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UNITED STATES NATIONAL MUSEUM

BULLETIN 217

SMITHSONIAN INSTITUTION

WASHINGTON, D. C.

1960

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Birds of Anaktuvuk Pass, Kobuk, and Old Crow

A Study in Arctic Adaptation

By LAURENCE IRVING

Research Associate, Smithsonian Institution

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Publications of the United States National Museum

The scientific publications of the United States National Museum include two series, *Proceedings of the United States National Museum* and *United States National Museum Bulletin.*

In these series are published original articles and monographs dealing with the collections and work of the Museum and setting forth newly acquired facts in the fields of Anthropology, Biology, Geology, History, and Technology. Copies of each publication are distributed to libraries and scientific organizations and to specialists and others interested in the different subjects.

The *Proceedings,* begun in 1878, are intended for the publication, in separate form, of shorter papers. These are gathered in volumes, octavo in size, with the publication date of each paper recorded in the table of contents of the volume.

In the *Bulletin* series, the first of which was issued in 1875, appear longer, separate publications consisting of monographs (occasionally in several parts) and volumes in which are collected works on related subjects. *Bulletins* are either octavo or quarto in size, depending on the needs of the presentation. Since 1902 papers relating to the botanical collections of the Museum have been published in the *Bulletin* series under the heading *Contributions from the United States National Herbarium.*

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON, 1960

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Contents

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Acknowledgments

The observations on which I have based these studies were made during expeditions for physiological investigations of adaptation to the arctic Alaskan climate. These were supported by the Office of Naval Research, through the Arctic Research Laboratory, from 1947 to 1949 and by the United States Public Health Service, through the Arctic Health Research Center, after 1949.

I am also grateful to the Arctic Institute of North America for a grant, from funds provided by the Office of Naval Research, to assist our biological reconnaissance at Old Crow in 1957, and for grants from the Explorers Club in aid of the reconnaissance on the Ahlasuruk in 1953 and at Old Crow in 1957.

Sig Wien, President of Wien Alaska Airways, whose many years of arctic flying has brought him a thorough understanding of the features of the country, and Thomas Brower of Barrow, whose keen understanding of life on the arctic coast had led him to suspect that many birds reached there by migration through the mountains of the Alaskan interior, were instrumental in leading me to choose the central Brooks range as the key to the faunal situation in arctic Alaska.

Thomas P. Brower of Barrow, son of Charles Brower, also pointed out to me the probable significance of the mountain passes as migratory routes of the birds which he knows so well on the Arctic Coast and related to me many pieces of information, sustaining that view, derived from his own observations on the coast and accounts of Eskimo travelers in the interior. In 1949 he made extensive collections and observations for me at Anaktuvuk which early presented an outline of the migration. Since that time his friendly advice has repeatedly helped to sustain my studies of arctic Alaskan animals.

Since 1950 my colleague John Krog has joined me in physiological studies of the effects of arctic temperature. I owe to him many long-sustained observations, and I have gained from him many clear views of arctic life which were supported by his vigor and skill in combining experimentation in the field with studies in the laboratory.

My colleague at Point Barrow, and later in Anchorage, Raymond Hock, has given me much assistance from his observations at Tuluak Lake during a few days in the spring of 1948, and from his observations on land and from the air in the lower Colville Valley during that summer.

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Robert Rausch first went with one of our expeditions from Point Barrow to Tuluak in 1948. He has since then intensively studied the mammals and parasites of the Anaktuvuk region (Rausch, 1951, 1953) and he has generously given me many keen observations and numerous specimens of birds. Neal Weber joined one of our expeditions to Anaktuvuk in 1948, and he has subsequently made important contributions to our knowledge of arctic insects (1948, 1949, 1950).

Carl Henkelman also accompanied one of our expeditions in 1948, in order to make a survey of the dentition of the mountain Eskimo, finding dental conditions excellent among these people subsisting almost exclusively on meat. Vladimir Walters in 1949, studied the fishes in the region of Tuluak Lake (Walters, 1955).

Lloyd Spetzman in 1949 made collections of the flowering plants at Anaktuvuk Pass, and George A. Llano, a former colleague in numerous undertakings, in the summer of 1949 collected lichens (Llano, 1950). Attracted by accounts of the mountain people, my son William Irving accompanied me in 1950 and 1951 in the Anaktuvuk and Killik Valleys to examine the people anthropologically, and has found many artifacts of flint and bone in sites occupied by the former human inhabitants of the mountains (William Irving, 1951, 1953).

It is with great pleasure that I acknowledge the helpful and pleasant association with these good colleagues in an area where our common interests in natural history could be well rewarded. Our separate observations have built up a good view of the background of life in the arctic mountain valleys, and have affirmed the early predictions of Tom Brower and Sig Wien as to the strategic importance of the locality for the advancement of biological knowledge in arctic Alaska.

I am sure that I express the views of all these scientific visitors in acknowledging with gratitude the hospitality and assistance of the mountain Eskimos. Without their help, existence for us would have been too difficult to permit methodical scientific investigation; thanks to their careful observations, accurate knowledge of country, and ability to travel, our studies proceeded rapidly. In these people, who live in primitive fashion, I have found a proud regard for accurate and penetrating observation. In their complete knowledge of their country they find the basis for a philosophical appreciation of nature which has added admiration to my feeling of grateful friendship.

From Alexander Wetmore, I have had kind assistance in naming several forms of birds, along with a continuing personal interest which I gratefully acknowledge. Remington Kellogg, who has always been a stimulating friend to field research, has cordially facilitated my working at the U. S. National Museum. Herbert Friedmann has given me much critical help and encouragement particularly in prob-

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lems of distribution and systematics. Ira N. Gabrielson has assisted me with determinations and information from his wide experience with Alaskan birds. While I take responsibility for the determinations, except as noted, I could not have undertaken them without the guidance of Herbert Friedmann, nor would I have compiled the studies without his help and encouragement. Herbert Deignan was most ready in extending to me the use of the collections and working facilities of the Museum, and Bernard Feinstein aided the identification of the specimens from Old Crow by making many comparisons and references, including a complete review of my arctic specimens.

The collections made include skins and sets of eggs with nests, which are deposited in the U. S. National Museum, where I was kindly afforded opportunity to compare the skins with those in the collections. Most of the series of birds were quite uniform and conformed with the average characteristics of their kind, so that identifications were, in general, not difficult.

In his editorial capacity John Lea has suggested many arrangements of the text, tables, and figures which would clarify the presentation of the information.

Whatever is interesting and worthwhile in this work I wish to dedicate to my wife and to our son Alan, whose short life was marked by its great promise.

LAURENCE IRVING

Anchorage, Alaska
February 1959

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Birds of Anaktuvuk Pass, Kobuk, and Old Crow

PLATE 1.
ANAKTUVUK PASS
(U. S. Air Force Photo)

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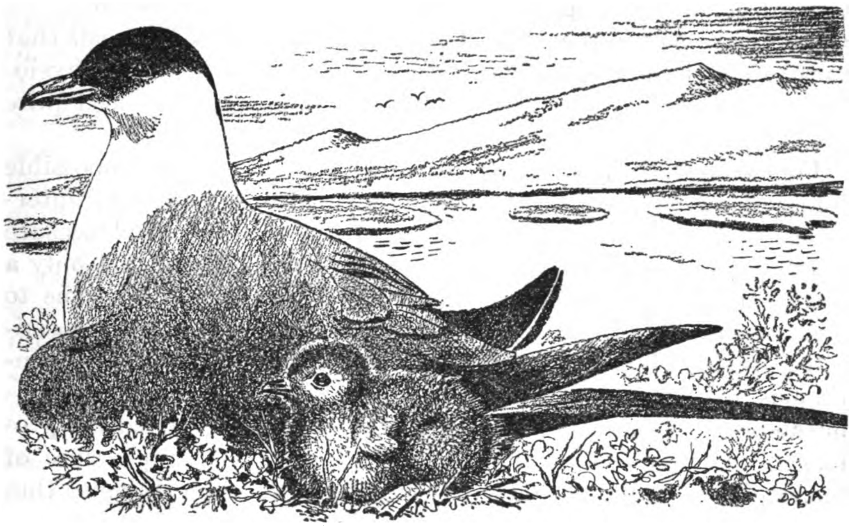

LONG-TAILED JAEGER *Stercorarius longicaudus* (see pp. 78, 200, 247).

1. The Background

WHEN I ENTERED the field of physiology after World War I, scientific research was beginning a period of rapid expansion. Accompanying this expansion, to enlarge the scope of scientific observation, was a corresponding development of increasingly complex instrumentation. For the analysis of physiological processes this instrumentation is essential, but it is most easily applied in the laboratory to the reactions of domesticated animals.

A consequence of this need to observe animals in laboratories is that the physiological reactions are seldom viewed in context with the natural situations in which the variety of responses evolved. In the various natural situations in which each species finds itself, animals have only the power of their intrinsic physiological and social processes with which to meet the environment and maintain the orderly distribution of life. Under domestication the artificial selection that produces animal varieties is exercised by processes extrinsic to natural biological systems. This extrinsic process is arbitrarily applied by human choice to decide the forms and associations in which life will

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exist in proximity to man, whereas natural selection proceeds according to natural law.

Thus, in spite of the progress in biology resulting from the application of new physiological instrumentation in the laboratory, we usually have had to speculate about the mode of life of animals that survive under those particular natural conditions which the physiological processes we were able to study in the laboratory seemed quite inadequate to cope with.

For example, the prolonged dives of whales and seals are impossible for land animals, which are characteristically intolerant of interference with breathing. But as soon as I began to observe and measure characteristics of respiration in diving animals, I found that only a small range of the respiratory capability of mammals had come to view because the laboratory study had been limited to a few domesticated species whose rapid breathing concealed the basically discontinuous process of respiration which supplies oxygen for continuous metabolism. I found, for example, that when a seal dived the prolonged intervals between its breathing magnified the appearance of the respiratory reserves and lengthened the cycle of breathing so that its sequential processes could be separated.

As a further consequence of their adaptation of respiration to long periods of interrupted breathing a few species of mammals and birds can enter waters which are well stocked with cold-blooded animals. These warm-blooded birds and mammals, with their air-breathing habit primarily suited to land, have a physiological mechanism superior in its output of power to the cold-blooded mechanisms. This special adaptation of respiration has enabled them to use the superiority of their warm-blooded metabolism for the exploitation of an aquatic environment.

Plans for Arctic Studies

A concern for these subjects led me, during World War II, to a tour of duty in the Air Force, during which I was engaged in developing techniques for human survival in the Arctic, and my interest in that region thus become aroused. When, therefore, in 1946 I returned to the Edward Martin Biological Laboratory at Swarthmore, I began, with some colleagues who, like myself, had just been released from the confinement of military service, to examine the prospects for further investigations in the Arctic. We saw that the establishment of routine transarctic air transport was opening the region to common experience, and that a new phase of Arctic exploration, involving comprehensive and intensive scientific research, was required to provide the information upon which would depend the establishment of extensive human life there.

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The present sparsity of human population in the Arctic and Antarctic gives the impression of vastness, but these nevertheless are the smallest of the earth's climatic regions. Concentrated in the ice of these limited areas are stored relics of ancient weather which buffer the seasonal changes in temperature produced by current rates of solar heating of the earth. Winter in the Arctic is so much colder than the freezing temperatures at which vital processes slow down to unproductive levels that it is, in a way, surprising to find there many animals and plants which indicate their long arctic establishment by having evolved special arctic forms. On the other hand, it is even more surprising that some arctic species are scarcely distinguishable from closly related populations living in warmer climates.

Only a small number of mammals, about 30 common species, and a similar small variety of birds, are resident in the Arctic, owing to the uniformly cold winter climate and the limited extent of the area, so it seemed feasible to make a comprehensive survey of their essential physiological adaptation to cold.

Research at Barrow

It was from these beginnings that plans grew for an expedition to make physiological studies of adaptation to arctic cold at Barrow, Alaska. This northermost point on the American Continent (latitude 71° N.) had the added advantage that an elaborate base was being established there to support exploration in the Naval Petroleum Reserve covering a large area in arctic Alaska. Means for support of the expedition were generously provided by the Office of Naval Research, stimulated by the interest shown by M. C. Shelesnyak, and in August 1947 seven members of our expedition of physiologists reached the Point Barrow navy station by air, a few days ahead of the arrival of our heavy equipment by boat.

Per F. Scholander, who had been my colleague for eight years at Swarthmore and in the Air Force, provided the scientific insight and vigor, as a result of which our program of research soon showed significant progress toward understanding physiological adaptation to arctic cold. These prospects encouraged us and the Office of Naval Research to extend our stay for a second year.

We found, however, that the investigation of physiological adaptation involves consideration of the many biological and physical conditions which define the environment to which animals and plants are suited by adaptation. Our need to consider these environmental conditions served to outline the wide scope of scientific research which could be usefully undertaken in arctic Alaska. As a result the Office of Naval Research was led to name the small quonset hut occupied by our party of physiologists the Arctic Research Laboratory, and during

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the winter I was asked to prepare a plan for a larger laboratory structure. From the skillful designs of Ben Atkinson, and with energetic construction by the Arctic Contractors, the new laboratory was ready in the summer of 1948 to be occupied by about 40 scientists. About 20 remained during the winter of 1948–49.

The summer of 1949 Scholander and I spent compiling the results of our studies in Alaska. George MacGinitie had taken over direction of the Arctic Research Laboratory. I was more attracted to research in the field than to the duties which tend to surround the direction of scientific programs, and as Joseph C. Mountin and Jack C. Haldeman were preparing to establish for the Public Health Service at Anchorage a laboratory for studying conditions basic to the maintenance of health in arctic Alaska, in the autumn of 1949 I joined them in the Arctic Health Research Center, where I have since continued my studies on adaptation to arctic cold.

At Barrow in 1947 we had found the birds of the arctic coast fairly well identified by the succession of naturalists (Bailey, 1948) who followed the pioneer study of Murdoch (1885) during the First International Polar Year. It is interesting that Ray (1885), the young lieutenant of engineers in charge of making these two years of geophysical recordings, also made the first significant anthropological report on the arctic Alaskan Eskimo. The coastal mammals, too, were known in 1947 but, as with the other fauna, their distribution and relations to terrain and seasons could not be described from the occasional collections which had been made. Only a few land animals can live through the long cold winter of the arctic coast, with its strong and often violent winds; and from June through August, when overcast skies and fog are more common than sunshine and snow flurries and frost occur frequently, warm days are too rare to produce more than a scant growth of vegetation for their sustenance.

The Interior of Arctic Alaska

For our studies we needed to know a greater variety of animals than we could find along the arctic coast and so we turned toward the interior of arctic Alaska. It is true that much had been earlier observed in the interior of arctic Alaska, but the biological information was discontinuous in time and space and restricted to identification of forms in only a few systematic categories. Geologists had surveyed the interior. During the winter of 1926–27 A. E. and Robert Porsild (1929) traveled by dog team from Buckland River along the Alaskan coast to Aklavik, surveying the flora and conditions for the route of the Canadian reindeer herd which was subsequently settled on the eastern side of the Mackenzie Delta. In 1947 there had been no reports on man or animals in the interior north of the ornithological

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survey of Grinnell (1900) and the archeological exploration of Giddings (1952) along the forested part of the Kobuk River. Olaus Murie (1928) had reported on some of the birds which he found along the Koyukuk and Alatna Rivers, but otherwise the arctic interior of Alaska and Yukon was biologically unexplored.

It was the necessity to obtain more animals that first sent some of us on short trips inland from Barrow. Gradually the scope of these trips increased, but the distribution and habits of the animals were unfamiliar, and without more information about their environment we were in a poor state for estimating the adaptive significance of their physiological processes. At first I could not imagine by what means we could acquire the necessary comprehensive information about biological conditions in the area of interior Alaska for 300 miles north of the arctic circle and ranging 700 miles eastward from Cape Lisburne to the Mackenzie Delta.

Fortunately Sig Wien, president of Wien Alaska Airways, was then often at Barrow, and because he had been flying over arctic Alaska for a number of years he thoroughly understood the features of the country. Tom Brower, a native and merchant of Barrow was also a good adviser, for Tom, his eminent father, Charles, and his brothers knew the arctic coast and its adjacent interior. He could view the country as a naturalist of experience, for his family was credited by Bailey (1948) with making known 63 of the 153 species of birds recorded from Barrow. To Wien and Brower the key to the faunal situation in arctic Alaska appeared likely to be found in the mountains of the Brooks Range. Bailey (1948, p. 177) expresses Brower's view: "He stated that there is a definite migration route over the Endicott Mountains and down the Colville, and that many water birds use this route to and from the eastern arctic coast."

We decided upon the system of passes about Anaktuvuk as the most favorable starting location for several reasons. The several passes that interconnect in that region constitute the primary system of easy northward passage of the Brooks Range overland or for low-powered aircraft west of the Canadian border and the air transport route to the arctic coast follows Anaktuvuk Pass (fig. 1), through which low-powered aircraft in contact flight can guide upon a well defined valley with ground elevations below 2,500 feet. In this complex of passes, lives a small community of inland Eskimos, who were said by Wien to know thoroughly the terrain and the wild life of their native mountains. His estimate of these people gave us reason to think that with their aid we might make a biological survey in an area where to establish our own bases and to travel unguided would require impossible expeditionary effort in time and expense.

I decided to utilize my interest in birds for developing a picture

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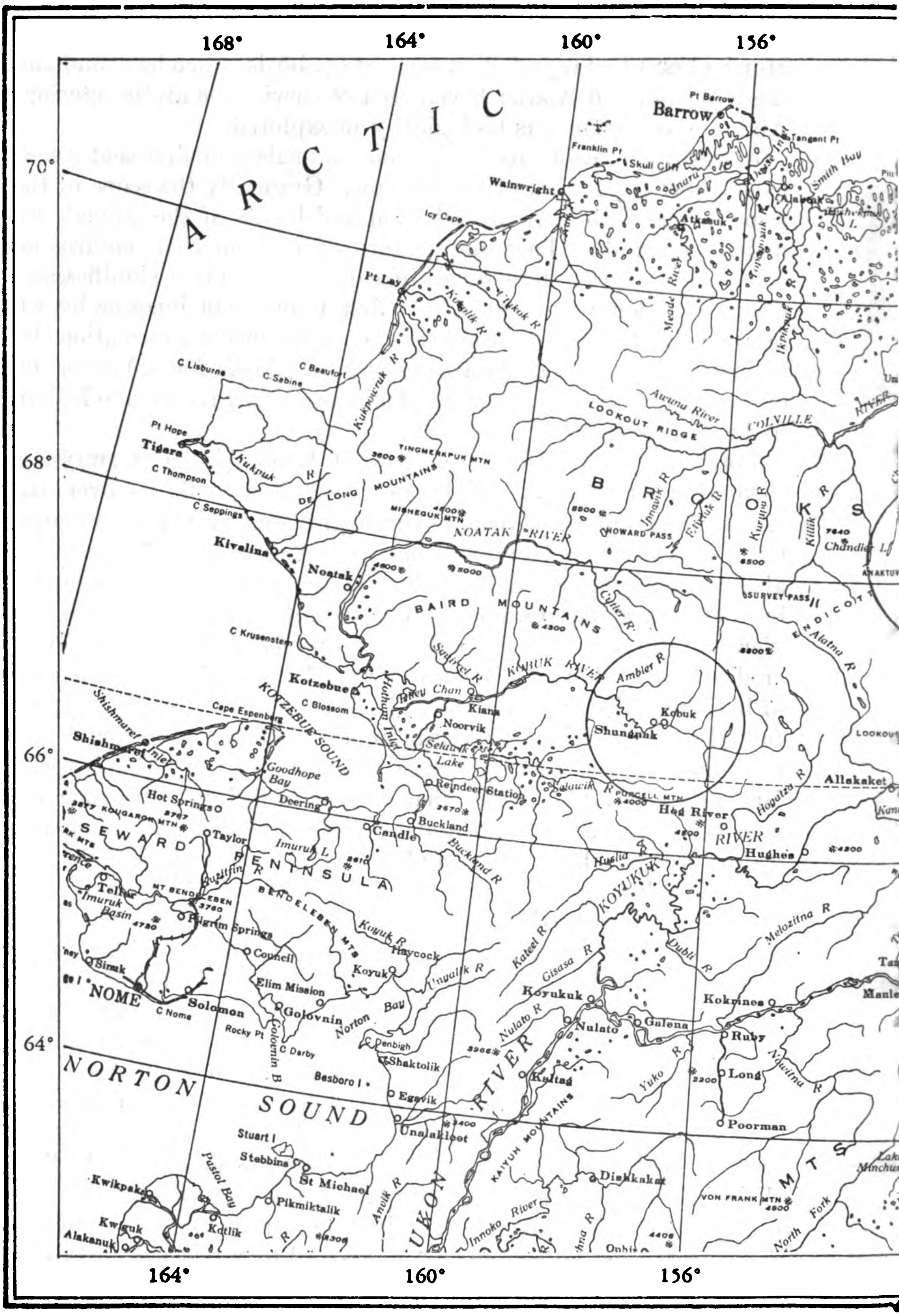

FIGURE 1.—Alaska, showing the principal localities discussed: (1) Anaktuvuk, (2) Kobuk, (3)

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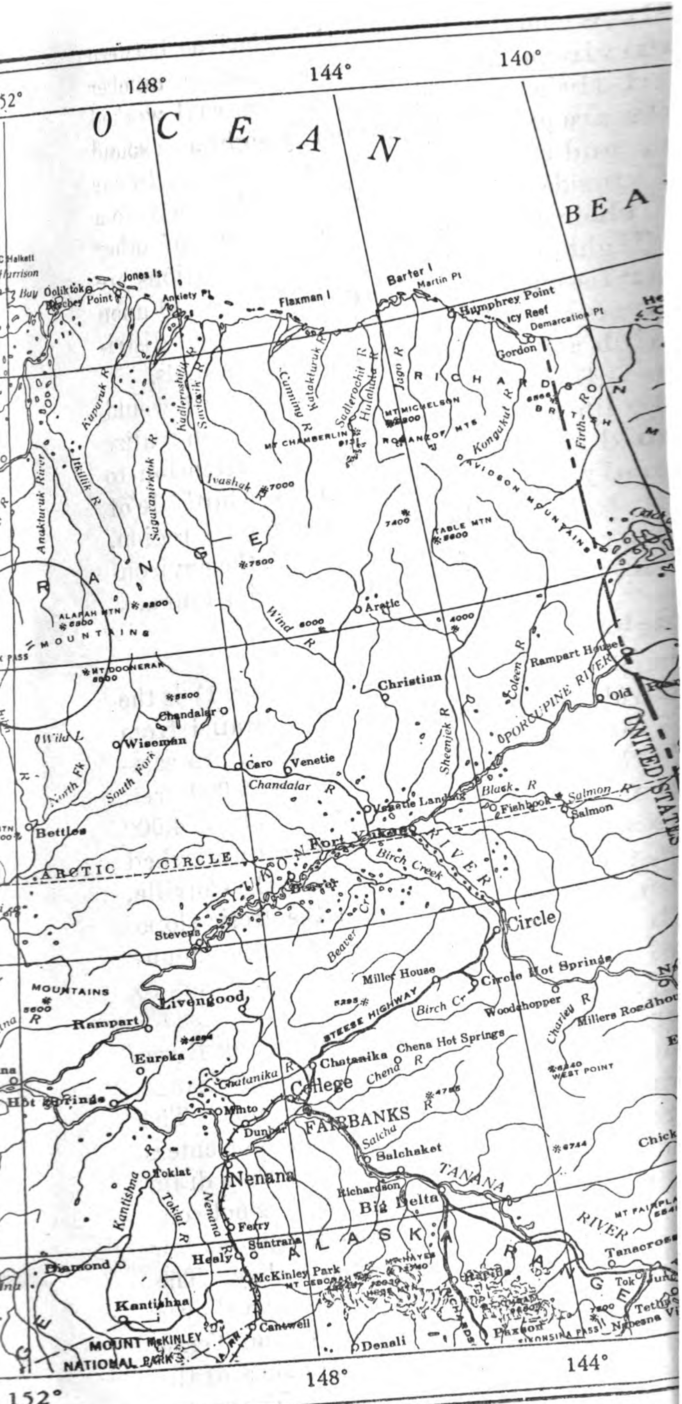

Old Crow. (From U. S. Geological Survey, Alaska, Map A, 1947, r

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nal group which would well indicate the relations between ıals and their environment. There are a sufficient number ety of birds, and their taxonomic relations are well worked e ourselves, birds are principally directed by sight and sound ties by daylight, and so they demonstrate themselves to our to their own. Consideration of the relations of animals to a brings to mind their connection with populations of other and the visible flight of birds indicates how populations are ed. In particular the migrations of birds had impressed upon est that their courses annually exhibit the operation of distri- inclinations which are invisible in sedentary animals.

ıot anticipate in 1947 that for the ensuing 12 years I would ng adaptations to life in arctic Alaska, nor did I then realize ıy biologists would become associated in their attention to . But after several years it was apparent that the bird life of aska indicated it to be a well characterized faunal region, s led to look for the geographic features by which the environ- ght be defined as a habitat for its somewhat special fauna.

ıphy of Arctic Alaska

incipal physiographic feature of arctic Alaska (fig. 1) is the Range, which extends eastward near the 68th parallel from burne for about 700 miles to the Mackenzie Delta. In east- ka the peaks of the Brooks Range rise above 9,000 feet. ninish in the center to about 7,000 feet, and to about 4,000 in 100 miles of the western coast. In the northern watershed short swift rivers, the central ones draining into the Colville, ws eastward through the rolling tundra of the arctic slope. he Colville mouth the coast approaches close to the moun- d north of the Colville the arctic slope gradually lowers to stal country of many lakes.

the southern watershed the westerly flowing Koyukuk River he rivers from the central mountains of the Brooks Range se in the east drain into the Yukon and Porcupine. The River runs west from the western Brooks Range and enters Sound just north of the Kobuk River; together they drain western base of the Range. Although the Kobuk is not con- ith the Yukon River, its southern watershed is open at low s to the Koyukuk Valley and so to the Yukon Valley. The River flows into the Yukon and from its upper valley a v pass leads to the upper Yukon Valley. In Yukon Terri- Porcupine River, draining the southeastern watershed of the ange, forms a continuation of the Yukon Valley. The south- shed of arctic Alaska thus is the northern part of the great

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Yukon Valley system, which provides a continuous valley across northern Alaska and Yukon Territory extending from the western coast to within 50 miles of the Mackenzie River without significant obstruction to the distribution of animals. McDougall Pass, at an elevation of 1,200 feet through the Richardson Mountains, is the lowest and shortest pass through the western mountains of North America.

Arctic Climates Present and Past

The northernmost treeline in America is in arctic Yukon. East of the Mackenzie River the forest retreats from the arctic circle and its distribution roughly follows the June isothermal line of 50° F. mean temperature, which reaches the Arctic in the interior of Alaska (fig. 2). In winter, interior northern Alaska and Yukon include the coldest part of North America, but in summer warm air from the north Pacific tempers the northwestern interior climate as far north as the Brooks Range. North of the Range the cold summers of arctic shores prevail. Many birds and mammals can endure any degree of arctic cold, but their existence depends upon the provision of food which is ultimately the product of vegetation. Many plants also endure cold but their growth occurs in summer warmth. The vegetation that results from these climatic conditions in the Yukon Valley enables the woodland animals there to reach their northernmost limit in America.

Since summer temperatures are cold north of the mountains and warm on the southern slope, in passing northward across the Brooks Range a rapidly cooling gradient of summer temperature is experienced. This steep northward gradient is peculiar to western arctic America, for east of the Mackenzie Valley summer warmth equaling that in the northern Yukon Valley reaches only as far north as James Bay. The northward extension of summer warmth into western arctic America is the result of conditions in the earth's circulation of heat which have been long in operation. This is shown by the southern limit of extensive permanently frozen ground in North America, which in Alaska lies north of Anchorage (lat. 61° N.), while in the middle of the continent around James Bay it extends farther southward by about 8 degrees of latitude. Near the arctic coast of Alaska exploratory drilling for petroleum shows that permanently frozen conditions extend for 1,000 feet below the surface. (Black, 1951.)

Relics of the great American ice fields of the past now exist only in southeastern Alaska although evidence for recent, more extensive glaciation is shown in the gradual invasion of vegetation into valleys from which it is apparent that glaciers have recently melted. The western limit of Alaskan glaciation extended only as a shelf into the

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deep and warm Pacific Ocean. The southern foot of the ice cover of the Wisconsin age was at about latitude 60° N. in central Alaska, while the midcontinental ice fields extended 15° farther southward.

In the late Wisconsin age continuous ice fields discharged glaciers north of the Alaska Range to form moraines along the southern sides of the Kuskokwim and Tanana Valleys (Péwé, 1953). North of the Brooks Range, the Wisconsin age glaciers also extended just beyond the mountains. In general it appears that in Alaska north of about latitude 64° extensive lowland areas were not then covered by ice and that the continuous ice cap in central Alaska extended farther southward across only about 5° of latitude (see map, fig. 3). McConnell (1890) first remarked that the northern part of Yukon Territory appeared to have been free from the continuous ice which covered the country far to the southward and which probably extended over

SEA-LEVEL ISOTHERMS : JANUARY (°C)

FIGURE 2.—Sea-level isotherms for January (left) and May (right). (From C. F. Brooks, Univ. Press, 1936,

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the arctic coast east of the Mackenzie (Flint, 1947). So in western arctic America the glacial regime appears to have left large areas in the Yukon-Porcupine Valleys and on the arctic slope of Alaska free from ice fields during the late Wisconsin age. The conditions northwest of the American ice cap were quite different from those on the massive ice sheets which continuously covered the rest of Alaska, Canada, and some northern States.

The records of glacial geology lead Flint (1947) to propose that Bering and Arctic seas were frozen during the last great Wisconsin glaciation, and that the precipitation forming the arctic ice caps came from the tracks of storms like those of the present. This moisture would then have originated in the temperate oceans. However, recently acquired oceanographic evidence of the history of temperatures in the Atlantic Ocean has led Ewing and Donn (1956) to a novel

SEA-LEVEL ISOTHERMS : MAY (°C)

A. J. Connor, and others, "Climatic Maps of North America," Cambridge, Harvard maps 1 and 3.)

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hypothesis that the moisture for the latest American ice cap came from the Arctic seas, which they postulate as unfrozen while the maximum glaciation developed. Geological and geophysical methods are rapidly developing evidence of climatic history, which is probably closer to elucidation than is indicated by these contrasting views on the climatic mechanisms of glaciation.

For the present we must be cautious in postulating what the climate was like on the arctic coast of Alaska adjacent to a sea which might have been frozen or unfrozen but in the interior the climate could not have been warm and was probably cold in the proximity of the great ice cap over the Alaska Range and the extensive glaciation in the Brooks Range. It appears that, in most of the ice-free northern American area which was connected with Siberia, the climate in the area that served as a "refuge for survival" was at least cold and could suit only animals like those now hardy in the north.

Climate and the Animal Populations

The masses of water frozen in polar and arctic ice near the end, and apparent maximum, of Wisconsin glaciation so reduced the oceans as to connect Alaska and Siberia over Bering Strait. Fossils of extinct animals as well as the systematic relations of many animals now found, indicate that some taxonomic groups in America derive from Asiatic predecessors and some in Asia from American predecessors. It is popular to speculate that the intercontinental exchange implied in the relations of the present and fossil animals of America and Asia was effected by traffic over the land bridge.

On the basis of systematic relations and the geographical and chronological sequences in which they are found, it is reasonable to propose that between Asia and America migrations have occurred that have altered the previous geographical distribution of animals. Walters (1955), for example, has shown that the land bridge of the late Wisconsin age could have lead to the present distribution of fresh water and coastal fishes in western arctic America and eastern Siberia. In the aquatic environment of fishes in the north, the temperature is always above freezing, but not much warmer, and suitable climatic conditions for fishes can be reasonably inferred for the waters about the recent land bridge.

Most of the species now living can be traced through fossil records to Pleistocene times but their evolutionary modification has been too slow to produce variation in form which would indicate an exchange between Alaska and Siberia in Recent time. A number of land mammals, many conspicuous by their size, have become extinct since the Pleistocene, some of them only a few thousand years ago (Flint, 1947). Unfortunately the situation of their remains in Alaskan loess

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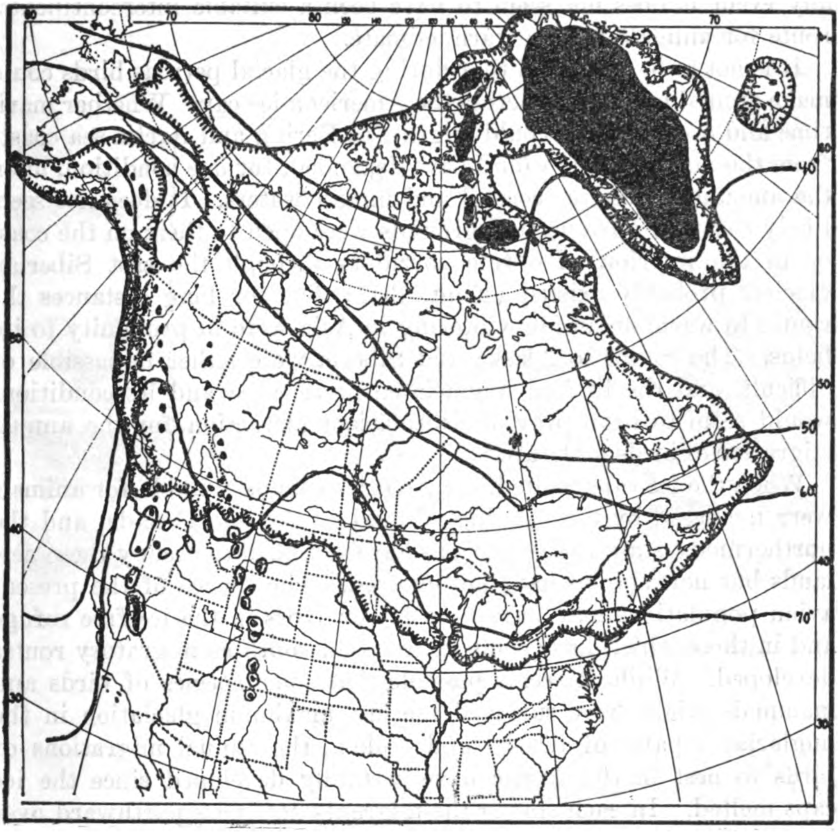

FIGURE 3.—Glaciation of the Wisconsin age compared with that of the present. Black areas are existing glaciation, hachured outline marks limits of Wisconsin glaciation, isotherms are present July means in degrees F. (From L. S. Dillon, "Wisconsin Climate and Life Zones in North America," Science, vol. 123, fig. 1, 1956.)

deposits do not well preserve the record of the surroundings in which they lived, and we cannot yet list by their remains the land animals which existed in Alaska during the last great glaciation about 10,000 years ago or say whether any then changed their range by migration over the land bridge.

If, as it appears, new species have not evolved during the Pleistocene, and these animals have passed through the climatic variations of recent ice ages without much evolutionary change in form, then the mammals and birds resident in ice-free arctic America and Siberia during the Wisconsin age could have been like those now resident there. Some of the large mammals have recently become extinct and some have moved in from the south since the ice sheet melted. By that time, however, the land bridge probably no longer existed, and in

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any event it does not seem to have been a suitable intercontinental route for animals from a warm climate.

It is not to be suspected that during the glacial periods birds could make annual migrations across the American ice cap. Whether maritime and oceanic birds could migrate to Bering and Arctic sea coasts from the north Pacific would have depended, for one condition, upon the amount of ice-free coastal and inland waters. It does not seem likely that extensive nesting grounds were open to them on the coast or in the interior. Ice free corridors through the east Siberian glaciers probably existed (Flint, 1947), but for long distances the routes to warm areas for wintering in Asia were in proximity to ice fields. The routes to Alaska and Siberia were either impassible or difficult, and the limited unglaciated arctic area and its conditions would seem to have provided insufficient attraction for the annual migration of birds to the arctic.

When the ice caps melted, the American lands suitable for animals were increased by the opening of most of Alaska, Canada, and the northernmost states. Populations have extended to occupy these new lands but new species have not evolved. The source of the present avian populations may have been in survivors in the ice-free refuge and in those which have come in from the south as migratory routes developed. While it seems possible that some species of birds and mammals might have survived the last maximum glaciation in the unglaciated parts of Alaska and Yukon, the annual migrations of birds to nest in the Arctic have certainly developed since the ice caps melted. In each spring the migrants now pass northward over lands which have only gradually become occupied during the last 10,000 years. Many of the populations that pass annually from a warm wintering place to nest in the cold arctic spring encounter cooling climatic gradients by their own movements, thus reversing the seasonal transitions in temperature encountered by northern sedentary populations. All the expanding populations of Canada and most of Alaska have had to adjust to the new and changing conditions of the environments in which they have settled. They have also had to adapt social habits to the requirements of moving and developing populations. The animals which live near the arctic limits of life must have possessed a great range of adaptability toward environmental and social conditions to have succeeded during the changes of the last 10,000 years.

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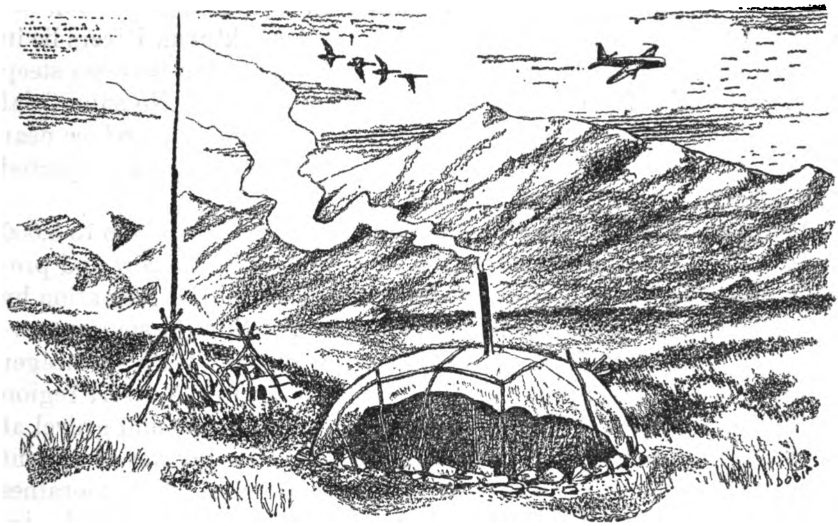

U. S. Post Office at Summit, Anaktuvuk Pass, 1951 (see p. 25).

2. *Anaktuvuk Pass*

From the borders of Yukon Territory westward to the sea the broad valley of the Yukon River offers no barrier to the flight of birds. Along the northern part of the central Yukon watershed the Koyukuk is its principal tributary, running approximately west near the southern border of the mountains. Near Bettles the John River enters the Koyukuk, after flowing about 90 air miles south from the divide locally called Summit (lat. 68°10′ N., long. 151°40′ W., elevation about 2,400 feet). Just north of the divide at Summit the Anaktiktoak River comes in from the eastward to join the head of the Anaktuvuk, which then runs about 100 miles nearly north to the Colville River.

A forest of spruce with some birch lines the John River and extends up its tributary valleys to maximum elevations of 3,500 feet on southward slopes as far north as Publatuk Creek, about 30 miles south of Summit. In the main valley, tree line is passed below 2,000 feet, where the forest terminates abruptly. Northward, willows are restricted to certain areas in the valley. In some places they may reach

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a height of 15 or 20 feet, in others they are only a few feet high. A few small cottonwoods occur in occasional and restricted areas and a few alders are found at Akvalutak Creek.

Northward in the John River Valley the traces of glaciation become more apparent, and the upper John and Anaktuvuk Rivers lie in an obvious glacial cut trough about 3 or 4 miles wide between steep mountain walls of much dissected metamorphic rocks. No superficial ice now remains permanent in the Pass, but a small mass of ice near tree line in the upper John Valley, not now evident, was reported by Schrader (1904) as of glacial origin.

Along Anaktuvuk Pass the mountains rise steep and sharp to 5,000 or 6,000 feet. Through their walls enter occasional narrow and precipitous valleys much eroded by water since their initial formation by tributary glaciers from former high snow fields. Now the sparse snowfall outlasts the hot June sun in only a few places. With its meager precipitation this country has some resemblance to the desert region in the southwestern States. The wide fans of boulders and gravel at the foot of the tributary streams attest the occasional power of ancient slides and occasional flood flow, and the appearance of lateral moraines on the mountain walls west of Kalutak Creek suggest that the ice levels of the glacier may have been 1,000 feet above the present floor of the John River Valley. The northern margin of the mountains rather sharply forms a mountain line, north of which only an occasional elevation rises to 2,000 feet among generally long-sloping smooth hills.

At the base of the steep side walls of the valley the talus slopes end at a level a few hundred feet above the valley floor. Below that level the gently sloping terrain is often dry and sparsely covered with short vegetation over the occasional, well drained areas of gravel. More often the surface is wet and irregularly spotted with hummocks of sedge clumps called niggerheads. The small tributary stream beds are often elevated upon fans of their own detritus, into which they cut annually varying channels. These are frequently lined with willows that are a few feet high near the mountain walls and up to 12 or 15 feet high in occasional stands along the river flats, where the basal trunks may be 5 or even 6 inches in diameter.

From the junction with the larger east fork (Anaktiktoak) just below Kangomavik, the Anaktuvuk meanders north in the mountains for about 15 miles through a flat valley floor of sand and gravel among small moraines, leaving several cutoff, or oxbow, lakes (see map, fig. 4). On the tundra adjacent to the river are many marshes and small lakes, some of which are of the strange but not unusual arctic type resembling limestone sinks, with steep sides cut deeply into the per-

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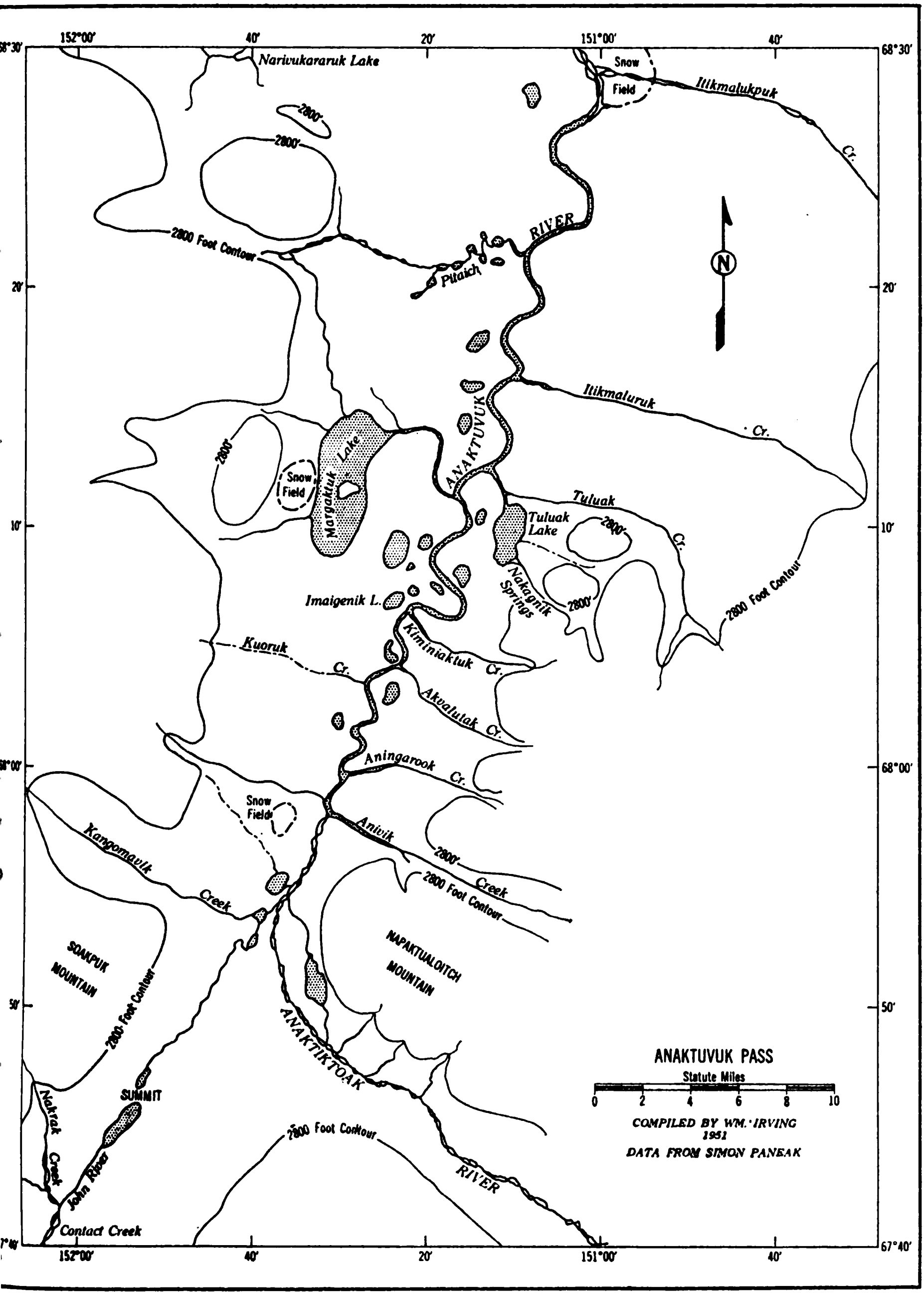

FIGURE 4.—Sketch map of Anaktuvuk Pass.

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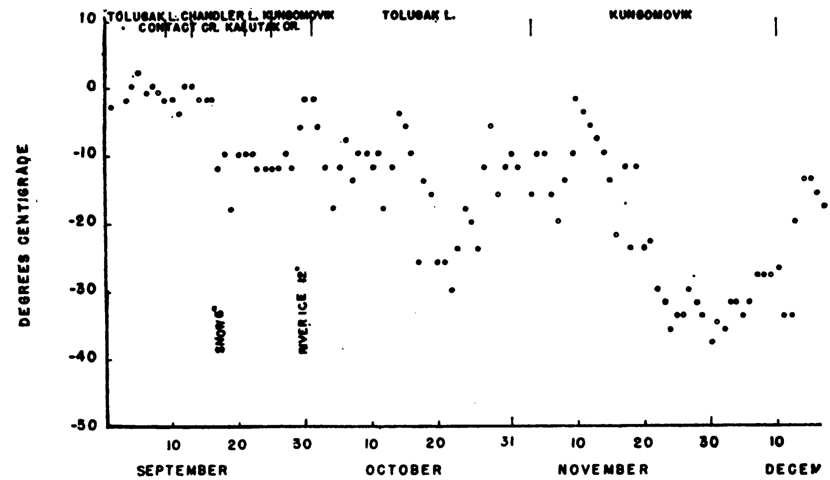

FIGURE 5.—Temperatures in Anaktuvuk Pass. Top: Winter temperature 1948–1949, taken daily at 8 a.m. (from the journal of Simon Paneak). Bottom: High and low temperatures, spring 1951 (from the journals of John Krog and Simon Paneak).

manently frozen foundation of the tundra. Few of the lakes in the valley are a mile in length.

Tuluak Lake on the east side of the valley (Lat. 60°19′ N., Long. 151°26′ W.), is formed principally by the clear streams from Nakagnik Springs, rising from about a quarter-mile east of the lake, and in places is open throughout the winter. Tuluak is a deep lake, nearly a mile in length, well stocked with grayling, a large and a small char, small lake trout, and whitefish. It is a pleasant spot, much frequented by migrating birds, and is still a favorite Eskimo campsite. Local stories and traces of old habitations nearby indicate its ancient importance to the mountain Eskimo, who formerly called that portion of the valley Tuluak, meaning "raven." The Eskimos say that they called the valley Tuluak and applied Anaktuvuk to another valley east of there. Schrader, who named the localities (1904), was apparently not guided there by the mountain Eskimos and he applied some names varying from historic Eskimo usage. Subsequent maps have often failed to use established aboriginal names and have applied trite, meaningless English names.

Weather and Climate

The record of temperature in figure 5, prepared from observations by Simon Paneak and John Krog, shows no extreme cold, but sudden fluctuations in winter temperature often occur. These changes are frequently accompanied by winds so violent and turbulent that, particularly in the Killik Valley, Eskimo boys were taught that winter travelers must camp only at sites known from experience to be shel-

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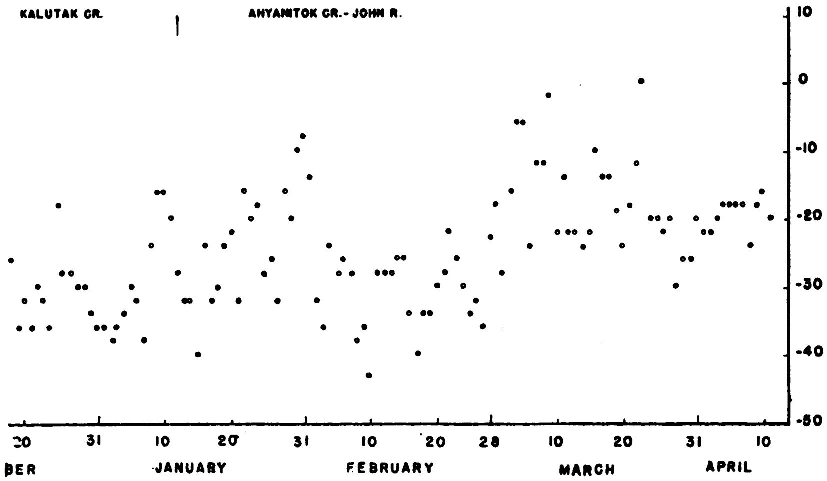

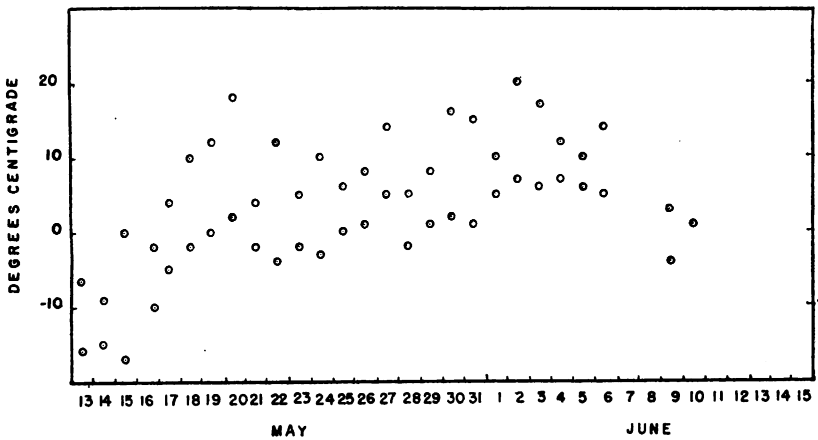

tered from the dangerous force of the winds. The power of the winds is shown by the wind erosion of the high rocky pinnacles above Kangomavik, by many large old dunes along the river, and by the furrow-like depressions on the surface of old dunes now covered with vegetation. In the Killik Valley these old and at present fast-building dunes are spectacular. From early June to mid-August storms are rare and in July the weather has often been the most delightful I have experienced.

North of the timbered southern slopes snowfall is sparse, probably not over two feet in winter, and it is usually drifted and compacted nearly but sometimes not quite hard enough to bear a man's weight, so that small snowshoes are in common use. Many exposed areas are blown free from snow, thus clearing the vegetation for the caribou

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and rock ptarmigan to feed upon. The branches and twigs of the willows protruding through the snow are exposed during most of the winter. Since the larger arctic animals and birds are not bothered by winter cold (Scholander, Hock, Walters, Johnson, L. Irving, 1950; L. Irving, 1951), the exposure of their sources of food gives a certain advantage to tundra residents over those in the windless forest areas where snow and frost cover the branches as well as the ground.

The lakes are not usually iced over until late in September, but by early October the ice may be a foot thick. On any extensive ice surfaces the snow may be blown into hard drifts with extensive clear areas, so that the frequent winds facilitate winter travel for men and animals. Thus, if properly considered and utilized, the tempestuous winter weather in the mountains facilitates the feeding of animals and the travel of man. And, in fact, the variety of human artifacts found widely distributed in Anaktuvuk and Killik Valleys (W. Irving, 1951, 1953), shows that people using Mesolithic implements once inhabited these valleys.

In late May the winter snow has generally melted or evaporated and the streams and rivers have broken through to flood over the ice which still remains fixed to the bottom. In some lakes the ice may remain sufficiently firm for landing light aircraft until after June 10, although the margins of many lakes are open sufficiently for the feeding of shore birds and ducks after the middle of May. Fresh snowfalls and cold freezing weather occurred in the first week of June in 1948 and 1949, and in 1949 another period of several days followed, around June 20, when the ground was covered with 6 inches of fresh snow. These June snow storms obviously harassed the shore birds, for they then had no place to feed or land except upon a few rocks protuding above the stream beds. The distress of the expressive yellowlegs and tattlers was pathetic to watch. Many nests were covered and the eggs destroyed by the snow; and yet a few days after the return of warm weather the exuberance of bird life in Arctic springtime reappeared. In spite of these recurring hazards, the bird populations flourish as a whole, and the occasional hardships are apparently offset by generally favorable conditions. It seems that these populations migrating to the arctic encounter an average condition of abundant food and favorable weather and only individuals suffer from the vicissitudes of climate.

After mid-June, freezing temperatures are rare, rain is uncommon, and long sequences follow of brilliantly clear days with most agreeable temperatures. Daylight is continuous and during warm parts of the long days children play as noisily in the river as they do in any climate. The well drained areas of the tundra and the mountain slopes rapidly dry to a desert appearance.

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By the first of June willows are flowering and large active bumblebees cover themselves with reddish pollen, often working in freezing temperatures when the sun is obscured. By mid-June mosquitoes are active and soon form an abundant cloud about each person and dog, even in the wind. Later they are supplemented locally by much more poisonous black flies.

Ranunculus (anemone) and *Pedicularis* (lousewort) flower early in June, followed by *Potentilla* and *Dryas*, while in July *Pinguicola*, a beautiful small insectivorous plant, *Epilobium* (fireweed), and a number of lupines and vetches brighten the tundra. The willow leaves are well out in July, when the dwarf Arctic *Rhododendron* flowers fall, and the early part of that month is a colorful period, particularly along the small streams. Grasses, sedges, and leafy plants develop so slowly that their green does not conceal the old vegetation until mid-July. Many lichens show little color in the dry summer, but in the moist weather of August their green begins to freshen and it remains bright long after being covered with snow in the fall. Altogether, the summer scene is delightful and in no place have I seen people, animals, and birds, appearing so well adjusted to their environment as in these arctic mountain valleys.

The Nunamiut

The 70 Eskimo people of the mountains trace their origin to Nunamiut ancestors. For them, the term designates an ethnic group as well as a community, and they consider themselves different from other Eskimo people. Their ancestors have lived in the mountains north of the forests, along the southern watershed of the Colville River, where they formed the flourishing interior population which Stoney and Howard met in 1885 and 1886 (Stoney, 1900; W. Irving, 1953; L. Irving, 1953; and L. Irving and Paneak, 1954). In historic times, and in the relatively recent prehistoric times which their stories penetrate, they ranged westward to meet for trade the Eskimo of the Kobuk, Noatak, and Utokok Rivers. But they did not themselves regularly traverse the mountains west of Howard Pass and they have little knowledge of the western arctic coast. Southward they sometimes encountered the Indians, with whom there have been alternating periods of conflict and rather indifferent accord. A tundra culture requires considerable modification in order to suit forest life, and the southern experience of the Nunamiut apparently just penetrates the edge of the forests. Their territory has not extended north of the Colville River in recent times. As a result of occasional conflicts at the border they have carefully left that country to its inhabitants, the coastal Eskimos, except for traffic along regular routes of travel.

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Eastward, the Nunamiut used to descend the Colville River in spring to obtain seal oil and sealskin for boots in exchange for caribou skin, wood, and flint products. Although the present Nunamiut are mountain people, they well understand sea travel and hunting for seals along the summer arctic coast. In fact, the eastward travels of some of the present group have extended to the Coppermine River, and they regularly correspond with friends and relatives all along that section of the Alaskan and Canadian arctic coast.

In keeping with these habits, they know accurately the birds of the arctic coast east of the Colville, but their stories show no familiarity with the conspicuous and distinctive avifauna of the Bering Sea coast and the western Arctic (L. Irving, 1953). In physical characteristics they appear to be distinguishable from Eskimos of the northern arctic coast, and their own view of their distinction from the present dwellers of the coast regions should be seriously considered.

Progress of the Investigation

On October 17, 1947, Per Scholander, Clay Kaigelak of Barrow, and I flew with Sig Wien from Point Barrow into the camp of the inland Eskimo people. The camp, consisting of 4 families and about 25 people, was situated on the west side of Chandler Lake Valley near the north end of the lake (lat. 68° 19′ N., long. 152° 35′ W.). We were courteously received by the people and were soon comfortably settled. After studying the country by day, we discussed during the long evenings in their domed tents of caribou skin the natural history of the mountain valleys. Simon Paneak best presented the descriptions in his accurate and expressive English, and his observations were supplemented by well considered comments from Jesse Ahgook and Elijah Kakena in Eskimo and by Frank Rulland in both languages. Their wives and older children were often consulted for confirmation and sometimes served as referees in the discussions. While the aurora flashed in the winter nights outside, the people described many birds with the intimate detail in which I had known them as a boy in the northeastern states. They pictured the springtime arrival of migrants as a wave, passing through or stopping to nest in the valleys. My curiosity about the birds of their country aroused their interest, and we soon came to discussing places and dates which would be suitable for making decisive observations. It was apparent at this first meeting that accurate reports and intelligent appreciation of birds could be obtained from the keen observations of these Eskimo residents of the mountains.

When we left them, the people of the village were preparing to travel south to winter within the spruce timber on the upper John River near Hunt Fork, for the low willows about Chandler Lake

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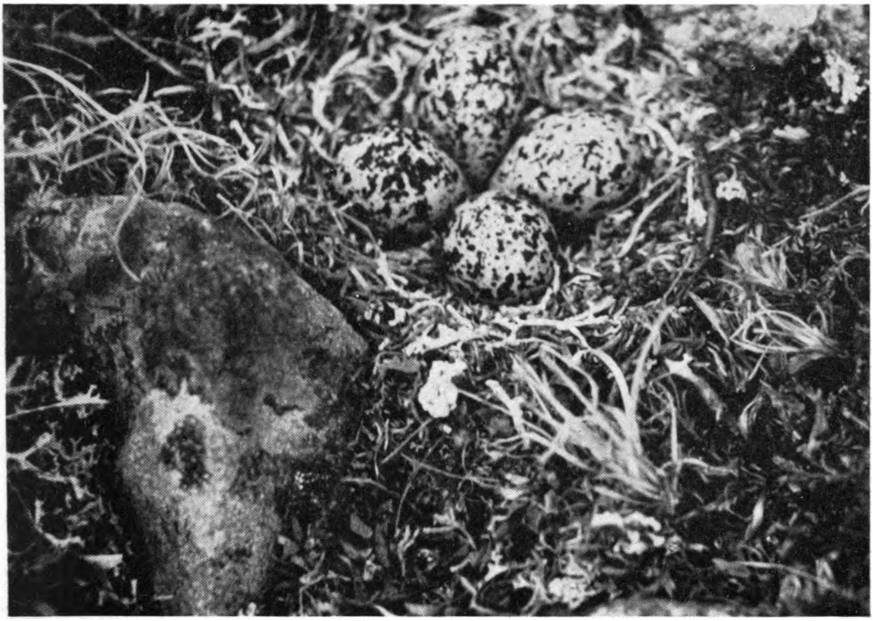

EGGS

Top: Eastern American golden plover, near Kiminiaktuk, June 14, 1951. Bottom: Short-billed gull, near Summit, June 24, 1951.

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EGGS

Top: Parasitic jaeger, with 16 gauge shell, near Kiminiaktuk, June 14, 1951. Bottom: Yukon phoebe, at Napaktoaloitch Cave, June 17, 1951.

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EGGS

Top: Kennicott's willow warbler, at Contact Creek, June 23, 1951. Bottom: Eastern robin, at Nacharach, June 10, 1952.

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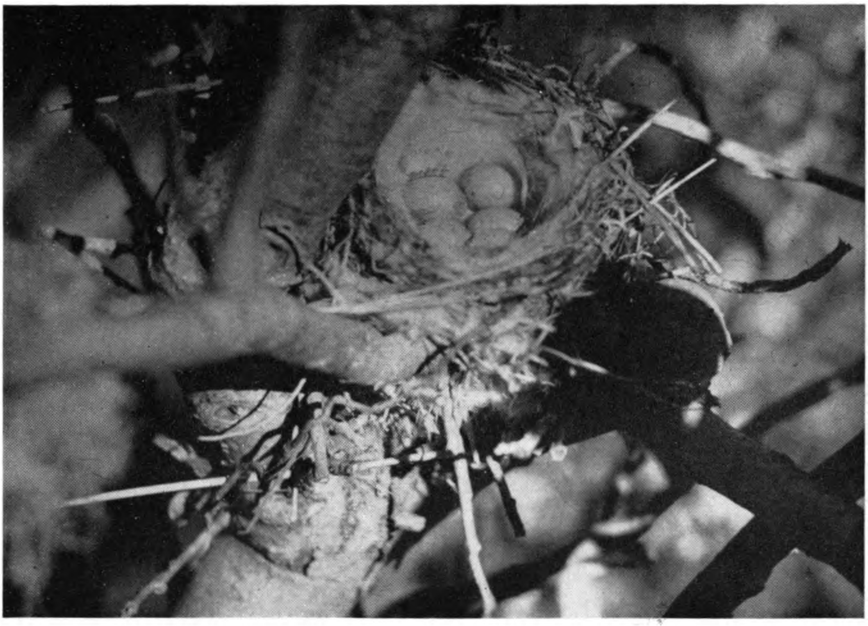

EGGS

Top: Common redpoll, at Imaiginiek, June 27, 1951. Bottom: Gambel's white-crowned sparrow, at Nacharach, June 10, 1952.

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EGGS

Top: Smith's longspur near Nacharach, June 10, 1952. Bottom: Western tree sparrow at Nacharach, June 11, 1952.

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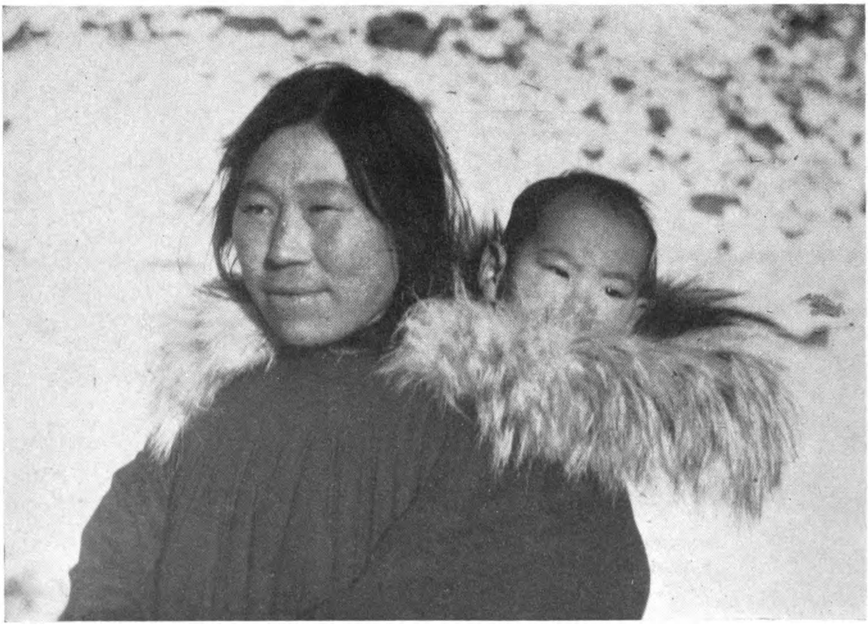

THE PANEAKS

Top: Simon Paneak at Chandler Lake, November 1947. Bottom: Mrs. Susie and Franklin D. Roosevelt Paneak (still called Mister) at Chandler Lake, November 1947.

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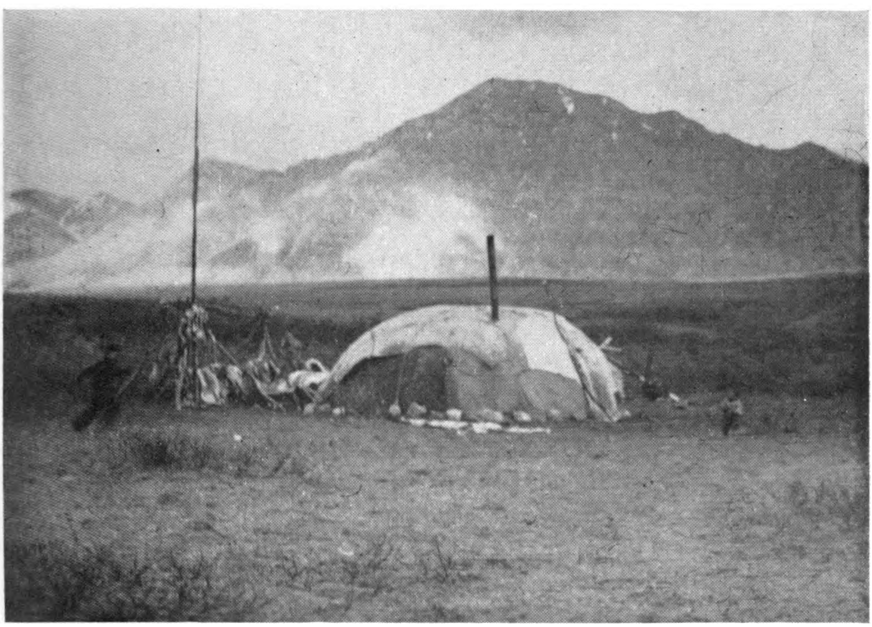

ANAKTUVUK VALLEY

Top: Simon and George Paneak before a rack of 37 wolf skins, February 1952. Bottom: Homer Mekiana's tent at Contact Creek, the new U.S. Post Office at Anaktuvuk Pass, August 1951.

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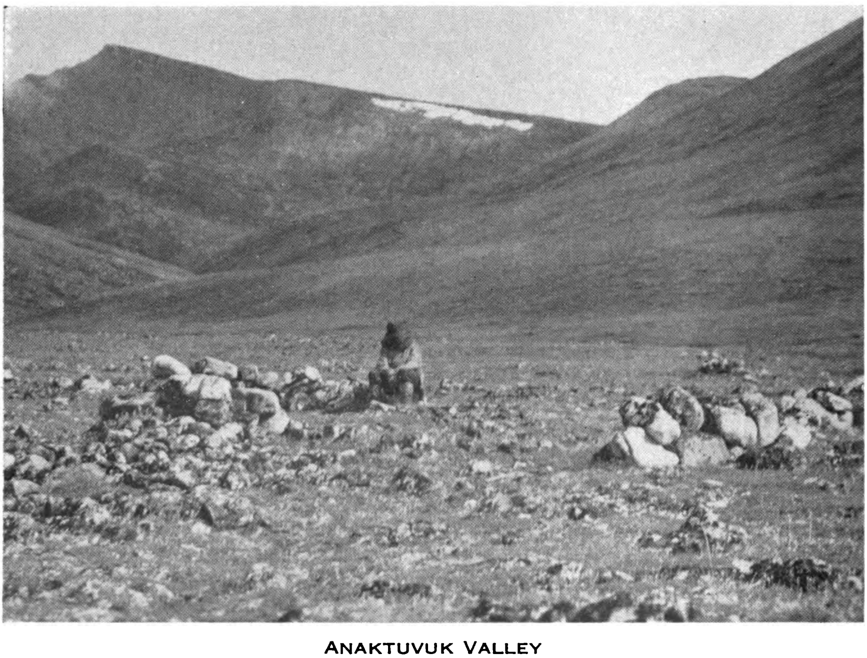

ANAKTUVUK VALLEY

Top: While a Nunamiut hunting party stops to cook sheep meat, one of the boys surveys the valley through his telescope, near Kungomavik, July 1950. Bottom: Jesse Ahgook among remains of old dwellings at Kiminiaktuk, looking eastward down the valley by which the creek emerges from the mountains, July 1950.

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KILLIK AND ANAKTUVUK VALLEYS

Top: Clumps of alder near Akmalik Creek in the Killik Valley, August 1950. Bottom: Cotton sedge in Itikmalukpuk Creek about 10 miles north of the mountain line, July 1950.

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ANAKTUVUK PASS AND CHANDLER LAKE

Top: Terminus of boating on Anaktuvuk River about 10 miles north of the mountains, looking southward, July 1950. Bottom: Camp near Chandler Lake, looking northeast across Chandler Valley, November 1947.

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ANAKTUVUK PASS

Top: Camp village at Nacharach (Summit) near Contact Creek, looking westward at the wall of the Valley, June 10, 1952. Bottom: Looking southeast across Tuluak Lake at the camp then located there, June 1, 1949.

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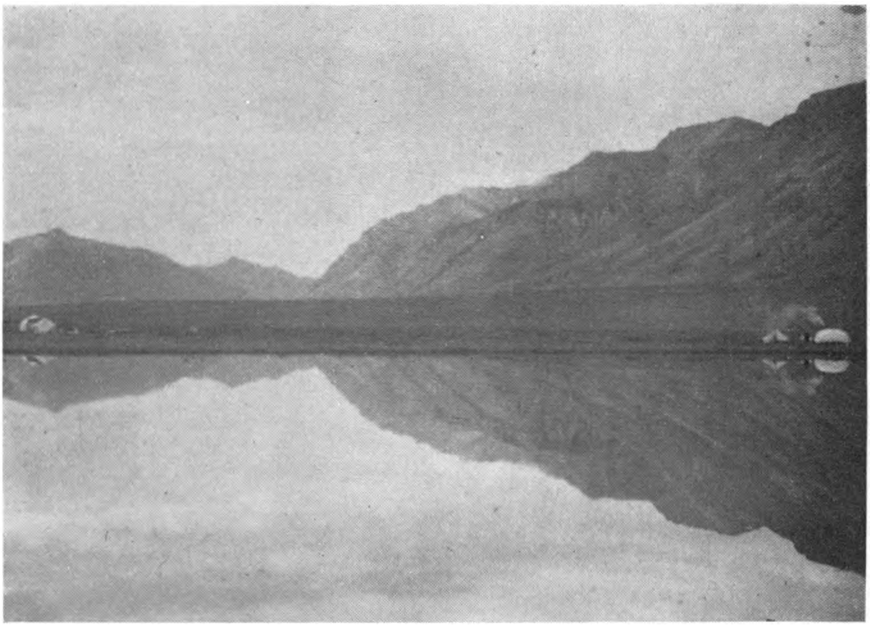

IMAIGNIEK

Top: Looking southwest at the camp at Imaigniek, August 1950. Bottom: Looking southward along the Valley from camp at Imaigniek, August 1950.

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afforded meager fuel for winter use. In March 1948, they returned north into Anaktuvuk Valley to camp on the east side of Tuluak Lake. This lake (lat. 68°19′ N., long. 151°26′ W.; see fig. 4) is situated on the eastern side of the valley near the northern edge of the mountains which they call the mountain line. The lake, almost a mile long, is fed on its eastern side by streams from Nakagnik Springs which remain open through the winter. Remains of ancient habitations and stone corrals for caribou drives, and the stories told by old Eskimos, indicate that this region has been the site of many old camps. Flint artifacts found near there at Imaiginik are assigned to the Cape Denbigh type of the earliest Alaskan artifacts yet described (William Irving, 1951). The modern residents of the mountains, who still subsist mainly by hunting caribou, thus follow the ancients in recognizing the suitability of this mountain valley for their way of life.

On June 1, 1948, with my younger son, Laurence H. Irving, I again visited the Tuluak Lake camp for a week. The winter snow had melted from the valley floor and lower mountains. The first flowers and pussywillows were showing. Wandering tatlers and yellowlegs were numerous and several of them, with some long-tailed jaegers, were held captive for me in the tents of the Eskimo people. Plovers and sandpipers, ducks, loons, Alaska and Smith's longspurs and, in fact, all birds were either still moving north or settling down to nest in the valley. This lively spring scene was changed after a few days with the fall of 6 inches of snow and the return of cold weather. Shore birds perched disconsolately on the few emerging rocks or willows along the shore of Tuluak Lake, but in a day or two the weather again warmed and migration and nesting were resumed.

Many records, specimens, and accounts were presented to me. Every report was clear as to location, time, and circumstances. These reports covered observations made during the preceding winter at the camp in the spruce timber along the John River, during the gradual travel of the Eskimo people north through Anaktuvuk Pass, and during their stay since the end of March at Tuluak Lake. The terse and precise written or spoken narrative style of Simon Paneak impressed me then with high regard for his powers of observation and his respect for accuracy. The outline picture of the resident, migrant, and nesting birds presented to me during my winter visit at Chandler Lake began to gain supporting data. With my own eyes I could observe the intensity of the migratory and nesting activity. It was plain that the arriving birds were robust and in fine shape. They were not groping their way into the arctic regions exhausted by forced flights nor were they harried by competitive search for a meager food supply. On the contrary, the arctic mountain valley provided so well for their sustenance that the long days were filled

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with bird songs and the varied activities of flocks migrating and separating for courtship and nesting. Feeding, in their daily program, appeared to require only incidental attention.

With Neal Weber and Carl Henkelman I next visited the Valley at the end of August 1948, and found that the people had moved to Pitaich, or "Hole," Lakes, a group of small lakes on the west side of the valley just north of the mountain line. As is common, the caribou had been absent from the valley during the summer and only a few had returned recently to relieve the meager diet of fish. Living was embellished by supplies which we brought in, for I have made a practice of carrying in rations more than adequate for our parties so that we might in no way drain the natural resources upon which the resident people depend.

Old squaws, white-winged scoters, and scaup ducks were numerous in the many small Pitaich Lakes set deep, like limestone sinks, in the high tundra about the camp site. I was pleased to obtain several greater scaup ducks, to see over the tundra a marsh hawk flying as it does in any climate, and to examine a sparrow hawk shot while hovering curiously over a group of equally curious and excited children. Longspurs, redpolls, and tree sparrows were numerous and restlessly moving south; by the first snowfall in September they seemed to be gone. We left early in September to escape the freezing weather which would close the Lakes to float planes.

During the winter at Barrow Tom Brower and I discussed plans for a careful survey during the nesting season of 1949, an undertaking for which his keen interest and thorough knowledge of the birds of the arctic coast eminently fitted him. Robert H. Stapleton visited the mountain Eskimo people for me at their winter camp near the northern edge of the spruce in the John River to take in some hardware, tools, clothing, and food which, by easing their life somewhat, would give them more time and better means of observing and recording for our survey parties. Simon Paneak now understood the projected survey so well that he and Bob Stapleton could settle upon the details of our plans for the next summer.

Tom Brower landed at Tuluak Lake on April 26, 1949, and found the Eskimo's camp established. His arrival preceded that of the first migrating birds, and he recorded them meticulously, collecting 215 specimens and 33 nests and eggs. He so carefully selected, studied, and described the birds that his notes give a comprehensive picture of migration and nesting. These notes were supplemented by Simon Paneak's records, which included the observations of the other people in the village. When I visited Tuluak on June 1 with my colleague Robert Rausch, it was evident that our information about the birds was rapidly developing and that a complete record would soon be

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obtainable. In this summer, about 40 people from the Killik Valley community of mountain Eskimos joined the people at Tuluak Lake and the two communities have remained since that time at Anaktuvuk.

My departure from Barrow in midsummer prevented the review of our observations until January 20, 1950, when, with Rausch, I visited Simon Paneak again in the Eskimo winter camp at Kalutak Creek on the upper John River (lat. 68°6′ N., long. 151°54′ W.). There I was able to see some of the winter birds resident in the Pass, to discuss the observation of the last year, and to make plans for the extension of our survey. We also met Helge Ingstad, who was spending the winter with Simon Paneak's family while collecting material for his book "Nunamiut" (Ingstad, 1954).

Traveling from Kalutak by air to Barrow I discussed Paneak's records and views with Tom Brower. We could now see that we needed more information on certain birds and particularly on the arrival of the birds and their nesting. This I obtained in July and August 1950, while at the Imaiginik Camp with Paneak and my older son, William Irving, who was investigating the numerous and varied archeological remains in the mountain valleys. For about 15 days in early August the three of us were able to collect on the Killik River (see map, fig. 6) between Odrivik Lake (lat. 68°30′ N., long. 154°9′ W.), and the mountain line at Akmalik Creek (lat. 68°25′ N., long. 154°12′ W.).

In February 1951, I was able to consult again with Brower while carrying on physiological experimentation on sled dogs at Barrow, and with the reindeer herd at Topagoruk, about 70 miles south. Review of our data on the Anaktuvuk birds showed that it could be best improved by further observations of dates of arrival and by information about weight of arriving birds, nesting, and the development of young birds.

On May 11, 1951, my colleague John Krog landed at Contact Creek and transported our supplies to the site on the east bank of the River, opposite Imaiginik, where Simon Paneak, Elijah Kakena, and Frank Rulland were camped with their families. Krog and Paneak carefully observed the arrivals and obtained weights of over 500 birds during a spring season slightly earlier, drier, and more variable in weather than usual.

The weather of May ran the gamut of temperature variation from about −20° C. to 15° C., but had less than usual precipitation. Consequently, when I arrived in June with William Irving the tundra was drier than I had ever seen it, mosquitoes were a smaller plague than usual, and walking was a pleasure. After Krog left, I continued my observations of birds through the nesting period. Because of the easy walking on the dry tundra our radius extended for about

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20 miles north and south along the Valley and 5 miles east and west, but without going above 4,000 feet. Nests and downy young of many species were found.

Early in July, after I left Tuluak, Simon Paneak and William Irving for 18 days conducted a combined ornithological and archeological reconnaissance in the Killik Valley from the forks at Easter Creek in the south to Odrivik Lake north of the mountain line, William Irving then returned to Tuluak, where he remained until September 1.

While passing through Bettles, on the Koyukuk River, I frequently had short opportunities to examine the birds there, but never for long or at a time favorable for obtaining decisive data on migration. In August 1951, however, John Krog and I were fortunate in being able to make a journey of reconnaissance for three weeks by boat down the Koyukuk to Alatna Village and thence for about 100 miles up the Alatna River to Oscar Creek, just north of the southern mountain line and well within the mountains.

In late February and March 1952, John Krog and I studied the temperature of birds and mammals with Simon Paneak in the vicinity of Tuluak Lake. In this year the willow ptarmigan were very numerous, caribou moved south and west through the Valley in large numbers, and wolves were frequently in sight. By trapping and by his near phenomenal open-sight rifle shooting Simon Paneak took 37 wolves, and the community took 160.

On our way back from Tuluak, we spent a week on the upper Alatna Malemute in Ernie Johnson's hospitable cabin, located in a spruce-forested valley high in the southern watershed of the mountains, where the snowfall is heavy. That spring saw a heavy accumulation of late snow in the mountains, particularly on their southern slopes and the rivers on the northern arctic slope were nearly two weeks late in breaking up, so that pilot J. L. Anderson was still able to land a Cessna 170 with wheels on the ice of the lake at Summit on June 12. At Fairbanks, the emergence of buds and leaves was nearly two weeks later than usual.

Terris Moore, President of the University of Alaska, became interested in seeing the passes through the Arctic mountains, and shortly after commencement, on May 26, we set out in his plane to the head of the Noatak River, where we spent a few days in Howard Pass. From there we flew eastward through the mountain passes, crossing the spectacular trails of a great westward migration of caribou, of which we saw several thousand laggards still moving. We landed in Anaktuvuk Pass, at Summit (called Nakrak by the Eskimo), where for about three weeks I continued to observe the migrant and settling birds in this uncommonly late season.

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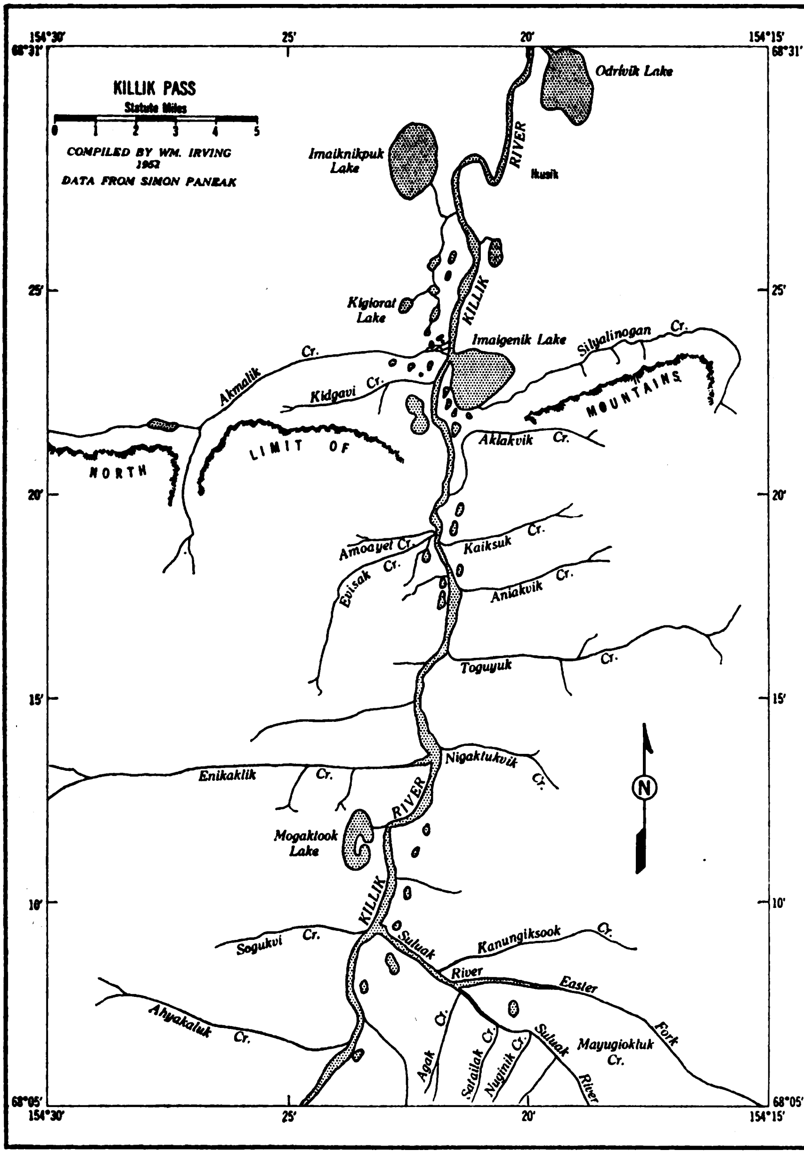

FIGURE 6.—Sketch map of Killik Pass.

In early February 1953, I was detained in Bettles for 8 days by a spell of weather below $-40°$ C., too cold for flying to Anaktuvuk. The time was used for making observations on the winter dessication of leaf and flower buds. The snow cover was unusually thin and the residents feared the effects of the consequent thick formation of ice in the marshy ponds in which muskrats and beavers had to live in the

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small remaining supply of unfrozen water. When I reached Anaktuvuk in early March I found that both willow and rock ptarmigan had been even more numerous than during the preceding winter, and from Bettles northward along the John Valley their winter progress toward the tundra was shown by their tracks in the snow. With Simon Paneak I discussed his winter observations of birds and his collection of data on the feeding and night shelter of the willow ptarmigan.

We met again in Bettles in mid-June to fly to Howard Pass, where Terris Moore and I had briefly surveyed the snow-covered country in the preceding spring (L. Irving and Paneak, 1954), and landed on Itivlik Lake 20 miles east of the Pass. For 6 weeks we searched the valley of the Ahlasuruk, finding 46 species of nesting birds. This is 14 fewer than in Anaktuvuk, and the absence at Ahlasuruk of some migrants from the American continent that are very familiar in Anaktuvuk suggests that on the Ahlasuruk, 140 miles westward, the strength of their westward migratory movement diminishes.

Since that time I have visited with Paneak and his family occasionally at several camps in Anaktuvuk Valley, at Savioyuk River, and at Anivik Creek, the last two being winter camps in the northern border of the forest. Simon and his wife Susie have continued to record bird migrations, and in 1955 he visited me at Anchorage for a month.

In March 1957, while he was in Fairbanks to join our expedition to Old Crow, Paneak developed an illness which was diagnosed as pulmonary tuberculosis and he went to the Alaska Native Hospital in Anchorage for treatment. His illness, when I saw him during the summer confined to the hospital, was in sad contrast to his former vigor. In October surgery promptly changed his outlook and prospects and late in the winter we enjoyed his frequent visits in the laboratory and for dinner at home. During March and April he kept watch from the fifth floor of the hospital with a telescope, recording the arrival of the earliest migratory birds. On April 22, 1958, he was discharged, and left eager to see his family and home after a year's absence.

The Birds of Anaktuvuk Pass

The accounts that follow here and in subsequent chapters are preceded by a 5-column tabulation of the number and sex of all specimens collected; the date on which they were collected; weight in grams; fatness on a scale ranging from fat (F), medium fat (MF), little fat (LF), to very little fat (VLF); and, where important, certain measurements.

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Family GAVIIDAE: Loons

Gavia immer (Brünnich)

2 males	June 4, 1948 June 21, 1951	weight (1), 3600 g.	—	wing 379, 342 mm. culmen 78, 73 mm. tarsus 79, 83 mm.

The measurements of these two examples of black-billed loons fall among the small-sized group which Bishop (1921) designated *Gavia immer elasson.* Inasmuch as I have not found a clear demonstration that a small race is discrete in size or separate in distribution, I would prefer to call these two specimens *Gavia immer*, as is done by Willett (1933, p. 11) and by Rand (1947), who did not think that races were distinguishable.

This loon is called *Tasingik*, meaning "black-billed," in Nunamiut. It is considered not common but of regular occurrence in the mountains. Two black-billed loons were recorded seen May 27, 1949. A pair was reported seen by Elijah Kakena at the lake near Summit July 23, 1950. In June 1951, several were seen and heard in Tuluak Valley so often that they were probably resident. One was observed calling on Napaktualoitch Lake during two days in June while we camped nearby. Calls and occasional subsequent views in flight nearby suggested that lake as the center of a nesting pair.

In Anaktuvuk Valley no nests have been found, but on a lake in Okmilaga Valley, about 50 miles west, a pair was known by Simon Paneak to have nested several years ago. During July 1951, several black-billed loons were observed and heard by Simon Paneak and William Irving in the Killik River Valley.

They are only seen on large lakes where fishing for human food is likely to be good. Without wind they cannot take flight, whereas yellow-billed loons take off somewhat more readily. Loons of both species frequent large bodies of water where they are clearly visible, and the black bill distinguishes them from yellow-billed loons at great distances in the bright light of arctic summer.

The lakes and country are daily searched by the Nunamiut with telescopes in their surveys for game, and large loons and even small birds are carefully examined until identified. All birds seen are noted and with other natural phenomena are the subject of careful discussion when people get together. Every such observation which a mountain Eskimo makes or hears seems to become recorded in his memory, for I have often asked them to recapitulate records and never found deviation in a statement of factual observation. It is therefore unlikely that there was another pair of black-billed loons in the Valley between Summit and the mountain line in 1950, but there may have been more than a pair present in 1951. The black-billed loons acted like steady

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residents in a lake, whereas the yellow-billed loons which were seen more often, appeared to fly more readily from lake to lake.

In the windy weather of late summer, black-billed loons are often heard calling while in flight. Simon Paneak thought that they frequently called while flying through light rain, but he doubted if the flight call predicted the onset of rainy weather.

The first records of the season are June 4, 1948, May 27, 1949, May 21, 1951 and June 1, 1954.

On the arctic coast Bailey (1948) mentions the report of a large black-billed loon which had been killed east of the Colville mouth. Anderson (1921) had been told by Leffingwell of one killed near Flaxman Island, and Leffingwell (1919, p. 651) reported that only one had been seen there and that the Eskimos only knew of one being seen on the Colville. I found among the Nunamiut the recollection of circumstances about the loon which Leffingwell mentioned and which is apparently the basis for all these published comments. They consider it a rarity on the coast, but I have found several coast Eskimos who know the black-billed loon from one observation or through a report from other Eskimos, and I do not question that black-billed loons occasionally migrate to the arctic slope and coast.

The specimens and these accounts show that *immer* is regularly present in and sometimes nests in the mountains. In addition a few probably migrate northward for nesting, for a pair was known by Simon Paneak to have nested some years ago north of Anaktuvuk on the lower Colville River.

Gavia adamsii (G. R. Gray)

1 female	Sept. 28, 1949	—	—	wing 375 mm. culmen 93 mm.
1 female, not preserved	June 9, 1951	weight 4050 g.	medium fat	—

Yellow-billed loons, by the reflection from their bills, are easily distinguished from common loons at surprisingly great distance in arctic light.

The earliest recorded arrivals are May 27, 1949, May 20, 1950, May 28, 1951, May 30, 1952, May 23, 1953 and June 1, 1954. Two were seen at Odrivik Lake in the Killik Valley daily August 13–15, 1950. On July 6, 1951, Simon Paneak and William Irving saw a pair with one young on a lake near Amorgoayat in the Killik Valley, where they also reported seeing frequent pairs and on July 10, observed six together in Akmalik Lake.

To the Nunamiut the yellow-bill is well known as *Tootlik.* Like black-billed loons they frequent the larger lakes, where they are sure to be observed by the frequent surveys of the countryside which the

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Eskimos make with their telescopes. Their call is unlike that of the common loon, and for another contrast, yellow-billed loons take wing more readily. No nests have been found in the mountain valleys, but these loons are seen and heard frequently during the summer. The Nunamiut consider black-billed loons more common in the mountains, although I was inclined to regard yellow-billed loons more numerous. I now think that the Nunamiut view is correct and that mine was formed because yellow-billed loons fly more frequently from lake to lake and in late summer occasionally indulge in aerial maneuvers.

The regular presence of these loons and the observed young are assurance of their nesting in large lakes near the mountains. There are few lakes large enough for them or for black-billed loons within the mountains in Anaktuvuk Valley, and so it is thought that most are visitors from larger lakes north of the mountain line, whereas the black-billed loons which are seen appear to remain steadily within a more restricted summer territory.

I consider yellow-billed loons to be migrants that visit and rarely nest in the mountains.

Gavia arctica pacifica **(Lawrence)**

1 male	June 23, 1949	weight 2326 g.	—	—
1 female	June 14, 1949	weight 1850 g.	—	—
1 downy young male, probably of this species	July 31, 1950	weight 1242 g.	—	—

The earliest recorded appearance of Pacific arctic loons is June 1, 1949. One or two weeks later, when the ice breaks up completely in the lakes, many of those a half mile across or larger, are occupied by a pair of Pacific loons. At the end of July, one parent may be seen closely accompanied by a large downy young or occasionally two. A parent and young were observed on the landing lake near Imaiginik and two days later a large young downy loon was brought in from there. It is listed with question under this species, to which it probably belongs.

The Pacific loons are at least 10 times as numerous as black-billed loons. Like the yellow-billed loons, they fly swiftly and frequently, and these two species seem to fish over a considerable area. They frequent larger bodies of water than the more sedentary red-throated loons, and are only about a tenth as numerous.

As *Malirgik* they are well known by the Nunamiut to be regular nesting residents in the lakes of the mountain valleys. The greater numbers seen in spring and late summer are thought to be migrating.

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Gavia stellata **(Pontoppidan)**

1 male	June 11, 1949	weight 1900 g.	—	—
1 female	June 11, 1949	weight 1522 g.	—	—
1 male, not preserved	June 28, 1951	weight 1711 g.	—	—
1 female, not preserved.	June 2, 1951	weight 1613 g.	—	eggs 30 mm. and 20 mm.

The earliest recorded appearances of red-throated loons are May 23, 1950, June 2, 1951, May 18, 1953, and June 1, 1954. The size of the developing eggs found in the bird on June 2, 1951, shows that the nesting date was close at hand. During summer they are common, particularly in smaller lakes, even those high up among the mountains, entering some which may be less than 100 yards across, although when these are narrow they are usually elongate. In these restricted waters they are much less shy than the other loons, and late in summer they may be seen there with their young. They are the most numerous of the loons and, because of the number of small bodies of water suitable to them, may be ten times as numerous as Pacific loons.

A late observation, September 8, 1950, at Contact Creek suggests that these loons traverse the mountains southward in fall migration, for at that date the lakes north of the mountains are likely to be ice covered.

In early June, they hold closely to the small lakes and are not as often seen flying as are the other loons. But at the end of June, their call in flight begins to be heard. The call is the basis for their Nunamiut name, *Kaksrauk*. During July and August, this fast repeated call is much heard overhead, and it is difficult to connect it with the bird, which flies so swiftly and so high that the sound seems to trail behind its origin. To search for the source of the call high in the overcast above the arctic tundra is a dizzying effort, but the Nunamiut like the trial of locating *Kaksrauk* in flight.

Red-throated loons nest in the valley and migrate northward and southward in numbers.

Family PODICIPEDIDAE: Grebes

Podiceps grisegena holböllii **Reinhardt**

Red-necked grebes have not been reported in the mountains, but Sidney B. Peyton told me that he found one floating dead in a lake near Bettles Village late in June 1954. Charles Sheldon of Kobuk reported them common there, with the Eskimo name Shoolishookruk. Since red-necked as well as horned grebes occur along the Koyukuk and Kobuk they may likewise be expected to venture north into the mountains.

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Podiceps auritus cornutus **Gmelin**

2 males	June 25, 1951, Tuluak Valley	weight 481, 459 g.	—	—

I had repeatedly described grebes to Simon Paneak, who said that his father knew them as *Malikak*, meaning "small loon," and that he remembered his father shooting several in 1907 with his .44-caliber rifle when the family was about 40 miles above the mouth of the Colville River. Jesse Ahgook also remembered seeing *Malikak*, along the Colville, but in the scale of his experience with 80 years of life the date was only recalled as "long ago." Elijah Kakena and Frank Rulland did not think they had seen a grebe.

On June 25, 1951, a horned grebe pushed its weird looking head out of the horseshoe lake just west of Akvalutak Creek within 30 feet of me and promptly drew it under water again. During the next two hours, Frank Rulland and I ran around the lake, locating three male horned grebes and obtaining the two male specimens, both with small testes and little fat.

In camp, Simon at once recognized the birds as the ones which his father showed him in 1907 and called *Malikak*. As Frank Rulland described the appearance of grebes and their methods of diving, along with a graphic and humorous commentary upon our hunt, it was evident that no one of the people had seen them before in the mountains.

Six weeks later on the Alatna River just below Helpmejack Creek, which is just south of the southern mountain line, John Krog and I saw four horned grebes fishing in the fast current of a sharp bend in the river. This location was about 100 miles southwest from Anaktuvuk.

I believe that these grebes only rarely come into the mountains. I class them as visitors because they are not far from their common range in the Yukon and Koyukuk Valleys.

Family ANATIDAE: Swans, Geese, Ducks

Olor columbianus **(Ord)**

The earliest northward flights of whistling swans is recorded only in one year, May 20, 1949, when a flight passed over Tuluak Lake. To the Nunamiut, they are known as *Kogruk*. Every year some are seen and heard passing over, often flying higher than the mountain tops. It is thought that, unlike the birds of weaker flight, they do not confine their course through the mountains to the passes. A few occasionally land and the flights and landings through the Killik Valley are said to be more numerous than in Anaktuvuk. On June 10 and 16, 1951, we saw a single swan in Tuluak Valley in grayish plumage, but the flights have passed by early June. I have also seen one in

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grayish plumage near Anivik Lake late in June. In fact a lone swan of grayish color has now (in 1954) been seen a few times in each summer. The summer occurrence and its appearance are so unusual that it is spoken of as if it were one individual.

Swans are not known to have nested recently in the mountains, but Simon Paneak recalls that a swan's nest was found by his father about 50 years ago on a lake near Akmalik Creek in the Killik Valley. He also recalls finding swans nesting along the Colville River from the junction of the Anaktuvuk to its mouth. Swans are so conspicuous on the tundra that their nesting would be observed. They are regarded as regular migrants which do not nest in the mountains.

