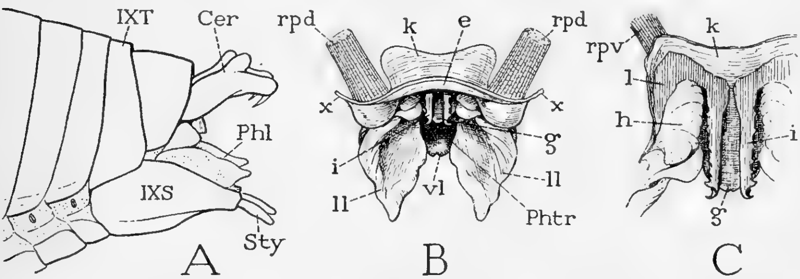

FIG. 28.—Tettigonioidea–Tettigoniidae–Decticinae: external male genitalia of *Anabrus simplex* Haldeman.

A, end of abdomen, lateral view. B, phallus, posterior view, showing also internal pouch (*k*) and muscles exposed before cut wall (*x*-*x*) of genital chamber. C, floor of dorsal phallic pouch and its armature.
For letter explanation, see fig. 22.

is successively more and more removed from the primitive structure of the phallus shown in all nymphal forms.

Anabrus simplex (fig. 28) gives a good example of the decticine type of phallic structure. When the phallus is viewed from behind (B) it appears to consist principally of two large, prominent lateral lobes (*ll*), between which are the mouths of two cavities, one dorsal, the other ventral, separated by a horizontal partition (*g*). The upper cavity, from which projects a pair of serrate, sclerotic arms (*i*), is roofed over by a membranous fold (*e*); the floor of the ventral cavity is formed by the ventral phallic lobe (*vl*). If the phallus is removed from the body, it will be seen that the dorsal cavity ("paramere sac" of Walker) forms a large internal pouch (B, *k*). On opening the membranous dorsal wall of the latter, it is at once evident that the floor of the pouch (C) is the floor of the usual dorsal cavity of the phallus. From it there arise laterally two thick, membranous folds (C, *h*), and closely associated with the base of each fold is a large U-shaped sclerite (*l*), the inner arm of which is prolonged posteriorly as one of the free serrate processes (*i*) above noted. The distal margin of the floor of the dorsal pouch (*g*) forms the upper lip of the phallotreme (B, *Phtr*). That the roof of the dorsal sac is formed by the posterior extension of the anterior margin of the usual dorsal cavity (fig. 22 D, *e*) is shown by the fact that the insertions of the dorsal retractor muscles (fig. 28 B, *rpd*) are carried posteriorly to points laterad of the mouth of the sac. The fold (*e*) forming the upper lip of the dorsal sac is, therefore, not the same as the fold over the base of the dorsal cavity in *Phaneroptera furcata* (fig. 25 D, E, F, *j*), for here the dorsal muscles (E, *rpd*) are attached on the base of the phallus and not on the fold. The rest of the phallus of *Anabrus* (fig. 28 B) has the usual tettigoniid structure. The ventral cavity ("spermatophore sac" of Walker) is the endophallic cavity, the large expanded lobes at its sides (*ll*) are the lateral lobes, and the small median lobe beneath it (*vl*) is the ventral lobe.

There would seem to be no question that the Decticinae are true tettigoniids, since, according to Gerhardt (1913), the spermatophore contains two sperm capsules, as in all other members of the Tettigoniidae.

The mating habits of the Tettigoniidae are well known (See Gerhardt, 1913). The male at first takes a position beneath the female and inserts into the genital chamber of the latter the neck of a large, bilobed spermatophore, the principal part of which hangs outside the vulva (fig. 29 A, *Sphr*), and generally is later eaten by the female. With some species the male assumes a reversed and inverted position before copulation is completed.

The tettigoniid spermatophore (not including that of Rhaphidophorinae) is said by Gerhardt (1913) to contain always two sperm capsules, thus differing from the spermatophores of members of related families, which, so far as known, have but a single capsule. A typical tettigoniid spermatophore (fig. 29 C) consists of two oval, thick-walled sperm capsules (*a*, *a*) more or less enveloped in a bilobed mass of white albumenlike substance (*c*). The two capsules are united on a cylindrical stalk, or neck (*b*), which projects through the outer covering and is inserted into the female genital chamber (A) at the time of copulation. Each capsule contains a relatively small inner cavity (C, *d*) filled with spermatozoa, from which a slender duct enters the base of the spermatophore stalk. In the species here illustrated, *Amblycorypha rotundifolia,* the two primary ducts appear to unite in a single duct (*e*) that traverses the stalk and ends in a free terminal point (*f*). According to Gerhardt, however, the tettigoniid spermatophore characteristically has two separate ducts.

The substances that form the outer and inner parts of the spermatophore are undoubtedly secreted in different sets of the accessory gland tubules of the male. The outer covering is said by Gerhardt to vary in different tettigoniid species from a semifluid, slimy consistency to the more usual, fairly solid texture resembling coagulated egg albumen. The walls of the sperm capsules are dense, laminated, and of

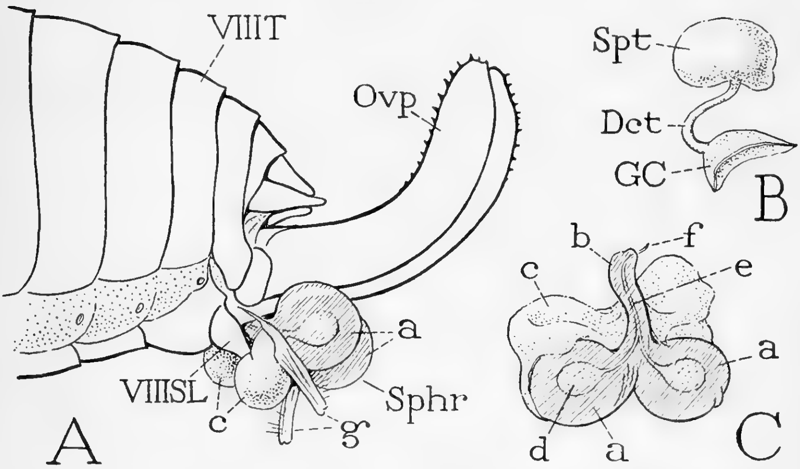

FIG. 29.—Tettigonioidea–Tettigoniidae: female genitalia and a spermatophore of *Amblycorypha rotundifolia* (Scudder).

A, end of abdomen with spermatophore attached. B, spermatheca, duct, and pocket of genital chamber. C, spermatophore.

a, sperm capsules of spermatophore; *b,* stalk of spermatophore; *c,* albuminous covering of spermatophore; *d,* sperm chamber of sperm capsule; *Dct,* duct of spermatheca; *e, f,* duct of spermatophore; *g,* flower bracts adhering to spermatophore; *GC,* pocket of genital chamber receiving spermathecal duct; *Ovp,* ovipositor; *Sphr,* spermatophore; *Spt,* spermatheca; *VIIISL,* subgenital lobe of eighth abdominal sternum.

a brown color. According to Ito (1924) the secretions of the two sets of accessory gland tubules differ in their staining reactions, and the outer covering of the spermatophore shows the staining properties of the secretion of the larger tubules. Gerhardt says also that the secretion taken from the long tubules is clearly the substance of the outer spermatophore covering. The relative size and anterior position of the larger tubes of the accessory glands (fig. 20 A, *a*) would suggest that these tubes furnish the more abundant material and the last to be discharged. The capsular substance of the spermatophore, therefore, is to be referred to the smaller tubules, but where there are several sets of the latter, as in *Phaneroptera furcata* (fig. 20 A, *b, c, d*), it must have either a differentiated structure or a mixed composition.

No studies have been made on the manner by which the tettigoniid spermatophore is formed, but inasmuch as only the necklike stalk is introduced into the genital chamber of the female, it is evident that the sperm capsules at least are produced in the genital tracts of the male. After the capsules are ejected from the endophallus, they are covered by a discharge of gelatinous or albuminous material from the large anterior tubules of the accessory glands.

In effecting copulation with the female, the male tettigoniid, as described by Gerhardt (1913), clasps the female at the base of the ovipositor with his cerci. The phallus is then everted and introduced into the genital chamber of the female. The sperm-containing capsules are now ejected, and, as the male organ is withdrawn, the outer covering of the spermatophore is discharged upon them. While the function of the various parts of the phallic apparatus are not described, it is evident that the exposed structures have no role in the formation of the spermatophore.

Rhaphidophorinae.—In the camel crickets the dorsal cavity of the phallus is entirely closed over by a posterior extension of its anterior margin as in Decticinae (fig. 22 F, *dc*), but the free margin of the covering fold (*e*) is strongly and variously sclerotized, forming a conspicuous plate (fig. 30 B, *e*) arched over the genital opening. The form of this plate (" epiphallus " or " pseudosternite ") is characteristic of different species; Hubbell (1936) says its modifications in structure are of utmost taxonomic value in the study of the genus *Ceuthophilus,* and he gives seven plates illustrating its variations of form in this genus. Most unfortunate it is, therefore, that the sclerite has no appropriate name. The term " pseudosternite ", commonly now given to it, suggests a sternal derivation, which the sclerite in question certainly does not have, and the alternative " epiphallus " would relate it to the sclerite so called in Acrididae (fig. 41 A, *Epph*). The latter is situated dorsally on the base of the phallus, where it is developed in the nymph (fig. 42 D, H, *Epph*). Since the sclerite in Rhaphidophorinae is evidently derived from the basal fold of the dorsal cavity of the phallus (fig. 22 D, F, *e*), it has a certain analogy at least with the epiphallus of Acrididae, and, for want of a better term, is here called the *epiphallus.* The same sclerite is highly developed in Gryllidae.

The dorsal sac of the phallus of Rhapidophorinae lacks the sclerotic armature present in Decticinae, but in place of it there is usually a pair of soft, eversible, fingerlike papillae (figs. 22 F, 30 F, *h*). The usual lateral phallic lobes appear to be absent; the ventral lobe, however, is well developed (figs. 22 F, 30 B, *vl*), and beneath it is a subsidiary ventral fold (*vf*).

In *Ceuthophilus gracilipes* (fig. 30 A) the genital region of the abdomen is concealed above the large hemispherical sternal plate of the ninth segment (*IXS*). When the subgenital sternum is depressed or removed the phallus may be seen projecting from the anterior wall of the genital chamber as a large body (B) with a deep central cavity, the mouth of which is partly occluded by a thick, tonguelike, ventral lobe (*vl*). Arched above the opening is the epiphallus. This structure, as seen from behind (B), presents an elevated, bilobed median part (*e*), with a reflected marginal flange (*o*), which is produced downward at the sides of the phallic opening as two tapering arms. On the dorsal surface of the phallus (C) the epiphallus includes a large median plate (*m*) with divergent basal extensions, and a pair of smaller lateral plates (*n*). There are no lateral phallic lobes, such as those always present in Tettigoniidae, but the ventral lobe (B, D, *vl*) is well developed and projects upward over the mouth of the phallic cavity. Beneath the ventral lobe is an accessory ventral fold (*vf*) of the under wall of the phallus. The phallic mouth leads into an ample, saclike, dorsal cavity (D, *dc*), and a smaller, ventral endophallic cavity (*Enph*), the two separated by the distal margin (*g*) of the floor of the dorsal cavity. From the floor of the dorsal cavity there arises on each side a large, thick, soft fold (*h*), which is probably distended when the phallus is protruded. The inner structure of the phallus of *Ceuthophilus* is thus seen to be the same as that shown diagrammatically at F of figure 22, and is clearly a derivation from the usual tettigoniid type given at D. That the dorsal fold (*e*), containing the epiphallus, is a production of the anterior margin of the dorsal cavity (fig. 22 D, *e*) is evident from the fact that in *Ceuthophilus* the dorsal retractors of the phallus (fig. 30 C, D, *rpd*) are inserted on the epiphallus.

The genitalia of *Ceuthophilus uhleri* (fig. 30 F) are only partially concealed by the ninth abdominal sternum, which here is a large, soft, bilobed structure (*IXS*) little resembling an ordinary sternum. Between the sternal lobes are seen the ventral phallic lobe (*vl*), and below this the edge of the accessory ventral fold (*vf*). Arched over the mouth of the phallus is the epiphallus (*e*), beneath which projects a pair of soft, cylindrical papillae (*h*) that arise on the floor of the dorsal cavity.

Walker (1922) describes the genitalia of *Ceuthophilus lapidicola, C. aridus,* and *C. maculatus,* and Gurney (1936) those of *C. brevipes.*

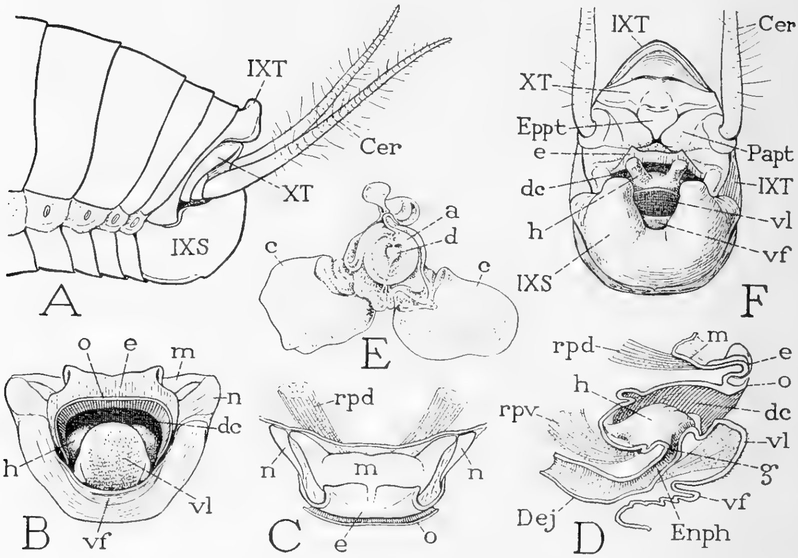

FIG. 30.—Tettigonioidea–Rhaphidophorinae: male genitalia and a spermatophore.

A, *Ceuthophilus gracilipes* (Haldiman), end of abdomen, lateral view. B, same, phallus, posterior view. C, same, phallus, dorsal view. D, same, phallus, median longitudinal section. E, *Diestrammena marmorata* de Hahn, spermatophore (from Gerhardt, 1913). F, *Ceuthophilus uhleri* Scudder, end of abdomen, posterior view.

The following letter explanations apply to figs. 30 to 37 inclusive. *a*, sperm capsule of spermatophore; *aa*, sclerite in base of grooved lobe *v; AcGlds*, accessory glands; *Amp*, mesodermal ampulla of ejaculatory duct; *bb*, apodemes of plate *aa* in base of grooved lobe *v; c*, albuminous lobes of spermatophore; *Cer*, cercus; *Con*, nerve connective; *d*, sperm chamber of spermatophore; *dc*, dorsal cavity of phallus; *dct*, duct of spermatophore; *Dej*, ductus ejaculatorius; *dl*, dorsal lobe of phallus; *e*, anterior margin of dorsal phallic cavity produced posteriorly and sclerotized as the epiphallus; *ejv*, vesicle of ejaculatory duct; *Enph*, endophallus; *Epdm*, epididymis; *Eppt*, epiproct; *g*, posterior margin of floor of dorsal phallic cavity; *Gpr*, gonopore; *Gng*, ganglion; *h*, eversible lobe on floor of dorsal cavity of phallus; *k*, dorsal pouch of phallus; *ll*, lateral lobe of phallus; *m*, proximal plate of epiphallus; *n*, lateral sclerite of epiphallus; *o*, marginal flange of epiphallus; *p*, lateral arm from epiphallus in base of phallus; *Papt*, paraproct; *Phl*, phallus; *q*, median process of epiphallus; *r, s*, lateral processes of epiphallus; *rpd, rpv*, dorsal and ventral retractors of phallus; *sl*, terminal lobe of ninth sternum; *Sphr*, spermatophore; *t*, sclerite in dorsal wall of dorsal phallic pouch; *Tes*, testis; *u*, median grooved fold in wall of dorsal phallic pouch; *v*, grooved rod or lobe serving to guide spermatophore duct; *Vd*, vas deferens; *vf*, ventral fold of phallus; *vl*, ventral lobe of phallus; *w*, phallic mold of attachment plate of spermatophore; *x-x*, cut edge of anterior wall of genital chamber; *XNv, XINv*, nerves of tenth and eleventh abdominal segments; *xt*, arm of tenth tergum; *y*, attachment plate of spermatophore; *z*, pouch of ventral wall of genital chamber.