***Branta canadensis taverneri* Delacour**

3 males	May 18–20	weight (1) 2551 g.	—	—
3 females	May 18–23	weight (1) 2150 g.	—	—

Until clarification of the systematics of the Alaskan forms of *Branta canadensis*, by Delacour and Zimmer (1951), a single specimen from Anaktuvuk was regarded as close to but not identical with specimens marked *leucopareia* in the U.S. National Museum.

With the aid of Herbert Friedmann I compared the single specimen then available with a specimen obtained by John Krog at Amchitka (J. Krog, 1953). By Delacour's definitions the Amchitka goose was *leucopareia* and the Tuluak bird was *taverneri*.

In August 1951, John Krog and I collected 4 males and 2 females along the Koyukuk and Alatna Rivers within about 100 miles of Anaktuvuk. These were identified as *taverneri*. They were among family groups containing well grown young which were just achieving flight in early August. By mid-August families were beginning to associate and a little later well formed flocks were assembling the geese of the vicinity.

In 1952 geese were collected by Tom Cade from among families of that season along the Colville River and identified by Delacour as *taverneri* (Kessel and Cade, 1958).

In 1953 five specimens were obtained from the flights which alighted more frequently than in other years at Anaktuvuk. These are all *taverneri*. The testes of three males measured May 18–20, 1953, were 26 mm. long. Two of the birds were noted to have little and one much fat. In a female examined May 18 the largest egg measured 22 mm.

Charles Sheldon obtained a specimen for me from Kobuk village on May 19, 1954. It was the male in breeding condition of a pair and the specimen was identified by Dr. Herbert Friedmann.

It is thus established that *taverneri* nests along the rivers of the wooded southern watershed of the central Brooks Range. They migrate through Anaktuvuk in spring, where they have been earliest reported May 22, 1949, May 11, 1950, May 22, 1951, May 13, 1953, and

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May 15, 1954. Southbound flights are seen in late summer but they land less often than in spring. One flock passed over Kangomavik on August 26. None are known to nest in the mountains, and the migrating flocks stop for only a brief time. During nesting season they are also on the Colville River near Umiat. These two nesting areas are different and separate, one being on the rivers in thickly wooded country and the other 250 miles north, on the treeless arctic slope beyond the intervening mountains.

Geese of the Canada type are known to the Nunamiut in the mountains and on the coast as *Eksrahgotilik*, "light-colored cheek." The occurrence of differences in size has been observed but has not been regarded systematically.

Many of the geese of this as well as of other kinds are regularly seen in migration, and judging from those which are seen and heard a great many traverse the mountains. Often they fly higher than the mountain peaks and it is thought that they need not follow the valleys except occasionally, when they wish to land.

***Branta nigricans* (Lawrence)**

1 male	May 30, 1952	weight 1494 gr.	—	—

The single specimen is normal to the characteristics of Pacific black brant (Delacour, 1952). Its testes at 20 and 25 mm. in length were probably not mature.

The earliest recorded observations of brant are May 26, 1950, May 26, 1951, and May 29, 1952. Usually they are the most commonly seen geese in spring, and land most frequently. But in 1953, when other geese were numerous, no brant were seen. Often they fly low through the valley, in their swerving and circling flight calling as if seeking a landing place. At other times they fly direct at the elevation of the high mountain peaks.

Brant have not been observed in the mountains during the late summer on the southbound course. Along the arctic coast near Barrow, I did not see migrating flocks of brant as often in the spring as in the late summer when the flocks commonly flew westward low in the air above the coastal tundra or over the sea close to the coast. Their migratory course in spring probably crosses the interior of arctic Alaska at many points, for they are known there by the Nunamiut in Chandler Lake, Okomilaga, and Killik Valleys. They are also common spring migrants at Kobuk and Shungnak, whence they appear to head northward in the direction of Howard Pass.

The Nunamiut call brant *Niklinagak*, meaning "almost like (white-fronted) geese." It is well known to them that many brant nest along the arctic coast about the mouth of the Colville River, but none are known to remain for nesting in the interior.

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Anser albifrons frontalis **Baird**

female	May 23	weight 2844 g.	—	—

White-fronted geese are familiar migrants, making frequent spring and fall flights through the mountains. The earliest observations are May 16, 1949, May 21, 1950, May 9, 1951, May 18, 1952, May 13, 1953 and May 15, 1954. In Nunamiut they are called *Niklivik*, which means "goose." Most of the numerous flights are heard passing high among the mountains during the short nights of late May. Landings have occasionally been observed in spring but not from the southbound autumn flights. The nearest nesting of these geese known to the Nunamiut is along the lower Colville River. It was my impression that white-fronted geese flew higher and more directly on their course than any but snow geese.

Chen hyperborea hyperborea **(Pallas)**

1 female	May 20, 1954	—	very fat	egg 30 mm.

Snow geese were first reported seen on May 20, 1949, May 15, 1950, May 19, 1951, May 14, 1953, and May 15, 1954, and many landed in Anaktuvuk Valley just north of the mountain line in 1948. In recent years none had been killed until a few landed in 1954. These geese, called *Kangok* in Nunamiut, are known as regular spring migrants which sometimes land in the Valley. They often fly high among the mountains, being the highest flying of the migrating birds. Occasionally they are seen in the fall, but they are not known to land at that season. A few are known by the Nunamiut to nest about the large river mouths on the eastern Alaskan arctic coast. Snow geese are more rarely seen than other geese and usually only in small flocks. Occasionally one or a few of them join in the flights of white-fronted geese.

Anas platyrhynchos platyrhynchos **Linnaeus**

2 males	May 24, 1949, June 26, 1951	weight (3), 1099, 1151, 1210 g.	—	—
1 female	May 28, 1949	weight 800 g.	—	—

The earliest records of common mallards are May 20, 1949, May 16, 1950, May 13, 1953, and May 15, 1954. To the Nunamiut they are well known and are called *Ogiuguk*, a word representing their call, and a better representation of the sound than our "quack." Six mallards were reported May 24, 1949, several groups of 8 to 10 were seen in 1953 and a few are seen in each spring. A male was seen in the Killik Valley near Odrivik Lake August 10, 1950, and a moulting male unable to fly was taken June 26, 1951, in Pitaich Lake. None are known to nest in the mountain valleys, but from the fact that

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they are seen in pairs in spring or singly in summer, it is believed that nesting occurs nearby.

***Anas acuta* Linnaeus**

5 males	May 21–June 25	weight (18) (May 10–June 25) 754 to 1030, average 817 g.	—	—
1 unlabeled, in male plumage	—	—	—	—
5 females	May 21, Aug. 7	weight (7) without eggs (May 17–June 11) 679–835, average 731 g.	—	—
1 nest, 6 slightly incubated eggs, female parent	June 10, 1949	—	—	—

Pintails were earliest recorded May 16, 1949, May 11, 1950, May 6, 1951, May 18, 1952, May 13, 1953, and May 15, 1954. The last date was probably several days after the first arrival. On May 17, 1949, 12 were recorded by Tom Brower and thereafter he reported the numbers seen as increasing to between 60 and 100 daily from May 21 to 30. The northbound migration goes on steadily during at least two weeks and many flocks comprise a dozen or more and are well formed. Some of these migrants stop to nest in the valleys, where in the extensive marshy regions they are the most numerous of the summer resident ducks. The number which remains to nest in the Valley is however, only a small percent of the great number of migrating pintails.

In 1951 developing eggs were found to be 6 mm. in length on May 18, one was ready to be laid on May 21, 12 mm. in length on May 22, and 12 mm. in length on May 28.

A nest found in a marshy area by Tom Brower June 10, 1949, with 6 slightly incubated eggs, was made of small grasses mingled with down. Another set of 6 eggs was discovered on the same date but not taken. It appears likely that eggs are laid between about May 20 and June 10. These dates are earlier than for the old squaw and merganser. A female with 8 young was observed in Akmalik Lake in the Killik Valley by Simon Paneak on July 8, 1951, and on August 28, 1950, young pintails were reported able to fly for some distance.

On June 16, 1951, six males were observed together at Napaktualoitch Lake, and thereafter the males were commonly grouped in small bands along the streams and in the lakes. One male taken on June 16, 1951, was moulting and just able to fly, while three others took wing with difficulty, unlike their usual ability to spring from the water into flight.

The Nunamiut name for the pintail is *Korugak*. They are the most numerous migrating and nesting ducks in the Valley.

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***Anas carolinensis* Gmelin**

6 males	May 24–June 26	weight (6) 293–379, average 332 g.	—	—
3 females	May 20, 29	weight (3) 265, 297, 334, average 343 g.	—	—

The first green-winged teal were reported seen at Tuluak Lake on May 20, 1949, May 22, 1950, May 11, 1951, and May 18, 1953. As *Korualorgosik*, meaning "smaller than pintail," they are well known in migration and as summer residents. The nests had not been found but on May 20, 1951, a female contained an egg 26 mm. long. The bird then weighing 410 grams. In the cold spring of 1952, teal were not seen until June 2 when the testes of a drake were 35 mm. in length and a duck contained a 12-mm. egg. Two days later a small duck contained a 35-mm. egg. About this time numerous pairs and single teal were present in the Valley. On June 5, 1950, Raymond Paneak found a nest with 6 eggs. On July 11, 1950, a female with 9 downy young, the wing feathers just showing, swam from Nakagnik Creek to Tuluak Lake. Young birds are seen each summer. In 1950 they were last reported seen August 27.

The teal nest in the Valley regularly and some migrate northward. Because they keep much in cover and do not congregate in flocks, they are probably a larger population than appearances indicate.

***Mareca americana* (Gmelin)**

2 males	May 24, 1949	weight (1), 714 g.	—	—

The first American widgeon were seen May 24, 1949, May 20, 1950, and May 13, 1953. The Nunamiut name is *Koruaknak*, meaning "like pintail." Small groups arrive in spring and they are occasionally seen in summer, but no nests have been found in the mountains. In 1948, an adult and six young were seen on the west side of Tuluak Valley. A female and about eight large downy young were seen August 6, 1950, on a lake about four miles north of Akmalik Creek in the Killik Valley. They are less numerous residents than green-winged teal, and they are estimated to be fewer in migrating numbers, but they are usual summer residents and nest in the mountains.

***Spatula clypeata* (Linnaeus)**

1 male	June 1, 1953	weight 578 g.	—	—

Two shovelers were reported by Thomas Brower on May 23, 1949, and one on May 26. Since he has obtained specimens of shovelers at Barrow his identification is correct. Simon Paneak recalled seeing

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a shoveler shot at Humphrey Point in 1926 and although they are considered rare in the arctic I find that they are well known to many Eskimos. A rare bird may be well known to Eskimos because each one which appears in any way unusual is studied by all who are near and the circumstances are discussed for years among a widening circle. I mentioned that three reports in the literature of the arctic coast appeared to stem from one black-billed loon which Leffingwell (1919) and some Eskimos saw sometime before that date. I have also heard of this same loon from several Eskimos and in different villages. So the well known shoveler is familiar from a few well remembered observations but it is rare in central and eastern arctic Alaska from the mountains northward.

On June 1, 1953, Elijah Kakena saw a pair and obtained the male. Its testes at 5 mm. were not much developed. These reports warrant designating the shoveler as migrating through Anaktuvuk, although I have no report that they nest north of the mountains.

Aythya marila nearctica (Stejneger)

3 males	May 24–June 4	weight (17), 844–1046, average 932 g.	—	—
5 females	May 27–July 10	weight (9), 856–1117, average 957 g.	—	—
1 downy male	July 10, 1951	weight 91 g.	—	—
1 downy female	July 10, 1951	weight 89 g.	—	—

Throughout the north, ducks are important for human food and are consequently so shy that I could rarely come close enough to distinguish by sight the greater from the lesser scaups. Among those taken for food, when closely observed, the extent of white on the wing, the larger bill, and the heavier weight of the greater scaup distinguish the latter from lesser scaup. No intergradation of these characters was noticed.

Judging from the number of birds taken by the Eskimos the greater scaup are probably at least ten times as numerous as the lesser. The earliest recorded observations of scaup are May 24, 1949, May 19, 1950, May 24, 1951, and May 14, 1953, and as specimens of both forms were taken early, they apparently arrive at about the same time, coming in numerous small flocks of both sexes which soon break up for mating. Many continue their flight northward. No nests have been found, but there is no doubt that the greater scaups, which among ducks are next in summer numbers to old squaws and pintails, nest about many of the larger lakes.

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The progress of egg development in the female greater scaup, as shown in the tabulation below, indicates that in 1951, eggs were ready to be laid June 5 and that one female had not completed laying on June 16.

Date (1951)	*Weight (g.)*	*Length of eggs (mm.)*	*Date (1951)*	*Weight (g.)*	*Length of eggs (mm.)*
25 May	856	4, 2	15 June	1067	8
28 May	918	15	15 June	985	6
28 May	1117	15	16 June	1034	31, 26, 17, 12, 10, 8, 5, 3
28 May	978	1, 2	10 July	740	(with downy young)
28 May	964	4, 2			
31 May	992				
5 June	1069	(1 larger egg broken)			

Young birds are often seen during the late summer accompanied by females. A female greater scaup, remarked upon as containing very little fat was collected at Kidgavik Lake, near the northern mountain line in the Killik Valley on July 10, 1951 with two downy young. These young birds, weighing 91 and 89 grams were then heavier than I would expect the eggs to weigh. I would guess that they were not a week old, and that the eggs from which they came had been laid early in June. Young scaup, not distinguishable as to the species were recorded as unable to fly on August 28, 1950, in Tuluak Lake.

Until about mid-June, male and female birds were observed together, and a female, collected with a male on June 16, 1951, contained eggs, the largest of which measured 31 mm. and was nearly ready to be laid. Two days later two small flocks of four and six males were seen on Napaktualoitch Lake and on June 28 several flocks composed exclusively of from 20 to 30 males were assembled near the center of Margaktuk Lake.

The Nunamiut call the scaup *Kaklutuk*, meaning "big-billed." Although they recognized that variations in size occurred they did not distinguish between the two scaup until the decisive characters were pointed out. They were not impressed by the difference until after several years of examining and weighing the birds. Now they accept the difference in size and bill as distinguishing the greater from the lesser scaup.

Aythya affinis (Eyton)

4 males	May 27–June 4	weight (3), 769, 681, 694 g.	—	—
4 females (thought to be of this form)	May 29–Sept. 10	weight (2), 601, 651 g.	—	—
1 large downy male	Aug. 7, 1950	weight 350 g.	—	—
1 large downy female	Aug. 7, 1950	weight 331 g.	—	—

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The fact that similar numbers of specimens of adult greater and lesser scaup were taken does not indicate populations of equal size. Out of about 100 dead scaup which I have examined only about 10 were lesser scaups, and since I looked particularly for them, I suspect that the greater scaups are more than 10 times as numerous.

Lesser scaup were taken about as early as the greater, so that their time of arrival is similar. Flocks of ducks are very difficult to approach, so that most specimens are singles. A male collected on May 31, 1951, at Imaiginik by John Krog was one of nine scaup shot on that day in the same lake, all the others being greater scaup. A female which I shot on June 28, 1951, was alone in the outlet stream from Margaktuk Lake, but in the lake nearby were over 80 males. Two females were collected September 10, 1950, about the latest time when ducks could find extensive open water, but I have also examined greater scaup shot at about that time. I cannot report any difference in the habitat of the two forms, but they are certainly frequently associated.

The female which was shot on June 28, 1951, had already laid eggs and from its actions might have had a nest nearby. The two downy young birds taken August 7, 1950, in a small lake near Akmalik Creek in the Killik Valley were among six young ducks with an adult female scaup, a pintail, and a white-winged scoter. The scaup attended the young most closely, and the young were not scoters and look like downy scaup ducks. As I watched them, for some time I thought that the attendant bird was a lesser scaup, but I was unable to confirm my view by collection.

From these observations and their presence throughout the summer I consider that the lesser scaup nest in the mountain valleys, but not having seen them further north I cannot say that they migrate beyond the mountains.

As I remarked in describing the greater scaup, the Nunamiut have only one name, *Kaklutuk*, for scaup, and they did not distinguish between them until several years of observations showed that the size characters made two discontinuous groups. While they know that scaup nest very commonly in the mountain valleys, they cannot add evidence for the nesting of the lesser form.

Clangula hyemalis (Linnaeus)

1 male	June 1, 1949	weight (6) 621–868, average 778 g.	—	—
1 female, nest, and 7 fresh eggs	June 30, 1949	weight (6) 510–713, average 606 g.	—	—

A young female oldsquaw on August 25, 1948, weighed 380 grams. The earliest records are May 21, 1950, May 17, 1951, and May 23, 1953.

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Few dates have been recorded, perhaps because the arrival of the oldsquaws is such a familiar event.

The largest unlaid eggs were 10 mm. in length on May 31, 1951, and 34 mm. on June 5, 1951.

The nest was situated on a dry slope near a small stream, and it was composed of dark-colored down entangling some small dry leaves. If the date of fresh eggs obtained on June 21 is representative, nesting is late and growth must be rapid to reach the weight of 380 grams observed on August 25.

Oldsquaws and pintails are the most numerous ducks in the Valley. They frequent open water, where in spring they are conspicuous and bring attention to their presence by their pleasant notes. In Nunamiut they are called *Ahalik*, which represents their call. Eskimo children try to toll any ducks with this call and frequently the ducks seem to be attracted. The large lakes usually contain several families of oldsquaw and even the small lakes may provide nesting sites, although islands seem to be preferred.

Coast and inland Eskimos like and admire these hardy arctic birds. As they fly through the haze on the arctic coast or in the mountains, ascending and descending as if to get ground bearings, it is most delightful to hear their musical calls, which give the impression that the oldsquaws are signaling to each other. The individuals of a group diving in the lakes or ocean seem to watch each other and to seek food in a group, like a fleet of fishing boats. On the coast when a boat goes among them they continue their fishing, opening up the flock to allow it to pass. They do not often take precipitous simultaneous flight as do the nervous scaup ducks or wary geese.

For all their abundance and lack of anxiety, they are not easy birds to shoot, and their loose system of organization never concentrates them like eider ducks so as to allow numbers to be taken at one shot. As food for man they are no delicacy, although superior to loons and scoters, and while they are good for hungry people, it requires more ammunition and hunting to obtain nutrition from oldsquaws than from any other common arctic duck.

I find them the most interesting birds of the duck family. I am sure they associate in well organized societies and they are, as far as I know, the only arctic ducks, which are not subject to flock alarms and retain their presence of mind and flock organization when an enemy has penetrated among them.

***Histrionicus histrionicus* (Linnaeus)**

3 males	June 2–4	weight (2), 639, 618 g.	—	—
1 female	June 2	weight 562 g.	—	—

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Western harlequin ducks were first reported June 2, 1949, May 31, 1950, and May 29, 1952. After that time they are occasionally seen, usually along the swift streams. In 1951, however, we did not record a single harlequin, although they are well known and conspicuous in habit and profile. Often they are called "current ducks" by the Nunamiut from their frequenting fast water, but the regular Nunamiut name is *Ahaliknak*, "like old squaw," which well indicates their adept diving. Sheldon (1911) reports that harlequin ducks occupied most of the swift streams along which he passed to the sheep country high in the mountains of western Yukon Territory. In August 1951, William Williams of Alatna Village showed me a pair of harlequin ducks which his wife had mounted very nicely. These were shot in 1950 on the Koyukuk from a group of about six, and he considered them to be of common occurrence in that region. During three weeks on the Koyukuk and Alatna Rivers in August 1951, however, we saw none, and Williams had no positive observations in that year.

They usually remain evident during summer, and several families of young have been seen by the Nunamiut, although nests have not been discovered. Resident harlequins may be nearly as numerous as baldpates but they are fewer than green-winged teal. The Nunamiut knew them along the Colville River, and I do not hesitate to say that some seen in spring at Anaktuvuk are migrating farther north.

Polysticta stelleri (Pallas)

Steller's eider was well known to the Nunamiut, when they were on the arctic coast, as *Eknikauktok*. Simon Paneak reported to me his great surprise at seeing a male and a female in late June standing on the gravel along Contact Creek. He watched them in amazement through his telescope to verify their marks but they flew before he could approach within range of shot. Although we are confident of the identification we agreed that the observation of an eider duck in the mountains was too anomalous for its inclusion in the list of Anaktuvuk birds. It was Simon's suggestion that these eiders may have ascended the Colville looking for another ocean.

Melanitta deglandi (Bonaparte)

3 males	June 11–14, 1949	weight (6), 1413–1907, average 1650 g.	—	—
2 females	June 17, Aug. 6	weight (2), 1548, 1700 g.	—	—
2 downy young females with female adult.	August 6, 1950	—	—	—

The first white-winged scoters were recorded May 31, 1950, May 24, 1951, May 20, 1953 and May 28, 1954. No large flocks are reported,

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and it appears that they come in principally to nest. At any rate, there are white-winged scoters on many of the larger lakes in the Valley and upon some of the smaller ones. A female with nine small downy young was seen July 26, 1950, on the landing lake near Imaiginik. On a small lake near Akmalik Creek in the Killik Valley the female and two downy young were collected from a group of five on August 6, 1950. This was one of the deep round lakes about 200 yards across, sunk like a limestone sink in the terrain of wind blown sand on river gravel. The scoters swam always near the opposite shore, but by running around the lake it was possible to approach them, for the young, which would weigh about 500 grams, swam very slowly. The young could dive well and swim some 50 yards under water, but the devoted female did not leave her escort duty even when the young dived and scattered.

These ducks, fewer in numbers than scaup, are well known as *Tongargagruk*, meaning "devil" in Nunamiut. As a few are known to range far north to the arctic coast, some of these observed in spring are undoubtedly migrating northward. Eggs contained in one female bird measured 30 and 20 mm. in length on June 5, 1951.

I could not distinguish my specimens from specimens of white-winged scoters from the east and west coast of America. It was also apparent that the bills of my scoters, which were taken while soft and perhaps distended in early summer, had warped into shapes influenced by conditions of drying. Accordingly, I could not assign them to a western form on the basis of small variations in size and shape of bill and I could see no other distinction warranting their assignment among specimens of eastern or western origin.

***Melanitta perspicillata* (Linnaeus)**

1 male	May 20, 1951	weight (5), 964–1006, average 987 g.	—	—
1 female	May 20, 1951	weight 980 g.	—	—

Until 1951, my knowledge of surf scoters in the mountains was limited to Nunamiut accounts, which gave clear descriptions of their appearance and habits, and the Nunamiut name *Avilyuktok*. It was reported that a number of these scoters regularly spent the summer on Chandler Lake and that young birds were seen there. None were reported in Tuluak or adjacent valleys during 1948, 1949, and 1950. From their conspicuous appearance and common choice of the open and deeper lakes, I believe that very few could have been present if they escaped the keen observation applied to the country often with the aid of 15-power binoculars and strong telescopes.

In 1951, four were observed on Tuluak Lake on May 20. These were collected and proved to be three males and one female, the latter with

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its largest egg 6 mm. in length. Two of the males had large testes and were moderately fat. The female was very fat. The third male, which was wounded, was not recovered until two days later, at which time it had little fat remaining. Another male which I shot near Pitaich Lake June 15, 1951, had little fat.

Along the Killik River near Togoyuk Creek in the mountains, one was observed on July 5, 1951, by Simon Paneak and William Irving. They reported that on June 13 a flock of about 100 surf scoters landed on Odrivik Lake, about four miles north of the mountain line, and that 5 landed there on July 15 and 10 on July 16.

I have no observations upon nesting in the Anaktuvuk or Killik Valleys, but I consider that the report of young birds at Chandler Lake and the numbers and conditions of the birds observed during 1951 indicate that surf scoters nest among the Endicott Mountains. The irregular records indicate that the numbers of surf scoters which reside or migrate fluctuate widely from year to year, and they are the only birds I know to vary conspicuously in annual numbers at Anaktuvuk.

The surf scoters I have eaten were the nearest to being objectionable meat that I have encountered in a country where any meat is acceptable.

Mergus serrator serrator Linnaeus

3 males	May 26, 30–June 1	weight (5), 992–1077 g.	—	—
1 young partly feathered	Aug. 29, 1950	—	—	nest with 9 eggs
	June 24, 1949			
2 females	May 30, 1951	weight (3), 808–975, average 918 g.	—	—

The first recorded red-breasted mergansers were seen June 2, 1948, May 23, 1949, May 21, 1951, May 29, 1952, and May 18, 1953. In the latter part of May, many of the lakes are occupied by a pair of mergansers, which in spring regularly travel in pairs, as do many mallards, teal, and harlequins. I did see one group of six mergansers flying north on May 29, 1952.

A nest with very large eggs was found by Thomas Brower among low willows about ten feet from the shore of a small island. Only one of the eggs showed signs of incubation. The nest was made of a number of small dry leaves with down. In a hole nearby were many remains of fish. The parent bird was seen, but it escaped.

The young bird obtained August 29, 1950, was partly feathered, but its primaries were still only an inch long. It seems late in the season for so small a bird to be able to complete its growth, for the lakes would be frozen over in a few weeks. Among the eggs found on June 24, 1949, only one showed signs of incubation. Among three

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females examined on May 30, 1951, the largest undeveloped eggs recorded were respectively 2, 4, and 27 mm. in length. It appears that eggs are laid during the first half of June.

In Nunamiut the red-breasted merganser is called *Akpaksruayook*, which means "runs (like a man) on top of the water." Because of their utilization of even small lakes and the river, a wide area of suitable habitat is open to them and the population is rather large, probably, because of their wide distribution, exceeding the number of white-winged scoters.

Family ACCIPITRIDAE: Hawks, Harriers

Accipiter gentilis atricapillus (Wilson)

1 male	November 1952, Ikiakpuk Creek	weight 1280 g.	—	—
1 female	Mar. 8, 1950, John River	weight 1290 g.	—	—

The first specimen of goshawk was taken by John Morry in the spruce timber along the John River not far from Hunt Fork. It is known to the Nunamiut as *Kidigavitch kiringit*, and the old folks were familiar with the regular nesting of a pair in that area. Goshawks are not conspicuous in the forest and they were considered uncommon, or at least they were infrequently seen. I did not hear of their being found on the tundra until Mory Maptigak brought me a specimen he had shot along Ikiakpuk Creek, some 30 miles north of tree line on the southeastern approach to the low divide between Ikiakpuk Valley and the watershed of Chandler Lake.

In the period 1954–1956, goshawks were more frequently seen than in earlier years near the limit of timber and a few were seen several miles farther north. I am inclined to think that the increased observations of goshawks resulted from their following the great numbers of willow ptarmigan which were migrating during those years.

I still regard the goshawk as a bird of the forest which, as in the case of our winter specimen, may venture a few miles over the tundra. It is therefore designated a visitor.

Buteo lagopus (Pontoppidan)

No specimens of rough-legged hawks have been collected in the Endicott Mountains, so that the race cannot be designated, although it probably is *B. l. s.johannis*, which Tom Cade informs me he regards as the form which he found along the Colville River. They are well known under the name *Ilyirgik*, which means "basket sled," a designation which might refer to their feather clad legs. In 1949 the first record was on May 5, in 1950 on May 19, in 1951 on May 3, in 1952

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on May 9, and in 1953 on May 3. In 1949, early observations were made more continuously than in other years by Thomas Brower, who reported one or two daily early in May and six on May 13. All these birds were flying northward in evident migration. One nest was seen by Simon Paneak in 1938 at Okpikyuak River near the mountain line in Tuluak Valley and another just east of the Killik Valley, but they are known to nest commonly on the cliffs which extend from Umiat northeast along the Colville River and this site is presumed to be the destination of these migrants through the Pass. A few are seen during the southward migration, but they are then never as conspicuous as when northward bound. They are probably rare as nesting summer residents in the mountains but regular as migrants in the Pass.

***Aquila chrysaëtos canadensis* (Linnaeus)**

No American golden eagles were brought into the collection, but several were examined for parasites by Robert Rausch, and numerous others have been brought in for my examination. The earliest sight records are April 7–10, 1948, when four were caught in wolf traps; March 29, 1949, April 3, 1950, April 10, 1951, March 28, 1952, April 4, 1953, and March 23, 1954. During April, May, and June, more eagles were seen than during the summer, the largest number reported by Thomas Brower being 14 on June 20, 1949. During the summer one or two eagles are usually in sight soaring high over the mountains or along the precipitous slopes of the upper sides of the Valley. In spite of their impressive size and capable flight, they are without expression, not social, and, in comparison with the ravens, uninteresting. In their individual and varied social activities, ravens are always expressive of purposive play or shrewd hunting.

In Nunamiut, the eagle is called *Tikmiakpuk*, meaning "largest bird." They nest in the mountains and occur in larger numbers during the fall migration. The latest record was September 14, 1950, at Contact Creek.

Many eagles migrate through the Pass in spring, but as there are few cliffs upon which they could nest north of the mountain line, and as eagles are seldom seen on the arctic coast, their only known northern destination on the arctic slope is the cliffs along the Colville River northeast of Umiat.

A single example for Contact Creek weighed 5900 grams.

***Haliaeetus leucocephalus alascanus* Townsend**

Northern bald eagles have been occasionally seen in the mountains, but only as visitors, giving no appearance of seeking residence. Simon Paneak recalled seeing several in the Valley in 1948, and had only rarely seen one along the eastern Alaskan arctic coast. I saw one on

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June 1, 1952, over Inukpasugaruk Creek. The Nunamiut name was not recalled by the people, but they described the bald eagle accurately and recognized it. Since these eagles are regular and common residents along the rivers in the wooded country to the south, their occasional visits are not unexpected.

Circus cyaneus hudsonius **(Linnaeus)**

1 unsexed but in female plumage	Aug. 28, 1950	weight 478 g.	—	—

I saw an American marsh hawk flying as if hunting over the tundra August 29, 1948. One was reported on May 30, 1951, May 20, 1952, and May 19, 1953. Simon Paneak saw one several times in early June 1951, around Tuluak Lake. Susie Paneak and May Kakena saw one "with reddish-brown breast" on June 11, 1952. The Nunamiut know them as *Papiktook*, which means "long parka tail," and Simon Paneak had described them to me accurately before the specimen was taken by Jesse Ahgook. No nests have been found and the occasional individuals seen appeared to have been on a hunting or exploring trip and not resident in the mountains. On August 9 and 14, 1951, I saw two marsh hawks while traveling up the Alatna River, the first about 10 miles and the second about 90 miles north by river from the Koyukuk and within 60 miles of Anaktuvuk. As their common range extends through the Yukon Valley, occasional visits to the tundra can be expected.

Family PANDIONIDAE: Ospreys

Pandion haliaetus carolinensis **(Gmelin)**

Several of the Nunamiut saw an osprey's nest before 1947 in a tree near Island River in the forested midpart of the John River, but I have not seen one along the upper Koyukuk and Alatna Rivers. On May 28, 1954, May Kakena saw one at the outlet from Tuluak Lake. Charles Sheldon pointed out to me a pair of ospreys over a nest in a high tree which had been occupied for many years on the Kobuk River about 10 miles above the village. On June 1, 1952, I saw an osprey flying over Contact Creek. The osprey is known to the Nunamiut from their occasional journeys to the forest country as *Kalloksioyuk*, meaning "goes after fish." They are occasionally seen flying, but not fishing in the mountains. It is not surprising that occasional visitors should venture to the Valley since it is only an hour's flight from their known nesting range in the wooded valleys. It is interesting that the Nunamiut remarked that the visiting ospreys had not been seen fishing in the tundra lakes.

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Family FALCONIDAE: Falcons

Falco rusticolus obsoletus Gmelin

1 female, Itikmalikpuk	Nov. 17, 1952	weight 1431 g.	—	—
1 young male, Irivik Creek, Killik Valley	July 2, 1951	weight 1330 g.	—	—

Gyrfalcons have been explicitly reported seen in the mountains in every month of the year and I can see no indication that the numbers vary in a way to suggest migratory habits. As I came to know some of the well established locations of the nesting pairs it appeared that the birds observed were usually within some miles of a nesting place and it was our opinion that a pair remained within its territory throughout the year.

During the late summer and autumn of 1952, gyrfalcons were occasionally seen around the heights of Soakpuk mountain. Birds seen a year earlier near the head of Kangomavik Creek were thought to belong to this family, and individuals were occasionally seen in the nearby valley during the months of February and March 1953. The location of the Soakpuk nest in the high cliffs was impossible to determine.

About the end of March 1952, Simon Paneak frequently observed a pair of gyrfalcons near Naniksruk, an open fishing place on the Anaktuvuk River some 60 miles north of the mountains. He thought they were then preparing to nest in the place which he knew as a historic nesting location. The young specimen was one of two full-sized nestlings shot by William Irving on a nest in a cliff near Irivik Cave in the Killik Valley. The other bird lodged in the nest, which was inaccessible, and which had long been a known but unattainable nesting site. It was remarked that another nest also inaccessible was located within a hundred yards.

The Nunamiut say that none of the hawks can overtake a sound ptarmigan or duck in flight at the same level. They also believe that a gyrfalcon strikes its prey with its breast and only seizes it with claws when it is struck to the ground. While this is not the common opinion of naturalists it was expressed by Nunamiut for whom observation of animals is an inherited career.

There are several Nunamiut names for gyrfalcon: *Okiotak*, *Kitgavikroak*, and for young birds in autumn, *Atkaruak*, meaning "like caribou mittens." The Nunamiut interest for gyrfalcons arises from their spectacular habits and their usefulness to a hunting people. Wing and tail feathers were used to guide arrows and spears, as were those of the duck hawk, pigeon hawk and rough-leg. For this purpose the first four primary feathers were preferred. Two feathers were

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common on each arrow, but sometimes three or even four were used. Paired feathers were preferably matched from corresponding feathers of the right and left wings. If tail feathers were used, matching parts were used by preference in pairs. I did not learn the principle or practical reason on which this practice was based. I also asked whether left wing feathers were preferred for convenience of attachment by right-handed arrow makers, as Bridges (1949) relates to have been the case among the Ona Indians of Tierra del Fuego. I could find no comparable discrimination among the Nunamiut.

Along the low arctic coast hawks are rare and feathers were accordingly one of the uniquely valuable articles of the old Nunamiut in their trade with the coast. Some of the old Nunamiut people were specialists in catching hawks with whalebone snares set near a perch or nest, and the nesting locations were established in old Nunamiut knowledge. I learned that many nests were known to have remained in use during the lives of the narrators and during their father's times, and so far as it appeared, indefinitely. The present generation had discovered a few nests which, so far as they knew were unknown to their fathers, but none were thought to be at new sites. From accounts of several older Nunamiut men has been compiled the following list of 17 nesting sites of gyrfalcons which they know in the area from the Killik on the west to the Anaktuvuk on the east, an area near 100 miles on each side (no nests are known on the Colville below the Anaktuvuk's mouth):

On Anaktuvuk River: 30 miles from mouth, near Naniksruk (specimen obtained); 60 miles from mouth; and 90 miles from mouth, Soakpuk Mountain.

On Colville River: 25 miles above Umiat; and 4 miles above mouth of Killik River.

On Killik River: 15 miles from mouth; 45 miles from mouth; 20 miles above Odrivik Lake, near Irivik Cave (two nests, both occupied in 1950, very close together; specimens obtained); 22½ miles above mouth; and at Akmalik Creek.

On Okpikyuak River, east of Killik.

On Okomilaga River: 8 miles east of preceding location; 3 or 4 miles inside mountain line; and at summit.

Between Okomilaga and Chandler River: At mountain line; and 6 miles north of preceding location.

It is thought that nests do not remain unused. If one bird of a pair is killed a substitute promptly joins the bereaved mate and the pair continues at the site. I could not press to learn the length of the delay except that replacement is thought not to be deferred until the next season but to occur right away. There seems to be a reserve, generally unobserved, of single birds in this population which otherwise exists in firmly attached pairs.

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Seventeen pairs are known in occupation of about 10,000 square miles. A gyrfalcon could cross the area in three hours flight and the element of transportation would be a small obstacle to keeping the pairs of the population in communication from the positions which the Nunamiut views ascribe to them. It is interesting to speculate as to what social bonds relate the few pairs of gyrfalcons in a population which appears remarkably conservative in its total numbers and in the location of its component pairs.

***Falco peregrinus anatum* Bonaparte**

1 male, Anaktuvuk Pass, Summit	May 1, 1948	—	—	—
1 young male, Anaktuvuk Creek	June 11, 1951	weight 590 g.	—	—

The male American peregrine from Summit was taken from the upper John River and north of the last spruce May 1, 1948, sent to George Sutton and identified by him.

The young male was taken by Jesse Ahgook where Akvalutak Creek comes out from the mountains into the Valley. While in pursuit of a companion peregrine, Jesse fell and his shot gun discharged both barrels so as to nearly sever the muscles of his leg anterior to the femur. After two days of first-aid treatment in camp, he was taken out by small plane to Bettles, and by the 10th Rescue Squadron to Fairbanks, where under skilled treatment he made a recovery which bids fair to extend his great usefulness as a bold and skillful hunter and a gentle companion through his 9th decade.

In Nunamiut, the name *Kidgavitch Kiriat*, meaning "small hawk," refers to a medium-sized swift flying and striking hawk known to nest along the cliffs of the Colville but not often seen in the Valley. They are occasionally seen as migrants, and judging from Nunamiut accounts it is uncertain that they nest in the mountains.

Simon Paneak related to me that along the cliffs of the Colville River he had seen a peregrine dive at a rough-legged hawk. The latter turned in the air and seized the attacker but was forced to release it by the onslaught of the peregrine's mate. Hawks frequently harry other hawks and even eagles, and the maneuvers are evidently seriously intended, for there seems to be no play in the relations among the species of predatory birds. In level flight ptarmigan and ducks are considered able to outstrip hawks, which are therefore dependent upon surprising their prey at a disadvantage or on the speed of their dives.

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Falco columbarius bendirei **Swann**

1 male	Aug. 12, 1950	weight 169 g.	—	—
2 females	June 16, 1952 Aug. 25, 1950	weight 142, 231 g.	—	—

The male western pigeon hawk had been seen on two days flying South directly through the willows covering the sand dunes on the south side of Odrivik Lake. On the last trip, its direction was followed for about a half mile nearly to the bank of the Killik River, and as it returned flying northward through a narrow marshy hollow between two willow covered dune ridges, it was shot. Its behavior so well suggested that a nest or perch was in the vicinity that a careful search was made in the area from which it had last appeared, but no sign of nest or perch could be found. The conviction that a residence site was near, led me to further observation of the area from the top of a dune a little distant. On the next day a dark bird of the same size left the area and flew swiftly across the Killik River and disappeared in a small patch of willows. The day was then dull and identification of this bird could not be established in the poor light and prolonged observation gave no other information. I think it likely that the bird collected was a resident and not a migrant. On two successive days in early June 1952, I saw a pigeon hawk fly through the willows on Contact Creek. A female collected there on June 16 had already laid eggs.

A pair was watched by Simon for several hours near the site of the gyrfalcons' perch on Soakpuk Mountain. The small hawks were screaming in agitation at the gyrfalcons and probably at the human intruders, but after watching for over an hour, he could find no nest of either hawk. One of the pair of pigeon hawks was collected.

One female specimen was collected at Tuluak Lake on August 25. That region had been under close observation through the summer, and as no pigeon hawks had been reported, it is believed that this example, recorded as having ample subcutaneous fat, was a returning migrant. Another pigeon hawk was reported seen September 8, 1950, near Contact Creek, and Simon Paneak and William Irving reported one seen July 6, 1951, in the Killik Valley among the mountains.

In August 1951, several pigeon hawks were seen along the Koyukuk and Alatna Rivers. A resident Indian, William Williams, said that they regularly nested at certain locations along the river. One was collected at the mouth of the Iniakuk River, at the southern mountain line and about 70 miles southwest of Tuluak Lake. In mid-March 1951, Ernie Johnson pointed out a small hawk which had offended him by harrying his tame jays and pursuing small birds about his cabin near the northern limit of spruce on the Alatna Malemute. John

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Krog and I were convinced it was a pigeon hawk but in spite of Ernie's encouragement we were unable to eliminate the disturber of his jays. Dall remarked that pigeon hawks were at Nulato all the year round (Dall and Bannister, 1869).

The Nunamiut name is *Kidgaviatchaurak*, which means "smallest hawk," a name which might also apply to the sparrow hawk. The latter is an unusual visitor, while the pigeon hawk is considered well known among the Nunamiut and nests among the cliffs of the Colville. It seems certain that pigeon hawks also nest in the mountain valleys.

These three specimens, together with a female collected on the Alatna River, conform well with the common appearance of specimens marked *bendirei* in the U. S. National Museum, and not with those marked *columbarius*.

Falco sparverius sparverius Linnaeus

I saw a small hawk repeatedly hovering over the camp at Pitaich on August 25, 1948. Elijah Kakena shot the bird, which I identified as a female American sparrow hawk. The skin was prepared but among the difficulties of travel in those days it has been lost. The Nunamiut had not seen a sparrow hawk before, and it is certainly unusual in the Valley. Since sparrow hawks in Alaska are known to nest as far north as tree line, this bird can be called a visitor.

Family TETRAONIDAE: Grouse, Ptarmigan

Canachites canadensis osgoodi Bishop

3 males (sex of 2 determined only by plumage)	Sept. 13–Oct. 9	weight (2), 611, 590 g.	—	—
1 male (sent to G. M. Sutton)	Feb. 23, 1948	—	—	—
2 females	Oct 3, 1950	weight 649, 734 g.	—	—

Four of these Hudsonian spruce grouse were obtained from the head of the Savioyuk River and one from the upper John River. All were from forested country. The male taken February 23, 1948, at Hunt Fork, was sent to Dr. G. M. Sutton and kindly identified by him. A female taken May 13 near Anchorage weighed 577 grams and possessed little fat, while the autumn specimens in the mountains were fat.

This bird, which does not venture north of the forest, inhabits the northern tree limits, often so abundantly that it is important as food for hunting parties. When the Nunamiut sometimes go in winter to the timber for trapping, they know the spruce grouse as *Napaktom Kadgia*, which means grouse of the spruce.

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***Lagopus lagopus alascensis* Swarth**

3 males	Dec. 13, 1948–May 31, 1952	mean weight (25), 641 g., std. var. 75	—	—
4 females	November 1948–May 30, 1952	mean weight (38), 602 g., std. var. 78	—	—

These Alaska willow ptarmigan inhabit a territory ascribed to *Lagopus lagopus alascensis*, and compare well with specimens of that species in the U. S. National Museum.

The willow ptarmigan are *Kadgivik* in Nunamiut, which is explained simply to signify "real ptarmigan." They are so familiar to the Eskimo life and economy that for them the name has no known descriptive meaning. The pebbles which are regularly found in the gizzards of ptarmigan are called "heaters" by the Nunamiut, using the designation of the stones which in former times were heated in the fire outside and then brought in to warm the people in their skin tents. The "heater" stones which the rounded pebbles in a ptarmigan's gizzard resemble were specially selected fire-resistant stones, well rounded by water. Many stones, even well rounded ones, crack and even burst dangerously in the fire, but the kind selected for heating were probably free from strain and thus less likely to burst. There is no implication that the function of the pebbles in the gizzard is for heating.

In summer a few willow ptarmigan remain in the mountain valleys and occasionally nests are found. In July 1951, William Irving and Simon Paneak saw several adults with young birds in the Killik Valley. On Contact Creek I obtained a female with developing eggs 25 mm. in length on May 30, and several pairs were courting on the open valley and among the willows.

By the first of October many ptarmigan come from the north into the valley, and through the autumn their movement is southward, but I have not found the southbound movement of any birds to be as evident as their northward migration, so the southward movement of ptarmigan is ill defined in our records. In January the traffic appears to be least, and in February a northward movement becomes apparent and continues through May, but with relaxed intensity during the middle of the migration.

The Nunamiut say that the ptarmigan migrate in two waves separated, around the end of March, by an interval of less frequent appearance. This pause in migration is evidently regular, for the Nunamiut sometimes date events as occurring during the first or second migration of ptarmigan. It seems to be an established schedule in the habits of ptarmigan but I do not know of any distinguishing form

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or condition of the birds. I suggested that they might come from different areas, but Eskimos are not much interested in speculation upon determinable but unknown facts. By the end of May the last migrating ptarmigan disappear and comparatively few remain to nest in the mountains.

In February and March 1952, willow ptarmigan were common in scattered flocks of 20 to 40. In the winter of 1952–1953 they were even more common, and this great abundance continued through the winters of 1954 and 1955. In 1957 they were still very numerous. Few of the willows lacked signs of removal of buds and twig tips. In the dark twilight before the brief day the ptarmigan could be heard calling. Before noon, feeding stopped and the birds rested on the snow or perched in the willows for one or two hours before resuming the feeding which filled their crops for night. Crops weighed in the morning and at noon were lighter than in the afternoon and, according to numerous weights obtained by Simon Paneak and John Krog, willow ptarmigan retire in winter at 4 or 5 o'clock with well filled crops weighing from 50 to 100 grams.

This store suffices for the 14 hours or so which they spend in individual burrows in the snow. The accumulated feces show that each bird remains in one spot. These burrows are a foot or so beneath the snow and extend from 18 inches to 2 feet. In the morning the ptarmigan leave their snow burrows usually by flying directly up through the soft snow. There is no indication that any weather causes them to remain longer than one night in their burrows. Reports of willow ptarmigan burrows in the snow come from other parts of Alaska, Yukon Territory and Newfoundland (Wetmore, 1945).

Although at times the tracks, noise, and sight of ptarmigan are reminiscent of the density of population of a farm yard, and although the willows showed signs of their intensive feeding, the ptarmigan were in good condition in the time of their greatest abundance. Occasionally, when the frost thickly covered the willows the ptarmigan sought sedges exposed by the wind on which to feed, but in winter willows alone afford probably 90 percent of their food. And yet as far as can be seen neither ptarmigan nor the restricted willows of the tundra suffer from the intensity of cropping which occurs when the ptarmigan are most numerous.

Ptarmigan meat never has enough fat to make it a satisfactory arctic food. Nevertheless, despite the arctic cold, and the competition on their crowded range from successions of migrating flocks, the ptarmigan in winter have flesh that is better eating and the birds are heavier than in summer, when they have access to a flourishing vegetation.

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TABLE 1.—*Weights of willow ptarmigan from several parts of Alaska*

Date	Males			Females		
	No.	Weight (g.)		No.	Weight (g.)	
		Extremes	Averages		Extremes	Averages
Anaktuvuk Pass						
November-December 1948	4	504–627	600	2	500–625	563
April 1949	1	706		4	504–627	560
February-March 1950	7	461–804	601	7	430–704	544
March 1952	13	580–743	633	20	527–706	617
	25		(621)	33		(591)
Arctic Village						
December 1951–February 1952	14	506–730	615	15	495–749	641
ARCTIC	39		(619)	48		(607)
Chugach Mountains						
December 1951–February 1952	12	450–617	530	8	446–525	495
Talkeetna Mountains						
December 1950, January 1951, and February 1951	3	473–519	539	5	493–627	573
SUBARCTIC	15		(535)	13		(525)

In the winters of 1948, 1949, 1950, and 1952 the mean of the weights of 128 arctic ptarmigan was 619 grams. Among willow ptarmigan taken in winter in the Chugach and Talkeetna Mountains about 600 miles south from Anaktuvuk the mean weights of 28 birds were 531 grams. In Mount McKinley National Park, Alaska, Dixon (1927) reported the average weight of male willow ptarmigan (of this race) in the breeding season to be 507 grams. My records (11 males from Anaktuvuk during April and May weighed 538 grams.) indicate that arctic willow ptarmigan are lighter in summer than in winter. While he was on the eastern arctic coast of Alaska in winter Anderson (1921) reported that 15 willow ptarmigan weighed 22 pounds which gives an average weight of 652 grams.

The distribution of weight about average in arctic willow ptarmigan is shown in the following tabulation:

		Percentage distribution about average weight		
Number	*Sex*	*±10%*	*±20%*	*±30%*
39	Male	54	96	100
49	Female	52	89	100

The difference between the winter ptarmigan of arctic and subarctic Alaska points to the arctic ptarmigan being significantly heavier than those from the subarctic locality. On the basis of weight differences of similar proportions (about 1 kg. in 5 kg.) von Zedlitz (1924)

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thought that geographical races of *Tetrao urogallus* living in lands about the Baltic Sea were distinguishable, although not recognizable by superficial taxonomic distinctions. Near the northern limits of spruce in the interior of Keewatin 6 adult males of *Lagopus lagopus albus* taken between May 31 and November 7 averaged 631 grams in weight (Harper, 1953).

Considering the variations in weight of domesticated animals which can be produced by feeding one would conclude that differences in the natural nourishment provided in parts of the range of a species could easily account for the differences in weight of grouse found in several distinct localities. Among the wild birds of Anaktuvuk, however, I find that the differences in weight among individuals of specific populations are small and they are evidently homogeneous in respect to weight. I am inclined to favor von Zedlitz's suggestion that genetic differences are likely to be at the basis of the distinction of weight in certain parts of the range of grouse. Nasimovitch (1936) reported an increase in the weight of *Lagopus lagopus* progressing eastward into that part of their range lying in the central regions of western Siberia.

In the years under observation (1947–1957) the abundance of willow ptarmigan in winter at Anaktuvuk has varied from their being common to very common. I have not found evidence for regular cycles of abundance. The difference in actual numbers seemed to be as much as ten fold, and I suspect that some orderly conjunction of events underlies the phenomenon. As no annual differences have been observed in their weight and condition of flesh the good nutritional condition of willow ptarmigan in winter is a characteristic of the season and locality in spite of the fluctuations in numbers which at times appeared to crowd the country with ptarmigan. It also seems that in the subarctic locality a distinction in weight occurs, although we have seen no superficial character to distinguish them from birds of other localities.

Lagopus mutus nelsoni **Stejneger**

9 males	May 8–July 14	weight (20), 411–559, average 466 g.	—	—
8 females	May 8–June 5	weight (7), 416–480, average 427 g.	—	—
1 marked female, but in male plumage	July 31	weight 412 g.	—	—
2 downy males	July 3	weight 15.2, 16.3 g.	—	—

These Nelson's rock ptarmigan correspond in beak size and in the distinctive summer pattern of males to those marked *nelsoni* in the U. S. National Museum.

As *Niksaktongik*, rock ptarmigan are nearly as well known, and form a more interesting part of Nunamiut life than are the larger wil-

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low ptarmigan. In an old Nunamiut story Willow Ptarmigan challenged Rock Ptarmigan. The latter said that although smaller he was more agile and had better staying power. In the ensuing combat he demonstrated his superiority and finally killed Willow Ptarmigan. Then his wife tattooed the black marks with soot on either side of his mouth as the sign used among Eskimos of one who has killed a man, or, along the coast, of one to be recognized for killing a whale. Rock ptarmigan appear bolder and more energetic than willow ptarmigan. In the rock ptarmigan the mothers seem to be more attentive in the care of the young chicks and male birds often share with them in the early care. The disposition for individual independence and effective care of family make the rock ptarmigan also seem like substantial mountain residents in the opinion of the Eskimos.

Rock ptarmigan do not appear to migrate as do willow ptarmigan but they do change their common feeding range during the year. They are familiarly seen in summer on high ground or occasionally on the gravel bars among the willows in the creeks, while in winter they often keep to higher rounded slopes where the low vegetation is exposed by the strong winds. Not as numerous as willow ptarmigan during their period of maximum number, they have a more restricted habitat which appears less productive of food than the willows, with their good supply of buds, on which the latter feed.

The largest eggs developing in females were measured in 1951 on May 17 at 14 mm.; May 18, 2 mm.; May 20, 12 mm.; May 21, 18 mm.; May 23, 45 mm.; and in 1952 on May 29 at 14 mm.; June 3, 44 mm.; June 5, large. The last was the size of eggs in nests. The two downy young taken on July 3 were, judging from their size, recently hatched. In country along the Itivlik similar to Anaktuvuk chicks were just able to run on June 25.

In early May the red about the eye of the male expands and becomes brilliant, and by mid-May a few dark feathers appear on the neck. On May 27, 1952, in Howard Pass the white males were conspicuously posturing, fighting, and occasionally pursuing the sly females, which, their backs and heads changed to summer plumage, remained well concealed on the alternating grassy and snow covered spots. A week later at Anaktuvuk the courtship appeared to have been accomplished. Through early June the male birds, still white except for a few dark feathers showing on their necks, stood in statuesque posture on the knolls where they often permitted a close approach before flying.

So seriously do male ptarmigan take exhibition as their function while the female is sitting on the nest that they stand for hours in full view, often with empty crops. During this period, their preoccupation with exhibitionism hinders feeding and makes them lean.

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The females feed busily and frequently while courting and nesting. By June 5, the females in their beautifully patterned summer plumage are difficult to detect.

During the whole period of mating and nesting, the females are as secret and retiring as the males are conspicuous. The secrecy of the females conceals them and their nests. The display of the males looks provocative to predators and it would be interesting to think that the males in this way distracted predation from the brooding females. As a predator myself I have often been attracted to the vicinity of nests by the displays made by the nonbrooding parent, and I conclude that the occasional danger of predation must be less than the constant need for advertising the occupation of a territory by a family of nesting birds. For successful breeding each family must be kept as a distinct unit within the society of rock ptarmigan. Thus both the isolation of families and their cohesion in an orderly society is effected by the display of the male. The inclination for display dominates the behavior of breeding male birds to degrees varying among the species. For the rock ptarmigan this concern for its family and society seems to suppress the attention for individual protection which is apparent in its behavior at other seasons.

Pedioecetes phasianellus (Linnaeus)

In addition to spruce grouse another timber grouse is called *Odgillyim kadgia*, "birch grouse," by the Nunamiut. At Bettles a sharp-tailed grouse was clearly described by David Tobuk, an Eskimo long resident there, who said that he had not seen one in recent years. Simon Paneak recalled taking one at Hunt Fork about 1939. Older Eskimos at Kobuk related to me the occurrence during one period in that region of "birch grouse." I have not yet been able to develop a chronology which would enable me to estimate the years when they were well known, but I suspect that sharp-tailed grouse have been rather common near the northern limit of timber during a period which ended some 20 years ago.

Cade and Buckley (1953) relate various accounts of sharp-tailed grouse which indicate that in 1934 the population became dense in the Tanana Valley. On one occasion in that year a large flock was seen to fly away. This movement seemed to mark their disappearance from that part of the Tanana Valley for thereafter there were no reports of their occurrence near Fairbanks. Since that date these grouse have not been widely common throughout interior Alaska. It seems possible that the reports of sharp-tailed grouse which I obtained in arctic Alaska may be related to a date when they were abundant in much of the subarctic interior.

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Family GRUIDAE: Cranes

Grus canadensis canadensis (Linnaeus)

Lesser sandhill cranes are seen and heard regularly during spring migration. They were reported May 30, 1949, and May 25, 1954. As *Tattidgak*, their characteristic mode of flight and calls are well known to the Nunamiut. It is said that flocks greater than six in number are not seen, and that they do not alight in the Valley. A few are known to nest along the lower Colville.

Family CHARADRIIDAE: Plovers, Turnstones, Surfbirds

Charadrius semipalmatus Bonaparte

16 males	May 19–June 22	weight (11), 39–48, average 42 g.	—	—
2 females	June 22–Aug. 6	weight (3), 41, 40, 39 g.	—	—
1 young male	Aug. 16	—	—	—
2 nests with 3 and 4 fresh eggs; one male, one female parent.	June 22, 1949	—	—	—

The attractive semipalmated plover was recorded in Tuluak Valley May 20, 1949, June 2, 1950, May 6, 1951, May 23, 1953, and June 1, 1954. One which had been collected at Tuluak June 3, 1948, was examined but could not be saved. A considerable number in migrant flight pass through late in May, and many settle to disperse along the sand and gravel bars of the river, where they may often be seen running with surprising swiftness for such small birds. The first set of eggs was found by Thomas Brower; it contained three eggs on June 12, 1949, and since no addition was made, it was collected partly incubated June 22. The other set listed was fresh.

The bird in young plumage was collected at Akmalik Creek, Killik Valley, on August 6. It could then fly well and was near full length and wing size. It was with an adult female, and both appeared to be in residence. The last record for 1950 was September 1 at Contact Creek.

One of the nests collected by Tom Brower was found on the fine sand near a little stream and was made of coarse and finer grasses with a few leaves and fragments of willow and other dry tundra material. The other was found on a ridge above the river and contained moss, fragments of grass, and small leaves from the adjacent dry tundra.

These handsome and alert little plover are well liked. The Nunamiut name *Kodrakoruk* is given them in resemblance of their call.

There is a considerable northbound flight of semipalmated plover. Those which remain in the Valley are conspicuous by their calls and

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for the swiftness with which they run over the gravel bars of the river, but because of their restricted habitat, the resident population in the valley is not large.

Charadrius vociferus vociferus Linnaeus

On the basis of recognition of pictures and from description of its appearance and habits, the killdeer was called *Talikvak*, by the Nunamiut. Simon Paneak says that a few may be seen as spring migrants, and reported one sight record May 29, 1950, at Tuluak Lake. On May 29, 1951, one was wounded by Elijah Kakena but it escaped. The Nunamiut think that they do not nest in the mountains, but that they nest on the lower Colville. These Nunamiut accounts undoubtedly refer to a plover or sandpiper differing from any which we obtained and resembling the illustrations and descriptions of killdeer. But there have been only two specimens of killdeer taken on the arctic coast of Alaska (Bailey 1948) and there is only one sight record from Yukon Territory (Rand 1946). Considering it possible that I could have been confused in our exchange of descriptions, I cannot now identify conclusively the killdeer in the list of birds of the mountains.

Pluvialis dominica dominica (Müller)

20 males	May 19–July 25	weight (36), 127–169, average 144 g.	—	—
18 females	May 21–July 25	weight (24), 126–169, average 146 g.	—	—
1 young male	July 25	weight 105 g.	—	—
2 young females	July 25	weight 111, 121 g.	—	—
5 nests, each with female and 4 fresh or slightly incubated eggs.	June 9	—	—	—

In addition to the specimens of eastern American golden plover recorded, seven birds were collected May 12–23, 1948, and about 100 others were examined. None were questioned as deviating from the form *dominica*. The earliest records are May 12, 1948, May 16, 1949, May 10, 1950, May 8, 1951, May 19, 1952, May 18, 1953, and May 17, 1954. Thereafter increasing numbers were seen daily feeding and whistling on the tundra, where the drier and more elevated part of the valley floor was their preferred habitat. Because the flocks were few and loosely formed, it is difficult to distinguish northbound migrants from the many birds which take residence and impossible to estimate the proportions of the two categories.

In early June pairs are established in their territory, where both often stand, conspicuous and statuesque, as the male whistles the cheerful call for which it is called *Todlik* by the Nunamiut. The first nests were recorded on June 9, 1949, two sets then being slightly incubated, one on June 8, 1951 and a nest with three eggs on June 10,

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1952. Some nesting occurs earlier, for eggs were used for food when a snowstorm on June 3, 1948, drove many birds from their nests. Females taken May 28, May 30, and June 1 contained eggs ready to be laid.

Nests were located on dry ridges near the river and over the valley in dry spots as far as the slopes leading to the steep valley walls. They were simply composed of fragments of lichen, a little grass, and a few small leaves. With the five nests female birds were taken in each case, but the males remained nearby.

The first young were recorded June 25. On July 8, 1951, a young bird taken at Amorgoayat in the Killik Valley weighed 77 grams. Thereafter, the young birds were inconspicuous until about July 20, when they began to reveal themselves as they ran over the tundra under watchful supervision of the parents. On July 25, 1950, of four young in one group, one escaped by flying and the largest of the three taken could fly a little. On July 24, 1950, seven young flew so well that they could not be run down and were taken with shot. They weighed from 121–135 grams, average 127 grams. Plover were numerous and usually still in pairs until August 2, but none were seen August 3–15, in the Killik Valley and none have been recorded later than August 15, 1950, in Tuluak Valley. About three months of arctic residence appears to satisfy them for their long flight from southeastern South America.

With their extensive range in the Valley, golden plover are extremely numerous and they probably outnumber the common Baird's and semipalmated sandpipers and northern phalaropes, all of which have a more restricted range than plover. Their numbers cannot compare with those of redpolls, tree sparrows, or Alaska longspurs. These observations will indicate the large size of the population of plover in the Valley, which is representative of great areas which I have seen on the arctic slope.

Their large numbers and calm, unhurried attitudes demonstrate that the satisfaction of their food requirements in the arctic environment is easily accomplished. The ability to obtain basic sustenance without strain suggests how these beautiful birds support their tremendous migratory flight. The charm of their appearance matches the splendid vigor of these birds, which can travel so far yet have the time and inclination to be lively but unexcited and alert but confiding, and which always present to an observer the appearance of being satisfied with and interested in their arctic environment.

Squatarola squatarola (Linnaeus)

4 males	May 31–June 3	weight (6), 206–234, average 214 g.	—	—
1 female	May 27, 1951	weight 192 g.	—	—

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Black-bellied plover were earliest recorded on June 3, 1948, May 14, 1949, May 30, 1950, May 29, 1952, May 23, 1953 and June 1, 1954. They are called *Todlivak* by the Nunamiut and being conspicuous by habit and appearance their presence is well known. A few are seen each spring but they do not remain in summer, and they are not seen in the fall.

A light-colored female specimen was one of four birds reported by John Krog to be similarly light in plumage, and it is evidently a year-old bird. It contained eggs 12, 6, 4, and 2 mm. in length and was very fat. As the largest egg was about ¼ of full length, the bird was ready to lay soon. The Nunamiut know their nesting places along the arctic coast.

In 1952, black-bellied plover were seen more commonly than in other years. Eskimos on the arctic coast have told me that the numbers of these plover seen varied greatly from year to year. They qualified their comments by remarking that their own chances to observe birds varied with the requirements of their families, the nature of their hunting, and the localization of their interests. They believed, nevertheless, that the numbers of black-bellied plover varied.

Where I have seen these plover, which is not on their nesting grounds, they have been shy and mute compared with golden plover. When watched through binoculars, their alert and confident posture is most impressive, and for their statuesque poise I admire them beyond even golden plover.

Arenaria interpres interpres (Linnaeus)

1 male	May 30, 1949	weight 105 g.	—	—
3 females	May 24, 31	weight 90, 97 g.	—	—

The earliest records for turnstones are June 1, 1948, May 18, 1949, May 30, 1951 and May 27, 1954. Two shot June 1, 1948, were examined but could not be saved. The female collected May 30, 1951, contained three eggs about 4 mm. in length. Well known as *Talivikeak* in Nunamiut, they usually pass hastily through Anaktuvuk Valley in spring, but none are known to nest there and they have not been seen later in summer.

I have followed Herbert Friedmann's identification of these specimens. Bailey (1948) named Alaskan specimens of turnstones *interpres* but remarked upon the difficulty of distinguishing them from *A. i. morinella*. The nesting areas assigned to *interpres* and *morinella* overlap east of Alaska and it would seem as if either the identifications or the taxonomic separation of the two as races is open to question.

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Family SCOLOPACIDAE: Woodcock, Snipe, Sanderlings

The list of shorebirds is extensive for an inland mountain region, and it is evident that there is much migratory traffic in addition to some nesting. I have no evidence to suggest that additional forms may be found, although I have frequently been asked by ornithologists for information about bristle-thighed curlew in the mountains. There appears little doubt as to the birds which are nesting or transient.

The weights of ten of the shorebirds shown in table 2 can be used for comparison of the size of the two sexes. In two species the average weight of males is heavier by more than 10 percent, in three the females are heavier, and there is no significant difference in the other five (inclusion of specimens carrying a temporary excess of weight because of being in laying condition can, of course, account for a higher average weight). I have heard it said that female sandpipers are larger than males, but that generalization does not apply to the dimension of weight.

TABLE 2.—*Average weight of the two sexes of* Scolopacidae *of ten species*

Name	Male		Female	
	Number	Weight (g.)	Number	Weight (g.)
Capella gallinago delicata	6	100	3	102
Numenius phaeopus hudsonicus	2	366	4	456
Heteroscelus incanum	13	101	16	116
Totanus flavipes	14	81	6	81
Erolia melanotos	25	86	10	60
Erolia bairdii	28	39	12	39
Erolia minutilla	16	20	14	22
Limnodromus scolopaceus	28	100	11	109
Ereunetes pusillus	32	24	10	26
Tryngites subruficollis	4	71	6	53

Capella gallinago delicata (Ord)

4 males	May 21–June 20	weight (6), 95–109, average 100 g.	—	—
1 female	May 22, June 2	weight 92, 113, 105 g.	—	—

The earliest recorded Wilson's snipe were seen at Tuluak Lake May 15, 1950, May 16, 1951, heard at Summit May 19, 1952, and seen on May 14, 1953, and May 25, 1954. Not many are seen in the spring, but the flight sound of snipe is heard almost every day in the Killik and Anaktuvuk Valleys until about mid-July. Between June 19 and June 24, 1951, I saw two Wilson snipe at Contact Creek and one at

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Kangomavik. Simon Paneak saw one at Contact Creek and John Morry, three. In late May and early June 1952, I saw numerous snipe, mostly in pairs, along Contact Creek.

The Nunamiut know them well as *Avikiak*, which means "like the walrus, Aivik," referring to the similarity of the far-carrying blowing sound made by walrus and the winnowing of snipe. According to an old story, killing a snipe would bring on bad weather, and the snipe is often called "weather maker."

Occasionally young birds have been seen by the Nunamiut in summer, and although nests have not been found, I believe that they nest in the Valley. None have been seen at the end of summer. The numbers seen in spring and the frequency with which snipe are heard in summer suggests that they may approach the yellowlegs in number, and that the retiring disposition of nesting snipe contrasts with that of the demonstrative yellowlegs sufficiently to give a false impression of their relative abundance.

Numenius phaeopus hudsonicus **Latham**

2 males	June 1, 1949, 1950	weight 382, 350 g.	—	—
3 females	May 23, 26	weight (4), 407–493, average 456 g.	—	—

The earliest records of whimbrels are May 20, 1949, May 23, 1950, May 19, 1951, May 26, 1952, May 14, 1953, and May 31, 1954. They appear briefly in spring, often in pairs or in groups of 6 to 10, but they act like transients and give no appearance of lingering in the Valley.

Two females taken on May 23 and 25, 1951, contained eggs respectively 10 and 12 mm. in length. As this is about one-fifth of the length of the eggs when laid (Bent, 1929, p. 117), the birds might easily with their swift flight reach the arctic coast before laying.

The Nunamiut call them *Sigoktovak*, meaning "long-billed," and they have not seen them in the mountains in summer. They know of nesting places near the mouth of the Colville River. One was reported seen at Tuluak on August 19, 1950, but fall appearances are rare. One shot on May 29, 1952, contained many crowberries in its crop.

Bartramia longicauda **(Bechstein)**

1 female	May 24, 1949	—	—	—

The single example of an upland plover is in excellent condition of plumage although it was beyond the range usually ascribed to it. The Nunamiut designated it a bird which they had not previously noticed.

On June 1, 1952, Simon Paneak, Elijah Kakena, Frank Rulland, and Old Hugo saw three sandpipers which they thought resembled

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the upland plover taken in 1949 and which differed from any other sandpiper they knew. A week later Paneak and I saw two birds which by appearance we could not refer to any other kind of sandpiper than upland plover. Susie Paneak thought she saw one at Pitaich on June 18, 1954.

There are a few Alaskan records of upland plover. Grinnell (1900, p. 75) did not see one on the Kobuk but mentioned Townsend's (1887, p. 12) specimen from there. It has been reported in west-central Yukon (Rand, 1946) and nesting settlements have been reported in central western Yukon (Buss, 1951). It has also been reported nesting in Mount McKinley National Park (Dixon, 1938, p. 77). Charles Sheldon of Kobuk recognized the illustration and description of this bird and gave me as its Kobukmiut name *Nanum kanockdoroagna*, "inland longlegger." I suspect that its occurrence in the mountains is not unique and that it is an occasional visitor from not distant ranges in the ornithologically little known interior of Alaska.

Actitis macularia **(Linnaeus)**

3 males, not preserved.	31 May, 14 June	weight 30.2, 34.1, 35.2 g.	—	—
2 females	28 May, 6 June	weight 37.7, 50.9 g.	—	—

I have frequently seen spotted sandpipers along the Koyukuk River from Bettles to Allakaket and on the lower Alatna River. The Nunamiut recognized a specimen which I had brought from near Bettles, named it *Oklaktak*, and said it was familiar to them as far north as the arctic coast. In 1952 I obtained a specimen on Contact Creek near an old caribou skin to which it may have been attracted by the numerous blow fly larvae. The bird was fat and its eggs, measuring 3 mm. in length, had started development. Another individual was reported seen soon afterward. In 1954 a second female was obtained by Simon Paneak and 3 males were weighed. The heaviness of the female indicates it was in laying condition.

In view of the Nunamiut knowledge of these birds, and with several specimens and records, I consider these spotted sandpipers to have been migrating birds northbound for nesting. They are reported by Kessel and Cade (1958) to be rather common in the Colville Valley.

Tringa solitaria cinnamomea **(Brewster)**

2 males	May 17, May 20	weights 55, 54 g.	—	—

These western solitary sandpipers are patterned like a specimen in the U. S. National Museum collected by Dall at Nulato (Dall and Bannister, 1869). The Nunamiut know the bird as *Kipilugoksiyook*, which means "looks for insects." They describe it as a lonely sandpiper found near lakes and in wet places, and seen occasionally in

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the mountains, and they recalled it as of regular occurrence near the arctic coast. Sidney B. Peyton informed me that in June 1954 he collected a set of eggs from the common nesting place of this sandpiper. I believe that solitary sandpipers are rather rare migrants through Anaktuvuk and not stray birds.

Heteroscelus incanum **(Gmelin)**

12 males	May 23–July 9	weight (13), 87–114, average 101 g.	—	—
12 females	May 20–July 9	weight (16), 98–130, average 116 g.	—	—
1 young female	July 31, 1950	weight 94 g.	—	—
2 young downy males	July 9, 1951	weight 43, 44 g.	—	—
1 young downy female	July 9, 1951	weight 45 g.	—	—

First records of wandering tattlers are May 25, 1949, May 19, 1950, May 26, 1951, May 29, 1952, May 22, 1953, and May 18, 1954. At this season they became common among the boulders on the gravel bars of the rivers and on the gravel fans where the swiftly running streams come down from the mountains. They are then familiar and friendly. Their calls, the Nunamiut describe in their name, *Silyirisoktok*, "it sounds like sharpening with a stone." Captured tattlers emitted this call in their cages, or, since they soon became adjusted to human company, as they ran about among the people in the tents and picked bits of food from the floor or from dishes. In their ready psychological adjustment to captivity tattlers are like lesser yellowlegs.

Soon after arrival the tattlers become very inconspicuous. Some doubtless fly north, but an occasional one or pair may be found among the small boulders of the rocky fans, often closely covered by willows, where the small streams rush down to the valley from the mountain sides. After the event, I was informed that my son Laurence and I ate tattler's eggs along with those of golden plover, on June 2, 1948, when many of the birds had abandoned their nests after a snow fall in early June. The tattler's nest had been found by Susie Paneak in the gravel of Nakagnik stream near Tuluak Lake, and Simon Paneak remarked that the nesting place was at lower elevation than usual.

Nesting is known to the Nunamiut to occur in the boulder-strewn stream beds, and I have evidence to confirm their story. A male bird taken June 21, 1949, had bare incubating spots on its breast. It was the smallest adult male recorded. The young female bird, taken at Kangomavik Creek July 31, 1950, weighing 94 grams, was sufficiently young to be a local fledgling.

In 1951, we examined eggs in the tattlers collected. The largest measured 6 mm. on May 26; 6 mm. on May 28; 2 mm. on May 28; 7 mm. on June 1. These figures do not set the exact date of nesting.

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We particularly searched for nests. Susie Paneak reported that on June 10 she had seen a tattler that acted as if nesting in Akvalutak Creek near its emergence from the mountain wall, but repeated searching failed to discover a nest. On June 24, a female tattler was collected on Kangomavik Creek about halfway from the river to the mountain wall of the Valley. Its behavior strongly suggested the proximity of a nest or young, but Simon Paneak and I were unable to find anything after long search in the grass-grown gravel. On July 9, Simon Paneak and William Irving collected a pair of tattlers with three downy young on Akmalik Creek about 1½ miles west of the Killik River. They were located on a grassy bar among the willows. Since these young tattlers were probably near twice the weight of the eggs from which they had hatched they had probably left the nest several days earlier. Simon and William had, in July, seen another pair of tattlers acting as if near a nest at Togoyuk Creek several miles higher in the Killik Valley.

In 1956 Simon Paneak's son Roosevelt found four fresh tattler's eggs on a gravel bar in Tuluak Creek. These were collected for Sidney Peyton.

We have no record of the late summer or return flight, for the birds remain inconspicuous all summer in the valley stream beds which they frequent and which are lined and filled with dense willow brush. During migration, tattlers are much less numerous than golden plover but more common than black-bellied plover. Some probably go on northward, although their summer habitat in the valley would only be found in a few places north of the mountain line. Among the Nunamiut, tattlers are considered to be a rather common nesting bird, but their concealing habitat and shyness in this period is the reason for uncommon summer observations.

It is interesting to compare the tattlers, yellowlegs, and snipe. The last are always of secretive disposition on the ground, particularly during nesting, revealing themselves in summer only by their flight sounds and in occasional flights. Yellowlegs show off their presence conspicuously all during the summer, when wandering tattlers mostly disappear up the small creeks. Although only yellowlegs are commonly seen, I suspect that all three birds are present in considerable and perhaps similar numbers nesting in the mountain valleys.

Totanus flavipes (Gmelin)

10 males	May 26–July 3	weight (14), 69–94, average 81 g.	—	—
4 females	June 13–July 3	weight (6), 77–92, average 81 g.	—	—
6, sex unknown	May–Aug. 6	—	—	—
1 nest, 4 slightly incubated eggs, with female	June 13, 1949	—	—	—

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The earliest records of lesser yellowlegs are May 15, 1949, May 16, 1950, May 18, 1951, May 16, 1952 and May 23, 1953. Thereafter they are conspicuous summer residents. No large numbers were noted in spring. They proceed rapidly to nesting in the wet marshy areas near willows and the nest collected by Tom Brower with the female bird contained 4 eggs already developed by several days incubation. This nest was on a dry ridge under short willows near the river and made of short fragments of grass and small leaves. It contained numerous pieces of the equisetum which grows abundantly in the marshy places which they frequent. This nest was visible from 10 feet away.

The Nunamiut name *Ovingoayook* means "whistling." Yellowlegs are not a numerous population, but they are conspicuous in habit and appearance. As one approaches a wet marshy area the yellowlegs may rise close at hand and fly fluttering about to land and balance on a slender willow branch, there continuing its sharp whistling call. Soon it may leave to flutter and repeat the balancing and calling. Even at a distance too great to explain the disturbance by intrusion of the observer, yellowlegs may rise, fly about, and balance upon the willows calling so that their restless behavior reveals the location of the population.

Although very attentive to human interference, they are apparently not deeply agitated by contact with man because captured yellowlegs, like tattlers, readily accept a prisoner's life and soon learn when released within a tent, to run about among and over the children and people. They feed readily upon bits of meat or crumbs and some have been kept for several weeks in this close association with the families. Their gentle behavior in captivity is like that of well-mannered guests. This and their demonstrative attention to human company when free makes them well liked by the children and adults, who appreciate their dainty friendliness. Their behavior contrasts with that of the sullen jaegers, which can also be kept for a time, but only as inexpressive captives showing no sentiment but greed.

The population of yellowlegs is conspicuous but not numerically large in comparison with that of the northern phalaropes. Judging from the frequency of summer calls of the Wilson snipe, they are as numerous as yellowlegs, but a snipe is seldom seen in summer. The spring numbers of yellowlegs are somewhat greater than in summer, so that there is a migration northward, where there are many marshy areas among willows resembling those inhabited in the mountains.

Erolia melanotos (Vieillot)

18 males	May 18–June 3	weight (25), 64–105, average 86 g.	—	—
9 females	May 18–July 29	weight (10), 58–69, average 60 g.	—	—

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The earliest arriving pectoral sandpipers were recorded May 18, 1949, May 24, 1950, May 20, 1951, May 26, 1952, May 18, 1953, and May 27, 1954. In the next week, considerable flights passed through, obviously on the way northward. By early June, migrating flights had ceased, but birds were frequently seen and occasionally heard in the grassy marshes in which, however, like snipe, they lay rather close and remained inconspicuous.

The eggs in several females were measured in 1951, and their length was found to be 1 mm. on May 24, 2 mm. on May 26, 4 mm. on May 27, 4 mm. on May 28, 4 mm. on May 29, and 4 mm. on June 1. From these figures, I derive the belief that nesting occurred after June 1.

No nests were found but the Nunamiut consider them to be nesting birds in many grassy places, where the soft booming sound of the males is often heard through June. The source of the sound is indicated in the name *Poviaktook*, which means "inflating the chest," and nesting is considered to occur rather commonly, but not to be easily discoverable. I am disappointed by the vagueness of my summer information upon the pectoral sandpiper, the nesting of which is reported upon so commonly in other arctic regions.

A female taken July 29 was in fresh plumage, with adult characteristics. It was one of a group of three found near the north end of Margaktuk Lake and is considered to be a resident bird, for no flight movements had yet been seen. In fact, southward flights have not been reported, and as in most species, they apparently do not form into flocks in the valleys.

Erolia fuscicollis (Vieillot)

1 male	June 1, 1954	weight (2), 40.2, 31.7 g.	—	—

The first white-rumped sandpiper to be recorded was collected by Simon Paneak and so named by him in the field from Peterson's (1941) descriptions. On the same date he weighed another male, found alone. Both birds were fat and the testes, which were 8 and 9 mm., respectively, were progressing toward breeding size.

Bailey (1948) reported that 8 specimens and 2 sets of eggs had been collected along the arctic coast between Wainwright and Demarcation Point. It is possible that the two specimens were migrating to nest further north but the record of two males only warrants their designation as visiting birds.

Erolia bairdii (Coues)

34 males	May 15–July 26	weight (28), 32–48, average 39 g.	—	—
8 females	May 16–July 20	weight (12), 34–45, average 39 g.	—	—
1 young male	July 26	weight 26.4 g.	—	—

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The first arrivals of Baird's sandpiper were recorded May 13, 1949, May 29, 1950, May 13, 1951, May 26, 1952, May 13, 1953, and May 12, 1954. In 1949, 200 were reported seen May 16 and again on May 17, but by May 23 only 8 or 10 were reported daily. The early large numbers seen along the lakes and streams probably included many northbound migrants as the resident birds often resort to the higher and drier parts of the tundra, even to elevation 1,400 feet above the valley floor. The rush of migration passed in late May 1949. These sandpipers, which are only known to nest north of the arctic circle, make their way northward in large numbers through the Pass.

On June 6, 1951, John Krog found a nest about 1,400 feet above the valley floor in the mountains west of Tuluak Valley. Robert Paneak found the young just breaking through the shell in a nest on the valley floor June 24, 1951. A female contained an egg 20 mm. long May 28, 1951. These observations set the date of nesting as about June 1.

Often they stand, like plovers, rather alert and suspicious, taking wing to rise swiftly and soar about singly or in pairs. They are more shy than semipalmated and least-sandpipers, but more conspicuous on the dry ground which they often occupy. During migration they are more conspicuous than the semipalmated and least sandpipers as is also the case of the resident birds in summer. They appear to be about as numerous as any migrant shore birds in their short season of flight. In summer they are probably not as numerous as semipalmated sandpipers.

The Nunamiut call Baird's sandpipers *Nuvuksruk*, which means that "they sound like a man with a bad cold." They can be confused in the field by the Nunamiut, as by us, with semipalmated sandpipers, but the name, like the birds' habits, was specifically distinct and was correctly applied in about 20 cases when skins were examined for a test.

Erolia minutilla **(Vieillot)**

4 males	May 16–June 8	weight (16), 16–23, average 20 g.	—	—
5 females	June 5–June 11	weight (14), 17–27, average 22 g.	—	—

Least sandpipers arrive in the latter part of May, and when first seen migrating are difficult to distinguish from semipalmated and even Baird's sandpipers. First arrivals, often in pairs, have been recorded May 30, 1950, May 16, 1951, May 29, 1952, May 22, 1953 and May 15, 1954. As one becomes accustomed to their habits and as they separate into their habitat, which is usually small streams and pools, their behavior is quite distinctive. They stand more quietly and look more delicate than the larger sandpipers. While capable of swift flight, they often flutter their wings like a moth in making turns, whereas

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semipalmated sandpipers bank and glide swiftly through their turns.

The faint sweet song of these two sandpipers has brought their similar Nunamiut names. *Liva livaurak* means "smaller *Liva liva*" and designates the least sandpiper. Its *liva liva* song is repeated more faintly and more rapidly than that of the semipalmated sandpiper. Like its mothlike behavior in flight, *Liva livaurak's* song reminds me of an insect call, while that of the semipalmated sandpiper has the qualities of a frog's call. The *liva liva* song may be given from the ground or from high in the air, but I have never with certainty seen more than one *Liva livaurak* at a time calling in flight.

A female examined June 5, 1949, contained an egg about ready to lay, but I have no other observation related to nesting.

Least sandpipers are more numerous in spring than later and a considerable number fly on northward. They are less conspicuous and more retiring birds than the larger sandpipers, less common in summer than semipalmated sandpipers and probably fewer than Baird's sandpipers. Nevertheless they are common and familiar birds which the Nunamiut like for their song.

Erolia alpina pacifica (Coues)

1 female	June 10, 1954	weight 58 g.	—	—

On May 14 and May 16, 1949, Thomas Brower reported seeing a red-backed dunlin. Because these distinctive sandpipers were familiar to us at Barrow his sight record is considered certain. On June 2, 1952, Simon Paneak saw one at Summit and on June 5 I thought I saw one in flight, but these were both short views and they are uncertain evidence. On June 10, 1954, Simon Paneak obtained the specimen.

The example had little fat and its eggs, at 4 mm. in length, were just starting to develop. These sandpipers are so distinctive in appearance and so familiar to our view on the arctic coast that the few records in the mountains show that dunlins rarely alight in Anaktuvuk. The evidence does not show the use of Anaktuvuk as a regular migratory path and at present I regard the birds recorded as visitors.

Limnodromus scolopaceus (Say)

21 males	May 23–June 3	weight (28), 90–114, average 100 g.	—	—
10 females	May 22–June 3	weight (11), 93–119, average 109 g.	—	—

Pitelka (1950) gives as mean measurements for the long-billed dowitchers, which he designated *Limnodromus scolopaceus*, the following: males—wing 139, culmen 62; females—wing 144, culmen 72. Our dowitchers agree closely with these measurements.

The mean weight of birds of this race taken in spring and fall in

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British Columbia and the United States is given by Pitelka (1950, p. 17) as males (11), 99 grams, females (7), 115 grams. In view of the known capability of some species of birds to deposit large amounts of fat and as small warm-blooded animals necessarily consume their intrinsic resources rapidly, weights recorded at different seasons and localities might not be of much use as indices of race. The agreement of our weights in the arctic with those of Pitelka shows that these dowitchers do not vary significantly in weight with season and place. Apparently they neither store nor exhaust much substance during migration.

In 1954 ten examples of dowitchers were weighed at Anaktuvuk on May 25 and 26 by Simon Paneak. This sampling, taken in a spring season reputedly uncommonly cold, did not deviate significantly from the mean weights of the preceding 5 years.

By comparison with specimens in the U. S. National Museum our dowitchers agree in characters with those from Alaska marked *scolopaceus*.

The flights of dowitchers are numerous but pass rather swiftly. The first records are June 3, 1948, May 20, 1949, May 26, 1950, May 18, 1951, May 29, 1952, May 16, 1953, and May 25, 1954. Many birds are seen in pairs but the largest developing egg found was 9 mm. In 1949 the maximum number recorded by Thomas Brower was 200 on May 30. Soon thereafter only a few were seen and it is believed that they pass rapidly to nesting grounds further north.

The Nunamiut name, *Kilyaktalik*, means "like a bundle when seen from behind," a rather apt description which should not, however, disparage the excellent ability of dowitchers in flight. They are said to be seen very rarely in the valleys during summer, but 140 miles west, along the Ahlasuruk, we have seen dowitchers in summer which acted as if nesting (L. Irving and Paneak, 1954). While it is thought that they may nest at Anaktuvuk, no indications of nesting are explicitly recalled, so I do not list them as nesting birds.

Micropalama himantopus (Bonaparte)

9 males	June 1–4	weight (10), 53–66, average 58 g.	—	—
3 females, not preserved	June 8–12	weight 54, 56, 55 g.	—	—

Stilt sandpipers were also recorded from two examples which Ray Hock and I examined after they had been taken on May 30 and June 3, 1948, and in observations by Thomas Brower between June 1 and 6, 1949. Since that time they were not again reported until between May 31 and June 12, 1954, when two singles, a group of 8, and a group of 3 were reported by Simon Paneak.

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The Nunamiut did not give me a name for stilt sandpipers. Our failure to notice them more often may arise from our lack of familiarity with these birds. I cannot believe, however, that many have been present without attracting our attention. Even A. C. Bent (1929) remarked that he could not give a general pattern for their appearance in various localities, and like some other not uncommon birds, records of stilt sandpipers seem to provide no clear track of their movements. I consider those which we have seen to have been normal migrants, but they are not common and may not appear in some years.

***Ereunetes pusillus* (Linnaeus)**

27 males	May 21–July 20	weight (32), 20–29, average 24 g.	—	—
14 females	May 20–July 24	weight (10), 21–27, average 26 g.	—	—
5 downy young	June 26–27	—	—	—
3 young males	July 20–26	weight 20.5, 19.1, 20.5 g.	—	—
1 nest with 4 fresh eggs and male bird.	June 12, 1949	—	—	—
1 nest with 4 largely incubated eggs and male bird.	June 18, 1949	—	—	—

Semipalmated sandpipers are the most common sandpipers. Large numbers arrive in early May, but because of easy confusion with least sandpipers, the earliest records may not be first arrivals. They have been reported May 20, 1949, May 30, 1950, May 14, 1951, May 24, 1952, and May 27, 1954. The earliest five males to be collected, between May 21 and May 23, were heavier than any males subsequently taken, weighing from 26.0 to 29.4 grams, and were then certainly not exhausted from their northward flight.

Soon after arrival they spread over the marshy tundra, feeding much by pools and lake edges and small streams, while the numbers diminished as some of the migrants moved north. During early June they are conspicuous as one, two, or several birds ascend rapidly some 200 feet in the air to circle about singing, and carrying out aerial evolutions in alternate fluttering and soaring flight. The sweet *liva liva* song, faint in the distance, was indefinitely repeated without variation or interruption, but because of the numbers and their distance I could not tell how long each bird sustained its calling. As I watched a pair on a sandy bank on Tuluak Creek, the one which was more forward in its attentions called repeatedly in 15-second runs, while the companion or mate called only occasionally in short runs of a softer sound. Frequently I have heard them on the ground calling only the two sounds, *liva liva.*

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A female bird examined on May 24, 1951, contained eggs 10 mm. long and one on May 28 had eggs 12 mm. long. Nests were found June 12 and June 18 with respectively fresh and incubated eggs. On June 26 a single downy female weighed 9.1 grams and was just able to walk slowly with an adult female in close attendance. Near Itikmalikpuk Creek on June 27 we found 4 small downy young huddled in a nest, still unable to stand. Their weights were 1 male, 4.3 grams; 3 females, 3.4, 3.5, 3.6 grams. At this date semipalmated sandpipers were feeding among the small waves on the sandy lea shore of one of the small Pitaich lakes. About a dozen were associated but not formed as a flock. From that time on, they are seen in larger numbers feeding along the sandy beaches of the windward shores of the lakes if the waves are small. Their association in these meeting places becomes closer as the young birds grow up, and they become more concentrated along lake and river shores than in their earlier wide distribution among tundra pools and streams.

The Nunamiut call all small sandpipers *Liva liva*, but this name really designates the song of the semipalmated and least sandpipers. These two are called *Liva livakpaurak* by the Nunamiut meaning "larger *Liva liva*" and *Liva livaurak* meaning "smaller *Liva liva*." At first view these and Baird's sandpipers are not readily distinguished, but upon careful observation one sees that they look, walk, fly, and sing so differently that it is not surprising that many, but not all, Nunamiut adults and children name each with specific precision. The arrival of *Liva liva* is a welcome event in spring and people may stand alone or in groups to search with delighted interest to locate the obscure source of the sweet *liva liva* song in the small birds flying high overhead.

Tryngites subruficollis **(Vieillot)**

4 males	May 29–June 3	weight (4), 64.2–80.5, average 71 g.	—	—
6 females	May 29–June 5	weight (6), 50–58, average 53 g	—	—

Buff-breasted sandpipers are often seen in spring migration. The earliest observations recorded are May 24, 1949, and May 31, 1950, and the brief but fairly numerous flight is soon over. Probably for this reason it is not always observed.

They were well known on the arctic coast to the Nunamiut as *Aklaktak*, meaning "spotted," but they are not known to remain in the mountains.

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Limosa lapponica (Linnaeus)

A small flock of godwits was reported on May 28, 1950, at Tuluak Lake and a few were heard on May 18, 1953. During each spring a few are said to appear in small groups, but none are known to remain, although their nesting at the mouth of the Colville in 1911 was recalled by Simon Paneak. Although I have not seen them, the clear description and Nunamiut name, *Torhatoruk*, convince me that the occasional view of migrating godwits represents normal migration through Anaktuvuk.

Crocethia alba (Pallas)

2 males	June 4, 1949	weight 52, 51 g.	—	—
1 female	June 4, 1949	weight 52 g.	—	—

Sanderlings were recorded in 1949 between June 1 and June 6, when they were not uncommon. I saw a single one on May 29, 1952. It seems that their migration through Anaktuvuk Pass is brief and not numerous but of frequent occurrence, and that they do not linger to be observed. The Nunamiut name, *Kimitkoilyak*, meaning "having no heel," is appropriate and would not be applied without close examination.

Family PHALAROPODIDAE: Phalaropes

Phalaropus fulicarius (Linnaeus)

3 males	May 30, 1950	weight 42, 41, 37 g.	—	—
2 females	May 30, 1950	weight 52, 51 g.	—	—

Some red phalaropes were seen late in May in 1948 and 1950. The early records are May 18, 1951, May 18, 1953 and June 9, 1954. The red phalaropes examined by Simon Paneak in 1954 had little fat. Eggs in the females had developed to about 2 mm. and the testes in the males were from 9 to 12 mm. in length.

Red phalaropes are usually seen in small groups or alone. Often they are so much engaged in their feeding or courting activities as to be quite undisturbed by human approach. Their Nunamiut name is *Auksruak*, which means "colored like blood." They are familiar spring migrants which act as if visiting for a short time or even considering residence, but they are not known to remain in the Anaktuvuk Valley in summer. Judging from their behavior in the Valley, some are close to their nesting ground. The Nunamiut know that many nest along the arctic coast. I have no record of their southbound flight at Anaktuvuk, but in late summer at Barrow large flocks are seen flying westward along the shore.

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***Lobipes lobatus* (Linnaeus)**

9 males	May 23, July 24	weight (14), 29–35, average 32 g.	—	—
12 females	May 18, June 24	weight (7), 29–33, average 35 g.	—	—
2 nests, each with 4 fresh eggs and 1 parent	June 22, 1949	—	—	—

The earliest records of northern phalarope are May 18, 1951, May 24, 1950, May 30, 1949 (when 40 were seen), May 18, 1952, May 19, 1953, and June 1, 1954. In late May, many migrants are seen, but within a few days the migrants hastily pass and the remainder of these nervous but friendly little birds settle on most of the pools and lakes of the Valley. The Nunamiut name *Kaiyiorgon*, meaning "float like an Eskimo in a kayak," aptly describes the appearance of phalaropes floating lightly on the water with head erect and dark eyes alert like a watchful Eskimo in a kayak.

Examination of developing eggs in 15 birds between May 18 and June 2, 1951, showed none longer than 6 mm. The first nest reported that year was found by John Krog at Imaiginik June 8.

These phalaropes are very numerous, probably equaling in their numbers the Baird's and semipalmated sandpipers.

Family STERCORARIIDAE: Jaegers, Skuas

***Stercorarius pomarinus* (Temminck)**

Pomarine jaegers are uncommon in the mountains. They are well known to the Nunamiut, from their experience on the arctic coast, as *Isongngakluk*. Accordingly, I credit Simon Paneak's sight records on May 11, 1950, and two dark and one light bird on June 10, 1950, and Elijah Kakena's report of three on May 31, 1952.

In the mountain valleys, they are said to be occasionally seen in small groups in spring, but are thereafter much less frequently observed than other jaegers and usually as single individuals. It is not known that they nest in the Valley, and they are so uncommon that I call them visitors. I would be surprised if these jaegers migrated northward through Anaktuvuk, for they are so seldom reported from interior Alaska that I suspect that those which come in to the mountains come from the north.

***Stercorarius parasiticus* (Linnaeus)**

2 males, 1 dark, 1 light	May 27, June 9	weight 513, 428 g.	—	—
3 females, 1 dark 2 light	June 11, July 29	weight 540, 520, 412 g.	—	—

The earliest recorded sight of 6 parasitic jaegers in 1949 was May 22 at Tuluak Lake. One was reported May 21, 1951, one on May 30,

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1952, one on May 23, 1954, and one on June 1, 1954. In the 1950 camp near Imaiginik it was the most commonly seen jaeger, whereas usually long-tailed jaegers are more numerous.

As a dark pair were approached while feeding at the carcass of a dog on the river bank July 14, 1950, two small gray birds the size of large sandpipers ran into the willows nearby while the old birds waited about and then flew only a short distance as if they had young to look after. We could not find them.

On June 14, 1951, Raymond Paneak showed me two eggs which his mother and he had found the day before. They were situated in a slight depression of the vegetation among small, marshy pools on the tundra near Kiminiaktuk. A single bird left the nest at some distance from us, but it could be clearly distinguished.

Their Nunamiut name, *Mirgiaksyook*, means "go after vomit." It is much better than our name, jaeger, for it refers to the common habit of these jaegers along the coast which is to harry gulls until they disgorge their food, which the jaegers then seize. They also feed greedily upon carrion. They regularly frequent Anaktuvuk Valley, commonly searching the tundra in twos and threes. Young birds are occasionally seen, and nesting is considered to occur regularly.

There appeared to be two dark and one or two in light plumage searching the tundra regularly in the vicinity of Tuluak Lake in 1950 during the summer. In spring a few more are usually seen, either in pairs or small groups. On June 5, 1952, a group of 17 was seen flying northward. They are seen at Point Barrow as early as our records in the Pass, and from the dates they might as well have come south to Anaktuvuk from the Colville Valley as from the southern interior.

Stercorarius longicaudus Vieillot

1 male, in 2d year	June 30	weight 216 g.	—	—
1 male	—	weight 305 g.	—	—
2 females	May 26, June 20, 1949	weight 347, 353 g.	—	—

Long-tailed jaegers have been earliest recorded as four live captives received June 1, 1948, and caught a few days earlier. Other early dates are May 20, 1949, May 11, 1950, May 27, 1951, May 24, 1952, May 22, 1953, and May 28, 1954.

The new tail feathers of the second-year male are only the length of those of a parasitic jaeger. The bill is small and not distinguishing. The gray feathers of the ventral area are barred as in immature birds, although the throat is faintly yellowish, indicating transition from immature to adult state. The identification is based upon the light coloration of the tarsi as compared with the black feet. The other birds are clearly distinguished.

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They are called *Isongnatcheak*, meaning "young or new jaeger" in Nunamiut. In spring they are frequently seen in pairs or small groups. Apparently they are then in migration, for they are less numerous during the summer. On June 5, 1951, a female contained eggs 18 and 12 mm. long. The female taken June 20, had a bare spot, as if incubating. Young birds have been reported, although I have not seen them. Long-tailed jaegers are usually more numerous than parasitic jaegers both in spring and summer.

Our early records in Anaktuvuk Valley are later than the time for arrival of jaegers at Barrow, as Tom Brower first pointed out to me. It may be that jaegers and some other birds migrate southward from the arctic coast in spring rather than into the mountains by the route through interior Alaska. Either route would be consistent with our date records for jaegers.

A number of captive long-tailed jaegers lived well for several weeks, but they became extremely dirty. They ate voraciously, and showed neither fear nor curiosity. They did not evince any interest in their surroundings nor did they appear depressed by them. Their stolid behavior resembled that of captive gulls, but was quite unlike the lively interest and adaptability to domestication which is shown by some sandpipers, ravens, and jays and by some of the Fringillidae.

Family LARIDAE: Gulls, Terns

Larus hyperboreus barrovianus Ridgway

1 male, adult, not preserved	May 18	weight 1605 g.	—	—
1 male, immature, in 2d year, white	June 11	weight 1824 g. wing 435 mm. culmen 60 mm.	—	—

The white-plumaged gull with some faint dirty brown on the breast appears to be a second-year bird and these measurements conform with those given by Bailey (1948) for western glaucous gulls from Barrow. The other male, with matured testes, was fat.

These gulls are called *Nauyavak* by the Nunamiut, meaning "larger gulls." The earliest recorded arrivals are May 14, 1949, May 10, 1950, May 6, 1951, May 29, 1952, May 4, 1953, and May 6, 1954. Between May 19 and 22, 1949, from 5 to 8 were seen daily. Between May 6 and 14, 1951, a few were seen each day, generally flying northward. It would be possible for these wide-ranging gulls to have come to Anaktuvuk either by northern or southern routes, for they arrive earlier at Barrow than at Anaktuvuk. During the summer of 1950 an occasional solitary bird patrolled the river daily. Frequently it was seen standing alone on the river bars. When disturbed it would fly only a few hundred yards as if reluctant to leave its territory.

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The Nunamiut say that nests are occasionally found in the Valley and I do not hesitate to designate it a regular but uncommon nesting bird. In spring many more are seen than in summer. I have not seen them along the upper Koyukuk and Alatna Rivers, where the herring gull seems to be the regular large nesting gull of the interior. Further west, on the upper Kobuk and Ahlasuruk Rivers, about 125 miles from the coast, the glaucous gull is very common, while the herring gull is rare.

Larus argentatus smithsonianus Coues

2 males	July 12, 1949, July 27, 1952	weight 1189, 1293 g.	—	—

The first specimen was obtained by Robert Rausch. One was reported seen on July 2, 1951, by Simon Paneak and William Irving on the Killik River within the mountains, but they are only rarely seen in the mountains. I have seen herring gulls with their young of the year along the Koyukuk and Alatna Rivers within 100 miles of Anaktuvuk. An adult male collected on the Alatna was identified as *smithsonianus*.

These and the few glaucous gulls of arctic interior Alaska are wary and difficult to shoot or to approach within range for distinct recognition. While this conduct embarrasses the naturalist, it is a blessing for the resident people that gulls do not rob and foul the meat caches as they do the environs of every boat and village along populated coasts. It appears that large aggregations of gulls and people induce reactions in behavior quite different from that which is natural to individuals or small groups.

The Nunamiut know the large gull with black wing tips which occasionally appears in the mountains but they give it no explicit name. It is probably an occasional but not infrequent visitor from the forested valleys of the central interior. There it seems to be common and the glaucous gull rare.

Larus canus brachyrhynchus Richardson

3 males	May 17–20, 1949	weight (5), 394–452, average 428 g.	—	—
1 female	June 20	weight 408 g.	—	—
1 female, in one year plumage, badly worn	June 20, 1949	weight 300 g.	—	—
1 female, of this year	Aug. 7, 1950	weight 422 g.	—	—

Mew gulls were first recorded on May 13, 1949, May 16, 1950, May 3, 1951, May 29, 1952, and May 18, 1953. Small flocks of at most 15 are sometimes seen during the last two weeks of May. Thereafter, during the summer, a few pairs are about and one or two may be seen

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almost any time flying over Anaktuvuk Valley, feeding on the river banks or lakes. The Nunamiut call them *Nauyatcheak.* They say that some are seen even at the mouth of the Colville.

A single egg was found on the wet mosses of a little hummock in a small tundra lake near Summit, June 24, 1951. One bird was sitting on the nest, and as I approached, it took off and was joined by another which sailed about over me as I took pictures.

The young first-year female bird was taken August 7, 1950, on the Killik River near Akmalik Creek. It had attained adult weight but not length. It flew strongly and might have come from a distance, but it was in the company of adult birds which acted as if in residence.

The latest record in 1950 was September 8 at Contact Creek. Mew gulls are common summer residents which nest in the Valley. Greater numbers pass through in spring than remain as residents. These are probably northbound migrants.

Occasionally these gulls fly high among the mountains. I watched one soaring with more grace and speed than an eagle as it rose over a 5,000-foot mountain. Early in summer, small groups carry on aerial evolutions, calling as they fly above the mountains and often pass vertically beyond range of glasses. I estimate that they reach altitudes of 10,000 feet.

***Rhodostethia rosea* (Macgillivray)**

Ross's gull is well known from earlier annual visits of the Nunamiut to the eastern arctic coast, and it is called by them *Kakmakloak.* At Barrow I saw these beautiful gulls first as if coming from the east early in September. Only one has been reported to me in the mountains, when in April 1949, it circled and hovered about the camp at Kalutak Creek for some minutes watching and watched by the children, who were joined by several adult witnesses before it flew away. The event made a distinct impression upon the people. The reported occurrence of this coastal gull in the mountains and in spring is so far beyond the scope of its reasonable wandering that this report does not entitle it to inclusion among the known avifauna of the Pass. The Nunamiut do not know of its nesting place.

***Xema sabini* (Sabine)**

One Sabine's gull was reported seen by Thomas Brower at Tuluak Lake on June 24, 1949, and the Nunamiut say that they occasionally see it in the mountains. This beautiful gull is well known as *Kadgagiak* to the Nunamiut from their former annual visits to the eastern arctic coast. The name is said to refer to the sound made by the gull. The name also resembles that of the willow ptarmigan and there is something about the gull which reminds me of a male ptarmigan as it

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begins to gain specks of dark color in summer. I do not hesitate to designate Sabine's gull a normal visitor.

Sterna paradisaea **Pontoppidan**

3 males	May 25–July 20	weight (4), 90 to 122, average 101 g.	—	—
4 females	June 1—July 20	weight (4), 84 to 101, average 96 g.	—	—
1 young male	Aug. 8, 1950	weight 102 g.	—	—
1 young female	Aug. 8, 1950	weight 101 g.	—	—

Arctic terns were recorded as seen June 1, 1948, June 1, 1949, May 25, 1951, May 29, 1952, May 23, 1953 and June 1, 1954. Migrant and resident behavior of terns is not distinguishable until the regular flights over their fishing grounds become established at nesting time, but inasmuch as the early population exceeds that in summer, some must be migrant birds. In May, terns could scarcely subsist on the arctic slope, and it is quite certain that they arrive from the south. They are well known as *Mitkotailyak* to the Nunamiut, and in some of the old stories, terns are important, usually interesting, and often spicy characters.

In the summer of 1950, about a dozen terns daily patrolled the river near Imaiginik occasionally cutting out to circle, or where it seemed favorable, to fish a lake. Their nesting place was described as among the gravel and rock bars some 10 miles down river, from which they flew in the morning and toward which they returned in the evening. This colony appeared to be the only one along about 20 miles of valley under observation. A like number was found present in 1951. A female examined in Tuluak Valley June 2, 1951, had laid an egg and still contained another ready to lay.

No young birds were seen until a colony of a dozen was found on the Killik River, roosting on the steep cut earth bank about 15 feet high opposite the mouth of Akmalik Creek. The two young birds obtained flew well; they were above the mean weight of adults and equal to them in wing length, but had not the adult length of tail.

Family STRIGIDAE: Typical Owls

Bubo virginianus lagophonus **(Oberholser)**

1 female	Nov. 27, 1947, Hunt Fork	—	—	—

The single specimen of a northwestern horned owl was obtained from within the forested region at Hunt Fork and sent to George Sutton, who kindly gave me this identification. Horned owls are well known in the spruce forest and called *Nukisirgak* by the Nunamiut. In a discussion among four Nunamiut hunters, they recalled from their

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experience of some 40 years, several instances of the capture of horned owls in wolf traps north of tree line. The valley is close to their normal range, and, while they are not common visitors there, it is therefore not surprising that these powerful owls venture over the tundra for exploration.

Nyctea scandiaca **(Linnaeus)**

1 female	Feb. 27, 1951, Contact Creek	weight 2267 g.	—	—

Snowy owls are frequently seen in the Anaktuvuk Valley during the winter, and they are well known by the Nunamiut name *Okpik.* Simon Paneak saw individual owls almost daily north of the mountain line in late March and early April 1951, and from the reports of other Nunamiut hunters then taking advantage of the lengthening days for extended hunting excursions, Simon remarked that there were quite a few owls in the Valley. The latest recent date for one to have been reported came from John Krog, who saw one May 25, 1951, at Tuluak Lake. They have occasionally been seen in summer at Chandler Lake, but no nests have been found in the mountains. I have heard no comment indicating in what circumstances the small numbers of owls seen vary systematically from year to year, nor is there any comment to indicate that there are cyclic changes in the small population of lemmings in the mountains. Any considerable change in either population would have been observed and remarked upon.

Along the arctic coast of Alaska the cyclic variation in numbers of lemmings is attended by variation in the numbers of all predators. I do not have enough information about the variation in numbers of snowy owls in the central parts of Alaska for it to serve as evidence for a cyclic migration. Neither do I have specific evidence that the winter movement of snowy owls to Anaktuvuk has the consistency which appears in the regular annual migrations of birds. For the present it seems best to designate snowy owls as visitors from the north coming to Anaktuvuk in winter.

Surnia ulula caparoch **(Müller)**

1 male	Mar. 1, Hunt Fork,	weight 350 g.	—	—
1 female	Feb.10, John River	weight 350 g.	—	—

American hawk-owls are well known as *Neakoktoakruk* among the Nunamiut to be dwellers in the timbered country, where they have been seen as far north as the last spruce at Publatuk Creek and on the upper Savioyuk River. They are not reported as venturing north of timber and are not included among the avifauna of Anaktuvuk Pass. Our records show that some hawk-owls of the northernmost population in the forests are winter residents.

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***Strix nebulosa nebulosa* Forster**

The American great gray owl, *Nattak* in Nunamiut, is well known in the spruce forests and is occasionally seen at the northern limits of spruce between Hunt Fork and Publatuk Creek. It is not considered likely to pass north of timber and, like the hawk owl, is not included in the avifauna of Anaktuvuk Pass. It is my opinion that this owl and the hawk owl are closely attached to the forest environment.

***Asio flammeus flammeus* (Pontopiddan)**

1 female	May 29, 1949	weight 400 g.	—	—

Short-eared owls, known as *Nipailyutak* to the Nunamiut, are regularly seen in Anaktuvuk Valley in summer. The earliest records are May 18, 1949, May 10, 1950, May 8, 1951, May 18, 1952, May 4, 1953, and May 15, 1954, at Contact Creek. In 1950, the last was observed September 11 at Inakpasugaruk Creek. During the summers of 1950 and 1951, one or two were seen frequently as if they were residents, and they undoubtedly nest in the Valley.

On one occasion, I shot at and missed a short-eared owl. As it flew away, some small bird the size of a redpoll rose to attack it. At a distance of about a mile, a golden plover harassed it severely and when last seen, two terns were pursuing the owl out of sight. The lives of these predators seem to be much disturbed by those whom they are represented to oppress.

In spring, and particularly as evening twilight develops in the late summer, several of these owls are often seen together and they are apparently then in migration to or from the arctic slope.

Something about short-eared owls seems to favor their use in Nunamiut stories to exemplify human traits and characters. In one a young woman who was unbearably influenced by unsatisfied sexual impulses was transformed into the erratically flying owl.

In another Nunamiut story, a short-eared owl and a Pacific loon were at one time arguing as to which could first fly from the mountains to the arctic coast. The loon asserted that he could fly much too fast for the owl's company and set out in its swift linear flight, while the owl floated upward on light wings until it was only a little ball in the sky. Then it dove far down with the swiftness shown in its short swoops over the tundra until it came to rest on the coast where it was quietly waiting when the loon arrived all out of breath from the labor of its direct flight.

The Eskimos say that the short-eared owls sometimes hang their small prey in the bushes as do the shrikes.

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Aegolius funereus richardsoni (Bonaparte)

1 male	Oct. 3, 1950, Savioyuk	weight 115.8 g.	—	—

These small boreal owls were described as residents of the spruce forests and were named *Takpilyakruk* by the Nunamiut before specimens were at hand for verification. Normally residents of the timber, they do, however, occasionally venture north. The specimen recorded is from within the most northern spruce forest at the head of the Savioyuk River. But one was recorded observed May 18, 1949, at Tuluak Lake and another September 27, 1950, at the head of Inakpasugaruk Creek. From these records they are considered to be occasional summer visitors to the treeless country of Anaktuvuk Valley.

Family PICIDAE: Woodpeckers, Wrynecks

Colaptes auratus borealis Ridgway

On May 31, 1952, I saw a yellow-shafted flicker 3 times at the edge of the willows near the mouth of Inakpasugaruk Creek, and I saw it again twice the next day. I could find no opinion that one had previously been seen in the mountains. However, from my description, Simon Paneak recognized it as like the skin of one which David Tobuk had shot while it was hammering on a pole by his house at Bettles Village. The people at Kobuk know the flicker well and say that to have its skin brings good luck. The bird observed at Inakpasugaruk is considered a rare visitor from the forested country.

Dendrocopos pubescens nelsoni (Oberholser)

1 female	Sept. 7, 1948, Tuluak Lake	—	—	—

Another specimen of Nelson's downy woodpecker was obtained November 27, 1947, within the spruce forest at Hunt Fork and sent to George Sutton, who identified it.

The Nunamiut distinguish two woodpeckers, *Toyuk*, and a larger bird *Toyukpuk*. The name for the smaller bird refers to the downy woodpecker, which is well known in the forest and occasionally seen in the willows north of the mountain line, but only in winter. The 3-toed woodpecker has never been seen north of the forest.

The willows of the northern valleys occasionally reach a diameter of six inches at a height of from one to three feet above ground, and there are very rare sparse northern stands of small cottonwoods. Dead, stunted willows do not look like good residential material even for a small woodpecker, and I could find no evidence that nest holes have been seen in the tundra willows. It may be that the downy woodpecker nests in timber and sometimes ranges north after the nesting

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season, a behavior in keeping with its independent, hardy nature and one for which its habits of feeding in small brush would well adapt it. The often associated Yukon chickadee may also nest in the timber and move north in winter.

I am inclined to think of the downy woodpecker as a visitor after nesting season.

Along the Yukon and on its Delta Turner (1886) reported these woodpeckers as common and present in winter.

***Picoides arcticus* (Swainson)**

Charles Sheldon of Kobuk informed me that both a ladder-back and a black-backed woodpecker with yellow head were well known in the spruce timber along the Kobuk. To demonstrate his point, he later sent me the skin of a male of *arcticus*, obtained April 22, 1954, weighing 71 grams. Grinnell (1900) had found *fasciatus* nesting on the Kobuk at Hunt River. It is apparent that both these forms of *Picoides* occur in arctic Alaska near the limit of spruce timber, but it is unlikely that either would pass north of the forests.

***Picoides tridactylus fasciatus* Baird**

Three examples of northern 3-toed woodpeckers have been brought to me from the spruce forest in the vicinity of Hunt Fork. These are a male, January 16, 1948; a female, December 22, 1947, and another male November 27, 1947. The skins of the two former were sent to George Sutton and identified by him. The third, obtained in the spring of 1948, was too badly decomposed for preservation.

This is the woodpecker which the Nunamiut know as *Toyukpuk*, but as it means only "larger *Toyuk*," the name is hardly specific. There is no indication that these woodpeckers ever abandon the wooded areas nor does it seem likely that their feeding habits among the large spruce trees would enable them to do so. But they do dwell in the most northern timber. They are not included in the avifauna of the Valley.

Family TYRANNIDAE: Tyrant Flycatchers

***Sayornis saya yukonensis* Bishop**

1 male, 1 female	June 17, 1951, Anaktiktok Valley, Napaktualoitch Cave	—	—	—
1 male, 1 female	June 23, 1952, Anaktuvuk Soakpuk Mountain	weight 25, 24 g.	—	—
1 male, 1 female	July 2, 1951, Killik Valley, Irivik Creek	weight 22, 19.1 g.	—	—
1 male	July 29, 1950, Kangomavik	weight 26.0 g.	—	—
1 female	Aug. 7, 1950, Akmalik Creek	weight 20.5 g.	—	—

I had been looking for the Yukon Say's phoebe although I could find no recollection among the Nunamiut of their having seen one. The male specimen collected in 1950, was with another and smaller phoebe which acted like a young bird among the low willows in a creek bottom near the western valley wall and about two miles north of Kangomavik.

The female taken in 1950 was one of three phoebes among the willows on the sand dunes just south of the mouth of Akmalik Creek in the Killik Valley. It was provided with abundant, soft, yellow subcutaneous fat.

The latter bird certainly, and the former apparently, were members of family groups. In 1951, two phoebes were seen near Napaktualoitch Cave on the north side of Anaktiktoak Valley where we were looking for archeological remains. Close to them was a characteristic phoebe's nest on an overhung ledge above the entrance to the cave. It contained five rather well-incubated eggs. Although there was an old robin's nest nearby there were no other signs of earlier nesting by phoebes.

The two birds collected in the Killik Valley were likewise near a cave which William Irving and Simon Paneak were searching for signs of its ancient use by man. Two other phoebes were present, but could not be obtained and no nest was found. One phoebe was seen June 4, 1952, high in a branch of Inakpasugaruk Creek. The two taken June 23, 1952, were a pair, the female having a bare brooding area. They were obtained at the base of high cliffs on Soakpuk Mountain in difficult terrain where the nest could not be found.

I am surprised and the Nunamiut were embarrassed that they did not know these phoebes, for the bird's habits and appearance are conspicuous and distinctive. Their nesting on rock ledges interested the Nunamiut for the caves and overhanging ledges have been used in the past for storage. The caves are frequently visited, and it is hard to see how persistent and regular nesting phoebes could escape the keen interest of the Nunamiut in natural events of this sort. And yet in 1950, one family of phoebes was seen in Anaktuvuk and one in the Killik Valley, and in 1951, one family was seen at a different location from the preceding year in each valley. In 1950, our observation was too late to show that the birds nested near where they were seen, and in 1951, only one nest was found. Simon Paneak was inclined to believe that they had been missed in observation rather than to suggest that phoebes were newcomers in the mountains. I believe that some migrate further north.

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Family ALAUDIDAE: Larks

Eremophila alpestris arcticola (Oberholser)

15 males	May 14–July 22	weight (15), 33–41, average 37 g.	—	—
7 females	May 19–June 23	weight (11), 30–40, average 37 g.	—	—
1 young male	July 13	weight 31 g.	—	—
1 young female	July 22	weight 32 g.	—	—

Seven pallid-horned larks from Tuluak Lake were brought to me for identification in 1948. They had been taken on May 15, 16, and 23. The dates of earliest record are May 15, 1948, May 18, 1949, May 28, 1950, May 3, 1951, April 28, 1953, and May 3, 1954. The irregularity in the recorded annual arrivals of horned larks result because the high ground which they frequent is off the common paths of travel in early spring. No flocks are recorded nor do I know the extent of the migration except that larks are common in many parts of the arctic slope to the northward.

The larks apparently nest earlier than any of the Fringillidae. A large egg was found in a female on May 22. Developing eggs 10 mm. in length were found in a female examined on May 31, 1951, and another female on that date was noted as having already laid its eggs. On May 29, 1951, a female was collected near its nest of four eggs. Four eggs found by Tom Brower on June 13, 1949, were so far incubated that they could not be saved. A nest with four eggs was reported to me near Imaiginik on May 28, 1951. Two young specimens taken on July 13 and 22 were flying and near adult size.

Although they are among the earliest migrant birds to arrive, some of the larks were plainly moving southward in preliminary migratory movement as early as August 5. Their arrival in the cold weather of the arctic spring conforms with the apparent suitability of their feathers for effective insulation. But in spite of their ability to live normally in cold weather they begin to leave soon after the warmest part of the arctic summer and all are gone before the onset of cold weather.

Larks kept pretty well to the elevated dry portions of Anaktuvuk Valley and its sides, and in July were found occasionally along the drier parts of the slopes. They ranged to 300 or 400 feet above the valley floor on the edge of the terrain occupied by the wheatears at the foot of the talus slopes, but they were commonly at lower levels. None have been recorded seen at high elevations. Larks were never numerous at one place, but they spread over a large area and therefore outnumber the wheatears and gray-crowned rosy finches. In 1950 at Summit larks were less frequently seen than Smith's longspurs.

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They are, nevertheless, rather common birds, and generally more numerous than the latter. Their Nunamiut name *Nakrulik* means "horned."

Family HIRUNDINIDAE: Swallows

Tachycineta thalassina lepida Mearns

In summer I have regularly seen violet-green swallows at Bettles, but they are the least common swallows there. Only in 1954 did Simon Paneak report to me that he had killed one on May 29 at Anaktuvuk. He had seen them at Bettles with me, but as we have no other report of the occurrence of this swallow in the mountains I consider it to be too unusual to designate it as a part of the avifauna of Anaktuvuk.

Iridoprocne bicolor (Vieillot)

1 female	June 7, 1949	Weight 19.5 g.	—	—
1 young male	Aug. 15, 1949	—	—	—
1 young female	Aug. 15, 1949	—	—	—

The two young tree swallows were identified by Alexander Wetmore. They were large enough to fly with adult ability. One was recorded seen at Tuluak Lake May 20, 1950, by Robert Rausch, and I saw two at Summit June 5, 1952. On the same day some boys clearly described tree swallows which they had seen. Swallows are said to come regularly each year into the Valley, but none are known to nest or reside. The Nunamiut name *Tolugaknek*, which means "like a raven," is applied to all swallows without specific distinction, nor with much accuracy as to color. But I must observe that the flight of ravens in the winds high over the mountain cliffs and peaks, where they may look almost as small as swallows, has a similar lightness of aerial maneuver.

Tree swallows are common on the Koyukuk River at Bettles, and in 1951, I have seen them along the Koyukuk and lower Alatna Rivers, the nearest places of occurrence yet reported. As these places are less than 100 miles distant from Tuluak, two hours' flight could bring in a visiting swallow, and that is probably the status of all of the swallows seen in the Valley.

Riparia riparia riparia (Linnaeus)

1 male	June 6, 1949	weight 16.8 g.	—	—

Occasionally an individual bank swallow is reported in Anaktuvuk Valley, but none appear to remain. Knowing that Anderson (1921) had reported seeing a cut bank on the Hula Hula River "thickly perforated with holes," I have looked for their nesting holes in the river banks among the mountains. I have not found a sign of their nesting

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north of the Koyukuk and lower Alatna Rivers, nor did any of the Nunamiut recall seeing nests north of those localities. The conspicuous method of nesting would have brought notice of bank swallows which remained to breed in the mountains. Accordingly, I conclude that the bank swallows occasionally seen in the mountains are visitors from nearby colonies along the Koyukuk and Alatna Rivers, where I have found them to be numerous and regular nesting birds. Some of these colonies are within 80 miles, which would be an easy flight.

The single specimen collected by Tom Brower, two which I obtained from a regular nesting colony at Bettles, and nine adult and ten young bank swallows collected for me by Tom Cade from along the Yukon River in the vicinity of Eagle and Forty Mile all fit among specimens referred to *Riparia riparia maximiliani* by Arny (1952), but considered uncertainly separable from typical *riparia.*

The bank swallows are only known as visitors to the Valley.

Hirundo rustica erythrogaster Boddaert

1 male	June 6, 1949	weight 17.7 g.	—	—

The barn swallow is known by the Nunamiut to be an occasional visitor to their country, but they do not know its nesting place. I have not seen one in the Koyukuk or Alatna Valleys. Charles Sheldon of Kobuk clearly described their appearance and nests and told me the Kobukmiut name for barn swallow. He said that nests were very uncommon near Kobuk. Tom Brower told me that he collected the young barn swallows at Barrow which are remarked upon by Bailey (1948) and that they were too young to have flown very far. Unusual nesting sites appear so often attributed to swallows that they may be currently venturing to extend their range. In Alaska, violet-green, tree, bank and cliff swallows now nest intensively about human habitations which only a few years ago did not exist. These species have recently taken new sites for nesting and the adaptability which they exhibit may also indicate a current tendency to extend the territory over which they breed.

As far as concerns the occurrence of barn swallows at Anaktuvuk there is no indication that their rare visits there represent other than the usual explorations of strong flying birds.

Petrochelidon pyrrhonota (Vieillot)

In the winter of 1908 or 1909, Simon Paneak recalled, he and some other boys, who were then near the head of the west branch of the Kuparuk River (lat. 68° 35′ N., long. 149° 20′ W.) found over a hundred mud nests built against the rock cliffs. When these were knocked down for examination they were found to contain frozen young

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birds which were well feathered and nearly ready to fly when they had died. Paneak and I discussed this story again as we watched the cliff swallows building their nests against the houses at Bettles. We agreed that he had certainly observed a colony of cliff swallows nesting on the Kuparuk River cliffs some 40 miles northeast of Tuluak. He has not seen nor heard of such nests anywhere else north of the timber.

The nesting of cliff swallows in natural arctic sites is not unknown. "On May 28, 1949, Mr. Rae found this swallow on the banks of the Coppermine, having constructed its clustered nest against the cliffs at the mouth of the Kendall River, latitude 67° N., but not yet laid its eggs" (Richardson, 1852, p. 395).

Cliff swallows are common nesting on the houses at Bettles Village and Airfield, but no other report than Paneak's has shown them to nest north of there in Alaska. The invasion of the arctic tundra for nesting turned out to be an unproductive effort for that particular colony of cliff swallows.

I do not have any records of their occurrence at Anaktuvuk.

Family CORVIDAE: Jays, Magpies, Crows

Perisoreus canadensis pacificus (Gmelin)

4 males	Feb. 17, Apr. 2, May 15, Nov. 17	weight (1), 79 g.	—	—
6 females	Jan. 26, Feb. 1, 21, July 31, Oct. 24	—	—	—
3 not sexed	Mar. 2, Oct. 2	weight (1), 76 g.	—	—

Alaska jays, called *Kirik* by the Nunamiut, are commonly seen north of timber in winter, where 11 specimens have been taken along the headwaters of the John River. During summer these birds are not seen. The two summer specimens are a full-sized young female found at Kangomavik July 31, 1950, and a male at Tuluak Lake taken May 15, 1951. Three were reported seen by Tom Brower May 8, 1949, at Tuluak Lake. A young jay shot in the Killik Valley July 6, 1951, by Simon Paneak and William Irving was a young enough bird to settle all doubt that it was raised in the mountains. The Nunamiut remark that they have never found a jay's nest is a good comment on the bird's extreme secretiveness in nesting season, but a few evidences of jays in summer and the young bird found on the Killik assure us that jays nest in the mountains.

Their sociable winter behavior makes the jays well known even on the tundra in that season in contrast with the mystery surrounding their nesting. No cold restricts their activity or range, but on cold winter days they erect their feathers until they appear spherical when at rest. They are seen so much more frequently in winter that I believe some jays travel north from their common haunts in the timber

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to winter among the small willows of the treeless mountain valleys, but apparently only a few remain to nest on the tundra.

Corvus corax principalis **Ridgway**

5 males	—	weight (5), 1100–1400, average 1240 g.	—	—
4 females	—	weight (3), 1125, 1050, 1300 g.	—	—

Northern ravens may appear alone in the mountains or in groups sometimes as large as 25 on almost any day and in any weather. They may fly singly and direct, or a dozen may soar into view above the highest mountain to maneuver aloft before diving down in complex flight patterns, calling as they disappear among the cliffs.

The Nunamiut name the raven *Tuluak*, which as they sound it resembles the raven's common call. In the coldest weather, ravens are active. Their adroitness in flight and keenness in finding caribou killed by hunters or wolves are much admired. Many stories attest the Nunamiut's appreciation for the raven's aerial skill, hardihood, and undoubted ability to communicate while hunting and in the course of their social flight maneuvers. The application of the raven's name to a man is a compliment to his searching ability and discretion, or glossy dark clothes, but it has the same connotation as the name of the fox in our usage.

Circling ravens often call the attention of Nunamiut hunters to dead animals upon which bears or wolves may be feeding. Against this service, the circling ravens may see the hunters and by their action and calls warn his prey. Thus the behavior of ravens is significant to the other residents of the north. To the Nunamiut ravens are also interesting, for they recognize in them observant, curious personalities which communicate with each other and so reveal their social methods of play and work.

No temperature or weather limits the raven's appearance, but they are seldom seen far from the rocky mountains about which they like to fly and where they nest. Observations in March, April, and May suggest that there is more raven traffic in those months than in others, but it is not obvious that there is any seasonal change in territory or numbers in the mountains.

As to the extent of the raven's travels in the mountains, I have a story from Simon Paneak that in his grandfather's time a man on the Colville River saw a raven suddenly drop dead from the cliffs. Examination showed that it had been killed by a whalebone spring such as in the old days was coiled and embedded in meat or fat and then frozen, serving by expansion on thawing in the stomach to kill a fox or wolf. The mark on the whalebone identified its owner.

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Later, when the observer of the raven's death met with the owner of the whalebone trap, it developed that it had been set near Publatuk Creek along the John River, about 150 miles from the cliffs of the Colville. Traces in the snow had shown that a raven had made off with the bait from Publatuk on the morning of the same day during which it had died 150 miles away on the Colville. This incident is considered by the Nunamiut to substantiate their impression that the common daily travel of ravens extends over wide areas.

Simon Paneak reported ravens nesting in March among cliffs about 20 miles north of the mountain line. A group of about five, which appeared like a family, were heard and seen high among the pinnacles of Napaktualoitch mountain during several days when we camped near there about June 15, 1951. On June 24, I surprised this group on a hillside as I walked over a moraine slope just south of Kangomavik. Two ravens flew at once, but the other three, which were full sized, waited until I walked within 40 yards of them, and we decided that they behaved like young birds.

I consider ravens to be established residents. I believe that some ravens come into the Anaktuvuk Valley from distant resorts, and that as the old Nunamiut believed, ravens often make long daily flights. In the mountains, there is no indication of seasonal migration.

Although displaying a certain cleverness, ravens have not always been successful characters in old Nunamiut stories. At one time a young raven was much admired for his bold manner and glossy dark feathers. He was singled out for attention by the richest man in the village and eventually Raven won the affection and hand of the richest man's daughter. But the affair turned out badly, for Raven was unable to procure any meat but carrion and the young lady's proper disparagement of that fare made Raven's life miserable.

Before the time of this story and doubtless long ago, Raven and Pacific Loon both had coats of light-colored feathers about like those of the glaucous gulls. One day Raven and Loon were discussing the handicap of their light feathers, which were so conspicuous on the summer tundra. They decided to darken each others coats with charcoal.

Raven first worked on Loon and applied the symmetrical black and white pattern which we now see on Loon's back. Since Loon could not hold his belly off the ground it retained the original lightness, but both of them were rightly pleased with the result. As Loon started work on Raven's back the curious bird could not restrain his impatience to see the progress. After standing a certain amount of Raven's fidgeting, Loon said the constant inspection unnerved him and had already caused him to mark the two sides unevenly.

Then Raven agreed to close his eyes while Loon completed the work

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in hand. Smiling quietly to himself Loon marked Raven all over with black. When Raven opened his eyes and looked curiously at his feet, back, and tail he croaked with anger at the unhappy sight of his uniform black appearance. Loon burst out in the crazy laughter for which he is renowned. Maddened by the thought of how he looked, Raven seized a handful of ashes from the fire and threw them at Loon. Loon was smart enough to dive into the lake, but not so quick but that he got the ash-gray patch on his head as it went below the water.

Now when Loon recalls what he did to Raven he cannot restrain his long bursts of crazy laughter as he sits safely on the lake. Raven, on the other hand, when he thinks of the affair expresses his feelings in his sad hoarse voice.

Family PARIDAE: Titmice, Verdins, Bushtits

Parus atricapillus turneri Ridgway

1 male	Jan. 26, 1950, north of timber	—	—	—
1 male	Oct. 7, 1950, Savioyuk River, just south of timber	weight 11.1 g.	—	—
1 unsexed	Jan. 26, 1950, Summit	—	—	—

A number of other specimens of Yukon black-capped chickadee could not be preserved. Four from Summit were brought into camp at Kalutak Creek and examined on January 26, 1950. A specimen from the upper John River, 1950, otherwise without data, was kindly identified by W. Earl Godfrey. Numbers were observed in late September and early October 1950 just within the northern limit of spruce forest on the Savioyuk River.

The Nunamiut have a name for only one chickadee, *Misikakak*. They recognize the brownish form and say that *Misikakak* applies strictly only to the black-capped kind. It is known and liked for the way it occupies the willows north of tree line in winter with the attitude of being the proprietor. The Nunamiut are accustomed to seeing it north of tree line in winter but not in summer. It is possible that this chickadee, downy woodpeckers, pine grosbeaks, and possibly jays, may be required by nesting habits to remain in the wooded area in summer, but that upon completion of duties for reproduction, they then wander north.

Although it is difficult to see how extreme arctic cold and wind can be endured by such a tiny bird, it appears oblivious to both. Its feathers, like those of the jay and grosbeak, provide effective but thin insulation and its habit of searching for food on the willow branches and twigs,

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which are blown clear of snow in the windy mountains, may make the wind-cleared twigs of the arctic willows a more suitable winter range than the still, snow-covered forest.

***Parus hudsonicus hudsonicus* Forster**

1 male	Oct. 13, 1950	weight 12.3 g.	—	—
1 female	Oct. 13, 1950	weight 10.8 g.	—	—

These two Alaska chickadees were obtained by Simon Paneak near the head of the Savioyuk River and within the spruce timber. The Nunamiut consider the brownish chickadees to be confined to the forest and it is not explicitly designated by their name for the black-capped chickadee. I have no observations to suggest that the Alaska chickadee ventures north of the forest and I include it as a bird of the nearby forest but not of the treeless country.

A female was collected at Hunt Fork on February 26, 1950, by Robert Rausch, an unsexed bird was obtained in 1950 from the wooded part of the upper John River, and I collected another unsexed bird on August 15, 1950, near Bettles. These were examined by W. Earl Godfrey and are deposited in the National Museum of Canada. He proposed including our Alaska specimens with those which he would designate *P. h. evura.*

Family CINCLIDAE: Dippers

***Cinclus mexicanus unicolor* Bonaparte**

1 female	Apr. 29, 1949	weight 49.4 gr.	—	—

This specimen along with a female dipper from Hunt Fork, February 3, 1948, sent to George Sutton, establish the winter residence of these birds north of the Arctic Circle, a fact which has been frequently described in narratives but not, so far as I can tell, earlier confirmed by specimens or the observation of ornithologists. We have several additional sight records of these birds with strange aquatic habits which fit so well into the tiny and uncommon niches of the arctic environment in which water remains unfrozen throughout the year.

The Nunamiut name for dipper is *Anaruk kiviruk*, which was translated as "old woman sunk."

At Nakagnik Springs, running into Tuluak Lake, Raymond Hock saw two dippers in May 1948. In attempting to secure them, both were unfortunately washed under the ice below the open water. At the same place the following year two dippers were shot by Tom Brower April 29, 1949. One was recovered and preserved, the other washed under the ice and was only recovered later when too badly damaged to be saved. Observations were made at this spring daily

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in 1950 and 1951, but no dipper was reported. Raymond Paneak saw two dippers there in April 1953. At the head of the Savioyuk River near open water and just within the northern limit of spruce forest, Rausch recorded an observation of a dipper on October 10, 1950. Four were reported from Savioyuk on February 10, 1951, by Simon Paneak.

Two dippers were seen by Robert Paneak at Naniksruk Springs, a winter fishing place, some 40 miles north of Tuluak Lake, on March 31, 1951. One was seen on Kanayat Creek by Elijah Kakena on April 9, 1951.

Where the waters are unfrozen a dull cloud of ice fog called "water smoke" may be seen for a long distance rising in the still winter air. These places of open water are called springs by the Nunamiut. They provide fishermen with access to water in winter, and they are therefore carefully examined and well known. In a stretch of about 100 miles south to north on the upper John and Anaktuvuk Rivers, dippers have been reported in four places during winter. In the country within 15 miles of that line there are three or four other places which might be suitable, making places for about 6 or 8 pairs of these small birds in about 3,000 square miles of arctic mountains which are otherwise completely snow and ice bound for eight months of the year.

Some of these open water locations are only a few yards in extent, and there are so few of them that individuals or pairs are often separated from each other during more than 6 months by 30 or 40 miles of frozen country completely unsuited for a dipper's sustenance. Territories vacated by death are nevertheless filled, so that in spite of the winter isolation of its members and their usual close restriction to a minute feeding territory, the population tenaciously retains the integrity necessary to preserve its small numbers.

The population density of dippers in northern Alaska is probably the least of any small bird in the north, and it may be suggested that the individuals and pairs live in isolation from their kind unique among animal populations.

Our scant physiological knowledge indicates hypothetical difficulties for so small a bird feeding under water in arctic winter conditions. But the individuals show no signs of strain and are undoubtedly adapted so that their lives are passed without continuing physiological stress. Their social scheme must also present a fine adaptation to their isolation in order to preserve the coherence of this remarkable population of widely separated families.

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Family TURDIDAE: Thrushes, Solitaires, Bluebirds

***Turdus migratorius migratorius* Linnaeus**

9 males	May 15–Sept. 18	weight (14), 70–91, average 79 g.	—	—
4 females	May 24–Sept. 18	weight (6), 72–94, average 82 g.	—	—
5 young males	June 21–Aug. 7	—	—	—
6 young females	Aug. 7–Sept. 18	—	—	—

The earliest records for eastern robins are May 13, 1948, May 18, 1949, May 11, 1950, May 10, 1951, May 18, 1952, May 19, 1953, and May 25, 1954. Robins appear to go directly upon arrival in spring to nesting places which are mostly in rather large areas of fair-sized willow brush, as around Contact Creek and Kangomavik. I have seen nests at many places in the narrow valleys where a few high willows grow and on a rock ledge at the mouth of Napaktualoitch Cave. On the open tundra around Tuluak Lake they are not often seen.

Around Contact Creek in the spring of 1952, the first arriving robins appeared to act in pairs at once to establish nesting territory, and females were taken within two days of the first male specimens in 1951. However, I saw groups of six robins and numerous single birds on the upper Noatak River and at Howard Pass on May 25, 1952, so that I believe that separation of the small migrant bands into pairs occurs about at the time of arrival at the arctic nesting grounds.

The tabulation of social and family activities observed among robins, below, presents a good chronicle of their summer activities because in the north, as elsewhere, robins are of conspicuous and demonstrative behavior:

May 10–18, 1948–52	First arrival	Anaktuvuk
May 25, 1952	Groups of six and single birds	Upper Noatak River and Howard Pass
May 28, 1951	Pair nesting	Akvalutak
May 29, 1952	Nest building	Contact Creek
May 30, 1952	All pairs settled	Contact Creek
June 5, 1952	First egg	Contact Creek
June 10, 1952	First set of 4 eggs completed	Contact Creek
June 17, 1951	2 well-feathered nestlings	Napaktualoitch Cave
June 21, 1951	Young in first flight	Contact Creek
June 22, 1950	Young male flying weighed 63 g.	Kangomavik
July 31, 1950	Young—76 and 79 g.	Kangomavik
August	Family groups	
September	Flocks frequent	Summit
Sept. 12, 1950	Flock of 50	Summit
Sept. 18, 1950	Last flock of 12	Summit

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Robins have been observed nesting at Umiat on the Colville River (Karplus, 1952). We have found them common in the Killik Valley in summer, and I have seen them in migration in the upper Noatak Valley and at Howard Pass. The conspicuous flocks seen about Summit in early September best indicate the large numbers of robins which have summered in the arctic mountains and among the larger willows of some of the more northern valleys. Because their range of terrain is limited, the total arctic tundra population of robins is locally conspicuous but not comparable with the numbers of the commonest birds.

While searching for the races of Dall's sheep high among the mountains along the Macmillan River in Yukon Territory, Sheldon (1911, p. 127) remarked upon the numerous passing flocks of migrating robins and noted that the last was seen on September 19.

In early summer, robins take poses nearly as conspicuously statuesque as are those of the golden plover. They sing cheerily, but to my mind much more weakly in the northeastern States, where, however, I heard them with younger ears. They appear vigorous and interested in their arctic environment but unhurried by anxiety for the shortness of the summer and the remoteness of their winter quarters, concerns which are in the usual thoughts of human strangers although not apparent in normal arctic residents.

Combative against other robins intruding upon their nesting territory in the early part of the season they later become increasingly noisy toward any potentially dangerous enemy to their young. As the young grow larger, other pairs from adjacent regions join in these disturbances with as much singleness of purpose as if nothing but the commotion among robins were important. Their excited calling and generally conspicuous parental solicitude draws attention to the presence of the young birds, whose answering youthful calls precisely locate their position. Whether these parental demonstrations are, on the whole, effective in protection of the young I cannot say. To me they illustrate such an exaggeration of parental solicitude as would attract a predator. Sometimes the social demonstrations of robins are joined by birds of other species, but a pair of robins can seriously trouble a marauding shrike so that his only safe tactic is to seize a nestling victim in a stealthy dash and hope to get out of range intact. In judging the interaction of animals we must recall that feeble birds sometimes pursue and obviously discomfit large predators, and that unexpected occurrences often disturb large mammals to flight. A human hunter can be much alarmed by strange sounds heard in darkness when there is insufficient sensory information available for reasoned calmness. Animals must often be mentally unstable in the darkness of their unreasoning minds.

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The noisy exhibitions of the robins indicate how their early summer concern for family affairs merges into a communal interest which widens and strengthens in early September to join them in well organized flocks ready for departure southward.

The aggressive, swift-flying robins, with their great concern for their own pattern of social behavior, apparently find the arctic nesting grounds very satisfactory. Perhaps it is because of this aggressive and demonstrative concern for their own social pattern that we white people find familiar sympathy for robins. The Nunamiut name for robin is *Koyapigaktoruk*, described to me as referring to their "noise" rather than to their song. Although the robins live about the Eskimo camps I did not detect as much Nunamiut interest in them as they have in many birds whose more gentle behavior better conforms to my impression of Eskimo manners.

Hylocichla minima minima **(Lafresnaye)**

7 males	May 29–June 14	weight (7), 26.1–33.6, average 30.6 g.	—	—
1 female, 1 nest; 4 fresh eggs, with female	June 22	weight (2), 27.8–35.5 g.	—	—

A northern gray-cheeked thrush was brought to me May 30, 1948, and I saw many along Contact Creek after May 29, 1952. The first birds seen appeared to be settled, and Grinnell (1900) reported that they were already paired when first seen on the Kobuk on May 24. The Nunamiut know the bird well, calling it *Niviokruksioyuk*, meaning "goes after flies." It is one of the regular and common summer inhabitants among the dense willows of the Valley.

The nest collected by Tom Brower was typically situated in the fork of high willows about two feet off the ground. It was bulky, compact, and rather well formed of flexed willow twigs and coarser round grass stems. It was lined with fine grass to form a deep depression.

They are not conspicuous birds after nesting begins in the mountains, but males sometimes come to small willows in the open and to the top of the willows in thick brush to sing. Nesting sites are among dense willows. In 1951, I found many gray-cheeked thrushes in the thick willows around Contact Creek. In 1952, they were more common there than robins and we saw many more than in preceding years. Early in June that year, the male thrushes were often engaged in driving away intruding males, which they did more decisively and in swifter flight than even the robins. I rank these thrushes and Alaska yellow wagtails ahead of robins for the sudden violence of their reaction to preserve their domestic territory for their own exclusive use.

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While many pairs were established in the dense willows along Contact Creek by May 31 they were elusive in the thick brush and I have only one explicit record of nest building on June 11 in addition to the set of eggs which was collected on June 22. Nesting thrushes are about as numerous as robins but nest somewhat later. At Umiat a family of nestling thrushes left the nest on July 6, four days later than a family of nestling robins (Karplus, 1952).

Oenanthe oenanthe oenanthe (Linnaeus)

14 males	May 21–July 31	weight (15), 21.0–28.1, average 23.9 g.	—	—
5 females	June 27–July 31	weight (6), 19.9–26.3, average 23.5 g.	—	—
4 young males	July 13–31	weight 29, 24, 24, 25 g.	—	—
2 young females	July 22–29	weight 24.6, 24.2 g.	—	—
6 downy nestlings	June 28, 1951	weight 6.4–7.9 g.	—	—

These birds correspond to the specimens of European wheatear in the U. S. National Museum. The earliest record is of the specimen taken May 21, 1949, May 23, 1951, May 23, 1953, and June 1, 1954, but in their mountainside haunts they cannot be closely observed. They occupy in summer a narrow band of dry ground along the wall of Anaktuvuk Valley starting just above the level of the Valley floor. There they may sit quiet but alert on a short willow or rock and when approached, rise nervously high into the air like the Alaska yellow wagtail, but usually they fly more directly away and for a greater distance. When one of a family group thus darts into the air, the others are likely to follow. Their rapid, periodically swooping flight along the Valley walls makes the Nunamiut name *Tikmiakpaurak*, "little eagle," easily appreciated by one who has pursued them over this steep, rough terrain.

Because of their location above the Valley floor, our information upon their arrival is uncertain. We also failed to discover nests until 1951, although the Nunamiut said that they were there but well hidden beneath rocks. Three males and three females taken June 25–29 had bare brooding areas and behaved as if their nests were nearby. A male watched on July 9, 1950, made two trips to the low willows along the depression of a small creek. It perched for some minutes on the same sharp stone before and after each trip. It returned one time carrying a moth and appeared ready to watch me indefinitely before moving again. Its earlier, although repeated visits to the willows gave me no indication of a nest or young family. No signs of a nest could be found, nor did the place look favorable.

On June 28, 1951, I saw a wheatear on the west side of the Valley and about 800 feet above its floor. After about a half hour it went to

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a small opening under a flat rock, where it was joined by its mate and the two made repeated visits with food, apparently insects, during the next hour. The birds were extremely alert and nervous. Lifting aside the covering rock I found a nice nest of fine grass lined with ptarmigan feathers and including 6 very small young weighing from 6 to 8 grams each. They must have been newly hatched. I estimate that the last egg of the clutch had been laid about 14 days earlier. The first egg would then have been laid 20 days earlier, or about June 8.

Young birds were flying well and had reached adult weight by mid-July, but through the rest of that month they remained associated in family groups as well organized as those of robins.

The fat of wheatears in late summer is white and fluid, similar in consistency but not in color to the yellow fat observed in the insectivorous Yukon phoebe of similar haunts. I suspect both birds of deriving their fat from a diet of insects and that the different pigmentation might offer a clue as to its origin.

Late summer observations were not regular, but two wheatears came into camp on the Valley floor at Imaiginik, August 15, 1950. Like the Alaska yellow wagtails in late summer, their shyness was gone, and they had discarded the temperamental behavior observed during the period of family life.

In their regular summer haunts wheatears are associated with occasional Alaskan longspurs, pallid horned larks, and American pipits. Along the narrow bank below the talus slopes, wheatears are numerous but the area occupied is small and their population is less than that of pallid horned larks. Since the extent of their habitat much exceeds that occupied by robins, they are probably the most numerous of the thrushes.

Luscinia svecica svecica **(Linnaeus)**

I have been on the lookout for the red-spotted bluethroat but have failed to find one about Anaktuvuk. In June 1953 I obtained a female near Itivlik Lake, about 130 miles west of Anaktuvuk (L. Irving and Paneak, 1954). The conspicuous foxy color of the tail and the wren-like attitude of the bird as I watched it convinced me that I had not previously seen one like it. When Simon Paneak saw it he was sure that he had not seen one like it nor had he heard it described among the Nunamiut until I had made known my interest in finding one. When my colleague Robert Rausch saw the specimen he was sure that he had not seen one during his extensive travels in the mountains and on the arctic slope.

The bluethroat has been found near Wales, Wainwright, and Barrow (Bailey, 1948). With the recent simplification of transportation to

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the arctic interior, several ornithologists have observed it during brief visits to Umiat. In 1952 Cade and Schaller recorded bluethroats on thirteen occasions while traveling along the Colville River (Kessel, Cade, and Schaller, 1953).

I am puzzled by the fact that I could find no acquaintance with a bluethroat among the Nunamiut, for had it been seen along the Colville, Simon Paneak is sure that he would have heard remarks about its distinctive appearance. To be sure, the regular summer experience of Nunamiut along the Colville is now more than 20 years past, but for the other birds of that region their recollections remain clear.

The recent observations of scientists have not sufficient sequence to warrant a suggestion that this migrant from Asia is significantly changing its range or abundance in arctic Alaska. It may be that the bluethroat is a late arrival in spring and that it occupies restricted habitats in certain localities.

Family SYLVIIDAE: Old World Warblers, Gnatcatchers, Kinglets

Phylloscopus borealis kennicotti (Baird)

5 males	June 19–June 24	weight (7), 8.8–10.2, average 9.4 g.	—	—
3 females	June 19–July 23	weight (4), 8.5–9.9, average 9.1 g.	—	—
1 sex unknown	June 24	weight 8.1 g.	—	—
2 young males	Aug. 14	weight 9.7, 10.2 g.	—	—
3 young females	July 23–Aug. 14	weight 9.3, 10.7, 9.8 g.	—	—

I had hoped to see one of these birds because of the reference by Baird (1869) of Dall and Bannister's (1869) specimen from Nulato to the name of Kennicott, the brilliant leader of the early scientific exploration of interior Alaska. Frequently I had discussed their appearance with Simon Paneak, and he had tentatively connected them with birds which he had known as a boy in the Killik Valley and which were named *Songakpalutunygik*, meaning "small bird the color of bile."

In August 1950, we were delayed for several days at Odrivik Lake in the Killik Valley by malfunction in the lubrication of the airplane in which John Cross had come to take us out. While I was hunting among the willows covering the sand dunes along the river, I saw several very small warblers actively feeding among the willow tops, apparently taking small insects. I failed to get them in view of my glasses, and they disappeared. As they were moving southward along the river when seen, I ran to make intercepts of their apparent course. At the third try and near a mile to the south I picked up a band of five, from which I collected 3 specimens. Simon recognized them as the *Songakpalutunygik* which he had known as a boy.

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On June 19, 1951, among the willows on Contact Creek, I saw two which acted as if in residence, watched them, and heard the male singing, although my unfortunate insensitivity to bird songs prevents me from definition of their faint but agreeable sounds. In the next 4 days I hunted daily along Contact Creek and formed the estimate that about 20 pairs were resident along one mile of the thick high willows along the stream.

On June 23, John Morry's son, Riley, brought me a willow warbler with its nest and two eggs. With his slingshot, the boy had wounded the bird, and had found its nest on the ground with one egg. As boys and men will often do with animals that they have just failed to kill, he compassionately brought bird and nest back to his parents' tent. There the bird had laid one additional egg before expiring, and in the morning Riley brought me the nest with its two eggs and the parent bird.

On June 24, 1951, as we returned northward to our camp at Imaiginik, Simon Paneak and I found two pairs of these little warblers among the willows of Kangomavik Creek, and I suspect there were other pairs there. In 1950 we had hunted this area carefully on several days wthout seeing willow warblers.

When I reached Contact Creek on May 29, 1952, I heard reports from Simon Paneak that a few willow warblers had already been seen. In the next 10 days, I saw two birds like willow warblers, and there were several observations reported by Eskimo adults and children. Unless one can see a willow warbler stationary and from nearby it is difficult to identify, because of its insignificant size and faint markings. When it is moving among the wind-shaken willow leaves and viewed against a light sky background its color and even shape are hard to distinguish. Several instances of singing willow warblers were reported to me, but in that year I saw none I could identify. By this time the Nunamiut shared my interest in these little birds and they gave me several reports indicating that willow warblers were not uncommon. But it was not until July 23 that Paneak collected an adult female and two young females of adult weight at Kangomavik.

On occasions the willow warblers have been easy for me to see clearly as they sang or moved about in the edge of the still willows. I have had so many views of them and received so many reports that I am sure there is a considerable population of them usually nesting among the willows along Contact Creek and at Kangomavik. The earliest date when one has been reported to me is May 30, 1954.

Simon Paneak and I saw many willow warblers among the willows around Lake Itivlik and along the Ahlasuruk River. A female that we collected had a bare area as for incubation (L. Irving and Paneak, 1954).

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The Nunamiut identification of willow warblers with a name recalled from their childhood is a good indication that the birds are historic members of the avifauna. That they had not recently seen them until I obtained a specimen in 1950 can be explained by the fact that the people with whom I most associated have resided north of the thick willows since 1936, whereas from 1920 to 1936 they had lived principally on the arctic coast.

I believe that my fragments of evidence combine to indicate the regular arrival of willow warblers at certain dense willow patches in the valleys at the end of May, where they promptly establish nesting areas and lay eggs in mid or late June. The young birds appear to be near adult size at the end of July and by mid-August they are in migratory movement.

It is quite understandable to me that the records of willow warblers are few and variable, and that no nesting in arctic Alaska has hitherto been confirmed in reports. From the vague literature on the subject, doubts of their firm establishment in Alaska were reasonably expressed (Bent, 1949). But my observations give no evidence that the population of willow warblers in Anaktuvuk is small, unstable, or irregular, and I believe that their existence is historic because of their designation with a specific Nunamiut name by Eskimos whom I have found to be singularly precise in the recognition and nomenclature of birds (L. Irving, 1953).

Regulus calendula calendula (Linnaeus)

I have had several reports of ruby-crowned kinglets at Anaktuvuk and, surprisingly, they point to its winter residence there. In the spring of 1948 Jesse Ahgook brought me an example with the bright red crown feathers of a male, reporting that he had collected it in early winter at Hunt Fork. The bird had deteriorated beyond possibility of saving. Simon Paneak said that the kinglet was familiar to them, that a few were usually seen in the northern part of the forest, and that some remained in winter. He thought that kinglets were occasionally seen north of the timber in winter.

We discussed kinglets frequently and several people thought that they had seen them among the willows north of timber in winter, but realizing the critical evidence required they did not at first wish to present their opinions as records. John Krog and I looked for them in winter and summer without success at Anaktuvuk. We obtained one specimen, identified as *Regulus calendula calendula* (Linnaeus) at Bettles on August 25, 1951.

Simon Paneak reported that he saw a kinglet among the thick willows at Nakrak just after Christmas 1952. He watched it from within a few feet during several minutes, but it was too close to

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shoot. A few days later his wife, Susie Paneak, watched several in the same locality and heard their faint calls. In early March 1954, while we were in camp at Kivik Creek on Hunt Fork, Simon described three kinglets which he had recently seen feeding among the alders in the company of a large flock of redpolls.

Bailey (1948) reports that Brower obtained a specimen from Cape Halkett in September and that one was collected near Barrow on April 30. Anderson obtained one found dead aboard ship off Cape Halkett on September 24. On the arctic coast winter conditions are in effect on these dates.

Our evidence warrants inclusion of the ruby crowned kinglet among the birds of Anaktuvuk. But its recorded winter range is southward from Nebraska to West Virginia. Without a winter specimen I do not now feel warranted in saying that it is a winter bird above the arctic circle in Alaska. Until further evidence is at hand I list the kinglet as a visitor at Anaktuvuk.

Family MOTACILLIDAE: Wagtails and Pipits

Motacilla flava tschutschensis Gmelin

12 males	June 4–Aug. 3	weight (10), 15.1–17.7, average 16.3 g.	—	—
9 females	June 6–Aug. 3	weight (9), 14.0–17.6, average 16.1 g.	—	—
4 nests, 5 fresh eggs	June 16, 17, 19, 20	—	—	—

My first specimen of Alaska yellow wagtail was collected at Umiat on the Colville River June 4, 1949, while the ground was still covered with deep winter snow. This bird flew violently to expel another wagtail and so seemed definitely located and committed to the protection of his own territory. At this date in Tuluak valley, 100 miles south, the winter snow has disappeared from the open tundra and the season is near a week ahead of Umiat. Wagtails were not reported at Anaktuvuk until June 6, 1949, June 4, 1951, June 7, 1953, and June 5, 1954. Bailey (1948) reports the collection of two males near Wainwright May 30, 1939, and June 17, 1941. These dates and my record at Umiat suggest that the wagtails when coming from Asia migrate eastward in Alaska through or north of the mountains. At St. Michaels they were reported by Turner (1886) to arrive about June 12 and to proceed at once to nest.

Nests were found with complete sets of fresh eggs from June 16 to 20. Even for the energetic wagtails to prepare their nests complete with eggs in 10 days after arrival seems rather rapid progress and it is possible that they arrive earlier than we have recorded.

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During early July on the valley bottom many willow patches a few hundred yards across contained a wagtail. The males perch briefly on the tops of high willows and while observed even at a distance beyond 50 yards, every half minute or so may rise rapidly high into the air, darting about in quite unpredictable directions, often to settle soon with equal suddenness near the original perch. It did not appear that these maneuvers were executed in alarm or in pursuit of insects, but as if they were expressions of the restlessness of the birds. I could see no capture of insects, but it may be that my exasperation in trying to follow these restless birds caused me to mistake some gainful activity for behavior which I attributed to their nervous disposition.

Wagtails are common and well known to the Nunamiut by the name *Piorgak*, referring to their call. They are more numerous in summer than Savannah sparrows and occupy the upper part of the same habitats in the fair-sized and more or less dispersed willows.

The nests are commonly under willows on a niggerhead, covered and difficult to find. Usually they are near wet ground. They are constructed loosely of grass, willow roots and bark, sometimes with considerable quantities of moss, and lined with fine grass, caribou hair and a few feathers.

At the end of July near Imaiginik, wagtails were evidently free from nesting cares for they had ceased their aerial demonstrations and started wandering calmly among the willows along the sandy river bars. In the Killik Valley by Odrivik Lake after August 3, 1950, in the mornings after the brief shadow of the first late summer arctic nights, numbers of wagtails were feeding among the willows. At this season they somewhat resembled the pipits in coloration, but they kept more in the branches of willows than do the ground-feeding pipits. During the next ten days the numbers were far greater than were seen in July and the trend of the groups was distinctly southward toward the mountain line about five miles away. This movement was evidently the early withdrawal of great numbers coming from the valley of the Colville. Judging from the habitats in which I have seen them, they might prefer routes north of the forests such as could be found in the willow-filled valleys in the mountains west of the head of the Killik.

In the wooded part of the Kobuk River valley Grinnell (1900) did not report wagtails, although he found them abundant and nesting in the treeless areas about the Kobuk delta. We found them numerous along the Ahlasuruk, 130 miles west of Anaktuvuk and about the same distance north of Grinnell's winter camp. (L. Irving and Paneak, 1954). In Yukon they had not been reported (Rand, 1946), but Munro informed me that he had seen them near the mouth of the Firth

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River. Anderson (1921) found nestlings near Niklik at the mouth of the Colville. Only a few records from the northern arctic coast are given by Bailey (1948). From information provided by my colleague Raymond Hock, they are common in the Colville Valley near Umiat. It seems that data are near at hand to establish accurately the distribution and abundance of these small birds which migrate far eastward from the interior of Asia to energetically occupy in summer the treeless section of arctic Alaska.

***Anthus spinoletta rubescens* (Tunstall)**

26 males	May 4–Aug. 7	weight (28), 19.2–25.5, average 21.6 g.	—	—
7 females	May 11–July 7	weight (8), 18.6–23.2, average 20.1 g.	—	—

The earliest recorded arrivals of American water pipits were May 10, 1949, May 10, 1950, May 4, 1951, May 14, 1952, May 13, 1953 and May 25, 1954. In 1949 the peak of migration was reached on May 19 when 500 were reported seen by Tom Brower. Thereafter the numbers dropped off sharply, but on May 30, 40 pipits were recorded. Since this number is larger than the number of residents seen on later days, it probably represents the late northward flight in that year. On May 19, 1951, the pipits were reported by John Krog to have suddenly disappeared from Nakagnik Springs where they had previously been numerous.

Males collected May 4 and 10, 1951, had small testes, but all examined later were large. Eggs in females examined in 1951 were 3 mm. in length on May 21, 2 mm. on May 23, and 2 mm. on May 26. On June 2 some females under observation had laid and one large egg was found broken; on June 19 all had laid.

One nest, found by Tom Brower on the ground under some low willows upon which dead grass was hanging, was large enough to accommodate the 6 eggs it contained (these appeared large for a bird of this size). It was loosely constructed of flat grass, lined with fine round grass, and contained no other material but grass.

Pipits are uncommon on the floor of Anaktuvuk Valley in summer, but in some high wet or dry grassy places and on the dry and rocky ground as high as 4,000 feet, the limit of our regular surveys, they are numerous, although inconspicuous. They ranged higher than the wheatears, which favor the foot of the talus slopes, but a common redpoll (*Acanthis flammea*) and the pipits were the highest ranging small birds to be collected.

In midsummer, these high mountain regions are extremely dry, bearing only a sparse low vegetation, and the pipits are inconspicuous on the ground among the rocks and grasses, but they frequently stand exposed on hummocks or rocks, revealing themselves only by twitching

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their tails. Like wagtails they may suddenly take wing for no obvious alarm, fly high in the air, swooping about unpredictably, and sometimes return close to their start, or having gained 100 or 200 feet altitude they may fly directly out of sight.

In August, they begin to move more deliberately along and near the ground on the Valley floor. In the Killik Valley in early August, they were generally moving southward in considerable numbers, but they were fewer than the wagtails. Some were seen at Chandler Lake, August 16, 1950, and the last recorded was seen at Contact Creek, September 2, 1950.

Many pipits remain for nesting in the Valley but as many more were seen during the spring and fall migration. A large population traverses the Pass toward the arctic slope.

The Nunamiut name *Piorgavik* refers "to the song." The name resembles the designation *Piorgak* given to the Alaska yellow wagtail.

Family BOMBYCILLIDAE: Waxwings

Bombycilla garrula pallidiceps Reichenow

Robert Rausch and Homer Mekeana saw a flock of Bohemian waxwings near the northern limit of spruce on the Savioyuk River, October 15, 1950. In August 1951 John Krog and I saw a flock of some 50 feeding among the bushes and tree tops along the Alatna River north of the stream from Iniakuk Lake and just about at the southern mountain line. I have obtained several specimens from Kobuk, where the Eskimos name them *Shooloktachailak*, meaning "wearing feathers like an Indian."

There is no evidence that they pass to the open country north of the forests, but in their wandering occupation of the wooded interior of Alaska they occasionally reach its northern border. They are not included in the avifauna of Anaktuvuk.

Family LANIIDAE: Shrikes

Lanius excubitor invictus Grinnell

4 males, adult plumage	Apr. 29–Sept. 5	weight (3), 72, 73, 75 g.	—	—
3 males, 1st year plumage	Aug. 6, 7	—	—	—
2 females, adult plumage	May 8, June 24	weight 71, 64, g.	—	—
3 females, 1st year plumage	May 26–Aug. 7	weight (1), 69.5 g.	—	—
3 males, in first summer	June 24, July 31	weight 68, 67, 67 g.	—	—
1, sex unknown, 1st year plumage	September	—	—	—

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The earliest observations of Northern shrikes were May 8, 1949 at Tuluak Lake, May 9, 1950 at Contact Creek, April 29, 1951, at Itikmalikpuk Creek, and May 9, 1952 at Contact Creek. The latest record was September 28, 1950, just within the limits of the spruce forest at the head of the Savioyuk River. Shrikes were observed almost daily during early September as the Nunamiut moved from Tuluak southward past Kangomavik to Kalutak Creek.

The Nunamiut name is *Irirgik*, "eye extractor," indicating the disagreeable activity attributed to shrikes of picking out the eyes of small birds and mice, after which, according to the story, the shrike watches its blinded victim blunder about until ready to eat it. The name and story are identical with the characterization of the shrike as given by Eskimo people on the lower Kobuk River (Grinnell, 1900), and as given me by Charles Sheldon of Kobuk.

A nest with one egg and a dead shrike was brought to me on June 1, 1948, but unfortunately it could not be preserved. On June 11, 1951, I found an empty nest 9 feet up in a willow where Itikmalikpuk Creek emerges from the mountains. It looked like a new shrike's nest and a shrike was seen nearby. One young bird, clearly hatched that season, was near adult weight and although its tail was still short, it was flying with other young among the willows at Kangomavik July 31, 1950. Two young males on June 24, 1951 were as heavy as the young male just mentioned. Another bird judged from its plumage to be of this summer was taken near Contact Creek in early September 1950, but the exact date and sex were not recorded.

Shrikes were observed commonly in 1950 and 1951 in the Killik Valley near Odrivik Lake, along the river 4 miles north of Akmalik Creek, and at least three family groups of three to five were observed in 1950 around Akmalik Creek. Mice and small birds hung by them or by short-eared owls in the bushes were occasionally found. The plentiful numbers of shrikes in the mountains was a surprise to me, but none were observed away from the rather large willows about 15 feet in height.

It appears that the summer produces a large increase in the population of shrikes which feed upon small birds like the redpoll and upon an occasional mouse. No evidence for migration further north can be presented, but since the favored habitat of high willows along the streams and the abundance of mice and redpolls are repeated through the Colville Valley, and through the upper parts of the valleys of northward flowing rivers like the Meade and Ikpikpuk it is assumed that a number of shrikes move through the Pass to nest on the arctic slope. Judging from occasional reports we will find that some shrikes winter in arctic Alaska.

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Family PARULIDAE: Wood Warblers

Dendroica petechia amnicola Batchelder

2 males	May 31, 1954	weight 9.4, 8.9 g.	—	—

These are the first records of yellow warblers obtained by Simon Paneak, who collected them in the mountains. It may be that some others have been mistaken for Kennicott's willow warblers. Several times warblers which appeared too yellow for willow warblers have flown swiftly past me. On the other hand I have observed several hundred willow warblers until sure of their identification, and I am therefore certain that other yellowish or greenish warblers are uncommon. At present the information only suggests that the two yellow warblers were visitors.

Dendroica coronata hooveri McGregor

1 in male plumage	May 26, 1953	weight 13.8 g.	—	—

The specimen listed above is the only record of the myrtle warbler from Anaktuvuk. Since the male birds are conspicuous as they sing and feed in the tops of poplar trees in the wooded portions of Alaska, I believe that they would be noticed if they were often present at Anaktuvuk. I consider this example to be a visitor.

Wilsonia pusilla pileolata (Pallas)

2 males	June 3, 7	weight 7.2, 6.9 g.	—	—

These pileolated Wilson's warblers are the lightest adult birds that I have examined in the Arctic. The first one, with a rapidity emphasized by its small size, flew to the top of a willow to sing, revealing to me its clear yellow underparts and black crown. For 15 minutes I watched its restless behavior and listened to its singing before it withdrew into the thick low brush. I was sure of its attitude as proprietor of the area. The next morning, after I had waited for about an hour, it returned at about three o'clock to sing in the same willow. In 1954 Simon Paneak obtained another example.

From time to time in earlier years I had reports of small yellow birds in the valley and I saw a warbler which I thought was brighter yellow than Kennicott's willow warbler or the yellow warbler among the willows along Contact Creek. Although the Nunamiut did not know the pileolated warbler explicitly I suspect that some of these elusive little birds will be found nesting in the mountains.

After we had watched through the night for wolves to return to their den, at about 3 a. m. I saw a male pileolated warbler sing twice on a willow near the Ahlasuruk River about 130 miles west of Anak-

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tuvuk (L. Irving and Paneak, 1954). Cade found them at Umiat (Kessel and Cade, 1958).

I consider that the indications warrant designating the pileolated warblers as birds nesting at Anaktuvuk.

Family ICTERIDAE: Blackbirds

Euphagus carolinus carolinus (Müller)

6 males	May 15–Aug. 31	weight (4), 60–66, average 63 g.	—	—
4 females	May 17–July 8	weight (3), 48.0–60.0, average 63 g.	—	—
1 young male	July 8	weight 55.4 g.	—	—
1 young female	July 8	weight 50.4 g.	—	—
1 young male	Aug. 31	weight 55.5 g.	—	—

Individual rusty blackbirds have been reported May 15, 1949, May 16, 1950, May 22, 1951, and May 18, 1952, and a few have been seen each year in each summer month. Mating and nesting or summer resident blackbirds were not remarked until 1951, and if they nested commonly their revealing habits would scarcely have allowed them to escape observation. But in 1951, Simon Paneak and William Irving collected an adult pair and a well-grown young male and female at Amorgoayat in the Killik Valley on July 8. I had formerly thought of them as visitors from the Koyukuk and Alatna Valleys, where I have frequently seen numerous family groups, but since a family group has been seen in the Killik Valley, I consider it certain that an occasional pair nests in the mountain valleys in addition to numerous visitors which come in from the wooded valleys to the south.

The Nunamiut name is *Tolungiksyaurak*, meaning "little raven."

Family FRINGILLIDAE: Grosbeaks, Finches, Sparrows, Buntings

Pinicola enucleator alascensis Ridgway

1 male	Nov. 11, 1948	—	—	—
2 females	Jan. 31–Nov. 11	—	—	—

I have seen pine grosbeaks frequently in the timbered regions of the Koyukuk and Alatna Valleys, and I have numerous records and specimens from the northernmost spruce forest of the John and Savioyuk Rivers. They are also seen occasionally in winter among the willows of the valleys as far north as the northern mountain line. According to Simon Paneak none have been seen further north. The Nunamiut name is *Kayatavak*.

I have only one observation recorded in summer north of the timber; Jesse Ahgook reported a pair to be nesting among the willows of Contact Creek, June 7, 1951. His observations are usually ac-

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curate, but later we could not find the nest or birds. Jesse and Simon Paneak agreed that since this was the only report of one north of timber in summer that they could recall, it did not establish normality of summer occurrence.

Small groups of pine grosbeaks appear occasionally to move about in winter over the open tundra north of the spruce forests as they do in the wooded regions. In winter the northern willows blown bare of snow may afford easier feeding than the snow covered branches of the windless forests. The grosbeaks' feathers are the fluffiest of any of the Fringillidae, and they and the redpolls (*Acanthis hornemanni exilipes*) are the only members of that family which regularly winter in the mountains. Their winter travel northward is a frequent occurrence, and it seems correct to designate the pine grosbeaks as winter visitors which at that season move from the forests 100 miles or so north of tree line. I also suggest their inclusion with the Yukon chickadee, downy woodpecker, and Alaska jay in a probably more or less regular northward movement in winter from the forest to the tundra.

Leucosticte tephrocotis irvingi **Feinstein**

7 males	May 22–June 29	weight (8), 26.8, 29.1, average 27.7 g.	—	—
5 females	June 7–29	weight (5), 25.8, 30.3, average 28.6 g.	—	—

Gray-crowned rosy finches were found along the west side of the valley at Tuluak as it slopes near and above the talus slopes 4 to 500 feet above the valley floor. They are well known and their rosy colors bring them the name *kaviksruak* among the Nunamiut. The earliest reports in spring are May 19, 1950, June 2, 1951, and June 1, 1954. The fall records show old birds with young of the year moving south on August 29, 1950, at Kangomavik, and the last were seen September 2, 1950, at Contact Creek, also moving southward.

No nests were found, but a male examined by Robert Rausch on May 22, 1950, had testes measuring 10 mm. and was in obvious breeding condition. Three male specimens taken on the mountain side between June 18 and June 29 had bare brooding patches. The behavior of the male and female observed by Thomas Brower on June 23, 1949, showed the alert and baffling indirection of a bird near its nest. Its efforts for diversion were successful, and no nest was found. John Krog observed several pairs about 1,400 feet above the floor of Anaktuvuk Valley several miles west of Tuluak and reported their behavior like that of nesting birds on June 2, 1951. The Nunamiut believe that they nest on the mountain sides and from the evidence there is no doubt that nests are made and young birds are reared along the Valley's mountain side, probably near the talus slope.

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It is unlikely that these finches move much further north, for beyond the mountain line there are only a few isolated elevations with the type of mountainside terrain to which they are usually restricted.

After repeated examinations these rosy finches appeared to differ from *L. t. tephrocotis* of more southern origin in being more extensively tinged with rosy color on upper and lower posterior parts of the body. The brown of the Anaktuvuk specimens is more red. Bernard Feinstein (1958), who has described them as a new race, remarked a more distinctive difference from *tephrocotis* in the gray pattern about the head, which approaches the pattern of *littoralis*. We consider the Anaktuvuk birds to be distinguished as a separate race.

Brina Kessel kindly sent three specimens of rosy finches obtained in the mountains near the head of Sheenjek River in the eastern part of the Brooks Range, in Yukon Territory. These, a specimen from Bettles, and two from the Cheena River also conform with our Anaktuvuk birds. A few specimens from Eagle are the northernmost examples of *tephrocotis* that we could find.

Acanthis hornemanni exilipes **(Coues)**

12 males	Feb. 14–July 19	weight (30), 10.7–16.1, average 12.7 g.	—	—
8 females	Mar. 4–June 26	weight (24), 10.4–14.8, average 12.8 g.	—	—
2 young males	July 19, 24	weight 12.5, 12.2 g.	—	—
2 nests, each with 5 fresh eggs and female	June 16, 17	—	—	—
2 nests, each with 4 fresh eggs, no female specimen, and therefore uncertain as to whether *flammea* or *exilipes*	—	—	—	—

Ira Gabrielson kindly reviewed my estimate of the redpolls collected up to 1950 and Herbert Friedmann reviewed my distinction of the whole collection of redpolls.

A few hoary redpolls are resident at Anaktuvuk in winter. In addition to four specimens taken in February and March, four mummified birds taken in February and March were identified by comparison in the U. S. National Museum. I have seen redpolls in late winter at Umiat under the alders, consuming seeds on the snow where they had fallen from the cones. They also feed on the bushes, usually moving rather rapidly and coherently as a scattered flock, the individuals acting nervously and the flock often flying together. I have not obtained a winter specimen of *flammea*. In winter plumage

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the two redpolls are more easily distinguished and I have then been certain in observations of *exilipes*, but I have not identified any *flammea* on the arctic tundra in winter.

During his winter on the forested part of the Kobuk, Grinnell (1900) found redpolls the only birds usually to be seen. His specimens of *flammea* were usually taken from flocks of *exilipes*. In his collection there were 104 specimens of *exilipes* and only 7 of *flammea* (p. 48). In his checklist (p. 77) Grinnell remarked that *flammea* was "common, chiefly along the coast," a comment which, I believe must result from his observations around Kotzebue Sound in summer.

In mid-May 1949 small flocks began to appear near Tuluak and by May 17 over 100 redpolls were reported daily by Thomas Brower. The numbers then diminished and not more than six were seen together after the end of May. Groups of five or six were occasionally seen moving together after the others had begun nesting.

A nest was reported building June 8, 1949, and fresh eggs were collected between June 16 and 20. With the first two nests were female birds identified as *exilipes*. Females were also collected and identified from two nests in which the eggs on June 13 were too far incubated to save. The others were named by sight, so that we have identification for only four individual parents of *exilipes* found nesting. Nests with 4 eggs have been found on June 4, but incomplete clutches are common until June 15. Nestling birds were found June 25, and on July 4 a family had left the nest. Young birds were flying July 19. The nests were bulky constructions low in the willows and made of small roots, twigs, grass, occasional moss, and lined principally with caribou hair and a number of ptarmigan feathers.

The following comments apply to *exilipes*, but I cannot determine whether they apply to *flammea* as well. The Nunamiut said that redpolls frequently have a second brood so late in the season that the young birds are abandoned, starve and freeze. It was thought that parental interest for their young was replaced in late summer by the desire for flocking together and migration, so that the young were first abandoned and then froze after starving. On June 26 I have seen male *exilipes* with testes of breeding size. At the same date I found a fresh set of eggs of *flammea* which would probably have had time for normal development of the young before cold weather. But a nest was then near completion by redpolls which I called *exilipes*, and I question whether birds could mature from that set of eggs before cold weather or the formation of flocks distracted the parents from family to flock activities.

On July 27, 1950, family groups were joining and numerous flocks of 8 or 10 birds were seen. Thereafter at Anaktuvuk and from August 3 to 15 in the Killik Valley loosely associated flocks were building

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up in the willows. Some apparently came from farther north and generally they were heading slowly southward as they fed. By September large flocks in fairly steady movement were working their way along the sides of the valley and its floor near Contact Creek. By the end of September the main migration had apparently passed, carrying great numbers of summer residents and migrants from the north toward the south.

In summer, resident hoary redpolls are the most numerous birds near the willows. Because they spread over more territory they probably outnumber the tree sparrows. Redpolls were more often seen in higher branches in the willows than tree sparrows, and they also dwelt as high in the Anaktuvuk Valley as the willows grew up along the narrow canyons of the tributary creeks to at least 1,000 feet above the Valley floor. Many redpolls and snow buntings were seen by Simon Paneak on August 29, 1950, above the head of Kangomavik Creek, an estimated 3,000 feet above the valley floor. He could not be sure of the kind, but they were apparently migrating.

In Nunamiut they are called *Suksangik*, a name which has no meaning except redpoll. It does not distinguish *exilipes* from *flammea*.

Acanthis flammea flammea **(Linnaeus)**

17 males	May 15–July 24	weight (21), 10.2–15.0, average 12.9 g.	—	—
6 females	May 19–July 7	weight (9), 10.1–14.2, average 13.1 g.	—	—
1 young female	Aug. 3	weight 12.5 g.	—	—

In view of the difficulty of making accurate distinction in the field while the birds are in summer plumage, I cannot say to what extent common and hoary redpolls mingle.

None of *flammea* have been identified in the mountains earlier than May 15, and I do not think that they remain there during winter.

In Anaktuvuk Valley, I have found more of *flammea* near the dense willows along Contact Creek than elsewhere, but I have specimens of each redpoll from every region in which I frequently hunted. A single *flammea* was collected among barren rocks at about 4,000 feet, the highest elevation from which a redpoll was obtained, but I cannot separate nor generalize upon the elevation of their ranges. It is my impression that *flammea* is more often in the denser and larger willow patches.

On June 27, 1951, a nest with five eggs was found about 4 feet above ground in one of the small willows along the river near Tuluak Lake, situated about 50 feet from a nest of *exilipes* which I had found on June 10. I could not be certain of the identity of the female, but a male well colored with rose red occasionally came to feed her as she sat on the nest. This bird was collected and identified in the U. S.

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National Museum as *flammea*. On June 11, 1952, I identified by sight as *flammea* birds which were working on two unfinished nests at Contact Creek. A third female allowed me to watch her from a distance of 2 feet while sitting on a single egg. So I believe that both species nest numerously in adjacent areas upon which I cannot now place any distinction.

Until 1952 I believed that *exilipes* were ten times more numerous than *flammea*. But I saw about equal numbers of each species as I hunted principally around Contact Creek in 1952, where I had not previously concentrated so much attention. I believe, however, that over the whole valley the numbers of *exilipes* in summer greatly exceed those of *flammea*, and that they are distributed in more varied situations.

In early and late summer, the migrating flocks of hoary redpolls are very much more numerous, and I have not positively identified flocks of *flammea* nor do I know whether they intermingle in migration with flocks of *exilipes*.

In weight the two forms are not distinguishable. In reports of fatness prior to nesting both redpolls in early summer are noticeably less fat than many common migrant species at Anaktuvuk. This observation can be compared with Barbara Oakeson's (1953) view that races of white-crowned sparrows of the Pacific Coast region making short migratory flights are not as fat on their wintering grounds before migration as are those sparrows contemplating a long migration. Furthermore, at the terminus of only a short migration, the Gambel's sparrows were not fat (Blanchard, 1942). Many redpolls remain during winter in Alaska, but I have seen more of *flammea* and but few of *exilipes* near Fairbanks and Anchorage.

The arrival of the redpolls is vaguely defined in my records, but the rarity of fat redpolls at migration time presents a contrast with the uniform fatness of arriving tree sparrows and Alaska longspurs, and in fact with the fatness of many arriving migrant birds which are known to winter in regions remote from Anaktuvuk. It may be that the meager fatness of early summer redpolls at Anaktuvuk is a symptom of a short migration, as Blanchard (1942) showed to be the case among the white-crowned sparrows of the Pacific-coast States.

Of the two species of redpoll, *exilipes* was found to be less fat than *flammea*, as the tabulation below shows:

	Fat	*Medium fat*	*Little fat*	*Very little fat*	*Lean*
Acanthis hornemanni exilipes					
Males	1	3	4	7	2
Females		2	2	2	1
Acanthis flammea flammea					
Males	2	2	7	6	0
Females	1	4	2	0	0

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On this basis alone, I would not suggest that *exilipes* make a shorter migration to Anaktuvuk than *flammea*, but a difference in fatness of the two birds reflects a difference in nutritional state which could well be significant of different migratory habits. It is among such differences in the physiology and habits of birds that we must look to find expression of the influences which combine those of like race in the patterns of similar flight activity, and which enable them to cohere in their migratory route.

Loxia leucoptera leucoptera (Gmelin)

1 male	July 10, 1954	weight 21 g.	—	—

Five white-winged crossbills were collected at Hunt Fork in the winter of 1947–1948 and brought to me in spring when the skins could no longer be saved. I saw a flock of about 30 feeding and flying about in their careful method of association in the spruce tops along the Alatna, just north of Helpmejack Creek, early in August 1951. I have also seen them at Bettles and, in March, among the most northern spruce around Ernie Johnson's cabin on the Alatna Malemute.

Susie Paneak collected one of two crossbills which she found at Itikmalikpuk Creek on July 10, 1954. Simon Paneak recalled seeing one west of Chandler Lake in 1938. The rare records and strangeness of a crossbill's occurrence north of timber cause me to omit the species from the normal avifauna of Anaktuvuk.

Their Nunamiut name is *Pakagik*, and they are so familiar at the northern limit of the spruce forests as to deserve mention in relation to the northern area.

Passerculus sandwichensis anthinus Bonaparte

6 males	May 16–July 17	weight (9), 16.1–19.8, average 17.8 g.	—	—
1 female, nest with eggs	June 13	weight 21.8 g.	—	—
1 female	July 2	weight 14.9 g.	—	—
1 young female	July 19	weight 14.6 g.	—	—

Called *Okpisoyuk* by the Nunamiut, which means "staying mostly near willows," Savannah sparrows are regularly present in summer and I have found them usually near marshy areas. Few are identified because of their unobtrusive behavior, but they are not uncommon. Our first recorded observations are May 13, 1949, May 16, 1951, May 25, 1952, and May 27, 1954. They are less numerous than Gambel's sparrows but more common than fox sparrows. In some of the other arctic valleys where the marshy areas are more extensive than at Anaktuvuk the Savannah sparrows are more numerous.

The nest is neatly and compactly made of fine round grass that diminished uniformly in diameter toward the lining, where it is inter-

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woven with caribou hair. It was located under dead grass near the stream from Nakagnik Spring.

***Junco hyemalis hyemalis* (Linnaeus)**

2 males	May 22, 1949, May 15, 1952	weight 19.5, 15.4 g.	—	—

Northern slate-colored juncos are not often seen in the mountains. My only records are two taken by Thomas Brower at Tuluak Lake May 22, 1949, and one seen at Nakrak May 9, 1952, in the same place where the specimen was collected on May 15. The Nunamiut know juncos and had described them for me before specimens were collected. They call the junco *Kayatavaurak*. This name is like that of the pine grosbeak *Kayatavak*, but with a diminutive ending added. I could find no information about the nesting of juncos in the mountains. Their appearance there is unusual, but the two specimens were in good condition. I have seen numerous juncos raised in that season in the wooded country along the Koyukuk and Alatna to the south and a few have been reported along the Arctic coast (Bailey, 1948, p. 296). It is my impression that juncos may nest in the mountains and that their occurrence represents migration. But from present evidence, they can only be called visitors to Anaktuvuk.

***Spizella arborea ochracea* Brewster**

26 males	May 15–Sept. 10	weight (43), 16.1–22.0, average 18.4 g.	—	—
6 females	May 21–Sept. 5	weight (11), 16.1–19.8, average 17.7 g.	—	—
8 young males	July 24–Aug. 14	weight (8), 16–20 g.	—	—
2 young females	July 13, 29	weight (2), 16–17 g.	—	—
5 nests with 5 eggs in 4, 6 eggs in 1	June 9, 16	—		

The first western tree sparrows were recorded May 14, 1948, May 13, 1949, May 11, 1950, May 8, 1951, May 20, 1952, and May 14, 1953. The latest date recorded is September 12, 1950, at Contact Creek. During May 1949, the numbers gradually increased until 40 were observed on May 30. This observation does not indicate the actual abundance, for they were throughout the summer second in numbers only to the redpolls, with which they occupied the same habitat of the low willow patches, particularly in the flat bottom of the valleys. They did not appear to venture to high elevations up the willow-lined streams, nor away from the willows among the dry rocky places, as frequently as did the redpolls and longspurs. They were usually seen near the ground among the lower willow bushes. Specimens are from Tuluak Lake, Kangomavik, and Contact Creek in Anaktuvuk Pass,

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and from Odrivik Lake in the Killik Valley. Their Nunamiut name is *Misapsak*, which refers to their song.

Among the series of seven young males collected between July 24 and August 14, all had attained adult weight but were deficient in tail length. Numerous nests were found rather clearly visible on niggerheads among short willows or in nearby long grass. The nests were rather bulky, predominantly of grass, occasionally of moss, were lined with fine grass and caribou hair, and always contained white ptarmigan feathers.

The tree sparrows practically overrun the short willows of the Valley in spring without, however, appearing in organized flocks as do the redpolls. A majority of the incoming birds act as if about to take up residence, but a comparison between numbers seen earlier and later indicates that many move north.

The Nunamiut regard them as common all the way to the arctic coast, and I have seen them over that range. My estimate is that a smaller proportion of arriving tree sparrows moves north than is the case among the redpolls. A great number of both species migrate northward.

As a natural accompaniment to the hardy behavior of tree sparrows in their winter range, their body feathers are as thick and fluffy as are those of arctic residents, and are of the same type. By that comparison, their feathers might well afford protection adequate for winter residence in the arctic. I have no indications to suggest that they winter in arctic Alaska, and the fatness of the arriving migrant tree sparrows is appropriate to a long migration route; in this respect they can be contrasted with the lean redpolls, which may be suspected of making a shorter migration (see p. 116).

Zonotrichia leucophrys gambelii (Nuttall)

15 males	May 16–Aug. 8	weight (29), 22.2–29.5, average 25.6 g.	—	—
9 females	May 28–July 31	weight (9), 21.7–27.4, average 23.3 g.	—	—
4 young males	July 29–Sept. 12	—	—	—
1 young female	July 31	weight 26.7 g.	—	—
2 nests, each with 5 fresh eggs	June 9, 12	—	—	—

Earliest arrivals of Gambel's white-crowned sparrows were recorded May 13, 1949, May 19, 1950, May 16, 1951, May 20, 1952 May 14, 1953, and May 18, 1954.

On May 24, 1952, as Terris Moore and I were preparing for a flight from Bettles to Kobuk and Howard Pass the Gambel's sparrows were apparently already settled in nesting places. This was a spring when the late winter snow and ice persisted uncommonly late in northern

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Alaska. The opening of the birch leaves was about two weeks later than usual at Fairbanks. On the Kobuk River at Kobuk Village the snow was still deep on May 25 and the streams, just beginning to flow, had yet to break open the ice on the river. Here the white-crowned sparrows were in small groups, but a few appeared to be paired. Seventy miles north, in the upper Noatak Valley I saw these sparrows in small groups, with some apparent pairs.

When we reached Anaktuvuk several days later, the first arrivals of white-crowned sparrows had been reported on May 20, three or four days later than the mid-date for the preceding 3 years. If this small delay in observation represented delayed migration, it was not apparent in the behavior of the birds, which took territory, sang and nested according to their regular calendar schedule.

Barbara Oakeson (1954) found that male white-crowned sparrows became numerous at Mountain Village, Alaska (on the lower Yukon River, lat. 62°07′ N.), before the females did. Of the specimens taken at Anaktuvuk in May there were 20 males and 5 females. Eleven of the males in which the greatest length of testes was measured ranged in this character between 6 and 9 mm. Six males measured in early June ranged in length of testes from 8 to 10 mm. It appears that at Anaktuvuk, as Mrs. Oakeson found at Mountain Village, male white-crowned sparrows arrived on the breeding grounds in numbers before the females. One female was taken at Mountain Village earlier than any male, so the precedence of males is not exclusive but rather a majority. Further, in the arriving males at Anaktuvuk the testes have not reached full size. The development of eggs also had not progressed beyond 5 mm. diameter in the latest female taken during May, and it is apparent that both male and female birds complete their physiological preparation for breeding after arrival on the nesting grounds.

In connection with these comments upon gonadal development it is important to note that Mrs. Oakeson studied only white-crowned sparrows which showed by their behavior that they had settled at Mountain Village to nest. The locality is in the peninsula of the Yukon Delta only 40 miles from the coast of Bering Sea. At Anaktuvuk we have not so carefully distinguished that the white-crowned sparrows examined had settled for nesting. But these sparrows are rare on the arctic coast of Alaska and there was no noticeable concentration of incoming birds in numbers nor were flocks larger than small groups observed. Since only about 100 miles of possible nesting territory for white-crowned sparrows exists north of Anaktuvuk the population examined is at or close to its breeding ground and in this respect comparable to the birds studied by Mrs. Oakeson.

In early June, many Gambel's sparrows were singing, having al-

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ready settled their territorial claims. They nested on the ground, usually well concealed under short willows or in long grass at the edge of willow patches, with five or occasionally six eggs. Like the birds, the nests were inconspicuous. Four early nests were found: with two eggs on June 1, 1954, by Simon Paneak; with a complete set of eggs, on June 9, 1949, by Tom Brower; on June 9, 1951, with eggs, by Susie Paneak; and with five eggs, at Nakrak, on June 10, 1952. Hatched nestlings were found by Tom Brower on June 25, 1949. The nests were rather bulky, and as a result the bottom was raised 50 mm. above the ground, they were made of fine grass with a few bits of moss. Among birds resident in Tuluak Valley, Gambel's sparrows were common, perhaps 1/20 as numerous as the redpolls and tree sparrows occupying the willow habitat. They were about 10 times as frequently seen as fox sparrows.

Seldom conspicuous, and in midsummer keeping to the cover of the willows, they were nevertheless easily discoverable about many of the willow patches in Anaktuvuk Valley or in the small alder thickets as well as in the Killik Valley. They were usually in willows exceeding 10 feet in height but an occasional pair was found among the low willows near damp places on the mountain sides. In the thick willows along Contact Creek in mid-June, I found that when I remained still for a few minutes a pair of Gambel's sparrows would frequently approach within 5 feet and examine me carefully. But outside the brush they were commonly shy. Their Nunamiut name is *Nungaktuakruk*, which refers to their white-striped crown.

At the end of July, the young were heavier than the adults. Their departure, like their arrival, is not conspicuous, and the latest record noted two birds (one young) on September 12, 1950, at Contact Creek. Although they spend a long season at Anaktuvuk their feathers are not as fluffy as those of tree sparrows and they do not appear so well insulated against cold weather.

The white-crowned sparrows were first seen at Mountain Village, Alaska (on the lower Yukon River, lat. 62°07′ N.), on May 9, 1950, 10 days ahead of the earliest record for that year at Anaktuvuk. On arrival at their breeding grounds at Mountain Village the average weight of 7 males was 25.8 grams and the average weight of 3 females was 25.5 grams (Oakeson, 1958). The records of weight and fatness of white-crowned sparrows at Anaktuvuk permit comparison to be made subsequently (see p. 320) with Mrs. Oakeson's information upon their nutritional condition in relation to migration.

Among 25 adult birds examined with the aid of Herbert Friedmann, 1 had only black feathers between the eye and mandible, 16 had the light superciliary line continuing to gray between eye and mandible, and 8 had the superciliary line continuing in light or white feathers

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between eye and mandible. Of the 2 additional birds from that part of Alaska, 1 from Bettles agreed with the gray birds and 1 from Ahlasuruk agreed with the lighter mark between eye and mandible.

The exceptional bird bears the pattern of the eastern white-crowned sparrow, as Alexander Wetmore first pointed out to me. It was a male taken on July 11, weighing 27 grams, with testes measuring 1.5 mm. It could be interpreted as an accidental wanderer of the eastern race, far from the usual range of its subspecies, or as an aberrant pattern of plumage in *gambelii* that happens to resemble typical *leucophrys*. The latter of these two choices is the one followed here, as it seems more logical than the other.

Passerella iliaca zaboria **Oberholser**

5 males	May 21, Aug. 6	weight (4), 34.3–42.7, average 37.4 g.	—	—
2 females	June, July 11	weight 30.2 g.	—	—
2 young males	July 11, 1950	weight 34, 34 g.	—	—

These fox sparrows compare well with those kindly shown me by Ira Gabrielson as representatives of this race from Alaska.

The earliest records are of a specimen brought to me May 19, 1948, which unfortunately could not be preserved, June 8, 1950 (an undoubtedly late observation), May 17, 1951, May 29, 1952, and May 28, 1954. Because of their shy withdrawal among the willow thickets early fox sparrows are unlikely to be seen until the males reveal themselves by singing from the tops of bushes.

The Nunamiut name for fox sparrows, *Iklikvik*, means "tool bag." This name is very appropriate, for it refers to the quick, rattling sound which the fox sparrow makes in the Arctic, as in temperate regions, while scratching in dry leaves. It resembles the rattling of the ivory bone and flint instruments formerly carried in an Eskimo's tool bag (the older men used to carry their tools in these bags as they went to work together on their fish nets and other gear in the men's social house of the village, where they would not be disturbed by women and children, who in turn also had liberty for their occupations and society). Barbara Oakeson informs me that at Mountain Village on the lower Yukon the Eskimos also base their name for fox sparrows on their scratching, but they are there called *Shachtayolik*, meaning "he scratches." As a small boy I first recognized fox sparrows when the odd rattling sound of their scratching among the autumn dry leaves in a swampy thicket called them to my attention.

Almost as early as they have been seen, the males were singing their fine, sweet song. Among early specimens, the testes varied considerably in size, so that I suspect that they, like Alaska longspurs, are not all ready for reproduction when they first arrive. Nevertheless a

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female bird contained an egg 17 mm. in length on May 29, 1952, and their nesting must be among the earliest of the sparrows.

A nest was reported on Contact Creek June 7, 1951. Through June, I saw and heard many fox sparrows singing in the willows along Contact Creek, where I suspected that they were already nesting.

There is no indication of extensive migration, but some must pass northward, for the Nunamiut know that fox sparrows are common in the willows along the Colville River.

Calcarius lapponicus alascensis **Ridgway**

30 males	May 10–July 20	weight (27), 24.6–33.1, average 28.6 g.	—	—
18 females	May 10–July 24	weight (22), 22.3–30.6, average 25.4 g.	—	—
9 young males	July 5–Aug. 11	weight (8), 22.3–24.7, average 23.6 g.	—	—
2 young females	July 20, 24	weight (2), 24.4–27.4 g.	—	—

The earliest recorded arrivals of Alaska longspurs at Tuluak Lake are May 15, 1948, May 1, 1949, April 29, 1951, May 9, 1952, May 4, 1953, and May 13, 1954. About the first of May is the usual date of their arrival. During the first two weeks of May a few were seen each day, but during the third week in May, flocks increased until May 19, 1949, when a thousand were reported by Thomas Brower. The population remained at migrant size for about a week further and suddenly declined to resident numbers and behavior before the end of the month. Their Nunamiut name is *Potokioluk.*

Early in May and in some years to the end of that month, winter snow persists in Anaktuvuk Valley. Then the longspurs may be seen in great numbers on the higher levels of the Valley and particularly where hummocks of sedge protrude above the snow. In the latter part of the month, the males frequently sing in downward hovering flights which terminate in swift, soaring glides to earth. In this time mating competition goes on, before nesting areas are exposed, among flocks which are generally moving northward on the ground and in short flights. I suspect that some mating occurs before the final nesting grounds are reached.