These species apparently do not differ essentially in their genital structure from the species described above, but on the dorsal surface of the phallus of *C. lapidicola* Walker notes the presence of two small openings leading into a pair of partly glandular tubules. In Gryllotalpidae a single long tube opens in a similar position (fig. 38 B, D, *PhGld*).

In a half-grown nymph of *Ceuthophilus* the phallus is a simple flattened structure, resembling that of a nymphal tettigoniid; it consists of a broad smooth dorsal lobe, and a smaller bilobed ventral lamella, with a flat cavity between them.

Judging from the structure of the male genital organ, the Rhaphidophorinae would appear to be related on the one hand to the Decticinae, and on the other to the Gryllidae. The enclosure of the dorsal sac and the development of an epiphallus on the margin of the covering fold are features highly evolved in the true crickets, though with more important accompanying modifications that set the gryllids entirely apart from the camel crickets. Again, the spermatophore of the rhaphidophorine *Diestrammena* (fig. 30 E), as shown by Gerhardt (1913), is of the gryllid and not of the tettigoniid type, in so far as it contains only one sperm capsule (and the same should be true f other genera since all have the same general structure of the phallus), but the spermatophore otherwise has no resemblance to a typical gryllid spermatophore (figs. 32 F, 35 E), and is covered during copulation with a bilobed mass of albuminous substance as in the tettigoniids, including Decticinae. If we might assume, as Walker (1922) does, that the rhaphidophorine type of phallus is generalized, we could then suppose that the gryllid type has been produced from it by elaboration, and the tettigoniid type by simplification. As already pointed out, however, the nymphal development of the phallus leads directly into the simpler phallic structures found in the Tettigoniidae.

Stenopelmatus fuscus.—*Stenopelmatus* is inserted here not because its genital structures show any close similarity to those of the Rhaphidophorinae, but because they do not include the characteristic genital features of the Gryllidae. The true crickets have a well-developed epiphallus, and the dorsal wall of the dorsal phallic sac bears a distal lobe or long process with associated supporting sclerotizations, which serves to guide the slender duct of the spermatophore into the receptacle of the female. However, *Stenopelmatus* has such general grylloid characters as the close union of the epiproct with the tenth tergum (fig. 31 A), the presence of a dorsal phallic pouch, though the latter is relatively very small (D, *dc*), and the absence of eversible processes or other armature on the floor of the dorsal sac.

On the other hand, a typical epiphallic sclerotization is not present in *Stenopelmatus,* but a pair of long transverse sclerites (B, *p*) are seated on the upper lip of the dorsal phallic sac, and curve laterally and ventrally in the outer walls of the phallus. These sclerites are present in the Gryllidae as lateral arms of the epiphallus (fig. 32 B, *p*).

The nymphal phallus of *Stenopelmatus* (fig. 31 F, G, H) much resembles that of *Cyphoderris* (fig. 21, G, H, I). It is a flattened structure with an undivided basal part, presenting distally a broad dorsal lobe (fig. 31 F, G, *dl*), a pair of tapering lateral lobes (*ll*), and a wide,

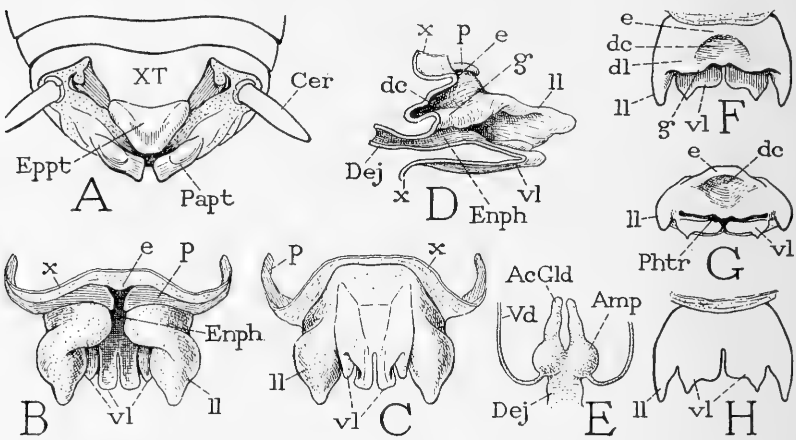

FIG. 31.—Tettigonioidea–Stenopelmatidae: external male genitalia of *Stenopelmatus fuscus* Haldeman.

A, end of abdomen, dorsal view. B, mature phallus, dorsal view. C, same, ventral view. D, same, median section. E, ejaculatory duct and ampullae of nymph. F, G, H, immature phallus, dorsal, posterior, and ventral views.

For letter explanation, see fig. 30.

medially subdivided ventral lobe (H, *vl*). The dorsal lobe shows on its upper surface a slight but distinct median depression (F, G, *dc*), which is the beginning of the dorsal cavity. In the mature phallus the dorsal cavity becomes a small pocket (D, *dc*) between the extended anterior margin of the dorsal lobe (D, *e,* cf. F, *e*) and the retracted posterior margin (*g*). The lateral lobes of the mature organ are large, soft, folded structures (B, C, D, *ll*), suggestive that they serve to hold the body of a spermatophore. The ventral lobe (C, *vl*) is flat and subdivided into four parts. The small endophallic cavity (D, *Enph*) is directly continuous with the ejaculatory duct (*Dej*). In a late nymphal stage the short ejaculatory duct is surmounted by two small globular ampullae (E, *Amp*), each of which is produced into a single diverticulum (*AcGld*), evidently a rudiment of the definitive accessory gland tubules.

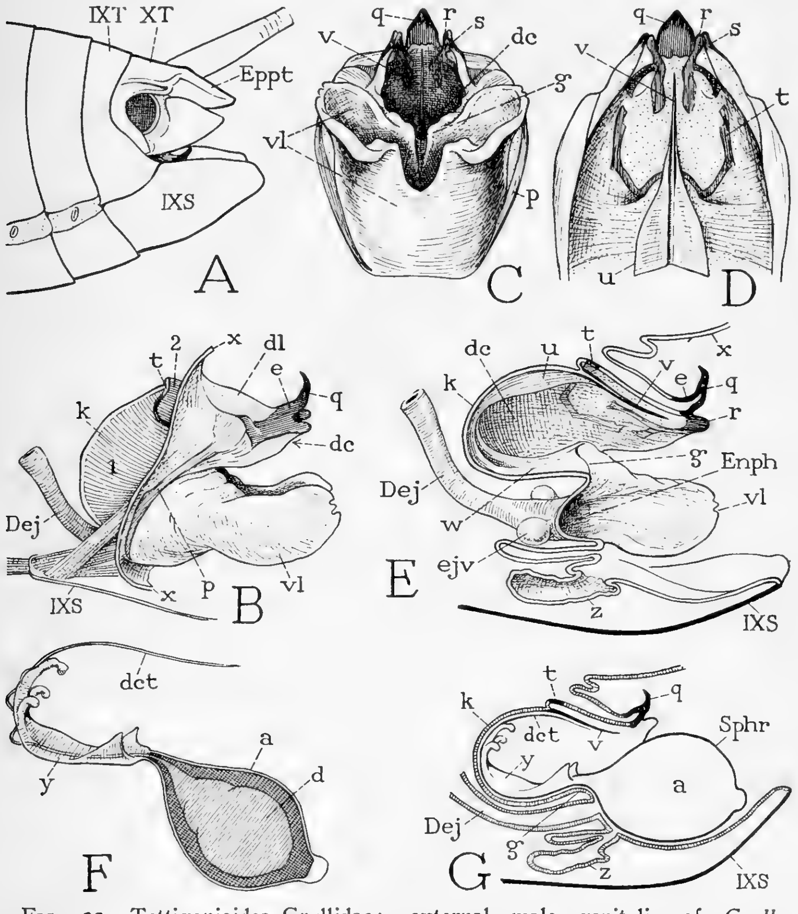

FIG. 32.—Tettigonioidea–Gryllidae: external male genitalia of *Gryllus assimilis* Fabricius.

A, end of abdomen, lateral view. B, phallus, lateral view, showing ectophallus to right of anterior wall of genital chamber (*x-x*), and internal parts to left. C, phallus, ventral view. D, distal part of dorsal wall of dorsal cavity of phallus (C, *dc*), ventral view. E, semidiagrammatic median section of phallus and ninth abdominal sternum. F, spermatophore. G, spermatophore in phallus.
For letter explanation, see fig. 30.

Gryllidae.—Characteristic of this family, in the terminal structure of the abdomen, is the union of the epiproct with the tenth tergum (figs. 32 A, 35 A, 36 A). The phallus attains a highly specialized form, which is an extreme modification of the tettigoniid type of phallic structure, and is entirely an adaptation of the latter to the formation of the gryllid type of spermatophore and the insertion of the tip of the spermatophore duct into the spermathecal aperture of the female. The gryllid spermatophore (fig. 32 F) contains a single, large sperm capsule (*d*), and has a long, slender duct (*dct*), at the base of which is usually an irregular plate (*y*) for attachment in the genital chamber of the female. A more generalized condition of the phallic structure is found in *Gryllus* and *Gryllodes*, the opposite extreme occurs in *Nemobius*. The nymphal development of the genital organs shows that the phallus of the crickets is formed from the usual dorsal and ventral phallic lobes only, lateral lobes being absent, and that the principal modifications pertain to the dorsal lobe, on which an epiphallic sclerotization is highly developed. The dorsal cavity (fig. 32 E, *dc*) is entirely concealed beneath the posteriorly extended epiphallic region (*e*), and the ventral endophallic cavity (*Enph*) is enclosed by the ventral lobe (*vl*), which, in *Gryllus* and *Gryllodes*, is subdivided into two large lateral valves. The spermatophore and its duct are molded in the two cavities of the phallus (G).

The phallus of *Gryllus assimilis* (fig. 32 B) presents externally a large dorsal lobe (*dl*) capped by the epiphallus (*e*), and a soft ventral lobe (B, C, *vl*) divided into two valvelike lateral flaps, the form and size of which may be quite different in different specimens according to the state of expansion or the presence or absence of a spermatophore. The sclerotic epiphallus is produced into a broad, recurved median lobe (B, C, *q*), and two lateral lobes each subdivided into two points (*r, s*). From the dorsal epiphallic plate (B, *e*) a long arm (*p*) extends downward on each side in the base of the phallus. Beneath the epiphallus is the entrance to the dorsal cavity (B, C, *dc*), which latter extends forward as a large, thin-walled pouch (B, E, *k*). The ventral lip of the pouch (E, *g*) lies far anterior to the epiphallic extension of the dorsal lobe, but its position in *Gryllus* is relatively the same as in *Ceuthophilus* (fig. 30 D, g). *Gryllus* thus differs from *Ceuthophilus* in the greater development of the epiphallus, and in the enlargement of the pouchlike dorsal phallic cavity; but it should be noted also that in *Gryllus* (as in all members of the Gryllidae) there are no eversible lobes or other armature arising from the floor of the dorsal cavity corresponding with the structures here located in Tettigoniidae and Rhaphidophorinae (fig. 22 D, F, *h, i*). The endophallic cavity of *Gryllus* (fig. 32 E, *Enph*) is enclosed by the proximal part of the ventral lobe of the phallus (*vl*), and is directly continuous with the wide terminus of the ejaculatory duct (*Dej*). The floor of the genital chamber beneath the phallus is inflected to form a large median pouch (*z*).

The musculature of the phallus comprises intrinsic muscles of the dorsal pouch (figs. 32 B, 34 D, *1*, *2*) and the ventral lobe, and several pairs of extrinsic muscles. The latter (fig. 34 D) include two pairs of muscles arising from the anterior angles of the ninth abdominal sternum, one pair (*3*) inserted on the lower ends of the lateral sclerites in the base of the phallus, the other (*4*) on the base of the lateral walls of the dorsal lobe. Dorsal phallic muscles from the tenth tergum, such as are present in the tettigoniids, appear to be absent in *Gryllus*. The phallus is innervated from a nerve trunk (D, *XNv*) that branches from the base of the large cercal nerve (*XINv*), and appears to belong to the tenth abdominal segment, since it certainly does not pertain to either the ninth or the eleventh segment.

The dorsal phallic pouch of *Gryllus assimilis* has a thin, membranous inner wall, but it is covered externally by a muscular sheath of transverse fibers (figs. 32 B, 34 D, *1*). Though, as above noted, it has no armature arising from its floor as in Tettigoniidae and Rhaphidophorinae, it has other structures adapting it to its function of forming and holding the spermatophore and inserting the spermatophore duct. On the floor of the pouch is a thickened median plate (fig. 32 E, *w*), having its proximal angles at the ventral lip of the pouch (*g*) produced as a pair of triangular lateral expansions, and its distal part furrowed by a median depression and two lateral grooves. The distal end of the plate is continued in a troughlike fold (*u*) with a median groove that extends upward and then posteriorly in the anterior and dorsal walls of the pouch, and ends with a long, free, tapering, virgalike rod (E, D, *v*) that projects from the wall of the pouch beneath the epiphallus. The axial groove of the fold is continuous from the distal depression of the ventral plate to the tip of the terminal rod (D, *v*). The base of the rod is supported by a W-shaped sclerite in the dorsal wall of the pouch (figs. 32 B, D, 34 D, *t*), on the median part of which is inserted a pair of broad muscles (fig. 34 D, *2*) converging from the lateral parts of the epiphallus. The inner structures of the dorsal sac are clearly the molds of the attachment plate and the duct of the spermatophore, since the shape and contour of the attachment plate (fig. 32 G, *y*) fit exactly the form and depressions of the ventral plate of the pouch, and the long, recurved, tapering duct of the spermatophore (*dct*) follows the groove of the fold (D, *u*) and the terminal rod (*v*).

Walker (1922) in his description of the phallic structure of *Gryllus* calls the dorsal cavity the " spermatophore sac ", though he observes that it would appear at first sight that the dorsal sac of *Gryllus* is the paramere sac (i. e., dorsal sac) of Tettigoniidae. This view, which

Walker discards, seems to the writer the only logical interpretation of the gryllid structure, since the latter is so clearly but an adaptation of the structure of the phallus in *Ceuthophilus* (fig. 30 D), which in turn is derived from the more primitive tettigoniid structure (cf. figs. 22 D and F with fig. 32 E).