On May 10 and 11, 1951, five males examined were recorded to have small testes. On May 14 and 15, the records show that the testes of four were getting larger and in four, the testes had reached breeding size. In 11 birds examined during the rest of May, the testes were in all cases of breeding size.

All males (15) which were examined between May 10 and 16 were fat. On May 21 and later in that month among 10 males examined

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only two were reported fat, three were designated medium fat and five had little fat. These figures indicate less fat in the males in breeding condition and during the time of mating, but they were nevertheless in good nutritional state.

The progress of egg development may also be observed from records in 1951. In 13 females examined between May 10 and 21, the eggs were recorded as 1 mm. in length. Eggs were recorded as 2 mm. on May 21 and 28, 10 mm. May 28, with only small eggs found on June 8 and 9.

On May 10 and 15, seven females were recorded to be fat. Of nine females examined in the remainder of May, two were recorded to be fat, three were considered medium fat and four had little fat. These figures indicate that females, like males, are fat until about the time of active mating and nest preparation and that thereafter they are not commonly so well supplied with fat, although their state of nutrition is generally very good.

Two nests found on June 6, 1949, and one on June 6, 1953, contained two eggs each. On June 7, 1949, another nest contained four eggs and on June 8, one set of two eggs had increased to four, the other nest having been destroyed. On June 12, several nests were found with four eggs too far incubated to be saved, and because of this condition and destruction no specimens were preserved.

The first nest recorded in 1951 contained four eggs on June 4 and 10 days later it contained two nestlings and one egg. On this same date, June 14, another nest contained four newly hatched birds.

The young were first seen flying inexpertly June 29, 1951, and the young were all flying over the grassy tundra in early July. In the series of nine young males taken between July 5 and August 11, 1950, of eight weighing from 22.3 to 24.7 grams, none had reached adult weight or length except one which on July 2, weighed 28.5 grams while still in juvenal plumage. Its testes measured 1.5 x 1 mm., large for a young bird, and their condition may indicate the reason for enlargement of the bird. It was omitted from the series of weights as an abnormal bird.

These longspurs are the most numerous birds of the wet grassy tundra and in open grassy places among the willows. Commonly, they remain near water, but they sometimes venture far up onto dry areas and onto the talus slopes on the Valley sides. Around the tents of Nunamiut, they are common visitors and in late summer the young birds venture familiarly close among people and dogs

In the summer of 1951, I saw so many more males than females that I tried to estimate whether this apparent predominance of males observed represented the state of affairs in the population. About mid-May, John Krog remarked that he saw about ten times as many

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males as females. During June, I noticed that there were frequently groups of four or five males amiably feeding together on the dry parts of the tundra, occasionally to be joined by a female. So frequently were these small groups of males seen together at the same place that it was my impression that they were regularly associated companions. They walked about in their awkward, stiff-legged gait as deferential to each other as a group of old gentlemen at their club.

When the young birds scattered from the nests at the end of June, the females came out of retirement and were usually seen in the proportion of one female to three or four males, but thereafter the grouping of males was not noticed. The clubs were now broken up. A collection of young birds which had left their nests was made in 1950. These birds were not selected and the sexes were not distinguishable in the field either by appearance or habit and yet the results gave nine males and two females. When I consider the revealing habits of these longspurs in May and June, I wonder if the males in the population in 1951 considerably outnumbered the females.

In the Killik Valley in August 1950, Alaska longspurs were as abundant as at Anaktuvuk and about twenty times as numerous as Smith's longspur. Two young birds from Odrivik Lake and Akmalik Creek correspond in size with birds from Tuluak. In late July at Tuluak and more noticeably in early August in the Killik Valley, longspurs frequently were grouped loosely in larger than family numbers of a dozen or so, and the direction of flight was more often south than north. They were observed August 15, 1950, at Chandler Lake. On August 25, 1948, there were not many around Tuluak Lake and our latest record is September 2, 1950, at Contact Creek.

Alaska longspurs arrive earlier and remain later than Smith's longspurs. Alaska longspurs go far north on the arctic tundra in summer and are common along the arctic coast, but they have not the feathers typical of northern birds, and they retreat from the far north before cold weather sets in.

The view of large but loosely organized flocks moving northward in mid-May shows that Anaktuvuk Pass is an important thoroughfare for these longspurs in their movement to the arctic slope.

***Calcarius pictus* (Swainson)**

13 males	June 4–July 10	weight (22), 25.5–31.8, average 28.5 g.	—	—
11 females	June 4—July 20	weight (7), 22.0—26, average 24.3 g.	—	—
1 young male	July 27	weight 27.6 g.	—	—
2 young females	July 24, 27	weight 28.1, 25.3 g.	—	—
Eggs, 4 fresh with female	June 18, 1949	—	—	—
Eggs, 4 fresh with female	June 19, 1949	—	—	—

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The earliest records of Smith's longspur are May 28, 1948, June 4, 1949, June 8, 1950, May 27, 1951, May 26, 1952, May 22, 1953, and June 1, 1954. We have not noted flocks of these longspurs nor any grouping of them that might be related to migration, and so I think that most of those in Anaktuvuk have reached the northern terminus of their migration. The latest to be reported was seen on August 24, 1950.

The Nunamiut consider that *Kallorgosiksook*, so named because of the ability of Smith's longspurs to sing like several kinds of birds, are common in some years and scarce in others. During 1950, it was estimated that they were about a twentieth as numerous as Alaskan longspurs which would rank them as about the second species in abundance over the open wet grassy part of the tundra at the level of the floor of Anaktuvuk Valley. In 1951 and 1952, the proportion observed in summer was about the same.

They did not frequent the dry places, but were often seen in wet grassy places. Although they stand and fly like Alaska longspurs, Smith's longspurs when feeding move through the grass with the swift purposiveness of a hunting weasel, whereas the Alaska longspur has a slow, stiff gait, like that of an old man.

Examination of the testes of 10 of these longspurs between May 27 and June 9, 1951, showed all to be at breeding size at the time of arrival. In this they were unlike the Alaska longspurs which had been reported two weeks before the time all males were at breeding size. Three male birds examined May 27 and 28, 1951, were fat. Between June 1 and 9, out of seven males examined, two were designated medium in respect to fatness, while five had but little fat. It seems that like the Alaska longspurs the early male Smith's longspurs are fat, and that during the mating and nesting season their fatness diminishes.

In four females examined between May 27 and June 1, eggs were recorded at 2 mm. in length (that is, to have undergone a little growth), but on June 5, a bird contained a fully formed egg.

The nests collected by Thomas Brower in 1949 were located on hummocks in the grassy tundra, slightly raised above the wet or damp surroundings and not concealed. They were rather bulky and were constructed of grass lined with fine round grass, some caribou hair, and a few ptarmigan feathers. The sets of eggs were observed for two or three days before being taken and were complete in number by about June 15. This places the nesting date about 10 days later than that of Alaskan longspurs. A set of three eggs was first observed on June 23 and on June 26, having received no addition in number, it was found that the eggs were too far incubated to be preserved.

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In 1951, a nest found with two eggs on June 10 contained three eggs on June 11 and four on June 12. Another nest with two eggs was found June 11, one with four June 12, and one with five eggs June 21.

In 1952, a nest found on June 3 contained no eggs. Another nest, empty on June 3, contained three eggs on June 7, four on June 8, and five when next examined on June 10.

The young birds collected had reached adult weight on July 27 and the latest recorded observation of Smith's longspurs was on August 24, 1950. The evidence points to their being briefer summer residents as well as less numerous than are Alaskan longspurs. Among the Fringillidae, Smith's longspur appears to be least suited for cold by the style and coherence of their feathers. The observations made so far do not show any formed flights of Smith's longspurs heading north through Tuluak Valley. In mid-August, however, more individual birds and family sized groups were seen flying south through the Killik Valley than had been earlier apparent in the local population. It is concluded that the main northward movement extends to the mountain line, but that some proceed further north.

***Plectrophenax nivalis nivalis* (Linnaeus)**

11 males	Apr. 2–May 26	weight (2), 38.9, 32.6 g.	—	—
3 females	May 2–May 26	weight (1), 30.6 g.	—	—

In their northward flight the first migrating snow buntings were recorded March 28, 1949, April 3, 1950, April 3, 1951, May 9, 1952, April 3, 1953, and April 16, 1954. The late 1952 observation may indicate that the buntings were retarded by the late heavy snow cover which persisted in interior Alaska that spring. But I am inclined to think that they passed unobserved. They commonly reach the arctic coast at Barrow in mid-April (Bailey, 1948). Sir John Ross (1835, pp. 322, 511) recorded that the first snow buntings reached their winter quarters at Boothia (lat. 69° 58′ N.) on April 17 in 1830 and again in 1831.

At Bettles Hannah Anderson told me that she had seen the first few snow buntings of 1953 on about March 10. She remembered from her childhood there that snow buntings returned early in March and remained numerous for several weeks. It appears that the most northern part of the migration is prolonged on the Koyukuk and then moves only slowly from Anaktuvuk to Barrow.

Snow buntings are known to winter in southern Alaska from the Peninsula to Sitka (Ridgway, 1901). Brandt (1943) was informed by local people that snow buntings were occasionally seen during winter in the villages along the lower Yukon River. At Kobuk Village,

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Charles Sheldon has informed me, snow buntings were seen in February and March 1954, and the local people expected to see them occasionally every winter. Dall (1869) saw them in winter at Nulato on the Yukon near the mouth of the Koyukuk. The wintering population of snow buntings nearest to those of northern Alaska is in British Columbia. There they have been reported at Atlin (Swarth, 1936), and I saw a flock near Fort St. John in mid-December 1949 and again in January 1954. Between the areas where snow buntings are known to winter in Alaska and Canada the mountains appear like a barrier which would be formidable in winter and which would deter east-west migration of snow buntings in spring. Of this we cannot be certain, but Salomonsen (1947, 1950) thought the Alaskan buntings might be of a race intermediate between the darker American *nivalis* and the lighter Siberian *pallidus*. At present there seems to be no way to establish whether snow buntings wintering in Canada join the large numbers which proceed northward in spring to nest along the arctic coasts of Alaska.

By April 29, 1949, snow buntings had become numerous at Anaktuvuk. The peak of their abundance was reached on May 9, when over 400 were recorded by Tom Brower. The numbers diminished from the hundreds seen daily near the peak of migration until the last flock was recorded on May 18, but a final pair was observed on May 26 and May 27.

The Nunamiut name for snow bunting is *Amauligak*. Henry Collins informed me that many Eskimo groups give that name to snow buntings because it is related to the distinguishing black-and-white pattern of plumage of male king eiders, which shows especially clearly in flight. Simon Paneak remarked upon the resemblance of the two patterns. Several other birds are named for their resemblance to a single character of another bird, although the resemblance holds in no other respect. Swallows are named for the resemblance of their acrobatic flight to the aerial evolutions of ravens. Wheatears are named little eagles because of their free flight over the rocky mountainsides.

During summer no snow buntings were seen on the floor of Anaktuvuk Valley nor at elevations up to 4,000 feet, which were frequently visited. At the head of Kangomavik Creek; at an elevation estimated to be about 6,000 feet Paneak saw snow buntings on August 29, 1950. We thought these might have been early migrants returning from the coast or possibly had nested in the mountains, for Ray Hock trapped nine snow buntings at Barrow between September 11 and 29, 1947. Mary Lobban saw them at Barrow and Wainwright until the end of September 1957, and Anderson (1921) last saw them on the Hula Hula

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River on September 20. It appears that buntings do not leave the coast until September.

While at Chandler Lake during the summer of 1955 Paneak frequently observed young buntings with their parents in the high mountains and Jack Campbell repeated these observations in 1956. It is thus certain that some nest in the high mountains of the interior of arctic Alaska.

Three snow buntings were seen high in the mountains above Kangomavik on October 2, 1950, by Robert Rausch and Simon Paneak, and Paneak again saw several near Summit on October 20. It is scarcely possible for the large northbound flights to return southward through the lower levels of the Pass without being noticed, and I believe that the southbound flights proceed through the high mountains.

Among the northbound birds the gonadal development was determined in only three males, which had testes of breeding size on May 15, May 26, and May 29. In two females the eggs were 2 mm. in length on May 26.

Captive snow buntings lived well through the winter of 1947–1948 at Point Barrow in an outside cage exposed to the full severity of arctic winter (Scholander, Hock, Walters, Johnson, Irving, 1950). One was seen among the willows near the winter camp at Kalutak Creek on January 30, 1950. The buntings possess the feathers characteristic of northern birds, although they are not as fluffy as those of the regular winter residents, jays and chickadees.

Anaktuvuk Pass is an important thoroughfare for snow buntings in migration to the arctic coast. The peak of their migration comes at least a week earlier than that of Alaska longspurs. At elevations up to 4,000 feet at least there are no regular summer residents.

A nest was brought to me in the late summer of 1947 at Point Barrow which resembled others of snow buntings in composition but which was uniquely located, for it was ensconced in the well bleached skull of an old Eskimo. One day about a year later I noticed that Chester Lampe, a Barrow Eskimo who most capably cared for the cleanliness of the laboratory, was looking at the skull and smiling as Eskimos do in appreciation for humorous observations. Expecting some witty comment I asked him if he did not think that an odd nesting place. He said that it was unusual but that it was the bird's nature to enclose its nest in shelter. He then asked me very seriously if I thought the nest had been built in the skull before or after the demise of its mortal owner. Suspecting some fantasy of Eskimo wit, I cautiously suggested that birds did not commonly nest in living human skulls. Thereupon he gravely remarked that he had known several men who certainly acted as if their skulls contained bird nests. I agreed that from the

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evidence his supposition that the skull was tenanted during the life of its owner by a bird's nest was as good as mine that the birds had only sought shelter in the shell of a former intellect. So perhaps if Hamlet had been as observant as an Eskimo he would not have felt warranted in basing a soliloquy upon the probability that intellectual processes had occurred in a single human skull selected at random.

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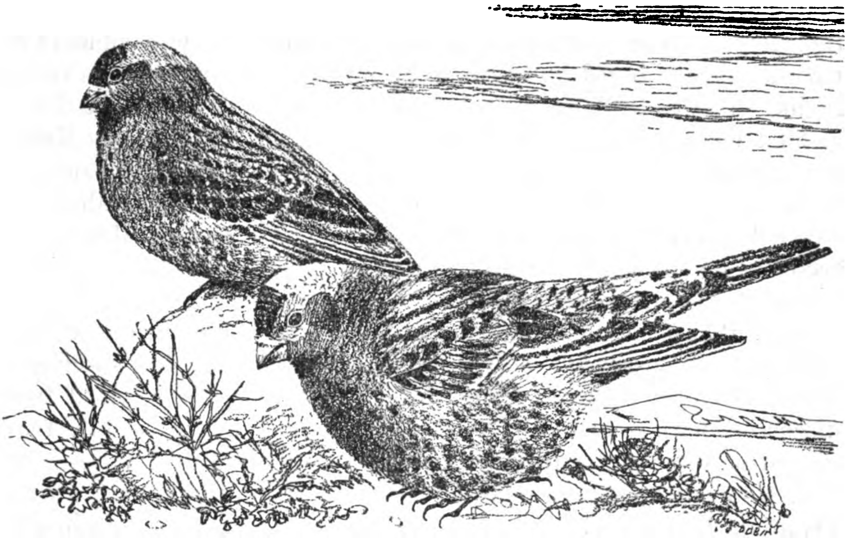

GRAY-CROWNED ROSY FINCH *Leucosticte tephrocotis irvingi* (see pp. 112, 148).

3. Kobuk

IT WAS IN MAY 1952 that I was introduced to a new portion of the northwestern interior of Alaska in the pleasant company of Terris Moore, president of the University of Alaska, when he piloted me to Kobuk village, the upper Noatak River, and Howard Pass (see map, fig. 1).

The climate of the Kobuk Valley is tempered by the protection of the mountains along its northern margin, so that subarctic plants flourish and cottonwood, birch, and spruce reach good size. As a result of irregular glacial deposition and the meandering of the river through its gravel plain the wooded areas vary in extent and pure stands of timber are rare. Water collects on level areas because it cannot drain through the underlying permanently frozen ground. Some of the frequent marshy flats and lakes give way to areas of dry tundra over the outwash from tributaries and moraines in the upper valley. Willow and alder thickets are extensive. Because of the terrain and proximity to the coast there are some tundra and maritime species of birds in addition to the fauna of the northwestern forest.

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Grinnell (1900) is the only naturalist who has observed the interior of the Kobuk Valley during all seasons of the year. Earlier McLenegan (1889) and Townsend (1887) had reported upon the birds they found during arduous summer expeditions for exploration of the Kobuk River, and Stoney (1900) left only a few comments on natural history based on his magnificent explorational travels in the region in 1885–1886. Grinnell described the birds which he found around Kotzebue Sound and around his winter camp on the Kobuk opposite Hunt River about 70 air miles from Kotzebue. I have selected those species which the three authors remarked as occurring along the wooded interior part of the Kobuk River. I find that McLenegan recorded 60 species, Townsend 50, and Grinnell 85. Their combined records list 99 species on the wooded Kobuk.

Since 1952 I have been at Kobuk Village on five occasions, during which I have observed the birds there and obtained a few specimens. The major part of my information, however, has been gained from discussion with some of the 60 resident Eskimo, and especially from migration records and lists prepared for me in 1954 by Charles Sheldon, who has long been a local leader in school and church affairs. (William Irving and I were led by Sheldon to a cursory examination of a number of old depressions which probably represented sites of ancient winter houses; these were at the mouth of Kugaluktuk Creek and are now overgrown with sizable trees.) Harry Brown, the long respected trader at Kobuk and member of the Alaska Game Commission, introduced me to the people who best knew the country and Simon Paneak, from his long acquaintance with the country and his knowledge of the people helped me to evaluate the information obtained.

As an aid for our discussion of birds we had a list of Nunamiut names for about 90 species of birds (L. Irving, 1953). Sheldon named 103 species in the Kobuk manner of speech and recognized explicitly 110 species of the list of 122 birds of Kobuk which I have compiled from published records and our information. Nunamiut and Kobuk names differ to some extent (L. Irving, 1958a), but Paneak and Sheldon were familiar with each other's nomenclature through the long and friendly relations of their people. Sheldon prepared several specimens and kept a journal of his observations during April, May, and early June 1954.

The combination of ancestral Eskimo knowledge of natural history with the current observations of individuals and communities affords information gathered by lifelong observers in all weather and situations. No visitor can by himself gain such understanding of the fauna as is possessed by some of the older members of these Eskimo communities. It is not easy to prepare one's self to receive the information

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of these Eskimo experts in natural history, for the people are extremely critical about accuracy in recognition of species and they cultivate precision in observation. However, Eskimo appreciation for competent interest in birds is so great that evidence of a visitor's serious scientific interest serves as an introduction which in due time opens for him the store of their knowledge, and they then eagerly join in making observations and records in order to provide for the transfer of their knowledge into the terms of scientific ornithology.

The Birds of Kobuk

On the following pages is presented the new information gained from our investigations at Kobuk, together with comments upon earlier reports. From these sources, too, has been compiled the list given in table 4 (p. 246) of species now known at Kobuk. Because the named races give important indications of geographical distribution in arctic Alaska, I have designated them in every case where it was possible to do so on the basis of specimens found in the U. S. National Museum, on identifications by Townsend and Grinnell (made consistent with modern nomenclature), and on specimens which Sheldon and I have obtained. The status of most species in respect to residence, migration and nesting appears clear. The designation of a bird as a visitor is not intended to suggest that the bird's occurrence was accidental. In most cases these birds were known in nesting areas or on migratory paths nearby and their appearance at Kobuk, although not known to be for nesting, migration, or residence, is not to be considered abnormal. In order to reduce the categories used a few birds are designated visitors because the scant information now available does not indicate their true status.

Family PODICIPEDIDAE: Grebes

Podiceps grisegena holböllii **Reinhardt**

Podiceps auritus cornutus **Gmelin**

Red-necked and horned grebes were clearly described in appearance, behavior, and call by Sheldon. Both had been found at the mouth of the Kobuk River to the west (Grinnell, 1900). I have seen red-necked grebes at Kobuk, horned grebes on the Alatna River about 80 miles east of Kobuk, and I have collected and designated the latter a rare visitor north of the forests at Anaktuvuk. Sidney Peyton saw red-necked grebes at Bettles on the Koyukuk, 140 miles east of Kobuk. Both species accordingly occur on the forested southern watershed of the Brooks Range across Alaska. Since they also

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nest at Old Crow where the Porcupine River extends the Yukon Valley almost to the Mackenzie River the normal range of both reaches just north of the arctic circle over the full extent of the Brooks Range.

Family ANATIDAE: Swans, Geese, Ducks

Branta canadensis taverneri Delacour

Sheldon obtained a male specimen from a pair of Canada geese on May 19, 1954, at Kobuk. It conforms with six specimens obtained in migration at Anaktuvuk and with six specimens of these geese from families raised on the Koyukuk and Alatna Rivers for which Herbert Friedmann confirmed my identification as *taverneri* according to a description by Delacour and Zimmer (1951). The testes of the Kobuk specimen were 37 mm. long, greater than in three geese measured during migration at Anaktuvuk. It was near breeding condition and may represent the numerous Canada geese which nest along the wooded Kobuk in the western interior of arctic Alaska. Grinnell (1900) reported *hutchinsii*, the common nesting goose on the wooded Kobuk. Townsend (1887) also reported *minima* and McLenegan (1889) *leucopacia*. Since their specimens are not available these earlier identifications cannot be reliably related to the current nomenclature and we cannot say whether other races than *taverneri* occur there.

Branta nigricans (Lawrence)

As Grinnell (1900) observed, numerous large flocks of brant migrate through the Kobuk Valley late in May but are not seen returning in autumn. Often the migrants fly over the Valley in a northeasterly direction at 4,000 or 5,000 feet, which would clear the adjacent mountains, but farther east I have watched and heard them clearing some of the highest peaks in northbound flights at elevations estimated to be over 8,000 feet. No specimens have yet been obtained from Kobuk but at Anaktuvuk *nigricans* has been identified.

Philacte canagica (Sewastianov)

Sheldon found an emaciated emperor goose near Kobuk in 1954. It is known at Kobuk to be a coastal species which rarely straggles inland and it is therefore not numbered in the regular avifauna of Kobuk.

Anser albifrons (Scopoli)

White-fronted geese appear about mid-May at Kobuk. Sheldon said that some flocks disappear northward and I have seen them in northward migration over Howard Pass. A large number remain in the Kobuk Valley in summer but move out in August before the Canada geese, some of which remain into September.

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***Spatula clypeata* (Linnaeus)**

Sheldon obtained and named the skin of a shoveler, which I have seen and identified, and described it as one of an apparently settled pair on May 23, 1954. It is known by the people at Kobuk that a few shovelers usually nest in the vicinity, but not enough are seen to show that migration proceeds further.

***Aythya marila nearctica* (Stejneger)**

The Eskimos at Kobuk reported scaup to be common. Some distinguished greater and lesser scaup by Eskimo names which they said specified two kinds. Sheldon's description seemed to distinguish two sizes. In support of the description, he reported the weight of a male scaup at 870 grams. This he named *Kaklodook* and said that it corresponded to our "lesser scaup." This is just within the smaller size range of *A. marila* and greater than three weights recorded at Anaktuvuk for male *A. affinis* (769, 681, 694 grams). By reference to these weights the bird was probably *A. marila.* The Kobuk names for the two scaups differ by only a suffix, "*puk*," meaning big. Although lesser scaup may occur and are perhaps distinguished at Kobuk, the evidence is not yet certain enough to include *A. affinis* in the established list of avifauna.

***Bucephala albeola* (Linnaeus)**

Sheldon's appropriate description and an explicit Eskimo name caused me to include the bufflehead as a regular occurrence at Kobuk, although it had not been earlier reported.

The four Alaskan species of eider ducks are well known to Kobuk people from their visits to the coast, but individual eider ducks which occasionally stray inland should not be listed as part of the regular avifauna.

***Melanitta deglandi* (Bonaparte)**

The white-winged scoter, which had been earlier reported only by McLenegan (1889), was clearly described by Sheldon and given an explicit Eskimo name. It is well known among Nunamiut and is also known as a regularly nesting bird at Kobuk.

***Oidemia nigra* (Linnaeus)**

The common scoter, previously reported at Kobuk by Townsend (1887) and Grinnell (1900), was named by Sheldon. As it has not been recognized at Anaktuvuk it probably does not range into the arctic interior beyond the Kobuk River.

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Family ACCIPITRIDAE: Hawks, Harriers

Accipiter gentilis (Linnaeus)

McLenegan had earlier reported goshawks as seen "once or twice," and he reported a specimen. Goshawks are well known to Eskimos at Anaktuvuk as woodland birds and they are designated with the same name at Kobuk, where they are known to these woodland Eskimos as residents of the forest.

Accipiter striatus velox (Wilson)

There are a number of names for hawks in Eskimo. In some conversations the various kinds of hawks appear to be as vaguely designated as by English vernacular names. It has therefore been difficult for me to relate the information of Eskimos to the species of this family. Sharp-shinned hawks are not known to occur at Anaktuvuk, and I could not be sure that they were explicitly known by the Eskimos at Kobuk. Grinnell's (1900) report shows that sharp-shinned hawks are found at Kobuk.

Aquila chrysaëtos canadensis (Linnaeus)

Although golden eagles had not been earlier reported on the upper Kobuk, they are named there, as at Anaktuvuk, and are so well known among Eskimos that they are listed as regularly nesting in the mountainous areas along the upper Kobuk.

Haliaeetus leucocephalus alascanus Townsend

The bald eagle, earlier reported seen only by McLenegan (1889) was clearly described and named at Kobuk but not known to nest there. It is a rare visitor beyond tree line at Anaktuvuk.

Family PANDIONIDAE: Ospreys

Pandion haliaetus carolinensis (Gmelin)

Sheldon showed me an osprey's nest in 1954 on a tall spruce near Kogaluktuk Creek. He said that the nest had been used for many years. In 1957 I saw an osprey carrying a fish toward this nest and was informed that the nest was occupied as usual. We have occasionally seen ospreys north of the timber in the central Brooks Range, but Simon Paneak remarked that he had never seen one fishing in those waters.

Family FALCONIDAE: Falcons

I am still uncertain that the Kobuk Eskimo name and description refer explicitly to duck hawks (*Falco peregrinus*). It is likely that

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they occur and are known on the wooded part of the Kobuk but since no other report names them, their presence is not taken to be established.

The variety of names given to small hawks in Eskimo can be as confusing as their vague designation in English. I do not think that the sparrow hawk (*F. sparverius*) is known in Kobuk. Only McLenegan (1889) had named them on the upper river. In agreement with Grinnell (1900) I do not consider their regular occurrence at Kobuk to be established.

Family TETRAONIDAE: Grouse and Ptarmigan

McLenegan (1889) heard ruffed grouse (*Bonasa umbellus*) drumming in the woods along the upper Kobuk, but Townsend (1887) did not mention them and Grinnell (1900) reported that he could find no valid indication of their presence. The Eskimos at Kobuk would know if ruffed grouse were now present, but they did not appear to recognize them from descriptions. They do mention stories of "willow grouse," which had been seen about 1928, and which they described like sharp-tailed grouse, *Pediocetes phasianellus*. Stories among the Nunamiut, and information related to me by David Tobuk and Big Joe Sousik, two older Eskimos at Bettles, indicate that sharp-tailed grouse (often called "willow grouse" in Alaska and Yukon) had occurred some years ago in the forests along the southern slopes of the central Brooks Range. Nunamiut and Kobuk people alike name these sharp-tailed grouse *Odgillimakadga;* the name meaning "birch ptarmigan." Dall and Bannister (1869) found ruffed grouse at Nulato and generally along the Yukon. It is possible that its range, and likely that of the sharp-tailed grouse, extended to Kobuk at some former time. The northwestern border of their range apparently does not now reach the forests of the Kobuk or the central-southern watershed of the Brooks Range.

Family CHARADRIIDAE: Plovers, Turnstones, Surfbirds

Charadrius vociferus vociferus Linnaeus

Among Kobuk people and Nunamiut the killdeer was apparently recognized in illustrations and its distinctive behavior and appearance were suitably described. Sheldon gave it a different Eskimo name from that of the Nunamiut, but both Eskimo names are akin to those for the other plovers and unrelated to any of the names for sandpipers. The appearance of killdeers at Kobuk would so far extend their reported range that the present evidence cannot be said to establish their occurrence there.

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Arenaria interpres (Linnaeus)

The turnstone is described and named at Kobuk, as at Anaktuvuk. At Anaktuvuk specimens have occasionally been taken during migration. With that inland range established and because of their common occurrence at Kotzebue, I accept the Eskimo information as evidence for the migration of some turnstones through Kobuk.

Aphriza virgata (Gmelin)

Three specimens were collected by Grinnell (1900) from a flock of six. I did not find that descriptions and pictures of surfbirds were recognized at Kobuk. Grinnell's identification lists the surf bird and his observations suggested to him that it nested there, but for lack of evidence as to the status of the species I designate it a visitor.

Family SCOLOPACIDAE: Woodcock, Snipe, Sandpipers

Bartramia longicauda (Bechstein)

Sheldon's description, recognition, and name, *Nanum kanockdoroagna* which he described as meaning "inland plover" indicated his familiarity with the upland plover. Townsend's specimen from Kobuk has provided the westernmost and until recently, the only report of upland plover in northern Alaska. Tom Brower obtained one specimen for me at Anaktuvuk and I have thought that several Eskimos and I saw them there a few times during the last 10 years. Although I think that the upland plover is known to Kobuk Eskimos, it is included in the avifauna because of Townsend's specimen.

Tringa solitaria cinnamomea (Brewster)

The absence of a name for solitary sandpiper at Kobuk probably results from some misunderstanding. Since Grinnell (1900) found these sandpipers common they should be known to the observant Eskimos. Solitary sandpipers are occasionally found in spring migration at Anaktuvuk, where they are well known to the Nunamiut. Sidney Peyton found their eggs near Bettles and the birds undoubtedly nest on the Kobuk and probably along the whole southern watershed of the Brooks Range, for they are common at Old Crow, Yukon Territory.

Heteroscelus incanum (Gmelin)

Wandering tattlers are well known among the Nunamiut, who find many of them and an occasional nest in the mountains, and we have found them north of Kobuk on the Ahlasuruk (L. Irving and Paneak, 1954). Among Alaskan sandpipers they are so distinctive in appearance and habits that Sheldon's name for tattlers, *Adlakuk*, meaning "stranger" is appropriate, although it differs from the onomatopeic

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Nunamiut name. His report and a specimen denote the tattler's occurrence at Kobuk. Because tattlers proceed quickly, after arrival from migration, to nest along gravelly streams in the mountains, they would have been seldom in the path of the ornithologists on the Kobuk.

Erolia bairdii (Coues)

Grinnell (1900) reported that few Baird's sandpipers were seen on the Kobuk, and in summer on the Ahlasuruk, 80 miles north, we saw only one (L. Irving and Paneak, 1954), although numbers migrate through Anaktuvuk and many remain there to nest. Sheldon recognized and named Baird's sandpiper as occurring at Kobuk but as they seem to be uncommon, the Valley is probably off the main routes of their migratory traffic. I have no evidence that they nest near Kobuk.

Erolia alpina pacifica (Coues)

The appearance of red-backed dunlins is familiar to inland Eskimos because the birds are well known on the coast. At Anaktuvuk only a few have been collected during the time of northward migration. From Sheldon's account it seems that a few are seen at Kobuk, although previous reports had not recorded their occurrence. Not being sure that there is a regular migration through Kobuk, I designate them as visitors.

Limnodromus scolopaceus (Say)

Only McLenegan (1889) had earlier reported dowitchers on the middle Kobuk. They were found in summer north of there, on the Ahlasuruk (L. Irving and Paneak, 1954). At Anaktuvuk dowitchers are common for a few weeks during spring migration. They are well known among Alaskan Eskimos, and Sheldon's description and a Kobuk name, although differing from that of the Nunamiut, indicate that dowitchers are known to occur there in their proper habitat during migration.

Micropalama himantopus (Bonaparte)

I could not discover that stilt sandpipers were known at Kobuk. At Anaktuvuk they were recognized and their nesting on the arctic coast was described. Several specimens have been taken there. The numbers seen are few, however, and in some years they are not noticed. If they are as irregular at Kobuk they could easily escape recognition in the greater concealment of the woodland.

Tryngites subruficollis (Vieillot)

Buff-breasted sandpipers are well known to Eskimos on the eastern arctic coast of Alaska. The duration of their migration through

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Anaktuvuk is brief and they have not been reported every year. An explicit Eskimo name and apt description of their distinctive plumage by Sheldon indicates their migration through Kobuk, although no previous observer had reported them.

Limosa lapponica (Linnaeus)

McLenegan (1889) reported seeing godwits on the Kobuk away from the coast. He listed his observations of godwits in the interior under *L. hemastica.* As Bailey (1948) indicates, *lapponica* is well known by specimens from the arctic coast and interior of Alaska, but *hemastica* is known there by only two specimens from Barrow and one attributed to Stoney on the Kobuk. The godwits seen by McLenegan on the interior Kobuk and described and named by Sheldon were probably *lapponica.* McLenegan's description suggests that they nest there, but I have only found evidence for their Eskimo recognition and name. Until evidence for nesting is available the godwits seen at Kobuk should be considered as migrating *lapponica.*

Crocethia alba (Pallas)

Only McLenegan (1889) had earlier reported sanderlings at Kobuk. Sheldon recognized the appropriateness of their Nunamiut name which means "having no heel," but gave a different Kobuk name, *Akpukshookti*, descriptive of their running on the shore. Since sanderlings can easily be distinguished among sandpipers by description, I consider them known to migrate through Kobuk. Few sanderlings have been seen at Anaktuvuk and they are apparently also uncommon at Kobuk.

Family PHALAROPODIDAE: Phalaropes

Both phalaropes are well known at Kobuk and Anaktuvuk. Red phalaropes are so conspicuous in appearance at the time of migration that Sheldon's explicit name and description indicate that in some spring migrations they are seen for a short time at Kobuk in various but not large numbers.

Family STERCORARIIDAE: Jaegers, Skuas

Pomarine jaegers had not been earlier reported at Kobuk, but Sheldon knew their odd-shaped tail feathers well and reported them as occasionally seen. Eskimos usually know the three jaegers and their various habits. Sheldon's description gave no evidence for migratory traffic, but suggested that as at Anaktuvuk, the pomarine jaegers which are occasionally seen should be called visitors at Kobuk until some regularity in their appearance is established.

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Family LARIDAE: Gulls, Terns

Larus hyperboreus Gunnerus

Glaucous-winged gulls are not known to the Nunamiut and I could not find that they were known to occur at Kobuk. Nelson (1887) found glaucous-winged gulls rare north of Bering Sea and remarked that no specimens had been taken from the interior. Bailey (1948) reported that Grinnell's (1900) Kobuk specimen was not a glaucous-winged gull and that various other arctic coast specimens reported to be glaucous-winged gulls should be otherwise identified. In August 1957, while occasionally traveling along the Kobuk between Ambler River and Manneeluk I did not distinguish a glaucous-winged gull among some 200 glaucous gulls which I saw. Adding this evidence together convinces me that Townsend's report of glaucous-winged gulls along the Kobuk River is not characteristic of their distribution and that they have not been identified in the interior arctic forested country.

Larus argentatus Pontoppidan

Herring gulls have not been earlier reported at Kobuk, but it was evident that they were well known to Sheldon for their wing pattern and difference from short-billed gulls in size and color of feet and bill. Occasionally a herring gull visits Anaktuvuk, and I collected a specimen from a family group on the Alatna River in its wooded section about 80 miles east of Kobuk village. They appear to be the common large gull nesting in the northern wooded interior.

Xema sabini (Sabine)

Grinnell (1900) saw only one group of six Sabine's gulls near Hunt River. Sheldon recognized the descriptions of them as common gulls on the coast and said that they were occasionally seen at Kobuk. They are also seen in the interior of arctic Alaska as far south as Anaktuvuk, and the Nunamiut and Kobuk names are similar. There is no indication that the Sabine's gulls seen in the interior are other than temporary visitors.

Family STRIGIDAE: Typical Owls

Bubo virginianus lagophonus (Oberholser)

Early in July 1954 Sheldon and I saw an adult and three young great horned owls just able to fly clumsily in the trees along Kugaluktuk Creek, the next large tributary to the Kobuk above the village. I also saw one in August 1957 about 10 miles above Kobuk. They are familiar to the residents of Kobuk and evidently nest in the western arctic forest.

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***Strix nebulosa nebulosa* Forster**

The great gray owl is known by both Nunamiut and Kobuk people as a woodland resident with the same name and clearly described appearance. Indians at Old Crow, Yukon Territory, named an example, which one of them shot for us, and remarked upon its appearance, habits, and even its merit as food which distinguish it from the great-horned owls. The Old Crow Indian name, *nastok*, is one of the three Indian specific names among 91 which resemble Eskimo naming. (L. Irving, 1958b). Arctic people seem to have a special interest in collecting and recalling information about owls. The great gray owl had been mentioned earlier on the Kobuk only in rather vague comments by McLenegan (1889).

***Aegolius funereus* (Linnaeus)**

The boreal owl is also well described by Eskimos at Kobuk, although it had not been earlier reported there. This little owl is named and described alike by Nunamiut (L. Irving, 1953) and at Kobuk. Like the great gray owl, it usually keeps in thick timber, where it is not commonly seen, but I find that many people living in the arctic forests are likely to give clear details as to localities and circumstances in which owls have been seen and that they are usually precise in the descriptive comments by which they distinguish the species.

Family ALCEDINIDAE: Kingfishers

***Megaceryle alcyon caurina* (Grinnell)**

Sheldon gave me three names for kingfishers and showed his special liking for them by saying that he would not care to shoot one. Kingfishers have been noted by all ornithologists on the Kobuk. I have seen them there and on the Alatna and upper Koyukuk Rivers. The Nunamiut have heard of them from their forest-dwelling neighbors, but I could find no sign that kingfishers had been seen north of the large forested rivers.

Family PICIDAE: Woodpeckers, Wrynecks

***Colaptes auratus borealis* Ridgway**

The yellow-shafted flicker, reported only by McLenegan (1889) on the upper Kobuk, was unmistakably described and named by Sheldon who reported it frequently heard in the spring of 1954. When I reported seeing a flicker at Anaktuvuk to the Eskimos there, they were surprised at its appearance on the tundra for they had only heard it described by neighbors living on the wooded Koyukuk.

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Kobuk must be about the northwestern limit of the flicker's range, but apparently it regularly nests there.

Dendrocopos villosos (Linnaeus)

From illustrations and descriptions, Sheldon considered the large, northern hairy woodpecker to be a resident bird at Kobuk, but without giving it an explicit Kobuk name. Since I have no other evidence for the hairy woodpecker's occurrence in arctic Alaska it is not listed among the birds of the Kobuk.

Dendrocopos pubescens nelsoni (Oberholser)

Although downy woodpeckers were only designated by the general Eskimo name for woodpecker at Kobuk, they were well described by Sheldon. There are a few specimens from Anaktuvuk, and they evidently sparsely inhabit the northwestern forested regions of Alaska.

Picoïdes arcticus (Swainson)

Because it had not been earlier reported from arctic Alaskan forests, Sheldon's description of the black-backed three-toed woodpecker caused me to question the correctness of our understanding until, to conclude the discussion, he sent me a correctly named skin for which Herbert Friedmann confirmed the identification.

Picoïdes tridactylus fasciatus (Baird)

With *P. arcticus* distinguished, it was clear that the ladder-backed three-toed woodpecker also was known at Kobuk. It had been identified from the Kobuk near Hunt River by Grinnell (1900) and from the northernmost forest just south of Anaktuvuk on the John River.

The ladder-backed three-toed woodpecker was the only one reported by Grinnell (1900) on the upper Kobuk, and McLenegan (1889) had reported seeing only a flicker and a downy woodpecker. Sheldon's accurate descriptions and specimen convince us that four species of woodpeckers are known by the Kobuk Eskimos, with uncertainty about the fifth, *D. villosus*. All are called *toyuk* by the interior Alaskan Eskimos. The Nunamiut distinguish a *toyuk* larger than *D. pubescens* as *toyukpuk*, and have provided specimens of *P. t. fasciatus* from the adjacent woodland for this name. At Kobuk, *toyuk* is applied to *D. pubescens*, *toyukpuk* to *P. arcticus* and *P. t. fasciatus*, which are nevertheless known as distinct forms, and the same name is given for another which they describe suitably for *D. villosus*. *C. auratus* is designated *toyushookruk*, meaning "beautiful" toyuk. Although Sheldon recognized four, possibly five, woodpeckers he gave only three modifications of a common name for them. It is surprising to find that

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people who have 18 explicit Eskimo names for their species of ducks and 15 Eskimo names for their 16 species of sandpipers (Irving, 1958a) are undiscriminating in nomenclature of woodpeckers, although they distinguish the species.

Family TYRANNIDAE: Tyrant Flycatchers

Say's phoebe (*Sayornis saya*) has not been reported in arctic Alaska west of the Killik Valley. It was not found on the Ahlasuruk (L. Irving and Paneak, 1954), nor has any flycatcher been reported in any account of the Kobuk.

Family ALAUDIDAE: Larks

Eremophila alpestris (Linnaeus)

The horned lark had not been reported earlier on the Kobuk, but it is familiar to the Eskimos and is named by Sheldon as by the Nunamiut, *Nakrulik*, meaning "horned." Horned larks are not woodland birds. In the Brooks Range they nest on open and usually dry elevations, away from the paths of observers on the main river. *E. a. articola* has been reported 80 miles north of Kobuk on the Ahlasuruk (L. Irving and Paneak, 1954) and larks nest in suitable mountain habitats near Kobuk.

Family HIRUNDINIDAE: Swallows

Iridoprocne bicolor (Vieillot)

Tree swallows now commonly occupy nest boxes and occasionally holes in the low buildings at Kobuk and villagers say they have become more common, or at least more familiar, since the practice of erecting nesting boxes was started. *Tachycineta thalassina*, violet-green swallows, which nest less commonly in the same places as tree swallows at Bettles, are not known at Kobuk.

Riparia riparia riparia (Linnaeus)

Bank swallows nest in many colonies along the river banks, and the people in the village remarked on the bird's skill in selecting suitable sandy banks unlikely to fall during the terrific erosion caused by the sudden and violent summer floods. Early in August 1957 a few were still on the Kobuk, the only swallows seen at that time.

Hirundo rustica Linnaeus

Barn swallows are known but are rare at Kobuk and are not now known to nest there.

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***Petrochelidon pyrrhonota* (Vieillot)**

Cliff swallows are not now familiar near the village, where the houses seem to be too low to be attractive for nesting. Cliff swallows at Bettles nest under the eaves of buildings with a second story. Eskimos at Kobuk know about their nests on cliffs and name them "mud swallows." Cantwell (1887) alone of earlier travelers reported seeing a great many nesting on the cliffs by the falls near the head of the Kobuk. The location of nests and probably the numbers of all but bank swallows have undoubtedly been much affected by the recent increase in numbers and size of buildings in northern Alaska.

For species of swallows which occur near the Nunamiut country and Kobuk there is an indistinction in the Eskimo nomenclature similar to that in their nomenclature for woodpeckers. Tree swallows (*I. bicolor*), bank swallows (*R. riparia*), and barn swallows (*H. rustica*) are known at Anaktuvuk by their occasional appearance. On visits to the Koyukuk, Simon Paneak promptly recognized cliff swallows (*Petrochelidon pyrrhonota*) and violet-green swallows (*Tachycineta thalassina*) as two forms new to him. But the Nunamiut have only one name, meaning "like a raven" for all swallows. The Kobuk people recognize four species of swallows but also give them only descriptive modifications of the single name.

It might be suggested that Eskimo names for the woodland woodpeckers and swallows are lacking because Eskimo nomenclature has developed during residence on the tundra. Their language seems not to have been expanded to fit such objects as the woodpeckers and swallows which are part of a woodland environment which few Eskimos know well. Nunamiut and Kobukmiut individuals are prompt to recognize distinct species of the woodpeckers and swallows which they see when they are away from their own environment, for in general new knowledge comes readily to the observant Eskimos, but new words evidently come slowly into their language.

Family PARIDAE: Titmice, Verdins, Bushtits

Sheldon was only sure in describing the black-capped chickadee (*Parus atricapillus*). Although the Nunamiut had collected specimens of Brown chickadees (*P. h. hudsonicus*) for me from the spruce timber along the John River and recognized them as differing from black-capped chickadees, they named the latter alone as "the chickadee." I have not yet seen *P. cinctus lathami*, but McLenegan (1889) and Grinnell (1900) have identified it at Kobuk. The absence of information about the forms of chickadees in both Kobukmiut and Nunamiut may result because only the black-capped chickadee is known as a tundra bird, where it is apparently part of the classical knowledge in the conservative Eskimo culture of the tundra.

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Family CINCLIDAE: Dippers

Cinclus mexicanus unicolor Bonaparte

The dipper was reported on the Kobuk by Grinnell (1900) from the unmistakable account of white trappers, for it is one of the few species of birds which white trappers and prospectors can describe well enough to demonstrate their explicit recognition. The Kobukmiut and Nunamiut know the dippers and their habits because in winter dippers frequent the open water of streams, places which the Eskimos observe as dangerous for travelers and which they watch for signs of fish. The two slightly differing Kobukmiut and Nunamiut names for dippers were translated for me as meaning "old woman sunk."

Family TURDIDAE: Thrushes, Solitaires, Bluebirds

Sheldon's report to me that olive-backed thrushes (*Hylocichla ustulata*) were distinguished from gray-cheeked thrushes at Kobuk, and nested there, is new. His description seemed to differentiate the bird and its nest from *H. minima*, but he had no explicit name, using that (*Beeauk*) which is also applied to *H. minima.* It would not be surprising to find *H. ustulata incana* at Kobuk for I have collected it at Bettles, 140 miles east in the same latitude, and at Old Crow. It seems probable to me that Sheldon's report from Kobuk will be confirmed, but I consider it as yet uncertain evidence for inclusion of olive-backed thrushes in the regular avifauna.

I have found the bluethroat (*Luscinia svecica*) once, at Ahlasuruk (L. Irving and Paneak, 1954), although I have searched for it in the Brooks Range. It has recently been found to be rather common in the Colville Valley (Kessel, Cade, Schaller, 1953). The interesting range of this small migrant to Alaska from Asia, thus far only found outside the tree line, prompts curiosity as to whether it enters the forested areas of Alaska. I have found no trace of Eskimo acquaintance with the very distinctive blue-throat, although it has now been reported to be rather common along the northern border of the country of the Kobuk people and probably occurs through much of the country formerly occupied by the Nunamiut.

Oenanthe oenanthe oenanthe (Linnaeus)

The wheatear is well known among Nunamiut and is apparently also a part of Kobuk natural history, with the same name in both places. While nesting, it is a shy bird of the rocky mountain sides in the central part of the Brooks Range, where I have found it from Anaktuvuk to the Ahlasuruk and in intervening valleys. Kobuk hunters for caribou and sheep know these areas, but they are not easy for a stranger to examine.

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Family SYLVIIDAE: Old World Warblers, Gnatcatchers, Kinglets

Phylloscopus borealis kennicotti (Baird)

Kennicott's willow warbler was designated by Paneak with an Eskimo name *Songakpalutungik*, meaning small bird the color of bile, and he recognized it when I first showed him a specimen. Since Sheldon applied the same name to a specimen identified as *Dendroica petechia amnicola*, his recognition of both species is questionable. Paneak considered the name *Songakpalutungik* explicit for *P. borealis*, which greatly outnumbered the not so common *D. petechia* and *W. pusilla* in our experience at Anaktuvuk. We found willow warblers common on the Ahlasuruk (L. Irving and Paneak, 1954), and Townsend (1887) and Grinnell (1900) identified them along the wooded part of the Kobuk. Although they are now widely known from the arctic tundra, Grinnell's report from Kobuk seems to give the only identification of willow warblers in the arctic Alaskan woodland.

Regulus calendula calendula (Linnaeus)

When naming ruby-crowned kinglets, Sheldon spoke of their presence in winter at Kobuk. Eskimos at Anaktuvuk have reported kinglets there in winter, and an Indian at Old Crow, Yukon Territory, told me it was a winter bird there. The few dates when specimens have been taken on the arctic coast were in the early and late winter (Bailey, 1948). Although I think that the information of the native people is correct, confirmation is needed before designating kinglets as resident during winter in the arctic forest.

Family MOTACILLIDAE: Wagtails and Pipits

Motacilla flava Linnaeus

Although yellow wagtails have now been frequently collected north of timber in the Brooks Range and on the arctic slope, no previous reports have shown them on the wooded part of the Kobuk River. On the arctic tundra wagtails are found about patches of willow brush on marshy ground. Sheldon reported that wagtails were found in such situations near Kobuk. The bird is so distinct and well known to Alaskan Eskimos that Sheldon's statement is evidence for its occurrence near Kobuk.

Family PARULIDAE: Wood Warblers

Among the six species of Parulidae reported by previous observers on the Kobuk, only the myrtle warbler was explicitly named by Sheldon in Kobukmiut. The yellow warbler and pileolated warbler are common near Kobuk, but in our discussion I did not establish their

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recognition as explicit kinds. At Anaktuvuk, where specimens of *D. petechia amnicola*, *D. coronata hooveri*, and *W. pusillus pileolata* have been obtained, no explicit Nunamiut names were found for them.

An ornithologist may realize that because of his interest or experience, he is alert in the field to recognize species in some taxonomic groups and slow in others. Personal and cultural experience develops and may also suppress acuity of observation, which is much influenced by the preparedness of the observing mind. The small warblers are, to be sure, unobtrusive, but they are easily distinguishable in arctic Alaska. In one year, Grinnell identified six species near Kobuk, and during one week in August I saw five, while Sheldon, a native resident, scarcely seemed to distinguish three of these birds which had surrounded him during his lifetime, and he knew a Kobukmiut name which was explicit for only one of the six species. By way of contrast, Sheldon described and named 15 species of sandpipers, many of them not obvious; whereas, so observant an ornithologist as Grinnell listed only 11 sandpipers.

Family FRINGILLIDAE: Grosbeaks, Finches, Sparrows, Buntings

Among the Fringillidae, Sheldon, like Simon Paneak at Anaktuvuk, had a name for only one redpoll. Distinguishing the species of redpolls requires criteria developed in the museum rather than in the field. Grinnell (1900) did not report gray-crowned rosy finches (*L. tephrocotis*) which Sheldon described and named like the Nunamiut, probably because even more than *Oenanthe* it keeps above tree line in the mountain country that is occasionally searched for caribou and sheep by the Kobuk and Nunamiut hunters. Grinnell identified golden-crowned sparrows (*Z. atricapilla*), which Sheldon named, but which apparently do not range north of the forests in arctic Alaska. Except for this form and the crossbill, the arctic Alaskan Fringillidae are equally birds of the tundra and of the bordering forest country.

Plectrophenax nivalis nivalis (Linnaeus)

A few snow buntings are seen in winter at Kobuk, where small groups occasionally remain for several days about the village. Snow buntings wintering in southern and western Alaska are geographically far separated from those wintering in the Mackenzie Valley, but their differentiation in form has, so far as I know, only been proposed by Salomonsen (1947, 1950).

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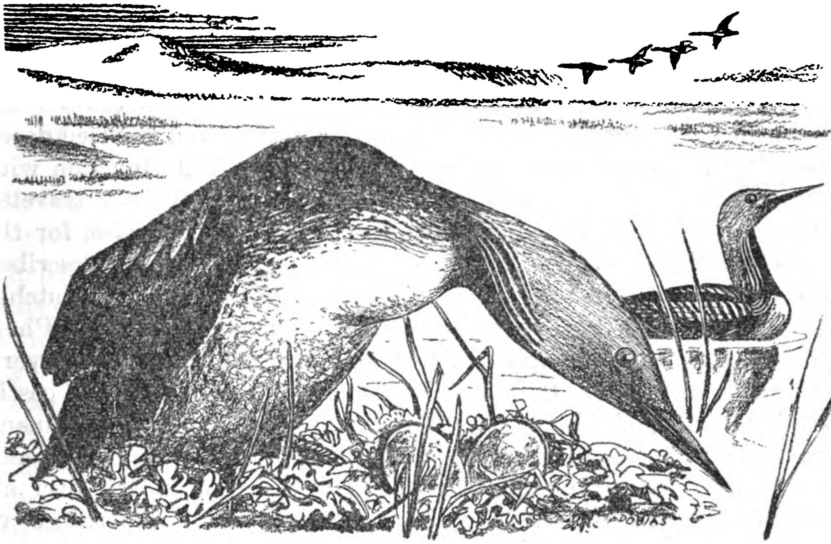

ARCTIC LOON *Gavia arctica pacifica* (see pp. 31, 158).

4. Old Crow

THE GAP IN OUR INFORMATION about the geographical distribution of life in the northern interior of Yukon Territory has been especially significant because there we could expect to find a transition from the specialized fauna of Alaska to the more generalized American fauna of the Mackenzie Valley, representing the central part of the American continent.

The Terrain

The Porcupine River extends the Alaskan Yukon Valley eastward across Yukon Territory to within 50 miles of the Mackenzie River and the arctic coast of Canada (see maps, figs. 1 and 7). Passes through the British and Richardson Mountains from Old Crow River Valley to the arctic coast are numerous and shorter and lower than the passes through the Alaskan part of the Brooks Range. Macdougall Pass through the Richardson Mountains, leading from the eastern tributaries of the Porcupine to the Mackenzie watershed, is shorter and, with an elevation of 1,200 feet, lower than any pass through the

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western mountains of America. The Porcupine Valley thus forms the eastern 250 miles of a corridor extending over thirty degrees of longitude from the Bering and western arctic coasts nearly to the central arctic coast and the great interior valley of North America.

The Porcupine River provided the first route for Canadian commerce between the Mackenzie Valley and interior Alaska. After having established Fort McPherson in 1840 John Bell crossed the Richardson Mountains in 1844 with Indian guides and traveled down Bell River to the Porcupine and southwestward to its junction with the Yukon (Osgood, 1936). In 1847 Alexander Murray traveled the same course to establish Fort Yukon as a trading post for the Hudson's Bay Company, and in his journal (1910) vividly described the Kutchin people, the animals, and the country. Related Kutchin tribes lived on the Peel River, where they traded with Fort MacPherson, and on the Porcupine, upper Yukon, and Chandalar Rivers, where Murray sought their furs in exchange for the scarce and costly trade goods which his company had transported across the continent. Sir John Richardson, one of the earliest biologists (1829) to evidence his understanding of the geographical distribution of life over all northern North America, quickly recognized the importance of Murray's location by soliciting from him information about the migrations of birds. Murray's reply, which Sir John quotes (1852), provides in brief and vivid expressions the first recorded information of the great spring migration of birds passing the upper Yukon and lower Porcupine Valleys.

Travel along the Porcupine was then easier than through the mountains by way of the Liard to the headwaters of the Yukon. In the early times the Kutchin people were better disposed toward the white fur traders than were the Indians near the head of the Yukon River, where the Chilkoot Tlingit, with the intention of reserving the area for their own trade, destroyed the early Fort Selkirk. Above the junction of the Bell River with the Porcupine, Lapierre House was established on the west side of MacDougall Pass as an intermediate station between Fort Yukon and Fort MacPherson. There Robert Kennicott visited briefly in 1860, 1861, and 1862 (Preble, 1908). In September Kennicott traveled down the Porcupine to stay at Fort Yukon until the summer of 1861. From his inspiring influence upon the educated employees of the Hudson's Bay Company there developed that interest for natural history which produced collections upon which most of our early knowledge of northern Mackenzie depends. One of these, B. R. Ross (1861 and 1862), then in charge of the Mackenzie district, was first to report observations on birds in northern interior Yukon from Lapierre House, and he also gathered an extensive collection. By 1900 steam transportation on the Yukon and traffic over

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White Pass had concluded the usefulness of the Porcupine route for transport and it has remained unused except by the resident Indians and an occasional traveler. In 1926 Olaus Murie visited Old Crow in summer and banded some birds, and Otto Geist traveled along the Old Crow and Porcupine Rivers in 1954 and 1955 surveying the region for fossils. Otherwise there is no record of biological attention to the Porcupine, although the river provides an easy course for travel.

Physiography and Climate

At Old Crow the Porcupine River is about 350 yards wide between cut banks about 15 feet high. Its current is swift but there are no falls along its length, and for a light boat it is an excellent waterway. At the ramparts along the Alaska Yukon border the Porcupine has cut a gorge through the highlands between the Ogilvie Mountains and the Brooks Range. Above the ramparts the river meanders through a valley between bluffs about 100 feet high and from two to five miles apart. At Old Crow the river has commonly cut from ten to twenty feet below the level of its valley plain through layers of fine dark sandy soil on top underlain with gravel, but sand and gravel layers have been much intermixed by the floods and meandering of the river. On this more or less flat valley white spruce is common, often mixed with birch and some poplar. In wetter parts willow and alder often form dense thickets. The valley between the bluffs looks like a flood plain of the present river, which in fact now floods much of its area in spring.

The bluffs north of the village are of a fine grained soil like loess into which the present flood plain has been cut. In places the bluffs are overgrown and in others still bare and eroding. A fragrant sage is one of the plants which settles upon the slopes even before they cease to slide. The bluffs are cut by steep ravines. Half a mile north of the bluffs the land rises to about 300 feet above the village, which is at an elevation of about 900 feet. Beyond this point a gentle rise, with black spruce gradually replacing the white, continues for about two miles to an altitude of about 1,600 feet, where the spruce forest gives way to a half-mile-wide ascending band of willow and alder, beyond which is reached the tundra at the foot of the Old Crow Mountains. These rise abruptly to about 3,300 feet on their southern side, with some steep slopes and slides of the sedimentary rocks of which they are formed.

To the northwestward the Old Crow Mountains are detached from the Brooks Range by several low, wooded valleys. Forests also extend along the Old Crow River to the northern margin of Crow Flats,

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but the tree line is low (1,600 feet) and the forest rather marginal along the Old Crow.

At the relatively low elevations of the headwater valleys north of Old Crow occasional spruce extends to the headwaters of the Firth River, flowing toward the arctic sea. This is about the northernmost occurrence of timber in America. The broad valley east of Old Crow River and north of the Porcupine is occupied by many lakes in Crow Flats, which occupy a depression among the mountains in arctic Yukon east of the high peaks of the Brooks Range in northeastern Alaska. From Crow Flats, however, only little drainage passes through Old Crow River after the spring flood, for the annual precipitation is evidently small. Between the Yukon arctic coast and Crow Flats the narrow Range of the Richardson Mountains extends the Brooks Range eastward along the arctic coast and continues southward along the Yukon-Mackenzie border.

The Porcupine River which rises in the northern watershed of the Ogilvie Mountains and runs 150 miles northeasterly before changing its course westward near the mouth of Bell River, has its southeastern headwaters not far from those of Peel River. On the map, the passage of the Peel through the southern Richardson Mountains appears to provide a valley route at low elevation by which birds might enter the upper Porcupine Valley from the Mackenzie, while southward and southwesterly the Ogilvie Range interposes what looks like a barrier of high and extensive mountains separating the upper Porcupine Valley from the upper sources of the Yukon. The route to northern Yukon Territory which seems to be open for birds migrating at low elevations from the Alaskan part of the Yukon Valley extends northeasterly along the Porcupine. The Porcupine Valley in Yukon lies north of the Rocky Mountains in some isolation by surrounding ranges through which, however, it provides lowland connection between the interior valley of Alaska and the Mackenzie Valley.

Warm weather comes to Old Crow a few weeks later than to Fort Yukon and summer is colder. About June 25, 8 inches of snow brought toboggans into use at Old Crow for two days. Since frost usually occurs in every summer month there is little chance for gardens. The summer weather at Old Crow is more severe than at Bettles, but is probably not quite so cool as Anaktuvuk. Old Crow is evidently just within the western arctic region where the close spacing of isothermal lines (see fig. 2) shows the rapid northward cooling of summer temperatures.

Of special interest in regard to the present geographical distribution of life in Alaska and Yukon is the history of the recent glaciation, which has left many clear marks, and the related climatic history, which is less obvious. In Wisconsin times Cordilleran ice (Flint,

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1947) diminished in thickness north of about latitude 54° and probably did not reach the Porcupine Valley. Massive though probably not continuous glaciers occupied valleys of the Brooks Range, but much of the Yukon Porcupine Valley system was free from continuous ice, as was also the arctic slope of Alaska. Thus northern Alaska and Yukon, while not covered with ice were cut off from habitable America by ice which apparently reached the sea west of the mouth of the Mackenzie and along the Pacific shores of Alaska.

We can speculate that hardy birds like those now resident in the Arctic might have survived the last glacial maximum in arctic Yukon. There is no doubt that the invasion of migratory birds has occurred since their paths from the south have become free from ice. The 10,000 years since the last maximum of glaciation have had fluctuations in climate and in the attendant condition of the land surfaces. If migrations have been long in operation the birds must have had a remarkably varying experience in their migratory routes. Not only have the climatic conditions changed but the changes in populations accompanying the opening and closing of great areas must have exerted powerful and changing social influences. Through this period of change, however, the essential features of the Rocky Mountains and Brooks Range have continuously maintained a northern Yukon and Alaska geographically and climatically distinct from the adjacent regions. At present we have then the maximal duration of time of development of modern migrations, which passed through areas of great climatic and biotic change and which are now established in a geographically distinguishable area.

Modern Indians seldom pass into the barren coastal mountains of Yukon Territory, the traditional barrier and boundary between them and the Eskimo people with whom they have long had hostile, or at best unfriendly, relations. There has probably been some exchange of material culture but the distinction between Indian and Eskimo ways is striking for neighboring people in similar climates. Among names of birds, for example, Indian and Eskimo names for about 90 species known by both people show resemblance in only three cases (Irving, 1958b), and I think that this instance about represents their general resemblance in respect to intellectual culture. Even in material culture it is surprising to see that their few natural resources have been used in many cases with such differing implement and fashions, and judging from what I have heard from them the blood of the two races has seldom mixed (Lewis, Chown, and Hildes in 1959 reported that blood samples taken in 1958 from most of the Indian population of Old Crow showed no serological evidence for intermixture with Eskimos).

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The Indians at Old Crow

At Old Crow about 170 Indians form the only village now in the territory of the Vanta Kutchin (Osgood, 1936; Leechman, 1954). The nearest settlements are Fort MacPherson, Herschel Island, and Fort Yukon, about 140 miles east, north, and southwest, respectively. Southward about 300 miles are the settlements on the upper tributaries of the Yukon. Old Crow had only three cabins and a store when Neil McDonald came there in 1913 but many of the residents are probably derived from the Vanta Kutchin of the Porcupine Valley, who were once more numerous. Long geographically isolated, their old people were nevertheless great travelers, the Porcupine being an ancient trade route between the Yukon and the Mackenzie. In winter now some of them travel great distances to hunt or trap, and to work or visit at MacPherson and Fort Yukon. Recently the prices of fur have been so low that little beside muskrats is taken, but although their price is cheap the numbers taken in spring on Crow Flats provide the principal cash support of the village.

The present chief, Charlie Abel, was elected in spring of 1958 to succeed Charlie Peter Charlie, who had been elected in 1953. The two former chiefs, each served for more than ten years, Peter Moses from about 1940–1953 and Joe Kay from about 1925–1940. All have demonstrated the high quality of strong leadership which seems to have been common among these Indian people. In addition a detachment of two Royal Canadian Mounted Police Constables administers law with the skill and wise concern for the people for which that force is noted. An Anglican preacher operates the church to which practically every villager belongs. A recently established Roman Catholic Mission has not acquired an Indian following.

Disturbed only by a monthly mail plane from Fort Yukon, and under the wise and strong guidance of their chief, the police, and the preacher, the community seems to be a well ordered and a more coherent body than most Eskimo villages, in which the regulatory power of the council is small and where families join to make a village on a very informal basis of sociable inclination. For sustenance, some fish are obtained in spring, but the caribou which cross the Porcupine in spring and fall migrations provide the principal source of natural food. For many years the caribou had usually been available, but in the autumn of 1957 their migration passed so far west of Old Crow that shortage of dog food reduced the range of hunting and prevented preparation for trapping in the next spring season. The people rose to this serious situation with increasing exertions at hunting but they were severely handicapped by the reduction of their radius of operation through the impairment of canine transportation.

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The people are strong travelers, good hunters, and lively companions. As they learned of our interest in birds they told us their observations and brought us many specimens. Without their help and advice we could have obtained little information. With their aid our survey shows the status of the birds in their country. Living and working with the Old Crow people has been pleasant and profitable for biologists.

From former chief Joe Kay I obtained Indian names for 99 of the 107 species which we now identify in the avifauna of Old Crow (Irving, 1958b). He wrote them for me in the orthography devised by Archdeacon McDonald (1911) for an Indian version of the Book of Common Prayer and Bible. Most of Joe Kay's identifications were from specimens, but some were made by reference to illustrations or descriptions of appearance and habits. I did not meet another Indian with such command of nomenclature. Furthermore, Joe Kay in any company was an exceptional man for his remarkable strength and ability. At about 75 years of age his wisdom and social understanding were impressive to us and respected by his own people.

He remarked that even among the older people few could recognize and name all birds. I believe that the names he gave me were true designations in his language, and yet I marvel that an unwritten language could persist in so small a community where only a few individuals can have such intelligence and learning as is required to preserve the comprehensive and accurate Indian knowledge of their natural environment. It is also revealing to find among the Indians and Eskimos who socially dominate their fellows by physical strength and skill the possession of such intellectual attainment as is illustrated by perfect recognition and naming of birds. Here, in a small community living among primitive conditions, we see how refined an intelligence can be developed, for the cultivation of such knowledge as deals with small birds demonstrates mental exertion for the pure love of knowledge.

Progress of the Investigation

Leonard Peyton and I reached Old Crow on April 2, 1957. We were kindly received and lodged for our first night by Constable P. A. Robin. The next day we obtained from Albert Abel the use of his cabin. To store our gear would require more shelves than he had. When I asked if we might build some shelves, I remarked that perhaps their absence from his cabin showed some special reason preventing their construction and observed that perhaps he would not want them. He simply replied that he had not needed shelves because he had nothing to put on them.

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Within a few days we engaged Robert Bruce to guide and help us in hunting and he proved to be a strong and clever hunter and a pleasant companion. His decision to work with us required some study, for he had planned to leave with his family for the spring period of hunting muskrats on Crow Flats. He did not enjoy the prospect of separation from his wife and children and the busy life in the muskrat-hunting camp which all the people so much enjoy. Within a few weeks every family in the village had left for their camps except a few who were too aged or ill, and in spite of his cheerful nature Bruce was often unhappy for his absent family. Edith Josie who helped us at skinning birds was usually smiling or laughing and soon acquired skill in the preparation of skins.

Leonard Peyton took over the arduous care of our collection of specimens so that I might be more free for hunting and observing. Usually I went with Robert Bruce, but Peyton also seized many occasions for hunting. His careful preparation of our supplies and equipment, diligent administration of their use, and attention to the collections and records were a basis for the success of our expedition.

During April the weather was generally cold, with prevalent northeasterly winds. On the river the snow was firm enough for travel on skis or snowshoes or with dogs and toboggan. Where the trails led through woods and up hills the slewing of the toboggans on the curves made the snow rough for travel. Occasional westerly winds brought warm chinook weather and melting conditions.

In May the sun was warmer and melting periods became more frequent. We were able to travel by dog team on the river until May 6, when we met elderly Paul Joseph returning from Fort MacPherson as weary as his dogs. Thereafter the overflow on the river increased, although until May 16 we could still cross by wading through the overflow, or during a temporary freeze. Then the ice began to erode rapidly, and after showers in the night of May 22 the water began to rise, lifting the ice from its attachment to the shores, and the floes began to move steadily during the day. During the next few days the water rose about 15 feet, nearly to the top of the cut banks, and the ice floes varied in concentration as they came in from various tributaries. In June some days were hot and mosquitos too common, but manageable by the use of spray and repellent. Brooks and swamps filled, making it difficult to walk.

On May 10, Francis Williamson joined us for a month collecting mammals. His keenness in recognizing birds by their calls enabled him greatly to extend our information. On May 28 Sidney Peyton, Leonard's father and an experienced collector of birds' eggs, and Webb McElvey joined us. The latter was a taxidermist collecting for W. J. Sheffler of Los Angeles, whose specimens we were very kindly per-

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mitted to study and report upon as our own. On June 4 Robert Whaley flew in from Anchorage bringing Mary C. Lobban, a physiologist from Cambridge, England, to make studies of the daily cycle of urinary excretion among the resident people during the long arctic days. For sleeping quarters and a laboratory, we utilized the old church, now deconsecrated.

Under Leonard Peyton's careful supervision 361 bird skins were prepared and have been deposited in the U. S. National Museum. Webb McElvey prepared 90 bird skins for the collection of W. J. Sheffler. Sidney Peyton, recorded the nesting of about 25 species of birds and collected 35 examples of nests and eggs, which are now in his collection. The nesting data are used in this report. Frank Williamson obtained 66 specimens of 16 species of mammals upon which he will report. Leonard Peyton and Frank Williamson collected a number of fishes which they have sent for identification. Mary Lobban's report on the cycles of urinary excretion and the daily rhythms will appear in physiological publications. A number of hearts of newly arrived and settled migratory birds and of resident birds were preserved and sent to George Burch, professor of medicine at Tulane University, for a determination of whether the migration to the arctic and the sudden transition there to sedentary habits has caused signs of stress to appear in their coronary structures.

The collaboration of these colleagues, with their wide range of observations and variety of viewpoints, has been most productive, and I am deeply grateful for the companionship in which we enjoyed together, as spring progressed, the view of the country and its rapidly changing biological phenomena.

The Birds of Old Crow

Family GAVIIDAE: Loons

Gavia immer (Brünnich)

Common loons were identified by sight and occasionally by call. The first certain identifications were made on May 28, when several single birds, pairs, and groups of four were seen in the evening flying directly up the Porcupine. After two groups had been noticed over the village a few others were observed to arrive from the west and pass beyond sight eastward. Other common loons were occasionally noticed at the end of May, apparently in migratory flight from west passing eastward. Judging from the direction of apparent migratory flight of the common loons, they come from a population wintering on the west coast.

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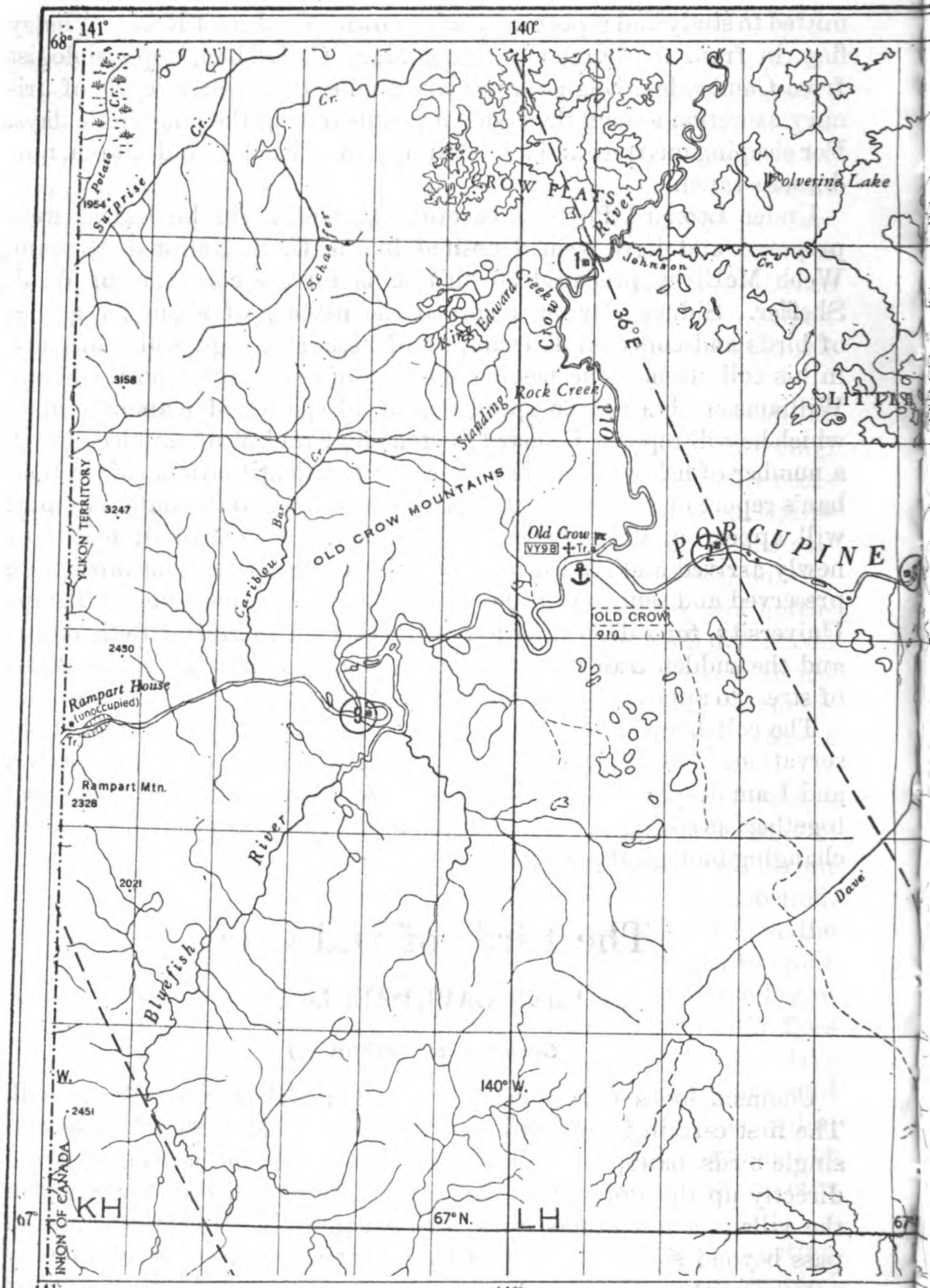
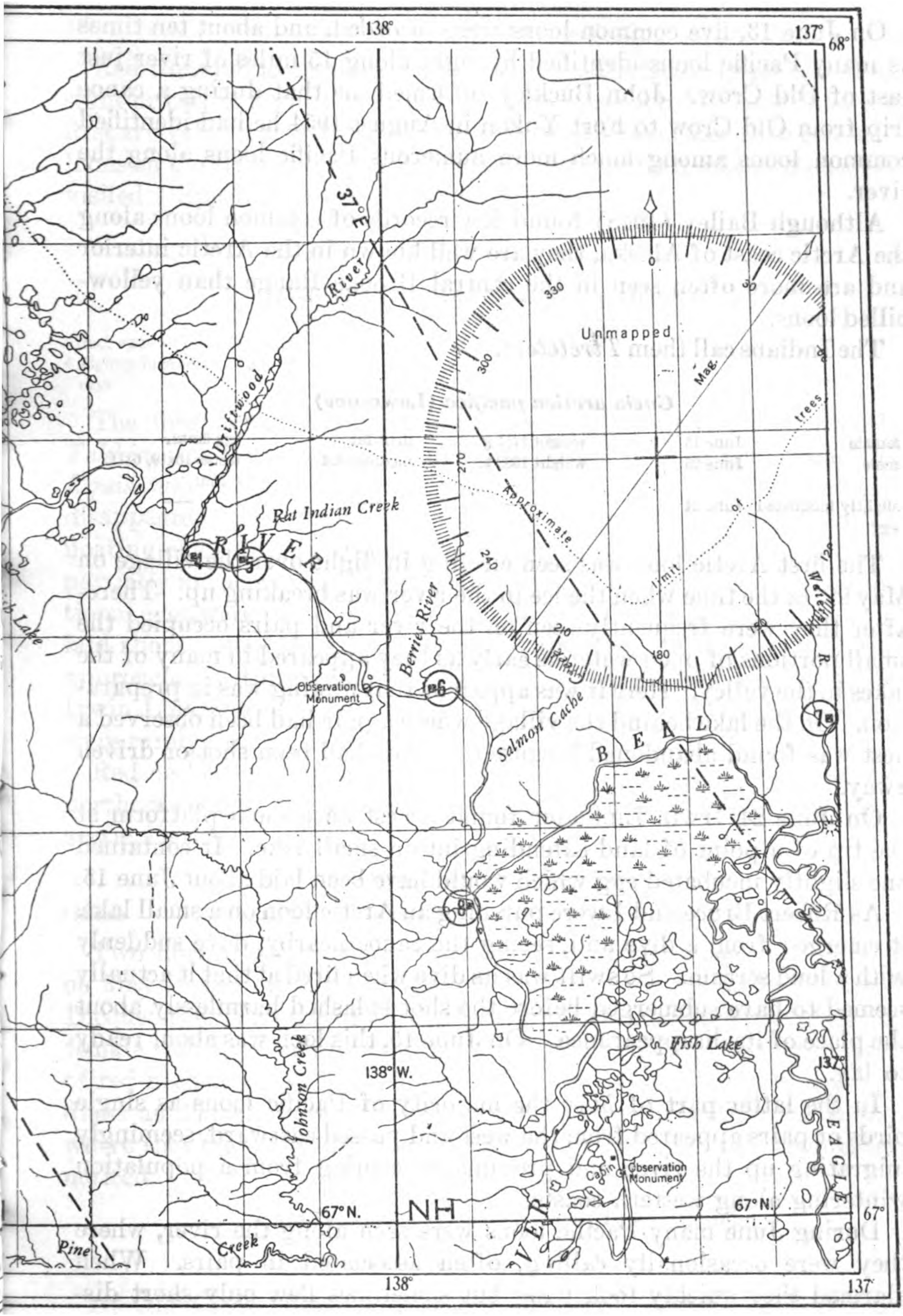


FIGURE 7.—Porcupine Valley in the vicinity of Old Crow. (From Canadian Dept. Mines a



Nat. Topogr. Ser., sheets 116 NW and 116 NE, 1945 (aeronaut. ed., 1955), scale 1:506,880.)

On June 13, five common loons were recorded, and about ten times as many Pacific loons identified by sight along 15 miles of river just east of Old Crow. John Buckley informed me that during a canoe trip from Old Crow to Fort Yukon in August 1954 he had identified common loons among much more numerous Pacific loons along the river.

Although Bailey (1948) found few records of common loons along the Arctic coast of Alaska, they are well known in the Arctic interior and are more often seen in the central Brooks Range than yellow-billed loons.

The Indians call them *Ttretetere.*

***Gavia arctica pacifica* (Lawrence)**

1 female	June 15	weight 1751 g.	little fat	egg 6mm.
1 male	June 25	weight 1882 g.	medium fat	testes 10x19, 6x11 mm.
1 slightly incubated egg	June 24	—	—	—

The first Arctic loon was seen circling in flight over the village on May 22, at the time when the ice in the river was breaking up. Thereafter they were frequently seen on the river and pairs occupied the small portions of open water as early as they appeared in many of the lakes in the valley. Here it was apparent that nesting was in preparation. On the lake behind the village where a pair had been observed a nest was found abandoned because the birds had been shot or driven away.

On June 24 Irwin Linklater found a nest on a moss platform at the tip of a point of land extending into a small lake. It contained one slightly incubated egg which would have been laid about June 15.

As Robert Bruce and I were pursuing an Arctic loon on a small lake, it emerged from a dive and, seeing the canoe nearby, dove suddenly with a loud scream. So swift was its dive when fired at that it actually seemed to have submerged before the shot splashed harmlessly about the place of its disappearance. On June 15, this loon was about ready to lay.

In the latter part of May the majority of Pacific loons as single birds or pairs appeared from the west and passed eastward, seemingly migrating up the river and presumably coming from a population wintering along western coasts.

During June many Pacific loons were seen along the river, where they were occasionally calling, often associated in pairs. When alarmed they quickly took wing but sometimes flew only short distances as if attached to the area. It was not apparent whether they nested along the river, but they occupied many lakes.

The Indians name the Arctic loon *Thulvit.*

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Gavia stellata (Pontoppidan)

Red-throated loons were not recorded as satisfactorily identified by sight or call in flight until June 2, which was probably later than the first arrivals. These loons were less frequently identified than common loons on the river and none were noticed on the small lakes which were visited. Speciments were obtained in 1958.

Family PODICIPEDIDAE: Grebes

Podiceps grisegena holböllii Reinhardt

5 fresh eggs	June 15	—	—	—
4 slightly incubated eggs	June 23	—	—	—

The first evidence of red-necked grebes, which the Indians call *Tekkin*, was the distant sight of the head and neck of one among the *Equisetum* at the margin of a small lake on June 13. The bird had disappeared when the spot was reached, but a nest was found on the floating clods of mud from a muskrat push up, with three eggs lying partially in the water. The eggs felt warm. Two days later two additional eggs were found in the nest, so that the first eggs must have been laid about June 11. The other parent was seen, but neither could be approached within a quarter of a mile. A second nest was found by Irwin Linklater at a similar site in another lake. Red-necked grebes were rarely seen on the river and those which were seen were shy.

Red-necked and horned grebes have now been reported near the northern border of the forest at Old Crow and in central and western arctic Alaska.

Podiceps auritus cornutus Gmelin

1 female	May 19	365 g.	very fat	egg 4 mm.

Two horned grebes were watched on the slough near the village on May 19 and on the same day one was collected for us by Philippe Dicquemare. The size of the egg which it contained suggested that the female was approaching readiness to lay at a date earlier than eggs of red-necked grebes were found. Horned grebes, known by the Indians as *Notsik*, were occasionally seen along the Porcupine River, where they were less shy than red-necked grebes and more frequently noticed.

Family ANATIDAE: Swans, Geese, Ducks

Olor columbianus (Ord)

At Old Crow village Father Mouchet reported that he had seen a swan flying up the river on June 3. Peter Lord and other local residents knew swans well and said that they had not seen many near the village and only a few on Crow Flats, where no groups larger

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than six were recalled. Ben Charlie and Freddie Frost reported that they saw two swan's nests containing five eggs each at Crow Flats this season. Joe Kay gave the Indian name of the swan as *Tarui*, and the stories related to me showed it to have a regular place in Indian tales concerning natural history.

Richardson (1852, p. 304) cites a letter written to him by Alexander Murray, who established Fort Yukon, in which occurs an interesting reference to swans in the course of a vivid description of the migrations of birds in spring at Fort Yukon: "Of the two kinds of swan only the largest sort are seen here; they pass on to the northward of the Porcupine River to breed in the lakes there." After Murray's reference to swans, Richardson wrote in "*Cygnus buccinator*." The observer and his reporter command such attention for the accuracy of their observations that we must believe that in about 1847 trumpeter swans migrated to the Porcupine. Dall and Bannister (1869) reported that Lockhart had found a set of trumpeter swan's eggs near Fort Yukon. It is to be hoped that it may turn out that trumpeter swans still migrate to the Porcupine. This hope is encouraged by the recent discovery of trumpeter swans nesting on the Copper River (Monson, 1956) and accumulating evidence that a fair number nest on the Kenai Peninsula.

***Branta canadensis taverneri* Delacour**

1 female	June 6	weight 1741 g.	little fat	6 ruptured follicles (brood patch)
1 female	June 19	weight 2219 g.	little fat	egg, 5 mm.

Canada geese were first seen May 6. Until May 11 a few groups of two or four birds each were seen. During this period about 30 geese were recorded. Most of those noticed on the wing were looking about as if interested in landing. A number of them alighted on the ice of the river, where their sleeping postures and the accumulation of droppings showed that they rested for some hours before leaving. Some of the Canada geese seen in this first period were flying from the east but the direction was not certainly established. By their inclination to rest they seemed to be arriving from a long flight. There was rarely a sound from them.

From May 11 to May 18 single birds, twos, and groups of four and six occasionally passed, sometimes honking. They now often appeared flying from the west along the Porcupine River, but their flight was less decisive of direction than in the first few days, and they often circled the village and swerved to the howls of dogs and calls of men. The river was only melted in superficial pools which froze at night, so that it could be regularly crossed afoot until May 16. Although brooks were now running, no lakes were open, the snow cover was con-

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tinuous, and only a few mud and gravel banks were exposed. We could not see a source of food available to the Canada geese which passed during the first ten days nor did we get any indication that they fed nearby.

On May 18, three days before the ice began to run in the Porcupine, the first large flock of 20 Canada geese was noticed flying eastward in a V and honking. From that date until June 1 occasional flocks formed in V's were seen, with considerable unorganized traffic. The formed flocks were only noticed flying eastward. Two Canada geese were seen flying in formation with a V of nine snow geese, and this mixture was seen again. This association seems to indicate the western origin of these Canada geese.

Two additional specimens were taken in 1958.

On June 3 and 4 two pairs of Canada geese appeared as if settled on the river bars near Kenneth Nukon's cabin. Francis Williamson reported that Canada geese were settled along the river in numbers increasing eastward from Nukon's cabin to Driftwood River and Indians reported that in summer geese are most concentrated along the eastern Porcupine and lower Bell River. Williamson collected the first female specimen near Driftwood River, where it had evidently begun to lay about June 1.

On June 13 a few separate pairs were seen near Kenneth Nukon's cabin. A flock of nine which included several birds without the adult sharpness of the black-and-white pattern on the head were feeding in a flock which included some mature appearing birds. As they flew away honking, two others joined them.

On June 17 a bird was wounded out of a flock of 12 which had landed on the muddy bank of the slough near the village. Two days later Robert Bruce collected it alone in a lake across the river. It was a female with eggs 5 mm. long but showing no indication of having laid.

Peter Lord reported the arrival of geese at Crow Flats on May 7, one day after the first sight of them at the village, a schedule suggesting that they came in the same migratory movement which first brought geese to the village. But at Johnson Creek, a tributary entering the upper Porcupine about 80 miles south by east from Old Crow, Lazarus Charlie reported the arrival of geese on April 30, eight days before they were seen at Old Crow. This discontinuity of schedule suggests that either migration is markedly retarded in that area, or that Johnson Creek is on a different migratory route. The arrival at Johnson Creek was slightly later than the dates reported in earlier years at Frances Lake and Sheldon Lake, about 300 miles further south by east from Old Crow (Rand, 1946). Murray's old report (Richardson, 1852, p. 304) places the arrival of geese at Fort

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Yukon near the time of arrival at Johnson Creek and suggests that different populations provide the first arrivals at Old Crow and Fort Yukon.

We have assembled four specimens of Canada geese from Anaktuvuk with Delacour and Zimmer (1951) ascribed to the range of *B. c. taverneri*, and also two specimens collected on Colville River by Cade and Schaller. The latter were on their breeding ground and the former were migrants collected while 150 miles south of Colville. We have also a specimen taken by Hughes and Chamberlain at College, Alaska, May 7 with largest ova 22 mm. The two specimens from Old Crow conform with the seven from central northern Alaska and differ from four specimens regarded as *B. c. parvipes*, taken in May near Lake Athabasca, Alberta, and one from the site of Old Fort Good Hope on Mackenzie River. Their measurements are shown in table 3.

TABLE 3.—*Dimensions of* Branta canadensis parvipes *and* Branta canadensis taverneri

Date	Sex	Locality	Measurements of culmen (mm.)				Testis or egg (mm.)	Weight (g.)
			Wing	Nail	Length	Depth		
		PARVIPES						
May 26	♂	Lake Athabasca	411	12	40	20		
May 26	♀	Lake Athabasca	409	12.5	36	18		
Jun 28	♂	Old Fort Good Hope	432	13	42	22		
Jul 3	♂	Athabasca Delta	420	13	45	21.5		
Oct 5	♂	Lake Athabasca	410	12.5	43	21		
		TAVERNERI						
May 7	♀	College	389	12	37	20	22	2688
May 18	♂	Anaktuvuk	422	11.5	33	22	6	
May 18	♀	Anaktuvuk	400	13	35	19	22	
May 19	♂	Anaktuvuk	405	12	35	20	22	2551
May 20	♀	Anaktuvuk	373	11	36.5	19		
Jun 6	♀	Old Crow	390	11	39(?)	19(?)	[1] 6	1741
Jun 10	♀	Colville	394	9	31	19.5	9	2250
Jun 19	♀	Old Crow	412	11	39	21.5	5	2219
Jun 20	♀	Colville	387	10	30	18.5	6	2250

[1] Laid.

The geese listed as *taverneri* have the small nail and short bill characterized by Delacour. Since the bill is as deep at the base as that of the longer billed geese, the angle formed by the top and bottom of the mandible is relatively steep. The breast of *taverneri* is generally darker, forming a sharper contrast with the white belly. The back of *taverneri* is darker. It is especially dark at the transition from

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neck to back, where the darkness of *taverneri* is a well marked distinction from the four birds called *parvipes*.

Several specimens in the U. S. National Museum, collected by Olaus Murie in 1926 along the Old Crow River, are regarded as *Taverneri*.

It appears that the specimens of geese of north central Alaska and Old Crow can be included and distinguished as *taverneri*. Except for the specimen from College, Alaska, which on May 7 was probably in migration, these specimens are in the breeding range ascribed to them by Delacour. One of the geese from Old Crow was a nesting bird, and Kessel and Cade (1958) obtained downy young on the Colville. In addition we have obtained six immature specimens from the Koyukuk and Alatna Rivers, where family groups were observed, and one male in breeding condition from Kobuk. These specimens appear to have the characters of *taverneri* and occupy the breeding range ascribed to *taverneri* by Delacour.

Bailey (1948) distinguished under *leucopareia* a dusky goose nesting in Arctic Alaska west of Barrow, inland from the coastal range of the very small *minima*, and approaching the coast east of Barrow. The measurements resemble those later ascribed to *taverneri* and are less than those of the northern interior geese which would be in the range ascribed to *parvipes* (A. O. U., Check-list, 1957). Bailey also pointed out the dusky character of the arctic Alaskan geese, which is matched by our specimens.

Our two specimens from Old Crow do not establish that the small-billed dusky goose is the only form nesting and migrating along the Porcupine. Mary Lobban reported that she saw a small goose calling in a manner only ascribed to *minima*.

During migration we gained the impression that Canada geese were traveling eastward and westward although a greater number were headed eastward.

The Indian name for the goose is *Kyha*.

Branta nigricans (Lawrence)

Only one flock of about 60 brant was noticed flying swiftly eastward close to the Porcupine River on May 25. They are, however, well known to the local Indians. As late may migrants they are seen passing eastward along the Porcupine at Old Crow, and more often on a northerly and northeasterly course over Crow Flats. Cade (1955) collected reports, mostly from older records, showing that numerous and large flights of brant late in May pass through the interior of Alaska. In part the brant pass Old Crow after coming up the Porcupine, apparently from Alaska. None are known to summer on the Porcupine and Old Crow Rivers (Murray, in Richardson, 1852, p. 304), but there are numerous summer settlements of black brant on the

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islands off the Mackenzie Delta (Porsild, 1943), and for a short distance eastward along the Arctic coast (Snyder, 1957).

At about the time when black brant were named from a specimen taken at Egg Harbor, N. J. (Lawrence, 1846), Alexander Murray, the venturesome and observant founder of the Hudson's Bay Company Post at Fort Yukon wrote to Sir John Richardson (1852, p. 304), "there are also black geese which I presume you have never seen," and gave a description which by Sir John's comment "applies pretty well to the brent goose." Murray added that the "black geese" breed only on the shores of the arctic sea.

Preble (1908, p. 308) wrote, "though keeping strictly to the seacoast east of the Mackenzie during migration, many of the flocks (probably all of the eastward breeding birds) strike across Alaska from near the mouth of the Mackenzie to the North Pacific." The Indians remarked that brant were not seen near Old Crow on their return, and, in agreement with Cade's (1955) survey, I have not been able to obtain reports on the return of brant across interior Alaska. Since Murray observed that white and black geese returned in September and October flying high, Preble's view of an overland return from the Mackenzie is confirmed. Murray also observed that a few black brant "pass down Peel's River," and the Porcupine may not be the only overland course by which the western black brant pass from the Pacific coast to the Mackenzie Delta and eastward.

The Indian name for the brant is *Ttsun tratesit.*

Anser albifrons frontalis (Baird)

We did not distinguish many or large flocks of white-fronted geese migrating through Old Crow, but those we saw were flying eastward. The first flock of seven was seen on May 16. Reports of the Indians, who call this bird *Techyo*, indicate that some white-fronted geese nest around the lakes on Crow Flats, but we did not get certain information as to whether they nest along the Porcupine.

In 1867–8 Dall (Dall and Bannister, 1869) found white-fronted geese arriving at Nulato about May 6–10. In 1849 Murray wrote to Sir John Richardson (1852, p. 305) that they arrived at Fort Yukon from April 27 to 29 and nested on the lakes "north of the Porcupine" where they are "more numerous than any other kind; and the number that pass northward there are perhaps equal to that of all the other species together." White-fronted geese are still numerous in migration at Anaktuvuk and Kobuk about May 15. Rand (1946) reports the banding of one by Olaus Murie at Old Crow as the only record in Yukon Territory south of the arctic coast. From these reports and our rather few observations it seems that the spring migration of white-fronted geese along the Porcupine River represents the east-

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ward extension of the population which migrates northward along the coast of British Columbia and "much less commonly in the interior" (Munro and Cowan, 1947).

***Chen hyperborea hyperborea* (Pallas)**

The first flock of nine snow geese, seen on May 20 included in its V formation two Canada geese. This association of two species of geese is often seen in arctic Alaska. Only a few flocks of snow geese were recorded at Old Crow, all in V formation and flying steadily eastward. It is reported by Indians that snow geese, which they call *Kookeh*, occasionally land on Crow Flats, where they are more often noticed than at Old Crow. Peter Lord reported that he first saw snow geese on the Flats on May 16, but that they always pass northward and do not remain in summer. The size of the flocks of snow geese and the numbers sighted vary from year to year at Anaktuvuk and from reports of the Indians, a similar variation appears to occur at Old Crow.

Dall (Dall and Bannister, 1869) found snow geese common in spring at Nulato, where they arrived on May 9 flying up the river. Rand (1946) gives no reports on snow geese in southern Yukon, and Swarth (1936) saw only three at Atlin—two on May 5, 1932, and one on May 5, 1934. It seems likely that the eastward flight at Old Crow brought snow geese from the Pacific Coast. Those which we saw were flying rather low and their numbers would not make a substantial contribution to the numbers nesting from the Mackenzie eastward. But since these geese often fly high over mountains we may have missed seeing most of the migration.

At Fort Yukon, wrote Murray to Richardson (1852, p. 305), the snow geese arrive about May 15 or 16 and "breed only on the shores of the Arctic Sea. They return in September and early October, flying high and seldom halting."

Subfamilies ANATINAE and AYTHINAE: Ducks

Of the 14 species of ducks at Old Crow, two have holarctic nesting areas, two are not quite so widely distributed in the Arctic, and 10 are restricted in arctic nesting to Alaska, Yukon and Mackenzie. East of central Mackenzie the northern border of nesting by these species extends southeasterly to the southwestern shore of Hudson Bay about parallel to but usually somewhat north of the forest. The northern limit also runs about parallel to the steeply declining isothermal gradient of summer temperatures which marks the extension of summer warmth far northward in western North America. East of the Mackenzie River the physiographic features also change, for

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eastern Mackenzie and Keewatin, which extend over the Barren Grounds and the pre-Cambrian shield, are not mountainous, in contrast with the rugged terrain of Yukon and Alaska. There are thus changes in the general climatic, geological, and vegetational conditions to correspond with the northern limit of nesting.

Among 28 migratory species of North American ducks only three are now divided into races (A. O. U., Check-list, 1957): the blue-winged teal, with an Atlantic race of separate range; the common eider, in which the maritime nesting range of the species is easily separable into separate ranges for each race; and the white-winged scoter, the races of which winter in widely separated maritime ranges on either side of the continent.

White-winged scoters and the five other species of ducks most common in migration at Old Crow showed the trend of their flights to be eastward along the Porcupine in spring. On account of their western wintering location, goldeneyes (*Bucephala*) are also suspected of migrating eastward. About 100 miles east of Old Crow the Richardson Mountains bound Mackenzie and Yukon, but they are low and provided with short passes between the easternmost marshes of the Porcupine Valley and the western marshes of the Mackenzie Valley. The eastward trend of migratory ducks on the Porcupine appears strong enough to lead them to contact with or even to intermingling with, the populations migrating and nesting in the northern Mackenzie Valley.

In addition to the six species observed and one estimated to migrate eastward to make contact with the ducks nesting in Mackenzie, lesser scaups nest so numerously along Porcupine Valley that their breeding area is continuous from Alaska to Mackenzie. Greater scaups were not recorded from southern Yukon (Rand, 1946), and we are not sure of their abundance along the Porcupine Valley. But some are there in summer and the Alaskan breeding birds are connected with the Mackenzie nesting ground by at least a scattered nesting population in a narrow band through northern interior Yukon. Barrow's goldeneyes are now known from all over Yukon south of the Arctic coast, but American goldeneyes, like greater scaups, appear to form the connection between Alaska and Mackenzie only in the north along Porcupine Valley.

All the observed trends in migration of ducks at Old Crow were eastward, and on grounds of propinquity the Alaska and northern Yukon nesting ducks are suspected of arriving in spring from the western parts of their wintering grounds. Spring migration and nesting appear to separate, although not to isolate the far northwestern population genetically so as to form geographic races. Only two species of ducks are acceptably differentiated as races and therefore,

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presumably, genetically distinct, the others apparently containing inheritance mixed from many localities by the wandering of individuals during the time before and after nesting.

Anas platyrhynchos platyrhynchos **Linnaeus**

1 male	May 19	weight 1063 g.	fat	testes 18 x 48 ,23 x 50 mm.
1 male	summer	—	medium fat	—
1 female	summer	—	medium fat	—

Mallards were first reported at Old Crow by Stephen Frost, who saw a flock of ten land early in the morning of May 8 just across the river in one of the few grassy sloughs of water then open. A small female mallard was shot that morning on the ice of the river, where it had alighted with two pintails. During the next week singles, pairs, and small flocks were often seen. Some flew intently eastward, but more circled as they flew up the river and searched for any of the few small pools of water in which to land. Occasionally landing on ice, they chose water more often than the pintails, which seemed to have no aversion for ice. At first the mallards were often with pintails, and later both mingled freely with widgeons.

In the first week of migration practically all of what little water lay on the ground was underlain with ice, and on several days of cold there were no unfrozen pools. During this week we saw no signs that food was available for ducks. Occasionally mallards, like pintails, settled to stand resting on the ice or to float on pools over the ice. The birds which alighted seemed ready to rest, but several that were examined were fat.

The trend of migratory flights of mallards at Old Crow was up the Porcupine River. During the first two or three days mallards were almost half as numerous as pintails. Since they were not in well organized flocks the arriving mallards gave an impression of being nearer to the end of their migration than the better organized flocks of pintails. After the first week the numbers of other migrating ducks continued to increase, but the main migration of mallards was over.

Evidently the mallards at Old Crow are not so near the end of their migration as at Anaktuvuk, where scarcely any but singles, and pairs are seen. The numbers of mallards observed passing Old Crow did not seem sufficient to populate the eastern and southern areas of Porcupine Valley.

On May 19 singles and pairs were flying locally and during the next week males were often seen flying in pursuit of loudly quacking females. On June 7 a nest was found with three eggs, the first estimated to have been laid on June 5. At that date a female mallard might occasionally be seen swimming on the lakes.

The Indian name for the mallard is *Natakcho.*

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***Anas acuta* Linnaeus**

Pintails were the earliest of the ducks to be seen, arriving on May 7. They were first noticed in the morning flying up the Porcupine River in small bands. Most of the early arrivals that morning seemed to be searching for a landing place. They landed readily on the ice or near shallow pools on the ice and sat quietly resting or sleeping. There was apparently no place attractive for feeding and so the early flights only stopped for a rest before continuing on in a generally eastward movement. The next day the largest flock of pintails noticed during the early season contained 30 birds, but for the first week most flocks appeared rather casually assembled and often included mallards. The number of individual ducks and small detached groups gave the impression that they were looking for a nearby location in which to settle, but the places open were too few and too rapidly changing in the alternate thawing and freezing of the overflow on the river. In these groups of pintails the proportions of adult males, females, and young varied. Often an adult male was the most wary and the first to lead the group on the wing.

On May 17 the flights appeared to increase in size and orderliness of formation. One well organized flock of 80 contained only pintails and flew directly eastward. After a few days this more intensive migration seemed to subside and there was more association with groups of mallards and widgeons. Pairs were occasionally observed about May 30, but migrating flocks of 20 or 30 pintails continued to be seen after the mallards and most flocks of widgeons had separated.

The flights of pintails past Old Crow seemed to be numerous and well organized enough to account for more than the summer population, which is rather scattered along Porcupine River. This suggests that the Porcupine River is an important route for the entry from Alaska of many pintails, some of which pass on to the arctic coast and Mackenzie Delta. The early arrivals (May 10, 1934, at Kittigazuit) reported by Porsild (1943), could be these early pintails passing through Old Crow and bent upon an easterly course.

The Indians call this duck *Chinchityo* and *Nakostikyi.*

***Anas carolinensis* Gmelin**

1 male	May 17	weight 307 g.	fat	testes 12x29, 12x27 mm.
1 male	June 15	weight 286 g.	little fat	testes 12x31, 16x29 mm.

The first green-winged teal noticed were a pair seen on May 17. For a week singles and pairs were common and males were soon following in flight after calling females and in small ponds teal were

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persistently splashing as they quarreled. After May 24 an occasional female was seen swimming alone in marshy pools as if settled there for nesting, but on June 1 two pursuit flights were seen to indicate that courting continued. On June 15 about a dozen males were peacefully scattered on a small lake, no longer disturbed to jealousy by impulses of sex, although the testes of a specimen had not regressed in size. There were no females in view and the males flew away as if unattached to the locality.

The combative nature of male teal is illustrated in an Indian story. Once Swan declared himself, as the largest of the birds, their chief. In order to make his position understood he called all birds to appear before him and defeated each species in combat. At last only Teal had not entered the contest, or demonstration, and when he was summoned he appeared with a bandage stained with old blood over his head and said that he was not in fit condition to fight. As Swan in sisted that Teal, like every other bird, must take his turn, with apparent reluctance Teal said that if he must fight he would do his best. In a short struggle Teal knocked Swan to the ground. Swan claimed he had not been honestly beaten and attacked again. This time Teal threw Swan down and only released him after he had admitted defeat.

Teal nest in Arctic Alaska, Yukon, and Mackenzie. In Alaska they nest north of tree line at Anaktuvuk, but they are rare on the Arctic coast (Bailey, 1948).

The Indian name is *Tarui kaka.*

Mareca americana (Gmelin)

American widgeons were first identified by one of a pair that was shot on May 17. Some probably arrived earlier, but the early migratory flight contained mainly pintails and mallards. From May 17 to 19 some flocks contained 20 or 30 widgeons; other flocks mingled widgeons, mallards, and pintails in various proportions. Many of these flocks of mingled species appeared from the west, settled temporarily and flew eastward as if organized for migrations together. Other groupings of mingled species were formed when scattered ducks accumulated by alighting at a favored or already occupied resting place. Individuals or groups seemed to detach themselves readily from these associations. All the mixed flocks seen after about May 20 were apparently loose and temporary associations. As with the pintails, flocks containing only widgeons were better synchronized in action and usually held to decided easterly course.

The first established pair was noticed on May 30, and many were seen after that date along the river, but there was no time during June when small flocks might not be seen. The number estimated to

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be settled in the Valley, mostly seen along the river, was slightly less than the number of scaup. The obviously migrating widgeons were estimated as much fewer than the migrating flights of pintails and white-winged scoters.

Porsild (1943) reported widgeons as "perhaps the most common duck in the Mackenzie Delta." They nest commonly across Arctic Yukon, but not on the Arctic coast (Rand, 1946), and across interior Arctic Alaska. The Indians know them as *Kaloree.*

Spatula clypeata (Linnaeus)

Shovelers were recognized by the Indians from illustrations, and Joe Kay described the duck and named it *Tetrik.* Its description was also recognized by several other Indians, who usually see shovelers in summer on the lakes of Crow Flats. They are known to Eskimos and Indians across arctic Alaska and Yukon, but rather by their unusual appearance than for commonness. According to Porsild (1943) the Eskimos said that shovelers nested in the Mackenzie Delta, and Indians reported them nesting on Crow Flats.

Aythya marila nearctica (Stejneger)

1 male	June 13	weight 917 g.	medium fat	testes 11x31, 12x29 mm.

Although a number of the scaup seen were thought to be *A. marila* only the specimen taken was identified satisfactorily by sight. Since its testes were only about as large as those of teal, they were probably less than breeding size, but the date was late enough for some regression to have occurred. Joe Kay recognized the specimen and distinguished it by name as *Tani cho.* We believe that greater scaup are regularly present in summer and probably nest along Porcupine River, but that they are uncommon in comparison with lesser scaup.

Porsild (1943) reported the greater scaup an "infrequent summer resident and no doubt breeding" in the Mackenzie Delta. Rand (1946) reported only one specimen from Yukon taken by Nelson at Fort Reliance, and referred to Swarth's (1927) opinion that a few sight records from southern Yukon should not be accepted as distinguishing *marila* from *affinis.* Greater scaup are probably not one tenth as frequent at Old Crow as lesser scaup, but the proportion at Anaktuvuk is about reversed. Judging from the few reports of greater scaup in southern Yukon and on the arctic coast, the Porcupine is the important arctic connection between the large Alaskan and Mackenzie Valley nesting populations.

During September 1958, of about 25 scaup shot and examined at Old Crow only one was *A. marila*, the others were *affinis.*

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Aythya affinis (Eyton)

1 male	May 22	weight 640 g.	medium fat	testes 8x21, 9x18 mm.
1 female	May 22	weight 613 g.	little fat	—
8 slightly incubated eggs	June 28	—	—	—

On May 18 the male of a pair of scaup near the village was identified as *A. affinis* by its purple head, but some seen a few days earlier were thought also to be lesser scaup. Occasionally scaup alighted in pools with mingled species of ducks, but they did not join with other species in organized flights. In the few days just before breakup occasional small flocks and many individuals and pairs of scaup were seen. Only a few individuals could be positively identified as lesser scaup and the directional trend of their flights was not determined. By the time of breakup several pairs of lesser scaup had been identified by sight among the considerable number of pairs seen in the partially open water of small lakes. The two specimens were flying together when they were obtained for us by Father Mouchet. The testes of the male specimen were only the size of a teal's and were probably immature.

Scaup were seen paired about as early as were mallards and teal, but the pairs of scaup remained longer evident as they swam on the lakes, while pairs of mallards and teal did not long appear together. On June 13 the last demonstration of pairing appeared when a male lesser scaup rushed away from a female to attack a surf scoter which had been shot nearby. On June 15 there were about ten male lesser scaup scattered about on a lake with no females in view and the males flew about singly as if not attached to a particular locality. The reformation of flocks of male scaup was not noticed during June.

On June 28, 1957, Irwin Linklater found eggs in a nest on top of a moss and willow hummock 50 feet from the shore of a small lake. Estimating about three days of incubation, the first egg was laid on June 18.

As evidence for late nesting of scaups, of a group of 4 flightless young scaup 2 which were shot on September 2, 1958 had only pinfeather primaries and were about half the adult weight.

Although Rand (1946) had found reports on lesser scaup only from southern Yukon it is evident that the Mackenzie and Alaskan birds are connected by continuous nesting across Yukon as far north as Porcupine.

The Indian name is *Nityitin.*

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***Bucephala clangula americana* (Bonaparte)**

1 male June 13 weight 1024 g. fat testes 11x18, 9x13 mm.

The single specimen of American goldeneye was shot from a flock of 25 flying over the river. The testes appeared to be less than breeding size. During the hour about the time when the specimen was obtained a flock of this same size was observed three times as we traveled along the river and we suspected that these were sights of the same flock. In it we distinguished male birds to form the majority, but we could not determine that there were no females. In our records a pair of goldeneyes was reported on the lake back of the village and three were reported seen on the river on June 14.

Because of our unfamiliarity with goldeneyes and their reported rarity in Yukon (Rand, 1946) we were at first reluctant to accept reports by Indians that they had seen goldeneyes. Robert Bruce recognized the specimen when it was taken and Joe Kay named it with an explicit Indian name, *Tovi.* Indians had spoken of seeing goldeneyes at least as early as May 21 and we had been informed that goldeneyes were rather common on Crow Flats.

We were also reluctant to accept reports of the presence of goldeneyes because we rarely found in the extensive forest the dead mature trees which could provide holes for nesting. This was in part because dead spruce are harvested for fuel along traveled routes, but even away from lines of travel mature trees do not appear to stand long after they die.

Only one other report of an American goldeneye comes from Yukon, a specimen from Forty Mile described by Grinnell (1909), but Swarth (1936) found them regularly in small numbers at Atlin, B. C. Nelson (1887) remarked upon Dall's (Dall and Bannister, 1869) finding American goldeneyes wintering on the Aleutians and passing along the middle Yukon among the earliest migrants. It was the first duck killed at Nulato, on May 3, 1868. According to these migratory schedules the goldeneyes on Yukon came from the western wintering grounds. Those on the Porcupine River might also have come from the west. American goldeneyes are common in summer on the Mackenzie Delta and have been reported first arriving on the Peel Branch on May 20, 1934 (Porsild, 1943). Preble (1908) reported American goldeneyes first seen at Fort Simpson on April 26, and there are many records of them in that part of the Mackenzie Valley, from which also migration to Porcupine Valley appears an open possibility. Past failure of our observations to distinguish the abundance and migratory course of the two species of goldeneyes caused us to miss valuable evidence bearing upon geographical distribution.

In September 1958 we identified several American goldeneyes which had been shot, and thought that some of the numerous migrating

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flocks were also of this species, but examples of Barrow's goldeneye were more numerous in hunters' bags and in flocks identified by sight.

***Bucephala islandica* (Gmelin)**

1 male	June 14	weight 914 g.	medium fat	—

Philippe Dicquemare kindly provided us with the specimen of Barrow's goldeneye, listed above. Joe Kay distinguished it from the specimen of American goldeneye, and named it differently, *Tesitet kyi.* The testes had been destroyed by shot, but it was in breeding plumage. Kay's familiarity with the two species indicates that both are known on the Porcupine. Rand (1946) reported Barrow's goldeneye as a fairly common summer resident in southern Yukon. Kessel, Murie, and Schaller, in an unpublished survey of the birds of the Sheenjek River, reported a sighting of Barrow's goldeneye on the Sheenjek River in 1956, probably the northernmost record in western America.

***Clangula hyemalis* (Linnaeus)**

Oldsquaws were not seen until just as the ice began to move in the river on May 22. On May 23, Father Mouchet and Philippe Dicquemare provided us with two males and a female which had been shot while together. During the next week small flocks were frequently seen flying eastward over the river. Usually the flocks of oldsquaws were not high and flew purposively, like the migrating scoters, and unlike the frequently deviating courses of migrating flights of pintails, mallards, and widgeons. Individuals and pairs of oldsquaws were often seen during late May on the lakes and river.

On June 4 there was much crying and maneuvering among several male oldsquaws attending females on a small lake. Males which intruded upon the pairs were vigorously repelled. During their noisy courtship the males lost their caution and allowed close approach by land or canoe. The preoccupation of both sexes with mating made them the least wary of the ducks. Until June 15 oldsquaws on the lakes demonstrated little concern for anything but breeding. During the following week several small flocks of oldsquaws were noticed along the river.

A comparison of the density of the local summer population of oldsquaws near Old Crow with the intensity of eastward migration suggests that the migratory flights would not much more than provide the Porcupine and Old Crow Valleys with their summer population. Rand (1946) mentions no observation of oldsquaws in Yukon south of the Arctic coast, so the migration through Old Crow cannot have traversed southern Yukon and probably came from the Alaskan Yukon Valley. Since oldsquaws are said by Dall and Bannister (1869) to be

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rare along the Yukon, it is to be suspected that they cross the Alaska Range from the Gulf toward the upper Yukon and Porcupine.

The onomatopeic Eskimo name for oldsquaw is close to the Indian name, *Ahaluk*. It and the name for great gray owl are the only two in which I can find resemblances between Old Crow Indian and Kobuk (forest-dwelling) Eskimo names for 90 species of birds known in both areas.

Histrionicus histrionicus **(Linnaeus)**

1 male	May 29	weight 582 g.	very fat	testes 11x21.5, 9x14.5 mm.

We are indebted to Philippe Dicquemare for bringing us the harlequin he shot on the river near the village. It was our only sight of this duck, but Joe Kay, who named it *Tsi tut kwilik*, said it was familiar to him in summer on the mountain streams. The testes were approaching breeding size.

In length of wing, depth of bill, and length of tarsus we could see no distinction between western and wintering harlequins. The four specimens from Anaktuvuk and one from Old Crow cannot be assigned to a racial division.

Melanitta deglandi **(Bonaparte)**

1 male	June 1	weight 1564 g.	very fat	testes 8x17, 8x18 mm.
1 male	June 14	weight 1649 g.	medium fat	testes 11x26, 12x30 mm.
1 male	——	weight 1663 g.	medium fat	testes 10x20, 9x25 mm.

The earliest white-winged scoters were seen on May 20. In the next 10 days more flocks were seen each day. During this period none were recorded as containing more than 30 scoters and they often included a minority of surf scoters. These flocks regularly appeared from the west and flew steadily eastward, usually 30 or 40 yards above the river, in rather compact and little changing order. The main migration of scoters was later than those of pintails, mallards, and widgeon. Migrating flights of white-winged scoters were even steadier on course than flights of oldsquaws.

Until June 15 flocks of from 10 to 30 white-winged scoters were not uncommon, but no trend in the direction of their flights could be seen after June 5. On June 3 I watched several groups of six or eight scoters, mostly white-winged as they floated down river for about a mile with the current and then flew upstream to repeat the course. Pacific loons and an occasional red-throated loon floated nearby without apparent interspecific interest.

On June 15 males and females appeared associated in pairs. The

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female usually dove on the splashing approach of the male, who followed her under water. Each female remained in one part of the lake and we did not observe them to go on shore, but the males occasionally left the area. Among the three male specimens, the late increase in size of testes was consistent with the late manifestation of breeding activities.

The Indians, who call this duck *Nya*, say that male white-winged scoters thrash about noisily in furious combat on the brushy shores, at which time they are heedless of the approach of a man or canoe. In this state the males seem to be more preoccupied by combativeness than male oldsquaws. Although male teal are regarded as redoubtable fighters during the mating period they and most ducks only reduce but do not abandon their alertness for other dangers.

White-winged scoters are conspicuous because of their size and because they remain in the open waters until their late nesting date. There may be little difference in the numbers of white-winged scoters, widgeon, and scaup nesting along the Porcupine, but the scoters are more easily seen, and during their prolonged migratory passage the steady succession of flights must account for the passage of an enormous number toward the east and northeast. It would be difficult to speculate upon whether these flights past Old Crow importantly contribute to the summer populations of Mackenzie, but they appear to be at least sufficient to occupy the Porcupine Valley as far east as Richardson Mountains.

Swarth (1936) remarked upon the sudden arrival from the coast of large numbers of white-winged scoters at Carcross May 24–26. If that date is typical of their first arrival, those reaching Old Crow before that date did not migrate through Carcross. I have seen scoters during migration through the upper part of the Copper River Valley, which is still south of the Alaska Range, but have found no reports confirming the overland course from the Gulf of Alaska which would bring them into the upper Yukon Valley. The regularity of their flights up Porcupine River indicates that scoters reach arctic Yukon from the population which winters along the Alaskan coast.

White-winged scoters seem to be the only species of migratory ducks distinguished into eastern and western races (A. O. U. Check-list, 1957). Brooks (1915) named the western race *dixoni* because he found them to have shorter and broader bills. During the breeding season the bills of scoters become more highly colored and the softer parts, in the males, at least, seem to swell. When dry the bills of scoters warp, and it is then difficult to compare their shape. We

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have made the following measurement of length of bills with some reservation as to their significance as dimensions:

	Eastern race	*Length (mm.)*		*Western race*	*Length (mm.)*
Mar. 7	Woods Hole	44	May 8	St. George Island	43.5
Mar. 7	Woods Hole	40	May 22	Nushagak	38
July 3	Athabaska Delta	36	June 1	Old Crow	42
Aug. 3	Rupert House	36	June 11	Tuluak	36
Dec. 9	New York	40	June 14	Tuluak	37
			June 14	Old Crow	40
(aver.)		39	June 14	Old Crow	41.5
			June 14	Old Crow	41
			July 20	Alloknagik Lake	41
			(aver.)		40

The length of bill does not distinguish these eastern and western specimens.

It may be remarked that the type specimen was taken at Humphrey Point, Alaska, where scoters are rare. As far as I know, scoters do not nest along the arctic coast in Alaska (Bailey, 1948), in Yukon (Rand, 1946), or in the Mackenzie Delta (Porsild, 1943). The type specimen was taken from the northern limit of its range and not from a nesting area. Distinction of an eastern and western race would imply some isolating process in the habits of white-winged scoters in contrast with the apparent intermingling within other species of ducks at some time of year, a condition which prevents localization of genetic forms.

These scoters cannot be distinguished on their breeding grounds as a western race, although I believe that they have migrated from a western wintering population. If this view is correct, and the two wintering populations are genetically alike they must mingle after breeding and before nesting. Since they preserve their geographical separation in winter and apparently during their spring migration to arctic Yukon, it is to be suspected that in summer, perhaps after nesting, enough scoters exchange their western or eastern wintering habits to maintain a genetically mixed population.

Melanitta perspicillata (Linnaeus)

1 male	June 13	weight 983 g.	fat	testes 11x24, 9x25 mm.

Surf scoters were first remarked mingled in a flock of white-winged scoters on May 20. Although they were usually in the minority of mixed flocks of scoters, one flock contained only one white-winged scoter among nine surf scoters. Scoters were not noticed in association with ducks of other species, and flocks containing only one species

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of scoter became more frequent after the first few days. In a week the two species appeared quite segregated.

The subsequent segregation of two species which seemed to be promiscuously associated during early migration may be related to the earlier appearance of mating behavior among surf scoters, for the pursuit behavior of males on June 5 was intense, but the mating pursuits of white-winged scoters were not so intense until a week later. As sexual ripeness develops, the different synchronization of its processes in each species intensifies intraspecific bonds and in the Arctic must practically preclude miscegenation.

The surf scoters in summer near Old Crow were estimated to be not half so numerous as white-winged scoters, but their total seemed to be only about a quarter that of the migrating scoters. It may be presumed, as suspected for white-winged scoters, that the eastward migration of surf scoters past Old Crow about suffices to occupy the Porcupine and Old Crow Valley, and that the two species of scoters come by a common route from a western wintering place.

Indians at Old Crow esteem white-winged scoters as food but dislike surf scoters, which they call *Tetre la.*

Dall (Dall and Bannister, 1869) did not remark upon surf scoters at Nulato, but Swarth (1936) described them as "fairly common" migrants at Atlin, B. C., where they were first seen May 8, 1931, and May 11–24, 1934. From this we suspect that their spring flight passes through the mountains in that region from the Gulf of Alaska to the upper Yukon, but that a coastal route extending further westward may serve western Alaska.

The two maritime wintering areas of surf scoters are separated by the continent, although stragglers have been found in many interior points. Since eastern and western winter specimens are not distinguished it may be presumed that there is no isolation to effect genetic distinction. The spring arrival at Old Crow appeared to be so consistently from the west that the mingling of the birds raised in various localities evidently occurs later in summer.

Mergus serrator serrator Linnaeus

1 male	May 22	weight 1157 g.	very fat	testes 19x42, 19x50 mm.

Red-breasted mergansers, which reach Anaktuvuk in pairs, nest northward to the arctic coast of Alaska and Yukon, as far north as pintails in those regions. Unlike the pintails, which approach their nesting ground with flocks just disintegrating, the mergansers, highly gregarious in winter, complete the separation into pairs before they approach their nesting grounds.

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The first red-breasted mergansers were seen May 20 at Old Crow. Some were single birds but most traveled by twos, male and female. As a result of this relation of breeding to migration, the spring course of migration could not be estimated nor could we compare the relation between migrating and nesting numbers.

The testes of the merganser and mallard had reached the largest size of any observed among ducks, indicating early maturity for breeding, and a common basis for their early pairing.

In September Francis Williamson saw large flocks of mergansers on the Porcupine. The trend of their flights was westward. Because of this observation it is to be suspected that mergansers migrate to Old Crow from the large population wintering on the western coast.

The Indian name is *Ttrah.*

Family ACCIPITRIDAE: Hawks, Harriers

A view of the dates of arrival of migrating hawks which prey upon birds show that they precede the arrival of any appreciable migration of their prey. This suggests that they are not attracted to the Arctic solely by the abundance of migrating birds, whose schedule they anticipate.

Accipiter gentilis (Linnaeus)

On two occasions we thought a goshawk was recognized in a brief view while flying among the tops of the spruces. Joe Kay provided the name, *Tzi choh*, and an appropriate description after studying illustrations of hawks. Since Olaus Murie in 1926 (Rand, 1946) banded young goshawks on the Old Crow River, their nesting in the area is established.

Accipiter striatus Vieillot

A report of a sharp-shinned hawk on May 8 is regarded as uncertain, but several times later one was recorded as seen flying through the tree tops near the edge of the bluff back of the village. On June 3 one was clearly viewed as it was slowed down in carrying a mouse across the slough near Kenneth Nukon's cabin. A specimen was obtained in September 1958.

The Indian name is *Chul rut tsit.*

Buteo lagopus (Pontopiddan)

The earliest rough-legged hawk was seen circling high over Old Crow Point on April 18. On April 29 two were seen several times along Old Crow River near the cliff about 8 miles north of the village, and an old nest there on June 10 was found occupied by a young rough-leg about a week old. A few duck wings were in the nest and

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at a nearby perch were feathers and rabbit fur. During the last few years Robert Bruce had seen the adults, but not the young perched on this nest when he was returning down river from Crow Flats at the end of the trapping season, just after the middle of June. Many people in the village were familiar with this nest.

Between May 2 and 5, six rough-legs were recorded flying over Porcupine River as we traveled with dog team to Dave Lord Creek and back. We thought that several were migrating and that their common direction was northward, but Ben Charlie, son of the former chief, was of the opinion that most rough-legged hawks arrived in April and were already settled before May.

The Indian name is *Chut rhui chun tsik*.

Aquila chrysaëtos canadensis (Linnaeus)

Joe Bryant of the Canadian Wildlife Service at Aklavik reported seeing a golden eagle about April 5 during a survey of muskrats at Crow Flats. While at Old Crow on April 20, Ben Charlie said that he had already seen a golden eagle on the Flats. The observations of our party record only one sight of a golden eagle, on May 16 flying eastward over Porcupine River. The mountainous areas we visited were restricted in extent and contained few ground squirrels. Consequently they were unfit for golden eagles. More suitable areas would be found in the high mountains, where Kessel, Murie, and Schaller (Unpubl. Ms.) reported golden eagles along the upper part of Sheenjek River.

The Indian name is *Chittese*.

Haliaeetus leucocephalus alascanus Townsend

On May 18 a bald eagle was soaring high above Porcupine River east of the village. A flock of 20 Canada geese flew under at half the eagle's altitude without changing their V formation or course, and the eagle continued its soaring flight eastward. On June 6, Francis Williamson saw two bald eagles near Driftwood River. A few bald eagles summer and probably nest along the Porcupine River, and from occasional views of them along the river they are familiar to the Indians, who call them *Chizin*.

Circus cyaneus hudsonius (Linnaeus)

1 male	May 14	weight 367 g.	little fat	testes 5.5x15.5, 7x13 mm.
1 female	May 19	weight 663 g.	fat	egg 16 mm.

On May 5 a marsh hawk with brownish flanks flew northward along Dave Lord Creek and continued its flight north by west across Porcupine River. Another seen earlier over Dave Lord Creek also was migrating northward. On May 7 two marsh hawks, later distin-

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guished as male and female, were pursuing separate courses parallel to the River hunting near the village. These birds repeated these hunting flights many times daily, but were not seen working together. This is the pair which I collected. During early May a marsh hawk was occasionally seen on the opposite side of the river and appeared to occupy an adjacent territory. Marsh hawks were seen several times along Porcupine Valley and a few times over the tundra above tree line on Old Crow Mountains.

The male specimen contained a *Microtus* in its gizzard. The enlarged egg in the female showed that it was near condition for laying.

The wide distribution of marsh hawks in winter from British Columbia to Massachusetts does not suggest the probable wintering area of the Yukon birds. The direction of a few migratory flights suggests their arrival on the Porcupine from the southeast.

This bird is known by the Indians as *Tzecho.*

Family PANDIONIDAE: Ospreys

Pandion haliaetus carolinensis (Gmelin)

On May 17 two ospreys flew up Porcupine River and circled several times close to the small channel of open water cut through the ice at the mouth of Old Crow River. They then proceeded up Old Crow River as if migrating northward. Later in the day an osprey was seen searching over Porcupine River although only a few channels of water were running on top of the ice. On May 20, still before ice started running in the Porcupine an osprey was seen carrying a fish westward past the village. A mile downstream it soared with its load to a great altitude before disappearing. Subsequently transportation of fish in this direction was observed several times, and ospreys were occasionally seen along the Porcupine.

The Indian name for the osprey is *Thuk.*

Family FALCONIDAE: Falcons

Falco rusticolus Linnaeus

We did not recognize a gyrfalcon, although numerous peregrines were seen. From an illustration and by comparison with peregrines Joe Kay named the gyrfalcon *Kwi tsi chi,* and said that it nested in spruce trees. Gyrfalcons are not mentioned by Rand (1946) as having been reported among birds of Yukon territory, but they were seen by Kessel, Murie, and Schaller (Unpubl. Ms.) on upper Sheenjek River in the Brooks Range. We consider this nearby observation to confirm reports by the Indians that gyrfalcons occurred near Old Crow. In the arctic interior of Alaska gyrfalcons are settled throughout the

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year in certain areas, where they also nest, and this is assumed to be their status near Old Crow.

Falco peregrinus anatum **Bonaparte**

4 fresh eggs	June 8	—	—	—

On May 5 a male and female peregrine were calling and apparently settled on the cliffs just below Dave Lord Creek. Guano near perches there indicated long use. After May 16 a male and female peregrine were occasionally seen and heard near the mouth of Old Crow River, a vicinity where Robert Bruce said that they often nested. At the end of the first portage across the long bend of the river, about 6 miles due east of Old Crow, a pair of peregrines were seen about a cavity in the cliff, and there Sidney and Leonard Peyton obtained four fresh eggs on June 8. Since peregrines are reported to lay their eggs every other day (Bent, 1938) we can estimate that the first was laid about June 1.

On June 13 eight peregrines, six of them associated as if in pairs, were seen at separate cliffs during 40 miles travel along Porcupine River. Because almost every suitable cliff was occupied, it is doubtful if many of the nesting peregrines remained unseen.

The Indians know this bird as *Chinechun*.

We had noticed in April that over a hundred old nests of cliff swallows were located along about a quarter of a mile of these cliffs where the peregrines' nest had evidently been situated for many years. Stalagmites of guano showed the ancient occupation by cliff swallows of some of the positions, and bulkier accumulations of guano near perches of the peregrines showed their long use of the area.

At the time the peregrines' eggs were found the nearest completed nest of cliff swallows was 100 feet distant, and within 200 yards were over a hundred nests in various stages of completion. It seems as if cliff swallows would be especially susceptible to attack during their social swarming, mating, and nesting. Accounts of peregrines' feeding indicate that in some places they capture and devour rough-winged swallows (Bent, 1938). To pluck nestling swallows from their nests would require no exertion of the strength of the peregrine's claws.

In his description of cliff swallows, Alfred Gross (Bent, 1942) reported that Coues, Taverner, and Forbush had each commented upon swallows nesting on cliffs where prairie falcons also nested, and said that Taverner also found them about a duck hawk's nest. Moreau (1942) has compiled numerous reports of African birds nesting close to insects which repel the approach of other animals by stinging, and several instances of small bird's nesting on the nest structure of larger birds which are usually considered to be predatory.

We did not observe the peregrines bothering the swallows, and it is

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apparent that predation upon them has not been sufficient to destroy that community of several hundred swallows, as would surely result if the peregrines obtained from them as much as a tenth of the subsistence needed during their Arctic residence, for it would take 100 swallows to weigh 3000 grams and provide enough to feed two adult peregrines for about one out of the approximately ten weeks during which they and the swallows are neighbors.

Perhaps the exertion for capturing a 30-gram swallow, about $\frac{1}{20}$th of a peregrine's daily food, is not worth the effort when a peregrine can take a duck equivalent to 30 swallows as easily as a human can remove an apple from his refrigerator. Whatever condition guides the habits of peregrines it must permit the existence of a neighboring population of cliff swallows.

Falco columbarius Linnaeus

The first pigeon hawk was reported seen on April 30. The swiftness of its flight left identification uncertain, but this early date did not surprise us, for a pigeon hawk was seen harrying jays in mid-March on the Alatna Malemute, just south of tree line in the central Brooks Range, and Dall (Dall and Bannister, 1869) found them in winter at Nulato. Another pigeon hawk was reported at Old Crow on May 8, but these small falcons are difficult to identify by sight because of the swiftness of their flight when close to brush and timber. Pigeon hawks have been reported on the lower Porcupine (Williams, 1925), at Lapierre House (Ross, 1862), and on the upper Sheenjek River (Kessel, Murie, and Schaller, Unpubl. Ms.).

The Indian name is *Chin tettree.*

Family TETRAONIDAE: Grouse and Ptarmigan

Sharp-tailed grouse (*Pediocetes*) were known by several Indians who had seen them along the Yukon River, where they were called "willow" grouse, a name also used in Alaska. They said that there were none near Old Crow. No information was obtained concerning white-tailed ptarmigan, but they have been recorded at Lapierre House (Ross, 1862).

The numbers of willow ptarmigan near Old Crow were locally regarded as showing a great decline in 1957 from their usual abundance. Varying hares were also few. We did not hear of a living hare being seen in spring of 1957 and ourselves saw only three fragments which appeared to be relics from winter, but the tracks of hares were not unusual and some were fresh. Periodic decreases of willow ptarmigan and hare are known locally to occur, but we did not inquire about the relation of their cycles.

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Some of the Indians suggested that the rarity of spruce grouse in 1957 might be associated with the reduced number of ptarmigan, but the number of spruce grouse near Old Crow is not usually sufficient to make their absence impressive.

Ruffed grouse, reported at Lapierre House (Ross, 1862) and Forty Mile (Grinnell, 1909), are so little known at Old Crow that failure to remark them in 1957 is not significant of a change in the population.

While rock ptarmigan are well known at Old Crow, their habitat is not regularly observed and our inquiries did not evoke opinions upon change in their numbers. I saw as many in the Old Crow Mountains as I have seen at various times in some Alaskan localities.

The Alaskan races of willow and rock ptarmigan extend to Old Crow in the arctic Yukon.

***Canachites canadensis osgoodi* Bishop**

We saw no signs of spruce grouse in 1957, and residents of Old Crow said that they had seen none that spring. In most years spruce grouse are often seen in August and 9 specimens were obtained in September and October 1958, at which time individuals and flocks were being occasionally reported. It seems that they are never abundant, but that a few are usually noticed in all seasons. The species is normally resident in Alaska, Yukon, and Mackenzie to the northern edge of spruce forests (A. O. U., Check-list, 1957).

***Bonasa umbellus* (Linnaeus)**

Joe Kay, elected chief at Old Crow from about 1920 to 1934 and a man possessing great wisdom about his country and its animals, said that he knew and used to hear the "thumping" of ruffed grouse, although for two years he had not heard or seen them. On the basis of his report, ruffed grouse are listed among the resident birds of Old Crow. The Indian name is *Chut tul.*

The species had been reported at Lapierre House (Ross, 1862), Forty Mile (Grinnell, 1909) and Fort Yukon (Bishop, 1900) and from Porcupine to Old Crow and Lapierre (Aldrich and Duvall, 1955). Residents in the Alaskan Arctic forest along the Koyukuk and Kobuk Rivers do not seem to be familiar with ruffed grouse, but they seem to extend just across the Arctic circle in Yukon.

***Lagopus lagopus alascensis* Swarth**

4 females	Apr. 5–12	weight 532–627, average 584 g.	little fat (2), no fat (2)	eggs 0.75, 1.5 mm.
5 sex unknown	Apr. 5	weight 546–636, average 591 g.	—	—

The average weight of willow ptarmigan in the small sample from Old Crow was less than the 619-gram average for 128 *L. l. alascensis*

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from the central part of the Brooks Range in winter. In summer, arctic Alaskan willow ptarmigan are lighter, and their weight then does not differ significantly from that of birds from Old Crow. They are, however, significantly heavier than the average weight (522 grams), found in 32 examples of willow ptarmigan from the Chugach and Talkeetna Mountains in the southern Alaskan range of *alascensis*.

Although not fat, none of the numerous willow ptarmigan brought into the village appeared ill nourished. They fed on willow buds and tips of twigs, reaching them from the ground or often from branches as high as 20 feet, where they appeared clumsy and insecure while reaching for the slender tips.

Some ptarmigan burrows in the snow showed by the quantity of droppings in them that they had been occupied throughout cold nights, but in moderate weather some of the open roosting depressions in the snow were shown by their content of droppings likewise to have been occupied during the night. It is not correct, however, to conclude that burrowing is for protection from the cold, because it certainly affords concealment and it is doubtful if the insulation of snow is needed in addition to the physiological adaptations which protect ptarmigan from cold. In mild weather the snow is heavier and since it may form a crust during the night, it seems to be generally unsuitable for burrowing.

At Old Crow, as in the Brooks Range, some but not all willow ptarmigan in white winter plumage have their feathers suffused with a delicate shell pink like a faint but beautiful fluorescent dye. This color appears in white ptarmigan and short-billed gulls in spring, and is most striking in Ross's gulls when they appear at Barrow in September. It disappears from specimens after a few days.

The nine specimens listed were all obtained within a few miles of Old Crow Village among the willows along the river. I had not noticed that Arctic willow ptarmigan regularly concentrated according to sex during migration. At Anaktuvuk, the sexes have been found mixed in the usual flocks which migrate near the level of the river, but Simon Paneak told me that in spring small flocks found occasionally on the hillsides might contain a majority of either sex. There is evidently some segregation by sex at times during migration.

Near Old Crow during a walk of 10 miles along the river in early April, several flocks of from 10 to 50 birds might be seen, but I did not record seeing more than 100 birds on any day. The people of Old Crow used the expression "no" ptarmigan and "no" rabbits in 1957 to compare the scarcity in 1957 with the numbers common in other years. The numbers of willow ptarmigan seen at Old Crow were few compared with those seen on occasions during the winters 1951 to 1954 at

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Anaktuvuk, where Simon Paneak reported they were still at the peak of exceptional abundance during the spring migration of 1957.

Moses Tizya, who returned April 14 from winter trapping on the Porcupine about 85 miles east of Old Crow, remarked that there were "no" ptarmigan there during the past winter, although the valley had been "white" with them in other winters. Paul Joseph, who returned May 2 by dog team from Fort McPherson, also reported that there were "no" ptarmigan along that route, covering about 140 air miles eastward, so the scarcity of willow ptarmigan in 1957 extended eastward at least to the Richardson Mountains. Several Indians remarked that no spruce grouse had been seen this winter although usually there were a few. Ruffed grouse, which are considered rare, had not been seen at all for several years. It seems that the period of scarcity among ptarmigan is not synchronous in the race which extends across arctic Yukon and Alaska.

The last flock of willow ptarmigan was recorded on April 9, but a single bird was collected on April 12. On April 8 fresh tracks of willow ptarmigan were found in the scrub birch and spruce near tree line at about 1,600 feet elevation on Old Crow Mountain, and Ben Charlie reported about 1,000 in one flock on April 18 above timber on the trail passing over the eastern shoulder of the mountain. He said that on April 26 willow ptarmigan were still on the mountain and at Crow Flats. While on patrol from Old Crow to Herschel Island during the week before April 26, Constable Robin saw ptarmigan, some with dark spots, as far north as the edge of timber, but he saw none northward to the coast.

The Indians informed us that in summer willow ptarmigan moved north of the timber or above tree line in to some of the extensive mountain tundra. The spring migrations probably occur in a direction which produces the requisite summer vegetation or climate either by change of latitude or elevation. The land along the Old Crow River, normally well occupied by willow ptarmigan in winter, extends with some timber northward for about 75 miles and the valley is practically cleared of ptarmigan during the summer. The Koyukuk Valley about Bettles is occupied in winter, but in summer it and the southern John River Valley are pretty well cleared for 50 miles by the northward migratory movement. On the Alaskan arctic slope willow ptarmigan are few in winter and usually rather numerous in summer. At Anaktuvuk, the center of density of ptarmigan seems to move from south of the divide in the Brooks Range in winter to north of the divide in summer, perhaps a distance of 200 miles. In the Old Crow Valley, where the forested wintering ground approaches to within 50 miles of the arctic coast, the mean migratory displacements appear to be shorter.

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Willow ptarmigan are usually near Old Crow in winter, but as the flocks rove about they cannot be called settled residents. Their annual schedules of movement appear to recur in each locality and so there is a true if relatively short distance migration.

The race *L. l. alascensis* in Alaska is distinguishable from *L. l. albus* by the size and shape of the beak, and our specimens from Old Crow were typical of the Alaskan race. The range of *albus* is reported to extend to northern Yukon (A. O. U., Check-list, 1957), but our specimens show that the Alaskan race extends eastward on the Porcupine at least to Old Crow.

The Indian name for this ptarmigan is *Taka.*

Lagopus mutus nelsoni Stejneger

9 males	Apr. 11–June 9	Weight 389–435, average 413 g., coeff. of var. 4.3%	fat (1), medium fat (2), little fat (1), very little fat (3), no fat (2)	testes 4–18 mm.
3 females	Apr. 21–May 25	weight 405–446, average 425 g.	medium fat (1), little fat (1), very little fat (1)	eggs 1.5–23 mm.

The average weight of male rock ptarmigan at Old Crow was found less than the mean weight (466 grams) in spring of male *L. m. nelsoni* at Anaktuvuk, but the three females did not differ in weight from those at Anaktuvuk.

The beautiful faint pink of the white winter feathers appeared often in rock ptarmigan of both sexes at Old Crow as it often appears in willow, rock, and whitetailed ptarmigan of Alaska.

In the vicinity of Old Crow, rock ptarmigan were seen only on the mountains above tree line at elevations from 2,000 to 4,000 feet, the highest examined. The small tracks and open night-roosting places in the snow were identified by droppings at the edge of the spruce, dwarf birch, and alder at about 1,600 feet elevation on April 8. On April 11, a wild flock of about 50 birds found at 2,400 feet scattered into several groups when pursued. One group which contained about 15 birds was approached while feeding at about 2,700 feet. On April 29, eight birds were seen in groups of two or three and no flocks were seen then or subsequently. The males were calling and mating was in progress.

In the breeding season females can often be distinguished by their compressed feathers, which give them a slender appearance as they stand or walk, and by their practice of carrying their head and tail extended nearly horizontally. The males stand straighter and with feathers erected, giving the impression of larger size, although the weight of the two sexes is not different. A trace of dark feathers was appearing on the head of the females and the red eye combs of the

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males were larger than on April 11. The testes had not reached half their maximum length when these initial steps toward pairing were in progress.

Specimens taken on April 17 and 20 were stained with crowberry (*Empetrum*) and these berries were found in the crop of one bird. At this time the snow had cleared from about 40 percent of the steep southeastern slope, but was continuous on the less steep and less sunny areas.

On May 10, a windy day, only one male rock ptarmigan was seen at about 2,500 feet. On May 25 three collapsed ovarian follicles and a brood patch in a female specimen showed that it had laid three eggs, the first on May 23. Only 10 percent of her white contour feathers and white primaries remained. A male companion had a few speckles on the crown and one on the back replacing not more than 5 percent of the white feathers, and its eye comb and testes were the largest noted. It is interesting that the female, although in the course of an intensive program of egg laying, was nevertheless marked as "medium" fat, which is about as fat as ptarmigan are found. The very considerable extra metabolic expenditure of laying was well covered by the food supply, leaving no sign of nutritional strain to suggest that the bird was under stress. This is in accordance with the appearance of unhurried actions of the female rock ptarmigan during the breeding season in arctic Alaska.

On May 26 two rock ptarmigan were seen as they stood on exposed rocky points at an elevation of 2,500 feet, in the statuesque pose which males take during nesting season. At this time and on June 9, other male rock ptarmigan stood on occasional eminences high in the first and second mountains at the conspicuous posts from which they signal their nesting territory. The testes of specimens taken at these times were smaller than the maximum size observed about May 25 but dark feathers had only covered the head and a few spots on the neck and body.

		Measurements (Mm.)		*Plumage Change (%)*	
Date	*Social Behavior*	*Testes*	*Ova*	*Male*	*Female*
Apr. 11	flocks disintegrating			0	0
Apr. 17		3x4, 3x4	1.5	0	
		6x8, 5x7		0	
Apr. 20	pairing	6x5, 7x5	2	0	Trace
May 22	♂ signals, ♀ laying				
May 25	♂ signals, ♀ laying	11x18, 11x17	[1] 23	1	95
		11x16, 9x13			
May 26	♂ signals, ♀ laying	11x18, 9x14		1	
June 4	♂ signals, ♀ incubating	11x13, 9x12		5	
June 9	♂ signals, ♀ incubating	11x14, 5, 10x13		5	
		11x13, 9x13			

[1] Three collapsed ovarian follicles.

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The flocks in winter occasionally flew out of sight several miles away. In summer male birds signaling or nesting were not seen closer together than about a mile. In the barren Old Crow Mountains that much range might be required for a brood of chicks, and the winter flock of 50 would accordingly need some 25 square miles of mountain for nesting. The first Old Crow Mountain scarcely contains 10 square miles of nesting territory. The others of that isolated mountain group may provide 100 square miles for nesting. These rough estimates suggest that winter flocks convene from a nesting area with peripheral points 30 miles separated. Within this area some may be resident through a year. Tracks showed that early in April rock ptarmigan had been among the dwarf birch, willow, and alder along the margin of the spruce forest, at about 1,500 feet elevation. We saw them in April, May, and June above 2,000 feet on the bare rocky slopes and mountain tops. Winter and summer movements of rock ptarmigan over Old Crow did not show regularity worth the designation of migrations, and we have not had certain evidence for any regular migration of rock ptarmigan in Alaska. As they are one of the swiftest among birds and have large hearts for their weight, rock ptarmigan are physically equipped for long flights.

The race *L. m. nelsoni*, which is easily distinguishable by the pattern of even a few feathers of summer plumage in both sexes, occupies all Alaska except the southeastern part. In arctic Yukon this race extends eastward at least to Old Crow without deviation in characteristics. Somewhere between there and northern Mackenzie occurs the border between *nelsoni* and *rupestris*. Porsild (1943) reports *rupestris* a rare visitor to the Mackenzie Delta where the forested lowland may separate the races of these mountain and tundra birds. In southern Yukon, however, Rand (1946) assigns 15 specimens to *rupestris*. As is the case among several species of migratory birds, the race found in Alaska extends eastward only across northern Yukon.

The Indian name for the rock ptarmigan is *Tako*.

Family GRUIDAE: Cranes

Grus canadensis canadensis (Linnaeus)

The first crane that we saw on May 14 was alone circling and calling high in the air. Again we heard one on May 18 and saw two on May 22. Cranes are well known to the Indians, who said that they nest on Crow Flats, but evidently not many come to Porcupine Valley. Their Indian name is *Chya*.

Rand (1946) quoted reports of great migrating flocks passing over points marking courses from the Liard River to the upper tributaries

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of the Yukon River. Evidently this route 600 miles south of Old Crow is followed by the bands of cranes which traverse southern Yukon and nest throughout Alaska.

Family CHARADRIIDAE: Plovers, Turnstones, Surfbirds

At Old Crow the species and numbers of plover were inconspicuous. It seems to be off the route of the migrations which take so many plover to nest in western arctic America.

Charadrius semipalmatus Bonaparte

2 females	20 May, 10 June	weight 38.3, 54.1 g.	little fat	4 broken follicles brood patch

Three semipalmated plover were the first of the species seen at Old Crow on May 19. They flew away eastward. During the time of breakup and until June, while the river remained high, a few semipalmated plover were seen about marshy places near the village. As the water fell pairs of these plover were occasionally seen on the gravel bars and banks of the river.

The female specimen taken on June 10 had evidently begun to lay by June 7. Although she had completed laying, she weighed 14 grams more than the average of the other females and three females from Anaktuvuk, an overweight condition sometimes noticed in females of other species at the time of laying.

The breeding range of the semipalmated plover extends across Alaska and Yukon without separation from the Mackenzie area. We have no evidence as to how the Porcupine is reached from the widespread migration through North America, and their wintering is widespread but apparently continuous across southern United States.

Its Indian name is *Shishenetyi*.

Charadrius vociferus vociferus Linnaeus

On May 20 Francis Williamson and Leonard Peyton saw a killdeer standing and calling by a grassy pool behind the village. On June 1 Leonard and Sidney Peyton also saw one which might have been the same individual.

Rand (1946) mentions only one sight record of a killdeer in Yukon territory. Its occasional presence in arctic Alaska is confirmed by specimens from Barrow (Bailey, 1948) and on the basis of Eskimo reports is suspected at Anaktuvuk and Kobuk.

There is no report of killdeers nesting north of British Columbia but it is apparent that individuals frequently wander in the western Arctic.

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***Pluvialis dominica* (Müller)**

It was thought that several golden plover were seen in flight over the village but not confirmed in 1957. Father Mouchet described several single golden plover and pairs which he had seen about the Mission in spring, 1956. Golden plover have been reported in Yukon north to the arctic coast (Rand, 1946). Apparently Old Crow does not lie on a route significant for the migration which brings so many golden plover to nest in northern Alaska. These could only belong to the race which winters in Argentina and migrates northward through the Mississippi Valley. They nest on the arctic coast of Yukon and some migrate across southern Yukon (Rand, 1946) but the available reports do not show where the bulk of the great population of golden plover nesting in Alaska traverses Yukon in its westerly course from the northbound migration in the upper Mackenzie Valley. Except near the arctic Yukon coast the golden plover nesting in Alaska seem to be separated from those which nest over such a wide area between Mackenzie and Hudson Bay.

Family SCOLOPACIDAE: Woodcock, Snipe, Sandpipers

Only 9 species of sandpipers were seen at Old Crow, a small list compared with the 16 known at Kobuk and 18 at Anaktuvuk. The terrain along Porcupine River suits snipe, spotted and solitary sandpipers, and lesser yellowlegs, but among these we could only establish that snipe and solitary sandpipers appeared in sufficient numbers to demonstrate numerically significant migration through Old Crow. As seen at Old Crow the Porcupine Valley is an unimportant migratory path for sandpipers as well as for plovers.

Six of the species of sandpipers at Old Crow are restricted in their Arctic nesting to Mackenzie, Yukon, and Alaska.

The fact that six of the nine species of sandpipers found at Old Crow are not divided into races suggests that these northwestern breeding birds are not genetically differentiated and that, as among ducks, the populations which are localized for breeding exchange members with the rest of the population of the species during migration or on their wintering grounds.

Among the three races of sandpipers there is no local differentiation among North American snipe (*Capella*). The whimbrel (*Numenius*) and solitary sandpiper (*Tringa*) are western races that migrate farther south in winter than the eastern races and they migrate farther north in summer. In both form and geographical distribution the western and eastern populations are distinct.

In southern Yukon snipe are uncommon (Rand, 1946) and whimbrel rare. Probably arctic Yukon is a geographically significant connection for the Alaskan and Mackenzie populations of these species.

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Hypothetical migration routes of Scolopacidae are shown in the following tabulation:

Species	*Arctic nesting in*	*Northern wintering*	*Route through U. S. and Canada*	*Coming toward Old Crow from*
Capella gallinago delicata	Mackenzie, Yukon, Alaska	British Columbia to Alabama	(?)	East or West
Numenius phaeopus hudsonicus	Mackenzie, Yukon, Alaska	Central California	Pacific Coast	East
Actitis macularia	Mackenzie, Yukon, Alaska	British Columbia	(?)	(?)
Tringa solitaria cinnamomea	Mackenzie, Yukon, Alaska	Ecuador	Mountain	(?)
Totanus flavipes	Mackenzie, Yukon, Alaska	Mexico	Prairie	Northwest
Erolia melanotos	Southampton to Siberia	Peru	Interior	Northwest
Erolia bairdii	Greenland to Siberia	Ecuador	Prairie	Northwest
Erolia minutilla	Mackenzie, Yukon, Alaska	Oregon to North Carolina	(?)	(?)
Ereunetes pusillus	Baffin Island to Alaska	Gulf coast	Interior	Northwest

Capella gallinago delicata (Ord)

1 male	May 22	weight 96.3 g.	medium fat	testes 7x15, 5x7 mm.
1 male	June 5	weight 93.0 g.	very little fat	testes 7x15, 8x12 mm.
4 slightly incubated eggs	June 7	—	—	—

Wilson's snipe were reported by Neil McDonald during the evening of May 7. On the next day their presence was apparent in the persistent winnowing over the lake and marshes back of the village. Until June the winnowing was often carried on with several snipe in the air steadily for a few hours, but some individual birds were noticed descending after only five minutes of winnowing flight. After May the winnowing was heard less often.

Joe Kay found a nest with four eggs on June 7. The first egg would have been laid about May 31. Peter Lord reported hearing the first snipe at his camp in the northern part of Crow Flats on May 16. Barbara Oakeson (1954) reported snipe on May 9 at Mountain Village, Alaska. At Anaktuvuk the mean first date from 1950 through 1953 was May 16, but in 1957 the surprisingly early date of May 8 was reported there. The number of snipe heard and seen during the early season at Old Crow appeared to be considerably in excess of the nesting territories about the village, suggesting that there was some migratory passage.

The Indian name is *Tazyah*, meaning "calling from the sky."

Snipe reach the Arctic in Mackenzie, Yukon, and Alaska. Since the wintering range extends from British Columbia across the northern States there is no basis in recorded migrations for suspecting how the Arctic nesting population travels. Rand (1946) remarked that "we have no records of snipe having been even moderately common in

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Yukon." They are common in the Mackenzie Delta (Porsild, 1943) and through Alaska. The plentiful nesting population on the Porcupine, apparently a main connection between abundant Mackenzie and Alaskan nesting populations, implies that the migration to the Porcupine is either from the west or from the east since central and southern Yukon seem to be but little visited by snipe.

Numenius phaeopus hudsonicus Latham

1 male	June 4	weight 364 g.	little fat	testes 8x12.5, 4x9 mm.
1 male	June 9	weight 312 g.	little fat	testes 8.5x15, 6x10 mm.
2 sets of 4 slightly incubated eggs	June 4	—	—	—

A whimbrel was heard on May 24 on the sedgy saddle extending for about a mile between the southern and next northern of the Old Crow Mountains. Hummocks of sedge interspersed with lichen cover extended over this gently sloping saddle at elevations from about 1,600 to 2,000 feet. On May 25 two pairs were watched and four other whimbrels were flying about calling the trill which resembles the loud call of a tree frog. These birds often landed and all appeared to be attached to the locality.

Two whimbrels were seen at the same place on May 27 and Father Mouchet saw several on May 29. On June 4 Sidney Peyton collected a male bird and two sets of four slightly incubated eggs which must have been first laid about May 27. On June 9 three pairs were again seen on the same saddle. The larger appearing bird of one pair was collected and turned out to be a male with a brood patch. Both of these birds were observed calling, were unwilling to leave the vicinity in spite of an hour of pursuit and several shots fired at long range.

Whimbrels, which the Indians call *Tetnjyo*, nest on tundra locations in arctic Mackenzie, Yukon, and Alaska. They are rare in the remainder of Yukon (Rand, 1946), and are common migrants only along the coast of British Columbia (Munro and Cowan, 1947). It is indicated that the arctic nesting population comes from the migration along the Pacific coast, and presumably reaches arctic Yukon and Mackenzie from the Yukon Valley after crossing the mountains from the Gulf of Alaska.

Actitis macularia (Linnaeus)

1male	June 8	weight 45.5 g.	medium fat	testes 7x12, 10x9 mm.
1 male	June 13	weight 39.7 g.	no fat	testes 5.5x13, 7x9 mm.
1 female	June 13	weight 41.7 g.	little fat	egg 5 mm.
4 fresh eggs	June 24	—	—	—

A spotted sandpiper was first seen flying near the bank of the Porcupine River at the time of the break up, May 22. No other was

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noticed until May 29, when one was seen on a mudbank just beginning to emerge as the river subsided; after that time, single spotted sandpipers and pairs were frequently seen along the banks. The two specimens collected on June 13 were together and apparently a pair. The female contained one 5-mm. egg but had not yet laid. A nest was found on June 24 with four fresh eggs, of which it was estimated the first was laid about June 18, the latest start of laying found among sandpipers.

Spotted sandpipers, known by the Indians as *Traruk*, are common along the Porcupine River but there was no evidence of migratory traffic in excess of the summer residents.

These sandpipers seem to nest north to the tree line, and so extend into the Arctic from Mackenzie, across forested Yukon and Alaska. In winter some remain as far north as British Columbia (Munro and Cowan, 1947) but are spread over more southerly States in the east. Their migratory course is too widely distributed to suggest from which direction Old Crow is reached.

Tringa solitaria cinnamomea **(Brewster)**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 16	53.6	F	5x7, 5x6.5			
May 17	52.2	F	5x10, 4x6			
	48.2	F	5.5x7, 4x5			
May 18	53.7	F	5.5x8.4, 5x7	54.6	F	6
May 20	59.6	VF	5x7.5, 5x6.5			
	52.2	VF	5x7, 4x6			
May 23				72.2	LF	12
June 1	55.4	MF	6x10, 4x5 brood patch			
June 5	55.4	MF	5x8.5, 3x4.5			
June 8	54.7	LF	5x8, 3x4	65.2	LF	[1] 6
(aver.)	53.8					

[1] 4 broken follicles.

Solitary sandpipers, which bear the Indian name *Tue*, had been heard on May 14 and several were seen on May 16 and 17. On May 18 about 12 were remarked in groups of 2 or 3 around marshy pools. From then until May 31 they were seen more often than they were later on, and their numbers seemed to exceed the old nests which could provide their eventual housing in the vicinity. Many of these birds appeared to be pausing in migration, and it was our impression that most of them took off in an easterly direction. Francis Williamson found solitary sandpipers at Fort Yukon when he arrived there on May 10.

A number of solitary sandpipers were settled around marshy pools and streams in June. Although we had not earlier observed many old nests there were enough new ones of robins and thrushes which could

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subsequently provide nesting places for a great many solitary sandpipers.

No eggs were found, but the female specimens taken on May 18 and 23 were evidently near to laying, for they had eggs measuring 6 and 12 mm. A male on June 1 was remarked with a brood patch and a female on June 8 contained four ruptured ovarian follicles. It appears that eggs were first laid about May 25.

The females taken on May 23 and June 8 were much heavier than the female taken on May 18. Such variation is not seen among adult birds except in the transient condition of females being overweight while ovulating.

Male specimens taken between May 16 and 20 were fat or very fat, but those taken subsequently were medium and little fat.

Solitary sandpipers appeared the most common species of the family to settle around Old Crow, and it is estimated that the migrating numbers could provide for their extension over much of Porcupine Valley.

All were distinguishable from *T. s. solitaria* in length of wing and in the heavier marking of the throat and breast. Of 12 Old Crow specimens, 11 had clear marbled patterns on the inner side of the first primary. The examples are typical of the western race, and in most the back pattern contained more buff and was rather more brownish than in *solitaria.*

The western race nests in arctic Mackenzie, Yukon, and Alaska, perhaps confined to the forested areas. In spring they migrate from Ecuador (and southward) principally through the intermountain region, reaching Atlin, B. C., on May 2, 1931, May 12, 1933, and May 10, 1934 (Swarth, 1936). It is possible that their arrival at Old Crow is either from the west or from the southeast.

Totanus flavipes **(Gmelin)**

1 male	June 11	weight 66.5 g.	——	testes 3x5, 2x4 mm.
1 female	May 31	weight 100.0 g.	medium fat	4 ruptured follicles, 1 formed egg, brood patch

The first report of a lesser yellowlegs on May 7 seems early in view of the weather and the condition of the snow and ice two weeks before breakup (Williamson found them present at Fort Yukon when he arrived there on May 10, and they have not been reported at Anaktuvuk before May 16). Additional yellowlegs were not recorded until May 23, but on May 31 the condition of a female specimen showed that it had begun to lay on May 28. This bird weighed 100 grams or about 25 percent more than the average of six females in spring at Anaktuvuk. This is another example of the transient overweight of laying females.

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The male specimen was abnormally light and its testes measured only 5 mm., which is smaller than usual among breeding sandpipers.

The lesser yellowlegs did not at any time seem to exceed the considerable numbers which were found in the marshy area during nesting time, and so there was no evidence for their migratory passage through Old Crow.

Yellowlegs migrate from their Mexican wintering places northward chiefly through the interior, (A. O. U., Check-list, 1957). Since they are abundant in autumn and scarce in spring transients in British Columbia (Munro and Cowan, 1947) we may suspect that spring migration to the northwestern Arctic is from the southeast. They had reached Atlin on May 3, 1930, May 2, 1933, May 5, 1934 and May 3, 1935 (Swarth, 1936); Ross Post, May 11, 1930 (Rand, 1946); and Anaktuvuk about May 17 in five years. It seems as if their spread to arctic Alaska is either slow or reached by a different contingent of the migratory population.

The Indian name is *Techuh.*

Erolia melanotos **(Vieillot)**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 23	76.2	VL	6x13, 7x12			
May 24	74.0	N	6.5x11.5, 7.5x11			
June 1	96.7	F	8.5x16, 10x13	53.6	L	4
				54.8	L	3
				57.7	L	4
				53.8	L	3
				61.1	L	4.5
				53.2	F	3
				52.7	F	3
				58.5	F	3
				57.4	F	4
				61.5	F	4
				57.0	F	2
(aver.)	82.2			56.5		

A flock of eight pectoral sandpipers was seen on May 23. During the next week from one to six were occasionally seen about the marshy pools behind the village. The latest record was of a female shot on June 11 but not preserved. Eggs were from three to five mm., so that the females were approaching breeding condition. The testes of two earlier male specimens were smaller than mature size but on June 1 they were full size. The pectoral sandpipers seen were evidently in migration and there was no indication that they nested near Old Crow.

The large variations in weight among male pectoral sandpipers are not unusual. In a series of 25 weighed in spring at Anaktuvuk were examples lighter and heavier than those weighed at Old Crow. In both sexes the visible fatness was also conspicuously variable. Among

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the species of Arctic migratory birds, the pectoral sandpipers are notably variable in weight.

The arrival of pectoral sandpipers at Old Crow was later than the usual date for the beginning of the large migration through Anaktuvuk. Judging from the few birds seen in comparison with their numbers migrating through Anaktuvuk, Old Crow is not an important station on the migratory route of pectoral sandpipers, and there was no evidence for their nesting. From their wintering places pectoral sandpipers migrate in spring northward from Peru mainly across interior States and Provinces east of the mountains (A. O. U., Check-list, 1957), so their arrival in Arctic Yukon and Alaska is probably from the east and southeast.

The Indian name is *Teggetesel.*

Erolia bairdii (Coues)

2 males	May 29	weight 38.4, 39.5 g.	fat (2)	testes 5x7, 5x5 and 5x3.5, 4x6.5 mm.

From their wintering place south of northern Ecuador, Baird's sandpipers migrate northward through the prairie States and Provinces (A. O. U., Check-list, 1957); and probably reach Old Crow from the east or southeast, but only a few groups containing two or three Baird's sandpipers were seen there, in sharp contrast to the great numbers migrating through and nesting near Anaktuvuk.

Erolia minutilla (Vieillot)

1 male	May 20	weight 22.1 g.	medium fat	testes 3.5x6 mm.
1 male	May 23	weight 22.1 g.	little fat	testes 2.5x3.5 mm.
1 female	May 17	weight 20.1 g.	fat	eggs 1.75 mm.
1 female	May 23	weight 24.9 g.	fat	eggs 2.75 mm.

It gives reassurance that spring is progressing to see these little sandpipers arrive in the Arctic. Two were seen feeding at the border of a marshy pool on May 17 and later a few were seen each day during May. On May 23 a dozen least sandpipers were running over the floating debris among the flooded willows on the margin of the river. No flocks were seen and their delightful song was not heard. On June 3 near Kenneth Nukon's cabin a pair was seen fluttering about together near the ground in courting manner with their wings rapidly beating like those of a large moth. The migration of least sandpipers through Old Crow was small and left only a few pairs nesting in the valley.

Since there is a wide wintering range from south of Oregon to North Carolina (A. O. U., Check-list, 1957) the source of these tiny migrants cannot be suggested.

The Indian name is *Tagatsil.*

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Ereunetes pusillus **(Linnaeus)**

1 male	June 1	weight 21.7 g.	fat	testes 4x7, 4x5.5 mm.
1 male	June 3	weight 22.7 g.	medium fat	testes 5x8 mm.
1 female	June 2	weight 23.3 g.	fat	eggs 2 mm.
1 female	June 3	weight 26.5 g.	medium fat	eggs 3 mm.

A flock of seven semipalmated sandpipers was noticed on June 1, a later date than their usual first arrival at Anaktuvuk. A few more small groups were remarked, and on June 13 three were seen feeding on the sandy shore of a slough, but the date of observation gave the only suggestion that they were present for nesting. The migration of semipalmated sandpipers through Old Crow was small and late. Their nearest wintering range is in the gulf-coast States and the migration northward passes through interior States and Provinces, usually east of the mountains (A. O. U., Check-list, 1957).

The Indian name is *Teggetselve.*

Family PHALAROPODIDAE: Phalaropes

Lobipes lobatus **(Linnaeus)**

male	May 24	weight 33.0 g.	medium fat	testes 7x13, 6x10 mm.
female	May 23	weight 35.3 g.	little fat	egg 5.5 mm.
1 female	May 24	weight 33.9 g.	fat	egg 4 mm.

A few northern phalaropes were first seen on May 23, the day after the ice moved in the river. For a few days some of the few phalaropes seen appeared to be resting during migration, and courting pairs were not recorded until May 29. Since the two female specimens had eggs measuring 6 and 4 mm., courtship was probably in progress earlier than it was recorded. During June individual phalaropes were often seen floating on marshy pools in quiet contrast to their dashing speed and remarkable aerial evolutions when in flight. A small migratory passage through Old Crow was believed to occur, but a good many phalaropes remain to nest in Porcupine Valley.

Believing that the other birds wintering in maritime situations come to Old Crow from the Pacific we suspect that these phalaropes are from the population wintering over the Pacific southward off Ecuador. Swarth (1936) says they are common migrants through Atlin, which they reached May 15, 1931, May 22, 1932, and May 12, 1934; but as they are widespread in summer through Yukon (Rand, 1946) and common all along the Yukon (Dall and Bannister, 1869), they may pass from the Gulf of Alaska to the interior by numerous routes through the mountains.

The Indian name is *Trevug.*

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Family STERCORARIIDAE: Jaegers, Skuas

Stercorarius parasiticus (Linnaeus)

1 male	June 14	weight 579 g.	little fat	testes 12x20, 11x16 mm.

The only record of a parasitic jaeger was obtained from the specimen brought to us. It seemed to be recognized by Joe Kay, who gave as its Indian name *Ttze kug*. From the size of the testes it was in breeding condition.

It is to be suspected that these jaegers winter with the Pacific population which ranges off shore as far north as southern California.

Stercorarius longicaudus Vieillot

1 male	May 26	weight 313 g.	fat	testes 8x17, 8x13 mm.

Long-tailed jaegers were seen only above the tree line on Old Crow Mountains, where the specimen listed above was shot. Six were recorded on May 27 on or over the sedge hummocks of the saddle between the southern and central mountain. Judging from their actions they had already paired and several pairs appeared to have settled upon nesting localities. The testes of the specimen were about mature in size.

It is to be suspected that this jaeger would have wintered with the Pacific population off shore from South America south of latitude 10° S.

Family LARIDAE: Gulls, Terns

Larus hyperboreus barrovianus Ridgway

Larus argentatus smithsonianus Coues

1 male in adult plumage	June 11	weight 1435 g.	very fat	testes 10x12, 6x9 mm.
1 female in second nuptial plumage	June 12	weight 1006 g.	little fat	egg 5 mm.

It came as a surprise on May 15 to see overhead four adult glaucous gulls flying swiftly eastward in compact formation close above the trees at the edge of the steep bluff overlooking the mouth of Old Crow River. Soon after another group of four appeared on the same course, then five and again four, all within an hour. It became evident that their course along the bluff gained advantage from a local wind condition by which their eastward flight was favored in the prevailing northeasterly wind, for the gulls lost speed in the turbulent air as they rounded the point. Then they found a northerly course with favoring wind conditions, resumed speed, and disappeared up Old Crow River.

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That afternoon and on May 16 these impressive flights continued to be composed mostly of four, but sometimes of five, or three gulls. Herring gulls, which the Indians call *Tetyet kkya*, were often among the groups, in a minority of about one in four. The number four also prevailed in the mixed flights and their formation and course were not different from the flights composed exclusively of glaucous gulls. A few of the flights passed eastward over the Porcupine River. On that day about 100 large gulls were carefully watched from their first appearance about two miles below the village. At the first sight of them it appeared as if their course was set and there was no hesitation at the mouth of Old Crow, where most of the flights turned north as if prepared by anticipation for the change in course.

The flights of these large white birds were so conspicuous and so obviously a purposive migration that it seemed warranted to estimate that the 100 gulls carefully watched comprised a sample numbering possibly ten percent of the two-days' traffic and perhaps less than one percent. This assumption leads to the estimate that between one and ten thousand large gulls flew up the Porcupine to Old Crow on May 15 and 16. Peter Lord first noticed large gulls flying north over Crow Flats on May 16.

On May 17 most flights continued up the Old Crow, but an increasing number went eastward over the Porcupine River. These two migratory courses were followed in similar fashion until May 22, but on some of the later days the route to the village passed over the river, in which the ice was beginning to move. The orderliness of the flights diminished as herring, and more rarely glaucous, gulls occasionally stopped along the swift running river after the breakup. Only adult gulls were noticed before the breakup.

Glaucous gulls are rare in the interior of Alaska south of the Brooks Range in summer. One in second-year plumage was taken at Old Crow November 28, 1957.

Since pairs of herring gulls in breeding season are seldom as close as a mile apart on the large rivers in the arctic interior, one day's migratory flight past Old Crow could probably introduce the entire nesting population of herring gulls found on the upper Porcupine. No significant part of the more numerous migration of glaucous gulls remains in the interior. It is likely that this impressive migration of glaucous gulls and fewer herring gulls brings up the Porcupine River from Alaska an important contribution to the summer population of large gulls on the shores of Mackenzie Bay and the Delta. The glaucous gulls were first sighted at Reindeer Station in the Delta on May 15 (Porsild, 1943, p. 30), and the summer population of western glaucous gulls extends along the American arctic coast about to Anderson River (Snyder, 1957).

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Peter Lord said that large gulls did not remain on Crow Flats in summer. In June we obtained two specimens of herring gulls on the Porcupine River and saw a number of adults apparently settled. The male specimen, in adult plumage on June 11, by the size of its testes was judged to be not then in breeding condition. The female in second-year plumage had eggs somewhat enlarged, but is supposed not to lay for another year. We saw no glaucous gulls on the Porcupine after migration.

The two specimens were identified as *Larus argentatus smithsonianus* and not *L. a. thayeri.* Judging from the date they were samples of the summer resident birds and do not represent the migrating gulls with dark wing tips, which might have included *thayeri* in the great transarctic flight which carries them from their Pacific wintering place as far east as Greenland. Thayer's gull is abundant in winter in southern British Columbia (Munro and Cowan, 1947, p. 117), and it is remarked in migration along the southeastern coast of Alaska. Apparently the next common records are from the Alaskan arctic coast, where numerous specimens have come from the vicinity of Barrow. There Thayer's gull is reported as a regular fall migrant by Bailey (1948), who remarks that there are few spring records. It might be that the spring migration of Thayer's gull crosses arctic Yukon from the Gulf of Alaska. Such a course is apparently taken by black brant.

If we believe that the association of glaucous and herring gulls has been maintained since their departure from the sea, the migratory course has probably not followed the Yukon River from Bering Sea, because glaucous gulls seldom pass up the River (Dall and Bannister, 1869), and such a migration as we saw at Old Crow would probably have been noticed. Glaucous gulls have not been earlier reported south of the arctic coast in Yukon (Rand, 1946) nor have they been remarked at Atlin (Swarth, 1936). However, Nelson (1887, p. 52) reported that fur traders had taken glaucous gulls at Fort Reliance, on the upper Yukon, on September 28 and October 18 when ice covered the river. He also remarked that Dall had obtained the young from the famous arctic collector Lockhart, who found them at Fort Yukon. The mystery of how these conspicuous gulls could pass unobserved from the Gulf of Alaska or the Peninsula to Old Crow should check speculation, were the answer less interesting.

Larus canus brachyrhynchus Richardson

1 male	May 16	weight 435 g.	very fat	testes 12x20, 11x14 mm.
1 female	May 16	weight 436 g.	very fat	egg 5 mm.

Three mew gulls on May 3 were the earliest gulls seen flying over the frozen river. Until May 9 groups as large as 12 settled on the

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ice, and later, as small pools appeared, floated on them. Like the early ducks and geese the early arriving mew gulls which landed remained still, as if resting. There was certainly scant food available to excite the gulls on the icy river and snow-covered land, and they seemed to accept the scarcity without wasting efforts on search. Unlike the direct flight of the large gulls the flight of mew gulls appeared casual and easily diverted, although there was little difference to be seen in the choice of the frozen landing places. It was clear that they came up Porcupine River from the west and apparent that most of them continued, or after a rest departed, eastward.

Between May 9 and 11 the eastbound traffic past the village became more intense. In their wavering flight and irregularly organized flocks these gulls nevertheless make swift progress. The flights comprised from 1 to 16 gulls. On May 13 few were seen and on May 14 none. It seemed that the early migration had left no settlers at Old Crow.

On May 16 a compact flock of 30 settled on the ice in mid-river. Four Bonaparte's gulls were with this flock, keeping near each other, but not otherwise discriminating as to position. Three times this flock made a great crying as it was disturbed, but alit again nearby after each disturbance. When two were wounded the flock scattered and individuals flew close to the wounded birds on the ice until I approached. The flock then reassembled and after many circles disappeared on an erratic eastward course. This was the last day on which we crossed the river on the ice. From May 15 until May 19 small flocks and single birds occasionally alighted, but it seemed that most of them continued eastward.

As the water began to run over the ice the migratory trend became less evident and gulls often left the river as a course. When the ice started moving on May 22 it appeared that many mew gulls were scattering over the country nearby, although a continuing easterly trend in the flights suggested that some migration persisted until June.

Peter Lord did not remark any gulls on Crow Flats until May 16. He said that only small gulls remained there in summer, and that they were common. Lazarus Charlie reported the first sea gull at Johnson Creek, about 80 miles south by east on the upper Porcupine on May 7. Spring weather is said to come earlier there than at Old Crow, and migration of a few species was reported in the upper valley of the Porcupine before it reached Old Crow. It seems likely that many of the earliest migrating mew gulls, passing Old Crow when the country seemed destitute of opportunity for gulls to feed, were following Porcupine River toward the more advanced spring in its southern valley.

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These hardy little gulls, graceful and swift in flight, often wheel and tower high in the air. The desultory appearance of their flights made it appear as if they were not bent upon long migratory course. They are likewise the first gulls to fly through Anaktuvuk in the same manner early in May. There they settle the arctic interior more densely than do glaucous gulls, but they are not common along the coast. The desultory nature of the flights of mew gulls through Old Crow and the large number which remain in Porcupine Valley make it difficult to speculate upon their eventual destination. But the great numbers which moved up the Porcupine suggest that mew gulls from those flights overflow Porcupine Valley and contribute significantly to the nesting population in the Mackenzie Delta.

These gulls winter on the Pacific coast from southeastern Alaska southward. Since they arrive in migratory flights from the west it can be suspected that they come from the Yukon Valley but we do not know by what course they leave the Gulf of Alaska and traverse the mountains. Swarth (1936) reported their arrival at Atlin, B. C., on May 7, 1932, May 3, 1933, and April 22, 1934. These dates are early enough to make the vicinity of Atlin a possible area for crossing the mountains to reach the Yukon system.

The Indian name for these gulls is *Vyou.*

Larus philadelphia (Ord)

Four Bonaparte's gulls were seen May 16 with 30 mew gulls. Another group was later seen with a flock of mew gulls. They were known and named *Chit tryo* by Joe Kay and other Indians, and are evidently common enough in summer in the upper Porcupine Valley to be familiar, but in small numbers compared with mew gulls. Their occurrence in company with the mew gulls suggests that they also came from the west along the Porcupine River and had wintered on the Pacific coast south of Washington.

Sterna paradisaea Pontoppidan

Only a few arctic terns were seen near Old Crow. Mary Lobban first reported them on June 5 about ten miles down river from Old Crow. Robert Bruce saw one near the village on June 14. On that same day it was remarked that no tern was seen in traveling 40 miles up the Porcupine River and back. To the Indians terns are familiar and not well liked because of their persistent diving at and even striking intruders into their nesting areas on Crow Flats. These terns are probably from the migratory population which travels the Pacific to their wintering place on antarctic waters. (Cooke, 1911). Probably they migrate to Yukon from the west.

The Indian name is *Kkya notetuthga.*

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Family STRIGIDAE: Typical Owls

Indians, like Eskimos, are interested in owls, take pains to observe them, and are clear in relating what they know about them. We did not see short-eared owls at Old Crow and our illustration and description did not evoke recognition of them which could be considered to be explicit. The resident owls and snowy owls were well known.

Bubo virginianus lagophonus (Oberholser)

1 male	May 3	weight 1445 g.	fat	testes 7x11, 6x9 mm.

John Moses brought us the great horned owl listed above from his camp 10 miles down river from the village. He reported that two owls were about a nest, but his later examination showed the nest to be old and the second owl could not be obtained. The testes of the specimen were less than breeding size, and the date of nesting would more probably have been earlier than later. On May 11 Francis Williamson observed a great horned owl hunting over the village at midnight. A feather thought to be from a great horned owl was found in May near a slough a mile south of the river, and in this area on June 5 Robert Bruce and I saw a large brownish owl while it made several short flights through the woods during which a rusty blackbird was able to engage the owl more closely than we could accomplish.

Great horned owls, because of their conspicuous appearance and calls rather than for their abundance, are well known to the Indians, who call them *Veesay*. Judging from what we could learn the residence areas of these owls are a number of miles apart.

From examples of northwestern horned owls in the U. S. National Museum this specimen differed in the general light color, small amount of brown, and the contrast of the black and white markings. When two additional examples, obtained in central arctic Alaska, had been borrowed from George Sutton of the University of Oklahoma who has designated them *B. v. lagophonus*, it became apparent that the specimen from Old Crow was a rather light example of *lagophonus*, distinguishable from *algistus*, *saturatus*, and most readily from *wapacuthu*. It is the form so far recorded in arctic Alaska and Yukon, whereas *wapacuthu* is the form to be expected in the Mackenzie Delta.

Nyctea scandiaca (Linnaeus)

None of our party saw a snowy owl, but to the Indians at Old Crow who call them *Riseitivay*, they are well known as occasional winter visitors and are more frequently seen on Crow Flats.

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***Surnia ulula caparoch* (Müller)**

1 male	Apr. 17	weight 322 g.	medium fat	testes 7.5x11, 5.5x9 mm.
1 female	Apr. 10	weight 384 g.	medium fat	egg 2.5 mm.
1 female	May 2	weight 310 g.	no fat	egg 8 mm.
1 female	May 4	weight 336 g.	no fat	egg 8 mm.

The first hawk-owl obtained made itself known by repeating a low call like a robin's note of alarm as it sat high in a willow on the island east of the village. It had a layer of white abdominal fat several millimeters thick and nearly as hard as beef tallow at ordinary room temperature. Hawk owls are familiar to the Indians for their boldness, since they often come into the village to perch on poles. The eggs in the specimens taken May 2 and 4 were 8 mm. in diameter. These birds appeared to be in condition for laying early in May. The May 2 specimen was taken from the top of a broken spruce near a cavity which looked as if it had been used last year for a nest and which showed some signs of preparation for use this year. About two feet lower was a flicker's hole apparently constructed about a year ago but not in use this year.

Pairs of these small but demonstrative predators are apparently distributed at intervals of only a few miles in the arctic forests from Mackenzie across Yukon and Alaska. The Indian name is *Tchichitoo.*

***Strix nebulosa nebulosa* Forster**

1 female	May 8	weight 1092 g.	no fat	egg 2.5 mm.

The specimen of great gray owl listed above was first seen flying among the spruce trees which predominated in the area at the base of the bluff a mile north of Kenneth Nukon's cabin, and was pursued for a mile of short flights. Its appearance of large size belied its actual weight, for although the thick feathers of the great gray owl make it look larger, great horned and snowy owls are much heavier birds.

There are few specimens or even sight records of great gray owls in western arctic America and the birds seem to be more widely separated than great horned owls. They are well known to Eskimos and Indians in the arctic forest, and from their reports I believe that great gray owls sparsely occupy the arctic forest across Yukon and Alaska. Joe Kay discussed owls and their habits in detail, even remarking that great gray owls are not bad eating, while the slightly more common great horned owls are not particularly good. As a matter of fact owls are seldom eaten, but his people have accumulated and preserved every observed detail about the birds of their country.

The importance of owls for food is calorifically small, but Indians, Eskimos, and some arctic travelers have encountered situations in

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which a bird or animal usually disregarded as food nevertheless served for a meal. Eskimos and Indians relate these experiences as objective comparative characterizations of the flesh and structure of animals rather than from gastronomic interest. The Indian name is *Nastok.*

***Aegolius funereus* (Linnaeus)**

Although we did not see a boreal owl they were obviously familiar to the Indians at Old Crow, who call them *Nastotesul.* Joe Bryant of the Canadian Fish and Wildlife Service reported that he saw an owl of this size about April 5 at Crow Flats, and Albert Abel gave a good description of one which he saw there on April 16. Although I have not seen one of these owls alive they are clearly described by Indians and Eskimos as not unusual sights in the arctic forest of Yukon and Alaska.

Family PICIDAE: Woodpeckers, Wrynecks

***Colaptes auratus borealis* Ridgway**

1 male	June 4	weight 154 g.	no fat	testes 6x15, 7x8 mm., brood path
1 female	June 4	weight 152 g.	little fat	egg forming 3 ruptured follicles, brood patch

A flicker was heard calling north of the village on May 16 and near Crow Point later on the same day. On May 19 Francis Williamson saw one near the village. On June 4 one was calling as it moved about in the mixed spruce and birch near Kenneth Nukon's cabin. After a prolonged search Robert Bruce collected a pair when they came to inspect an old flicker's hole near the nest of a pair of hawk owls (see p. 206). This hole had not been used this year by the flickers, but the condition of the female showed that she had first laid about June 1.

Flickers occur in the arctic forest from Mackenzie across Yukon and Alaska. In migration they pass through British Columbia (Munro and Cowan, 1947) as well as the Provinces to the east, but the wintering area is too broad to assign a probable migration route to the birds of the northwestern arctic forests. Their Indian name is *Chut lut.*

***Picoides tridactylus fasciatus* Baird**

male	June 14	weight 61.3 g.	little fat	testes. 3.5x5, 4x5 mm.

John Moses sent word that a nest of this northern three-toed woodpecker was near his camp. Leonard Peyton found it about four feet above ground in a stump and took the male, which was inside with sev-

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eral nestlings. The bird had a brood patch, but its testes had apparently regressed from breeding size. The eggs would have been laid about June 1. The resident range of this race extends in the arctic forests from Mackenzie (Porsild, 1943) across Yukon and Alaska. The Indian name is *Tutchun Tsya.*

We looked carefully for signs of woodpeckers' work. Dead birch or poplar, even on burned areas, seemed to rot rapidly and seldom bore visible marks of woodpeckers. Dead spruce stumps were rare. Several were noticed with holes suitable in size for flickers and about six had old holes suitable for three-toed woodpeckers, but none were found that were small enough to be appropriate for downy woodpeckers.

Family TYRANNIDAE: Tyrant Flycatchers

Sayornis saya yukonensis Bishop

1 male	June 5	weight 23.7 g.	medium fat	testes 3x7, 3.5x4.5 mm.

Leonard Peyton collected the male phoebe listed above as it flew in to light on a tent frame in the village. Its testes appeared to be near but not at breeding size. On June 6, Williamson saw a phoebe carrying nest-building material near the cliff opposite the mouth of Dave Lord Creek, but search there on two later occasions did not discover the phoebe again. The Indian name is *Ni kut itsi.*

Yukon phoebes have not been found west of Anaktuvuk but evidently extend across arctic Yukon and western MacKenzie. Since they are usually east of the Cascade and Coast Ranges in British Columbia (Munro and Cowan, 1947) they probably migrate through that part of British Columbia.

Empidonax traillii (Audubon)

1 male	June 12	weight 14.9 g.	little fat	testes 4x7, 4x5.5 mm.
1 female	June 17	weight 12.4 g.	little fat	eggs 3 mm.

Francis Williamson reported that Traill's flycatchers were at Fort Yukon when he arrived there on May 10, a date which seems early for flycatchers to be in that northern locality. The first record near Old Crow was of one heard on May 27 in the willow-alder brush adjacent to the village. Thereafter one was occasionally heard or seen. They were not easily discovered in the thick brush where they were calling, but since Leonard Peyton located four by their singing positions on June 12 they were apparently not uncommon. The testes of the male specimen appeared to be at breeding size; the female contained a small egg but had not yet laid. Although nesting appears demonstrated by the behavior observed during nesting time its date is not known.

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At Fort Yukon in 1958, Williamson and Peyton found *E. traillii* on May 7, a week after they arrived there.

The difference in date of arrival between Fort Yukon and Old Crow suggests that migration does not proceed between those two localities and suggests arrival of the migrants from the southeast. Since they remain east of the Cascade and Coast Ranges in British Columbia that is perhaps the western limit of their migratory course. This flycatcher is known by the Indians as *Sit tri gichi zzeh.*

Nuttallornis borealis (Swainson)

1 male	May 24	weight 35.5 g.	medium fat	testes 4.5x12, 4.5x9.5 mm.

Francis Williamson recognized this olive-sided flycatcher by its call on May 24. We followed the bird about among mixed birch, poplar, and spruce at the top of the bluff for about an hour without clearly sighting it, because it kept changing its calling position about every five minutes as it moved around in an area about ¾ mile across. Robert Bruce, who was hunting separately in the same area, finally shot it from the top of a poplar. Judging from the size of the testes it was near condition for breeding.

This flycatcher nests in the forested areas of central arctic Alaska (A.O.U., Check-list, 1957) and arctic Yukon, but has not been reported in arctic Mackenzie. The more southern range from coast to coast does not indicate a common migratory pathway for the species.

The Indians know it as *Tzivi.*

Family ALAUDIDAE: Larks

Eremophila alpestris arcticola (Oberholser)

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 25	36.3	MF	5.5x9.5, 6x7			
May 26	36.9	MF	5x8, 5x6			
May 26	37.5	VLF	5x8, 5x6, brood patch	37.5	LF	4 broken follicles, formed egg, brood patch

Horned larks were first seen as they were singing on the southernmost of the Old Crow Mountains on May 25. Estimating from the condition of the female on May 26 the first egg had been laid about May 22, and the larks must have arrived at least a week earlier, as is their schedule at Anaktuvuk.

Horned larks were seen only on the dry and barren rocky mountains where a few pipits, wheatears, and rock ptarmigan somehow existed in spite of the barrenness. Whenever the sun was warm many spiders and some other insects could be seen, and these undoubtedly served the small insectivorous birds. The occurrence of two medium-fat

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birds shows that even in the barren appearing mountains there is enough food.

The arctic breeding range of this race extends across Alaska and Yukon and to Mackenzie (A.O.U., Check-list, 1957) although Porsild mentions that *E. a. hoyti* occurs on the Mackenzie Delta. The wintering range in the northwestern States indicates that these larks migrate through the western mountains.

The Indian name is *Katu.*

Family HIRUNDINIDAE: Swallows

Four species of swallows extend their nesting range beyond the arctic circle in Yukon and Alaska and two nest also in arctic Mackenzie. These western ranges are far north of their limits in the east, and indicate northward migration through the mountain States and Provinces. Inasmuch as the northwesterly nesting races of several eastern species of birds extend farthest north, the tree swallows of Alaska may come from eastern wintering situations.

The four species have quite separate wintering areas, but viewing their entire distribution only the violet-green swallows (*Tachycineta*) are restricted to the west. The early presence of violet-green and tree swallows at Fort Yukon is so far ahead of their arrival at Old Crow that migration evidently does not enter the Porcupine Valley from Alaska and probably does not pass westward from Old Crow along the Porcupine River.

Tachycineta thalassina lepida Mearns

1 male	May 21	weight 18.5 g.	fat	testes 4.5x6, 3.5x4 mm.

This violet-green swallow was brought to us by Joe Kay who recognized it among the tree swallows then common about the village. By comparison with breeding tree swallows the testes of this violet-green swallow were not mature. Kay explained that violet-green swallows are not often to be expected around the village, for as indicated by its Indian name, *Tta shait sove*, it is a mountain swallow. Francis Williamson had seen them when he arrived at Fort Yukon on May 10. On June 21 a pair occupied a nest box at Old Crow.

The nesting range of these swallows extends in Alaska northward to Bettles but they are sometimes driven from their nesting places by the more aggressive tree swallows, which are more numerous where their common range just passes the arctic circle. Southward, violet-green swallows nest in western Alberta and British Columbia and migrate to southern California and Costa Rica in winter.

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***Iridoprocne bicolor* (Vieillot)**

	Male			Female		
Date	Weight (g.)	Fat	Testes (mm.)	Weight (g.)	Fat	Eggs
May 16	20.8	F	7x10, 7x9	21.8	F	1
May 20	22.9	F	7x9.5, 8x10.5	24.2	F	1
May 22	22.7	F	7x10, 8.5x11			
May 24				21.4	F	1
	——			19.8	F	1
(aver.)	22.1			21.8		

The first tree swallow was seen at about 2:30 p.m. on May 16, and within a few hours a number of them were inspecting the bird houses about the village. The numbers increased until on May 23 about 30 were circling in an area about a quarter mile long over the river bank. A little later the group comprised about 40 which were coursing in circuits about 300 yards in length over the meadow retrieving insects from among the flooded grasses. At this date they were still flying actively at 8:30 p.m. Toward the end of May the number of tree swallows about the village diminished as every nest box became occupied by a pair. Some must have migrated further or dispersed to natural nesting sites. Along the river tree swallows were occasionally seen but their natural nesting places were not discovered.

The number of tree swallows, which the Indians call *Sha sove*, was much exceeded by the cliff and even more numerous bank swallows.

It was noticed that some tree swallows with scarcely a trace of blue on their slate-gray backs were mating as females and occupying nest boxes. Two gray females taken for examination were indistinguishable in appearance of maturity from blue females.

Tree swallows are not reported from the Mackenzie Delta (Porsild, 1943) but extend across the wooded portion of arctic Yukon and Alaska. Their arrival was surprisingly early for an insectivorous swallow, preceding the breakup of river ice by six days, but all specimens were fat. In view of their early commonness in British Columbia (Munro and Cowan, 1947) and arrival April 10 at Craig, Alaska, it is likely that the migration passes to the northwest through many western valleys and is likely over a western flyway.

***Riparia riparia riparia* (Linnaeus)**

On May 31 a few bank swallows were noticed, and by June 1 they were as numerous about the village as tree swallows, whose feeding areas they shared. Their number then increased until it exceeded by many times that of the other swallows.

In groups of various sizes bank swallows nested in selected situations along the river. Their numbers are tremendous, but the greatest concentration was noticed in the vicinity of the village.

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On June 3, holes were started by one group of about 50 swallows along a section of bank, and in a few days there were 30 or 40 holes under construction within a stretch of 50 feet. This particular group seemed to swarm together as they flew in their unbelievably swift banks and turns, giving the impression of social organization in the pattern of flight. Many other holes were started in the bank in front of the village and scattered or concentrated groups of holes were formed in many banks exposed by the rapid fall of the river. The swallows are adept at selecting banks which do not disintegrate, as in many places they do during the summer by thawing and drying. The swallows also selected nest sites in firm but early-drying sandy loam. The construction of holes was still in progress on June 15. It is obviously a laborious operation for such small birds with their slight equipment for digging.

A recorded first arrival (Bent, 1942) in Fairbanks, May 14, precedes the arrival at Old Crow by two weeks. Alfred Gross (Bent, 1942) refers to an account, written for him by Frank L. Farley, of a large migratory flight of bank swallows passing northward over the Athabaska River about 125 miles northwest of Edmonton on May 11. Since they are reported to be rare west of the Cascade and Coast Ranges (Munro and Cowan, 1947), it is presumed that the northward migration travels through the Mackenzie Valley.

The Indians name this bird *Shai tso ve.*

Petrochelidon pyrrhonota hypopolia **Oberholser**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
June 10	30.2	MF	7x10, 10x10			
June 14	27.0	MF	9x11, 8x8	30.1	MF	1 in oviduct, 1 broken follicle, brood patch
June 14				30.0	F	1 in oviduct, 2 broken follicles
June 23		MF	5x9, 7x8			
June 17						5 fresh eggs, 4 slightly incubated eggs

A single cliff swallow was noticed on the evening of May 25. During the next day their number increased, and on May 27 was twice that of the approximately 50 tree swallows which had arrived in the village 10 days earlier. The arrivals at once set about examining the mud nests remaining from last year under the eaves of buildings. Many old nests had been destroyed, but those most nearly intact were first claimed and their reconditioning was begun. These did not suffice for all the swallows, and work was gradually started on badly broken nests and at new positions. The construction was a laborious operation, and often the instinctive engineering was frustrated by the

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choice of unsuitable material or situation. Progress was slow, but eventually about a hundred nests were completed on various buildings.

On June 14 a female was found to have laid an egg. On June 17 one nest contained four slightly incubated eggs, the first of which would have been laid about June 9, and another five fresh eggs, the laying of which would have started a few days later. At this date many nests were still uncompleted, and laying probably extends through June.

At several cliffs along the River, colonies of swallows were found nesting. The nests were usually concentrated on firm rock faces. In a few sites the droppings of swallows, accumulated in stalagmites, showed the length of the nests' occupation.

In the villages people often destroy the nests and sometimes block the approach to the site with wire. Then the determination of the birds is increased and for several days they may mill about trying to replace the destruction or to evade the obstacle. The destruction of nests is not wanton but because the droppings smear the windows, assault the person and the birds are reputed to bring noxious vermin unpleasant for man, a fair indictment since they are unnaturally using our habitations.

On three cliffs extensively used by swallows, peregrines were seen at nesting time. At one cliff where a peregrine was sitting on her eggs a swallow's nest was within 100 feet, and over 100 nests were within 200 yards. A peregrine's perch with abundant guano to show its long use was within 6 feet of a cluster of nests, near which swallow guano also showed their long use. We observed these in winter and did not actually see the predator and swallow in such close proximity, but during June, when we passed the cliffs, the swallows and their nests showed no signs of disturbance.

Cliff swallows nest across the wooded part of arctic Alaska, for I have found them common along Koyukuk River and they are known at Kobuk, but specimens are not available for identifying the race in interior arctic Alaska.

In spring migrating cliff swallows move more rapidly northward in the far west than in the east and at a much accelerated pace through British Columbia, reaching far higher latitudes in Alaska and Yukon than in the rest of Canada (Lincoln, 1952). Their arrival at Atlin, B. C., was reported on May 21, 1934 (Swarth, 1936), and at Peace River, Mackenzie, on May 20 (Bent, 1942). Our swallows could have arrived by any course between these localities but probably not from east of the Mackenzie River.

The Indian name for this bird is *Shattso*.