The endophallic cavity, together with the space between the lateral flaps of the ventral phallic lobe and the floor of the genital chamber, forms the mold of the large, oval ampulla of the spermatophore (fig. 32 G, *a*). When the fully formed spermatophore is still in place within the phallus, the ampulla is almost entirely enclosed by the flaps of the ventral lobe, and the mouth of the ejaculatory duct (*Dej*) is pressed close against the anterior part of its ventral surface; the narrow neck connecting the ampulla with the attachment plate (*y*) curves over the lower lip (*g*) of the dorsal sac and expands upon the ventral plate of the latter.

The development of the phallus of *Gryllus* can be followed in the nymph, but the phallic development of each instar begins in the preceding instar long before there is any evidence of ecdysis on other parts of the body. On removal of the cuticula from the genital region of any instar there is hence usually found beneath it the phallus of the next instar, which already has taken on quite a different form. In a half-grown male nymph (fig. 33 A) the phallic rudiments are slightly embossed on an oval area of the genital chamber wall (B); they include a pair of oval dorsal swellings (*dl*), a pair of similar ventral swellings (*vl*), and a somewhat depressed central disk (*dc*) with a faint median groove. At the lower end of the last is the gonopore rudiment (*Gpr*). By removing the cuticula there will probably be exposed the phallus of the next instar developing beneath it (C). At this stage the dorsal elevations are united in a large dorsal lobe (*dl*) with a prominent median projection (*q*), which will become the median lobe of the epiphallus of the adult (fig. 32 C, *q*). The ventral swellings of the preceding instar (fig. 33 B, *vl*) are likewise united to form an emarginate ventral lobe (C, *vl*). The central area is still more depressed, but shows no distinction between a dorsal cavity and a ventral cavity. At a later stage (D, E) the dorsal lobe is clearly taking on the form of the epiphallus of the adult, and a thick, tapering grooved process (*v*) projects from the dorsal wall of the median depression below it. Again, by removal of the cuticula, there is exposed the phallus of the succeeding instar (F), which is perhaps the beginning of the imago, for the organ now has distinctly adult characters. The epiphallus has become differentiated into three apical lobes, and the ventral process (*v*) has taken the form of a slender rod arising from a flaring base. Proximal to the latter is the mouth of a deep dorsal cavity (*dc*), the ventral lip of which (*g*) appears as a septum between the upper cavity and a lower endophallic cavity above the ventral lobe (*vl*). The ventral lobe itself is much enlarged, deeply cleft, and has several marginal lobules. Whether a stage intervenes between this one (F) and the fully mature adult (fig. 32 C) was not determined, but the specimen appeared to be a pre-imaginal nymph.

The internal reproductive organs of the male cricket (fig. 34 A) are characterized by the large size of the testes, the relatively uniform

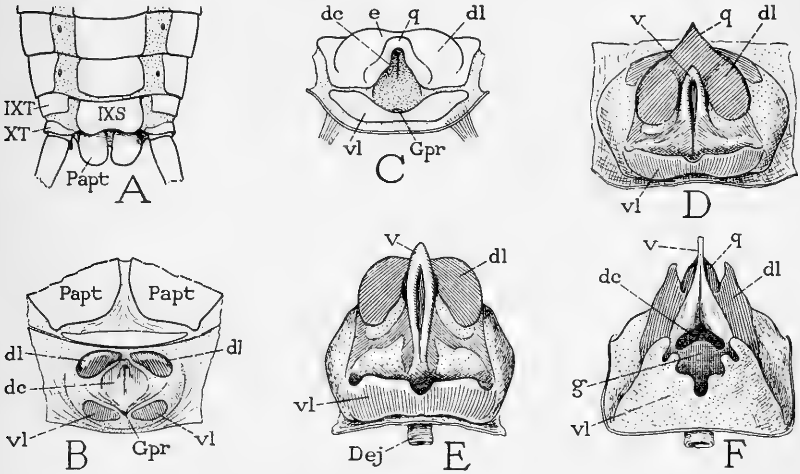

FIG. 33.—Tettigonioidea–Gryllidae: nymphal development of the phallus of *Gryllus assimilis* Fabricius.

A, half-grown nymph in premoulting condition, end of abdomen, ventral view. B, same, phallic rudiments in genital chamber wall beneath bases of paraprocts, posterior view. C, phallus of succeeding instar exposed by removal of cuticula from B, posterior view. D, phallus of later nymphal instar, posterior view. E, same, ventral view. F, phallus of succeeding instar (perhaps immature adult) exposed by removal of cuticula from E, ventral view.

For letter explanation, see fig. 30.

size of the accessory gland tubules, and the absence of sperm vesicles. The mature testes (*Tes*) lie against the lateral and dorsal walls of the second, third, and fourth abdominal segments, where they overlap the rear end of the crop, and almost meet along the midline of the back. Each testis consists of a large number of slender sperm tubules (B), approximately 280, according to Spann (1934), which overlie one another in concentric layers diverging posteriorly from the anterior end of the testis, and are enveloped in a delicate peritoneal sheath. The tubules discharge through narrow efferent ducts into the enlarged intra-testicular part of the vas deferens. Beyond the testis the vas deferens takes a straight course to the ninth abdominal segment, where it loops beneath the large cercal nerve (A, *XINv*), and then turns forward to enter the mass of accessory gland tubules. Here it becomes much thickened and forms a compactly coiled epididymis (C, *Epdm*), beyond which it again tapers to a narrow tube and opens ventrally into the ejaculatory duct near the bilobed anterior end of the latter.

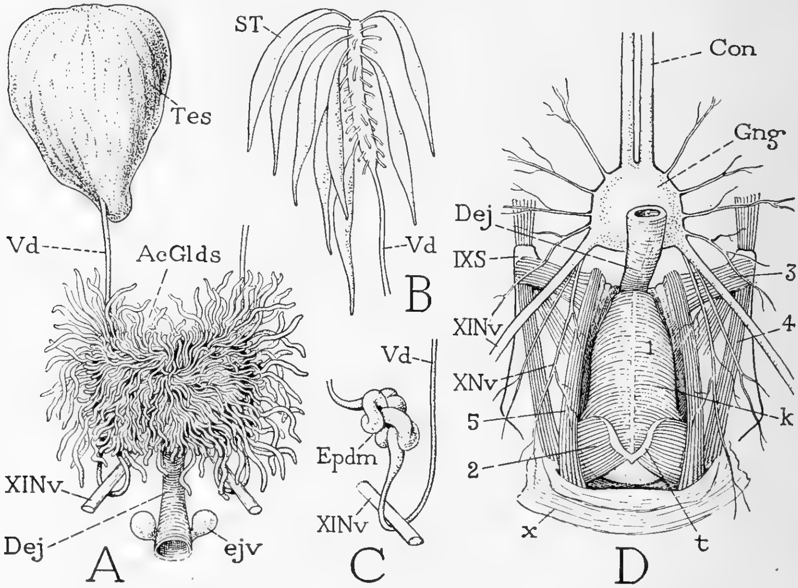

Fig. 34.—Tettigonioidea–Gryllidae: internal male genitalia of *Gryllus assimilis* Fabricius.

A, general view of internal reproductive organs, dorsal view. B, anterior intratesticular part of vas deferens and group of sperm tubes. C, posterior loop of vas deferens beneath nerve to cercus, right side, dorsal view. D, dorsal pouch of phallus (*k*) invaginated into body cavity, the phallic muscles, and associated last ganglion of ventral nerve cord, dorsal view.

For letter explanation, see fig. 30; for muscles, see text, page 81.

The accessory glands consist of a mass of slender tubules arising from the bilobed anterior end of the ejaculatory duct (fig. 34 A, *AcGlds*). The dorsal tubules are somewhat smaller than the lateral and more ventral tubules. The smaller tubules, according to Spann (1934), have a glassy appearance because of their clear granular secretion, which takes a nuclear stain, while the larger tubules have a milky-white secretion, which coagulates readily on exposure to air, and takes a cytoplasmic stain. The parts played by the products of the two sets of glands in the formation of the spermatophore will be noted presently. The ejaculatory duct (A, *Dej*) is a wide muscular tube that turns downward between the last ganglion of the ventral nerve cord and the dorsal sac of the phallus (D, *Dej*); it then goes posteriorly and enlarges at its opening into the endophallic cavity (fig. 32 E). A pair of oval lateral vesicles (*ejv*) opens into the extreme end of the duct.

The spermatophore of *Gryllus assimilis* (fig. 32 F) consists of a thick-walled, ovate or pear-shaped ampulla (*a*), of an elongate attachment plate (*y*) connected with the apex of the ampulla by a narrow neck, and of a slender recurved duct (*dct*) that traverses the plate and extends far beyond it. The wall of the ampulla, as observed by Spann (1934), contains three distinct layers. The innermost layer forms a distinct but thin-walled capsule (*d*) containing the spermatozoa; the middle layer is thick, hard, and usually dark yellow or brown in color; the outer layer is a thin, transparent external covering, which at the posterior end of the ampulla forms a small vesicular papilla. The middle layer, according to Spann, takes cytoplasmic stains and thus shows that its material must be derived from the larger milky tubules of the accessory glands; the outer and inner layers, on the other hand, take nuclear stains, and hence must be formed from the secretion of the smaller clear tubules. The attachment plate of the ampulla is pale or translucent, and its substance, Spann says, shows the same staining reactions as the outer and inner coats of the ampulla; the hard, dark middle layer of the ampulla does not extend into the pliable attachment plate. The extremity of the duct, when the spermatophore is taken from the male, Spann claims, is normally closed, but if the tip is broken off the spermatozoa flow out from it; the inner capsule of the ampulla is then seen to collapse within the more rigid outer walls as air diffuses through the latter to occupy the space around the shrinking capsule. The liberation of the sperm during copulation, Spann suggests, is probably accomplished by a dissolving of the end of the duct in the spermathecal passage. The spermatophore is then emptied of spermatozoa in from 45 minutes to an hour. According to Baumgartner (1911), however, the sperm automatically flows out of the tip of the duct when the spermatophore is placed in normal salt solution, and the capsule may be emptied in 15 minutes, but whether the tip was presumably perfect or not Baumgartner does not say.

The mating habits of *Gryllus* and *Liogryllus,* the structure of the male genital organs and the spermatophore, have been described by Lespés (1855, 1855 a), Baumgartner (1911), Gerhardt (1913), and Regan (1924). At the time of mating, the male takes a position below the female. Copulation is said to be effected by the thrusting of the epiphallic armature into the genital chamber of the female; probably the median recurved hook (fig. 32 B, *q*) holds in the fold of soft tissue on the floor of the genital chamber posterior to the gonopore, while the tip of the rod (G, *v*) carrying the spermatophore duct is inserted into the spermathecal opening, situated on the end of a thick process projecting downward and backward from a pouch in the dorsal wall of the genital chamber (see Snodgrass, 1933, figs. 18, 19). A contraction of the muscular sheath of the dorsal sac of the phallus

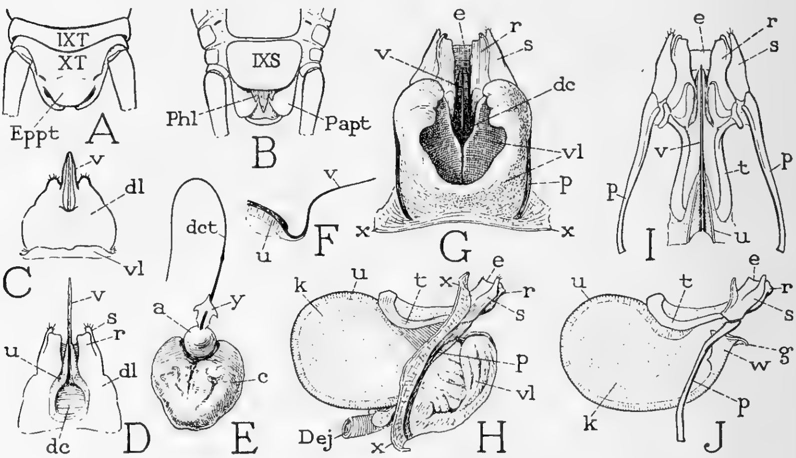

FIG. 35.—Tettigonioidea–Gryllidae: external male genitalia and spermatophore of *Gryllodes sigillatus* (Walker).

A, adult, end of abdomen, dorsal view. B, late nymphal instar (full-grown), end of abdomen, ventral view. C, same, phallus, removed from genital chamber, ventral view. D, phallus of succeeding instar (probably immature adult) taken from within cuticula of C. E, spermatophore, dorsal view. F, end of guide rod (G, I, *v*) for spermatophore duct. G, mature phallus, ventral view. H, same, lateral view, showing ectophallic parts to right of genital chamber wall (*x-x*), and internal parts to left. I, distal part of dorsal wall of dorsal pouch of phallus, together with epiphallic lobes (*e, r, s*) and basal ectophallic sclerites (*p*), ventral view. J, epiphallus and dorsal pouch of phallus, lateral view.

For letter explanation, see fig. 30.

would now protract the spermatophore duct from the guiding rod, and also force out the attachment plate (fig. 32 G, *y*), which latter, being inserted into the genital chamber of the female, holds the duct in place, and supports the ampulla, which hangs from the neck of the plate mostly outside the genital chamber. After copulation the female carries the spermatophore a varying length of time, but eventually removes it with her jaws or by rubbing against the ground.

Gryllodes sigillatus (fig. 35) presents the same type of structure in the genital parts as does *Gryllus,* though there are distinctive minor differences between the two forms. The epiphallus of *Gryllodes* (G, H, I, *e*) lacks the median recurved process of *Gryllus,* but the two lateral epiphallic lobes (*r, s*) are well developed. In the nymphal phallus (B, *Phl*) the large dorsal lobe (C, *dl*) ends in three terminal processes, but the median one (*v*) represents the ventral rod of the adult (I, *v*) that guides the spermatophore duct. An intermediate stage is shown at D, which was taken from within the cuticle of C, and probably represents the beginning of the imaginal instar. The median process is here a slender rod (*v*) at the base of which is forming the dorsal cavity (*dc*) on the under surface of the dorsal lobe. The ventral lobe of the phallus is a small, inconspicuous fold in the nymph (C, *vl*) beneath the base of the dorsal lobe, but in the adult it becomes much enlarged, deeply emarginate, and is ordinarily irregularly folded against the posterior surface of the phallus (H, *vl*). When a spermatophore is present in the phallus, however, it is almost completely embraced by the expanded lateral halves of the ventral lobe (G, *vl*), which enclose a large oval cavity in which is held the body of the spermatophore (E).

The spermatophore of *Gryllodes sigillatus* is similar in shape to that of *Gryllus,* but structurally quite different in some respects. The sperm capsule is a small spherical ampulla (E, *a*) attached by a sunken neck to the upper surface of a large oval supporting body (*c*). A long, slender, recurved duct (*dct*) extends anteriorly from the capsule, and at its base is a small attachment plate (*y*). The single example of the spermatophore was obtained from a male specimen in alcohol. Before removal, the oval body of the spermatophore was held in the pocket of the ventral lobe of the phallus (G, *vl*), the sperm capsule projected dorsally before the mouth of the dorsal phallic cavity (*dc*), and the curved duct followed the median groove of the latter into the ventral channel of the guide rod (*v*). The dorsal sac of the phallus is oval and compressed (H, J, *k*); its lateral walls are formed of a thin, transparent membrane, but are covered by a muscular sheath (not shown in the figures) as in *Gryllus.* At the mouth of the sac, just within the ventral lip (J, *g*) is the mold (*w*) of the relatively small attachment plate of the spermatophore (E, *y*), and from the mold is continued the grooved channel (H, I, J, *u*) to the guide rod (I, *v*). The rod, as seen in lateral view (F), is abruptly curved upward at its base, and then goes posteriorly. The base of the rod is supported by a large, U-shaped sclerite (H, I, J, *t*) in the dorsal wall of the dorsal sac, on which are inserted protractor muscles from the sides of the epiphallus (H).