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Family CORVIDAE: Jays, Magpies, Crows

Perisoreus canadensis pacificus (Gmelin)

	Males			Females		
Date	Weight (g.)	Fat	Testes (mm.)	Weight (g.)	Fat	Eggs (mm.)
April 9		VLF	4.5x7, 4x6			
April 15	85.9	VLF	6x9, 5x6	74.9	VLF	1
April 17	80.4	NF	5x6, 4x7.5			
April 23	72.2	VLF	2x4, —			
April 23	76.0	VLF	5.5x8, 5.5x6			
May 1	73.5	NF	3x4.5, 2x3	61.5	NF	0.5
June 1	76.5	NF	2x4, 2x3			
June 10	87.8	LF	2x3, 1.5x3	73.5	LF	0.5
June 17	75.4	LF				
June 28	85.8	MF	2x2.5, 1.5x3	74.0	LF	0.3
	Young Male			Young Female		
May 30				66.5	NF	
June 14	74.9	LF				
June 28	73.1	LF				

A few Canada jays often came into the village looking for scraps around the feeding places of the dogs. The Indians had some dislike for jays in addition to their prejudice against them for stealing meat. Their name for them is *Titimkotom.*

Jays were encountered through the woods in situations indicating pairs to be about a mile separated. On April 8 a pair appeared to be courting, and during the latter part of April jays could often be attracted by call and came in twos. Sometimes three appeared together and on April 23 two males were called, and were collected together.

Among the specimens collected the largest testes were found in those taken April 15 and 17, and smaller testes were found in those taken after April 23. The earliest young birds just flying were seen on May 28 and recent fledglings were occasionally seen in early June. Presumably the eggs were laid between middle and late April.

Old Crow and Anaktuvuk specimens of Canada jay had less brown than *P. c. canadensis*, but matched satisfactorily with *P. c. pacificus.*

Corvus corax principalis Ridgway

Early in April one or two ravens were often seen searching for scraps of dog food. At that time their flight was marked by calling and maneuvering, but toward the end of the month linear flights became more frequent, suggesting that nesting or feeding young was in progress. No variation in the numbers of ravens was observed which would suggest migration.

The Indian name for this bird is *Tatoo.*

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Family PARIDAE: Titmice, Verdins, Bushtits

Parus cinctus lathami Stephens

We did not see any gray-headed chickadees. Olaus Murie (1928) remarked that after nesting season they were rather conspicuous along Old Crow River but that along Porcupine River he found only boreal chickadees, an interesting distinction of range which he thought to result from the preference of *P. cinctus* for the narrow fringes of forest near the limit of trees.

Parus hudsonicus hudsonicus Forster

We occasionally saw boreal chickadees, usually in pairs, in a variety of situations among thick willows and alders and in mixed timber, but since they were rather quiet and secretive the population may have been larger. The largest testes found were in a specimen collected on May 21, but we have no other indication of the time of laying. Olaus Murie (1928) found these chickadees common along the Porcupine River but it is interesting that along Old Crow he found none, although gray-headed chickadees (*P. cinctus*) were common.

Our series of chickadees is uniformly a little paler brown on back and crown than most examples of *P. h. hudsonicus.* Their tails are as long as the longer examples among Alaskan birds. In these respects they differ from the characters of *P. h. farleyi*, which Earl Godfrey (1951) named as in the neighboring range of southern Mackenzie. The specimens from Old Crow resemble two from the Savioyuk River, at the northern limit of trees in central arctic Alaska. Our specimens fit the vague characterization of *P. h. evura* by Coues (1884) and Godfrey kindly informed us that he regarded three chickadees sent to him from the John River, Alaska, as that race.

When Alaskan specimens were compared for degree of brownness of back the palest and the darkest groups contained examples mingled from eastern and western localities. Since we could not see that the brown was distributed among Alaskan specimens according to a geographic pattern it seemed to serve no purpose to distinguish races on this basis among Alaskan boreal chickadees. There is no advantage apparent in naming the boreal chickadees of Old Crow differently from the nominate race.

The Indians call this bird *Tchichika.*

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Family CINCLIDAE: Dippers

Cinclus mexicanus unicolor Bonaparte

We did not see in the ice-covered arctic rivers any of those infrequent areas where the water remained open and where dippers remain in winter, usually in pairs. Stephen Frost carefully described two dippers he had seen in April in the stretch of open water near the mouth of Bluefish Creek and said that in February 1956 he saw similar small birds at several of the open water stretches over 200 miles from the mouth of the extraordinarily crooked Black River. Joe Kay confirmed these observations from his own much earlier observations and named the dipper as soon as he saw its picture.

The Indian name for this bird is *Tzi rzui.*

Family TURDIDAE: Thrushes, Solitaires, Bluebirds

Turdus migratorius migratorius Linnaeus

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 15	71.5	LF	5x11, 8x12.5	75.2	LF	2 mm.
	86.7	LF	6x14, 6x15			
	74.3	LF	7x12, 6.5x11			
May 16	81.0	LF	7x11, 8x10	79.4	LF	1 mm.
	76.2	LF	7x11, 7x10			
June 6	80.0	F	9x14, 10x13			
June 9	60.2	LF	8x13, 9x15			
	59.1		9x18, 10x15			
(aver.)	73.5					
June 2						4 fresh eggs, 4 slightly incubated eggs

The first robin was seen on May 8. It was shy and quiet and a week elapsed before more than one was noticed, although a few may have been about but not observed. On May 15 a few more robins were about and their numbers, noise and swift and often aggressive flights rapidly became conspicuous until on May 18 the village appeared to contain more than a suitable population for nesting. The robins seemed to be of this opinion also for their quarreling continued until the latter part of May. We then thought that some robins must have left the area, for, in addition to the subsidence of their activity, their numbers appeared to decrease.

Two nests were found on June 2. These we presume to have been laid about May 25 and 27, 10 days after the conspicuous influx of robins on May 15, but 17 days after the first was seen. In 1952 the first robin was noted at Anaktuvuk on May 18 and the first egg was reported on June 3, an interval of 16 days.

The maximum testes size was observed in a robin collected on June 9. Judging from the first eggs, some males were in breeding condition by May 25.

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Robins at Old Crow had little fat. Among 10 males at Anaktuvuk in May one was fat, the others had little fat. They are one of the arctic nesting species which are not fat during the time of arrival from migration, but September arctic specimens may be fat and heavier by about 10 grams.

Lazarus Charlie's report of a robin on Johnson Creek on May 8 is a date consistent with a migratory path through the southern part of Porcupine Valley to Old Crow. Williamson found robins at Fort Yukon when he arrived there on May 10 and they were reported arriving at Anaktuvuk on May 12, 1957. They were reported as first seen at Frances Lake on April 22, 1943 (Rand, 1946). As Frances Lake is 300 miles south by east from Old Crow there appears a discontinuity in dates of arrival across the Ogilvie Mountains, which also appear to offer a difficult migratory course. It can be suggested that robins may enter the southern Valley of the Porcupine through Peel Valley from Mackenzie Valley.

They probably travel the central flyway to the Mackenzie Valley and turn westward to occupy central British Columbia, Yukon, and Alaska.

The Indian name is *Syo*.

Ixoreus naevius meruloides **(Swainson)**

	Males			*Females*		
Date	*Weight* (*g.*)	*Fat*	*Testes* (*mm.*)	*Weight* (*g.*)	*Fat*	*Eggs*
May 4	71.5	LF	5x9, 4x7			
May 20	66.7	NF	7x12, 8x11			
May 25				86.5	F	4 broken follicles, brood patch
June 1						2 fresh eggs
June 3	81.5	F	6x10, 6x10			5 half incubated eggs
June 4				98.2	MF	3 mm.
June 5						4 slightly incubated eggs
(aver.)	73.2					

The earliest varied thrush seen was flying from the top of a spruce into the willow brush along Dave Lord Creek on May 4, when the first signs of melting were seen. Its testes were not so large as were those of specimens taken later in May. No more thrushes were noticed at Old Crow until May 16, when they were heard singing among the spruce. The interval between the first sighting and evidence of common establishment was longer than for robins which were conspicuously exposed about the village. After May 16 varied thrushes were often heard but not easily approached.

The female collected on May 25 had begun laying about May 21. This early date of laying suggests that pairs probably started preparations for nesting some 10 days earlier and that the first arrivals near

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Old Crow were unobserved. On June 1, 3, and 5 nests were found containing eggs which would have been first laid about May 23, 27, and 31, respectively. Within 100 yards of one of these nests were three old nests among small spruce, a situation conforming to the reported return of varied thrushes each year to a location close to their previous nesting sites. The other nest found this year was about a third of a mile distant.

The weight of the two female varied thrushes was greater than that of the males. Probably this represents the condition of overweight which has been frequently observed among laying females of other species.

The range of this thrush to Kobuk and Old Crow indicates its extension north of the arctic circle to near the edge of the forest across Mackenzie, Yukon, and Alaska. Since it winters from southern British Columbia to Baja California, it is a western migrant, probably passing through the mountain valleys.

The Indian name is *Sya.*

Hylocichla ustulata incana **Godfrey**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 24				31.6	M	4 broken follicles, brood patch
May 29	28.8	VLF	7x12, 7x12			
June 3	29.4	LF	7x8.5, 6x9			
June 3	28.9	LF	6x11, 6.5x10.5			
June 23	26.0	LF	5x7, 7x8			
(aver.)	28.2					

Francis Williamson heard a Swainson's thrush sing, and obtained the female specimen listed above on May 24. From its condition it must have begun laying about May 20, so that these thrushes must have been about the earliest to arrive in the vicinity of Old Crow. They were the most retiring of the thrushes, but they were by no means scarce because they were heard frequently and seen rather often although usually only briefly.

Sidney Peyton found a nest on June 29 with three fresh eggs in a slender spruce about 15 feet from the ground, in a thick growth of spruce. The first egg in this nest was laid about June 26, 37 days after the first female had begun laying. It does not seem possible that such a late laying could have followed successful fledging of an earlier brood. Before the date when this late clutch was started, the gonads of one male had been found at less than full size, and June 26 is an uncommonly late date of laying for this latitude.

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A specimen which I obtained from Bettles on July 1, 1951, establishes the occurrence of *H. u. incana* there in a habitat typical for this thrush. Reports from Eskimos at Kobuk described the nesting and singing of another thrush very much like the gray-cheeked in appearance, but differing in song and nest, and in the typical habitat. The range attributed to *incana* (A.O.U., Check-list, 1957) should be extended from northern Yukon across arctic forested Alaska to Bettles, and I suspect to Kobuk, near the western extremity of the forest.

The Indian name for this thrush is *Tzi chi tlio.*

Hylocichla minima minima (Lafresnaye)

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes*	*Weight (g.)*	*Fat*	*Eggs*
May 31	28.6	VLF	8x12.5, 10x13			
June 1				28.1	LF	3 mm.
June 3	31.7	NF	6x10, 6x10			
June 5				29.3	LF	2 mm.
June 7	31.7	LF	6x11, 7x10			
June 10	30.4	LF	7x13, 9x13			
June 12	30.4	LF	9x12, 8x12	32.5	LF	4 broken follicles, brood patch
June 13	30.6	LF	7.5x12, 8x11	34.3	LF	10 mm.
June 20	30.7	LF	8.5x10.5, 9x10			
June 22				26.8	LF	2.5 mm.

Francis Williamson reported first hearing a gray-cheeked thrush on May 22. On May 23 I saw a gray-cheeked thrush as it dashed from the willows in the swift pursuit of another, an action characteristic of male thrushes when attacking invaders of their territory. After that date thrushes were frequently heard and occasionally seen in the thick willow brush back of the village.

The testes of the first male specimen taken were as large as any found later. Date of laying can be set by the condition of the female specimen taken June 12, which indicated laying prior to June 9. This female and the one taken June 13, which contained an egg 10 mm. long, were above usual weight, a condition frequently remarked during laying.

The first date of laying by gray-cheeked thrushes was later than was observed among the three other species of thrushes which were common near Old Crow. It was remarked at Anaktuvuk that gray-cheeked thrushes were not found nesting early, and at Kobuk Grinnell (1900) recorded their first arrival on the rather late date of May 24.

The specimens from Old Crow and Anaktuvuk were typical of the nominate race which extends from arctic northwestern Alaska through southwestern Alaska and northeastern British Columbia. In migration they use the Mississippi flyway to Central and South

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America. Their northward flight in spring must proceed to about latitude 60° N. before turning westward for over 1000 miles to traverse Alaska and penetrate deeply into northeastern Siberia.

The Indian name for this bird is *Tzintzio.*

Oenanthe oenanthe oenanthe (Linnaeus)

1 male	June 9	weight 32.0 g.	little fat	testes 5x8, 6x6 mm.
1 female	June 9	weight 35.5 g.	fat	egg 10 mm., 4 empty follicles

Wheatears were not observed on the southernmost of the Old Crow Mountains but Robert Bruce and I found a pair near the base of the next northern and higher mountains on June 9. Altogether we saw about ten in a few hours while climbing over the barren rocky mounttain at elevations from about 2,000 to 3,500 feet. They were as shy and restless as usual during nesting time in the Alaskan Brooks Range. Joe Kay identified the specimens at once, giving their Indian name as *Ttha Tze*, and was familiar with their shyness on the rocky mountain slopes.

The condition of the female listed above established first laying about June 6. The soft fat of the wheatears was creamy white, as was remarked at Anaktuvuk. The female was fat and above usual weight showing its adequate nutrition while living on the barren mountain during the intensive production of eggs.

Wynne-Edwards (1952) reported the southeastern record of these Asiatic birds in America in the eastern part of the Mackenzie Mountains at latitude 64° 20′ N., longitude 128° 20′ W., a point which he remarks upon as not much more than 1,000 miles west of the western record of wheatears from eastern America. They are reported summering in mountain areas of southwestern Yukon and along the arctic coast (Rand 1946). Their migration leads from Alaska to the Chukchi Peninsula and southwestward along the Stanovoi Mountains to Udski and thence farther through the interior of Asia (Stejneger, 1901, p. 474). The nearest reported regular wintering place of this race is far westward from Alaska in North China, and their migration which almost reaches the Mackenzie, leads them farther eastward into the American Continent than any of the other land species wintering in Asia.

Because of the large weight of these two wheatears, Bernard Feinstein kindly reexamined the measurements of these specimens and those from Anaktuvuk. He found them all to conform to *O. o. oenanthe*, no distinction being signified by these weights.

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Family SYLVIIDAE: Old World Warblers, Gnatcatchers, Kinglets

Regulus calendula calendula (Linnaeus)

1 male	June 3	weight 6.7 g.	no fat	testes 4x5 mm.

On May 17 a kinglet was observed. The male which was collected was in company with another, apparently its mate. Joe Kay remarked that kinglets were sometimes seen in winter at Old Crow, where they are called by the Indians *Khut traluk.* We have also had reports from Eskimos at Anaktuvuk and Kobuk, Alaska, that kinglets were occasionally seen there in winter, but these reports are not confirmed by winter specimens.

In the northwest the kinglets are all *R. c. calendula.* The winter range of this race is eastward and southward from Nebraska (A.O.U., Check-list, 1957), so it is likely that the northwestern population migrates southeasterly along the eastern parts of the mountains. Records are scarce in British Columbia (Munro and Cowan, 1947), whereas Rand (1946) found these kinglets "fairly common" in southern Yukon.

Family MOTACILLIDAE: Wagtails and Pipits

Anthus spinoletta rubescens (Tunstall)

13 males	May 6–June 9	weight 18.8–23.6, average 20.7 g.	fat (8), medium fat (1), little fat (3), no fat (1)	—

Joe Kay on May 8, brought in the first two specimens of pipits, which the Indians call *Kwit kkyo zyo.* For six days they occasionally alighted in the meadow by the river near our cabin. Some of the flocks seen contained 12 pipits, but because they were usually so restless we could not form an estimate as to how many were migrating through Old Crow. The first eight specimens obtained near the village and during migration were fat males with testes less developed (5 to 7 mm.) than when they were found later on the mountain.

After May 15 pipits were not seen near the river. In June they were occasionally heard and seen in grassy or rocky places above 2500 feet in the mountains where three males were collected. Their testes were then enlarged, (8 to 9 mm.) they had little or no fat, and appeared to be occupants of breeding territories.

Our specimens of pipits from Old Crow (13), Anaktuvuk (33), and Ahlasuruk (2) are identified as *A. s. rubescens,* the range of which is thus extended across arctic Yukon and Alaska to within 200 miles of the western arctic coast. *A. s. pacificus* has been named by Bailey (1948) as the race at Barrow, and northern Alaska and Northeastern

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Siberia are given as the range of *pacificus* in the A.O.U. Check-list (1957), which does not extend *rubescens* west of arctic Yukon. Since Ahlasuruk River is about 200 miles from the western arctic coast of Alaska, *rubescens* and not *pacificus* extends across arctic Alaska at least in the interior.

As this race of pipits winters east of Texas their migratory flight probably passes east and west across most of Yukon (Rand, 1946). Since they are not recorded from British Columbia (Munro and Cowan, 1947) they probably travel the Mackenzie Valley and the central flyway.

Family BOMBYCILLIDAE: Waxwings

Bombycilla garrula pallidiceps Reichenow

3 males	Apr. 18–June 1	weight 49.6, 50.3, average 54.0 g.	fat (2), medium fat (1)	—
4 females	Apr. 18–June 29	weight 59.1–58.7 g.	fat (4)	—

A flock of ten Bohemian waxwings was seen on April 10 in their characteristically erect positions on the tops of some birches and poplars. Later they were frequently heard and seen in small flocks flying, feeding, or resting in the tops of the birches and poplars. Six of the seven specimens taken were fat. The testes of the last male specimen, taken on June 1 were enlarged but perhaps not to breeding size, and on June 29 a female specimen had a brood patch. These dates bracket egg laying.

There was no apparent change in the numbers of waxwings present, but flocks were not remarked after June 1.

The Indians spoke of waxwings as winter birds near Old Crow, where they are called *khut tsa luk*, and at Kobuk they are considered to be winter birds by the Eskimos. Rand (1946) called the waxwings migratory in Yukon and we have not found reports of them in arctic forests earlier than April or later than October 15. At these seasons winter conditions prevail. The birds of several species in the arctic forests are migratory in the sense that in winter flocks concentrate and move for some distance in search of favorable feeding places. If they are true forest-dwelling birds the trend of their concentration and movement in the northern margin of forest could only take them southward. It has also been remarked however that in central arctic Alaska some chickadees and pine grosbeaks move north of the forest on to the tundra in winter. We have not now the evidence which would show in these wanderings the precision of course that characterizes the great spring migrations. The distinction of the marked and long migrations is not only their distance, but the regularity

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which demonstrates that they are developed through long experience of the population and repeated through the operation of memory. These are quite different influences from the current impulses apparently directing movements of waxwings without known directional regulation.

Family LANIIDAE: Shrikes

Lanius excubitor Linnaeus

On April 16 a shrike lit in the top of the willows along the river and after a few short flights from our pursuit disappeared among the willows on the island just above the village.

Joe Kay recognized the illustration of a shrike and gave the name *Tsi kwut go katshilyi*, which he said referred to the shrike's habit of hanging its prey on bushes. No other shrike was seen. Above the timber on the mountains we did not find the situations in extensive willow-filled valleys where shrikes are rather common in spring and summer in central arctic Alaska.

Family PARULIDAE: Wood Warblers

Four of the wood warblers at Old Crow are assigned to races which extend far eastward from Yukon. *Vermivora celata celata*, *Dendroica petechia amnicola*, and *D. striata* nest across northern Yukon and Alaska, while *Wilsonia pusilla pusilla* is replaced by *W. p. pileolata* at Anaktuvuk. *V. c. celata*, *D. p. amnicola*, and *D. s. lurida* seem to be confined to the northern part of Yukon. This area serves as an arctic bridge connecting the Canadian and Alaskan populations, which extend to the northern limit of forest.

It is difficult to decide whether the water thrushes from Old Crow are *Seiurus noveboracensis notabilis* or *S. n. limnaeus*. If they are *notabilis* they should be counted as eastern warblers, if *limnaeus* they are of a western race, as is clearly the Old Crow *D. c. hooveri*. The western races of warblers extend farther south in Alaska and Yukon than do the four eastern races.

It is not yet clear whether the eastern races of warblers migrate to Alaska along the Porcupine Valley, where they nest, or through southern Yukon, where the migrating races have not been clearly separated. In fact better identifications and range determinations of warblers in Alaska and Yukon will give significance to what now appear to be peculiar distributions.

I am particularly indebted to Bernard Feinstein of the U. S. National Museum for his help in making the comparisons by means of which the wood warblers are identified.

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The species at Old Crow are listed below with regard to their habitat preference and nesting abundance:

Species	*Order of habitat wetness*	*Order of nesting abundance*
Vermivora celata celata	5	4
Dendroica petechia amnicola	3	1
Dendroica coronata hooveri	6	5
Dendroica striata	4	6
Seiurus noveboracensis notabilis or limnaeus	1	2
Wilsonia pusilla pusilla	2	3

Vermivora celata celata **(Say)**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 21	8.7	LF	4x5, 3x4.5	8.8	MF	1.25
May 24	9.6	LF	4x5, 4x4	8.9	LF	1
	9.1	LF	3.5x6, 4x4			
	9.5	LF	4.5x6, 5x6			
May 27	9.7	VLF	5x7, 5x5			
May 28	10.0	LF	4x4.5, 3x4			
May 31	8.8	LF	4x6, 4x5			
June 1	9.5	LF	4x5, 4x4	10.1	LF	5
	9.1	LF	4x5, 4x4			
June 10	9.4	LF	3x6, 4x6			
June 29				10.0	LF	1.5
(aver.)	9.3	(Coeff. of var. 4.4%)				

Two orange-crowned warblers were first heard by Frank Williamson on May 20 singing among the poplars and scattered spruce along the slope of the bluff. Thereafter several might be seen in that area daily, where they came readily and swiftly to a call. Frequently a pair of birds came and pairs were seen among the earliest orange-crowned warblers. Until May 28 these were the most common of the warblers, but thereafter water thrushes and yellow warblers became much more numerous. This was in part because of the rather limited areas in which orange-crowned warblers were found. The testes of the males taken during the month showed no trend in changing size.

On June 1 a female contained an egg 5 mm. long, which must have been nearly ready for laying.

The nominate and most northern race of orange-crowned warblers nests from Alaska to Quebec and winters widely across the southern states. In Yukon this race has only been identified from Old Crow, not from further south. The range of this eastern wintering race seems to extend for about 1000 miles in arctic western America near the border of forests.

The Indians call this bird *Tzi vit tich kwatlo.*

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***Dendroica petechia amnicola* Batchelder**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 27	10.2	LF	4.5x7, 5x5.5			
May 28	10.0	VLF	4.5x7, 4.75x 5			
May 31	9.0	LF	5x7, 5x5	10.4	LF	6 mm.
	9.3	LF	4x7, 5x5			
	8.7	LF	6x6, 5x5			
	9.3	LF	4x5.5, 3.5x5			
June 1	9.5	LF	5x7, 5x5	9.6	LF	3 mm.
June 2	9.6	LF	4.5x8, 5x6			
	10.3	LF	4x6, 4x5			
June 6	9.4	NF	5x7, 5x5	9.8	MF	2 mm.
	9.5	LF	5x7, 5x5			
	10.3	LF	5x8, 6x6			
	9.6	LF	——, 5x6.5			
	9.7	LF	——. 4x4.5			
June 7	8.5	LF	6x8, ——	9.5	LF	2 mm.
	9.8	NF	7x8, ——			
	9.8	LF	6x7, 4.5x6			
June 8	8.7	NF	5x7, 5x6	9.7	LF	1 mm.
	8.6	NF	5x7, 5.5x7	8.8	VLF	2 mm.
June 10				8.8	LF	3 mm.
				8.5	LF	2 mm.
June 12	8.1	NF	2x3, 5x6	9.4	LF	2 mm. 1 broken follicle
	9.3	LF	4x5.5, 4x4	10.8	LF	1 egg forming
	8.1	LF	2x5, 5x5			
June 16						3 sets of 5 fresh eggs
June 18						1 set of 5 fresh eggs
June 20				10.5	LF	2 mm.
June 23						1 set of 5 fresh eggs
(aver.)	9.3	(Coeff. of var. 7.0%.)		9.6		

The first male yellow warbler was seen May 23 in the willows above the overflow from the river. No others were noticed until May 27, when they were occasionally seen in the willow-alder brush on the flat behind the village. The numbers kept increasing until about June 8, when they were the commonest birds in the vicinity, for a pair might be seen every 50 feet along a trail for a distance of several hundred feet. Apparently some pairs occupied a territory with the center only 25 feet distant from the edge of a neighbor's territory. In other willow-alder thickets along the river many yellow warblers were seen. Farther up the Porcupine River the prevalent spruce reduced the extent of their habitat.

About June 8 their territories and mating appeared to be in settled good order. On June 12 the testes of three male specimens either had regressed or were still undeveloped, and a female specimen contained a formed egg and a collapsed ovarian follicle. On June 16 three nests, each with five eggs, were found by Sidney and Leonard Peyton, and on June 23 one with five fresh eggs was found. Yellow warblers were the latest of the warblers to arrive and nest. The first eggs in these nests were laid about June 10, 11, and 16 respec-

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tively. The first egg was thus laid 18 days after the first male was seen and 14 days after yellow warblers became common.

The excess of weight in females over males may be related to the presence of numerous females with enlarged eggs. In several other species it has been remarked that gravid females are heavier than those not laying. At no time during our observation were any of the species of warblers found to be fat. Of 91 specimens only three, all females, were found to be medium fat.

These yellow warblers and those from northern Alaska were all consistent with the race *amnicola*, which ranges across the continent undifferentiated from Alaska to Labrador. The arctic range, however, is confined to the area west of the Mackenzie River.

The Indians call this bird *Tsetso*.

Dendroica coronata hooveri McGregor

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 20	12.0	NF	4.5x7, 4x4.5	11.8	NF	1
May 21	11.8	NF	——, 3x5			
May 24	13.5	LF	5x8, 5x7			
June 3	13.0	LF	——, 5x5			
June 4	13.2	NF	6x10, 5x6			
June 28	14.0	LF	5.5x9.5, 8x8			
(Aver.)	12.9					

Frank Williamson heard the first myrtle warbler singing on May 18. Between May 20 and 28 an individual or a pair could occasionally be called in the mixed spruce and poplars along the slope of the bluff, but thereafter they were seldom noticed. Williamson found them rather common at Driftwood River, and near Kenneth Nukon's cabin, 15 miles east of Old Crow, there were a few about on June 3, 4, and 5. No eggs were found but because of the presence of pairs during the breeding season it is concluded that myrtle warblers were nesting. The Indians call this bird *Kyekyszez*.

This northwestern breeding race of myrtle warblers migrates to winter from southern Oregon through the valleys of California (Wetmore, 1926, p. 206).

Dendroica striata (Forster)

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 29	12.4	LF	5x7.5, 6x6			
June 3	12.1	NF	5x9, 5x7			
June 5	13.7	LF	5x7, ——			
	12.6	LF	5x7, 4x5			
June 6	12.5	LF	5x9, 5x6			
June 10	11.4	NF	4x6, 4.5x5.5			
June 23				12.8	MF	5 heavily incubated eggs

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The first blackpoll warbler was heard singing by Frank Williamson two days before the first one was seen and collected on May 29. Since they are considered common in far northern forests we searched for them but saw fewer than of any other warbler around Old Crow. At Kenneth Nukon's cabin, 15 miles east of Old Crow, blackpolls were common on June 3. The only nesting record was June 23, when Sidney and Leonard Peyton collected the female specimen with 5 well incubated eggs. The first egg was estimated to have been laid about June 12.

The Indians call this this bird *Tzi vit sitik kwarzui.*

At the U. S. National Museum, Bernard Feinstein remarked that our blackpoll warblers and specimens from Alaska differed from eastern specimens in having less black on the back and generally duller gray upper parts, as described by Burleigh and Peters (1948), for *Dendroica striata lurida*, a form not recognized by the A.O.U. Checklist (1957). The area in which intermediates between *lurida* and the more eastern form were found was around Fort Severn, Ontario, and Churchill, Manitoba, so that our Old Crow specimens were far from the eastern border of the range of their race.

Seiurus noveboracensis notabilis **Ridgway**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 21	17.4	VLF	4.5x7, 4x6			
May 28	17.9	VLF	4x6, 4x5			
	17.7	VLF	5x5, 4x5			
May 29	16.6	NF	6x7.5, 5x7			
	15.7	NF	4x4.5			
	16.9	LF	4.5x6			
May 31	17.8	LF	5x6, 6x7			
June 3	17.4	LF	5x7			
June 5	15.6	VLF	5x6.5, 5x6	18.5	LF	2
June 7	16.1	NF	3x7, 4x5.5			
	17.3	LF	5x9, 6x7			
	16.4	NF	4x7, 5x6			
	18.1	LF	5x6, 5x5	17.9	NF	6
June 12	16.4	LF	4.5x6, 5x6.5	22.5	LF	[1] 7
June 13	16.6	LF	5x7, 5x6			
June 20	16.5	LF	5x8			
(Aver.)	17.0 (Coef. of var. 3.8%.)					

[1] 1 broken follicle, 1 egg forming.

On May 20 the first northern waterthrush was heard singing in the willows, above the noise of the river, and thereafter their loud clear song could be heard, often at considerable distance from the swampy willow brush. The male would fly to the top of a willow, sing his series of notes about half a dozen times and then dive groundward into the dense brush. Within five minutes he might be up again for a period of song, this time on another willow, until after occupying

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four or five positions he returned to a point near the first perch. The song and singing positions were conspicuous but the thickness of the brushy surroundings and the brevity of the bird's appearances made it difficult to observe them near the ground.

After several males had been collected, a special effort was made to find females and evidence of nesting. The sexes could not be distinguished in appearance and apparently were not distinctive in action in their wet marshy terrain under the thick willows, for only three females were obtained. One of these, taken on June 7, had an egg ready to lay and one taken on June 12 contained a formed egg and a collapsed ovarian follicle.

The Indians know these birds as *Chootzi*.

After examining our waterthrushes at the U. S. National Museum, Herbert Friedmann wrote me, "McCabe and Miller (1933) indicate that *S. n. notabilis* exists in two geographically separate populations. These birds [from Old Crow], from the northwestern of the two groups, are darker above, varying in the direction of *limnaeus*, from which race some of the individuals are difficult to separate. This raises the possibility that the western section of *notabilis* may better be grouped with *limnaeus*, and in this way we can do away with the discontinuity in the distribution of *notabilis* which McCabe and Miller indicated."

The migratory course of these waterthrushes does not appear definable from the scattered records of localities. Since they approach the western race in appearance it may be presumed that their migration passes west of the Mississippi.

Wilsonia pusilla pusilla **(Wilson)**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 20	8.5	NF	4x7, 4x4.5			
May 21	7.7	LF	3.5x5, 3.5x4			
May 22				7.3	VLF	0.75 mm.
May 29	7.9	NF	3x4, ——			
June 1	7.6	VLF	5x7, 4.5x5			
	7.3	VLF	4x6.5, 5x5			
	7.7	LF				
June 7				8.8	LF	4 broken follicles, 1 formed egg, brood patch
June 8	7.5	NF	5.5x8.5, 5x6.5	8.1	LF	2 mm.
June 10	8.3	LF	5x8, 5x6			
	7.8	LF	4.5x6, 5x6			
(Aver.)	7.8 (Coeff. of var. 5.2%.)					

The first Wilson's warblers seen were singing in low willow brush, where they were subsequently often seen, usually near running water. The first part of their Indian name, *Tsetso khekui*, means water.

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They appear in lower brush than waterthrushes and less commonly over standing marshy water. The female specimen taken on June 7 indicated first laying about June 4. A Wilson's warbler was seen in the 4-foot high willow brush along a small stream valley between the second and third of the Old Crow Mountains, above tree line and at an elevation of about 2,000 feet.

I have found *W. p. pileolata* the form occurring along the headwaters of streams flowing northward through the arctic tundra in Alaska. This, together with Bailey's (1948) reports on their occurrence in northern Alaska, establishes this species, the smallest in the family, as the most northerly of the wood warblers.

On June 20 Sidney Peyton found six newly hatched young in a nest well hidden in the moss at the bottom of a small bank. The first egg was probably laid about June 4. On June 21 snow began to fall, and, on the next day it was 6 inches deep. On June 24 all the young were found dead.

Three of the specimens trend a little in coloration from the darker backs of *pusilla* toward the lighter *pileolata* but all match *pusilla* in color of underparts. It appears that the specimens are variants among *pusilla* rather than intergradations with *pileolata*. On this basis they are extensions westward of an eastern population. Porsild (1943) had reported *pileolata* from the Mackenzie Delta, and Rand (1946) attributed Ross' (1862), Lapierre House record to *pileolata*. In southern Yukon *pileolata* has been commonly recorded. Our specimens probably indicate that the eastern form extends westward through the Porcupine Valley meeting the Alaskan range of *pileolata*, which extends along the Yukon River. This extension of *pusilla* westward is north of the range attributed to *pileolata* in southern Yukon and northwestern British Columbia.

Family ICTERIDAE: Blackbirds

Euphagus carolinus carolinus (Müller)

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 10				52.1	MF	1.5 mm.
May 22	63.5	LF	10x15, 7x10			
June 6	66.2	LF	7x10, 9x8			
June 26	60.9	MF	9x13.5, 12x12.5	52.9	MF	2 mm.
June 7						5 half incubated eggs

A female rusty blackbird was collected near the village on May 10 by Joe Kay. Until May 17 blackbirds were frequently seen as they were apparently settling in the willow alder brush near by. On May 19 a male was chasing a female and on May 20 some pairs

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appeared to be settled. The numbers increased and pairs became more numerous, until by about May 24 the population of blackbirds became about one fourth as numerous as the robins. Keeping near the tops of the trees, they were as conspicuous as robins, but much less active. On June 5 a blackbird was seen flying in hot pursuit of a large owl.

On May 22 the testes of specimens taken had reached the largest size measured, and on June 5 a nest with 5 half-incubated eggs was found, the first evidently laid about May 25.

Lazarus Charlie reported that the first blackbird arrived on May 2 at Johnson Creek, a tributary to the southern part of the Porcupine River. The air distance from Old Crow is only 80 miles south by east, but it is three times as far along the river.

The winter range of this bird is so widespread that it provides no suggestion as to the migratory course taken to Old Crow.

The Indians call this bird *Chilly cho.*

Family FRINGILLIDAE: Grosbeaks, Finches, Sparrows, Buntings

Three species of Fringillidae are found in winter at Old Crow. Only pine grosbeaks (*Pinicola*) are differentiated as a race confined to Alaska, Yukon, and Mackenzie. White-winged crossbills (*Leucoptera*) and hoary redpolls (*Acanthis hornemanni exilipes*) have a wide North American range. The arctic Yukon population of hoary redpolls is significant, however, because they have not been reported in southern Yukon, and so this northern population forms the narrow connection between the numerous hoary redpolls of Alaska and Mackenzie. Snow buntings have not been reported wintering in Yukon, which thus separates the populations wintering in Alaska and Mackenzie. In their early spring migration the arrivals at Old Crow seem to come from the Alaskan wintering population. One other migratory species (*Calcarius*) forms a race which nests principally from Alaska to Mackenzie. Northwestern America is thus the special range of a race of resident pine grosbeaks, a race of migratory Alaska longspurs, and a population of migratory snow buntings.

Among the other migratory species of Fringillidae six races nest in arctic America only from the Mackenzie westward. Only the fox sparrow (*Passerella*) can be called an eastern American race, the remainder migrating through western States and Provinces.

It is probable that snow buntings approach Old Crow from the west and fox sparrows from the east or southeast. The arctic routes of the others cannot now be indicated.

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This information is summarized in the following tabulation:

Species	*Arctic nesting range*	*Nearest wintering place*	*Migratory course*
Acanthis hornemanni exilipes	Lapland east to Mackenzie	Old Crow	–
Acanthis flammea flammea	Scandinavia east to Keewatin	Northern Alaska	–
Passerculus sandwichensis anthinus	Alaska to Mackenzie	Southwestern British Columbia	Western Mountains
Junco hyemalis hyemalis	Alaska to Mackenzie	Southwestern British Columbia	Western Mountains
Spizella arborea ochracea	Alaska to Mackenzie	Southern British Columbia	Western Mountains
Zonotrichia leucophrys gambelii	Alaska to Mackenzie	California	Western Mountains
Passerella iliaca zaboria	Alaska to Mackenzie	Eastern Kansas	Mississippi, Mackenzie
Melospiza lincolnii lincolnii	Alaska to Mackenzie	Northern California to northern Georgia	–
Calcarius lapponicus alascensis	Alaska to Mackenzie	Montana	Western Mountains
Plectrophenax nivalis nivalis	Alaska to Greenland	Alaska	Porcupine River

The species present at Old Crow are numbered below in order of their nesting abundance:

Species	*Order of nesting abundance*	*Species*	*Order of nesting abundance*
Pinicola enucleator alascensis	7	Spizella arborea ochracea	3
Acanthis hornemanni exilipes	4	Zonotrichia leucophrys gambelii	1
Acanthis flammea flammea	5	Passerella iliaca zaboria	2
Loxia leucoptera leucoptera	8	Melospiza lincolnii lincolnii	–
Passerculus sandwichensis anthinus	9	Calcarius lapponicus alascensis	–
Junco hyemalis hyemalis	6	Plectrophenax nivalis nivalis	–

Pinicola enucleator alascensis Ridgway

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 6		LF	2.5x3, 2x2		VLF	1
May 13	59.3	VLF	7x10, 7x8	61.9	LF	2
May 19	60.1	VLF	5.5x7.5, 5.5x6.5	59.0	VLF	2
May 30	59.2	VLF	11x13.5, 12x12	64.6	VLF	2
June 4	53.5	NF	9x11, 9x10			
June 20	55.6	LF	8x9, 8x9	54.5	LF	2
(Aver.)	57.5			60.0		

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Early in April pine grosbeaks were commonly seen feeding in willows. The small groups included some pairs, for the bright rosy males were conspicuous. Some males with very little pink could not be distinguished in coloration from females. Both sexes were singing, as some female specimens were collected while singing.

Of the specimens collected, those taken, at the end of April had testes of the largest size and their plumage was the deepest red. The males were then exhibiting themselves most conspicuously, so that nesting was probably in progress. Even in April, the feathers of specimens were loose and in June could scarcely be kept on the skin. Apparently moulting followed soon after the early nesting date.

Pine grosbeaks and willow-ptarmigan, both of which feed on willows in the Arctic spring, are commonly lean birds. The grosbeaks were the only species of *Fringillidae* at Old Crow which commonly had very little fat. At the same season the migrating snow buntings, which feed upon seeds of annual plants, and the resident cross-bills, which feed upon spruce cones, presumably eating their seeds, were fat. The resident waxwings also were fat.

The Indian name for the pine grosbeak is *Teevay*.

Acanthis hornemanni exilipes **(Coues)**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
Apr. 19	14.6	F	3x4, 3x3			
May 1	13.3	VLF	5x6, 5x5			
May 16	13.3	MF	5x6.5	12.5	MF	
May 18	14.3	LF	5x6.5, 4x6.5			
	13.3	NF	5x6.4, 4x4.5			
May 22	13.4	LF	6.5x7, 4.5x6			
May 24	13.4	VLF	6x8, 6x7	13.5	F	0.75
June 6	13.9	MF	5.5x6, 6x6			
June 7	12.6	LF	4.5x5, 5x5.5			
June 12	13.1	LF	6x6, 5x5.5	12.0	NF	2
June 12	14.0	NF	5x6, 5.5x5.5			
(aver.)	13.6			12.7		

During April small groups of redpolls were occasionally seen. They moved so restlessly that few of them could be identified, but those which could be seen were thought to be hoary redpolls. The Indians consider redpolls winter birds, and no increase in numbers suggesting migration was noticed until after May 20, when the first common redpolls were remarked. Hoary redpolls as well then became more conspicuous, but it appeared that the increase in numbers was temporary, as if a small migratory flight passed through.

No flocks of more than ten redpolls were seen, and the numbers were few in comparison with the great numbers visibly migrating in spring and nesting in summer on the tundra in the central part of

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the Brooks Range. There a few hoary redpolls are also winter residents.

Hoary redpolls have been reported in southern Yukon only from Forty Mile (Rand 1946). Since that country has been traveled by a number of observant naturalists, the lack of records indicates that the large hoary redpoll populations of Alaska and Mackenzie are separated in the south but connected in the north.

The Indians call this bird *Taloo.*

Acanthis flammea flammea **(Linnaeus)**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs*
May 21	12.3	VLF	5x7, 4.5x5			
May 24	12.8	NF	5x8.5, 5x6			
May 31	13.0	MF	5x6, 5.5x5.5			
	12.2	LF	5.5x6, 5x6			1 egg, brood patch, 2 empty follicles
June 5	13.6	MF	6x7, 5x6	15.7	F	
June 6	12.4	NF				
June 9				11.2	LF	1.75 mm.
June 12	13.0	LF	5x6, 5.5x6			
June 17	12.8	NF	5.5x7, 5.5x6	14.9	F	1.75 mm.
June 26	14.5	LF	7x8, 7x7			
(aver.)	13.1					

The earliest common redpoll observed was collected on May 21. Thereafter specimens were sought more eagerly than were hoary redpolls, but in spite of our bias it seemed that after their migratory arrival common redpolls were more numerous than hoary redpolls. On June 1 a redpoll's nest with two eggs was found and on June 17 a nest was found with five slightly incubated eggs, but neither parent was identified. A female specimen of common redpoll had laid two eggs on June 5.

The common redpolls at Old Crow were less fat than the hoary redpolls and weighed slightly less. The average weight of common redpolls at Old Crow, 13.1 grams, was not significantly different from the average 12.9 grams at Anaktuvuk. Common redpolls are not known to winter in either locality, but they are found near Nulato (Dall, 1869) and at Forty Mile (Rand, 1946). This sight record appears to indicate winter residence, and one of Grinnell's (1909) specimens from Forty Mile was dated November 5. The wintering common redpolls of southern Mackenzie or Alaska might be the source of the nesting common redpolls. We have no indication of which direction they travel to Old Crow, but it seems likely that it is either eastward or westward, rather than northward over the Ogilvie Mountains.

Common redpolls are recorded from various parts of Yukon (Rand, 1946) and their distribution seems to be continuous in summer across Yukon and is probably continuous across southern Yukon in winter.

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In the southern continuity of their range from Alaska to Mackenzie the common and hoary redpolls seem to differ.

Loxia leucoptera leucoptera Gmelin

2 males	Apr. 8 and 18	weight, 22.5, 28.0 g.	fat (1); medium fat (1)	testes 4x4, 8x8 mm.
1 female	Apr. 18	weight, 24.6 g.	medium fat	——

On April 8 a loosely associated flock of twelve crossbills included some which remained associated as pairs while they were feeding among the black spruce near its upper limit. The testes of the male specimen were then 4 mm. in length. On April 18 a pair was collected in the black spruce at about 1,200 feet, the male having well developed testes, but the eggs in the female were little enlarged. Occasional small flocks were seen in April and pairs were found thereafter, always in the spruce. The Indians speak of crossbills, which they name *Tizinkee*, as birds resident throughout the year.

Passerculus sandwichensis anthinus Bonaparte

1 male	May 21	weight 18.4 g.	very little fat	testes 5x9, 7x8 mm.

Accustomed to the commonness of Savannah sparrows in much of northern Alaska, we looked carefully for them at Old Crow, but only about four were noticed, too few to allow us to seek information about them from the Indians there. The areas searched did not have much of the grassy marshland where these sparrows are so familiar in northern Alaska. Porsild (1943) remarked that in some years they were common, in others rare in the Mackenzie Delta.

Junco hyemalis hyemalis (Linnaeus)

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 15	19.4	VF	1x125, 0.5x0.75			
May 16				18.0	F	0.5–1
June 10				20.0	LF	[1] 2
June 17				19.4	NF	2
June 28	20.3	LF	6.5x8.5, ——			([2])
June 1						

[1] Brood patch.
[2] 5 fresh eggs.

Two juncos were seen on May 15 and on the next day a few were heard singing. Thereafter they were often heard singing and were seen occasionally. Most often they were in the rather open mixtures of spruce and deciduous trees or brush.

On June 1 a nest with five fresh eggs was found by Sidney Peyton. The first of these must have been laid about May 25, ten days after the earliest junco was seen. A female specimen on June 10 had a brood patch.

The Indian name of this bird is *Tchikikeekeejay*.

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***Spizella arborea ochracea* Brewster**

8 males	May 16–June 20	weight 16.7–20.2, average 17.8 g.	medium fat (2), little fat (2), very little fat (1), no fat (1)	—
6 females	May 20–June 29	weight 14.1–19.4, average 16.8 g.	medium fat (2), little fat (3), very little fat (1)	—

In this small series the male and female tree sparrows at Old Crow were a little lighter in weight than the respective averages of 18.4 and 17.7 grams found during several years at Anaktuvuk.

The first male was collected on May 16. On the next day males were singing extensively in the willow-alder brush near the village. By May 18 many territories seemed to be settled but the numbers of birds seen increased until May 24. Tree sparrows were then nearly as numerous as Gambel's sparrows but not quite so conspicuous as fox sparrows. In fact their arrival, settlement, and general behavior was quieter than it was for most of the migratory species. By June tree sparrows were widely distributed in grassy places and deciduous brush, but not in the continuous spruce forest. They were found at elevations 500 feet above the upper limit of spruce growth.

On June 5 a nest with five eggs was found by Francis Williamson at Driftwood Creek, where tree sparrows were uncommon in the extensive spruce forests. Another nest with five half-incubated eggs was found on June 29, one of the latest discovered. It might have been a second attempt at nesting but was too early to follow a successfully raised brood.

The Indians call this bird *Tchinkee.*

***Zonotrichia leucophrys gambelii* (Nuttall)**

18 males	May 15–June 22	weight 25.3 g., average; coeff. var. 6.5%.	—	—
10 females	May 21–June 22	Weight 23.4 g.	—	—
	June 1	—	—	5 fresh eggs
	June 2	—	—	5 fresh eggs
	June 14	—	—	6 half-incubated eggs

In the grassy areas and willow-alder brush around Old Crow Village white-crowned sparrows, which the Indians call *Natsik*, were about equally as numerous as tree and fox sparrows. Wherever spruce was replaced by grass or deciduous brush they might be found. They were about the commonest species seen in the whole area. They were above tree line, and a nest with five eggs was found at about 3,000 feet on the steep, barren, dry, rocky slope of the second Old Crow Mountain. Because of the extent of their varied habitat white-crowned sparrows are considered the most numerous among the species of Fringillidae nesting about Old Crow.

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Gambel's white-crowned sparrows were recorded as first seen at Old Crow on May 14. By May 17 many were singing. On May 19 the numbers had further increased until they were the most commonly seen bird in the vicinity of the village. At this date they appeared to have settled most territorial limits, in which the males were singing, but there were still some territorial adjustments in progress through invasion and judgment by combat.

In average weight of males and females white-crowned sparrows at Old Crow did not differ significantly from males and females at Anaktuvuk, or from males at Mountain Village, Alaska (Oakeson, 1953). The average weight of six males in the first 5 days after arrival was greater than the average of nine males weighed during the next 30 days, and the degree of fatness recorded indicated that some fat which was present at the end of migration had been consumed at the time when the young were fledged (see fig. 19, in the Appendix).

During the time of laying eggs three females weighed 31, 33, and 31 grams, about 8 grams, or over 30 percent above the average weight of nongravid females. The heaviest, which had laid five eggs, as shown by collapsed ovarian follicles, and contained a formed egg, was then nearly 10 grams heavier than the usual nonbreeding female. An individual egg might weigh three or four grams, but this is not enough to account for the excess in weight of the gravid females. One of these females was marked as having little fat and two as medium fat. The degree of fatness was not greater than in nongravid females, so that not all of the tissues responsible for the increment in weight can be indicated.

The efficiency of a hen in converting food to egg may be 77 percent (Brody, 1945), so that in forming its own weight of eggs, as is contained in a clutch of six, a sparrow must consume more than its own equivalent of food for egg production during the six days of laying. The rate of energy consumption in forming eggs probably requires something like twice the usual consumption of food by the female bird during laying. Evidently the resources in the sparrow's metabolic capability and its food supply in arctic spring are sufficient to permit this sudden extra metabolic effort required during egg laying. I have earlier remarked that while male birds of several species appear to decline in weight and fatness after arrival in arctic Alaska and during breeding, females do not so often show a decline until after the young birds are being fed. The good condition of the laying birds is evidence that these events impose no stress.

The reproductive schedule of Gambel's sparrows at Old Crow can be indicated from the ruptured ovarian follicles found in two female specimens, each of which also contained a formed egg, from three

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sets of eggs collected, and from three broods of birds near fledging which were banded (see fig. 19). The degree of incubation or progress toward fledging was estimated by considering 9 days the duration of nestling growth, following Barbara Oakeson's (1954) studies on Gambel's sparrows at Mountain Village, Alaska, and our observations at Anatuvuk (L. Irving and Krog, 1956), and 12 days the duration of incubation. In six nests the first egg was calculated to have been laid between May 25 and May 28. The first egg was laid 11 days after the first male was seen and the interval between the arrival of the first male and the average date for the first egg in six clutches was 13 days. The schedule appears reliable because there is no error in calculating the date of the first egg from the discovery of ruptured ovarian follicles and a well formed egg. As additional evidence for early laying, an egg 7 mm. long was found in the first female collected on May 21. This egg could be expected to be laid within a few days.

At Anaktuvuk, two eggs were recorded by Simon Paneak as found on June 1, 1954, and two females, taken on May 25 and May 27, each contained an egg 3 mm. long. The first migrants are usually seen there about May 15. This suggested an interval of about 15 days between the first arrival and the first egg, three days shorter than was estimated from occasional earlier records at Anaktuvuk.

The careful records of the schedules of individual Gambel's sparrows at Mountain Village presented by Barbara Oakeson (1954) showed that in 1950 the first male arrival on May 10 was followed by the first egg on May 25, an interval of 15 days. At Old Crow the completion of all of the preparations for the first laying observed occurred in the 11 days after the first male bird was seen. There the country is evidently well suited for the large breeding population, while at Mountain Village, Barbara Oakeson found Gambel's sparrows not numerous, and at Anaktuvuk they were far less common than at Old Crow. Mrs. Oakeson found that the duration of the intervals between arrival and laying at Mountain Village was only about half as long as for *Z. l. pugetensis* at Friday Harbor. There is undoubtedly acceleration of the breeding cycle at Old Crow and shortening of its duration by synchronization of the schedule throughout the population. The shortening of the schedule is of course a necessity in a high latitude where the season suitable for breeding is so short. From information which Mrs. Oakeson kindly provided on the breeding of Gambel's sparrows at College, Alaska, in 1957, the interval between the average first arrival of males and first egg was 13 days and only 4 days after the average date of arrival of the females.

Her studies will indicate whether or not there is acceleration in the physiological processes preparatory to breeding. We do not have that

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evidence. I do not suspect that incubation can be environmentally modified and I would be surprised if nestling growth could be significantly modified by environment (L. Irving and Krog, 1956). The conspicuous influence upon the breeding cycle appears in the synchronization of events so that their succession is swift in the entire population. The adaptation of breeding to the arctic environment thus appears as a social phenomenon rather than as a modification of the individual's physiological processes, many of which are so deeply rooted in the origins of the species that their adaptive modifiability to local conditions is hardly to be suspected. (For a further discussion of this subject see also chapter 7.)

In six of the nests where complete clutches were apparent the average of the numbers of eggs was 5.5. I think it proper to regard the set of three nestlings as diminished by casualty. At Anaktuvuk several complete clutches contained either five or six eggs. Mrs. Oakeson kindly permits reference to her comparison of clutch size among white-crowned sparrows in various localities:

Race	*Location*	*Clutches*	*Average size*
nuttalli	Central California	147	3.25
pugetensis	Seattle, Friday Harbor, Victoria	44	4.09
gambelii	Mountain Village	6	4.7
gambelii	College	13	4.9
gambelii	Old Crow	6	5.5

Our observations do not have the significance of her more careful studies, but they show that the number of eggs laid near the arctic limit of the range of white-crowned sparrows is largest. We would not be inclined to relate this northward increase to latitude, for the increase of eggs is not proportional to the differences in latitude. We have earlier remarked that in many species, like plovers and sandpipers, the size of clutch is invariable, and the influence of environment upon size of clutch is not general. The large number of eggs laid is, however, certain evidence of the adequacy of nutrition near Old Crow in a dense population of white-crowned sparrows. The rarity of casualties observed in nests is another indication of the successful adaptation of breeding habits to the locality.

Passerella iliaca zaboria **Oberholser**

25 males	May 14–June 20	Weight, average (25), 35.9 g., coeff. of var. 5.8%	—	—
7 females	May 16–June 20	Weight, average (3), 34.3 g.	—	—
2 young males	June 20	Weight, average (2), 26.8 g.	—	—
1 young female	June 20	Weight 29.0 g.	—	—
4 half-incubated eggs	June 1	—	—	—
4 heavily incubated eggs	June 11	—	—	—

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A few fox sparrows, known by the Indians as *Tcheekeekak*, were seen in the willow-alder brush near the village on May 14 and 15 and on May 16 numbers were singing and vigorously repelling invasions of the territory they had assumed. On May 17 the numbers had increased, there was much local flying as invasions were made and repelled, and on May 18 it seemed that the area was saturated. The quarreling persisted, and evidently extra males were seeking territories; an hour after one had been shot while singing, another was singing on the same willow. By May 20 there was little disorder and much placid singing.

On May 24, fox, Gambel's, and tree sparrows were very common in the willow-and-alder brush about the village and along the river. Fox sparrows were found wherever the spruce was thin in swamps or on slopes, usually in willow brush. They were seen on the mountain as high as the brush was still continuous at about 1,700 feet.

Males were not far ahead of females in arriving, for the first male was collected only two days before the earliest female specimen was taken. Two sets of eggs with four eggs each and four sets of nestlings were examined and two young birds were captured when just able to fly and recently fledged. The degree of their development was estimated on the basis of the scale observed by Oakeson (1954) in white-crowned sparrows at Mountain Village, viz., eggs laid one day apart, but with incubation twelve days and nestling stage ten days as we found among tree sparrows at Anaktuvuk (Irving and Krog, 1956). Using these figures for calculation implies that the most advanced nesting birds developed from clutches for which the first egg had been laid May 20 (see fig. 20, in the Appendix).

Two sets of eggs were started 6 days after the first male arrived and the average interval between first arrival and first laying was 8 days in seven of the eight nests. For the first male observed on May 14 to have taken a territory and a mate which could prepare a nest and egg within 6 days is rapid progress in those complicated social and marital processes. Other evidence points to the earliness of fox sparrows' laying at Old Crow. In four female specimens taken eggs were measured as 3 mm. on May 16, 9.5 mm. on May 20, 7 mm. on May 22, and 3 mm. on May 22. A brood patch was remarked on a female on June 1.

The arrival of fox sparrows is made conspicuous by their songs, the flashing of their bright rusty color in flight through the gray willows, and the vigorous demonstrations of the males in taking nesting places. Four observers in the scientific party were daily searching for birds in the habitat about the village where fox sparrows were very numerous, and earlier reports of the observant Indians coincided with our first sight of common species within a day. The

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6-day interval between first observed arrival of fox sparrows at Old Crow and their first egg was even shorter than for Gambel's sparrows.

It was earlier remarked that the community of fox sparrows was in good order by May 20, for territorial transgressions were not then frequent, although some nests were not a hundred feet apart. Within about 8 days the entire society of fox sparrows had become changed from an organization of individuals in which the influence of sex was scarcely visible to a new social order in which sex impulses were dominant in separating the society into pairs. The social reorganization was mainly effected by the demonstrative activities of male birds.

The swift settlement of large numbers of fox sparrow in their respective territories proceeded so rapidly and, in spite of the brief period of combat, with so little disorder that provision for the social processes which could organize them into a community of families must have been already inherent in the individuals when they reached Old Crow. The expression of social organization appeared only in the nesting environment, but the physiological preparations had been completed and the inclination of every bird toward the correct sequence of social behavior must have been already perfected. Some common bond, as well as temporal and spatial association, must have joined the birds during their migration toward Old Crow, producing a synchrony in their physiological and social states. Somewhere in each bird's "memory" there is brought about the synchronous preparation of breeding activity which eventually segregates and orders a predetermined segment of the whole migrating population to proceed to settlement on its nesting ground at Old Crow. The social "memory" cannot be described by analytical reference to physiological processes and mechanisms alone, for the organization of societies also involves the environmental terms of time and space that are so evident in the annual migrations of birds.

In specimens taken of arriving male fox sparrows the testes were not found at their largest size until about May 27, but some must have been ready for breeding before May 20. The early males were mostly medium fat, and examples during early nesting had little fat, but picked up fat again while nestling birds were being cared for. Their generally good condition attests the adequacy of the food supply and suggests that the revolutionary physiological and social transitions while nesting were effected without nutritional strain.

As was remarked about female white-crowned sparrows, several female fox sparrows preparing to lay were about 8 grams, or 20 percent, heavier than the average of nongravid females. This increase is near four times the probability of normal variation in weight of males, and is about twice the weight of an egg. As those individuals were fat, its accumulation and the ovarian enlargement are plausible

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explanations of the oversized weights. They show the expansive capacity of avian metabolism for egg laying, the adequacy of the food supply, and imply that the individuals were secure for an expanded feeding program in a social system organized to preserve individuals from stress during the period of reproduction. This view goes with the appearance of leisurely behavior among the birds, at least until the nestlings must be often fed.

The fact that no casualties were observed among the eggs or nestling birds suggests that reproductive efficiency was high in this rather dense population of fox sparrows, which went through its reproductive cycle with such amazing speed.

Since some of the patterns of individual breeding behavior were compressed within such short intervals, it seems quite likely that the contributory development of some physiological changes was accelerated. The duration of incubation and of nestling growth are not to be suspected of being much influenced by the environment for they are ancient characters of species and even higher systematic relations (Irving and Krog, 1956). The conspicuous modification in arctic breeding occurs in the synchrony of the stages in the entire population, as Barbara Oakeson has so clearly shown in Alaskan Gambel's sparrows (Oakeson, 1954). That this synchrony greatly reduces strife and promotes social order is undoubtedly a factor of advantage for the economy of arctic nesting, and the resultant short period devoted to breeding in the Arctic must further reduce the social and physical stress which birds encounter during the longer breeding seasons of warmer climates. Because of its apparent advantages, the synchrony of the progress of arctic birds through their arctic breeding cycle can be regarded as an adaptation. This viewpoint is discussed in detail in chapter 7.

Fox sparrows of the race *zaboria* winter mainly east of the Mississippi. Their northern nesting range reaches the Arctic only in Mackenzie, Yukon, and Alaska. They are the only species of the Fringillidae nesting there which can be called eastern in reference to their wintering range, and yet they, with gray-cheeked thrushes and some wood warblers, also eastern wintering races, migrate from near extreme southeastern to extreme northwestern parts of North America to nest.

Melospiza lincolnii lincolnii (Audubon)

1 male	May 31	weight 19.1 g.	little fat	testes 5x10, 8x10 mm.

Francis Williamson heard the male Lincoln's sparrow singing in the rank grassy clearing by the Roman Catholic Mission and collected the only record of its occurrence at Old Crow. The bird acted as if it had assumed a territory. It has been identified at Forty Mile (Grinnell, 1909), found sparsely along the Yukon River west of the

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international boundary to Circle (Bishop, 1900) and is not uncommon in southern Yukon (Rand, 1946).

Calcarius lapponicus alascensis **Ridgway**

	Males			*Females*		
Date	*Weight (g.)*	*Fat*	*Testes (mm.)*	*Weight (g.)*	*Fat*	*Eggs (mm.)*
May 4	24.6	MF				
May 8	23.0	F	3.5x4.5, 3.5x4			
May 9	28.4	F	4x5, 3x4			
May 13	27.1	LF	5x7.5, 4.5x7			
May 14	27.7	MF	5x6.5, 6x6			
May 17				24.3	F	1
(aver.)	26.2					

In contrast with the great flocks of longspurs which migrate through the Alaskan Brooks Range, only a few small groups were seen at Old Crow. The largest count recorded was four. From May 4 to May 12 only males were seen, and from then until May 24 an occasional female was seen with a few males. Those seen at Old Crow do not represent the great migration of longspurs as it is seen at Anaktuvuk. They were lighter in average weight and with less fat. The earliest arrivals (May 4) were apparently expected at Old Crow by Joe Kay, who promptly obtained specimens, named them *Shinjee*, in the Indian language, and described their singing. Their arrival there is apparently part of a regular schedule, but the vicinity of Old Crow does not provide the grasslands and tundra where longspurs congregate in large numbers.

Plectrophenax nivalis nivalis **(Linnaeus)**

16 males	Apr. 5–May 21	weight 35.5–44.9, average (7), 40.3 g., coeff. of var. 8.1%	very fat (6), fat (10), little fat (2)	testes 1.5–4 mm.

At Old Crow in 1957 the residents reported that snow buntings had first reached there about the middle of March. Their name for the bird is *Kukuzu*. After we arrived on April 2, a flock of 20 or 30 was usually to be seen along the river bank in front of the village feeding among the accumulated debris of the winter. This rubbish contained little food which could please a small seed-eating bird, and the interest of these earliest migrants to the Arctic was more likely in weed seeds than in garbage.

Some flocks were followed back and forth for a mile along the river bank, a few hundred yards at a move. The flocks often showed their attraction to the village by returning after starting to fly away. It was suspected that some flocks remained for a day or longer, but it could not be established by observation and pursuit that a flock remained for longer than several hours. Most of the records are of course from the village, but occasional observations along the river and reports of Indians show that while the flocks probably congre-

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gated at villages, they may stop at any clearing. After April 30, none were reported. A single bird was noted on May 15, two on May 17, five on May 19, and the final recording of a single bird was on May 21.

On Old Crow Montain four buntings were seen on April 11 and two were collected by Joe Kay on April 17, but after the snow melted, they were not seen, for the Old Crow Mountains are not high enough to provide the sort of weather in which they nest along the arctic coast and in the high mountains near Chandler Lake, Alaska, where Simon Paneak reported them in 1955.

The fatness of these snow buntings at Old Crow was an impressive indication of the adequacy of their food supply. In 1954 Susie Paneak at Anaktuvuk recorded weights of 13 male snow buntings which averaged 34.9 grams, and which were not as fat as at Old Crow, rating as 2 VF, 1 F, 5 LF, and 1 VLF. Seven snow buntings in September 1947 at Point Barrow were, however, like the Old Crow birds in weight, so there is no evidence in weight records to distinguish buntings at Old Crow from those in central arctic Alaska. The variation in weight among individual birds of each series of snow buntings is larger than is found in most series of arctic migratory birds at Old Crow, for the coefficient of variation was 8.1%. The mean weight of the Old Crow and Anaktuvuk series differed according to the degree of fatness reported in each series, but it appears that in this species individual weight as a function of stature is a variable factor as well as fatness. As observed visually, the fat of snow buntings was light corn yellow and soft at room temperature. The consistent appearance of the fat suggests its origin in a constant dietary source and implies a single major component in the food.

Only male birds were found among the 16 specimens sexed in spring at Old Crow. At Anaktuvuk, from 1949 to 1953 11 males and 3 females were collected. In 1954 there were 3 females in a series of 16 weighed at Anaktuvuk. No females have been collected at Anaktuvuk during April and there are accordingly indications that at Anaktuvuk and Old Crow males are segregated in some flocks.

The testes of the specimens at Old Crow were but little enlarged and the series did not show growth. When the latest flocks were leaving Old Crow, at the end of April the birds had at least two weeks, but only one hundred and forty miles before the earliest arrivals would be due at their nesting grounds on the arctic coast.

In central arctic Alaska the stages in progress of migration of snow buntings northward are indicated by first arrival dates at Bettles about March 15, at Anaktuvuk April 1, and at Barrow April 15. It appears that this schedule results from a movement the front of which traverses the last 300 miles northward to their arctic Alaskan nesting grounds in a month. Indians of Old Crow Village say that snow buntings first reach Crow Flats later than they reach the village, and

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that they remain numerous on the Flats until later in spring. Apparently the northern part of their migration is as leisurely and as prolonged in Yukon as in Alaska. (A general discussion of migration is to be found in chapter 6.)

Fourteen of our Old Crow specimens still possessed much brown color on the head and rump, a color usually lost at breeding time, leaving the white in sharp contrast with the black on wings and back. It was apparent that the edges on the brown feather tips of our specimens were much weakened and about ready to be shed. The change is not one of wear, as it is commonly called, because it occurs at a predetermined position and leaves the edges of the feathers in a sharp new outline quite in contrast with the irregularly worn condition of tips of wing and tail feathers often apparent just before the moult. The brown edging of contour feathers is retained for about nine months and until the buntings are near their breeding grounds.

We could not detect any distinction in size or plumage which would distinguish between snow buntings from Alaska, Yukon, and Mackenzie. In describing the snow buntings of Siberia as *P. n. pallidior*, Salomonsen (1947) remarked that a few moulted specimens from western Alaska showed the lighter backs by which he distinguished *pallidior* from *nivalis* of "Arctic America, perhaps except Alaska." We did not have enough specimens in fresh plumage to test Salomonsen's suggestion of a distinct Alaskan color character.

At the U. S. National Museum Bernard Feinstein pointed out that specimens from Alaska had stouter claws than a series of specimens taken during migration at Fort Simpson on Mackenzie River. On the basis of the average difference in stoutness of claws the Old Crow birds go with those from Alaska rather than with those from Mackenzie.

In the discussion of snow buntings at Anaktuvuk it was mentioned that many occur in winter scattered through central and southern Alaska. They are separated from those wintering in Mackenzie by a mountainous region in Yukon which seems unsuited for wintering buntings and from which none have been reported in winter. That the geographical separation in winter may also isolate the two populations on their breeding grounds is further suggested by the fact that it has been possible to sort Alaskan from Mackenzie buntings on the basis of stoutness of claws. The resemblance in claw stoutness between Old Crow and Alaskan buntings suggests that both belong to the Alaskan wintering population and that migration passes eastward along the Porcupine at least as far as Old Crow. In summer there is apparently no geographical gap in the extension of breeding snow buntings along the arctic coasts of Alaska, Yukon, and Mackenzie.

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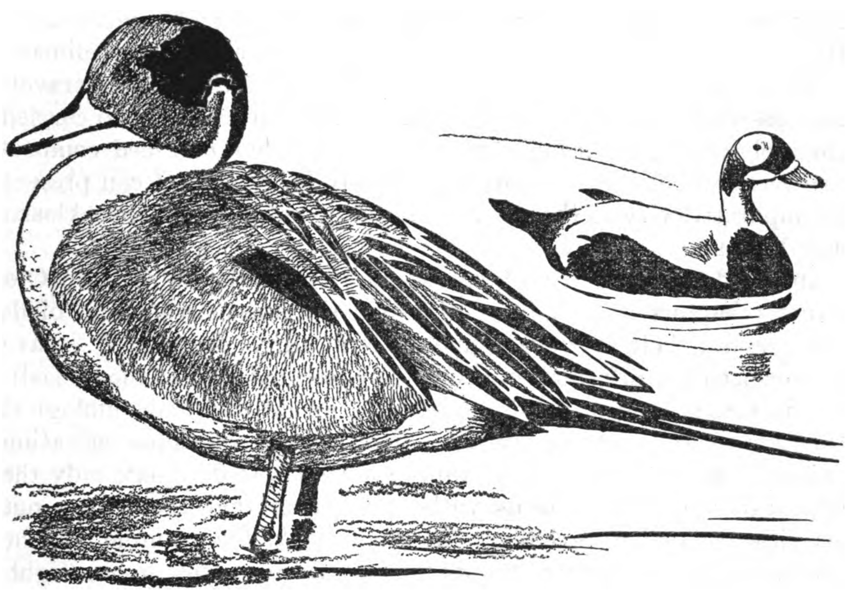

Pintail and Spectacled Eider, *Anas acuta* (see pp. 37, 170) and *Lampronetta fischeri* (see pp. 35, 168).

5. *Status and Distribution*

Interior arctic Alaska has been comparatively little changed by its human occupants, for until the last few years it has been subjected only to aboriginal methods of exploitation. In modern times, however, in those parts of Alaska where the search for gold has been carried out, the application of water and mechanical power has caused intensive unnatural erosion. Forests near the mining operations have been destroyed by lumbering, clearing, and fire, and the invading population has added greatly to the aboriginal use of game. Along the arctic coast whaling, the fur trade, and reindeer grazing have intensively removed natural products that earlier had been sparingly utilized by the aboriginal inhabitants. As a result these areas have been visibly changed.

The tundra of the arctic interior has been less affected by civilization than the coast or the forest, but we can nevertheless record the total disappearance of the musk ox and Eskimo curlew as indications

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of recent instability among the animals of the Alaskan tundra. There are no records to show how the other animal populations have been changed, but the lack of evidence of depletion suggests that the arctic interior of Alaska is exceptional for the retention of conditions as they were established by the natural progress of erosion and climate.

These considerations, together with the results of my own travels and observations, and the reports of the few naturalists who carried their observations through the seasons until they obtained comprehensive views of the avifauna, allow me to believe that I can present a comparative view of the natural distribution of birds in arctic Alaska and Yukon.

In the description of each species at Anaktuvuk, Kobuk, and Old Crow (chapters 2–4), I have discussed the season when the birds are present, their migration, and their nesting. In table 4 I have summarized the information about their seasonal stay at these localities in terms descriptive of the seasonal extent and main biological function served by their presence. I have used the characterization "visitor," which for us would imply a purpose, to designate only the appearance of certain birds without evidence that they carry out activities related to breeding. At Anaktuvuk, for example, all the species called visitors are known to nest within a few hours flight, and most have been seen frequently and in good condition, so their appearance there gives no evidence of abnormality. Inasmuch as the designation of birds as "visitors" defines an activity which appears normal, however, it does include the implication of biological purpose often suggested by a regular form of animal behavior.

TABLE 4.—*Status of birds at Anaktuvuk, Kobuk, and Old Crow*

[Explanation—(R) resident, (RM) resident and migrating, (M) migrating but not remaining to nest, (MN) migrating to nest and also migrating, (N) migrating to nest there and not migrating farther, (V) visitor, (WV) winter visitor, (O) not present.]

Species	Anaktuvuk	Kobuk	Old Crow	Species	Anaktuvuk	Kobuk	Old Crow
Gavia immer	MN	MN	MN	Anas platyrhynchos platy-			
Gavia adamsii	MN	M	O	rhynchos	M	N	MN
Gavia arctica pacifica	MN	MN	MN	Anas acuta	MN	MN	MN
Gavia stellata	MN	MN	MN	Anas carolinensis	MN	MN	MN
TOTAL GAVIIDAE (4)	(4)	(4)	(3)	Mareca americana	MN	MN	MN
Podiceps grisegena holböllii	O	N	N	Spatula clypeata	M	MN	MN
Podiceps auritus cornutus	V	N	N	Aythya marila nearctica	MN	MN	MN
TOTAL PODICIPEDIDAE (2)	(1)	(2)	(2)	Aythya affinis	MN	O	MN
Olor columbianus	M	MN	MN	Bucephala clangula americana	O	O	M
Branta canadensis taverneri	M	MN	MN	Bucephala islandica	O	O	M
Branta nigricans	M	M	M	Bucephala albeola	O	N	O
Anser albifrons frontalis	M	MN	MN	Clangula hyemalis	MN	MN	MN
Chen hyperborea hyperborea	M	M	M	Histrionicus histrionicus	MN	MN	MN

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TABLE 4.—*Status of birds at Anaktuvuk, Kobuk, and Old Crow*—Continued

Species	Anaktuvuk	Kobuk	Old Crow
Melanitta deglandi	MN	MN	MN
Melanitta perspicillata	MN	MN	MN
Oidemia nigra americana	O	V	O
Mergus serrator serrator	MN	MN	MN
TOTAL ANATIDAE (21)	(17)	(18)	(19)
Accipiter gentilis atricapillus	V	R	R
Accipiter striatus	O	N	N
Buteo lagopus	MN	M	MN
Aquila chrysaetos canadensis	MN	MN	MN
Haliaeetus leucocephalus alascanus	V	V	N
Circus cyaneus hudsonius	V	N	N
TOTAL ACCIPITRIDAE (6)	(5)	(6)	(6)
Pandion haliaetus carolinensis	V	N	N
TOTAL PANDIONIDAE (1)	(1)	(1)	(1)
Falco rusticolus obsoletus	R	R	R
Falco peregrinus anatum	M	O	MN
Falco columbarius bendirei	MN	MN	MN
Falco sparverius sparverius	V	O	O
TOTAL FALCONIDAE (4)	(4)	(2)	(3)
Canachites canadensis osgoodi	O	R	R
Bonasa umbellus	O	O	R
Lagopus lagopus alascensis	RM	RM	RM
Lagopus mutus nelsoni	R	R	R
TOTAL TETRAONIDAE (4)	(2)	(3)	(4)
Grus canadensis canadensis	M	MN	MN
TOTAL GRUIDAE (1)	(1)	(1)	(1)
Charadrius semipalmatus	MN	MN	MN
Charadrius vociferus	O	O	V
Pluvialis dominica dominica	MN	MN	V
Squatarola squatarola	M	MN	O
Arenaria interpres interpres	M	M	O
Aphriza virgata	O	V	O
TOTAL CHARADRIIDAE (6)	(4)	(5)	(3)
Capella gallinago delicata	MN	MN	MN
Numenius phaeopus hudsonicus	M	MN	N
Bartramia longicauda	V	V	O
Actitis macularia	M	MN	MN
Tringa solitaria cinnamomea	M	MN	MN
Heteroscelus incanum	MN	MN	O
Totanus flavipes	MN	MN	MN
Erolia melanotos	MN	MN	M
Erolia fuscicollis	V	O	O
Erolia bairdii	MN	M	M
Erolia minutilla	MN	MN	MN
Erolia alpina pacifica	V	V	O
Limnodromus scolopaceus	M	M	O
Micropalama himantopus	M	O	O
Ereunetes pusillus	MN	MN	MN
Tryngites subruficollis	M	M	O
Limosa lapponica	M	M	O
Crocethia alba	M	M	O
TOTAL SCOLOPACIDAE (18)	(18)	(16)	(9)
Phalaropus fulicarius	M	M	O
Lobipes lobatus	MN	MN	MN
TOTAL PHALAROPODIDAE (2)	(2)	(2)	(1)

Species	Anaktuvuk	Kobuk	Old Crow
Stercorarius pomarinus	V	V	O
Stercorarius parasiticus	MN	MN	V
Stercorarius longicaudus	MN	MN	MN
TOTAL STERCORARIIDAE (3)	(3)	(3)	(2)
Larus hyperboreus barrovianus	MN	MN	M
Larus argentatus smithsonianus	V	N	MN
Larus canus brachyrhynchus	MN	MN	MN
Larus philadelphia	O	V	MN
Xema sabini	V	V	O
Sterna paradisaea	MN	MN	MN
TOTAL LARIDAE (6)	(5)	(6)	(5)
Bubo virginianus lagophonus	V	R	R
Nyctea scandiaca	WV	WV	WV
Surnia ulula caparoch	O	R	R
Strix nebulosa nebulosa	O	R	R
Asio flammeus flammeus	MN	MN	O
Aegolius funereus richardsoni	V	R	R
TOTAL STRIGIDAE (6)	(4)	(6)	(5)
Megaceryle alcyon caurina	O	N	O
TOTAL ALCEDINIDAE (1)	(0)	(1)	(1)
Colaptes auratus borealis	V	N	N
Dendrocopos pubescens nelsoni	WV	R	O
Picoides arcticus	O	R	O
Picoides tridactylus fasciatus	O	R	R
TOTAL PICIDAE (4)	(2)	(4)	(2)
Sayornis saya yukonensis	MN	O	N
Empidonax traillii traillii	O	O	N
Nuttallornis borealis	O	O	N
TOTAL TYRANNIDAE (3)	(1)	(0)	(3)
Eremophila alpestris arcticola	MN	MN	MN
TOTAL ALAUDIDAE (1)	(1)	(1)	(1)
Tachycineta thalassina lepida	O	O	N
Iridoprocne bicolor	V	MN	MN
Riparia riparia riparia	V	MN	MN
Petrochelidon pyrrhonota hypopolia	O	N	MN
Hirundo rustica erythrogaster	V	V	O
TOTAL HIRUNDINIDAE (5)	(3)	(4)	(4)
Perisoreus canadensis pacificus	R	R	R
Corvus corax principalis	R	R	R
TOTAL CORVIDAE (2)	(2)	(2)	(2)
Parus atricapillus turneri	WV	R	O
Parus cinctus lathami	O	R	R
Parus hudsonicus hudsonicus	O	R	R
TOTAL PARIDAE (3)	(1)	(3)	(2)
Cinclus mexicanus unicolor	R	R	R
TOTAL CINCLIDAE (1)	(1)	(1)	(1)
Turdus migratorius migratorius	MN	MN	MN
Ixoreus naevius meruloides	O	N	N
Hylocichla ustulata incana	O	O	N
Hylocichla minima minima	MN	MN	MN
Oenanthe oenanthe oenanthe	MN	MN	N
TOTAL TURDIDAE (5)	(3)	(4)	(5)

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TABLE 4.—*Status of birds at Anaktuvuk, Kobuk, and Old Crow*—Continued

Species	A-nak-tu-vuk	Ko-buk	Old Crow
Phylloscopus borealis kennicotti	MN	MN	O
Regulus calendula calendula	V	MN	N
TOTAL SYLVIIDAE (2)	(2)	(2)	(1)
Motacilla flava tschutschensis	MN	MN	O
Anthus spinoletta rubescens	MN	MN	MN
TOTAL MOTACILLIDAE (2)	(2)	(2)	(1)
Bombycilla garrula pallidiceps	O	R	R
TOTAL BOMBYCILLIDAE (1)	(0)	(1)	(1)
Lanius excubitor invictus	MN	MN	V
TOTAL LANIIDAE (1)	(1)	(1)	(1)
Vermivora celata celata	O	N	N
Dendroica petechia amnicola	V	N	N
Dendroica coronata hooveri	V	N	N
Dendroica striata	O	N	N
Seiurus noveboracensis notabilis	O	N	N
Wilsonia pusilla pusilla	O	O	N
Wilsonia pusilla pileolata	N	N	O
TOTAL PARULIDAE (7)	(3)	(6)	(6)
Euphagus carolinus carolinus	N	MN	MN
TOTAL ICTERIDAE (1)	(1)	(1)	(1)
Pinicola enucleator alascensis	WV	R	R
Leucosticte tephrocotis irvingi	N	MN	O
Acanthis hornemanni exilipes	RM	RM	RM
Acanthis flammea flammea	MN	RM	MN
Acanthis flammea holboellii	O	V	O
Loxia leucoptera leucoptera	O	R	R
Passerculus sandwichensis anthinus	MN	MN	N
Junco hyemalis hyemalis	V	MN	N
Spizella arborea ochracea	MN	MN	MN
Zonotrichia leucophrys gambelii	MN	MN	MN
Zonotrichia atricapilla	O	N	O
Passerella iliaca zaboria	MN	MN	MN
Melospiza lincolnii lincolnii	O	O	V
Calcarius lapponicus alascensis	MN	MN	M
Calcarius pictus	MN	O	O
Plectrophenax nivalis nivalis	M	M	M
TOTAL FRINGILLIDAE (16)	(12)	(14)	(12)
TOTAL, ALL FAMILIES (139)	(106)	(122)	(107)
SUMMARY OF STATUS			
(R) resident	5	20	18
(RM) resident and migrating	2	3	2
(M) migrating but not remaining to nest	21	12	9
(MN) migrating to nest and also migrating	49	57	48
(N) migrating to nest but not migrating farther	3	19	24
(V) visitor	22	10	5
(WV) winter visitor	4	1	1
TOTAL	106	122	107

The Birds of Anaktuvuk Pass

Anaktuvuk Pass has been so little disturbed by human activities that the birds still live there in an environment as stable as the natural terrain and climate. Their comparative stability greatly simplifies description of how their activities relate them to the populations of birds elsewhere. Among the 11 species of birds regularly present there in winter, 7 also remain to nest in summer, as shown in table 5. But the nesting birds cannot be called residents simply because individuals are seen there at all seasons of the year. For example, the number of nesting willow ptarmigan (*Lagopus lagopus alascensis*) is very small in comparison with the great numbers which migrate northward through the valley in late winter. Only occasionally are hoary redpolls (*Acanthis hornemanni exilipes*) seen in winter but great numbers migrate through in May and September. At present there is no indication whether the nesting individuals of these two species had been present in winter or arrived during migration. The migrant ptarmigan and redpolls at Anaktuvuk are probably a thousand

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times more numerous than those which remain to nest. The disparity in numbers of rock ptarmigan (*Lagopus mutus nelsoni*) present in winter and summer is not as great, but the migrants are perhaps ten times as numerous as the nesting individuals. Accordingly, in case a species is differently represented during the year at Anaktuvuk we cannot conclude whether a specialized sedentary habit distinguishes a resident from a migratory section of the populations.

TABLE 5.—*Winter birds in the valleys at Anaktuvuk Pass, north of the forests*

	Nesting	Migratory	Winter visitor
Falco rusticolus obsoletus	x		
Lagopus lagopus alascensis	x	x	
Lagopus rupestris nelsoni	x	x	
Nyctea scandiaca			x
Perisoreus canadensis pacificus	x		
Corvus corax principalis	x		
Dendrocopos pubescens nelsoni			x
Parus atricapillus turneri			x
Cinclus mexicanus unicolor	x		
Pinicola enucleator alascensis			x
Acanthis hornemanni exilipes	x	x	

Because of their secretive nesting at a time when softening snow impedes travel we are also uncertain as to whether the few jays (*Perisoreus canadensis pacificus*) which are seen in winter remain to nest on the tundra. It would be only a guess to suggest that jays circulate back and forth to some extent between forest and tundra. But although they are only occasionally seen they have always been familiar to the Nunamiut and there is no indication that in recent years the numbers or activities of jays on the tundra have changed.

Gyrfalcons (*Falco rusticolus obsoletus*) appear to occupy the country around their nesting sites throughout the year as resident birds. Although they are in a degree isolated from the rest of the population of gyrfalcons, they can reach the territory of adjacent pairs quickly.

At certain arctic sites where open water persists in winter, dippers (*Cinclus mexicanus unicolor*) have been seen at various times throughout the year. I believe that they are residents in these small areas which for more than 8 months in winter are surrounded by such distances of frozen country as would seem to form barriers completely isolating each pair of dippers from the rest of their population. Yet their numbers seem to remain about the same and their dwelling sites are known to have been occupied for many years. In spite of their apparent isolation it is evident that they are coherent members of a population of dippers.

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Ravens (*Corvus corax principalis*) are often seen throughout the year in the vicinity of the high cliffs where they nest. They are considered to be birds of established residence. It is also known that they often make long flights which are considered to imply that their hunting extends over wide ranges. The frequent association of various numbers of ravens shows that they are related by their sociability to the ravens of a greater area.

Among those species which are seen throughout the year at Anaktuvuk, gyrfalcons and dippers appear to be birds of settled residence and the ravens are probably mainly fixed residents. In the case of the other four species which are represented throughout the year at Anaktuvuk I have no opinion as to whether the settled residence is a habit fixed in certain individuals. If so, it might be connected with traits individually inherited.

Four birds not found nesting there in summer are seen in winter at Anaktuvuk and are listed as winter visitors in table 5, although their appearance is too frequent to be considered casual. The snowy owls (*Nyctea scandiaca*) come from near the arctic coast, where they nest and where some spend the winter. The numbers seen vary with the years. More are usually seen in late winter, but individuals do not remain long in one place. It is not apparent whether they are in migration southward through Anaktuvuk. Their visits, while usual, do not show any regularity that I can detect. Downy woodpeckers (*Dendrocopus pubescens nelsoni*), black-capped chickadees (*Parus atricapillus turneri*), and pine grosbeaks (*Pinicola enucleator alascensis*) also do not seem to have fixed winter locations on the tundra, where they move about among patches of willows. Their winter foraging on the tundra appears to be well established. All are hardy birds, well able to live among low willows, where they may find the branches bared by the winter winds of the tundra better suited for feeding than the branches in the still forests, which are often thickly covered with snow. In summer these three species have not been seen on the tundra. They reverse the usual seasonal direction of movement by coming at least a limited distance northward in winter. It seems likely that they return southward to the forests for nesting in areas where the others of their kind are regularly present.

In spite of several reports on its winter occurrence on the tundra I list the ruby crowned kinglet (*Regulus calendula*) as a visitor to mark my uncertainty rather than to describe the bird's status. Without a winter specimen I do not like to say that it occurs in winter 3,000 miles north of the range currently ascribed to it.

In addition to the birds listed in table 5 as present in winter at Anaktuvuk, one snow bunting (*Plectrophenax nivalis*), one goshawk

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(*Accipiter gentilis atricapillus*), and several great horned owls (*Bubo virginianus lagophonus*) have been found on the tundra in winter. There is nothing remarkable about finding these birds on the tundra in winter except that it has been too uncommon to be called a habit.

The group of birds listed below include some of those familiar as residents in the northern borders of the forests but not reported on the tundra:

Bird	*Locality of observation*
Canachites canadensis osgoodi	Savioyuk River
Pedioecetes phasianellus	Hunt Fork
Surnia ulula caparoch	Hunt Fork
Strix nebulosa nebulosa	Hunt Fork
Picoides tridactylus fasciatus	Hunt Fork
Picoides arcticus	Kobuk Village
Parus hudsonicus hudsonicus	Savioyuk River
Bombycilla garrula pallidiceps	Savioyuk River
Loxia leucoptera leucoptera	Hunt Fork

In the forest they occasionally encounter weather colder than any that occurs on the tundra, so cold is not the barrier to their northern dispersal. Among them the crossbills (*Loxia leucoptera leucoptera*) are associated with spruce for feeding, and the three-toed woodpeckers (*Picoides*) feed on tree trunks but not on branches. It is likely that the exercise of certain essential habits requires trees and thus these hardy, and in some cases wide-ranging, birds are held within the border of the forests.

Among the 73 species of birds shown in table 4 to migrate to or through Anaktuvuk, 39 have been established as nesting by specimens or photographs of eggs, downy young birds, or eggs ready to be laid, found in collected female specimens. The behavior of birds demonstrates their intentions to each other through sight and sound, senses which we can appreciate, so that behavior gives reliable circumstantial evidence for the breeding of birds. In 20 additional species, such circumstantial evidence for breeding was regarded as conclusive indication of nesting, giving a total of 52 migratory and 7 resident species nesting at Anaktuvuk. Evidence for the nesting of most of this group of birds was obtained repeatedly and conformed with information which Eskimo people gave me from former years.

Some species are seen in different numbers each year, but the variation is not as noticeable as is the impression of regularity in the annually repeated occupation of the Valley by each common species. For example, the number of surf scoters observed varies greatly from year to year and I know of only one locality in the mountains (Chandler Lake) where the sight of young surf scoters has provided evidence that they nest in the area. Their long establishment in the mountains is shown by old Nunamiut accounts and the application

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of an explicit name. In spite of the history of long occurrence, the variation in numbers seen from year to year shows that surf scoters occupy the mountains irregularly. In this irregularity the surf scoters stand in contrast with most nesting species.

Where so many sharp-sighted people were engaged in observation, the reported absence of birds at nesting time is significant. The designation of birds as migrating individuals implies that they are traveling to nesting grounds and not wandering. Of the 21 migrants that do not remain at Anaktuvuk in summer, as listed in table 5, we know the northern nesting areas of most. Taverner's goose (*Branta canadensis taverneri*) is an interesting example. I have obtained specimens from family groups of these geese along the Koyukuk and Alatna Rivers about 100 miles south of Anaktuvuk and a specimen from Kobuk, about 140 miles west of the Alatna and also on the southern watershed. Two specimens were obtained at Old Crow. Cade and Schaller found families of these geese along the Colville River, about 100 miles north of Anaktuvuk (Kessel and Cade, 1958). The nesting area of these geese in the forested and in the tundra areas of central arctic Alaska and Yukon is separated by an unoccupied area of mountains about 200 miles across. Although there is a recollection of a pair of swans' nesting in the Killik Valley about 50 years ago the failure of swans (*Olor columbianus*), geese (*Branta*, *Anser*, *Chen*), and cranes (*Grus*) to nest in the mountains is historic Nunamiut knowledge.

I am somewhat doubtful about the correctness of designating shovelers (*Spatula clypeata*) as migrants because I do not know that they nest north of Anaktuvuk. Although they have been reported in only two years of my observations, they are well known to Nunamiut and other Eskimos, but Eskimo acquaintance with shovelers shows that rarity rather than frequency of observation distinguishes these unique-appearing ducks. From questioning I am sure that very few shovelers have been seen in the Arctic and that the birds are not common, but since the arctic appearance of shovelers is not a new event the birds probably should be considered as migrants.

Godwits (*Limosa lapponica*) are not often seen at Anaktuvuk but the few observations indicate that they move swiftly through the mountains. They are well known and named explicitly by the Nunamiut, who have seen them nesting farther north, and I do not hesitate to call the godwits regular migrants through Anaktuvuk.

Stilt sandpipers (*Micropalama himantopus*) and sanderlings (*Crocethia alba*) have not often been reported at Anaktuvuk and the numbers observed have been so few that I am not certain that they were on a normal migratory path which would lead them successfully to a nesting ground. Sanderlings are well known along the arctic

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coast in summer. Nunamiut have reported to me that stilt sandpipers nest near the Colville mouth, and Tom Brower knew of a nest that was found near Barter Island. I include these sandpipers as migrants thinking that their rapid progress in part accounts for the few observations.

Under the designation of visitors I list the following 22 species which come to Anaktuvuk in summer but not to nest there or farther north:

Visitor	*Nearest known nesting place*
Podiceps auritus cornutus	Bettles
Accipiter gentilis atricapillus	Hunt Fork
Haliaeetus leucocephalus alascanus	Koyukuk River
Circus cyaneus hudsonius	Alatna River
Pandion haliaetus carolinensis	John River
Falco sparverius sparverius	Yukon River
Bartramia longicauda	Eastern Alaska
Erolia fuscicollis	Arctic coast
Erolia alpina pacifica	Arctic coast
Stercorarius pomarinus	Arctic coast
Larus argentatus smithsonianus	Alatna River
Xema sabini	Arctic coast
Bubo virginianus lagophonus	Hunt Fork
Aegolius funereus richardsoni	Hunt Fork
Colaptes auratus borealis	Bettles
Hirundo rustica erythrogaster	Kobuk Village
Iridoprocne bicolor	Bettles
Riparia riparia riparia	Bettles
Regulus calendula calendula	Hunt Fork
Dendroica petechia amnicola	Kobuk Village
Dendroica coronata hooveri	Kobuk Village
Junco hyemalis hyemalis	Alatna River

I regard their attachment to Anaktuvuk as more casual than that of the three species that usually come northward from the forests to feed in winter among the willows on the tundra, or of the snowy owls (*Nyctea scandiaca*) that usually appear in late winter. I suspect, however, that some of the species now called visitors will subsequently be found nesting near or north of Anaktuvuk. For example, marsh hawks (*Circus cyaneus hudsonius*) have been seen a number of times and are so familiar to the Nunamiut that an explicit name is applied to them.

Two reports indicate that swallows have nested north of the Brooks Range. Anderson (1921) reported seeing the characteristic burrows of bank swallows (*Riparia riparia riparia*) along the Hula Hula River. I have not seen their burrows north of the woodlands and the Nunamiut, who study as problems the absence of birds well known elsewhere, do not know of any burrows north of the Koyukuk. We

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occasionally saw bank swallows in spring at Anaktuvuk and they nest commonly 100 miles south, along the Koyukuk and lower Alatna Rivers.

Simon Paneak recalled (see p. 90) seeing mud nests with frozen young cliff swallows (*Petrochelidon pyrrhonota*) while hunting with some other young men along the west branch of the Kuparuk River, about 40 miles northeast from Anaktuvuk. His report indicates that a colony once ventured to settle in an Alaskan location 200 miles north of any place where they are now known to nest. Their attempt was unproductive and it cannot have been often repeated or the conspicuous evidence of their nesting would have been remarked.

In 1849 Rae reported seeing the nests of cliff swallows on cliffs along the Coppermine River (Richardson, 1852), but I do not know whether that was a single venture or a sustained habit. I have never had a report of a cliff swallow at Anaktuvuk, although they are the most numerous nesting swallows around Bettles. They are more colonial than the other swallows and perhaps do not wander so much individually.

It was only in 1952 that I obtained evidence that a rusty blackbird (*Euphagus carolinus*) had raised young in the mountains. Individuals are seen each year and as their common nesting grounds are nearby this event cannot be taken to represent a new trend. Except for the two reports on swallows the evidence obtained so far indicates no tendency of the birds designated as visitors to expand from transient to more lasting occupation of Anaktuvuk. In the stories from past years I can find no sign which shows that expansion or contraction of the range of birds at Anaktuvuk is visibly in progress.

The common range of these visitors is not far from Anaktuvuk, 17 being regularly seen along the Koyukuk and Alatna Rivers, and 4 being known to nest along the arctic coast. The frequency of their brief appearances varies, but only a few hours' flight would be required for them to travel from their known regular ranges.

As I have noted in numerous instances in the descriptions of the species, the occasional appearance of these visitors has been long remarked by the Nunamiut. Some of the intervals between observations were long (about 40 years separates two occasions when horned grebes were seen) but the birds were well remembered, explicitly named, and regarded as rare but not strange appearances.

While we must regard the evidence of bird occurrence at Anaktuvuk as indicative of a well established fauna, it is reasonable to suggest, however, that the transient visits of certain species represent a tendency among birds from both north and south of Anaktuvuk to make occasional sallies from their usual range. That is, the visiting habit is thus a normal form of behavior in those populations, even though it is

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infrequently apparent. What it shows is that some birds are curious, restless, or otherwise unconstrained by the influences which hold the rest of their populations to their present nesting grounds. A very elaborate and unlikely conjunction of physiological and environmental conditions would be necessary to expand or contract a well established nesting area. The persistence of visiting nevertheless suggests that inherent inclinations exist which could, under special conditions, effectuate an increase in range. The long persistence of the occasional expression of the tendency shows how seldom it changes the range of a population and indicates the essential conservatism of bird distribution at Anaktuvuk.

The Birds of Kobuk

At first view the Kobuk avifauna as summarized in table 4, seems not to differ as much from that of Anaktuvuk as do the environmental conditions. Kobuk is in a wooded valley, Anaktuvuk is in mountain tundra. Climatically they differ, in that at Kobuk frost-hardy vegetables can be grown in the usual summer warmth, whereas at Anaktuvuk warm summer days are too infrequent for growing vegetables and hard freezes occur there as often as mild summer frosts at Kobuk.

A rather large difference appears in the status of the birds of the two areas, for whereas at Anaktuvuk 22 are summer visitors from their nearby ranges, at Kobuk only 10 species, because they are not known to nest or normally migrate there, are considered to be summer visitors. The winter best demonstrates the large difference between biotic conditions on the tundra and in the forest, for only 7 birds are regular winter residents at Anaktuvuk in contrast with 23 at Kobuk.

Numerous other differences are apparent to the observer who has lived in these places. Swallows are rare visitors to Anaktuvuk whereas three species nest at Kobuk. Six species of warblers nest in large numbers at Kobuk, but only one has been occasionally found nesting at Anaktuvuk. Several species of sandpipers, common along the tundra streams, are scarce in the wooded valleys, and at Kobuk longspurs (*Calcarius*), pipits (*Anthinus*), and larks (*Eremophila*) are to be found only in the tundralike elevations above the valley floor.