The genitalia of *Oecanthus* have been described by Walker (1922), who shows that they differ from those of *Gryllus* only in a few unimportant details. The spermatophore of *Oecanthus pellucens* is described and figured by Boldyrev (1913 a), Gerhardt (1914), and Hohorst (1937). It resembles the spermatophore of *Gryllus* except in the small size of the "attachment plate" and in the greater thickness of the duct, but Gerhardt and Hohorst show that the plate in the case of *Oecanthus* does not enter the genital chamber of the female, and that the spermatophore is held in place entirely by the duct, which, according to Hohorst, is armed near its tip with a small brush of short bristles. While the spermatophore lies within the phallus the duct is recurved above the ampulla as in *Gryllus*, but after its ejection and insertion in the female the duct is straightened out, as shown in figures by Gerhardt and Hohorst.

A quite different type of phallic structure occurs in *Nemobius*, but it is one clearly derived from that of *Gryllus* and *Gryllodes*. In *Nemobius fasciatus* (fig. 36) the epiphallic margin of the dorsal phallic lobe (F, *e*) has been carried so far back, and the ventral lobe (*vl*) set so far forward, that the dorsal cavity (*dc*) is flattened out until it appears as a shallow depression on the *ventral* side of the dorsal lobe (C, F, *dc*), and the endophallic cavity (*Enph*) comes to lie in front of it above the ventral lobe (*vl*). The two cavities are separated by a U-shaped fold (*g*), which represents the originally posterior lip of the dorsal cavity. The dorsal cavity of the phallus has thus undergone a complete inversion in *Nemobius*, since it now occupies the ventral surface of the dorsal lobe, where it is entirely exposed on removal of the ninth sternum from beneath it (C, *dc*).

When the phallus of *Nemobius* is viewed from above (fig. 36 B), the epiphallic surface of the dorsal lobe is seen to have the form of a long truncate cone with a large V-shaped sclerite (*m*) in its basal half, and a weakly sclerotized, deeply emarginate distal area (*e*). At the sides are two elongate sclerites (*p*) ending distally in two pairs of strong lateral processes (*r*, *s*), and a pair of ventrally convergent mesal processes. The ventral surface of the dorsal lobe (C), as seen by removal of the ninth sternum, presents a long, shallow median depression (*dc*), which is the inverted dorsal cavity, limited anteriorly by the U-shaped fold (*g*) above noted, which corresponds with the ventral lip of the dorsal cavity in *Ceuthophilus, Gryllus,* and *Gryllodes* (figs. 30 D, 32 E, 35 J, *g*). An elongate plate on the floor of the cavity tapers distally into a groove between the halves of a soft, globular, median lobe (*v*). Since the duct of the spermatophore passes through this groove, the cleft lobe evidently represents the virgalike rod of *Gryllus* and *Gryllodes* that guides the end of the spermatophore duct. The lobe is set somewhat back from the extremity of the epiphallus (F, *v*), and in its base dorsally is a transverse sclerite (E, F, *aa*), from which a pair of apodemal arms (E, *bb*) projects into the body cavity above the wall of the dorsal phallic cavity. The inner

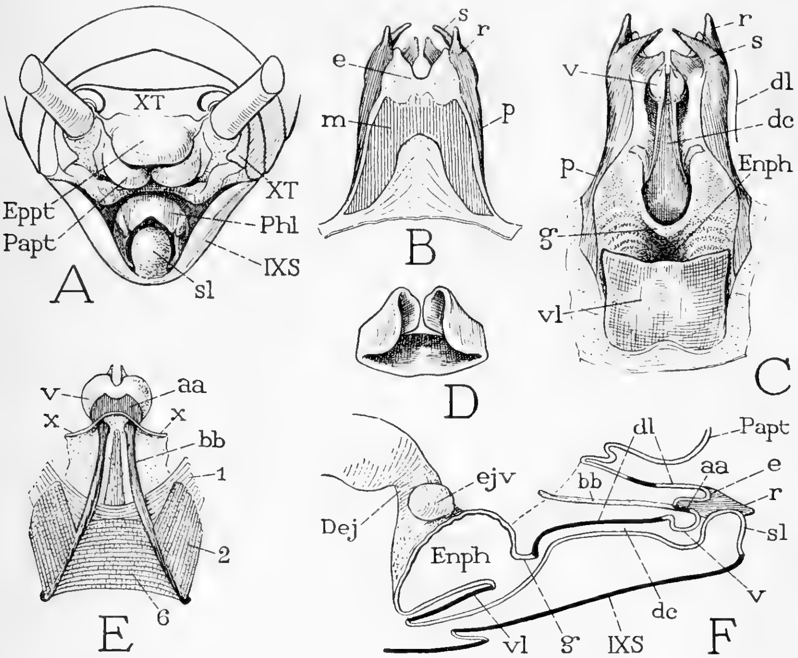

FIG. 36.—Tettigonioidea–Gryllidae: external genitalia of *Nemobius fasciatus* (Degeer).

A, end of abdomen, posterior view. B, epiphallus, or exposed dorsal wall of dorsal lobe of phallus, dorsal view. C, phallus, ventral view, showing dorsal cavity (*dc*) open ventrally beyond ventral lobe (*vl*). D, ventral lobe of phallus, posterior view, showing inflected margins. E, distal part of dorsal wall of dorsal cavity of phallus, and free guide lobe (*v*) for spermatophore duct, dorsal view. F, diagrammatic median section of phallus, base of paraproct (*Papt*), and ninth abdominal sternum (IXS).

For letter explanation, see fig. 30.

ends of the apodemes are connected by a broad sheet of muscle fibers (*6*), and on each apodeme is inserted laterally a strong muscle (*2*) from the lateral sclerites of the epiphallus. The apodemes and the supporting plate, therefore, must represent the sclerite of the wall of the dorsal sac in *Gryllus* and *Gryllodes*. Beneath the apodemes and their muscles are the usual transverse muscles (*1*) of the wall of the dorsal cavity.

Proximal to the anterior lip (*g*) of the dorsal cavity is the deep, pouchlike endophallic cavity (C, F, *Enph*), the soft walls of which are thrown into rugose folds. The endophallus is mostly closed below by the wide, quadrate ventral lobe (*vl*), which, when viewed endwise (D), is seen to have its lateral margins inflected as two broad flaps. The ejaculatory duct (F, *Dej*) opens by a funnel-shaped enlargement directly into the endophallic cavity.

In the normal position of the genital parts of *Nemobius* the ninth abdominal sternum entirely conceals the phallus from below (fig. 36 A); a high median fold of its dorsal surface fits closely into the cavity on the ventral surface of the dorsal phallic lobe (F), and a soft end lobe of the sternum (*sl*) plugs the entrance to the dorsal cavity between the terminal processes of the epiphallus (A, *sl*).

The spermatophore of Nemobius resembles that of *Gryllus* in that it consists of a sperm-containing ampulla with a long recurved duct, but the attachment plate appears to be an expansion of the duct near its distal end (see Lespés, 1855; Gerhardt, 1913; Baumgartner, 1911; Fulton, 1931). The spermatophore of *Nemobius fasciatus* is described by Fulton as having a spherical ampulla about $1\frac{1}{3}$ mm in diameter, and a flattened curved tubular duct about $2\frac{1}{2}$ mm long with an expanded part near the recurved tip. By comparison with *Gryllus* it would seem that the ampulla of the spermatophore of *Nemobius* must be molded likewise in the endophallic cavity, and the duct formed in the median channel of the dorsal cavity (fig. 36 C, F). Fulton gives a figure showing the walls of the dorsal cavity of the phallus evaginated in the form of a large, grooved fold with the ampulla hanging free from its lower end, and the duct lying in the groove of the fold. He describes the formation of the duct in the groove as it appears when the spermatophore is first seen on the male, but this stage must be after the ampulla has been formed in the endophallus and ejected from the latter. The end of the duct at the time of its insertion into the female is probably held in the slot of the terminal lobe of the dorsal cavity (fig. 36 C, *v*) between the epiphallic processes. The spermathecal aperture of *Nemobius,* as in *Gryllus,* is situated on the end of a small knoblike papilla of the dorsal wall of the genital chamber, and Fulton observes that this knob " is about the right size to be grasped by the male claspers (epiphallic armature), which would bring the tip of the spermatophore tube to the hole in the apex of the knob."

The development of the phallus of *Nemobius* is somewhat simpler than that of *Gryllus,* and leaves little doubt that the grillid organ is a modification of the more generalized phallic structure of the Tettigoniidae. In a young nymph of *Nemobius fasciatus,* in which the hind wings do not yet project from the margin of the metatergum, and the subgenital sternum is not enlarged (fig. 37 A), the phallus is a small, simple lobe in the genital pocket above the ninth sternum (B). With its base is connected a pair of slender ventral extensions (*xt*) of the tenth tergum (C), suggestive that the phallus is primarily a derivative of the tenth segment and not of the ninth. The phallic

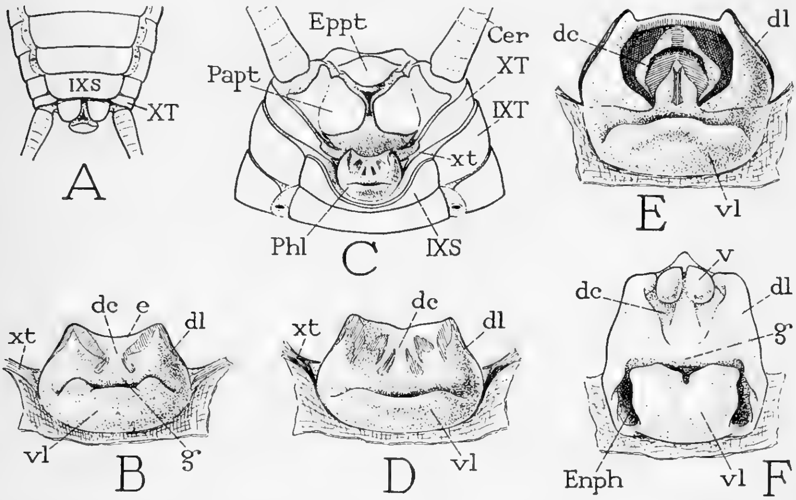

FIG. 37.—Tettigonioidea–Gryllidae: nymphal development of the phallus of *Nemobius fasciatus* (Degeer).

A, young wingless nymph, end of abdomen, ventral view. B, same, phallus, ventral view. C, older nymph with hind wings reaching to end of first abdominal tergum, end of abdomen with subgenital plate (*IXS*) partly removed to expose phallus (*Phl*), postero-ventral view. D, same, phallus, ventral view. E, phallus of nymph with hind wings reaching almost to fifth abdominal tergum, ventral view. F, phallus of succeeding instar (perhaps immature adult) exposed by removal of cuticula from E.

For letter explanation, see fig. 30.

rudiment consists of a thick dorsal lobe (B, *dl*), and a short, wide ventral lobe (*vl*). The distal surface of the dorsal lobe presents a shallow depression (*dc*), which is the beginning of the dorsal cavity, the exposed position of which suggests its identity with the dorsal phallic cavity of Tettigoniidae. At a somewhat later stage, when the hind wings extend to the end of the first abdominal tergum, the phallus has changed but little in structure (C, D); but when the wings reach to the fifth abdominal segment, the phallus (E) begins to show some of the adult modifications. If the specimen is in a premoulting condition, and the cuticula is removed, the organ exposed within (F) is so distinctly of the imaginal type of structure (fig. 36 C) that there is no question of the identity of the parts.

Gryllotalpidae.—The abdomen of *Gryllotalpa* has a simple, rounded posterior end (fig. 38 A). The ninth segment is short above and

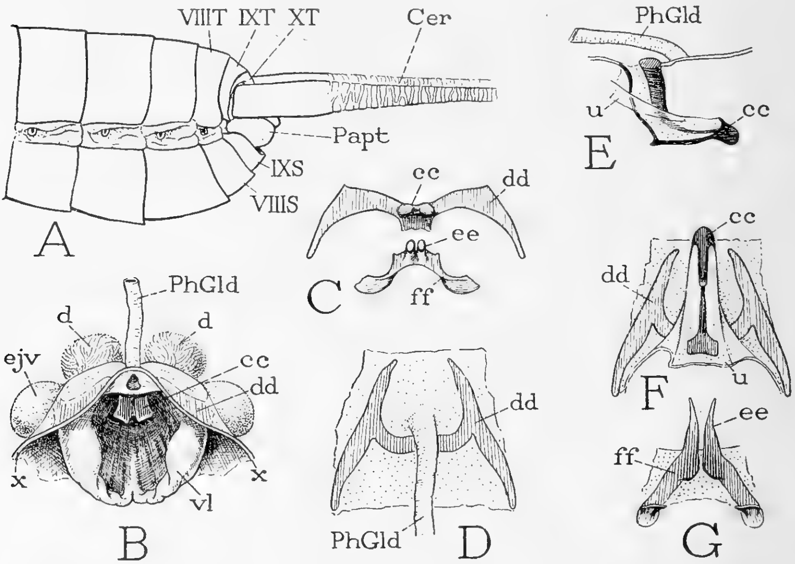

FIG. 38.—Tettigonioidea–Gryllotalpidae: external male genitalia of *Gryllotalpa* and *Scapteriscus.*

A, *Gryllotalpa hexadactyla* Perty, end of abdomen, lateral view. B, same, phallus and associated internal structures, dorsal view. C, same, sclerites in dorsal wall of phallic cavity, ventral view. D, *Scapteriscus vicinus* Scudder, dorsal wall of phallic cavity, and terminus of phallic gland, dorsal view. E, same, distal process of dorsal wall of phallic cavity, and terminus of phallic gland, lateral view. F, same, distal process of phallic cavity, and supporting sclerite, ventral view. G, same, proximal processes of dorsal wall of phallic cavity, ventral view.

cc, distal process of dorsal wall of phallic cavity; *Cer,* cercus; *d,* mass of small accessory glands (see fig. 39 A); *dd,* sclerite in dorsal wall of phallic cavity; *ee,* proximal processes in dorsal wall of phallic cavity; *ejv,* vesicle of ejaculatory duct; *ff,* supporting sclerites of proximal processes (*ee*); *Papt,* paraproct; *PhGld,* phallic gland; *u,* fold of wall of phallic cavity; *vl,* ventral lobe of phallus; *x-x,* cut edge of anterior wall of genital chamber.

below, the sternum (*IXS*) not being enlarged as a subgenital plate. The lateral angles of the small tenth tergum (*XT*) extend above the bases of the long, tapering cerci. The epiproct is free from the tenth tergum, and together with the paraprocts forms a small conical proctiger.

The male genital organ of *Gryllotalpa hexadactyla* is ordinarily concealed above the ninth abdominal sternum, and has a very simple structure. As exposed by depressing the ninth sternum (fig. 38 B), the phallus appears as a large, rounded, thick-lipped, membranous fold (*vl*) with a concave upper surface that leads into a deep pouch above it. There is no epiphallic sclerotization, and the dorsal lip of the pouch is reflected directly into the dorsal wall of the genital chamber (*x-x*), but on it there opens a long, median, tubular phallic gland (figs. 38 B, 39 A, *PhGld*). From just within the dorsal lip of the phallic pouch a strong, median, flattened, bilobed process (fig. 38 B, *cc*) projects downward from the dorsal wall, in which it is supported by a wide, transverse sclerite (B, C, *dd*). This sclerite and its median process are termed the "ancre" by De Saussure and Zehntner (1894); Walker (1922) regards it as the "pseudosternite" (epiphallus), but its shape in *Scapteriscus* (E) suggests rather a homology with the guide of the spermatophore duct in *Gryllus.* Concealed in front of the median process, when viewed from behind, and closely appressed to its anterior surface, is a pair of peglike processes (C, *ee*) supported on a second and smaller plate (*ff*) in the dorsal wall of the phallic cavity. These processes are the "titillators" of De Saussure and Zehntner; they are generally longer and slenderer than in *G. hexadactyla* (G). Anterior to the second sclerite the dorsal wall of the phallic pouch presents a median depression, and the ejaculatory duct opens directly into the anterior end of the pouch.

In *Scapteriscus vicinus* the phallus is similar to that of *Gryllotalpa,* but the dorsal armature of the phallic pouch is quite different. The median, posterior process here has the form of a large, descendant, but abruptly elbowed arm (E, F, *cc*) ending in a sclerotic knob, and is contained in a membranous fold (*u*) of the dorsal wall of the pouch. This process would thus appear to represent the median rod or lobe of Gryllidae (figs. 32 D, 36 C, *v*) that holds the end of the spermatophore duct. Its base is supported by an **H**-shaped sclerite in the dorsal wall of the phallic pouch (fig. 38 D, F, *dd*), just behind the cross-bar of which opens ventrally a long, tubular phallic gland (D, E, *PhGld*) similar to that of *Gryllotalpa.* The anterior dorsal processes of *Scapteriscus* are long and tapering (G, *ee*), and arise from separate basal extensions (*ff*) in the pouch wall.

The gryllotalpid phallus has evidently been derived from an organ having the gryllid type of structure, which has been simplified by the union of the dorsal and endophallic cavities, the former being represented only by the depression of the dorsal wall of the common phallic pouch. The separation of the epiproct from the tenth tergum might be regarded as a character relating the mole crickets to *Stenopelmatus,* but the phallic structure of *Stenopelmatus* (fig. 31) has little in common with that of *Gryllotalpa* and *Scapteriscus.*

The spermatophore of *Gryllotalpa vulgaris* is described by Gerhardt (1913) as an oval body, strongly convex on its upper surface, the shape evidently being such as would fit the phallic pouch, where undoubtedly the spermatophore is molded. The outer surface of the spermatophore, Gerhardt says, is formed of a hard, smooth external coat, which encloses both the sperm capsule and the duct of the latter. The duct, after leaving the capsule, is looped within the spermatophore, and opens on a papilla at one end of the latter between two small lobes that serve for the attachment of the spermatophore in the female. No observations have been made on the manner in which the sperm capsule and duct are formed within the phallic pouch before they are ensheathed in the common outer covering.

The mating habits of *Gryllotalpa* (presumably *hexadactyla*) are described by Baumgartner (1911), who says that two pairs of insects observed in copulation took the very unusual position for Orthoptera of having the abdomens attached end to end, the female standing upright, but the male being on his back. Gerhardt (1913), however, says that the mating habits of *Gryllotalpa vulgaris,* as exhibited by one pair observed, are the same as those of Gryllidae, the male taking the usual position beneath the female, and the bodies of the two insects being in the same direction.

The internal reproductive organs of *Gryllotalpa* (fig. 39 A) differ from those of *Gryllus* (fig. 34 A) in the large size of the anterior part of the ejaculatory duct (fig. 39 A, *Dej*), the greater differentiation among the tubules of the accessory glands (*AcGlds*), the presence of a pair of seminal vesicles (*Vsm*), and of a median tubular phallic gland (*PhGld*). The testes (*Tes*) are elongate oval bodies, each composed of numerous small pyriform sperm tubes within a common peritoneal sheath, attached radially by fine ducts to the vas deferens, which traverses the axis of the testis. The vasa deferentia form each a large, closely coiled epididymis (*Epdm*) before entering the ejaculatory duct. Most of the accessory glands consist of two large lateral masses of tubules, of which the more anterior are longer and thicker, but posteriorly there are two small globular masses of fine tubules (*d*) lying close to the usual vesicular glands (*cjv*) opening into the end of the ejaculatory duct. The vesiculae seminales (*Vsm*) are a pair of large, dilated, lateral diverticula from the posterior part of the ejaculatory duct; at their bases are given off a pair of slender tubes. The long, median, tubular phallic gland (*PhGld*) lies on the dorsal surface of the ejaculatory duct, and, as already noted, opens on the dorsal lip of the phallus (fig. 38 B).

The innervation of the distal segments of the abdomen as shown in *Scapteriscus* (fig. 39 B) illustrates well the typical relation of the segmental nerves to the genital organs in Orthoptera. The last ventral ganglion innervates segments *VII* to *XI*. The lateral nerves of the first three of these segments in the male go *beneath* the vasa deferentia (or the epididymes), and the nerves of the tenth segment (*XNv*) would do so if brought forward. The large cercal nerves of the

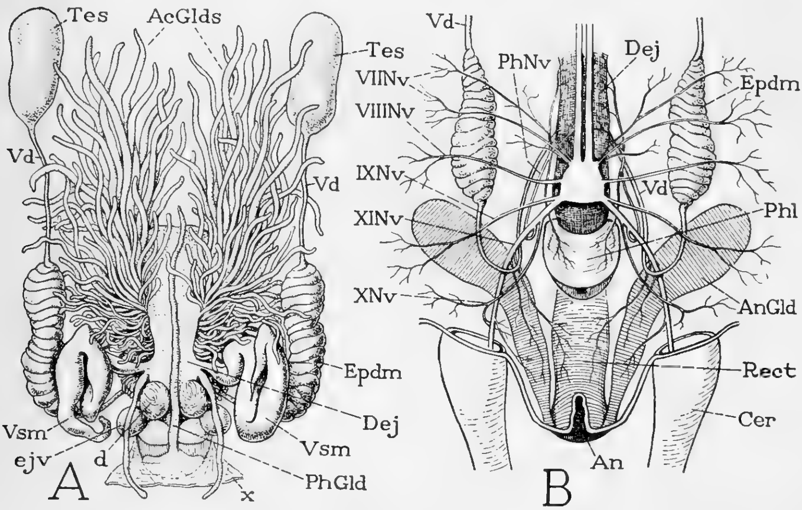

FIG. 39.—Tettigonioidea–Gryllotalpidae: internal male genitalia and associated organs of *Gryllotalpa* and *Scapteriscus*.

A, *Gryllotalpa hexadactyla* Perty, internal organs of reproduction, dorsal view. B, *Scapteriscus vicinus* Scudder, internal organs of terminal part of abdomen, ventral view.

The following letter explanations apply to figs. 39 and 40. *AcGlds*, accessory glands; *An*, anus: *AnGld*, anal gland; *Cer*, cercus; *d*, body of very small gland tubules; *Dej*, ductus ejaculatorius; *ejv*, vesicle of ejaculatory duct; *Epdm*, epididymis; *Eppt*, epiproct; *GC*, genital chamber; *Odc*, oviductus communis; *Odl*, oviductus lateralis; *Ov*, ovary; *Papt*, paraproct; *PhGld*, phallic gland; *Phl*, phallus; *PhNv*, phallic nerve; *Rect*, rectum; *Tes*, testis; *Vd*, vas deferens; *Vsm*, vesicula seminalis; *x*, wall of genital chamber; *VIINv-XINv*, segmental nerves of seventh to eleventh abdominal segments.

eleventh segment (*XINv*), however, go *dorsal* to the vasa deferentia, which loop forward beneath them to join the ductus ejaculatorius. This relation between the segmental nerves and the male genital ducts is possible only on the condition that the primitive vasa deferentia turned downward and united with the body wall somewhere between the tenth and eleventh nerves, and therefore probably on the posterior part of the tenth abdominal segment. The nerves of the tenth segment branch from common basal trunks with the cercal nerves, and just beyond them arises from the cercal trunks a pair of phallic nerves (*PhNv*) that go to the phallus and the ejaculatory duct. The phallus and the ectodermal part of the ejaculatory duct, therefore, must be derivatives of the tenth segment, since it is improbable that they belong to the eleventh segment, and they have no connections with the nerves of the ninth segment. The proctiger, the terminal part of the rectum (*Rect*), and the large anal glands (*AnGld*) derive their innervation from branches of the cercal nerves.

In contrast to the condition in the male, the lateral oviducts of the female (fig. 40 A, B, *Odl*) turn downward behind the nerves of the

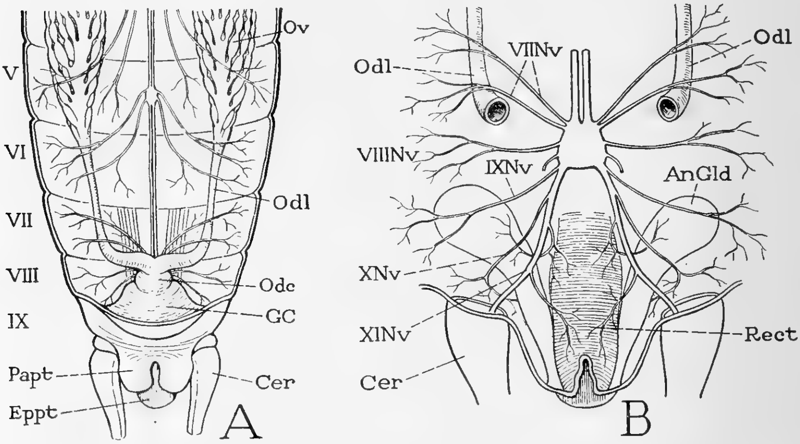

Fig. 40:—Tettigonioidea–Gryllotalpidae: internal female genitalia and associated structures of *Scapteriscus vicinus* Scudder.

A, posterior part of abdomen, showing reproductive organs and nerves, ventral view. B, innervation of posterior abdominal organs from last ganglion of ventral nerve cord, ventral view.

For letter explanation, see fig. 39.

seventh segment (*VIINv*). The primitive openings of the paired oviducts, therefore, must have been at a position between the nerves of segments *VII* and *VIII*, and hence probably on the posterior part of segment *VII*. The innervation of the following segments in the female of *Scapteriscus* (B) is essentially the same as that in the male except for the absence of phallic nerves. The median oviduct and the genital chamber appear to be innervated from the second pair of lateral nerves in segment *VIII* (A).

X. ACRIDOIDEA

The phallic organ of the Orthoptera attains in the Acrididae its highest degree of development and integration into a mechanism of spermatophoric insemination. Structurally, the acridid phallus belongs to the tettigonioid type, in so far as the primary phallomeres unite to form a single organ; but any closer relationship to either the tettigoniid or gryllid form is not clear, either from the adult structure or the nymphal development.

The mating and copulating habits of the grasshoppers are well known, but only a few studies have been made on the manner of sperm transfer. According to the accounts of different investigators it would appear that some species produce a number of small spermatophores and eject them entirely into the sperm receptacle of the female, while others insert only the end of a long neck from a single bulblike spermatophore into the receptaculum (see Snodgrass, 1935, pp. 71-73). Fedorov (1927) claims that the first type of insemination occurs with *Anacridium aegyptium*; Boldyrev (1929) describes the second for *Locusta migratoria*, the spermatozoa in this case being pumped through the neck of the spermatophore into the receptaculum of the female by the endophallic apparatus of the male, after which the end of the spermatophore neck breaks off and remains in the sperm receptacle. The structure and mechanism of the phallic organ are so nearly the same in all species of Acrididae that we should scarcely expect to find any considerable difference in the manner of insemination; the apparatus appears to be well adapted to the type of action described by Boldyrev.

The acridid phallus consists of a complex ectophallus contained in the genital chamber (fig. 41 A, *GC*), and of a large, strongly musculated, bulblike endophallus (*Enph*) projecting downward and forward into the body cavity beneath the floor of the genital chamber. The ejaculatory duct (*Dej*) ends in a muscularly compressible ejaculatory sac (*ejs*) that opens into the ventral wall of the endophallic cavity between two sclerites (*y*) that, operated by muscles of the endophallic wall, regulate the gonopore.

The ectophallus includes a proximal part, or phallobase (fig. 41 A), and a diversified distal part, which may be termed the aedeagus (*Aed*). The phallobase appears as a membranous elevation of the floor of the genital chamber, having its distal margin produced into a broad basal fold (*bf*) overlapping the base of the aedeagus; on its anterior part is situated a large, irregular sclerite, the epiphallus (figs. 41 A, 42 I, *Epph*). Between the basal fold and the epiphallus there may be a deep depression (fig. 42 I, *c*). The aedeagus (fig. 41 A, *Aed*) is differentiated into several parts, but its major subdivision is into a dorsal lobe (*dl*) and a ventral lobe (*vl*), between which is the phallotreme, or opening from the endophallic cavity. The dorsal lobe itself is usually differentiated into an irregular basal section (B, *m*) and a cylindrical distal part (*r*), and is cleft posteriorly (or ventrally) by the long, slitlike phallotreme (C, *Phtr*), which may involve also the distal end, and thus divide the apex of the aedeagus into two lateral terminal lobes (fig. 42 I, *r*). One or two pairs of apical processes

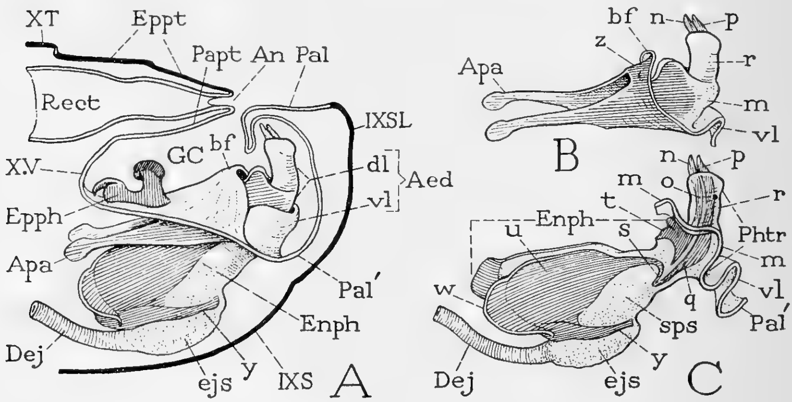

FIG. 41.—Acridoidea–Acrididae: structure of the external male genitalia, diagrammatic (from Snodgrass, 1935).

A, section of end of abdomen somewhat to left of median plane, showing organs within genital chamber (*GC*), and those invaginated into body cavity. B, distal part of ectophallus and apodemal arms. C, aedeagus and endophallus, basal parts of phallus removed.

The following letter explanations apply to figs. 41 and 42: *a*, basal part of nymphal phallus; *Aed*, aedeagus; *Amp*, mesodermal ampulla; *An*, anus; *Apa*, apodeme of aedeagus; *b*, *b*, terminal lobes of nymphal phallus; *bf*, basal fold of phallus; *c*, dorsal depression of phallic base; *Dej*, ductus ejaculatorius; *dl*, dorsal lobe of phallus; *ejs*, ejaculatory sac; *Enph*, endophallus; *Epph*, epiphallus; *Eppt*, epiproct; *GC*, genital chamber; *IXSL*, subgenital lobe of ninth abdominal sternum; *m*, basal part of dorsal lobe of phallus; *n*, dorsal (anterior) apical process of aedeagus; *o*, dorsal (anterior) sclerite of phallotreme wall; *p*, ventral (posterior) apical process of aedeagus; *Pal*, pallium; *Pal'*, inner fold of phallium; *Papt*, paraproct; *Phm*, phallomere; *Phtr*, phallotreme; *q*, ventral (posterior) sclerite of phallotreme wall; *r*, distal part of dorsal lobe of phallus; *Rect*, rectum: *s*, arm connecting posterior phallotreme sclerite (*q*) with endophallic plate (*u*); *sps*, spermatophore sac of endophallus; *t*, dorsal bridge of dorsal phallotreme sclerites; *u*, lateral plate of endophallus; *Vd*, vas deferens; *vl*, ventral lobe of phallus; *x-x*, cut edge of anterior wall of genital chamber; *X.V*, venter of tenth abdominal segment; *y*, gonopore process of endophallic plate; *z*, zygoma of aedeagal apodemes.