Large migratory flights of geese and ducks and lesser flights of gulls pass along the Kobuk River in spring, the gulls appearing to come from the coast. It is not apparent whether the geese and ducks come from the interior or from the coast, but flights of geese can be often seen to leave the river for the north. The direction of migration of small birds is especially obscure in wooded country. Since most of the land birds and many of the shore birds migrate northward through western Canada, these must have traveled some 500 miles westward across Alaska in order to reach Kobuk. The few records of arrivals

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indicate that the migratory species reach Kobuk a few days before their arrival at Anaktuvuk. Several of these species also appear to reach Old Crow earlier than Kobuk in conformity with their suspected

Birds of Old Crow

Longer observation at Old Crow might add to the small number of visitors now recorded there, but it seems that the nesting birds are established firmly in their migration to the Porcupine Valley, which is also the northern limit for migration of more species than either Kobuk or Anaktuvuk. Also the smallest number of species migrate through Old Crow without leaving any nesting pairs. Summer at Old Crow is less warm and is shorter than at Kobuk, but is sufficient for the growth of spruce to fair size. Warblers, thrushes, and sparrows form dense populations in some of the brushy areas along the Porcupine River, showing little attenuation in density of population at the northern limit of their ranges. Surface-feeding ducks are not especially numerous but for old squaws and scoters it is an important nesting ground. The marked discrepancy at Old Crow appears in the small number of species and individuals of sandpipers and plovers, both nesting and migrating. Except for a few species using the inland marshes the Porcupine Valley is an insignificant nesting area and unimportant as a migratory route for members of these groups.

Birds of the Arctic Coast

For records from the Yukon arctic coast I have selected from Rand (1946) the reports from Herschel Island westward to the Yukon-Alaska boundary. From Anderson's (1921) journal account and from Brooks (1915) and Dixon (1943) I have taken records pertaining to the arctic coast of Alaska between the mouth of the Colville River and Demarcation Point.

Bailey's (1948) extensive report on the birds of arctic Alaska covers a coast line and certain interior localities very diverse as habitats of birds. I have chosen Barrow as the best studied locality. From Bailey's explicit references to the locations where observations were made I have been able to select a list of the birds found within about 40 miles distance from the village of Barrow. Even with that restriction, the list of birds found at Barrow presents a strange assortment difficult to resolve into a pattern related to our knowledge of the geographical distribution of birds.

Bishop (1944) described the situation at Barrow well by saying that "of about 140 forms recorded from the northern coast of Alaska about 48 have been taken not over four times and 34 only twice. This would indicate that most of them were lost birds, wandering until

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they came to the sea." Since that time new observations have been made, but Barrow is still a locality where unusual birds appear so often that its exceptional avifauna warrants further comment.

Out of the 126 species counted as from near Barrow in table 7, about 17 are still known from only one specimen and 8 from only two specimens. For many years expert naturalists have studied at Barrow. In addition to the published accounts of these distinguished naturalists there are the observations, extending over 60 years, of Charles Brower and his sons, a family which has provided the first specimens of 63 species and subspecies of the birds now known from arctic Alaska. From his vivid, pictorial memory and with precise recollections of time and circumstances Thomas Brower has related to me that these rare appearances of unusual birds clearly implied to him that they had come as strangers to Barrow.

TABLE 6.—*Distances from their nearest reported nesting grounds of some birds recorded at Barrow*

Miles from nearest nesting place	Birds	Specimens
2400	Piranga olivacea	1
1800	Tyrannus tyrannus	1
1800	Euphagus cyanocephalus	1
1200	Troglodytes troglodytes alascensis	1
1100	Agelaius phoenicus arctolegus	1
1100	Piranga ludoviciana	1
1000	Charadrius vociferus vociferus	2
1000	Chordeiles minor minor	1
900	Spizella passerina boreophila	1
800	Hylocichla guttata guttata	1
800	Passerella iliaca unalaschcensis	2
800	Oporornis tolmiei	2
800	Contopus sordidulus	1
700	Falco sparverius	2
500	Sialia currucoides	3
300	Tachycineta thalassina	2
300	Iridoprocne bicolor	4
300	Hirundo erythrogaster	6
300	Petrochelidon pyrrhonota	3
300	Riparia riparia	3
300	Dendroica coronata	3
200	Wilsonia pusilla	4

Some land birds found at Barrow were far from their known nesting grounds and on a terrain and in a climate very strange to them. Some of these strange birds from Bailey's report with my estimate of the distance to their usual nesting grounds are listed in table 6. The location of their nearest nesting ground was obtained from the A.O.U. Check-list (1957) or from my own experience with birds nesting in Alaska. Although better information may modify the estimated

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distances, the fact will remain that many birds have reached Barrow after long travel over country in which their ability to exist comes to us as a surprise.

By comparison most of the visitors to Anaktuvuk (see p. 253) are known to nest within 100 miles of that locality and none were more than 300 miles from their normal nesting range. In distance from regular nesting grounds they resemble only the end of the list of occasional birds at Barrow, and no bird was as far from its proper nesting place as were the birds of 15 species which have been recorded at Barrow.

The presence of strange birds at Barrow and the lack of them at Anaktuvuk is apparently characteristic of each locality, for it does not seem possible that such a great disparity in phenomena can be ascribed to difference in intensity of observation. Point Barrow is unique because it is the northernmost continental locality in the western arctic. The promontory is worked by conflicting ocean currents that deposit along the coast to the west of Barrow, driftwood originating in the Yukon Valley and to the east driftwood from the valley of the Mackenzie (Giddings 1952) and often the coasts on each side of Barrow have such differing ice conditions that ships have to wait for a change before rounding the point. It is near the eastern end of the annual migration of Pacific walrus. Many older villages have occupied the locality, which in the past has evidently attracted people to settle there during several cultural periods. These characteristics indicate that Barrow has been an important point in the distribution of animals and man.

Land birds may concentrate at a promontory and they are likely to be attracted to the dwellings of people in a landscape otherwise little marked. These circumstances concentrate stray birds and lead to their observation, but they do not explain why the birds went so far from their regular haunts, traversing a country far different from the normal experience of their populations. It is not possible to invoke storms or weather as causes which could divert them for such distances and through such a diversity of terrain and local weather as they must have passed. At present we must take the appearance of numerous strange birds at Barrow as an interesting fact we cannot yet connect with the rest of our knowledge of the geographical distribution of birds.

It is these strange birds which make the Barrow avifauna more numerous than that in the other localities. Among the birds normally found at Barrow are several of the maritime birds so numerous on Bering Sea. These birds are absent from the interior, and relatively few are found along the coast eastward from Barrow. Few land

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birds except snow buntings (*Plectrophenax nivalis*) and Alaska longspurs (*Calcarius lapponicus alascensis*) are found common at Barrow, and many that are common at Anaktuvuk occur there rarely.

Distribution in Western Arctic America

In table 7 is presented a comparison of distribution in six localities (see maps, figs. 1 and 8): (1) Anaktuvuk; (2) Kobuk Village, on the forested middle and upper part of Kobuk River about 150 miles west by south from Anaktuvuk; (3) the arctic part of interior Yukon about Old Crow, 350 miles east of Anaktuvuk; (4) the eastern arctic

TABLE 7.—*Species of birds in the families reported from six localities of western arctic America*

Families	Anaktuvuk	Kobuk	Old Crow	Arctic coast		
				Yukon	Eastern Alaska	Barrow
Gaviidae	4	4	3	3	3	3
Podicipedidae	1	2	2	1	0	1
Procellariidae	0	0	0	0	0	2
Phalacrocoracidae	0	0	0	0	0	1
Anatidae	17	18	19	14	12	20
Accipitridae	5	6	6	2	1	2
Pandionidae	1	1	1	0	0	0
Falconidae	4	2	3	1	2	3
Tetraonidae	2	3	4	2	2	2
Gruidae	1	1	1	1	1	1
Charadriidae	4	5	3	1	4	7
Scolopacidae	18	16	9	8	9	14
Phalaropodidae	2	2	1	1	2	2
Stercorariidae	3	3	2	1	2	3
Laridae	5	6	5	4	6	9
Alcidae	0	0	0	0	0	7
Strigidae	4	6	5	1	3	3
Caprimulgidae	0	0	0	0	0	1
Alcedinidae	0	1	0	0	0	0
Picidae	2	4	2	0	0	0
Tyrannidae	1	0	3	0	0	3
Alaudidae	1	1	1	1	0	1
Hirundinidae	3	4	4	0	0	7
Corvidae	2	2	2	1	2	1
Paridae	1	3	2	0	1	1
Cinclidae	1	1	1	0	0	0
Troglodytidae	0	0	0	0	0	1
Turdidae	3	4	5	2	0	7
Sylviidae	2	2	1	0	0	1
Motacillidae	2	2	1	2	2	2
Bombycillidae	0	1	1	0	0	0
Laniidae	1	1	1	0	0	0
Parulidae	3	6	6	0	0	3
Icteridae	1	1	1	0	0	3
Thraupidae	0	0	0	0	0	2
Fringillidae	12	14	12	6	5	13
TOTAL	106	122	107	52	58	126

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coast of Alaska from Flaxman Island to Demarcation Point, some 250 miles northeast of Anaktuvuk; (5) the arctic coast of Yukon Territory, about 350 miles east by north; and (6) Barrow, about 250 miles north.

I believe that the small number of species reported on the eastern Alaskan (58 species) and Yukon coasts (52 species) is significant of the true situations there. While observers and collections have been few, Anderson (1921), Dixon (1943), and Brooks (1915) each spent the cycle of the seasons there. They were skillful and energetic naturalists and I think it unlikely that they missed much. Reading their records impresses me with their reliability as indices of an avifauna which is meager in species and probably in numbers. Their records agree with information I have derived from Nunamiut and other Eskimo accounts.

While birds of strict maritime habits are absent from the arctic interior, some loons, ducks, certain sandpipers, jaegers, and gulls that in winter are maritime birds on the Pacific coast and adjoining islands migrate in summer to nest in the interior of arctic Alaska and Yukon.

Of the four species which migrate from the continent of Asia to nest in Alaska only wheatears (*Oenanthe oenanthe oenanthe*) were found at Old Crow. We did not find Kennicott's willow warbler (*Phylloscopus borealis kennicotti*), Alaska yellow wagtails (*Motacilla flava tschutschensis*) and red-spotted bluethroats (*Luscinia svecica svecica*), nor do they appear on Rand's (1946) list of Yukon birds. On the eastern arctic coast of Yukon only wheatears and wagtails among the Asiatic birds have been reported. Thus the migration of these land birds from Asia hardly carries them beyond Alaska on the American continent.

There is a difference in the ducks of arctic Yukon and Alaska in that the proportion of lesser scaup (*Aythya affinis*) to greater scaup (*Aythya marila nearctica*) at Old Crow was about like the proportion of greater to lesser scaup at Anaktuvuk. Golden-eyes (*Bucephala clangula* and *islandica*), common at Old Crow, do not appear to reach arctic Alaska.

The species and individuals of plovers and sandpipers at Old Crow were fewer than at Anaktuvuk and Kobuk and except for snipe (*Capella gallinago*), yellowlegs (*Totanus flavipes*) and solitary sandpipers (*Tringa solitaria cinnamomea*) none of their populations were numerous. In Rand's (1946) list only 16 species of sandpipers are reported from all Yukon. The common coastal forms seem seldom to migrate through interior Yukon, although many traverse Alaska at Anaktuvuk and Kobuk. In the Mackenzie Delta Porsild (1943) reported only 11 species of sandpipers.

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I had earlier shared Bishop's opinion, formed as he traveled westward along the Yukon River that the number of species of American land birds gradually diminished westward in Alaska. But comparison of the avifauna of Old Crow, Anaktuvuk, and Kobuk shows the decrease to be marked only in the family of flycatchers (*Tyrannidae*), none of which have been reported at Kobuk. Swainson's thrush (*Hylocichla ustulata incana*) has not yet been identified at Kobuk, but I think that it occurs there. Otherwise the swallows (*Hirundinidae*), thrushes (*Turdidae*), and even the small wood warblers (*Parulidae*) populate the arctic woodland thickly from Old Crow to Kobuk and some species of thrushes and wood warblers commonly nest on the tundra.

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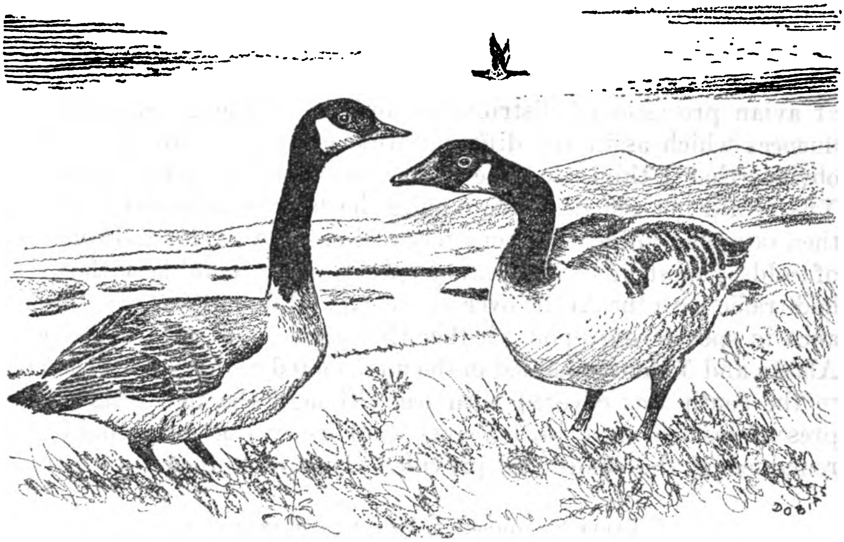

Canada Goose ***Branta canadensis*** **(see pp. 34, 134, 162).**

6. *Migration and Origins*

The ice of the last and maximal Wisconsin glaciation, it has been earlier pointed out, lay over Canada and southern Alaska for many thousand years (Flint, 1947) and separated an unglaciated area in northern Alaska and Yukon from the southern parts of North America, which during that time remained in habitable condition for birds. It is doubtful that the climate and ice of northeastern Siberia then permitted migration to Alaska from temperate parts of Asia. The maximum stage of this ice period was probably about 10,000 years ago and current developments in glacial geology tend to shorten the estimates of the time during which the migrations we now see could have established their present routes to arctic North America. It is evident that the migration of birds to Alaska is a comparatively modern development and the distances many species have traveled to occupy new areas point out the extent of this recent redistribution. There must also have been a great multiplication of numbers as new populations developed to occupy the extensive lands in most of Alaska, all of Canada, and some northern States as they

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were released from the cover of ice. This expansion in distribution and numbers of birds appears favorable for the development of new populations and their subsequent variation from the species type.

It is tempting to hope that in their geographical courses the annual migrations we now observe may show traces of their development which, in relation to climatic history, will recapitulate the kinetics of avian processes of distribution and reveal the geographical influences which assist the differentiation of species into races. It is obvious that I think that the species now migrating to Alaska and Yukon did not remain there during the last ice age, and that they then occupied milder southern territories. The habits and tolerance of cold of most of the migratory species make it unlikely that they had traffic with the Arctic over an ice cap. I do not feel equal assurance in speculating upon whether the species now resident in arctic Alaska and Yukon remained in the unglaciated regions while the land to the south was covered with ice, although the hardiness of the present resident land birds makes it plausible that they could have remained if the conditions provided them with food.

TABLE 8.—*Ranges of birds present in winter*

[Explanation—(P) presence established. American range: (A) Alaska, (Y) Yukon, (M) northwest Mackenzie.]

Species	Anaktuvuk	Kobuk	Old Crow	Range	
				World	American
Accipiter gentilis atricapillus		P	P	Eu As Am	
Falco rusticolus obsoletus	P	P	P	Eu As Am	
Canachites canadensis osgoodi		P	P	Am	AYM
Bonasa umbellus yukonensis			P	Am	AYM
Lagopus lagopus alascensis	P	P	P	Eu As Am	AYM
Lagopus mutus nelsoni	P	P	P	Eu As Am	AYM
Bubo virginianus lagophonus	P	P	P	Am	AY
Nyctea scandiaca	P	P	P	Eu As Am	
Surnia ulula caparoch		P	P	Eu As Am	
Strix nebulosa nebulosa		P	P	Eu As Am	
Aegolius funereus richardsoni	P	P	P	Eu As Am	
Dendrocopos pubescens nelsoni	P	P		Am	
Picoides arcticus		P		Am	
Picoides tridactylus fasciatus	P	P	P	Eu As Am	
Corvus corax principalis	P	P	P	Eu As Am	
Perisoreus canadensis pacificus	P	P	P	Am	AYM
Parus atricapillus turneri	P	P		Am	A
Parus cinctus lathami		P	P	Eu As Am	AYM
Parus hudsonicus hudsonicus		P	P	Am	
Cinclus mexicanus unicolor	P	P	P	Am	
Bombycilla garrula pallidiceps		P	P	Eu As Am	
Pinicola enucleator alascensis	P	P	P	Eu As Am	AYM
Acanthis hornemanni exilipes	P	P	P	Eu As Am	
Acanthis flammea flammea		P		Eu As Am	
Loxia leucoptera leucoptera		P	P	Eu As Am	
Total (25)	(13)	(24)	(21)		

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The winter-resident birds of the forested parts of arctic Alaska and Yukon (table 8) are well represented at Kobuk and Old Crow, but only 4 of the 13 at Anaktuvuk are strictly birds of the tundra, showing the restriction imposed by lack of trees. These species are now adapted to life on arctic tundra and might have survived under similar conditions during an ice age. Inasmuch as all 25 species also now live in arctic forest, that condition would have been more suitable. As for their present world distribution, 9 of the species are now confined to America and 16 also extend widely over Asia and Europe. Of the 10 American species 5 are differentiated as races restricted to Alaska, Yukon and northwestern Mackenzie. Among the 16 holarctic species are 4 races restricted to the area. The differentiation of 9 populations resident in the area implies that they have been long isolated from interbreeding with the remainder of their species. It also indicates a certain degree of faunal homogeneity of the arctic interior of western North America from the western border of forest to some line near the Mackenzie Delta where contact is made with other resident races.

Species and their Migration Routes

Distinguishable populations of 19 migratory species of land birds nest mainly in Alaska, Yukon, and western Mackenzie, as shown in table 9. Of these, 3 (in *Aphriza*, *Heteroscelus*, and *Limnodromus*) have no nesting range outside the area except on the adjacent coast of Siberia. The American populations of *Oenanthe* and *Plectrophenax* are not recognizable by taxonomic distinction; but I have indicated that the Alaskan snow buntings appear distinguishable in the thickness of toes and claws. The wheatears are not taxonomically distinguishable from those of Europe and Asia, although their migration to nest in northwestern America takes them far east of their Asiatic range. Among the 14 populations assigned to taxonomic races nesting only in Alaska and Yukon, I find local differentiation visible in 3 racial designations that are not considered as established by the A.O.U. Check-list (1957): *Branta canadensis taverneri*, *Leucosticte tephrocotis irvingi*, *and Arenaria interpres interpres*. The separation of the latter from *A. i. morinella* rests upon distinctions which are difficult to make and accordingly their ranges are uncertain. In spite of these reservations as to the distinction of the populations, 3 species and 11 races nesting mainly in northern Alaska and Yukon are commonly recognized and the area is characterized by the nesting of a number of distinguishable populations of migratory species.

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TABLE 9.—*Land birds migrating to nest mainly in Alaska, Yukon, and western Mackenzie*

[Explanation—(P) present, (M) migrant. Migration routes: (W Am) western America, (E Am) eastern America, (Pac) Pacific, (Asia) Asia, (Al) Alaska.]

Birds	Migration route	Anaktuvuk	Kobuk	Old Crow	Range of the species
Branta canadensis taverneri	W Am	M	P	P	Am
Arenaria interpres interpres	Pac	M	M		Eu As Am
Aphriza virgata	W Am		P		Am
Tringa solitaria cinnamomea	W Am	P	P	P	Am
Heteroscelus incanum	Pac	P	P		Am
Limnodromus scolopaceus	W Am	P	P		Am
Limosa lapponica baueri	Asia	P	P		Eu As Am
Sayornis saya yukonensis	W Am	P		P	Am
Eremophila alpestris articola	W Am	P	P	P	Eu As Am
Phylloscopus borealis kennicotti	Asia	P	P		Eu As Am
Motacilla flava tschutschensis	Asia	P	P		Eu As Am
Ixoreus naevius meruloides	W Am		P	P	Am
Hylocichla ustulata incana	E Am			P	Am
Luscinia svecica svecica	Asia	P			Eu As Am
Oenanthe oenanthe oenanthe	Asia	P	P	P	Eu As Am
Dendroica coronata hooveri	W Am		P	P	Am
Leucosticte tephrocotis irvingi	W Am	P	P		Eu As Am
Calcarius lapponicus alascensis	W Am	P	P	M	Eu As Am
Plectrophenax nivalis nivalis	Al	M	M	M	Eu As Am
TOTAL (19)					

The migratory routes of these populations are diverse: 10 pass through western America, 1 through eastern America, 2 over the Pacific Ocean, 5 through Asia, and 1 lies within Alaska; while 9 of the species listed nest only in America, and 10 have a widespread distribution in the three northern continents. It is unlikely that any of these species migrated to Alaska and Yukon during the maximum of Wisconsin glaciation and their present migrations have developed since the American ice cap melted. Their differentiation in form has accordingly been brought about by special migratory habits which have isolated these populations within Recent geological time.

Of the 35 species, shown in table 10, that nest in Alaska and Yukon and winter or migrate as maritime birds along Pacific American coasts, 11 also nest over variously wide extents of North America and the remainder are holarctic in distribution. A number of these species also migrate along Atlantic coasts, but we have observed birds of several of these species migrating to Old Crow from the west, and there is evidently some segregation of the Pacific populations. Only 3 of these species (in the genera *Numenius*, *Erolia*, and *Larus*) are differentiated as western American races, but these also nest east of Mackenzie. Although neither restricted in range nor differentiated as local races the use by these winter maritime species of long overland flight routes through complex terrain shows that special migra-

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tory habits are established among these maritime species which nest in Alaska and Yukon. In none of these maritime species, however, have the specialized migratory habits resulted in the visible differentiation which distinguishes the resident and most of the migratory populations of land birds which are restricted in nesting to Alaska and Yukon. Judging from their powers of flight and adaptability to arctic conditions these species could have been among the earliest to come to Alaska after the last glacial maximum. It appears that the isolation produced by special migratory paths and special nesting areas is broken down by behavior after nesting which leads to mixing with the remainder of the species. Here the specific behavior has prevented physical differentiation.

TABLE 10.—*Birds wintering or migrating along American Pacific coasts*

[Explanation—(P) present.]

Birds	Anaktuvuk	Kobuk	Old Crow	Range of the species
Gavia immer	P	P	P	Am
Gavia adamsi	P	P		Eu As Am
Gavia arctica pacifica	P	P	P	Eu As Am
Gavia stellata	P	P	P	Eu As Am
Podiceps grisegena holbŏllii		P	P	Eu As Am
Podiceps auritus cornutus	P	P	P	Eu As Am
Olor columbianus	P	P	P	Am
Branta nigricans	P	P	P	Am
Chen hyperborea hyperborea	P	P	P	Am
Aythya marila nearctica	P	P	P	Eu As Am
Bucephala clangula americana			P	Eu As Am
Bucephala islandica			P	Am
Bucephala albeola		P		Am
Histrionicus histrionicus	P	P	P	Am
Clangula hyemalis	P	P	P	Eu As Am
Melanitta deglandi	P	P	P	Am
Melanitta perspicillata	P	P	P	Am
Oidemia nigra americana		P		Eu As Am
Mergus serrator serrator	P	P	P	Eu As Am
Aquila chrysaetos canadensis	P	P	P	Eu As Am
Haliaeetus leucocephalus alascanus	P	P	P	Am
Squatarola squatarola	P	P		Eu As Am
Numenius phaeopus hudsonicus	P	P	P	Eu As Am
Erolia alpina pacifica	P	P		Eu As Am
Crocethia alba	P	P		Eu As Am
Phalaropus fulicarius	P	P		Eu As Am
Lobipes lobatus	P	P	P	Eu As Am
Stercorarius pomarinus	P	P		Eu As Am
Stercorarius parasiticus	P	P	P	Eu As Am
Stercorarius longicaudus	P	P	P	Eu As Am
Larus hyperboreus barrovianus	P	P	P	Eu As Am
Larus canus brachyrhynchus	P	P	P	Eu As Am
Larus philadelphia		P	P	Am
Xema sabini	P	P		Eu As Am
Sterna paradisaea	P	P	P	Eu As Am
TOTAL (36)	(30)	(34)	(26)	

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Birds of 25 species that migrate overland in northwestern Canada and probably through the western mountains to nest in northern Alaska and Yukon, are listed in table 11a. Although swallows (Hirundinidae) are widely distributed across North America during migration I have included all 5 species as probably flying northward along a western course to Alaska because the early northward progress of the spring migration of swallows in the west fits their time of arrival in Alaska and Yukon. Two of the five swallows (*Tachycineta* and *Petrochelidon*) are differentiated as western races. The difficulty in proposing the migratory paths of some wide-ranging species is shown in the cases of the Savannah sparrow (*Passerculus*) and Junco (*Junco*), for both migrate through most of the northern states. In these cases one may suspect that these migrants to Alaska come from the western fringe of the widespread populations. The majority of these birds can be regarded as western American and 14 of them are taxonomically distinguished as western races. Of the species listed in table 11a, 5 nest in the Arctic far east of Yukon, 9 have already been referred to (table 9) as providing races mainly restricted to nesting in Alaska and Yukon, and 11 are assigned to races which nest over a considerable American area south of the Arctic. But among these 25 western migrants, 20 reach the Arctic only in Alaska, Yukon, and western Mackenzie, so that their most northern nesting range in the west is apparently related to the favorable environmental conditions of Arctic Alaska and Yukon.

The 17 species that migrate principally east of the Rocky Mountains, as shown in table 11b, can be assigned to the central flyway, which is routed over the watershed east of the Rocky Mountains. Among these species the 2 thrushes (*Turdus* and *Hylocichla*), the kinglet (*Regulus*), pipit (*Anthus*) and 5 wood warblers (*Vermivora*, *Dendroica petechia* and *striata*, *Seiurus*, and *Wilsonia*) also migrate through paths east of the central States and Provinces. Alaska and Yukon are only part of the extended nesting areas of these birds, but 9 of them reach the Arctic only in Alaska, Yukon and Mackenzie. Again the favorable nesting environment in the western arctic is apparent.

Only 5 species nesting in Alaska and Yukon (table 11c) can be regarded as migrating mainly east of the Mississippi River. There is some migration of each of these species west of the Mississippi but they are commonly regarded as eastern birds. The arctic nesting races of two of these species are restricted to Alaska and Yukon. All of them also nest south of the arctic circle.

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TABLE 11.—*Status of various migrating birds*

[Explanation—Arctic nesting range: (A) Alaska, (Y) Yukon, (M) Mackenzie, (Eu) Europe, (As) Asia, (Am) America.]

Species	Arctic nesting range	Anak-tuvuk	Kobuk	Old Crow
A. MIGRATING THROUGH BRITISH COLUMBIA				
Branta canadensis taverneri	AY	P	P	P
Anser albifrons		P	P	P
Falco columbarius bendirei	AY	P	P	P
Grus canadensis canadensis		P	P	P
Tringa solitaria cinnamomea	AYM	P	P	P
Limnodromus scolopaceus	A	P	P	
Megaceryle alcyon caurina	A		P	
Sayornis saya yukonensis	AY	P		P
Eremophila alpestris arcticola	AY	P	P	P
Tachycineta thalassina lepida	AY		P	P
Iridoprocne bicolor	AYM		P	P
Riparia riparia riparia	AY		P	P
Hirundo rustica erythrogaster	AY		P	
Petrochelidon pyrrhonota hypopolia	AY		P	P
Ixoreus naevius meruloides	AY		P	P
Lanius excubitor invictus		P	P	P
Dendroica coronata hooveri	AY	P	P	P
Wilsonia pusilla pileolata	A	P	P	
Leucosticte tephrocotis irvingi	AY	P	P	
Passerculus sandwichensis anthinus		P	P	P
Junco hyemalis hyemalis	AY		P	P
Spizella arborea ochracea		P	P	P
Zonotrichia leucophrys gambelii	AYM	P	P	P
Zonotrichia atricapilla	A		P	
Calcarius lapponicus alascensis	AYM	P	P	P
TOTAL (25)		(16)	(24)	(19)
B. MIGRATING BETWEEN THE ROCKY MOUNTAINS AND THE MISSISSIPPI RIVER				
Bartramia longicauda		P	P	
Totanus flavipes		P	P	P
Erolia melanotos		P	P	P
Erolia bairdii		P	P	P
Tryngites subruficollis		P	P	
Empidonax traillii traillii	Y			P
Nuttallornis borealis	Y			P
Turdus migratorius migratorius		P	P	P
Hylocichla ustulata incana	AY			P
Regulus calendula calendula		P	P	P
Anthus spinoletta rubescens		P	P	P
Vermivora celata celata	AY		P	P
Dendroica petechia amnicola	AY	P	P	P
Dendroica striata	AY		P	P
Seiurus noveboracensis notabilis	AY		P	P
Wilsonia pusilla pusilla	AYM			P
Calcarius pictus	AYM	P		
TOTAL (17)		(10)	(12)	(14)
C. MIGRATING EAST OF THE MISSISSIPPI RIVER				
Pluvialis dominica dominica		P	P	P
Micropalama himantopus		P		
Hylocichla minima minima		P	P	P
Dendroica striata	AY		P	P
Passerella iliaca zaboria	AY	P	P	P
TOTAL (5)		(4)	(4)	(4)

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TABLE 11.—*Status of various migrating birds*—Continued

Species	Arctic nesting range	Anak-tuvuk	Kobuk	Old Crow
D. MIGRATING TO ASIA FOR THE WINTER				
Limosa lapponica baueri	A	P	P	
Oenanthe oenanthe oenanthe	Eu As Am	P	P	P
Luscinia svecica svecica	A	P		
Phylloscopus borealis kennicotti	A	P	P	
Motacilla flava tschutschensis	AY	P	P	
TOTAL (5)		(5)	(4)	(1)
E. MIGRATING OVER THE PACIFIC OCEAN				
Arenaria interpres interpres	AY (?)	P	P	
Heteroscelus incanum	A	P	P	
TOTAL (5)		(2)	(2)	(0)
F. WINTERING IN ALASKA				
Acanthis hornemanni exilipes	Eu As Am	P	P	P
Acanthis flammea flammea	Eu As Am	P	P	P
Plectrophenax nivalis nivalis	A (?)	P	P	P
TOTAL (3)		(3)	(3)	(3)

A remarkable 5 species (table 11d) migrate after nesting in northern Alaska to winter in Asia. Among these species the godwit (*Limosa*) winters on Asiatic coasts, while the others seek some as yet undefined wintering areas on the continent of Asia. The wheatears (*Oenanthe*) are not differentiated from a widespread Asiatic and European race. The four others are ascribed to races which are restricted to nesting in northern Alaska and Yukon. Long establishment of their remarkable migratory paths to a restricted nesting area in western arctic and subarctic America is indicated in the racial designations which distinguish them from close relatives in Asia.

There are 2 species (table 11e) which nest mainly in northern Alaska and Yukon as far north as the arctic coast and which migrate widely over the Pacific Ocean to winter on its coasts and islands. Among the three migratory species which both winter and nest in Alaska (table 11f) I can only distinguish the Alaskan snow buntings (*Plectrophenax*) by a small difference in the thickness of their claws from the widespread North American race. The winter distribution of snow buntings suggests isolation of these in Alaska. I have no evidence to suggest whether the nesting redpolls of Alaska and Yukon come from the populations wintering in Alaska or from the western Provinces of Canada.

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Main Paths of Migration

By utilizing as indicators of migratory paths the differentiation of races, direction of observed migration and a few significant recorded dates of migration on the approaches to the northern nesting grounds, I have assigned 93 of the species nesting in northern Alaska and Yukon to migratory paths in North America, over the Pacific, and in Asia. The majority of these migrations pass through western Canada and along American Pacific coasts, and only 22 of these species appear to migrate east of the Rocky Mountains. The totals from tables 10 and 11 are summarized below:

Along American Pacific coasts	36
Through western Canada	25
Rocky Mountains to the Mississippi	17
East of the Mississippi	5
To Asia	5
Over Pacific Ocean	2
In Alaska	3
Total	93

Without this analysis I would have subscribed to Dixon's (1938, p. 5) comment on the birds of Mount McKinley Park, Alaska, a fauna similar to that of northern Alaska, "a large proportion of the breeding birds of the McKinley regions consist of eastern forms." As it is, I do not.

The designation of birds as western or eastern American depends on the location assigned to the geographical boundary between east and west, and to whether the reference is to species or race. It is further influenced by whether current distribution or the origin of the form is meant. The present development of taxonomy, geographical distribution, and recent climatic history are leading to the assignment of each taxonomic form to a meaningful position in time and space.

The migration of 22 species of birds through North America east of the Rocky Mountains into northwestern Alaska and Yukon is impressive. In his explorational travels in the Yukon Valley, W. H. Dall (1870, p. 288) detected the eastern character in the fauna north of the Alaska Range, and remarked upon the common distribution of North American pike (*Esox lucius*) in the Yukon River as far west as tidewater as an indication of a nearly continuous connection by water between northern Alaska and the interior of North America. By recognizing an extensive fauna in Alaska related to that of the interior of Canada, Dall concluded that the northern mountains were readily traversed by birds migrating to Alaska. In his great study of the fauna of northern North America, Sir John Richardson

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(1852, p. 124) saw the geographical relations of the Mackenzie Valley in a manner different from Dall, for he remarked, "On the Mackenzie there is an intermingling of the flora of both coasts, as well as of the migratory feathered tribes, the Rocky Mountains not proving a barrier to either." Actually Dall's view, limited to Alaska and overemphasizing the eastern character of the fauna properly accentuated the remarkable trend of bird migration in northern North America to the westernmost parts of northern Alaska and even into Siberia. This westerly trend in migrations is undoubtedly related to conditions produced by the east-west direction of mountains and valleys in Yukon and northern Alaska.

The very complexity of the terrain of southern Yukon and Alaska leads me to believe that, although we now have few significant observations of northern routes of migration, we can by reasonable speculation predict the situations in which these routes may be discovered. It is my belief, based upon observation in northern Alaska, that the high mountains of the coastal and Alaska ranges must funnel much of the migratory bird traffic through the few low passes by which the cold and barren high elevations can be avoided.

Some of the maritime birds wintering on Pacific American coasts (table 10) must leave the Gulf of Alaska to pass overland to the Porcupine Valley, where a number of these species were seen arriving at Old Crow from the west (see p. 157). Their crossing of the Coast Range may be suspected to start its overland passage east of the high St. Elias Mountains. Westward along the Gulf of Alaska the next break in the lofty Coast Range is through the Copper River Valley, which in its lower part is still raw from the recent retreat of great glaciers. Further west the Susitna Valley opens from Cook Inlet and leads northward, as does the Copper Valley, to passes through the Alaska Range into the Tanana Valley. From Cook Inlet, also, Rainey Pass leads through the Alaska Range west of Mount McKinley to the Kuskokwim Valley. Some of the maritime birds wintering along the Alaska Peninsula and Aleutians probably cross and round the Peninsula. These routes are postulated from a few records of migration but mainly from geographical appearances and as suggestions for a strategy of further observation.

A few of the maritime species (table 10) which winter on southwestern Alaskan coasts probably pass from Bering Sea eastward along the Yukon, for Dall (Dall and Bannister, 1869) remarked upon the early arrival of goldeneyes (*Bucephala clangula*) at Nulato from the west. According to Dall they winter extensively in the Aleutians. Mary Lobban informed me that late in October 1957 goldeneyes were numerous about Cold Bay, near the western end of the Alaska Peninsula. Since much of their nesting area lies east of Alaska the west-

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ern wintering population probably traverses its entire breadth eastward in spring. Many maritime birds of the western coasts in winter come to nest and migrate farther northward in the passes through the Brooks Range.

Many of the land birds of the Pacific-coast States (table 11a) have been reported in migration northward between the Coast Range and the Rocky Mountains in northern British Columbia (Swarth, 1936). I suspect that those which are headed for Alaska pass through southwestern Yukon into the upper Tanana and Yukon Valleys. Those of them which reach Old Crow may be suspected of avoiding the crossing of the Ogilvie Range to travel along the Yukon until they can enter Porcupine Valley. In this way they would be following the eastward routes of inland travel observed among loons, geese, ducks, and gulls in their visible flights past Old Crow.

The species which migrate northward between the Mackenzie and Rocky Mountains (table 11b) are seen in considerable numbers during migration in southern Yukon. It is likely that they pass over the valley of the upper Liard River into the headwater valleys of the Yukon and proceed from there westward into Alaska. With exception of the sandpipers, 13 of these species are very common nesting birds at Old Crow. If we consider the Ogilvie Mountains likely to bar them from a direct approach to the Porcupine, they could pass along the Yukon to the Porcupine and enter its valley from the west, as do the maritime wintering birds. There is an objection to considering that these birds would enter Porcupine Valley from the west because some of them have been observed in the Yukon Valley in Alaska a week or more earlier than they appear only 140 miles northeastward at Old Crow. But not enough dates of northward progress are yet available from the right locations for us to use the calendar to plot the probable routes of these migratory flights. Some eastern birds may cross the mountains in northern British Columbia to reach their nesting grounds around Cook Inlet, but the majority of these populations nest north of the Alaska Range and seem likely to enter Alaska along the Yukon.

The five species which migrate through the United States east of the Mississippi (table 11c) pass northward in the Mackenzie Valley, probably holding to its warmer western watershed. In its northern part they bear west to enter Yukon. Since golden plover (*Pluvialis*) are rare at Old Crow they probably traverse northern British Columbia and southern Yukon to occupy their extensive Alaskan nesting areas. The gray-cheeked thrush (*Hylocichla minima*), blackpoll warbler (*Dendroica striata*), and fox sparrow (*Passerella*) migrate extensively through southern Yukon with other birds from east of the mountains.

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Near Old Crow we saw a few hawks and geese flying as if in migration from the southeast. Lazarus Charlie recorded some arrivals of land birds at Johnson Creek, on the Porcupine 80 miles southeast of Old Crow, before we saw them. These observations suggest that some eastern birds reached the Porcupine by flights northwesterly from the Mackenzie Valley. We have no clear evidence whether the Porcupine is an important migratory route for small eastern birds on their flights toward Alaska, but the Peel River breaks through the southern Richardson Mountains in low passes which, from their appearance on the map, would be favorable routes from the Mackenzie to the Porcupine Valley, so I suspect that eastern birds, and possibly some eastern components of the western migrations enter by this course.

For birds from the westernmost United States to reach western arctic Alaska requires a westerly flight over at least 40 degrees of longitude. Birds arriving in arctic Alaska from the Mississippi Valley must have traveled 70 degrees westerly and some golden plover (*Pluvialis dominica*) when southbound from Alaska to Nova Scotia must traverse 100 degrees of longitude easterly in order to clear the Atlantic coast on their overwater flight to South America.

The 45 species of birds which migrate over land through North America must pass westerly from at least 30 to more than 70 degrees on their flights to arctic Alaskan breeding grounds. The amount of westing involved may be seen by comparison with that of about 100 degrees from San Francisco to Manila. The changes in local time at solar noon encountered by the migrating golden plover (*Pluvialis*) during a few weeks of late summer is comparable in rate and hours to that during a voyage by ship across the Pacific Ocean.

The Asiatic wintering birds (table 11d) reach western Alaska by an as yet undefined oversea route from Siberia. Since in eastern Alaska they are concentrated in its northern and arctic parts, I suspect that they cross Bering Strait.

It may seem that these Asiatic wintering species make only a feeble penetration into the American continent, but they are not always easy to see, and they occupy secluded haunts within untraveled areas. In my experience, with the exception of the bluethroat (*Luscinia*), they are numerous and widely distributed. Although their hold upon the American continent has been regarded as tenuous, actually they are established in Alaska by easterly migrations as impressive as those of any American wintering birds. If the wheatears (*Oenanthe*) which nest in eastern Alaska come from the central wintering area for the race in Arabia (Mackworth-Praed and Grant, 1951) their spring migration passes halfway around the world. Ascribing to them the most easterly winter residence possible in China, they would still have

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to migrate across 100 degrees of longitude to reach Yukon. This is a remarkable flight for a bird weighing 24 grams. And from its nearest known wintering place in the Philippines (Parkes and Amadon, 1948) Kennicott's willow warbler (*Phylloscopus*) also travels eastward about 100 degrees of longitude to nest in central arctic Alaska. It weighs less than 10 grams.

The two species which fly over the Pacific (table 11e) also fly along its shores. Present records give no clue as to their Alaskan landfall.

Along the arctic coast of Alaska a powerful trend of bird migration moves eastward in spring, in contrast to the predominant westward trend of land birds in the Yukon Valley. These eastbound migrants along the arctic coast may be assigned to three groups, according to the length of their arctic flight courses. One includes the birds wintering on north Pacific coasts (table 10). At Barrow flights of brant, some shore birds, gulls, and terns are often seen migrating eastward in spring and westward at the end of summer. On the eastern arctic coast of Alaska, Dixon (1943) remarked eastbound flights of loons, brant, and other geese in June and westbound flights of brant in August. It has been my impression that along the coast near Barrow the flights of these North Pacific wintering birds break up in spring and assemble in late summer. East of Barrow the flights of these birds appear to diminish, while westward they are more often reported, so that coastwise migration of North Pacific wintering birds tapers off between Barrow and eastern Alaska.

At Barrow some of the migrating loons, geese, ducks, and sandpipers appear in spring as if they were arriving from the interior. Before we began our studies at Anaktuvuk, Thomas Brower believed there were indications on the coast that many water birds, and probably all land birds, coming to the arctic slope and coast had passed through the Brooks Range. My occasional observations in the country between the coast and mountains showed that many birds were coming from the south in spring and forming flocks for southward migration in late summer. At Anaktuvuk, in the Killik Valley, and at Howard Pass the migratory movements I have seen were sufficient to bring large numbers of birds to the arctic slope and coast.

A second group of species, which migrates northward over Bering Sea and then east along the arctic Alaskan coast, contains members of the great bird associations characteristic of the Bering Sea coast in summer. The distinctive birds are cormorants, auks, murres, guillemots, and puffins. These species reach Barrow and individuals occasionally pass eastward, but their abundance rapidly diminishes east of Cape Lisburne, where the last good nesting cliffs are found.

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A spectacular phenomenon of arctic life is seen in the eastbound flights of four species of eider ducks along the coast in spring at Barrow. King eiders outnumber all other species and move in such close sequence of large flocks as to exceed any migration I have seen. Sir Hubert Wilkins remarked to me that they constitute the most impressive sight of migratory movement in the world. At the same time gulls (*Larus hyperboreus* and occasionally *Rissa tridactyla* and *Xema sabini*) move eastward, but in much smaller numbers. The flights of loons, geese, ducks, and shorebirds, while sometimes numerous, are irregular, so that they do not compare with the flights of eiders as orderly migratory phenomena.

From reports originating on the eastern arctic coast of Alaska I gain the impression that the orderly movement of king eiders continues an easterly migration far beyond Alaska. For other birds the eastern arctic coast of Alaska does not seem to be an important migratory route.

There are no reports known to me which indicate that spring migration passes westward from Mackenzie to the arctic coast of Alaska. The short list of the avifauna on the eastern Arctic coast of Alaska suggests that the region is a terminus for the migration of only a few land birds. The evidence available suggests that some of the land birds arrive there after crossing near the center of the Brooks Range and flying eastward down the Colville Valley.

The migratory movements of birds in northwestern America can be represented by a diagram (fig. 8) showing the main trend of the several migratory routes which have been described. For the movements pursued in arctic Alaska and Yukon the evidence is rather clear, but the other migratory routes referred to are at present hypothetical. We thus have the courses of migration delineated with greatest certainty near their arctic terminus and through a country commonly regarded as little known. There an orderly pattern appears which can be easily distinguished because the migratory populations are homogeneous at the time of their proximity to their nesting grounds. These orderly currents of migration are related to such major topographic features as the Rocky Mountains, the Yukon Valley, the Brooks Range, the Bering and Arctic coasts along with their associated influences upon weather and climate.

Migration, the Climate, and Taxonomic Differentiation

I have pointed out a number of distinctions in the races of birds in northern Alaska and Yukon: all resident species restricted to the area form taxonomic races (table 8), and of the 19 migratory species principally nesting in the area, 14 form American taxonomic races

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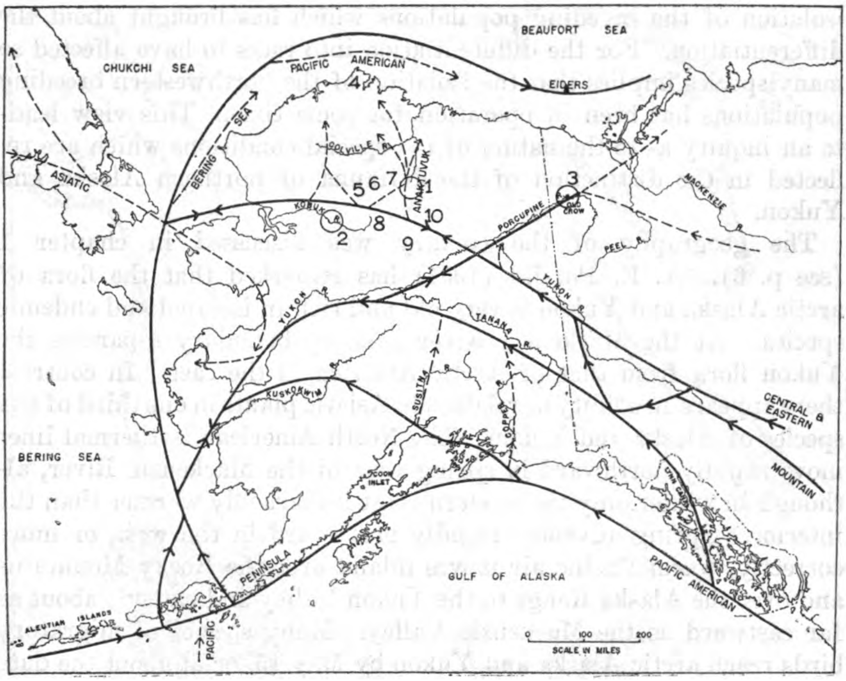

FIGURE 8.—Main migration routes in northwestern America. Large circles (1-3) mark localities where comprehensive observations have been made by the author. Numbers 4-10 mark localities where observations have been made several times for brief periods, or once over a period of at least 3 weeks.

Explanation:

1—Anaktuvuk	5—Ahlasuruk River	8—Alatna River
2—Kobuk	6—Killik River	9—Bettles
3—Old Crow	7—Chandler Lake	10—Big Lake
4—Barrow		

(table 9). Thus, 23 local populations are distinguished taxonomically out of 28 resident and migratory species which nest mainly in northern Alaska and Yukon.

The migratory species come from wintering grounds in America and Asia distributed over at least 170 degrees of longitude, or nearly half of the circumference of the earth. The diversity of their winter experience stands in contrast to the similarity of their summer experience on the breeding ground which they occupy for only about three months of the year. If we assume that the races nesting in northern Alaska and Yukon became differentiated as a result of their segregation there as isolated breeding populations, the formation of 23 distinguishable races out of 28 species is a significant step in the separation of species into races. The characters by which the local races are distinguished are matters of color, pattern, or dimensions to which no adaptive value can be assigned and so, as far as can be seen, it is

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isolation of the breeding populations which has brought about the differentiation. For the differentiation into races to have affected so many species implies that the isolation of the northwestern breeding populations has been in operation for some time. This view leads to an inquiry as to the nature of the special conditions which are reflected in the distinction of the avifauna of northern Alaska and Yukon.

The geography of the country was discussed in chapter 1 (see p. 6). A. E. Porsild (1951) has remarked that the flora of arctic Alaska and Yukon is very old and rich in isolated and endemic species. At the Mackenzie River a sharp boundary separates the Yukon flora from that of Arctic America in the east. In contrast there appears an affinity of relation to Asiatic plants in one third of 604 species of Alaska and Yukon. The North American isothermal lines move rapidly northward in spring west of the Mackenzie River, although in winter only the western coast is markedly warmer than the interior. Spring advances rapidly northward in the west, or more correctly, warm Pacific air moves inland over the Rocky Mountains and over the Alaska Range to the Yukon Valley and extends about as far eastward as the Mackenzie Valley. Many species of migratory birds reach arctic Alaska and Yukon by May 15, or at about the date when they come to northern Ontario in the east. At the time of spring migration the isothermal lines above freezing extend nearly 20 degrees of latitude farther north in western than in eastern America.

The distinctive flora and fauna of northern Alaska and Yukon about correspond with the area in which the lowlands were not covered with ice during the last stage of Wisconsin glaciation (see figs. 3 and 9). In thinking about the effect of this area as a refuge in which life might survive while the rest of the northern part of the continent was covered with ice it must be recalled that some climatic conditions which left the country free from continuous ice in Wisconsin times still exist. The general formation of the mountains has not varied, and the resulting climate and low preciptation may well have been a persistent distinction of the extreme northwest. Until we can discover their remains and assign them to dates in glacial history, it is pure speculation to view the wintering birds now present as derived from stock which survived in an unglaciated arctic Alaskan refuge. It seems more plausible to suspect that the warmth of the Pacific Ocean early melted the coastal ice and made the coasts habitable for maritime birds and a fit path for coastwise migration before the interior was cleared. But even now the glaciers around the St. Elias Mountains leave only a narrow path for land birds along the coast. Although the majority of the taxonomically differentiated migratory races in the Alaskan breeding avifauna are western American birds, the fact

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FIGURE 9.—Hypothetical life zones of the Wisconsin age: (A) arctic glaciation, (B) tundra, (C) Hudsonian, (D) Canadian, (E) Transitional, (F) Upper Austral, (G) Lower Austral. Heavy broken line marks the limit of 20-inch mean annual rainfall. (From L. S. Dillon, "Wisconsin Climate and Life Zones in North America," Science, vol. 123, fig. 11, 1956.)

that some are of eastern and Asiatic species show that birds from all sources became differentiated by their relation to the Alaskan nesting grounds.

Some hardy species of birds, like those which winter in the Arctic may have survived in ice-free lowlands of northern Alaska and Yukon, during maximum glaciation in the Mankato substage of Wisconsin time but land birds could not migrate over continental ice caps. The migratory populations now nesting in the northern part of America must, therefore, have become established within the last 10,000 years. During the earlier glacial maxima of Wisconsin time the existence

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of life on most of the northern part of America must have been similarly reduced, but in the interglacial periods climatic conditions may have been suitable for repopulation.

The assumption that differentiation of the migratory species of birds has taken place since the ice cover melted sets a time when populations migrating to nest in western arctic America could have started their isolation from more southern members of the species. But although melting of the ice removed one barrier against the migration of birds into the Arctic, it did not at once make a path fit for their travel and nesting, for the changes were gradual and did not progress steadily toward the conditions we now see. Relics of vegetation under sediments and in Alaskan bogs provide evidence that marked climatic fluctuations have occurred there as elsewhere during the last few thousand years. The warmest period since the Wisconsin ice, for example, is indicated to have been widespread in North America about 6,000 years ago (Karlstrom, 1957), and many species could then have extended populations far north of their present limits, for a warmer climate seems likely to favor increase of the variety of living forms. Only a few hoary redpolls (*Acanthis hornemanni*) now winter in the Arctic, and snow buntings (*Plectrophenax*) and common redpolls (*Acanthis flammea*) sparsely winter along the margin of the Arctic, but a little moderation of climate would allow large populations of these species to remain as residents and the extent of many migrations would be reduced.

The larger species of northern mammals are visibly adapted to cold by their insulation. Although the physiological adaptability of small mammalian species is limited, large populations of lemmings, mice, and shrews live in the Arctic sheltered from the cold by their adaptive behavior. Arctic human populations are adapted to their cold environment mainly by each individual's learning of the cultivated practices of an arctic society. Birds seem to have devised few methods of behavior which are obviously protective against cold; the larger species are adapted by their insulation, but the obviously successful adjustment of small birds to arctic cold is not now satisfactorily explainable in terms of physiology and behavior.

Following Bergmann's (1847) important discussion of animals' economy of heat in relation to size, it has become popular to say that the northward increase in dimensions of clines within some species demonstrates natural selection of a climatically adaptive trend in variation. P. F. Scholander (1955) has shown that such small dimensional changes as are reported in clines are insignificant for the economy of heat. Therefore they could not be selected for adaptive value in relation to climate.

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The physical characters of some races may be adaptive, but it is a difficult task to demonstrate the adaptive nature of most physiological characters even in full species. In a few important studies, local populations have been shown to have adaptive distinctions. In his classical demonstration of physiological adaptation of local populations R. Goldschmidt (1948) found populations of *Lymantria dispars* at high elevations which were more hardy in cold than populations living at lower and warmer elevations. Some of these physiologically distinguishable neighboring populations were shown to be genetically differentiated by incompatibility for reproduction. J. A. Moore (1949) has shown that examples of *Rana sylvatica* from northern ranges produce eggs which are viable in colder water than can be endured by the eggs of southern populations. Some incompatibility in fertilization by parents from remote ranges also indicates their genetic distinction. The differentiation of *Rana sylvatica* has occurred in northern areas and is probably of recent origin. These obviously adaptive and genetic variations distinguishing populations show that adaptively significant variations sometimes become established within species.

I consider it inescapable that natural selection will favor any adaptive variation according to its value to the possessor. If the variation is an inheritable character it will proceed through the genetic mechanism with a bias for its preservation in proportion to its adaptive value. However, if we consider how rarely the small variations within a species have been proved to be inheritable adaptations, we must admit that there are few demonstrations of opportunities for natural selection, *per se*, to operate in the differentiation of discrete populations within a species. Some other factor or agency must then be sought for the differentiation of the numerous taxonomic races which are found.

The variations shown in the northern races of Alaskan birds have no obvious adaptive value. Nevertheless, they clearly mark off geographic populations readily distinguishable from other populations of the same species elsewhere. The distinctions, whether of large or small degree of difference, appear to be maintainable only by prevalent inbreeding among the members of each race. Segregation of a species into recognizably distinct populations cannot take place without a sorting process, by means of which the homogeneous species becomes fragmented into races. Rather than surmise that some invisible adaptation in form or in function favors the orderly segregation of populations within a species, it seems preferable to seek out the conspicuous behavioral activities of birds that can keep these groups apart and intact as reproductive segments of the whole. This

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leads us to consider the possibility that the species involved, by virtue of their behavior, are their own active isolating agent rather than that they are the more or less passive recipients of molding influences of external factors operating on undiscernible variational values.

We have seen that in neither resident nor migratory species of arctic birds are the taxonomic distinctions of their races adaptive. Natural selection cannot operate directly upon nonadaptive characters, but yet in 9 resident species and 14 migratory species, the populations nesting mainly in northern Alaska and Yukon have become differentiated to the point where they are taxonomically distinguishable as races. It would appear that some influence other than natural selection must operate to bring about the segregation of their special although nonadaptive variations from the common attributes of the species.

Small inheritable variations mark individuals of a species, and any sample of individuals contains a genetic assortment which is somewhat different from the whole species. The smaller the sample of a population, the less complete is its representation of the genetic complement of the species and the greater is the probability that the genes will vary during their hereditary transmission. If a population is reproductively isolated it may well be different in its total genetic range from the remainder of the species and that difference may well increase with reproduction in isolation. These conditions for variation of a population are fulfilled by the isolation of the breeding populations which are restricted to northern Alaska and Yukon. The breeding isolation conforms with geographic limits, but for strong and mobile birds like ptarmigan the restriction by inert geographic obstacles appears to be not so much a factor as their active coherence in a population that selects its own range and associations.

Birds of many species return to the nesting places from which they have been experimentally removed, and they recognize their own nests and their young even after only brief acquaintance. Birds of some species persistently return in spring to nest in the locality where they were raised, evidently attracted by some pattern imprinted on their memories by early experience in the nesting locality. This particular impression upon memory appears not to be inheritable and is acquired by each individual.

Some races breeding mainly in Alaska and Yukon migrate to remote wintering grounds different from those of other races of the same species. Western solitary sandpipers (*Tringa solitaria cinnamomea*) winter mainly south of the equator in South America, while the eastern race (*T. s. solitaria*) winters from Texas and Louisiana south to the equator. Near the time of autumn departure and spring return the appearance of organized flocks of some species on their nesting

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grounds shows that there is some association of individuals of the breeding populations apart from the time of nesting. Common experience and some association of members within each arctic population while away from nesting grounds is also indicated by their synchronous return in spring with all individuals in the same phase of the brief arctic nesting cycle. Since the schedule of a bird's physiological preparation for breeding and migration can be experimentally modified by changing the duration of daylight, the physiological synchronization is not a genetically fixable character and it can arise only from similarity in the physical and social environment encountered while away from the nesting grounds.

Birds migrating to the Arctic are similarly oriented in time and space. It would be difficult to imagine the whole mechanism of individual behavior, physiology, and social activity which operates to keep these migratory populations on the same coordinates of time and space, but an acquired recollection of locality seems to be the essential instrument of their isolation. Memory is the guide which associates individual birds in populations along their long migratory paths throughout the year. The strength of its influence for return to the nesting grounds at the right time is especially impressive in relation to the small size of some species. Kennicott's willow warblers, for example, weighing only 10 grams, remain a distinct population within their wide ranging species while annually moving swiftly over a large and geographically complex part of America and Asia.

The results of this behavior permit the migratory races to exploit an arctic area which is only suitable for a brief season. The establishment of such migratory races shows that their migratory behavior has met the test of natural selection for value. The essential instrument for their segregation is the memory pattern which acts as if to direct energy of avian activity toward isolating racial characters from the random mixture of the whole species.

Many maritime species (table 10) nest in arctic Alaska and Yukon without having formed recognizable races. Although the area has long been occupied by these species, they have not become differentiated into taxonomically discernible entities. Occupation of the arctic nesting grounds must be useful to the species, or birds would not have become established as migrants to that area. However, either the area is not an isolated one as far as they are concerned, or each individual bird's association with one locality is not maintained consistently enough to segregate the requisite proportion of breeders to allow for their eventual differentiation. It cannot be assumed that those birds lack sufficient homing ability to maintain group solidarity, as this ability is known from experiments in which several species

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of gulls and terns returned to their nests after being transported long distances away. It may be suggested that these maritime, locally undifferentiated birds are not persistently affected by companionship with nesting associates during the nonbreeding season away from their breeding grounds, and that they may be diverted to join individuals bound for other nesting areas sufficiently often to keep the characteristics of the entire species in a mixed state.

Outside of Alaska and Yukon, examples of long and specialized migration routes can be seen to be associated with taxonomically distinguished populations. Although maritime species have not formed races confined to nesting in the northern interior of Alaska and Yukon, R. C. Murphy (1936) has described many examples of populations of oceanic birds which regularly return to nest on small South American Islands after remarkable long oceanic migrations. Thayer's gull (*Larus argentatus thayeri*) winters with other herring gulls on the coast of British Columbia and migrates across arctic America to nest in its eastern part. The physical characters of the race are only significant for taxonomic purposes. It shares the strength and hardiness of other herring gulls but behavioristic association with a locality isolates the race on an unusual migratory path.

There are many variations in form among races of some species which are not visibly adaptive and which cannot reasonably be assumed to have been established by natural selection. And yet without some segregating influence these characters could not be placed in separate order from the common characters of the species. Isolation, which in birds is often visibly governed by an acquired pattern of geographic memory, can segregate breeding populations and thus provide conditions suitable for variation. Under the protection of isolating behavior small and nonadaptive differentiation could progress until it became significant for natural selection to perpetuate or destroy. Isolating behavior could protect differentiation until even completely nonadaptive characters became so distinct that the variant population was genetically separated from its former associates in the species. Small variations are common and nonadaptive racial distinctions are numerous. Isolation by behavior seems to be a process which preserves these adaptively insignificant variations until they distinguish populations.

During great biotic changes in northern lands, and in fact since Pleistocene times, the surviving species of birds have remained essentially unaltered (Wetmore, 1931, p. 5). Although they have probably moved their ranges northward and southward to escape some drastic climatic changes, the northern species have met the fluctuating conditions of recent times without modification of their specific char-

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acters. The versatility of specific physiological processes and behavior is made impressively apparent by this stability. Thus, although it is often proposed that the occurrence of taxonomic races shows an evolutionary process by which species have been formed, there is no convincing evidence that the races of birds form steps toward the evolutionary divergence of species. We can say that natural species formation has not been evident during the enormous environmental fluctuations of the last 100,000 years. It is amazing that the species were physiologically so versatile as to meet these changes without essential modification.

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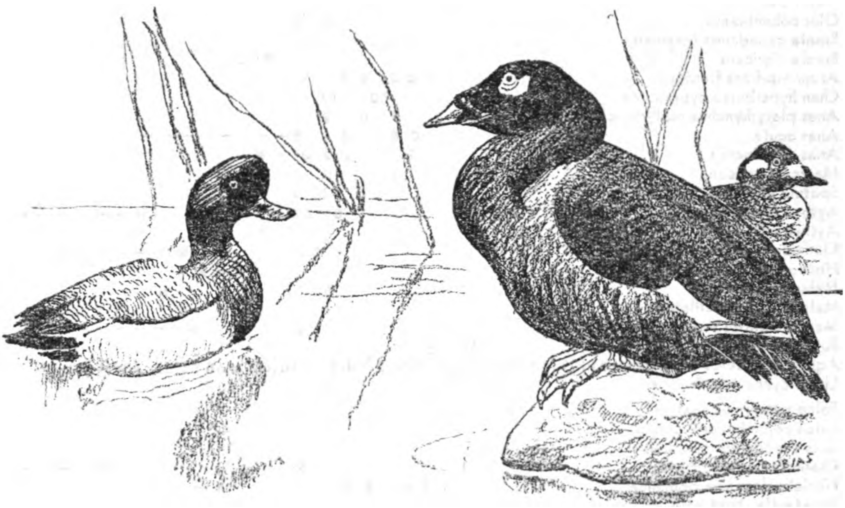

Lesser Scaup and White-Winged Scoter, ***Aythya affinis*** **(see pp. 40, 135, 173) and** ***Melanitta deglandi deglandi*** **(see pp. 43, 135, 176).**

7. *Residence in the Arctic*

The outsider engaged in arctic exploration and exploitation usually follows a program quite different from the native way of life. Travel and construction by nonindigenous methods take place mainly during the few months of open water and unfrozen ground. A year's labor must often be completed within a few months. Haste drives the white man through the arctic summer and he is inclined to think that natural processes move by his schedule. For the natural arctic resident, however, life proceeds at a normal rate in each season.

Annual changes in the arctic temperature are large and the progress of related natural phenomena is pronounced because of the conspicuous character of seasonal transitions. It would be easy to believe that the intensity of seasonal change requires acceleration of those biological processes which must run through their cycle in the arctic summer, for in three months or less birds must terminate their migratory flight, mate, nest, rear young, and prepare their departure southward. How these important periods are compressed within the short duration of the birds' summer residence in the Arctic is the subject of this chapter.

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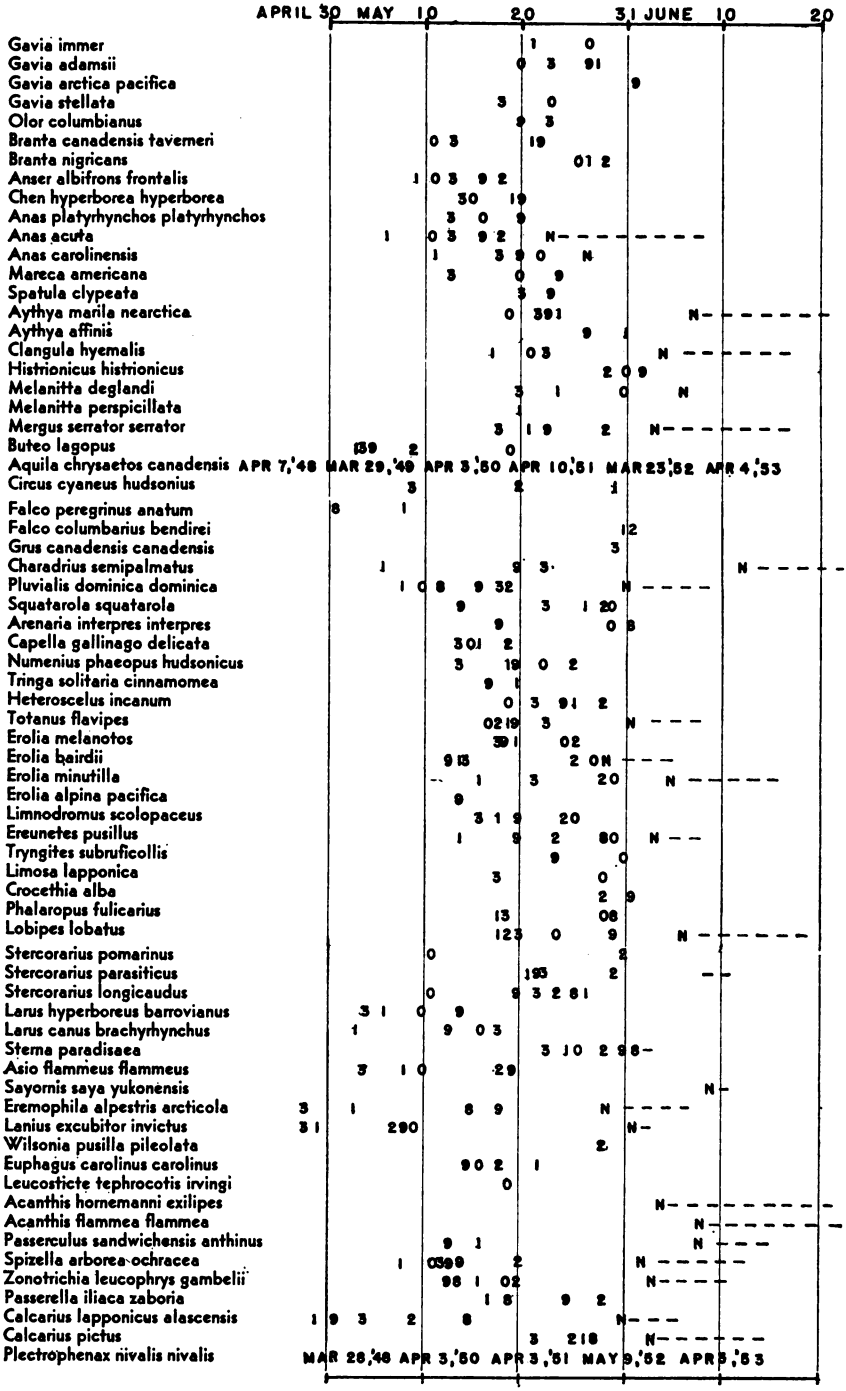

FIGURE 10.—First arrivals of migrants at Anaktuvuk, 1948–1953. Number is the last figure of the year, N marks the date when the first egg was found, and dashes mark the period during which eggs were laid.

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Arrival

The arrival of migrant birds in spring makes a great impression upon arctic people. First a few early comers appear. Shortly thereafter a wave of individuals, pairs, and flocks sweeps in to populate the formerly lifeless tundra. Not only do the birds suddenly enliven a formerly quiet scene but each species at once displays its special pattern of living on its nesting ground. Separating from social groups the birds mate and establish territories in which to pursue domestic and family life. Their program is as orderly as the settlement of a traveling nomadic community of people in a new village site. The community separates into groups of individuals for whom the family is the dominant association, whereas in traveling the direction of the community prevailed.

The conspicuous similarity of basic social concerns in the lives of birds and men is clearly an attraction for the interest of people who live a simple life. The birds are graceful, alert, neat of plumage, and competent in managing their own affairs. Even the jealousy shown in claims upon mate and territory is redeemed by the faithful support which bird parents give to their families. Such staunch support of their families is appreciated by Eskimos whose lives are bound up in the preservation of family associations.

The birds arrive in an arctic season changing at a rate which cannot be imagined from experience confined to temperate regions. Daylight becomes continuous in May. In that month, from levels lower than those of the coldest part of winter in the temperate regions, the arctic temperature rises to the warmth of summer. The water in the environment changes its physical state from snow and ice to liquid. But in any one year these day to day changes are not orderly, for until early June pleasant warmth, snowfall, and bitter cold can succeed each other within a few hours (see fig. 5). In these vagaries of the arctic weather in spring the birds arrive, settle, and proceed to nest with such regularity that their behavior sets the steadiest schedule among the natural phenomena.

I have recorded in figure 10 the earliest birds seen in spring at Anaktuvuk from 1948 through 1953. These records come from Nunamiut observers, from specimens obtained in the course of their hunting, and from my own observations. Tom Brower carefully studied the birds arriving in migration in 1949, and John Krog reported on the condition of migrant arrivals in May 1951. During each of the 6 annual migrations under consideration I have been present at least some of the time. In the open valley so favorable for observation, and with the interested assistance of the keen and understanding Nunamiut, I obtained records of migration that I believe are unusually complete. Adding to the effectiveness of Eskimo observation was their pleasant social custom of spending long periods

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in conversation and discussion upon the events of natural history. In this way all observations made in the village were brought into a pool from which Simon Paneak and I could study in careful, critical discussion the details and circumstances by which the migration was marked.

Often numerous individuals of the commoner species are seen on the same day in spring when they are first reported. Within a few days the presence of the common species is familiar to all the people. Thereafter new arrivals of the species may be distinguishable. The early arriving snow buntings are followed by successive flocks which continue to move northward for as long as 6 or 7 weeks. The early eagles all arrive within a period of 2 weeks. Golden plover continue to gain new migrant arrivals for about 2 weeks, but Baird's sandpipers seem to arrive during a shorter time, as do robins, Gambel's sparrows, and Smith's longspurs. The arrival of migrants appeared to be concentrated in the latter part of the season.

If the appearance of migration is compared with a moving wave, its crest occurs several days after its initial appearance. The length of the waves certainly differs among the species by as much as from 1 to 6 weeks. But if the analogy of migration to a wave is pursued, the initial appearance is a characteristic presaging the birds which follow. The first birds which arrive are seen as individuals or as flocks which are fewer than the entire migration. Since the birds of a population are coherently related, their average behavior and condition indicate the normal characteristics of their coherent action. On the other hand certain occasional behavior is seen which is inconsistently related to migration. These observations of aberrant behavior cannot be used in describing the progress of migration.

Migratory birds arriving at Anaktuvuk either settle there to nest or they proceed northward as far as the arctic coast. There is no likelihood that significant numbers pass eastward or westward beyond arctic Alaska. No Alaskan land lies more than 200 miles north of Anaktuvuk, and the geographical center of the arctic slope north of the Brooks Range is less than 100 miles distant. The location of Anaktuvuk is accordingly within a few hours of the limit of northward flight overland in this sector and thus is near or at the terminus of migration. We may say that, practically, the locality is the northern terminus and that the condition of the migrant birds represents their state upon arrival from a long migration to an arctic region. Considering the rapidity of change in behavioral and physiological processes in birds about to nest, there will be some loss of physiological detail in considering all these migrants through Anaktuvuk alike as birds that have reached their breeding grounds, yet they indicate better than do those at lower latitudes the general condition at the terminus of migration.

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Distance Traveled and Arrival Date

In studying the arriving populations it must be considered that they come from such widely distributed wintering grounds as are shown in table 12. Among the migratory birds, only hoary redpolls are known also to be resident in winter at Anaktuvuk, and few are seen then in comparison with the large numbers present late in May. During that month the numbers progressively increase, but there is no conspicuous climax in numbers which accurately designates a mean date of migration. Nevertheless, the numbers seen in late May exceed those seen in winter many hundred times. The many redpolls seen in summer are still not a hundredth of those seen in May or again in late August. In winter hoary redpolls are sporadically common or occasional in interior Alaska. There are not enough indications to suggest whether the arctic nesting hoary redpolls come from winter resorts in nearby Alaska or from their winter range, which extends to northern United States.

Common redpolls have not been found at Anaktuvuk in winter and their nearest reported wintering area is in the Tanana Valley (Cade

TABLE 12.—*Least migratory path of birds arriving on central Alaskan arctic nesting grounds.*

[Anaktuvuk (location, lat. 68°10′ N., long. 151°46′ W.) is taken as representative of the northern destination. The reference localities of the wintering range areas represent the nearest well known points now assignable to the species designated.]

Genus or migration group and number of species		Nearest winter range	Winter residence reference locality	Least migration distance		
				Latitude (degrees)	Longitude (degrees)	Miles
Acanthis	2	Alaska				
Plectrophenax	1	Alaska	Anchorage, Alaska	7	2 W	450
American Pacific coast (table 10)	19	Gulf of Alaska	Seward, Alaska	8	2 W	550
West and Northwest American (table 11a)	20	Northwestern States	Seattle, Washington	2	29 W	1800
East of Rocky Mts. (table 11b)	12					
(Hylocichla)		Eastern base of Rocky Mts.	Great Falls, Montana	22	42 W	2100
(Passerella)		Southeastern States	Atlanta, Georgia	35	67 W	3800
(Pluvialis)		Argentina	Buenos Aires, Argentina	104	93 W	8500
North American (table 11c–f)	31	Mountain States	Great Falls, Montana	22	42 W	2100
Pacific	2	Northwestern States	Seattle, Washington	22	29 W	1800
(Heteroscelus)						
(Arenaria)		Aleutians	Cold Bay, Alaska	14	12 E	1100
Asiatic	3	China	Shanghai, China	38	95 E	5200
(Oenanthe)						
(Phylloscopus)						
(Motacilla)						
TOTAL SPECIES	90					

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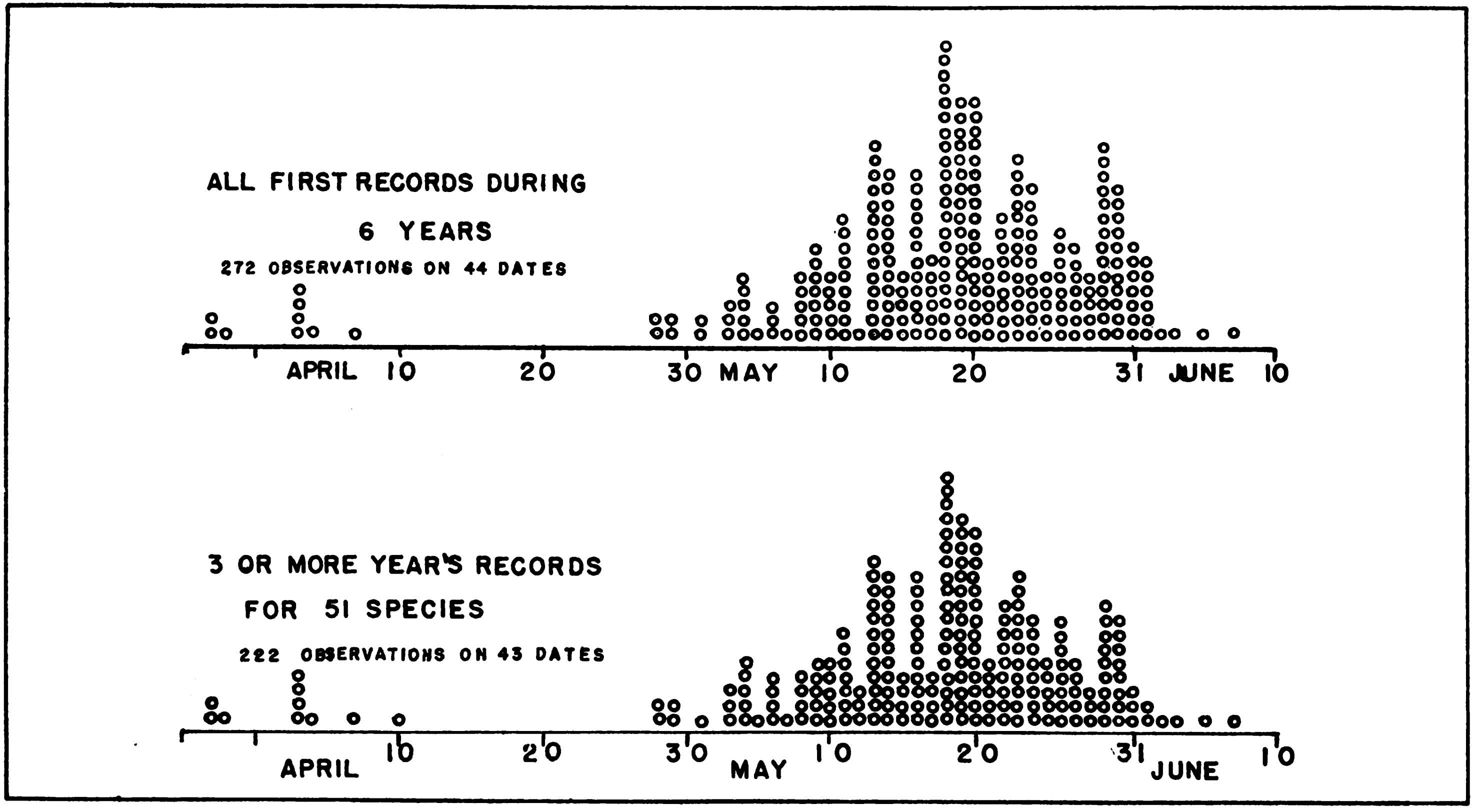

FIGURE 11.—Top: Frequency of first arrivals at various dates, 1948–1953. Bottom: Frequency distribution of first arrivals, 1948–1953, among species for which three or more annual arrivals are recorded.

1953) and in the Kobuk Valley (Grinnell 1900). They may winter a little farther from their arctic nesting ground than the hoary redpolls.

Snow buntings winter in southern and western Alaska and are also seen in winter in northeast British Columbia, about 1,200 miles from Anaktuvuk. Inasmuch as Salomonsen (1950) considered the Alaskan buntings to be distinguishable in color from the Canadian birds, I regard the migrants to arctic Alaska as coming from wintering grounds within that territory. The front of the northbound movement of snow buntings appears to pause in the Koyukuk Valley and then to proceed slowly northward. It reaches Anaktuvuk early in April but does not usually reach Barrow until mid-April, apparently covering the northernmost 200 miles in about 2 weeks. This rate is slow in comparison with the progress of the later season migrants. The slow progress in the Arctic of snow buntings is nevertheless regular from year to year at Anaktuvuk and Barrow. It is also interesting to note that James Ross (Ross, 1835) reported sighting a snow bunting in upper Boothia on April 17 in 1831 and 1832. The position corresponds in latitude with Barrow and the date of arrival of snow buntings agrees in both places.

The remainder of the migrants (89 species) come from wintering grounds which are from 500 to 8,500 miles distant. In view of the remoteness of most of the wintering grounds, the use of Anaktuvuk rather than Barrow or Umiat as a northern reference point cannot much affect estimates of the distance traversed in migratory flights. On the other hand, wintering grounds of many species are extensive. For example, wandering tatlers and turnstones are reported in winter on many Pacific islands and continental coasts. There is no present way of knowing whether the migration of these species to Anaktuvuk comes from the areas of their nearest reported occurrence in winter, which for the tatlers are coasts of northwestern States and for the turnstones the Aleutians.

It is not intended to imply that arctic Alaska is a unique focus of migration. It is, however, a point where observations show the arrival of migrant birds at their breeding grounds after traversing many different routes. Some of these routes cross many degrees of latitude and longitude with the related changes in climate and the variation in the direction of migrating flight relative to the sun's position. Most of these flights cover more than 600 miles of land before reaching their destination at Anaktuvuk. Even for bird migration this is a long distance, and with few reservations the Anaktuvuk birds can be regarded as long distance migrants.

By plotting the dates of first arrivals observed in each species during 1948 to 1953 the most common arrival dates, as shown in figure 11, is about May 20. Also about half the May records fall

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before and half after that date. Accordingly about May 20 is the mean and median date for recorded first arrivals of all species. The arrivals about this date are not arranged in a normal distribution curve, but form one negatively skewed. For early season progress the curve is long and concave, and after May 20 it is short and convex. Since the peak of arrivals precedes the maximum of summer heat by about two months the relations to maximum heat is not explanatory for migration.

Influence of Seasonal Phenomena

The accelerating progress of environmental conditions in spring and a factor resulting from contingencies of observation may both be concerned in the skewed distribution of arrival dates. No bird can be recorded before it arrives, and even with intensive search some delayed observations inevitably result, tending to skew the curve. The separate plotting of the records for the years 1949–1953 in figure 12 shows the component years of the record. The median dates of distribution of arrivals in those years occurred on May 20 in 1948, 1949, 1950, 1951; on May 24 in 1952; and on May 18 in 1953. Observations of arrival were deliberately relaxed in 1952 for the interval from May 21 until May 26 in order to give attention to other studies. On May 29 they were resumed intensively, and it may be suspected that the large block of records in the last of the month resulted from delayed observation. The low temperature and late snow melting in May of that year will be discussed later. It was also the year between 1949 and 1953 when fewest observations were made, and the abridged observation makes it doubtful whether the resulting records well represents the dates of first arrival. With these reservations about 1952, the close correspondence of the median of dates of recorded first arrivals in each year suggests that the composite curve presents a summation of substantially similar annual migration records.

It might be suspected that the records for those species most consistently observed would contain fewer observational errors than for birds which could be less regularly observed. In order to examine the data by this criterion I have separated in figure 11 the first recorded arrival dates of species for which 3 or more annual records were obtained. The median date for this group falls on May 19. The small advance is consistent with the view that the most evident birds are reported a little more promptly than those which are less conspicuous. Altogether these views of composite and selected records suggest that the homogeneity of the data results from regularity in bird behavior and has been little modified by erroneous observation. Because of the skewed characteristic of the curves it is likely that

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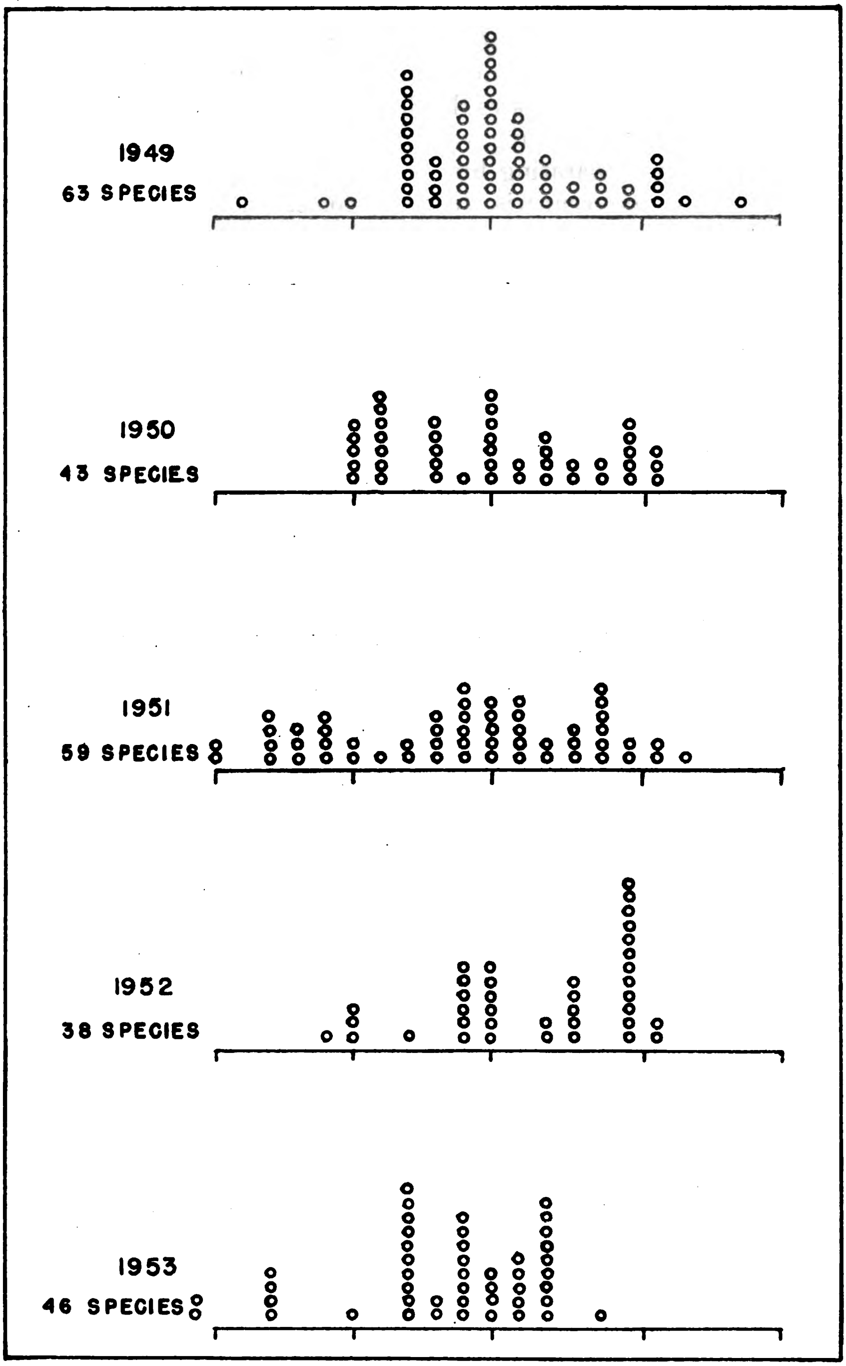

FIGURE 12.—Frequency distributions of first arrivals, 1949–1953.

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delayed observation adds a little lateness and consequently a slight increase to the appearance of regularity in the plotted median dates.

Inspection of the arrival records indicates that species arrive at various dates. In many cases the dates of first record of a species are close together in succeeding years. I have shown in figure 13 the number of days separating first recorded arrivals of a species in 3 years. It did not seem wise to assess commonness of occurrence or our familiarity with a bird as a basis for selecting the most reliable

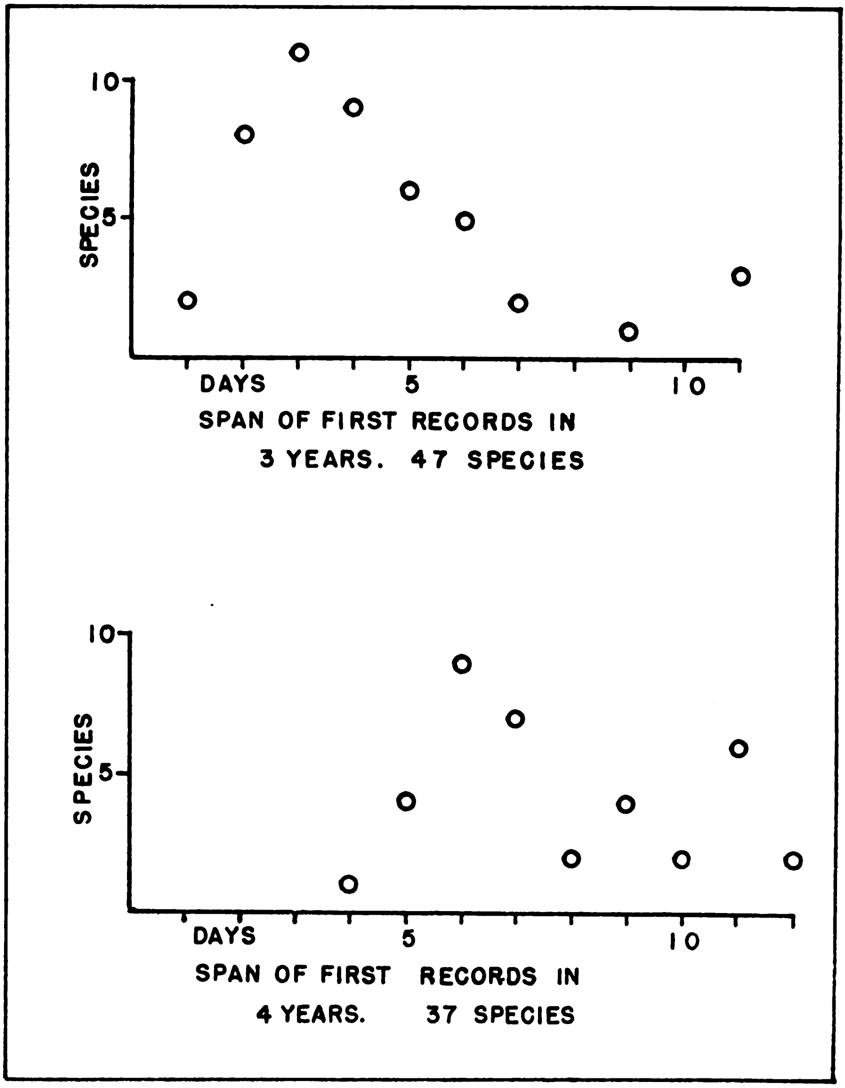

FIGURE 13.—Top: Span of first arrivals in the three closest annual arrivals among 47 species. Bottom: Span of first arrivals in the four closest annual arrivals among 37 species.

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observations. All records of the shortest interval covering the arrival reports of each species in any 3 years are therefore plotted together. They comprise 51 species and the range of first recorded arrival dates extends from one to 11 days. The median range is between 3 and 4 days. Among 30 species the range of arrival dates did not differ more than ±2 days. Since there are few records from 1948, the period comprised is principally from 1949–53.

The range of first-arrival records in 4 years, shown in figure 13 for 37 species, extends from 4 to 12 days. In 23 of the species 4 annual arrivals were recorded within a period of 7 days. In a longer series of years the arrival of the birds can vary more than in a shorter period, and errors of observation likely to prolong the span of arrival records can also enter more frequently. It is my belief that in the 4-year series, owing to the influence of erroneous observation, the variations in date of arrival are more apparent than real, and that the first birds of any one species will be found to arrive at close to the same date each year. For example, during 3 years out of 5, with 1948 eliminated, 30 species were first seen within 2 days of the mean date of the species and 45 species arrived within 5 days of the mean date. As shown by the records of 37 species during 4 of the 5 years, 27 were first seen within 3½ days of the mean date characteristic of the species and all were reported within 6 days of their mean date of arrival.

As a seasonal event, migration must be related to annual changes in the sun's heat. In weather records this seasonal variation is indictated by measurements of air temperature. These are, by present convention of the U. S. Weather Bureau, measured as daily maximum and minimum, and their mean is designated daily mean temperature. For a longer period of time, the daily mean temperatures are averaged as the mean temperature of the period. C. E. Watson and Robert F. Dale, U. S. Weather Bureau climatologists, kindly made available to me the mean temperature records for 3 Alaskan localities and for 3 localities in northern states representative of western, Rocky Mountain and east-central areas through which the northbound migration of American birds must pass. I have plotted in figure 14 winter to summer progress of the monthly mean temperatures in these 3 localities. It shows that in the Arctic the change of air temperature in spring is pronounced, and that in general both rate and amount of rise of spring temperature increases in higher latitudes, while the seasonal change diminishes southward and is imperceptible in the low tropics.

A sequence of official records of mean temperatures is not yet available at Anaktuvuk, for only in July 1953 was an observaiton station established there by the Weather Bureau. The temperatures shown in figure 5, from Simon Paneak's journal records and from our oc-

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casional comparisons, indicate that winter temperatures in the narrow mountain valley at Anaktuvuk do not reach the extreme lows measured in the broad valleys at lower elevations at Umiat, Bettles, and Fairbanks. It appears that the mean monthly temperatures in spring at Anaktuvuk lie between those of Umiat and Bettles. Between March and June the mean temperature at Anaktuvuk rises from about $-20°$ C. to about $+10°$ C.

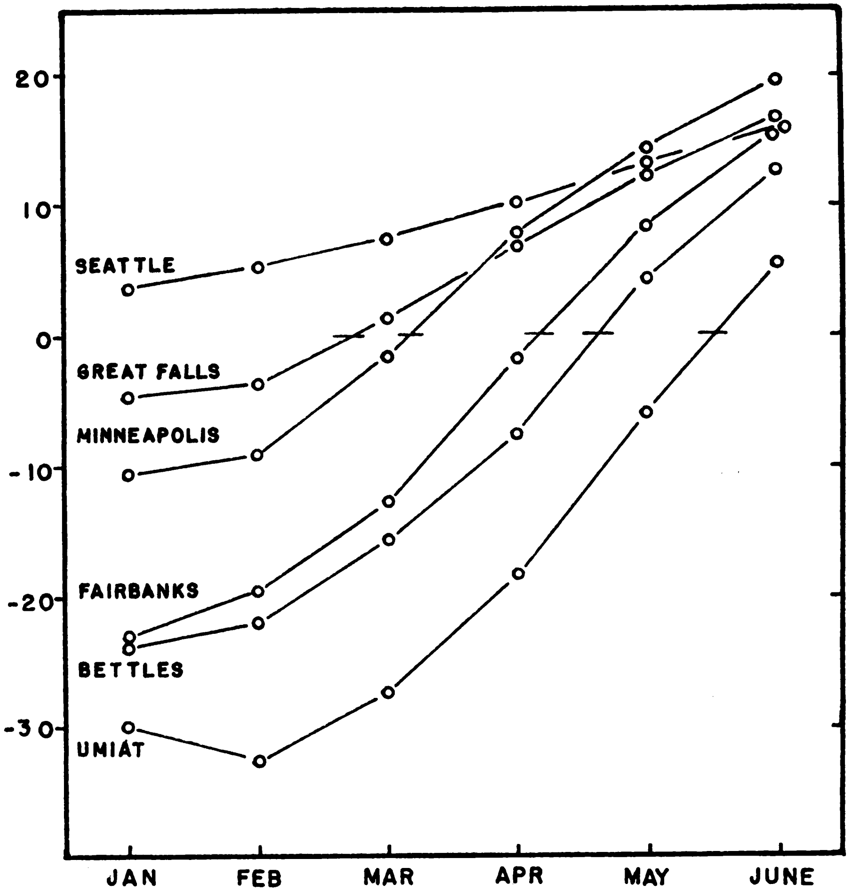

FIGURE 14.—Winter to summer progress of monthly mean temperatures in three Alaskan localities and in three northern States.

During the days before and after May 20, when most migrant bird species first reach Anaktuvuk, the mean temperature of the air is just above freezing. Migratory birds can be regarded as land birds at Anaktuvuk in the sense that they feed on snow-free ground or in shallow pools and waters free of ice. This requirement of unfrozen feeding ground is probably common for most of the birds migrating

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into arctic and boreal regions. It does not limit the advent of birds predatory upon mammals or feeding upon carrion, seeds, and insects in exposed vegetation. Eagles, rough-legged hawks, snow buntings, and longspurs precede the appearance of water and snow-free ground. But for most species of migrants water and unfrozen ground seem to be the main feeding places.

Although brought about by solar heat, the breakup of ice on large rivers is also influenced by the thickness of winter ice and snow and by the amount of water impounded at the time of the autumn freeze-up. The date of the breakup of the Koyukuk River near Bettles has been observed at various dates from early to late May. In 1949 and 1952 small airplanes could land on wheels on the ice of lakes at Anaktuvuk until mid-June. In 1951 the ice was insecure in late May and Pilot J. L. Anderson landed with us on floats before the end of May. The complete breakup of ice is too variable and ill-defined to use in dating a phenomenon which appears with such regularity as bird migration. These events are all related to the increasing heat of the sun, but not by obvious, simple parameters.

Heavy arctic snow cover in May would appear to be a handicap to birds migrating from the south. In 1952 snow was unusually deep over the mountain valleys and along the Koyukuk until the end of May. In 1950 and 1953 most of the ground was bare early in that month. The dates when the ground is mostly free from snow may differ by 3 or 4 weeks in successive years.

In May the arctic land vegetation shows little change that could be significant for birds. The first pollen appears on willows at the end of the month, when a few bumblebees are seen. Early flowers of sedge serve ptarmigan and caribou but seem to afford no sustenance for most migratory birds. In short, the spring outburst of land vegetation is considerably preceded by the advent of the birds. Farther south at Bettles and Fairbanks the emergence of birch leaves is a conspicuous and rather sudden event. I know of no published records, but my memory of the events of spring and examination of the recollections of old observers indicates that the emergence of birch leaves in interior Alaska may differ by as much as two weeks from one year to the next. It commonly follows the arrival of most migratory birds.