(fig. 41 B, C, *n*, *p*) may project from the walls of the phallotreme. The basal part of the dorsal lobe (B, *m*) usually contains a sclerotization in its lateral walls, from which a pair of long apodemal arms (*Apa*), the "endapophyses" of Walker (1922), project internally above the endophallus (A). The endophallus is a large laterally compressed sac, with a narrowed meatus leading inward from the long phallotreme cleft (C). Its lateral walls contain a pair of large plates (*u*), from each of which a slender sclerotic bar (*s, q*) is continued through the wall of the meatus, and may terminate in a free apical process (*p*). A second pair of anterior (or dorsolateral)

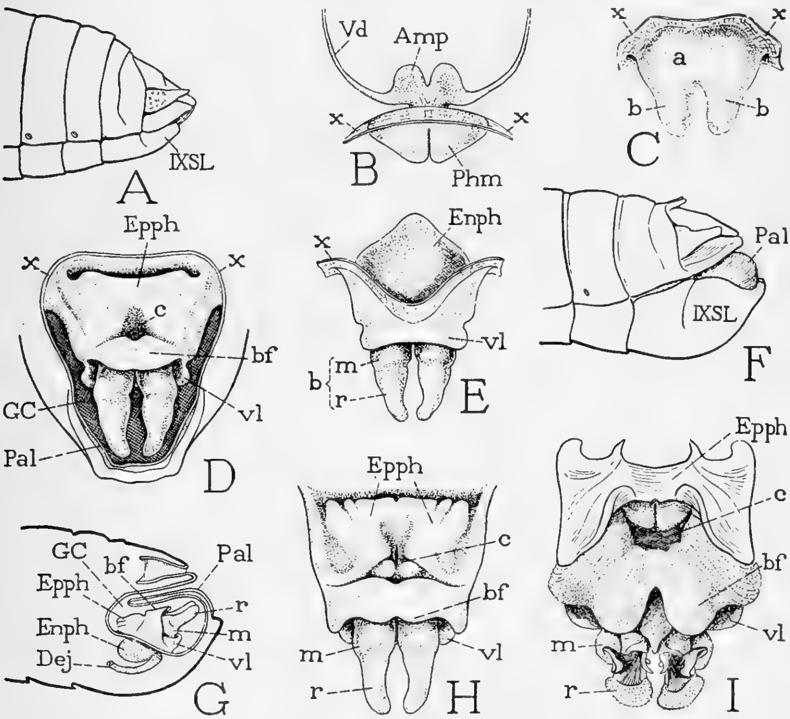

FIG. 42.—Acridoidea–Acrididae: nymphal development of external male genitalia.

A, *Dissosteira carolina* (Linnaeus), end of abdomen of nymph with wings just differentiated from tergal plate. B, same, phallic lobes, connected by short ejaculatory duct with mesodermal ampullae of vasa deferentia. C, *Melanoplus mexicanus* (Saussure), phallus of nymph with wings not extending beyond metatergum, dorsal view. D, same, nymph with wings reaching to middle of first abdominal tergum, phallus in genital chamber beneath outer cuticula, dorsal view. E, same, ventral view, showing endophallic sac. F, same, end of abdomen of nymph with wings extending to middle of third abdominal tergum. G, same, diagrammatic section of end of abdomen of F. H, same, phallus of nymph in stage of F, dorsal view. I, same, mature phallus, dorsal view.

For letter explanation, see fig. 41.

bars in the meatus wall (C, *o*), united basally by a dorsal bridge (*t*), runs out into the anterior apical processes (*n*). Further details of the structure of the complex phallic organ of the Acrididae, its musculature and mechanism, and its variations in the several acridid subfamilies the writer has described in a former paper (1935).

It is possible to conceive of the acridid phallus as an extreme development of the gryllid type or organ, as does Walker (1922), in which the dorsal cavity and the endophallic cavity have united to form the common inner sac; but the simple development of the organ in the nymph does not bear out this interpretation.

The developing phallus in the various instars of the acridid nymph is always entirely concealed in the genital chamber beneath the covering pallial fold (fig. 42 G, *Pal*) ; the latter, therefore, must be removed in order to study the growth of the genital organ. In a young nymph of *Dissosteira carolina* (fig. 42 A) in which the wing pads do not yet project from the angles of their tergal plates, the phallus has the form of a simple, bilobed, conical papilla arising anteriorly from the floor of the genital chamber (B). The two lobes, or phallomeres (*Phm*), are closely appressed, and from their united bases arises a short ejaculatory duct connected with the ampullae (*Amp*) of the vasa deferentia. This same stage in the development of the phallus of *Melanoplus differentialis* is described and figured by Else (1934). At a somewhat later stage, as shown in *Melanoplus mexicanus* (C), the two phallic lobes (*b, b*) have lengthened and have been carried out upon a common basal part (*a*). In an older nymph having the hind wings reaching slightly beyond the middle of the first abdominal tergum, the phallus shows distinctly the beginning of adult differentiations (D), but the specimen here shown was exposed by removal of the outer cuticula, and therefore belongs to the following instar. Dorsally there is a sharply defined anterior margin of the epiphallus (*Epph*), a central depression (*c*) in the phallobase, and a distinct basal fold (*bf*). On the under side, the ventral lobe (*vl*) appears as a small transverse fold, above which is the opening of an already well-developed endophallic pouch. When the wing pads reach to or slightly beyond the middle of the third abdominal tergum, the end of the abdomen has the adult characteristics (F), and a section (G) shows the phallus in the mature position. The epiphallic region of the phallobase is now well demarked (H, *Epph*), the central depression (*c*) deepened, and the basal fold (*bf*) much enlarged. The two processes of the dorsal lobe, which in *M. mexicanus* remain distinct from the early nymph (C) to the adult (I), are differentiated into proximal and distal parts (E, H, *m, r*), and the ventral lobe (*vl*) projects beneath their bases. Between this stage (H) and the adult (I) the basal structures take on their definitive form, and the various details of the aedeagal lobes are developed.

The development of the acridid phallus thus clearly shows that the complex phallic apparatus of the Acrididae has essentially the same beginning as the simpler organ of Tettigoniidae, except that at first there are only two phallic lobes instead of six as in *Conocephalus* (fig. 23 B, C). Since a ventral lobe soon appears, however, the phallic rudiments of the acridids might be more directly likened to the laterodorsal nymphal phallomeres of Blattinae (figs. 12 E, 15 B). Lateral lobes, such as are characteristic of the Tettigoniidae, are absent in Blattidae, Gryllidae, and Acrididae.

The central depression in the dorsal surface of the phallic base of *Melanoplus* (fig. 42 H, I, *c*) suggests the dorsal cavity of the tettigonioid phallus (fig. 22 C, *dc*), particularly as it appears in the nymphal development (fig. 31 F, G, *dc*). The acridid epiphallus, furthermore, is developed from the dorsal wall of the phallus anterior to the median depression (fig. 42 D, H, I, *Epph*), and the so-called epiphallus of the Rhaphidophorinae and Tettigoniidae is a sclerotization of the posteriorly produced anterior margin of the dorsal cavity (fig. 22 C, D, F, *e*). The large inner cavity of the acridid phallus appears to be formed as a direct endophallic invagination, but its strong musculature might be taken as evidence that most of its lumen represents the dorsal phallic cavity of *Gryllus* or *Gryllodes* (figs. 32 E, 35 H, *k*). In the absence of conclusive evidence on homologies between the mature phallic organs of Gryllidae and Acrididae, we may regard the acridid phallus as an independent line of development from phallic rudiments such as are common to the nymphal stages of all the Orthoptera.

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GROWTH OF AVENA COLEOPTILE AND FIRST INTERNODE IN DIFFERENT WAVE-LENGTH BANDS OF THE VISIBLE SPECTRUM

BY
EARL S. JOHNSTON
Assistant Director, Division of Radiation and Organisms
Smithsonian Institution

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GROWTH OF AVENA COLEOPTILE AND FIRST INTERNODE IN DIFFERENT WAVE-LENGTH BANDS OF THE VISIBLE SPECTRUM

By Earl S. Johnston,
Assistant Director, Division of Radiation and Organisms
Smithsonian Institution

INTRODUCTION

In a former paper the author (1934) discussed the sensitivity of the *Avena sativa* coleoptile to different wave lengths of light as manifested by phototropic curvature. Maximum sensitivity occurred at wave length 4400 A, with a secondary maximum at 4750 A. From this point the sensitivity rapidly fell to a very low value at 5000 A and gradually tapered to zero between 5400 and 5500 A. Beyond this region and out into the near infrared no phototropic response was detected.

In the present paper the results of a growth study of the oat coleoptile and first internode[1] with respect to different wave-length bands of very weak light are reported. Data are also presented on some intensity effects of radiation. In all these experiments the variety Markton, obtained through the kindness of T. Ray Stanton, of the United States Department of Agriculture, was used.

As mentioned by Boysen-Jensen (1936), the elongation of the first internode has been attributed to numerous factors such as low temperature, low soil moisture content, and high carbon-dioxide content of the atmosphere. Several experimenters have shown that the elongation of the first internode can be suppressed by illuminating the seed when it is in a moist condition. One should, therefore, expect to obtain short first internodes on growing oat seedlings in light and long first internodes when they are grown in darkness. This raises

[1] According to Avery (1930), the elongated structure between the cotyledon and the coleoptile in oat seedlings is the first internode of the axis. He regards the term "mesocotyl", as applied to this structure, meaningless. The term "first internode" is the author's preference, although, in discussing the work of others, "mesocotyl" is sometimes used.

the question as to what differences, if any, may occur in the length of the first internode when the seedlings are subjected to different wave-length bands of the visible spectrum.

EXPERIMENTATION

First series (with Mazda lamp).—Two Bausch and Lomb quartz monochromators were set up in tandem to obtain the desired isolated regions of the spectrum. A 1000-lumen, 1.6-ampere street-series lamp served as the light source. A small mirror reflected the beam of light onto the young plants. The intensity was adjusted to 1.2 ergs/cm^2/sec. at the position of the seeds. The dry seeds with the chaff removed were placed on a moist medium in a moisture chamber

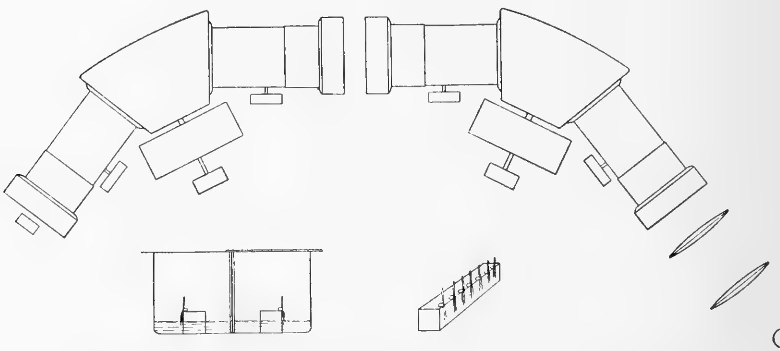

FIG. 1.—Diagram showing general arrangement of monochromators and position of seeds on "germination wick" in moisture chamber.

and allowed to remain undisturbed for a period of four days. The moist medium on which the seeds were placed was filter paper saturated with distilled water. This system was used for the first 16 experiments. It was not always possible to get the same degree of moisture, and certain irregularities in germination occurred. This system was discarded in favor of one in which the Livingston solid wick mentioned by Norem (1936) was used. These porous stone pieces were cut 1 inch square and 4.5 inches long. After they were moistened with distilled water a piece of wet filter paper was wrapped around each. They were then placed in a moisture dish containing about $\frac{1}{2}$ inch of water. The seeds were laid, groove side down, along the edge with the base end extending slightly over the edge. The roots attached themselves to the filter paper and grew down into the water. After the first 24 hours in darkness they were irradiated continually for three days with monochromatic light. (See fig. 1.)

A set of similar seeds was grown simultaneously in darkness for the entire period of four days. In the first nine experiments the dark controls were grown in a separate container. For the other experiments of this series the dark controls were grown in the same container with the illuminated plants but were separated from them by a black paper partition held between two pieces of glass. The top of the chamber was covered with a piece of glass and the entire top area, as well as the sides, covered with black paper and cloth, except for the opening, which permitted light to reach the exposed set of plants. Subsequent experiments showed that even these precautions to keep light from reaching the dark control plants failed. Examination of data in table 3 clearly shows that the dark controls in the same chamber with the exposed plants must have received some scattered light because of their differences in growth. Because of this scattered light effect the dark controls with the exception of the first nine experiments in the first series are of little value.

An experiment for each wave-length setting was repeated at least once. At the end of each 4-day experiment the lengths of coleoptiles and first internodes were determined. Because of the restricted size of the light beam coming from the monochromator the number of seeds exposed was limited to about seven without too great crowding. Occasionally a seed or two failed to germinate, and sometimes something happened that justified the elimination of others. For the entire series of experiments the average number of seedlings in each exposed group and each dark control was six. Since each experiment was repeated, this at least doubled the number of seedlings for each wave-length setting.

The experiments were conducted in a small room with no outside walls. The lamp was located in another room, so that after an experiment was started no entrance was made to this room until its conclusion at the end of four days. Because of the location of this room in the basement of the Smithsonian Building, the temperature variation was exceedingly small. Seldom was the difference between maximum and minimum temperature greater than 2° F. for any of the 4-day periods. Once there was a 4° difference and twice a 3° difference. The average maximum and minimum temperatures for the 36 different experiments were 75° F. and 74° F., respectively.

The average lengths (mm) of the first internode, coleoptile, and total oat seedling of each 4-day experiment are presented in table 1. For each wave length the data of at least two experiments are given. The last two columns show the maximum and minimum temperatures (° F.) for each experiment. It will be noted that there is fairly good agreement between the duplicate experiments of the exposed series. The greatest discrepancies occur for wave lengths 5195 A and 5403 A. In the dark series of experiments there is considerable variation between the averages of similar experiments. This is especially noticeable for those corresponding to wave lengths 4050 A, 4405 A, and 5403 A. For example, there appears to be no good reason why the dark experiments corresponding to those of wave length 4405 A should give an average for the first internode of 59 mm in one case and 34 mm in the other. The temperature ranges were exactly the same, 76°–75° F. There is the possibility that the filter paper medium here used was drier in one experiment than in the other. The dark controls of the first nine experiments were in a different container than those of the exposed series. It would appear from this example and general observations throughout all the experiments that individual variations are enhanced when the oat seedlings are grown in the absence of light.

The growth data of table 1 are diagrammatically represented in figure 2. The ordinates represent length in millimeters. Similar experiments are grouped together with the wave length designated below. In the series exposed to light the first internodes are represented by the dotted sections and the coleoptiles by the clear sections. In the dark series the shaded portions represent the first internodes and the hatched portions the coleoptiles.

The most striking feature of this diagram is that for all wave lengths the first internodes of the exposed plants are always shorter than the first internodes of the corresponding dark control plants. There is not a single experiment in which this is not the case. Even in wave length 7600 A, which was scarcely visible to the eye, the lengths of the first internodes of the exposed plants are depressed. Data from experiments not shown here but carried out several months earlier, covering the range of wave lengths whose average was 7600 A, were very similar to those here presented. Another feature that this diagram clearly shows is that the coleoptiles of all the dark experiments are short in comparison to the coleoptiles in the exposed series. Here again there are no exceptions. Furthermore at the end of the 4-day periods the total length of seedlings in the dark series of experiments is somewhat greater than the total length of seedlings in the exposed series. There are a few exceptions. The average total length of seedlings in the former group is but 7 mm greater than the total length of the latter or exposed group. This would indicate that the total growth attained in a 4-day period was not greatly influenced by light. If growth depends on the amount of growth substance present, it would indicate that light of this low

TABLE 1.—*Data Showing Average Length (mm) of First Internode, Coleoptile, and Total Oat Seedling (Avena sativa var. Markton) After Four Days' Growth in Light and in Darkness at the Indicated Maximum and Minimum Temperature (° F.)*

Wave length A	Exposed series			Dark series			Temperature	
	First internode	Coleoptile	Total	First internode	Coleoptile	Total	Max.	Min.
4050	30	30	60	75	10	85	77	76
	30	29	59	47	6	53	79	77
4265	31	30	61	51	6	57	79	77
	29	26	55	65	9	74	78	78
4405	29	23	52	59	6	65	76	75
	30	27	57	34	6	40	76	75
4595	24	24	48	64	8	72	78	77
	27	22	49	55	8	63	76	76
4798	30	21	51	59	7	66	76	75
	27	25	52	54	11	65	88	88
5005	30	24	54	59	11	70	73	72
	30	28	58	61	9	70	73	72
5195	32	26	58	55	9	64	74	72
	29	31	60	60	12	72	75	72
	25	30	55	56	10	66	74	73
5403	28	30	58	56	11	67	73	72
	30	31	61	57	18	75	74	73
	23	22	45	42	11	53	72	71
5605	22	22	44	37	9	46	73	72
	19	19	38	40	10	50	74	72
5795	22	26	48	46	15	61	74	73
	19	28	47	39	15	54	74	72
5990	17	23	40	44	14	58	74	72
	21	27	48	43	18	61	74	72
6200	18	20	38	35	12	47	74	73
	15	23	38	43	16	59	64	62
6395	16	29	45	42	16	58	75	72
	19	34	53	39	19	58	75	73
6595	15	27	42	33	17	50	74	72
	17	31	48	33	14	47	75	73
6800	24	35	59	40	20	60	76	74
	20	38	58	38	23	61	74	72
7005	24	34	58	36	19	55	75	74
	25	32	57	35	16	51	76	75
7600	33	28	61	41	7	48	76	74
	32	25	57	51	9	60	78	74

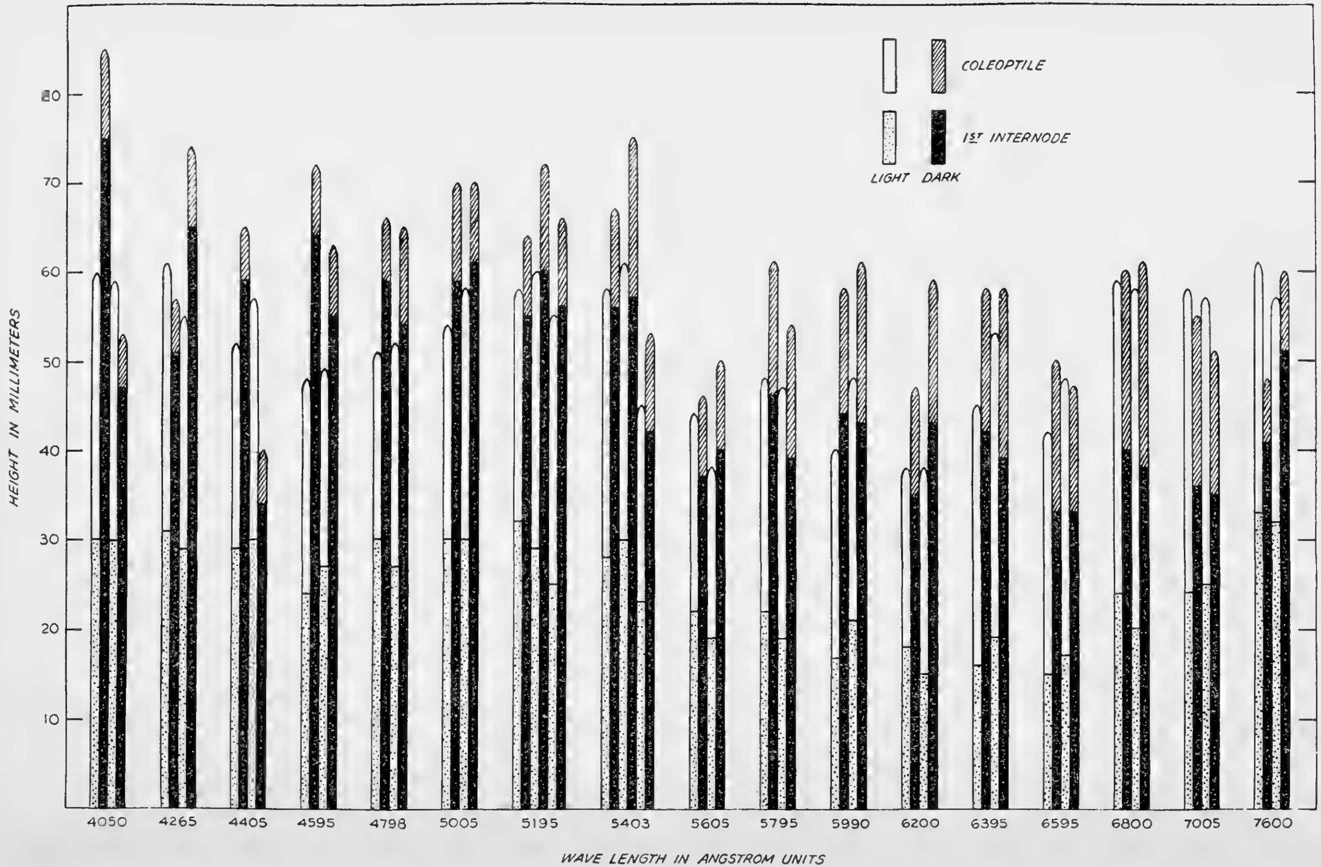

FIG. 2.—Diagram representing growth of oat seedlings in different wave-length regions of the spectrum. The coleoptiles are shown as clear and hatched areas for the exposed and dark controls respectively. The first internodes are shown as dotted and blackened areas for the exposed and dark controls respectively. The lengths as ordinates are given in millimeters, and the center of the wave-length bands in angstrom units.

intensity acts as a factor redistributing these substances. This is evidenced by differences in lengths of first internodes and coleoptiles of exposed and darkened series of plants. If the total amount of growth substance were changed at all, there is the suggestion that a smaller amount is present in plants exposed to light than in plants kept in darkness.

The ratio of the length of the first internode to the total length of seedling was determined for each plant and averaged for each experiment and again averaged for the corresponding wave-length group. These data are presented in table 2. There is surprisingly small variation between the duplicate and triplicate experiments. There was such small variation between the different seedlings of a given group that the first internode was found to be a fairly definite percentage of the total length of the seedling regardless of whether the seedling was long or short. In the exposed series, the average ratio values vary from a maximum of 0.56 for wave-length regions 4798 A, 5005 A, and 7600 A to a minimum of 0.36 at wave-length regions 6395 A and 6595 A. In the dark series the average ratio values vary from 0.89 in the first two wave-length experiments to 0.65 in the third from the last experiment.

The natural question to be asked is why should the ratio of the dark controls vary to that extent especially since the temperatures (see table 1) of these different experiments were about the same. If it were a matter of total growth alone, then it is to be expected that the seedlings of the first two experiments would be longer because of a higher average temperature. As previously mentioned, the dark-control plants of the first nine experiments were grown in a separate growth chamber where there was no possibility of scattered light reaching the young plants. The ratio values of the other dark control experiments are, in general, lower, especially for wave-length regions 5403 A to 7005 A, inclusive. Here a partition of black paper held between two glass plates separated the exposed from the darkened seedlings.

To correct the ratio values for differences in temperature, atmospheric conditions, and viability, each exposed value was divided by the corresponding dark value. These are recorded in the sixth column and the average for each wave-length group placed in column 7. However, since the dark control values (except the first nine) appear not to be true values because of scattered light, all the average ratio values (exposed/dark control) have been made relative to the average of the first nine dark control ratios (0.89). These have been placed in the last column of table 2.

TABLE 2.—*Average Ratio of Length of First Internode to Total Length of Seedling for Each Experiment and for Each Wave-Length Region in the Exposed and Dark Series*

Wave length Å	Exposed series	Average	Dark series	Average	Ratio exp./dark	Av. ratio exp./dark	Ratio av. exp. to av. dark (0.89)*
4050	.50		.89		.56		
	.52	.51	.89	.89	.58	.57	.57
4265	.51		.90		.57		
	.53	.52	.88	.89	.60	.59	.58
4405	.55		.90		.61		
	.53	.54	.85	.88	.62	.62	.61
4595	.51		.89		.57		
	.55	.53	.86	.88	.64	.61	.60
4798	.59		.90		.66		
	.52	.56	.83	.87	.63	.65	.63
5005	.55		.85		.65		
	.56	.56	.88	.87	.64	.65	.63
5195	.55		.85		.65		
	.48		.84		.57		
	.47	.50	.85	.85	.55	.59	.56
5403	.47		.83		.57		
	.49		.76		.64		
	.52	.49	.79	.79	.66	.62	.55
5605	.50		.80		.63		
	.49	.50	.81	.81	.61	.62	.56
5795	.45		.75		.60		
	.41	.43	.71	.73	.58	.59	.48
5990	.42		.76		.55		
	.45	.44	.71	.74	.63	.59	.49
6200	.46		.74		.62		
	.39	.43	.72	.73	.54	.58	.48
6395	.36		.73		.49		
	.36	.36	.66	.70	.55	.52	.40
6595	.36		.67		.54		
	.36	.36	.69	.68	.52	.53	.40
6800	.41		.67		.61		
	.34	.38	.62	.65	.55	.58	.43
7005	.42		.65		.65		
	.45	.44	.69	.67	.65	.65	.49
7600	.55		.84		.65		
	.56	.56	.85	.85	.66	.66	.63

* In the first nine dark experiments the seedlings were grown in a separate moist chamber. Since there was no possibility of exposure to stray light, the average ratio of first internode to total length for these nine experiments has been used as unity in determining the values in the last column.

In order to visualize these ratio values, figure 3 has been constructed. The average ratio value of first internode to total length per wave length is indicated by the dash curve (L). The corresponding dark values are shown as the continuous curve (D). It will be noted that in the exposed series there is a fairly consistent drop in the curve from about 5000 A to the region 6400–6600 A. From this region the curve rises to a second maximum at 7600 A. The dark control curve shows much the same shape, and this would indicate that some stray light or some common external factor was affect-

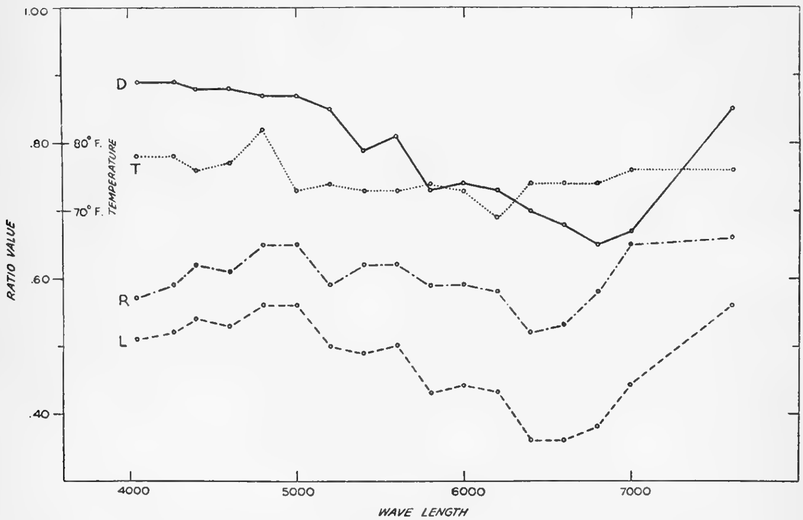

FIG. 3.—Graphs showing the average ratio values of first internode to total seedling length per wave-length region of the exposed series (L) and the corresponding average ratio values of the dark series (D). The ratio values of the exposed series divided by the corresponding values of the dark series are plotted as curve R. T is the average temperature curve.

ing the growth of the first internode. If it be assumed that all external growth conditions be the same in the two series with the exception of light, then the effect of light is shown by dividing the values of the exposed series by those of the dark series. The values in column 7 of table 2 have therefore been plotted in figure 3 as the dash-dot curve (R). This curve shows a distinct falling off in the region 6400–6600 A, with two maximal regions 4800–5000 A and 7600 A.

Since it is probable that there were some scattered light effects in all but the first nine experiments of the dark series, curve L probably gives a better idea of the light response of the first internode as related to total length of seedling than curve R. It is doubtful if temperature differences were great enough to bring about marked variations in growth rates. The average temperatures for each wave-length group are plotted as the dotted curve (T) in figure 3.

The average ratios of coleoptile to total length of seedlings are not given in table 2, but they may easily be obtained by subtracting the values in the third column from 1.00. The shape of the curve

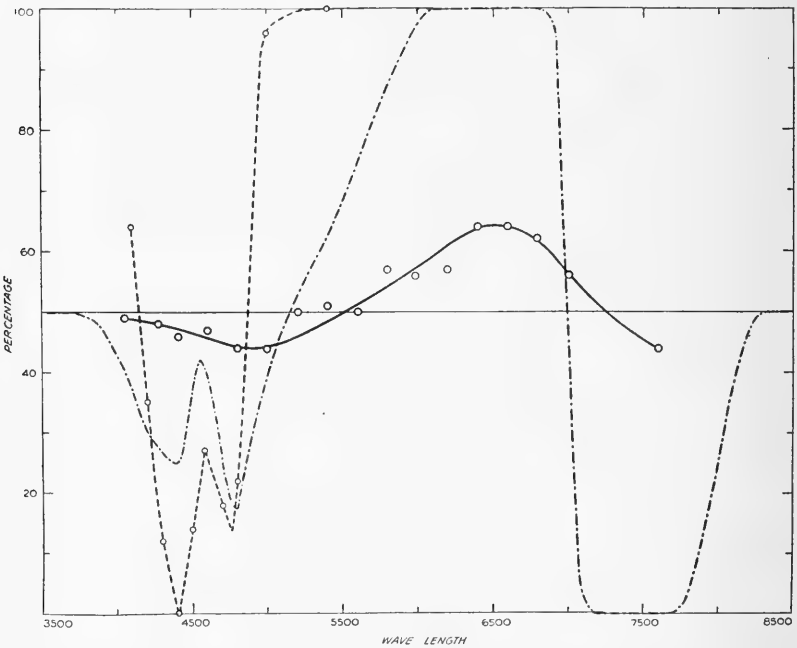

FIG. 4.—Graph showing percentage of coleoptile to total length of seedling of exposed series (continuous curve). For comparison the germination curve (dash-dot) of light-sensitive lettuce seed (from Flint and McAlister) and the inverted phototropic sensitivity curve (dash) of *Avena* (from Johnston) are plotted in the same figure.

is that of the mirror image of curve L in figure 3. This smoothed coleoptile curve has been plotted in figure 4 as a continuous line. It will be observed that from wave length 4050 A to 5500 A the ratio values are less than 0.50. In this region the coleoptile is less than 50 percent of the total seedling length. Furthermore, the length of coleoptile is greater than 50 percent of the seedling length from about wave length 5500 A to wave length 7200 A. Maximum coleoptile elongation occurs at the region 6400 A to 6600 A with a minimum at about 4800 A to 5000 A and another in the region of 7600 A.

The similarity of this curve to that found by Flint and McAlister (1935, 1937) representing the germination of light-sensitive lettuce seed was so marked that their curve has been plotted as the dash-dot line in this same figure. The general similarity of these two curves is suggestive of a common physiological process. The retarding action of radiation on growth in the region 4000 A to 5000 A is likewise seen by inverting the phototropic sensitivity curve found by Johnston (1934) and plotting it as the dash curve in figure 4. In the phototropic studies, however, no acceleration in growth was noted in the region 6000 A to 7000 A as would have been indicated by negative bending. This lack of response may be due to an insufficient light gradient in this region.

Second series (with mercury lamp).—In the experiments so far described, the wave-length bands averaged in width about 300 angstroms. By using a capillary high-pressure mercury lamp (H–3 type) as the light source, a greater amount of energy could be directed on the plants and most of the energy concentrated in the mercury line selected for the exposure. In the second series of experiments four mercury lines were used. The intensity at the beginning of each experiment was set at 13 ergs/cm^2/sec. This intensity sometimes dropped as low as 7 ergs/cm^2/sec. at the end of the experiment because of the creeping of the lamp in its socket. However, it was still considerably higher than that in the first series (1.2 ergs/cm^2/sec.).

Two dark controls were run with each set of exposed plants. One control was in the same moisture chamber with the exposed plants but separated from it by a black partition, as was the case in the first series of experiments. The other dark control was placed in another moisture chamber wrapped with black paper and covered with a black cloth. Here there was no opportunity for exposure to scattered light. Each wave-length experiment was run three or four times with an average of six seedlings for each run of the three conditions. Data showing the average length of first internode, coleoptile, and total length of seedlings after four days of growth are presented in table 3. The maximum and minimum temperatures are also included in the table. The average data for each wave length are shown in boldface type.

In the exposed series, the first internodes were always shorter than the coleoptiles. In the dark-control series in the same chamber with the exposed, the first internodes were always longer than the coleoptiles, while in the other dark control, where no light of any kind could reach the seedlings, the first internodes were very much longer than the coleoptiles. These differences in lengths of first internode and coleoptile clearly show the marked effect of light. Even the dark-control plants exposed to a minute amount of scattered or diffused light showed that the seedlings are extremely sensitive to light. It is rather remarkable that such small amounts of radiation should completely change the relative length of first internode and coleoptile.

TABLE 3.—*Data Showing Average Length (mm) of First Internode, Coleoptile, and Total Oat Seedling After Four Days' Growth in Light (Approximately 13 to 7 ergs/cm²/sec.) of Mercury Lamp and in Darkness, at the Indicated Maximum and Minimum Temperature (° F.)*

[Average Data in Boldface Type]

Wave length	In same moisture chamber						Separate chamber			Temperature	
	Exposed			Dark control			Dark control				
A	Int.	Col.	Total	Int.	Col.	Total	Int.	Col.	Total	Max.	Min.
4047	15	27	42	22	10	32	..	..	..	75	74
	20	45	65	45	21	66	..	..	..	79	76
	24	23	47	..	..	..	48	7	55	79	76
	25	35	60	48	15	63	73	11	84	78	77
	21	**33**	**54**	**38**	**15**	**54**	**61**	**9**	**70**	..	..
4358	26	40	66	51	16	67	66	11	77	79	77
	25	38	63	52	16	68	66	11	77	78	76
	25	34	59	47	13	60	60	8	68	78	77
	25	**37**	**63**	**50**	**15**	**65**	**65**	**10**	**74**	..	..
5461	20	32	52	39	15	54	63	8	71	77	76
	14	21	35	33	13	46	57	7	64	76	76
	20	28	48	38	13	51	48	7	55	75	75
	20	39	59	43	17	60	55	10	65	79	78
	19	**30**	**49**	**38**	**15**	**53**	**56**	**8**	**64**	..	..
5780	17	49	66	45	36	81	61	10	71	79	78
	19	47	66	47	31	78	50	8	58	80	79
	20	46	66	45	28	73	67	10	77	78	78
	19	**47**	**66**	**46**	**32**	**77**	**59**	**9**	**69**	..	..

The average total seedling lengths for the three series are 58, 62, and 69 mm, corresponding to the exposed, "diffused" control, and totally dark control, respectively. Here again the effect of light is noticed. The total length is greatest in complete darkness, less in the presence of minute scattered light, and least in the illuminated series. Although the total length is not greatly changed by light, as was true in the first series of experiments, yet there is a distinct indication that total growth is less and that the activity of growth substance or regulators is slightly decreased even by very weak light.

The marked differences in relative lengths of first internode and coleoptile in the dark and exposed series indicate some drastic redistribution of growth regulators.

The ratios of first internode and of coleoptile to total length of seedling are shown as percentages in table 4. These percentages were determined for each seedling and then averaged for each experiment and again averaged for each wave length. This last average is shown

TABLE 4.—*Percentage Length of First Internode and Coleoptile of Total Length of Avena Seedling for the Designated Wave Lengths and Temperatures*

[Average Data in Boldface Type.]

Wave length	In same moisture chamber: Exposed		In same moisture chamber: Dark control		Separate chamber Dark control		Temperature (° F.)		
A	Int.	Col.	Int.	Col.	Int.	Col.	Max.	Min.	Average
4047	36	64	68	32	..	..	75	74	74.5
	31	69	69	31	..	..	79	76	77.5
	51	49	..	..	88	12	79	76	77.5
	42	58	76	24	87	13	78	77	77.5
	40	**60**	**71**	**29**	**87**	**13**	..	..	**76.8**
4358	38	61	76	24	86	14	79	77	78.0
	40	60	76	24	86	14	78	76	77.0
	43	57	78	22	88	12	78	77	77.5
	41	**59**	**77**	**23**	**87**	**13**	..	..	**77.5**
5461	38	62	73	27	88	12	77	76	76.5
	39	61	73	27	89	11	76	76	76.0
	41	59	74	26	87	13	75	75	75.0
	34	66	72	28	85	15	79	78	78.5
	38	**62**	**73**	**27**	**87**	**13**	..	..	**76.5**
5780	25	75	56	44	86	14	79	78	78.5
	29	71	60	40	87	13	80	79	79.5
	30	70	61	39	87	13	78	78	78.0
	28	**72**	**59**	**41**	**87**	**13**	..	..	**78.7**

in boldface type. Temperature data are given in the last three columns. But little difference is to be seen in the percentages of lengths of first internodes and coleoptiles in the first three wave lengths. The values for 5780 A are, however, different. A comparison of these percentage values in the two series of experiments for the exposed coleoptiles is shown below. The wave-length values between the two series are not strictly comparable but are approximately correct.

Each set of values shows about equal lengths of coleoptile for the first three wave-length values. The value for the 5780 A region of each series is higher. All values in the second series of experiments are higher. If it is assumed that the small temperature differences between the various experiments exert but little influence, then it must be concluded that the increased intensity in the second series of experiments has increased the percentage length of the coleoptile. This

Table 5.—*Comparison of Percentage Length of Coleoptiles in the Two Series of Experiments for Corresponding Wave Lengths*

Wave length *A*	First series *Percent*	Second series *Percent*
4047	49	60
4358	48	59
5461	51	62
5780	57	72

is in agreement with the observation that the coleoptiles were longest in the exposed series (greatest intensity), shortest in the completely darkened series (zero intensity), and intermediate in length in the dark control exposed to very diffused light. The reverse is true regarding the first internodal values, which are the coleoptile values subtracted from 100.

DISCUSSION

In determining the sensitivity curve (Johnston, 1934) of *Avena* coleoptile, only the tips were illuminated. In the experiments here reported entire seedlings were grown in restricted wave-length regions of the spectrum. Went (1926) has pointed out two distinct light responses in the coleoptile, one the tip response, the other the base response. Where the entire coleoptile is illuminated, both responses are concerned. Van Overbeek (1936 b) calls attention to a third type of response described by Tollenaar and by Van Dillewijn, which is designated as the " dark growth response." It is the increased response to growth substance in darkness and has nothing to do with bringing the plants back into darkness. Plants continuously exposed show the response.

In the present experiments the time period was exactly four days, and in that length of time the first internode as well as the coleoptile attained considerable length. The light response of both organs must be considered as well as their interactions. Also the seed and roots in the exposed series received a certain amount of radiation. The problem becomes further complicated when the action of plant growth substances with their production, inactivation, and transport is considered.

Du Buy and Nuernbergk (1934) report an experiment in which monochromatic light of higher intensity (170, later 80 ergs/cm²/sec.) was used. The mercury arc and incandescent lamp with appropriate glass and liquid filters were used. After six days the following lengths of first internodes and coleoptiles are given:

TABLE 6.—*Length of First Internode and Coleoptile in Monochromatic Light (After Du Buy and Nuernbergk)*

Wave length A	First internode (mesocotyl)	Coleoptile	Total length
3663	13.5	39.5	53.0
4358	18.3	44.3	62.6
5461	19.7	51.2	70.9
6000	19.6	46.4	66.0
Dark control	22.5	50.3	72.8

At the end of four days the average length of mesocotyl under each of the five different treatments was given as 1.5. Under the four conditions of illumination, the coleoptile varied in length from 22 in the ultraviolet to 26.6 in the red. The dark value given for the coleoptile was 12.5, approximately half that of the exposed values. At the end of the third day no growth of the mesocotyl was detected. By the sixth day in these experiments the primary leaf had broken through in 90 to 100 percent of the seedlings. In the Smithsonian experiments the primary leaf was usually at or near the top of the coleoptile but had never broken through in the plants of either the exposed or the dark series. From the above table it will be noted that the first internode or mesocotyl of the dark control was longer than those of the illuminated seedlings. The coleoptile was also longer with one exception than those of the exposed seedlings. The reason for this disagreement with our experiments is not clear unless it may be due to a difference in oat varieties used. In the Smithsonian experiments the coleoptiles of the dark controls were always shorter than those of the exposed plants. This was also true on the fourth day in the experiments of Du Buy and Nuernbergk. At the end of six days, with the exception of the group exposed to 3663 A, there is but little difference in total length of seedlings. Here also the total length of their dark control is slightly greater than those of the exposed series.

Du Buy and Nuernbergk (1935) give two explanations as to why growth of the mesocotyl is depressed. First, according to their theory, protoplasmic streaming is correlated with the activity of growth regulators. Temperatures above 25° C. and illumination retard protoplasmic streaming. The cells of the coleoptile will, therefore, retain more growth regulators than are transported to the mesocotyl cells at high temperatures and when illuminated. Hence, under such conditions the coleoptile grows faster than the first internode or mesocotyl. The length of path that the growth substance must travel to reach the cells of the mesocotyl is thus increased and less growth in this latter tissue will result. Their data (1934) and those of Hamada (1931) show, as one would expect from this theory, the mesocotyl cells of illuminated plants to be smaller than those of dark-grown plants. A second explanation is that mentioned by Van Overbeek (1935), who states that a temporary increase in temperature increases the use of auxin, thereby decreasing the amount available to the mesocotyl. According to DuBuy and Nuernbergk (1935), it is very probable that a decreased protoplasmic streaming and an increased use of auxin together cause an increased growth of the coleoptile and a decreased growth of the mesocotyl. The reaction capacity of cells to growth substances may also enter into the problem since such reaction capacities appear to be different for light and for dark exposed plants, as shown by Du Buy (1933), and for plants grown under different humidity conditions, as shown by Gorter and Funke (1937).

The results of several experimenters show that the growth of the first internode may be depressed by light, high temperatures, and decapitation of the coleoptile tip. Van Overbeek (1936 a) depressed mesocotyl growth of maize seedlings by exposure to a temperature of 48° C. for half an hour. The amount of growth substance taken from the tips of similarly treated seedlings was less than that from the controls. That there is a linkage between the amount of growth substance obtainable from the tip of the coleoptile and the growth of the first internode seems evident. It is reasonable to suppose than any condition that would inactivate the growth substance in the tip of the coleoptile or that would interfere with its transport to the first internode would depress the growth of the first internode. From the data here presented, it would appear that radiant energy, even as low in intensity as 1.2 ergs/cm^2/sec., has a very definite influence. Whether this influence is exerted through a direct effect on the growth substance itself or on its mode of transportation through protoplasmic streaming or other means cannot be stated. There also appears to be a wave-length effect. But whether this is a direct effect on the first internode or a secondary one through its action on the coleoptile, which in turn would control the growth substance reaching the first internode, cannot be concluded from these data. Under one set of conditions (darkness) the first internode is long and the coleoptile short. Under other conditions (illumination) the first internode is short and the coleoptile long. It would appear that in the first case the growth substances were not utilized for growth in the coleoptile, but transported to the first internode where the greater amount of growth was found. In the second case considerable more growth took place in the coleoptile. Here it would appear that some growth substance was prevented from acting on the cells of the first internode. In these experiments light was evidently the controlling factor in the distribution of the growth substance.

Reference to figure 4 shows that wave lengths 4050 A to 5500 A slightly depressed the growth of the coleoptile. In this region growth of the first internode was somewhat increased. In the wave-length region 5500 A to 7200 A the reverse effect is noted. Here the coleoptile growth is increased and that of the first internode decreased. Since there is very little difference in total growth of the entire seedling between light and dark conditions, one is led to the conclusion that light of this low intensity functions mainly as a distributing rather than an inactivating factor on growth substance. However, since there was actually a slight difference in total growth, there may also be a slight inactivating influence of light, for the experimental data show slightly greater average growth for the dark control plants than for the illuminated ones.

SUMMARY

Two series of experiments were conducted in which the growth of the coleoptile and first internode (mesocotyl) of *Avena sativa,* Markton variety, was studied in different wave-length regions of the visible spectrum.

Radiation of low intensity greatly depressed the growth of the first internode as compared to that in darkness. On the other hand, growth of the coleoptile was depressed in darkness. Total growth of the entire seedling (coleoptile plus first internode) for the 4-day periods of all these experiments was slightly greater in darkness than in light. Although the total length of seedling was not greatly dependent on intensity of illumination, the ratios of first internode and coleoptile to total length were extremely critical indices to intensity of illumination. It is extremely difficult to get conditions dark enough to avoid light effects on these ratios.

All wave lengths give much the same tendency to decrease the ratio of first internode to total length and this effect increases with light intensity. Yet there is a wave-length effect yielding a minimum ratio at about 6500 A.

It would appear that growth of the coleoptile retards the growth of the first internode and that the growth of the one tissue takes place at the expense of the other. Light probably acts more as a redistributing agent of the growth substances than an inactivating agent. However, even at the low intensities here employed, there was a slight indication that some inactivation occurred, since the average total length of the illuminated seedlings was slightly less than that of the dark controls.

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