The spring progress of arctic and subarctic vegetation is scarcely visible when the main migration occurs. I have not noticed many seeds of flowering plants at any time in the Arctic and I suspect that they are not abundant in spring. During May flying insects are rare and few can be discovered moving on the ground. Terrestrial arthropods could have been little influenced to new growth in the arctic spring when the birds arrive and those serving as food for birds

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must have survived the winter. But an important change in the environment of arctic aquatic life has been remarked by John Krog (1954) to occur some time before the waters are ice free. Ice is impermeable to air and in the underlying pools of water which remain unfrozen during the northern winter the oxygen supply becomes much depleted because of the thickness of the covering ice. In late winter the added pressure of water trickling under the ice from melting snow begins to crack the ice on streams and cause the "overflows" which are so dangerous to travelers. As the season progresses more of this circulating water is returned below the ice by the pressure changes resulting from heat and barometric variations. As this circulation increases, aerated water is mixed with the oxygen-deficient sluggish streams and pools beneath the ice. The restoration of the aquatic oxygen supply begins some time before the breakup of ice occurs and before the temperature of the water changes appreciably. It appears that the metabolism of arctic aquatic plants and animals starts a spring revival as soon as the first localized melting starts the circulation and reoxygenation of the waters. Thus, although the formal breakup of ice is often later than the principal arrival time of the birds, the beginning aeration of the water is earlier. I suspect that this process initiates an efflorescence of aquatic growth some time before the ice breaks and starts production of a new crop of aquatic food in time for the arriving birds, for while watching beaver trappers cut holes through several feet of ice in April, I have found the buds of lilies pressed against the bottom of the ice. A few days after the ice melts from Alaskan lakes the lily buds rise above the water, having grown four or five feet from the bottom before an appreciable change in water temperature takes place.

That the curves for mean temperatures during the time of migration vary greatly from year to year can be seen in figure 15. At both Umiat and at Bettles the mean temperatures of May differed by as much as 6° to 8° C. between 1948 and 1953. The cold mean of −9.1° C. at Umiat in May 1952 was but little warmer than the mean of −12.5° C. there in April 1948. In a longer series of arctic records the mean temperature of May can vary ±5° C. If birds guided their arctic migration upon a fixed mean temperature, in some years they would have to vary the date of their arrival by several weeks, whereas the annual variation in arrival of a species at the arctic terminus of their flight is not more than a few days.

While daily temperatures in May are not so variable as in April, between May 15 and 20 temperatures as low as −16° and as high as 18° C. were recorded at Anaktuvuk in 1951 (fig. 5). Wide springtime fluctuations in temperature are so frequent in the Arctic that birds must commonly encounter days of more severe cold there than

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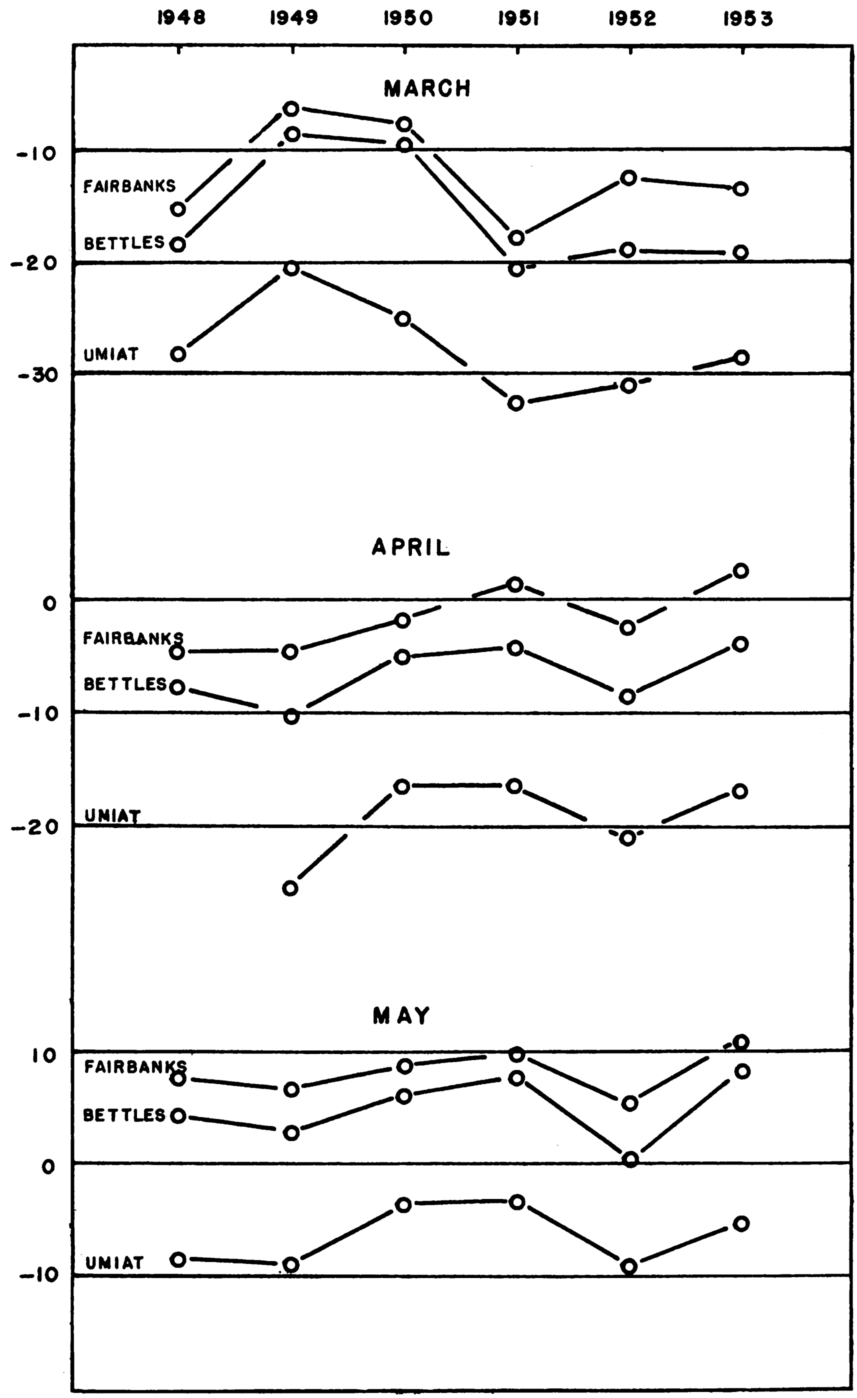

FIGURE 15.—Mean temperatures in March, April, and May at Fairbanks, Bettles, and Umiat, 1948–1953. (Compiled from climatological data.)

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most of the species have met at any time on their wintering grounds. We have no measure of the casualties which result from this exposure to cold, but by their long existence it is evident that the birds regularly endure these wide variations in temperature. The tolerance for cold exhibited by such small birds as sandpipers is remarkable but it must nevertheless be regarded as a normal ability, for it is exercised every year.

Nesting

The social behavior and family relations of birds are elaborately developed and their importance for the existence of races is more conspicuous than is generally the case among other animals, which can detect others of their kind through scent and in darkness. Such animals may thus remain strange to us because of our lack of suitable perception, whereas among birds social and family coherence is maintained by visible and audible actions. These are as apparent to us as they are to the birds for which these signals are produced, and in many cases their significance is in a general way understandable to us. Without claiming full comprehension of the demonstrations by which birds maintain coherent flocks and families we can often recognize the general purport of their activity at a given stage near breeding.

Duration of Migratory Behavior

The latest date when the birds of a species nesting in the area have arrived can be determined only by circumstantial evidence, but because of their expressive behavior it is generally easy to distinguish in even a single bird whether it is migrating or has settled down to nest. Migratory flocks disintegrate before the pairs nest. In any single season the record of the first migrating bird observed may be a day or so after the first arrival of the species on migration. To decide from journal notes when the migration has ended is not so easy. While there is thus uncertainty in setting the end of migration as a normal date, it appears to be fairly regular, and in most years probably few birds of a species arrive after the dates registered for the last migrants in table 13. I believe, however, that favorable or unfavorable weather may shorten or prolong migration in any year, whereas the first arrival does not appear to vary in date.

The duration of the migratory arrival period among 28 species varies from 2 to 60 days. The 2 days attributed to the wagtails is probably shorter than the actual period, which is nevertheless brief. The long period of arrival shown for snow buntings is substantially correct, for none remain to nest at Anaktuvuk. Since these early migrants first appear at Barrow about April 15 they also have time there

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TABLE 13.—*Duration of phases of migratory and reproductive cycles in 28 species of birds at Anaktuvuk*

Species	Arrival date		Duration of arrival period (days)	First egg date	Days from mid-arrival to mid-laying	Latest departure date	Duration of departure period (days)
	First migrant	Last migrant					
Plectrophenax nivalis nivalis	Apr. 1	June 1	60	[a]June 1	34	[a]Sept. 10	
Aquila chrysaetoes canadensis	Apr. 3	Apr. 18	15				
Lanius excubitor invictus	May 4	May 16	12	May 27	23	Oct. 15	
Calcarius lapponicus alascensis	May 6	June 7	32	May 31	14	Sept. 2	20
Buteo lagopus	May 8	May 23	15				
Eremophila alpestris arcticola	May 10	June 1	20	May 29	13	Aug. 24	19
Anthus spinoletta rubescens	May 11	June 6	26	June 1	12	Sept. 3	30
Anas acuta	May 13	June 6	24	May 23	4	[b]Sept. 10	10
Spizella arborea ochracea	May 13	May 30	17	June 3	17	Sept. 12	
Pluvialis dominica dominica	May 14	May 31	17	May 28	10	Aug. 15	15
Turdus migratorius migratorius.	May 15	May 30	15	May 30	12	Sept. 18	13
Zonotrichia leucophrys gambelii	May 16	May 29	13	June 3	16	Sept. 12	12
Charadrius semipalmatus	May 16	June 5	20	June 12?	21	Aug. 16	15
Anas carolinensis	May 18	June 5	14	May 27	6	[b]Aug. 30	10
Totanus flavipes	May 19	May 27	8	June 1	13	Aug. 6	
Erolia bairdii	May 19	May 31	12	May 29	8	[b]Aug. 10	
Aythya marila nearctica	May 20	May 26	6	June 5	17	[b]Sept. 10	
Clangula hyemalis	May 20	May 28	8	June 4	15	[b]Sept. 10	10
Lobipes lobatus	May 22	May 29	7	June 6	16	[b]Aug. 25	10
Ereunetes pusillus	May 23	June 1	9				
Mergus serrator serrator	May 23	June 3	11	June 9	17	[b]Sept. 10	11
Oenanthe oenanthe oenanthe	May 23	May 27	4	June 5	14	[b]Sept. 1	20
Erolia minutilla	May 24	June 5	12	June 3	8		
Stercorarius parasiticus	May 24	June 5	12	June 8	13	[b]Sept. 5	10
Melanitta deglandi	May 25	June 14	21	June 6	9	[b]Aug. 30	10
Calcarius pictus	May 26	June 3	8	June 4	12	Aug. 24	10
Sterna paradisaea	May 28	June 6	9	May 31	4	[b]Aug. 30	10
Motacilla flava tschutschensis	June 3	June 5	2	June 10	10		
TOTAL (28)				(aver.)	(14)		

[a] Estimated from observations at Barrow.
[b] Estimated from growth of young.

sufficient for a prolonged arrival from migration before their nesting begins in early June. At Anaktuvuk the equally early eagles (*Aquila chrysaetos canadensis*) and somewhat later shrikes and rough-legged hawks arrive in a wave lasting only a quarter as long. Such early and plentiful birds as pintails, Alaska longspurs (*Calcarius lapponicus alascensis*), horned larks, and pipits have also a rather prolonged migration. Species which are numerous are not necessarily diverse in behavior, but the populations of those species which are numerous at Anaktuvuk are not so closely synchronized in migration as those less numerous.

Snow buntings winter in much of Alaska south of the Alaska range from Unalaska and Nushagak to Sitka, along the lower Yukon and north of the arctic circle at Kobuk, and also east of the Canadian

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Rocky Mountains in an area separated from Alaska by extensive and high mountains. I suspect that those nesting in Alaska winter there, but since its winter climate is very diverse and its terrain is separated by massive mountains into regions with distinct conditions, the origin of migrants in such diverse regions can be a cause of variation in their migratory schedules.

Urner's (Urner and Storer, 1949) long records of the migratory flights of plovers and sandpipers along the coast of New Jersey show the duration of migration in that locality. From their reported records between 1928 and 1938, I have extracted the dates during which were observed principal migratory flights of some species also familiar at Anaktuvuk.

		Duration in days	
	Inclusive dates of flights in New Jersey	*New Jersey*	*Anaktuvuk*
Charadrius semipalmata	May 4–June 4	31	20
Totanus flavipes	April 24–June 13	50	8
Erolia minutilla	April 29–May 30	31	12
Ereunetes pusillus	May 7–June 7	31	9

It is apparent that in New Jersey the birds of these species are migrating toward nesting in localities variously distant northward, and that the samples are from populations known to be heterogeneous in regard to nesting area. The shorter migration waves at Anaktuvuk are produced by populations which are alike in nesting within Arctic Alaska. Heterogeneity of migratory populations in regard to either nesting or wintering areas may prolong the migratory passage over any locality. In fact it seems likely that diversity of either background or future events might reduce the synchrony of migratory action.

Regardless of the explanation for the diversity in the duration of their migratory flights, it is apparent that the birds of no single species arrive synchronously at Anaktuvuk. Let us consider the implications in the lack of synchrony of Baird's sandpipers which continue to arrive for about 12 days. If they had traveled at the rate of 60 miles a day during the 12 days preceding their arrival the population would have been spread out along a course 720 miles long. It is immaterial how closely this assumption fits the progress of migration in its northern course, for in relation to the range of sight of birds the migrating elements of either flocks or individuals would be scattered beyond range of communication with the remainder of the population most of the time. I cannot imagine by what sense small migrant birds could communicate in order to bring about coherent action when spread over the time and distance in which each species appears to be distributed during migration. In terms of proximity of individuals relative to the range of sensory communication, the

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migratory process is not concerted but widely distributed. It seems as if individuals and groups, but not the populations as units, guide the migration.

Progress Toward Laying

Judging from the size of testes, males of most species are ready for breeding at the end of migration, although Alaska longspurs with small testes were taken during the first 10 days in which migrants were arriving. However, readiness for reproduction does not terminate migration and start settled residence on the breeding ground, for immature individuals of some species migrate to summer near the breeding grounds.

Mallards, mergansers, golden plover, and birds of several other species commonly appear on the nesting grounds in pairs. On the other hand, some flights of arriving sandpipers are composed principally of males, and the males of some passeriform species take up nesting territories before females are seen. The variety of physiological phases and behavior of arriving migrants is interesting, but no common sequence can be derived from it to mark the conditions which transform a migrating bird into a settled bird with all its interest focused upon mating and preparations for subsequent nesting. From my general impression of their behavior, I would have said that pintails ducks and all earlier arriving migrants took the transition from the migratory to breeding state in more leisurely fashion than did later migrants, yet an examination of my records gives no suggestion that the interval between arrival and laying is related to earliness of arrival.

The recorded arrival period of migrants of nesting species lasted from 2 to 32 days. I think that more migrants arrived to settle during the first half of the period of each species than arrived later. Some later migrants appeared in haste to move northward and those which settled found less free territory. The period from midmigration to the middle of the week after nesting begins is a fair measure, for most of the species at Anaktuvuk, of the time elapsed between arrival and laying. This elapsed time is estimated for 24 species in table 13. The interval is 4 days for 2 species, 5 to 9 days for 4, 10 to 19 days for 16, and 20 to 23 days for 2 species. These estimates indicate that the interval between arrival and laying differs among species and that for a few species it is less than a week. In temperate climates some early nesting pairs of many species lay as soon after arrival as do the arctic birds. Mrs. Oakeson (1954) shows that at Mountain Village, Alaska, for Gambel's sparrow the interval between the average arrival date and first laying was about 8 days. The earliest nesting birds of the race of white-crowned sparrows (*Zonotrichia*

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leucophrys pugetensis) at Friday Harbor, Washington, on the average went through the same phases of the reproductive cycle about as rapidly as the Alaskan birds. The individuals of the Puget Sound race, however, were not so well concerted in phase of the reproductive cycle as were the Alaskan birds.

At Barrow, Pitelka (1954) found that 80 to 90 percent of all breeding Alaska longspurs and snow buntings began laying within a single week in the first half of June. These birds pass Anaktuvuk in a relatively prolonged migration extending, respectively, over about 30 and 60 days. Both longspurs and snow buntings winter in quite diverse areas, but at Barrow their reproductive activity is synchronized to occur within a remarkably short time.

The simultaneous breeding of arctic populations is based upon synchronization of the internal reproductive condition of individual birds. As Mrs. Oakeson (1954) observed, individual arctic birds may take a nesting area, mate, and copulate a little more quickly than in a warmer climate. The sequence is a little expedited, but I suspect that the shortening is produced by reduction in the time required for transition from the end of one physiological phase to the beginning of another.

At Old Crow, in Yukon, our observations were carried on through only one season and the records in table 14 show the date between the first individual seen of the species and the first egg observed. This information is empirically determined, while the interval between middle of arrival of the species and the middle of laying at Anaktuvuk includes a factor of judgement estimated from a number of years' observations. The species reported upon at Old Crow also differed, including only 5 of those at Anaktuvuk. The average of the intervals observed among 27 species at Old Crow was 17 days between first arrival and first egg, whereas among 25 species at Anaktuvuk it was 14 days, indicating that the progress from migratory to laying condition was at similar rates in these two arctic localities.

In each locality the progress toward laying varied among the species. The longest interval at Old Crow was 31 days and at Anaktuvuk 34 days. The shortest observed interval at Old Crow was 7 days for the fox sparrow, and at Anaktuvuk 4 days for the pintail and arctic tern, a period which seems likely to be too short. At both places the progress of some species from migration to laying was remarkably rapid and of others comparatively leisurely. The species likewise differed in the rapidity of their transition from migration to reproduction.

It is apparent that the speed of the transition varies among species of ducks at Anaktuvuk and within the family of sandpipers in both localities. Only in the family Fringillidae are the species much

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TABLE 14.—*Progress from migratory to laying condition in 27 species of birds at Old Crow*

Species	First arrival	First egg	Interval (days)
Gavia arctica	May 22	June 15	24
Anas platyrhynchos	May 8	June 5	28
Aythya affinis	May 18	June 18	31
Buteo lagopus	Apr. 18	May 5	17
Circus cyaneus	May 5	May 20	15
Falco peregrinus	May 5	June 1	27
Charadrius semipalmatus	May 19	June 7	19
Capella gallinago	May 7	May 31	24
Actitis macularia	May 22	June 18	27
Tringa solitaria	May 14	May 25	11
Totanus flavipes	May 7	May 28	21
Colaptes auratus	May 16	June 1	15
Petrochelidon pyrrhonota	May 25	June 9	15
Turdus migratorius	May 8	May 25	17
Ixoreus naevius	May 4	May 21	17
Hylocichla minima	May 22	June 9	18
Vermivora celata	May 20	June 3	12
Dendroica petechia	May 23	June 11	20
Dendroica striata	May 27	June 12	16
Seiurus noveboracensis	May 20	June 8	17
Wilsonia pusilla	May 20	June 4	13
Euphagus carolinus	May 10	May 25	15
Acanthis flammea	May 21	May 30	9
Junco hyemalis	May 15	May 25	10
Spizella arborea	May 16	May 26	10
Zonotrichia leucophrys	May 14	May 26	12
Passerella iliaca	May 14	May 21	7
TOTAL (27)		(Aver.)	(17)

alike at Old Crow, but considering the long interval apparent in the snow bunting at Barrow, there is variation in the rate of progress toward breeding among the species in this family as well. It is significant that the intervals in four of the five species common to the two localities differ considerably, i. e., yellowlegs (*Totanus flavipes*) 21 and 13 days, robin 17 and 12 days, tree sparrow 10 and 17 days, and Gambel's sparrow 12 and 16 days. The best documented very short interval of transition from migratory to laying conditions is afforded by the 7 days recorded at Old Crow for fox sparrows. There is undoubtedly a minimum time, probably differing among species, in which the necessary physiological and behavioral processes can convert a migrating to a laying bird. Evidently external circumstances can variously prolong the physiological process in an individual, or at least prolong the physiological state of readiness to lay. Accordingly, I conclude that the transition of a species from migratory to breeding condition in two localities can be extended beyond the minimum physiological requirement by amounts varying according to local environmental conditions.

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The progression of physiological changes toward reproduction seems to be punctuated by actions or stimulation which must come from another bird (Tinbergen, 1953). Thus copulation, which may occur at any time during a certain reproductive period, is necessary to start the formation of fertile eggs. Thereafter, in the Arctic the eggs of most birds are laid on successive days, and once the phase of egg laying is initiated subsequent progress is invariable in all climates. Such internal processes occur in homoiothermous birds under conditions separate from external environmental influence and must proceed at rates prescribed by ancient phylogeny. Certain types of behavior which are the outward expressions of these internal processes must be equally inevitable and unmodifiable by local and transitory climates. But during the intervals between phases in the reproductive cycle stimulation from another bird or even from the environment may be quicker to set in motion the operations of the next phase.

Elaborate patterns of behavior concerned with possession of territory, courting, and mating are precisely followed by birds of each species in sequences related to reproductive condition. Among individuals in the same phase of their reproductive cycle no scrutiny is needed to determine that any bird of the same sex is physiologically ready to compete for territory or mate. All birds of opposite sex are disposed to the one phase of reproduction current in the local population. In such a society no bird is likely to untimely action and one of the common causes of social disorder is removed by the uniformity of impulses in a population progressing synchronously through the sequences of reproductive behavior. The duration of competition and conflict in reproduction is shortened and actions decisive to the sequence of events in reproduction are prompt.

I do not imply, in this respect, that a natural society ordered by such well synchronized impulses would be favored for existence in all environments. But it appears to be by the ordering of society rather than by acceleration of the individual's physiological processes that adaptation of the breeding populations of birds conforms with the shortness of the arctic season.

Incubation

Mrs. Nice (1954) has pointed out the frequency of erroneous reports of the time during which eggs of wild birds are incubated. For a clutch of eggs laid on successive days, it is difficult to set as a single figure the duration of incubation. If incubation is considered to begin only when the last egg has been laid its termination may differ by as much as several days in the successive hatching of individual eggs. The stage of embryonic development which is attained when

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eggs of wild birds are hatched has not been well defined. Accordingly the observed duration of incubation is not a factor in the velocity or chronology of embryonic growth, but only in the behavioral process of incubation.

If the conventional definition of the duration of incubation among wild birds is taken to start when the last egg is laid and to extend until the last egg hatches, rather consistent records are obtained for each species. After examining the incubation of many species of birds in equatorial Africa, the Moreaus (1940) remarked, "there is no doubt that the incubation period is, within limits, specific. . . ." In only a few species in tropical Africa did they find the incubation period to be slightly longer than among their relatives in temperate parts of Europe.

Lack (1948) commented upon the common similarity between the duration of incubation and the time which nestling birds of altricial habit spend in the nest before leaving. It is certainly remarkable that these two periods are often numerically similar and appear as time constants of species. If incubation and nestling periods are constants of species, and probably of larger taxonomic groups, they are not likely to be much influenced by climate. But to seek by comparisons among species whether incubation or nestling periods can adapt certain species to particular climates these periods should be defined in terms of developmental processes or stages in growth. Otherwise we may be comparing such different stages of growth as are shown in extremes by the development of precocial and altricial birds.

Once the egg is laid, incubation provides heat, so that the temperature maintained during incubation is the only visible parental influence upon embryonic development. Kendeigh and Baldwin (1928) showed that the mean temperature of the eggs of house wrens (*Troglodytes aedon*) in nests near Cleveland was about 35° C. In the same summer climate Huggins (1941) found the mean temperature during incubation of 37 species of 11 orders to be 34.0° C. Among the passeriform species the mean temperature during incubation was 33.8° C. At Cleveland, Ohio, birds of diverse phylogeny adjusted their incubating behavior to the weather so as to maintain a surprising similarity and constancy in the temperature of their eggs.

In summer at Anaktuvuk the temperature of the air is more variable than at Cleveland. Freezing is occasional and temperatures are mostly between 0° C. and 10° C. Among eggs in nests of birds of 7 species the median range of temperature was found to be between 33° C. and 35° C., with 76 percent of the records between 33° C. and 37° C. (L. Irving and J. Krog, 1956). We had thought that some arctic nests appeared constructed for good insulation. But among the eggs of a sandpiper (*Ereunetes pusillus*) with no nest the tem-

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perature was like that in the well insulated nest of tree sparrows. It is not by nest construction but by the amount of heat contributed by the incubating parent that the temperature is kept in arctic nests at the same level as in temperate regions. The extra heat dissipated to cool arctic air could be described in physiological terms, but the uniform temperature in the nest is regulated by the behavior of parent birds.

This fact has long been known. In his famous essay Claude Bernard (1876) referred to the even warm temperature maintained during incubation as an example of regulation by behavior, and mentioned as a remarkable illustration the Australian mound builder, which constructs a mound of earth and vegetation in which heat from fermentation supplements solar heat to maintain the correct temperature for incubation. And a recently reported measurement by H. J. Frith (1956) of the temperature around the eggs of the Australian mallee fowl (*Leipoa ocellata*) shows it to be at the common level for avian incubation. The birds work over the mounds daily to modify the heat conductance of the material in accord with the varying supplies of solar and fermentative heat.

Our temperature measurements among eggs of arctic birds were not as well controlled as those made near laboratories in a temperate climate, but the records appear no more variable than those observed under better technical conditions by Kendeigh and Baldwin and by Huggins. It thus seems that incubation probably does not in general modify avian embryonic development through temperature, the only course which we can see open. Having no measure of the progress of development within the eggs I have not recorded the duration of incubation. The progress of arctic reproduction suggests that its essential physiology is about the same as in temperate regions, and on general grounds I doubt if embryonic development can be modified in race or local populations as a climatic adaptation.

Growth of Nestlings

After the eggs hatch the parent birds might influence growth of the nestlings by the temperature of brooding and by the amount of food provided. Karplus (1952), observing the short duration of nestling life in a brood of robins at Umiat, related it to the prolongation of feeding in the 20-hour daily active period of the arctic parents. In Swedish Lapland (lat. 68° N.) Armstrong (1954) remarked upon the prolonged daily parental feeding in connection with the apparent shortening of the period of nestling growth.

There is some evidence for shortening of the duration of nestling life from the tropics northward. Among 10 species of Central Amer-

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ican Fringillidae, Skutch (1945) reported nestling life of from 12 to 15 days. Lack (1948) listed the duration of nestling life among 16 European species as being between 11 and 14½ days. Mrs. Oakeson's (1954) observations of three races of western white-crowned sparrows nesting respectively at Berkeley (lat. 38° N.), Friday Harbor (lat. 49° N.), and Mountain Village (lat. 68° N.) are pertinent indications that in the highest latitude the nestling period was shorter in the relation 10.1, 9.6 and 9.0 days. In the duration of the nestling stage at Anaktuvuk we found indications of about 10-percent shortening among several species of Fringillidae. This difference is not related to the much greater prolongation of daily arctic feeding. In fact, without some true measure of nestling development the duration of nestling life is only a time of parental and nestling behavior and not a dimension of growth.

We measured the temperature of nestlings in seven nests of five species at Anaktuvuk (L. Irving and J. Krog, 1956). Starting with the incubation temperature between 33° C. and 35° C. at hatching the temperature increased but did not quite reach the temperature of adult birds. In general the temperature of the nestlings was rather even, for 72 percent of the records fell between 36° C. and 42° C. and 86 percent between 34° C. and 42° C. While the mean temperature of nestlings was cooler than that of adults, adult birds may be 3° C. cooler at night than at rest by day and they may warm 3° more during activity (L. Irving, 1955). In arctic nestling birds the variation in temperature little exceeds the changes in body temperature which an adult usually passes through in each day. The range of body temperature of the adult is regulated physiologically. The regulation of nestling body temperature is effected by the parental behavior of brooding, although in older stages the nestlings contribute some metabolic heat and a certain amount of regulation as they acquire insulation and control of heat production.

It has long been known that in hot climates parent birds shield their young from intense heat of the sun (Wetmore, 1921). Bartholomew, Dawson, and O'Neill (1953) showed that brooding behavior was accurately regulated to protect nestlings in Baja California from exceeding a normal body temperature.

The temperature requisite for growth of avian embryos or young does not appear to be modifiable for adaptation to local climatic conditions. Although the mean temperature during growth is lower than that of the parents at rest, the variations to which the young are exposed scarcely exceed the normal transition in adult body temperature from sleep to intense activity; and although the young lack control of their body temperature, it does not seem useful to regard

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them as poikilothermous when they live with and probably require about the same uniformity of temperature as their parents.

Since this sort of homoiothermism seems to be innate in the embryo, which originates from cells in a warm parent, there appears little opportunity for the environment to modify avian development through the influence of temperature. At present this opinion is speculative because it is based only upon observations of time and temperature without support from measurements of differentiation or growth.

Among 28 species for which I can prepare schedules of migration and nesting at Anaktuvuk the first eggs, as shown in table 14, were found between May 23 and June 10. The latest fresh eggs found in this latitude were in a robin's nest on July 21 (L. Irving and Paneak, 1954). Late in June I have found a few pairs of redpolls beginning to lay. The Nunamiut tell me that among the bare willows in winter they occasionally find nests containing frozen emaciated nestling redpolls. Starvation had preceded freezing. The Eskimo view is that as August progresses redpoll parents become so anxious to join a flock that they lose interest in family affairs. This good subjective description of the situation shows that it is not the cold weather which marks the end of parental care but the onset of molt or other internal changes which are represented in the social transition from family attachments to the formation of flocks.

It seems clear that young and adult birds must prepare in summer for the change of social regime which goes with the change of season. In order to leave time enough for the late summer preparations for change of habit, residence, and season, arctic birds must pass rapidly through the stages of the reproductive cycle occurring between migration and nesting.

Departure

The departure of most species of birds from Anaktuvuk in late summer is not easy to record accurately. The termination of concern for breeding first becomes obvious among some species of ducks, like scaup and pintails, when the male birds begin to assemble in flocks in mid-July. By the end of July the young of most of the passeriform birds are flying. Family associations then relax and the birds of some species begin to assemble in more or less well organized flocks. Other species, like tree sparrows, withdraw from view and are infrequently seen. Some conspicuous associations before migration southward can be seen in the following examples:

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Flocks compact	*Flocks coherent but not compact*	*Southward movements loosely associated but apparently coherent*
Anas acuta (♂)	Clangula hyemalis	Eremophila alpestris
Aythya marila (♂)	Ereunetes pusillus	Motacilla flava
Melanitta deglandi (♂)	Sterna paradisaea	Anthus spinoletta
Turdus migratorius	Acanthis hornemanni	Calcarius lapponicus
		Calcarius pictus

While they are molting the birds of several species become very retiring and they are not seen again in their earlier numbers. Some common species simply disappear without any visible preparatory association. I know of no behavior by golden plover which signals their departure, but the birds of most species give indications which suggest that they are about to depart. By various signs as well as from the last sight records fair estimates can be formed as to the end of their migratory departure, as given in table 27. The duration of the departure on migration can be estimated, but this is the most uncertain observation in the birds' program at Anaktuvuk.

The last sight records differ so much among the species that the duration of summer occupation of the arctic tundra is clearly seen to vary considerably. Plovers and sandpipers leave early. From my recollection of migration near Barrow some of the sandpipers and phalaropes appeared there as migrating flocks later than the last records for those species at Anaktuvuk. The plover and sandpipers are so inconspicuous in August at Anaktuvuk that near the ground level, at least, no extensive southbound flights were seen to assemble there or to pass through from northern arctic Alaska.

Numerous flocks of ducks, geese and a few flights of swans and cranes are seen on their southbound course, but brant have not been reported in the southbound flights. With that exception the southbound geese and ducks seem to be about as numerous as they are in northbound flights. The flights seen moving southward do not alight as often as they do in spring.

I have only one record of southward movement for the snow buntings. A flock was seen in the high mountains at the end of August. A few others have been seen in the Valley in fall, but I do not know the southbound route of the large numbers which fly northward in spring. Our failure to record a date for the southbound eagles and shrikes is not significant because there are not many of these birds. A few rough-legged hawks are seen in late summer, which suggests that their return occurs for the most part unnoticed along the spring route.

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The variety of departure dates among the passeriform species is conspicuous. Robins are the latest recorded, except for shrikes. The latter, I suspect, occasionally winter in Alaska. My records fail to show many late tree sparrows. Although they are occasionally seen in September I have no idea when most of the large summer population of these sparrows leaves Anaktuvuk. The early start of the movement of wheatears and yellow wagtails is not surprising if we regard the great distance of their migratory course to Asia, but a few wheatears have been seen on the first of September. It cannot be said that migrants to the nearer wintering grounds leave Anaktuvuk late in the season, for the early arriving horned lark has its winter range nearer than those of many species which depart at later date. There is no clear general relation between duration of residence or date of departure and remoteness of wintering ground.

The late birds remain in the arctic until ice and snow are likely to cover their feeding places. At this season they encounter cold weather, but it is not as severe as near the common date of arrival in spring. The majority of the birds leave in August when the mean temperature is above freezing and while even frost is of brief duration. Evidently cold sets the latest termination of the stay of migratory birds in the Arctic, but many birds leave just after the peak of summer's heat and while the weather is still warm. As it appeared at the time of arrival, the departure of migration is not in phase with the temperature changes of the seasons.

Thus, it can be seen that the departure schedule of the various species differs as to terminal date and as to approximate duration of the process of departure. Although estimates of the duration of departure are far from precise, there are evident large differences among the species. In no case is the departure process short enough to suggest that all individuals of a species act in concert. Considering the homogeneity to be expected in populations breeding in the same area, the duration of both arrival and departure seems rather long. Neither part of the migratory process suggests that it is sufficiently shortened at Anaktuvuk to indicate a strong, general, synchronizing influence from the shortness of the arctic season.

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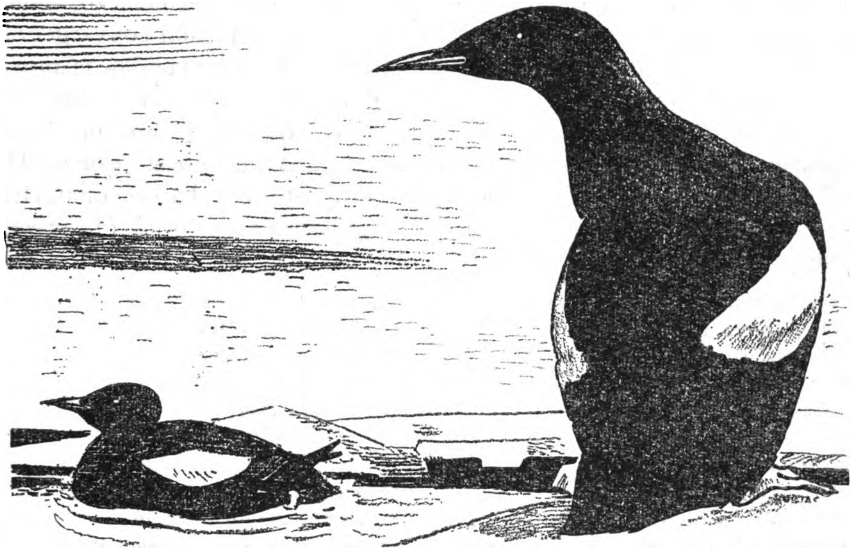

GUILLEMOT *Cepphus grylle mandtii* (see p. 275).

8. *Biological Aspects of Migration and Nesting*

WE WHO WALK SO SLOWLY consider with amazement small birds such as sandpipers, wheatears, Kennicott's willow warblers, and yellow wagtails that fly half the distance between the poles and a nearly equal distance eastward or westward to nest in the Arctic. Accustomed to warmer climates, people see in the short, cool arctic summer a difficult time for the nesting of birds; and even the sympathy of the Eskimos is evoked when the frequent cold weather of May smites these small migratory birds, which appear so ill fitted to encounter snow and cold. Yet, as we will find, the arctic season suits their biological activities in a manner which dispels early impressions that arctic life is passed in hardship.

I have discussed in chapters 6 and 7 the various courses of birds migrating to the Alaskan arctic regions and the impressive magnitude of the distances of their nesting from their wintering grounds. The

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19 migratory species nesting principally or exclusively in northern Alaska (table 9, p. 266) are of many families and vary in weight from 10 to 2500 grams. Some winter below the equator in South America, on the shores of the Pacific Ocean, or in the continent of Asia. They have few common characters except their habitual convergence on the same arctic nesting area. The family Scolopacidae is most numerously represented among these arctic-nesting birds, but 12 other families are also represented at Anaktuvuk by one or more species. Among the 80 migratory species arriving to nest at or north of Anaktuvuk, the 34 listed below nest only in the Subarctic or in the Arctic, and of these species, the 18 marked with an asterisk (*) breed solely in the Arctic.

*Gavia adamsii
Olor columbianus
*Branta canadensis taverneri
*Branta nigricans
*Anser albifrons frontalis
*Chen hyperborea
Clangula hyemalis
Grus canadensis
Pluvialis dominica dominica
*Squatarola squatarola
*Numenius phaeopus hudsonicus
Heteroscelus incanum
*Erolia melanotos
*Erolia bairdii
Erolia fuscicollis
*Erolia alpina pacifica
Limnodromus scolopaceus
*Micropalama himantopus
Ereunetes pusillus
*Tryngites subruficollis
*Limosa lapponica
*Crocethia alba
Phalaropus fulicarius
*Stercorarius pomarinus
*Stercorarius parasiticus
*Stercorarius longicaudus
*Larus hyperboreus barrovianus
Sterna paradisaea
Sayornis saya yukonensis
Oenanthe oenanthe oenanthe
Phylloscopus borealis kennicotti
Montacilla flava tschutschensis
Calcarius lapponicus alascensis
Plectrophenax nivalis nivalis

Size of Clutch

There are many records of the numbers of eggs in the sets of birds' eggs which have been assiduously collected, and if the collector unobtrusively watched the nest until the last egg was laid and then determined that no subsequent addition was made, the number taken as a set represents the reproductive accomplishment of the female bird. But if sustained observation of the nest is not recorded, there is a chance that collection of the eggs preceded the completion of laying or that accident or predation may have removed one or more of them. This can introduce a statistical bias in any calculation, based on collected sets, of the normal number of eggs laid in a clutch.

In order to illustrate data available from collections by experienced naturalists, I have listed below the number of eggs in sets taken by Murdoch and his associates at Barrow during their expedition for observation of the First International Polar Year 1882–1884, and in

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some sets taken by A. C. Bent from several American localities. (These sets were deposited in the U. S. National Museum and the information is abstracted from the catalog in the Division of Birds):

	Eggs in set				
	1	2	3	4	5
Pluvialis dominica dominica, Barrow (Murdoch)		3	5	11	
Bartramia longicauda, Martha's Vineyard to Saskatchewan (Bent)			1	9	
Actitis macularia, Massachusetts to Labrador (Bent)			6	15	1
Catoptrophorus semipalmatus semipalmatus, South Carolina (Bent)			1	6	
Catoptrophorus semipalmatus inornatus, Saskatchewan to Utah (Bent)			4	4	
Erolia bairdii, Barrow (Murdoch)			1	5	
Tryngites subruficollis, Barrow (Murdoch)			2	6	1
Ereunetes pusillus, Barrow (Murdoch)		1	6	13	
Phalaropus fulicarius, Barrow (Bent)			1	8	
Lobipes lobatus, Barrow (Murdoch)	2	4	7	14	
Lobipes lobatus, Unalakleet (Bent)			1	14	
TOTAL	2	8	35	105	2

Sets of the 7 species of sandpipers listed average a fraction over 3 but less than 4. A. C. Bent's (1927, 1929) published reports on the nesting of 50 species of sandpipers (Scolopacidae) in North America, give 4 as the characteristic size of a clutch in all cases. He chose to generalize by the criterion of his vast experience with the nesting of birds in concluding what their normal reproductive performance is. Numerous published reports upon the number of eggs characteristic of the clutch of each species in different parts of the world, do not allow a determination of whether the bias often present in collecting of eggs has been eliminated from the conclusions. It is therefore necessary to restrict comparison of the number of eggs laid in the arctic and in other climates to cases in which rather large differences in reproductive effort seem to distinguish arctic birds from those in warmer climates.

Although the family Scolopacidae, discussed by Bent (1927, 1929) as occurring in North America, includes many species which nest in the north there are some (e.g., *Catoptrophorus semipalmatus*) which do not migrate away from warm temperate regions. Others, like spotted sandpipers (*Actitis macularia*), nest over a range extending from warm temperate states to the Arctic. Some of the species which nest farthest north regularly migrate many times as far as those which nest in the south. This condition holds true among North American sandpipers; and the same sized clutch is also characteristic of the sandpipers in Germany and England, for Lack (1947) reported that

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in 13 species the clutch contained 4 eggs. Since the number of eggs in a clutch is characteristic of 63 widely distributed species of the family Scolopacidae, this constant number is a reproductive characteristic of the family and presumably is not modifiable for adaptation of any of the species to any climate.

In other species of birds, like the snowy owl, the reproductive procedure is not limited to a fixed annual production of eggs. The number of eggs laid by snowy owls, however, has been related to the great annual fluctuation in the population of lemmings (Salomonsen, 1950) and is not an example of climatic influence on egg production.

The birds of some species lay fewer eggs in a clutch in tropical climates than in Europe, according to Lack (1947), who reported that in most families the clutches of species nesting in equatorial Africa were smaller than the clutches produced by species of the same families nesting in mid-European latitudes. Over the nesting range of western white-crowned sparrows the largest clutches, averaging 5.5, were laid at Old Crow (see p. 238). Less extensive observations indicated that 5 or 6 eggs were usual at Anaktuvuk. In this species two arctic populations laid more eggs in a clutch than were found in southern localities. The average number of eggs in a clutch of song sparrows (*Melospiza melodia*) in Baja California was near 3 and in southern and southwestern Alaska it was about 4 (Johnston, 1954). In some species the difference of about one egg seems to represent the distinction in clutch size between hot and temperate or between temperate and arctic climates. However, it is doubtful that the increased size of clutch in a few species can be usefully related with latitude, for latitudinal influences are applied without exception to all widely distributed birds and in only a few species is the size of clutch affected. In a significant relation to a general condition there should be no exceptions.

Repeated Nesting

Differences amounting to less than one egg in an average clutch can affect the reproductive rate, but the effect is likely to be considerably less than that produced by multiple clutches in areas with longer breeding seasons. In the long summer of temperate climates there is time for twice or even thrice the number to be added to the populations of fast breeding birds in comparison with the number from the single clutch possible from an arctic pair. Thus, I have found only one robin's nest late enough in the season to have allowed for the successful rearing of an earlier brood yet leaving time enough for the young to grow sufficiently to migrate before freezing weather terminated the arctic season for robins (L. Irving and Paneak, 1954). I have found a few fresh eggs of redpolls late in June (see page 114),

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but I doubt if they were late enough to have permitted their parents to rear an earlier brood. Simon Paneak has related to me that occasionally they find late nestling redpolls which have perished before cold weather because the social attraction of the preautumnal flocks of redpolls distracted the inclination of the parents from further care for their young. The Eskimos believe that seasonal change in parental attitude rather than immediate cold weather dooms the late-hatched birds to destruction. I agree with the philosophical conclusion based on Eskimo experience, that in arctic life a family is unlikely to survive behavior at variance with the regular seasonal program of a population. Pitelka (1954) remarked that near Barrow late broods are doomed because premigrational molting terminates parental care of young. In his study of the behavior of snow buntings in Greenland, Tinbergen (1939) remarked that second broods were rare and he did not allude to the possibility of their successful contribution to the population.

Migration and the Reproduction Rate

Loons and some other species do not produce more than two eggs from each pair. Since visible casualties destroy some eggs and young birds, I would estimate that these migrant populations returning from the Arctic in autumn do not include more than one young bird for each pair of adults which had arrived in spring. These species could not preserve stable numbers unless at least two-thirds of the departing migrants returned in the next spring.

Among the broods of sandpipers, plovers, and robins, I have observed two is a common number to survive into late summer and approach adult size while the families are still distinguishable. Considering that some families are wiped out and that some adults do not reproduce at all, I doubt if the arctic populations of these species are twice as numerous at the start of the southbound migration as they were when they arrived in spring. During the eight or nine months of their absence from the Arctic and in migratory flights over thousands of miles an average mortality of less than 50 percent is provided for by the new birds raised in the arctic summer.

It might be possible for the species like robins, which nest over extensive ranges, regularly or occasionally to recruit from the sections of their populations raised in warm climates in order to maintain the arctic sections. But there is no nesting reservoir in milder climates from which to recruit bird populations nesting exclusively in arctic regions, and yet there is no sign that they are less stable than the populations of species which nest over a wide range of latitudes.

Estimates of the young birds reared are, of course, conjectural, but a population of birds reared in the Arctic seems unlikely to start

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south with numbers permitting on the average 50 percent loss before it returns to the breeding ground in spring. The losses from some populations probably cannot be as much as 30 percent during their absence from the Arctic. These estimates show that a major annual loss from an arctic population cannot be normal and that it must be rare. If an estimated death rate of 50 percent were distributed uniformly over 8 months of absence from the arctic the allowance would be only 6 percent in each month. Some deaths must occur rather regularly, because aging is not spasmodic and predators feed throughout the year. There does not appear to be any reproductive provision to offset the possibility that arctic populations may lose heavily at any single stage of migration.

Energy Resources for Migration

Hunters and ornithologists well know that storms cause migrating birds to fly low and that bad weather may force them to land. After severe weather during the time of migration some birds are found which have perished from exposure or which have been scattered to localities so far from their usual ranges that they can never rejoin their populations. Many reports mention birds landing on ships at sea exhausted during stormy weather and it is at these times that birds are most often found injured by collision with lighthouses or buildings. These reports indicate some of the hazards for birds in migration. They do not give any idea of the normal proportion of mischances because in fair weather the flights pass without presenting unusual observations worthy of note. Often the normal flights are not even visible in the darkness or occur on remote migratory routes.

There are numerous records attesting that birds arrive at the end of long flights over water in exhausted condition. Wetmore (1939, p. 178) vividly described the fatigue and emaciation which he saw prevalent among the small migratory birds landing on the shores of Venezuela from flight over the Caribbean Sea. In later studies at the same landfall Voous (1953) reported that hundreds of blackpoll warblers appeared tame because of fatigue, and remarks that blackpolls and redstarts weighed only half what Beebe had reported for these warblers at their assembly points in northern Venezuela, before their return northward. On Dry Tortugas, Florida, Bartsch (1919) remarked that the migratory birds looked worn out in spring and autumn. The condition of the overseas migrants may vary, for another observer on Dry Tortugas reported that in autumn the migratory land birds appeared in good shape (Sprunt, 1951).

The records of land birds seen over the western Atlantic Ocean during cruises for oceanographic researches have been analyzed by Susan Irving Scholander (1955). Some land birds were found at sea further than 400 miles from nearest land and they must have cov-

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ered these distances by continuous flight. While many of these birds alighted exhausted on the ships there is evidently some traffic of certain species of land birds between America and Bermuda (600 miles) which, if not regular, nevertheless occurs each year. Seasonal winds had certainly influenced some of the flights, but recorded winds could not be used to explain the frequent occurrence of these apparently hazardous flights of lone land birds over the ocean. The repeated occurrence of these long flights demonstrates the long distance that a single bird can cover without social guidance or landmarks.

For a hummingbird to fly across the Gulf of Mexico would exceed the requirements of energy which Pearson (1950) could calculate to be at its disposal. Weigold (1926) reported considerable variations in the weights of migrant bird species arriving at Helgoland which suggested that the lighter individuals had exhausted their reserves. It is certain that long oversea flights tax and at times exceed the normal capability of birds, but a stationary observer is more likely to remark upon migrating birds which are unsuccessful than to report the swift flights of normal migrants.

Among Eskimos at Anaktuvuk it is commonly the impression that migratory birds arriving in spring are in good condition and usually fatter than later during the nesting season. It is also their view that birds of some species become fatter again just before their departure southward at the end of summer than they were at the time of arrival, but the arctic people hesitate to generalize upon the condition of departing migratory birds because the time of their departure is so uncertain and the birds are then so often inconspicuous.

After examining many birds in 1948, 1949 and 1950 it was my impression that in general they were in good condition and commonly fat during the spring season of migration. The weights of birds taken for specimens had been recorded along with occasional notes on their apparent fatness. After 1950 the fatness of the birds was routinely recorded. The designations were based upon the amount of fat visible on the birds in terms fat, medium fat, little fat, and very little fat. These terms mean whatever the observers associate with them in relation to their value as food. Eskimos know that the fattest ptarmigan has hardly as much fat as a rather lean loon or duck. The great differences in the characteristic amounts of fat in the various species required that the birds be compared according to the amount of fat appropriate for each species. Finding good agreement in the designations of fatness by several Eskimos I followed their usage of the terms, for their judgments were based upon their established code.

Among several thousand records of the fatness of birds which were examined when taken for food or as specimens, I found fewer than ten birds which were designated as lean or skinny. Wounded ducks have been found after several days to be actually in emaciated con-

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dition, so that it is apparent that birds can survive to the point of depletion of their visible reserves of fat. Even the birds which we designated as very little fat still appeared active and in good condition of plumage. They were not shrunken in other respects than fatness. I believe that the birds in this category were not injured by starvation.

TABLE 15.—*Distribution of degrees of fatness among males of 21 species and females of 9 species of common migrants to Anaktuvuk*

Fatness	Including redpolls		Not including redpolls	
	Number	Percent	Number	Percent
Fat	136	28	132	30
Medium fat	124	27	113	26
Little fat	165	34	150	35
Very little fat	55	11	37	9
Total	(480)		(431)	

The records of fatness of common migratory birds at Anaktuvuk are shown in the Appendix (figs. 21–36). For male birds of 21 common species and the female birds of 9 species the distribution in each category of fatness is shown in table 15. The male and female hoary redpolls (*Acanthis hornemanni exilipes*) and male common redpolls (*Acanthis flammea flammea*) included in the first two columns of figures, were less fat than the other migratory birds, having only 8 percent of fat birds. Since I suspect that redpolls winter not far from Anaktuvuk, they are subtracted from the totals in the last two columns to show the fatness of those species which migrate for long distances. These records of fatness of migratory birds at Anaktuvuk show that during the whole season only a small proportion were in the lowest category of fatness.

The records in figures 21 to 36 were mostly concentrated during the early season when the birds came in as arriving migrants. Among the males of 9 species (*Anas acuta*, *Aythya marila nearctica*, *Limnodromus scolopaceus*, *Erolia bairdii*, *Ereunetes pusillus*, *Eremophila alpestris arcticola*, *Anthus spinoletta rubescens*, *Zonotrichia leucophrys gambelii*, and *Calcarius lapponicus alascensis*) the weight curve, as judged visually by the best fitting line, declined between 10 and 15 percent after the first arrival of migrants in spring. Among males of 4 species (*Pluvialis dominica dominica*, *Heteroscelus incanum*, *Erolia minutilla* and *Calcarius pictus*) the decline was between 4 and 9 percent. The males of *Spizella* showed no change. The two species of *Acanthis*, suspected of wintering nearby and probably making only short migratory flights, showed no indication of chang-

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ing weight during the early season. One well known migratory sandpiper, *Erolia melanotos*, showed an increase in weight during the early season. There is wide variation in the weight of individuals of this species (see p. 197).

In three species (*Turdus migratorius migratorius*, *Oenanthe oenanthe oenanthe*, and *Motacilla flava tschutschensis*) the weights were not distributed in a manner that would show seasonal change. The weights of two species of Turdidae were affected by the heaviness of a few individuals just before migration southward and by sparse early season observations. The weights of *Motacilla* are too few to indicate a trend.

Less extensive data is available to show the condition of female birds. In 5 species (*Pluvialis dominica dominica*, *Heteroscelus incanum*, *Erolia bairdii*, *E. minutilla* and *Calcarius lapponicus alascensis*) weights declined in the early season by between 10 and 15 percent. In the early part of the season the females of *Lobipes lobatus* gained weight. The females of *Acanthis hornemanni exilipes*, like the males, showed no change. Because of my belief that they are not long-distance migrants they are not comparable with the other birds. The number of weights of females of *Zonotrichia leucophrys gambelii* is too small to show a trend, but it is reported for its relation to Mrs. Oakeson's interesting studies of this race.

Although the records of fatness are fewer than those of weight and not numerical, they show a general correspondence with the predominating decline in weight after the first birds arrived. The males of 13 species and the females of 2 species which declined in weight during the early season also diminished in fatness. The males and females of *Acanthis* did not show a significant change in fatness or in weight. In comparison with many other species they were not fat. Males of *Erolia melanotos* appeared to gain in fatness as they did in weight. The species *Turdus*, *Oenanthe*, and *Motacilla* gave as uncertain indications about fatness as they did in their weight.

These data are summarized in table 16.

TABLE 16.—*Summary of differences in weight and fatness of common migratory species after arrival at Anaktuvuk*

Type of migrant	Weight			Fatness		
	Lost	No change	Gained	Lost	No change	Gained
Long migration						
Males	13	1	1	14	0	1
Females	5	0	1	2	0	1
Short migration						
Males		2			2	
Females		1			1	

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There is such a sudden change in the activity of migratory birds when they reach their nesting grounds that it would be surprising if visible signs failed to indicate a change in their physiological condition. The northward progress of migration involves all migrants to Anaktuvuk in flights which must proceed at a rate sometimes greater than 60 miles a day in order to conform with the indications of the northbound schedule. After reaching their destination many species do not fly often or far and become sedentary birds in contrast with their activity during migration. The mechanisms of flight remain usable but they are little exercised.

There is a possibility that the musculature of flight may diminish in migratory birds which become sedentary on their nesting grounds. The evidence available is insufficient to suggest whether the birds like gulls, jaegers and hawks, which continue to fly extensively while on their breeding grounds, maintain their migratory weight while breeding.

The average weight of specimens of birds in various parts of their range is known to differ in some cases without other visible taxonomic distinctions appearing. Von Zedlitz (1924) reported that the average weight of *Tetrao urogallus* from Sweden was 3.65 kg. and from Hinterpommern 5 kg. I have discussed the variations in the weight of willow ptarmigan (*Lagopus lagopus alascensis*) from various localities, which appear to be significant of populations differing in weight although without taxonomic distinction. It is not known whether these differences in weight are maintained through heredity or whether they are simply induced in individuals by the two environments.

The birds nesting in the part of arctic Alaska we are considering are geographically homogeneous populations, and this factor may be important in the small "coefficients of variation" which were found in the weights of the species. I have taken as "coefficient of variation" the usual meaning, i. e., standard deviation as percent of the mean weight. In the weights of adult males of 21 species the coefficients of variation were between 5.3 and 12.6 percent. Among 9 species the coefficients of variation in the weights of female birds were from 7.2 to 12.4 percent. The average of the coefficients of variation in male examples of 21 species, each composed of from 10 to 40 individuals, was 8 percent. Among samples of the females of 7 species the average of the coefficients of variation was 9 percent. Considering the chances for error in gathering figures for weight under the conditions of arctic field study the birds of each species appear homogeneous in their weight characteristic at Anaktuvuk.

The weight of a small bird may change considerably during the course of a day, as is shown in the report by Linsdale and Sumner

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(1934) of a golden-crowned sparrow weighing usually about 28 grams which lost 20 percent of its weight between one afternoon and the next morning. That this change was exceptional appears from their records showing that several days elapsed before the bird regained its usual weight. Many records show that a decline in weight of small birds occurs over night and that their weight increases during the day. Baldwin and Kendeigh (1938) reported that the average diurnal curves for the weight of several passeriform species changed from about 97.5 to 101 percent of the mean weight between 7 a.m. and 6 p.m. Since sparrows weighing 20 grams lost about 10 percent when caged without food during a night, the rate of loss of the captives exceeded the average nightly loss of free wild birds in summer. I am inclined to think that the regularity of weight records for each species at Anaktuvuk, although they were taken at random times during the day, is influenced by the fact that with scarcely an hour of darkness there in early May, feeding is never for long interrupted. It is also my impression that the birds there feed frequently but not for very long periods.

The daily food intake of small birds is undoubtedly a quite appreciable part of their body weight. Captive English sparrows weighing about 24 grams consumed from 4 to 9 grams of mixed feed daily, according to my calculations from the metabolic heat production described in Kendeigh's detailed study (1949). The fact that average weight characterized each of Kendeigh's sparrows shows that their food intake and its utilization were kept in close relation in captivity when food was abundant. The same close accord between consumption and utilization of food seems to be the rule under natural conditions.

It has been implied in our discussion that variation in weight among the birds of a homogeneous population represents changes in the quantities of nutritive substances in their bodies disposable for metabolic purposes. The metabolizable substances include food which has been recently consumed and parts of the tissues themselves. Weights of Anaktuvuk species under consideration differed nearly 100 fold from redpolls (*Acanthis*) weighing only 12 grams to scaup (*Aythya*) as heavy as 1000 grams. The basal metabolic rate of birds has been found to vary with their size according to a formula given by Brody (1945, p. 371) empirically describing the metabolism of domesticated birds:

$$\text{kilo-calories per day} = 89 \times \text{weight (in kilograms)}^{2/3}$$

A few wild birds which we have examined in Alaska (Scholander, Hock, Walters, and L. Irving, 1950; L. Irving, H. Krog, and M. Monson, 1955) conformed sufficiently well with this relation to warrant its use for calculations. A bird weighing 10 grams has a metabolic rate at rest which would expend about 4.8 k.-cal. in 24 hours. A

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bird of 1000 grams would utilize 84 k.-cal. in 24 hours at the resting rate. In case the two sizes of birds metabolize substances of equal value for energy, the bird weighing 10 grams would consume a given percentage of body weight about 6 times as fast as the bird weighing 1000 grams.

In order to relate the conversion of energy with the substances which are actually metabolized it is necessary to define the energy provided by the substances which are oxidized in the course of metabolism. Fat has the highest value for energy production and its storage and use involve little water. In the metabolic oxidation of fat, one gram yields 9.4 k.-cal. (Brody, 1945, p. 35). A bird weighing 10 grams would accordingly obtain 9.4 k.-cal. by the oxidation of 10 percent of its substance in the form of fat. The oxidation of a given weight of protein or carbohydrate produces only about half as much energy as is derived from fat. These lower yielding substances are further less suited than fat for metabolic reserves in that they are likely to be stored and used along with a certain amount of water.

The comparison of metabolic rates just given was based upon the condition of animals resting in air warm enough so that no special metabolic provision would be needed for maintaining the warmth of the body. These metabolic rates are accordingly at the minimum attainable experimentally for brief periods and they do not make provision for the usual activities of life or for cold weather. Reasonable estimates can be prepared to indicate the magnitude of the daily metabolism of birds migrating during the cool season when they reach the arctic. These are shown in table 17. Because of the limited natural insulation of birds of small size, at just freezing temperature, a bird weighing 10 grams would need at least double its basal metabolic rate in order to preserve its warm body temperature (Scholander,

TABLE 17.—*Estimate of the daily budget of metabolism of three sizes of birds approaching the arctic terminus of migration in 0°C. average temperature*

Item	Relation to normal basal metabolic rate		
	Size 10 g.	Size 100 g.	Size 1000 g.
Sleeping (10 hours)	20/24	10/24	10/24
Waking, but not very active (10 hours), 2 times basal rate	20/24	20/24	20/24
Flight (4 hours), 6 times basal rate	24/24	24/24	24/24
Sum of metabolic periods	64/24	54/24	54/24
Relation to basic metabolic rate	2.67	2.25	2.25
Kg.-cal. per day	12.8	45.0	189
Equivalent grams of fat	1.36	4.8	20
Reserve (days) provided by metabolism of 10% of body weight as fat	0.74	2.1	5

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Hock, Walters, Johnson, and L. Irving, 1950; L. Irving, H. Krog, and M. Monson, 1955) but an arctic bird weighing 100 grams would probably be sufficiently insulated to get along at freezing temperature with just the heat produced by basal metabolism. In table 17 I have allowed 10 hours in the day for rest with metabolic rates on account of cold, at twice the basal level in birds weighing 10 grams and at the basal level in birds weighing 100 grams or more. I have then allowed that during the 10 hours of the day when migratory birds would be awake but not very active, they would require about double the basal rate of energy expenditure in that period. I have allowed that during 4 hours of active movements of flying the metabolic rate would be six times as great as the rate at rest, an expenditure of energy that corresponds with the rate of a man or dog walking rapidly. I have used the figure, however, because Pearson's (1950) measurements showed that the hovering flight of a hummingbird elevated its metabolism to about six times the resting rate.

The activity of a wild bird can hardly be regularly 50 percent greater or less than I have allowed, for wild birds commonly pursue their lives at a moderate pace. Even their swift movements in air, which so far exceed the speed of man on the ground, are probably so well within their capacity that they can probably fly as easily as a trained man can walk. I have not noticed an arctic bird that appeared to be exhausted by exertion, and it is my impression that they seldom work at their highest rate.

These estimates of daily metabolic costs allow us to evaluate the significance of the reserves for nutrition which exist in the body of a bird. If these reserves are in the form of fat and amount to 10 percent of the body's weight they would provide the metabolic energy which is expended during from ¾ of a day to 5 days according to the size of the common birds.

The accumulation of fat which we acquire on our bodies is not readily removed by current metabolism. The fat of obesity for example is sequestered from current use and can only gradually be withdrawn. But fat in the amount of 10 percent of the body weight does not constitute obesity. I have found ducks two or three days after they had been wounded to be in lean condition whereas ducks killed instantly from the same flock were fat. It has been shown (p. 322) that about a 10 percent decline in average weight is often visible among certain species of arctic birds two or three weeks after their arrival on their nesting grounds, and that (p. 324) there are numerous instances of rapid decline in the weight of birds during starvation which indicate that their substance can be quickly utilized for metabolism when food is unavailable. Among the migratory birds after their arrival at Anaktuvuk the amount of visible fat decreased as their

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weight diminished (see p. 323). As an example of extreme utilization of reserves, the small weight of warblers which arrived exhausted after flight over the Caribbean (see p. 320) shows that they had made extensive use of their substance during a long flight (Voous, 1953). It appears that the body substance of birds can be rapidly consumed and that at times it is used to meet current metabolic demands or emergencies during migration.

In comparing the weight of birds at the start of migration with their weight at the terminus we are disturbed by the fact that a sample of a migratory species taken on its wintering ground or along its migratory route may be setting out for any part of its eventual nesting grounds. There are many reports indicating that before departing for northbound migration birds wintering in temperate climates acquire fat, but few reports show condition at the end of migration. I will only refer to a few observers whose records of fatness appear directly comparable with my observations at Anaktuvuk.

In the discerning view of von Zedlitz (1926, 1927) the terminus of migration in Sweden was a favorable place for observation because all the birds were alike in proximity to their nesting place. On his estate in central Sweden, where he had watched the birds through many years, he reported careful records of the weight and condition of the migrant birds which for the most part came to settle and nest there. The list of birds is interesting because their names were all assigned by Linnaeus whose residence had been nearby. *Corvus cornix cornix*, *Sturnus vulgaris vulgaris*, *Fringilla coelebs coelebs*, *Columba palumbus palumbus*, and *Scolopax rusticola rusticola* arrived fat and then lost weight at mating time. Von Zedlitz' observations differ from those of Weigold (1926) on Helgoland, a point along a migratory route over water. There Weigold found variation in the weights of examples from a number of species which he took to illustrate occasional encounter with nutritional hardship during migration. Von Zedlitz' point of observation corresponds with mine in being at the terminus of a normally completed migration. His conclusions agree with mine that there is no evidence that successful migration leaves signs of strain in the nutritional state of birds.

To T. T. McCabe (1943), a long-experienced collector of birds in British Columbia, it was apparent that the northbound migrants were commonly fat and frequently very fat but that they lost weight rapidly on their breeding grounds. As an interesting contrast Mrs. Oakeson found that the Puget Sound race of white-crowned sparrows (*Zonotrichia leucophrys*) on arrival at their nesting ground at Tillamook were not fat (Blanchard 1942). Unlike the birds considered by McCabe these white-crowned sparrows had reached Tillamook after only a short migration from a nearby wintering ground. These in-

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teresting studies developed the evidence for the proposition that races of Pacific Coast white-crowned sparrows destined to make long migratory flights northward became fat in the period before departure while races preparing for only a short migratory flight accumulated little or no fat before the event.

Mrs. Oakeson has kindly sent me figures recording the weight and fatness of examples of the race of white-crowned sparrows examined by her just before leaving their California wintering ground and by McCabe at a station in British Columbia more or less in midcourse of migration. At both places the sparrows were generally heavy and commonly fat. When members of this race were taken after arrival on their breeding ground at Mountain Village, Alaska, they were lighter and less fat than in the early stage of the migration through Santa Barbara, California (Oakeson, 1953). The average weight of 7 males in May at Mountain Village was 25.8 grams. At Anaktuvuk 25.6 grams was their average weight during the summer, but during the first week after arrival the males were about 5 percent heavier. I conclude from Mrs. Oakeson's records that in April when this race started migration through California their average weight was as much as 20 percent greater than after their settlement on their Alaskan breeding grounds. A decline in weight of birds on the nesting ground appears to occur soon after arrival, but I suspect that some migrants start to lose weight during the last stages of their northern flight.

In several species at Anaktuvuk the females did not appear to lose weight until after their eggs had hatched. This contrast between the sexes conforms with the intense activity of male birds after they arrive, while courting and maintaining their nesting territories. This period does not appear to involve the female birds in especially intense activity, for they take life easily during mating and incubation. During the mating season the males may even be too busy to eat well. Their fat, which is certainly not completely used up during migration, could serve them well on the breeding ground in the way that reserves of fat enable male fur seals and bull caribou to neglect feeding in order to devote their time exclusively to the jealous watchfulness and demonstrations by which they seek to secure their paternity in the offspring of their mates.

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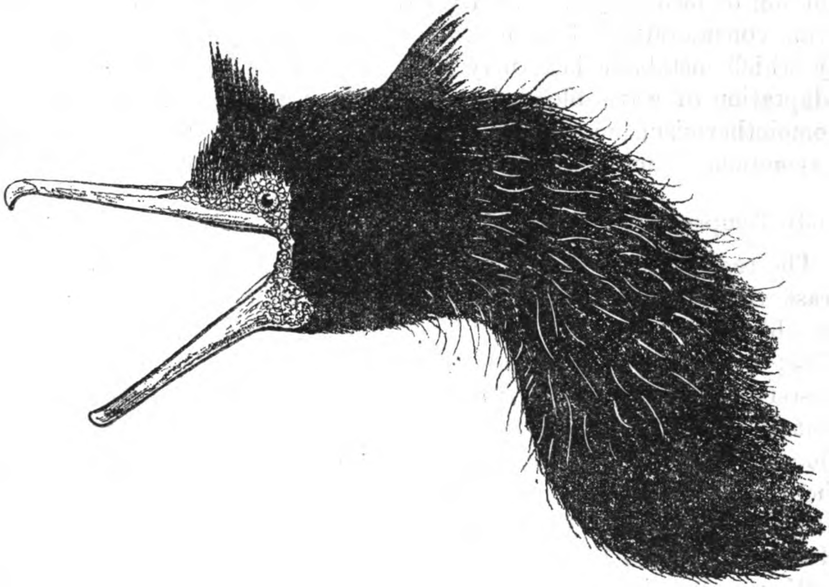

PELAGIC CORMORANT *Phalacrocorax pelagicus* (see p. 275).

9. *Arctic Metabolic Economy of Warm-blooded Animals*

WITH SUPPLIES SHIPPED from outside, a foreigner to the Arctic can afford to eat as much food for fuel as his metabolic process can handle, but an indigenous people must maintain a culture, a society, and families on food provided from local sources. Recognition of the large portion of man's schedule applied to other activities than feeding should indicate to us the common necessity for animals also to conserve their metabolic expenditures in order to have time in which to maintain family and social systems, and we should therefore be cautious about viewing the economy of animal heat in the arctic with the thought that arctic animals can preserve their body temperature by increasing their metabolic heat production much beyond the rates normal for animals in other climates.

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The availability of food, the time applicable to obtaining food, and the capacity of the metabolic processes set limits upon the extent to which warm-blooded animals can, by increasing their metabolic production of heat, adjust their lives to the cold arctic climate. These prior considerations lead us to look particularly for the methods by which metabolic heat may be conserved, as an essential to the adaptation of warm-blooded creatures to arctic life, and to analyze homoiothermism among arctic animals to see how the operation of its component factors is suited to the arctic environment.

Body Temperature of Arctic Animals

The regular warmth of birds and mammals appears in sharp contrast with the temperature of arctic winter, which has been reported as cold as −68° C. in eastern Siberia (Bartholomew and Herbertson, 1899; Court, Sissenwine, and Mitchell, 1949), and −65° C. in northwestern Canada (fig. 16). In experimentation at Barrow we found that at temperatures frequently occurring in winter, arctic warm-blooded animals could maintain their bodies some 80° warmer than the air by the production of metabolic heat at their basal rate and by its conservation with their natural insulation (Scholander, Walters, Hock, and Irving, 1950).

We now have temperature measurements for many resident species of Alaskan birds and most mammals except those of the smallest size (L. Irving and J. Krog, 1954). In winter at −45° C. and in warm summer the mean body temperature of 15 arctic and subarctic resident species of birds averaged 41.3° C. The mean body temperatures differed among the arctic species of birds by about as much as was found by Wetmore (1921) among species from temperate regions, and the means (fig. 17) for the arctic and temperate species exhibited about the same differences.

Body temperatures of homoiothermic species are phylogenetically differentiated, but the differentiation shows no common regard for geographical range, and their temperatures are more stable than the climates of the earth, which have changed appreciably, while the temperatures of the birds that inhabit them apparently have remained fixed. Body temperatures of arctic species show no indication of modifiability by climate and the small differences in temperature among the species show no adaptive qualifications for arctic life.

During our experimental study a number of arctic mammals were observed to hold their body temperature with remarkable constancy for several hours in air as warm as +30° C. or as cold as −50° C. We have not as extensive a view of birds, but it appears that their regulation of body temperature is about equally stable. Mammals or birds which had been active showed temperatures elevated 2° or even

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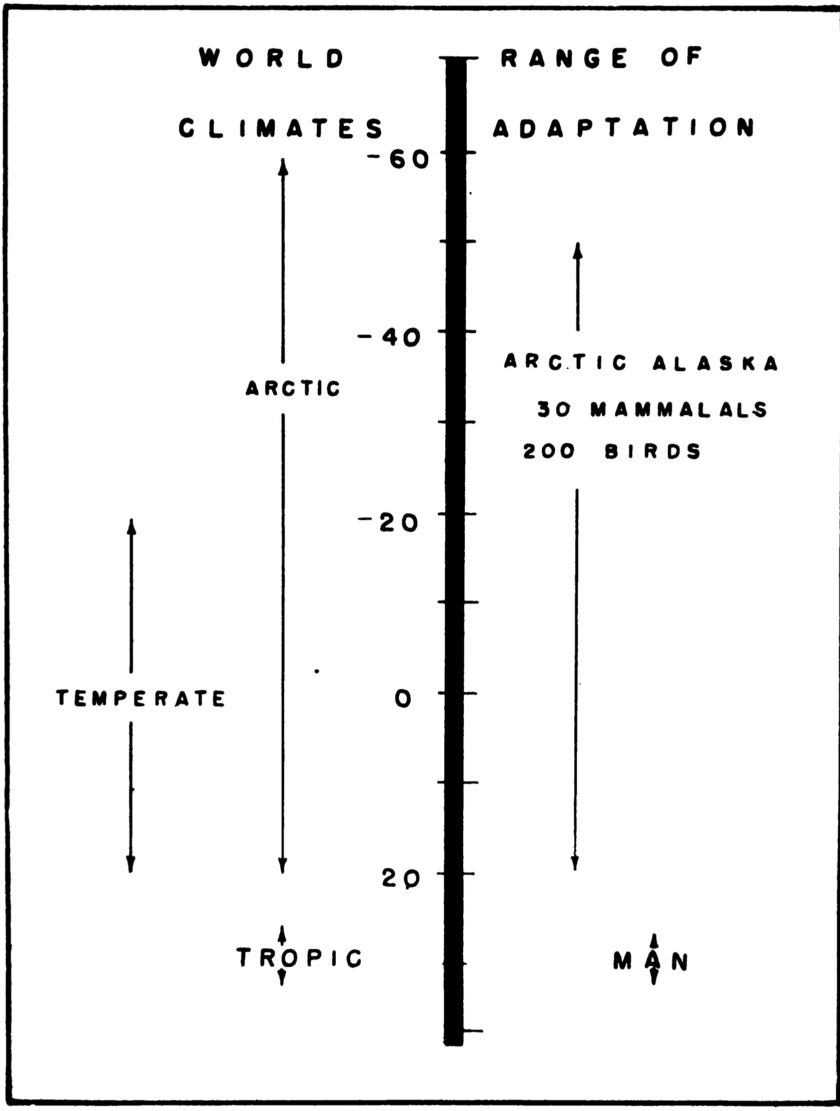

FIGURE 16.—Temperature ranges for which warm-blooded animals are physiologically adapted compared with those of the world's climates.

3° above the lower range of body temperatures at rest. It is my view that the body temperature of arctic mammals and birds remains at a miniumum value characteristic of the resting state except when excitement or activity elevates it above this well regulated minimum level.

During winter nights at Anchorage when the air was −10° C. to −20° C. I found the body temperatures of six species of Alaskan wild

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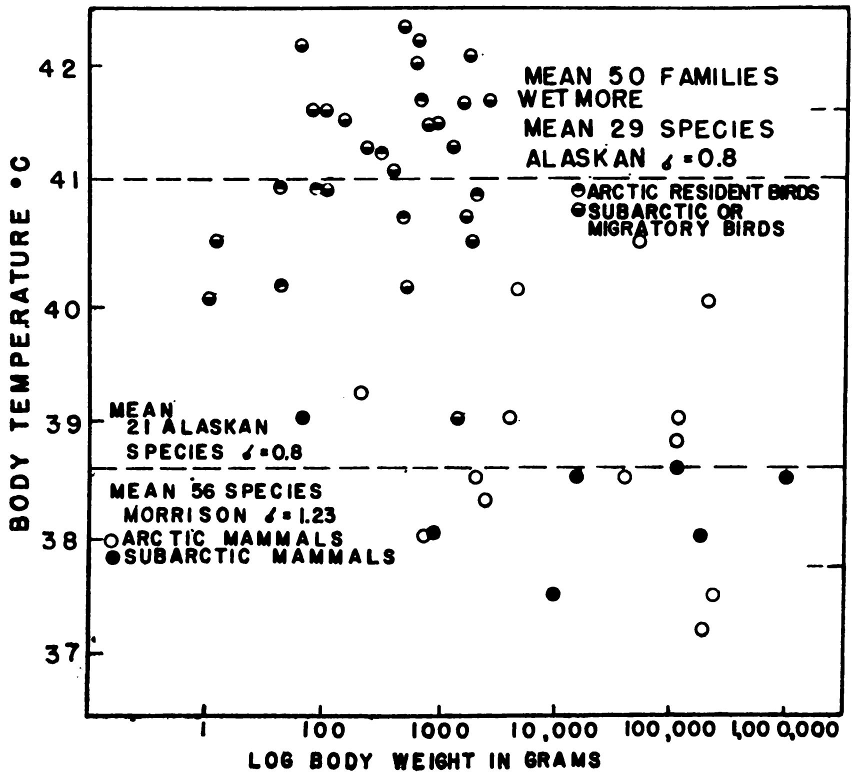

FIGURE 17.—Mean body temperatures of arctic and subarctic birds and mammals. (From L. Irving and J. Krog, Journ. Appl. Physiol., vol. 9, fig. 6, p. 677.)

birds more variable than during the day (L. Irving, 1955). At night the birds were often awake and active when we approached their cages. On several occasions, however, the body temperatures of some of them were 3° lower than the resting level by day, and I concluded that in cold nights, probably during sleep, northern birds may cool below their daytime body temperature by about as much as Dawson (1954) reported for birds in temperate regions. This nocturnal relaxation of either minimum temperature level or regulation among northern birds, however, is not enough to have much significance for the conservation of bodily heat in the Arctic.

It is true that during hibernation at reduced body temperature mammals save on the expenditure of metabolic heat (Hock, 1951). At Barrow hibernating ground squirrels (*Citellus undulatus*) were often near 0° C. (Erikson, 1956). At this low temperature their heat production is so meager that it cannot protect them from freezing in air only a few degrees colder. Accordingly their winter survival depends upon obtaining such effective insulation from a nest and bur-

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row as will conserve their feeble production of metabolic heat. For the very numerous arctic population of ground squirrels, hibernation is a successful evasion of winter cold, but as far as I know the faculty of hibernation at depressed body temperature is only exercised in the Arctic by two mammalian species, *Citellus* and *Arctomys.*

It has been suggested that ptarmigan hibernate in their burrows under the snow, but no indication was found that the body temperature of willow ptarmigan shot early in winter mornings or late in the afternoon differed from the midday level (L. Irving and J. Krog, 1954). Willow ptarmigan enter snow burrows at evening with crops containing tips of willow twigs and buds amounting to as much as one sixth their body weight. When they leave in the morning a large mass of droppings shows that their digestion has been active during the night.

Birds of the tundra lack the shelter of trees. Cliff dwelling gyrfalcons and ravens on their roosts can find shelter from wind, but I doubt if they find or require protection from arctic cold. Cade (1953) has observed the common redpoll in winter near Fairbanks entering apertures formed through the snow around weed stems, and it is reasonable to suppose that such shelters afford some protection. Simon Paneak remarked that hoary redpolls had been seen entering the spaces in the snow through which willow bushes protrude. Inasmuch as these openings are sealed by each fresh snow and do not commonly form before the sun rises in winter, we did not think that the redpolls would regularly be able to find shelter much warmer than in the open air. I do not know where chickadees, jays, and grosbeaks roost on the tundra, but I do not think that any small tundra birds use shelters so well enclosed that at night the air in them would be warmed much above the temperature outside. Under these conditions arctic birds cannot reduce their body temperature by hibernation or in torpidity, for because of the diminished heat production observed in torpid birds they could not be expected to counteract the cold of even just freezing weather (Pearson, 1953). Arctic tundra mammals smaller than hares remain under the snow. Signs of pursuit by fox and weasel reveal the extensive winter activity of the great numbers of mice and lemmings otherwise concealed by snow. Nordenskiöld (1882, p. 114) described vividly how the melting of the snow disclosed the surprising extent of the hidden winter activities of arctic small mammals by showing the runways, nests, and dung. We have no measurements of the body temperature of these small mammals in their natural winter habitat, but the indications are that they are those usual for mammals. Underneath the snow the small mammals are exposed only to modified arctic cold, but the small arctic birds seem to be unable to escape the severe cold of arctic winter.

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Essentials for Maintaining Body Temperature

Before his sacrifice to the political tempers of the French revolution, Lavoisier (1777) had demonstrated that the production of animal heat could be ascribed to the oxidation of carbon and hydrogen in the animal's body. Since that time physiological complications have often been allowed to obscure the view that the heat produced by animal combustions must pass to their environment in accordance with physical laws for the exchange of heat. The difficulty has been largely methodological, and has arisen because man and the domestic and laboratory animals commonly used for metabolic studies are so little accustomed to cold that the factors of heat exchange are not large enough for their relations to be readily apparent. The contrast between the conditions for heat exchange in arctic and tropical animals presented their heat exchange in dimensions of such contrast that the essential physical factors of the process could be related in a simple form of Newton's law of cooling (Scholander, Hock, Walters, Johnson, and Irving 1950).

Heat escapes from a warm body to cooler surroundings by conduction at a rate which is proportional to the difference in temperature between the body and its surroundings. Warm-blooded animals, in order to maintain a constant temperature, must produce as much heat as escapes from their bodies. The loss of heat from animals proceeds through surfaces which are insulated. Fur and feathers afford the conspicuous insulation of animals but other natural insulating systems also serve in the conservation of bodily heat. If all the devices resisting the loss of heat are regarded as components which combine to provide insulation in still air, the system preserving body temperature can be described by the use of Newton's law of cooling (Scholander, Hock, Walters, Johnson, and Irving, 1950),

$$T_b - T_a = KIH,$$

where T_b and T_a are the temperatures of the animal body and of the surrounding air, I is the overall insulation of the animal, H is the production of heat by metabolism, and K is the factor appropriate to relate the units of measurement used.

In order to compare heat exchange among animals of various sizes the basal metabolic rate of each animal was represented as 100 and the observed metabolic rates were plotted against air temperatures. Figure 18, which shows these relations among arctic and tropical species of mammals and birds, indicates that the larger arctic birds and mammals maintained their basal metabolic rates in cold and could apparently sustain any arctic winter weather without heat beyond that produced at the level of basal metabolism. Tropical animals, on the

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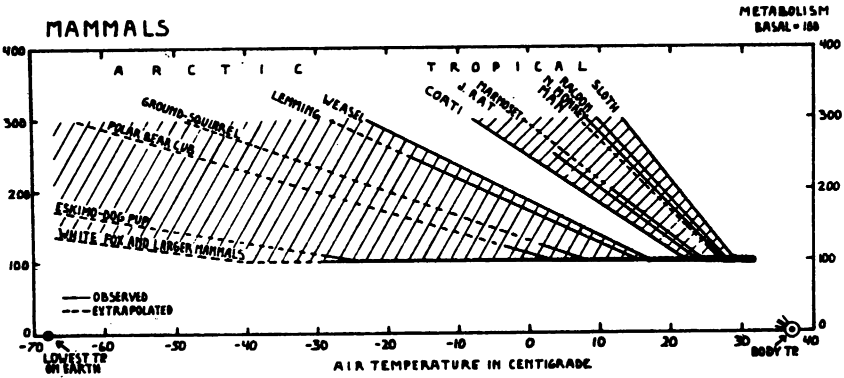

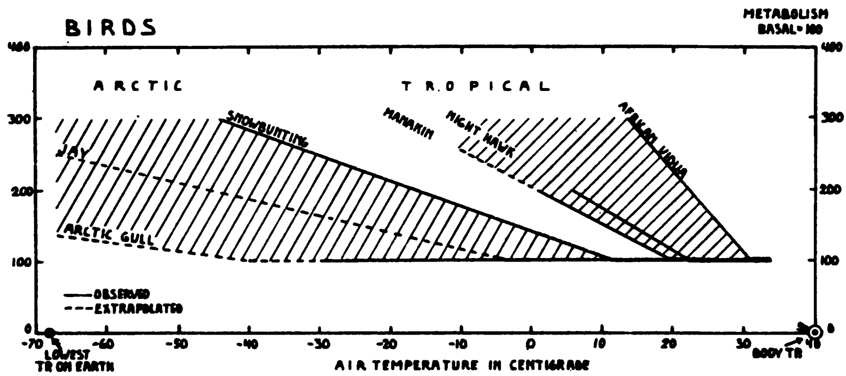

FIGURE 18.—Heat regulation and temperature sensitivity in arctic and tropic mammals (top) and birds (bottom). (From Scholander, Hock, Walters, Johnson, and L. Irving, Biol. Bull., vol. 99, figs. 10 and 11.)

other hand, started to increase their metabolism at temperatures only a little below those normal in their natural environment.

By using this method of formulation it was found that the metabolic measurements by a number of investigators working in temperate climates produced curves showing the same pattern of relation between metabolism, insulation, and temperature. The formulation was successfully used by Hart (1952) for defining the character of the metabolism in cold of several kinds of wild and domesticated mice. The formulation also served to compare the metabolism in summer and winter of three species of mammals and of two birds in Alaska (L. Irving, H. Krog, and M. Monson, 1955), to describe the metabolism in cold of an Alaskan mountain goat (H. Krog, and M. Monson, 1954), and to compare the endurance of cold by wild brown rats and by rats of the white laboratory form (H. Krog, M. Monson, and L. Irving, 1955).

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Critical Temperature

The temperature at which an animal must increase its metabolic heat production above the basal level is spoken of as the "critical temperature," and it differs among species, as shown in tables 18 and 19. No small mammals or birds have been found with a low critical temperature, since the mechanics of movement prevent them from wearing enough fur or feathers for substantial insulation. Among the northern mammals the arctic white fox (*Alopex lagopus*), weighing about 4 kg., is the smallest that we have found able to stand arctic cold with only its basal metabolic rate (Scholander, Hock, Walters, Johnson, and Irving, 1950). The distribution and habits of arctic hares (*Lepus timidus*) of about the same weight show that they withstand exposure to any arctic cold, but snowshoe hares (*Lepus americanus*) obtain some shelter in their brushy habitat (L. Irving, J. Krog, H. Krog, and M. Monson, 1957). At Leningrad, Olnianskaya and Slonim (1947) showed that arctic hares and several other arctic mammals conserved their body temperature better in cold than some northern, but not arctic, species. Smaller arctic and subarctic mammals such as weasels, mice, lemmings, and ground squirrels seldom emerge for long from their burrows and nests under the snow, where the protection from

TABLE 18.—*Critical temperatures at which the metabolic rate increases in some birds*

Species	Region	Season	Weight (g.)	Critical temperature (° C.)
Larus hyperboreus barrovianus (1)	Barrow	Winter	1500	below −30
Perisoreus canadensis pacificus (1)	Barrow	Winter	60	−5
Plectrophenax nivalis nivalis (1)	Barrow	Winter	40	12
Branta nigricans (2)	Anchorage	Winter	1118	6
Branta nigricans (2)	Anchorage	Summer		6
Corvus caurinus (2)	Anchorage	Winter	280	−10
Corvus caurinus (2)	Anchorage	Summer		−10
Anser (domestic) (3) (4)	Europe		4700	3
Gallus (domestic) (4)	Europe		2000	26
Gallus (domestic) (9)	America		2000	26
Columba (domestic) (5)	Europe		400	28
Columba (domestic) (4) (6)	Europe			20
Passer domesticus (7)	Ohio		24	22
Troglodytes aedon (8)	Ohio	Summer	10	25
Nyctidromus (1)	Panama		45	25
Pipra (1)	Panama		12	20
Vidua paradisaea (3)	Native to Africa		13	32

SOURCES:

(1) Scholander, R. Hock, Walters, Johnson, and L. Irving, 1950, p. 237.
(2) Irving, H. Krog, and M. Monson, 1955.
(3) Terroine and Trautmann, 1927.
(4) Giaja, 1931.
(5) Kayser, 1930.
(6) Falloise, 1900.
(7) Kendeigh, 1944.
(8) Kendeigh, 1939.
(9) Mitchell and Haines, 1927.

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TABLE 19.—*Critical temperatures at which the metabolic rate increases in some mammals in Alaska*

[Explanation—(A) Arctic, (SA) (Subarctic.]

Species	Region	Weight (kg.)	Critical temperature (° C.)	
			Winter	Summer
Thalarctos maritimus (1)	A (cubs)	9	0	0
Mustela rixosa (1)	A	0.04–0.07	18	
Vulpes vulpes (2)	SA	5	−13	8
Alopex lagopus (1)	A	3.8–5.5	−40	
Canis familiaris (1)	A (pups)	15	−25	
Citellus undulatus (1)	A	0.870–1250		8
Tamiasciurus hudsonicus (2)	SA	0.165–0.230	20	20
Dicrostonyx torquatus (1)	A	0.045–0.056	15	
Rattus norwegicus (3)	SA	0.200	23	
Erethizon dorsatum (2)	SA	4–7	−12	7
Lepus americanus	SA	1	−12	
Oreamnus americanus (4)	SA	32	−20	

Sources:
(1) Scholander, Hock, Walters, Johnson, and Irving, 1950.
(2) L. Irving, H. Krog, and M. Monson, 1955.
(3) H. Krog, M. Monson, and L. Irving, 1955.
(4) H. Krog and M. Monson, 1954.
(5) L. Irving, J. Krog, H. Krog, and M. Monson, 1957.

weather afforded by their behavior in seeking shelter probably keeps their immediate environment at about their critical temperatures. It appears that in general large arctic mammals have sufficient insulation of their own to suit the climate in which they live. Smaller mammals with inadequate insulation for arctic weather obtain shelter in the burrows and nests habitual to their kind and by curling up to rest in especially well protected sleeping places in effect insulate themselves by their behavior.

Under natural conditions small arctic mammals come out of their shelters occasionally to run about on the snow. The tracks of ground squirrels show that in spring and fall they are often out during weather much colder than the temperatures which have been found experimentally to be critical. Tree squirrels (*Tamiasciurus hudsonicus*) are seen occasionally in arctic forests during midwinter, lemmings (*Dicrostonyx torquatus*) are seen in late winter running over the snow, particularly in the years of their cyclic abundance. Clay Kaigelak and I found a lemming scratching outside our camp one morning in April on one of the Plover Islands, a scarcely perceptible sand bar rising above the sea ice more than a mile from the shore east of Point Barrow. The nights had been as cold as −30° C. and the days were no warmer than −10° C. while the lemming ran out there over the sea ice. Lively and pugnacious, it lived captive in the cold camp for

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another day. We crossed the tracks of an occasional lemming while traveling some 20 miles at some distance from shore over the sea ice and I found one about four miles from land dead but undamaged by predators. These forays of lemmings turned out badly but they show that while active these small and poorly insulated mammals can for some hours withstand cold far below their critical temperature.

It is common to see the tracks of the arctic least weasel (*Mustela rixosa*) in the snow of the arctic forest and over the tundra. I have never followed them successfully very far before losing them where they apparently returned beneath the snow. The tracks of the larger weasel (*Mustela erminea*) I have followed for a mile without reaching the end of its continuous journey in cold winter air. They are larger and have somewhat thicker fur than the least weasel, but I doubt if their insulation could protect them with resting metabolism in air colder than 0° C. Both species of weasels regularly expose themselves while active, and they can probably pursue their intensive activity for several hours at a rate sufficient to preserve their body temperature by the heat of activity, although their insulation is not sufficient for them long to endure cold while at rest.

Although some species have been observed to raise their metabolic rates about six times in cold, others managed only about a 3-fold increase during several hours of experimental exposure to cold. As yet no climatic pattern in the possession of this faculty is shown among tropical and arctic, small and large forms of mammals and birds, but that it is, in part, a matter of metabolic disposition, is suggested by the fact that aggressive wild brown rats (*Rattus norwegicus*) of Fairbanks raised their metabolism in experimental cold nearly twice as much as white laboratory rats (H. Krog, M. Monson, and L. Irving, 1955). And we have as yet no criteria for deciding whether the metabolic increase originates in other tissues than the visibly active muscles.

When the increase of metabolism below the critical temperature accurately supplies the heat lost and maintains normal body temperature the line relating metabolism to air temperature is straight. This is the situation postulated in the description of homoiotherms as heat machines (Scholander, Hock, Walters, Johnson, and Irving, 1950). Hart (1952) found the body temperature of mice to be well preserved by their muscular activity for a certain amount of cold below their critical temperature. White rats regulated their body temperature during short experimental periods in air temperatures 10° or 20° below their critical temperature, but in colder air their body temperature dropped and the line showing elevation of metabolism progressively fell below the theoretical line for

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homoiothermism (H. Krog, M. Monson, and L. Irving, 1955). Porcupines in winter maintained body temperature and related metabolism to cold below their critical temperature better than they did in summer (L. Irving, H. Krog, and M. Monson, 1955). In general, well adapted arctic mammals preserve their body temperature very accurately over ranges of cold which are far beyond the tolerance of tropical forms (L. Irving and J. Krog, 1954). As already mentioned, the small mammals find in their habits and behavior the supplemental protection from the arctic climate which physiological adaptation or adjustment cannot provide for them.

Stability of Basal Metabolic Rate

Although we have now no measurements of the temperature in the burrows occupied by arctic tree squirrels, weasels, lemmings, mice, voles, and shrews, these animals while resting probably are not exposed to temperatures much lower than their critical temperature. If this expectation is confirmed, they can rest without their metabolic expenditure exceeding the basal level appropriate to animals of their size. We have not found the basal metabolic rates of small or large wild arctic mammals to differ from those of tropical or temperate forms in any manner related to climate (Scholander, Hock, Walters, and Irving, 1950; H. Krog and M. Monson, 1954; H. Krog, M. Monson, and L. Irving, 1955; L. Irving, H. Krog, and M. Monson, 1955). Mammalian basal metabolism, like body temperature, is a characteristic not modifiable for climatic adaptation; and individuals of three species (*Vulpes vulpes*, *Erethizon dorsatum*, *Tamiasciurus hudsonicus*) did not change basal metabolism significantly in passing from the cold subarctic winter to the mild weather of summer at Anchorage (L. Irving, H. Krog, and M. Monson, 1955).

After white laboratory rats have been exposed for a month to air about 0° C. their resting metabolism is elevated some 60 percent above the level characteristic of them when they are kept in a warm laboratory. This enabled them to survive cold better than the rats from a warm room, but their reactions to low temperatures were not as well balanced nor as effective as those of wild brown rats, living out of doors in the Alaskan winter, whose basal metabolism did not differ significantly from that of normal white rats. Although the white rats acquired some extra tolerance of cold with their elevated resting metabolic rate, it appeared that this adjustment resembled the physiological alterations that compensate individuals for pathological conditions or unnatural stress but which could not be regarded as a natural adaptation proper for a race of animals (H. Krog, M. Monson, and L. Irving, 1955).

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I view with suspicion of harmful consequences the prolonged exposure of mammals to such cold as they can only meet by metabolism which persistently stands high above the basal level. During periods of activity mammals can regulate body temperature by utilizing the heat which they produce above the basal level. Under experimental conditions they regulate body temperature well for some hours in air much colder than their critical temperature. Both the degree of cold and apparently the duration of its tolerance are, however, limited. During experimentation we have found that the time of endurance of arctic winter cold by small arctic mammals is limited to a few hours. It appears likely that animals of smallest size, having also the higher critical temperatures, must soonest expend the metabolic reserves available for activity. Apart from the question as to whether the mammalian metabolic processes can run normally under such stress of cold is the question of the stress upon the economy of nutrition, for neither food nor time to obtain it are commonly disposable except with limited possibility of expansion.

The Barrow glaucous gull did not increase its metabolism at −30° C. and by extrapolation it is safe to locate its critical temperature as low as −40° C. It is probable that arctic gyrfalcons and ravens have low critical temperatures, and it is reasonable to suppose that arctic rock ptarmigan weighing 400 grams are about the smallest birds with a critical temperature as low as arctic winter cold, for an arctic Alaskan jay weighing 60 grams needed to elevate its metabolism in air colder than −3° C. As an arctic resident the jay had every incentive from its habits and environment to enlarge its insulation if it were physically possible.

It is estimated that the smallest species of birds which can carry insulation completely adapting them to arctic cold are about $\frac{1}{10}$ the weight of the smallest species of mammals fully adapted by their insulation for arctic cold. Many northern and arctic birds weighing less than 400 grams are constantly abroad in the coldest arctic weather (see p. 94), nor have I discovered habits which could give them shelter as a substitute for their deficiency of bodily insulation. During much of the arctic winter it would seem that they must exceed the basal metabolic rate normal to homoiothermous animals of their size. In this respect they appear not to be fully adapted to arctic cold. John Steen (1958) has demonstrated that small Norwegian wild birds have critical temperatures so high that through most of the winter they cannot relax below twice normal metabolic rate.

Returning to view the relation between critical temperature and normal geographical range, it appeared that the tropical mammals and birds had critical temperatures about conforming to the climate in their natural range (Scholander, Hock, Walters, Johnson, and

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Irving, 1950). A red fox and porcupines captive at Anchorage had critical temperatures closely conforming with the mean environmental temperature in winter and in summer, for by changing the length of their fur they suited their metabolism to the temperature of the season in the locality where they lived. Their adaptive variation in insulation shows that seasonal and geographical variation in critical temperature in individuals of some species of mammals correlate reasonably well with the climate to which they are exposed (L. Irving, H. Krog, and M. Monson, 1955).

We were surprised, however, to find that the critical temperature for a brant (*Branta nigricans*) and a fish crow (*Corvus caurinus*) did not change seasonally. The crow's critical temperature in winter and summer at Anchorage corresponded to the January mean in the warmer climate of Seward, where it had been captured from among birds resident in the coldest part of their usual range. When forced to remain in the colder winter of Anchorage, the critical temperature of the crow and migratory brant remained the same as the mean temperature of the warmer winter on the natural wintering ground of the species. Neither bird showed any modification of its critical temperature with season or with its exposure to a winter in Anchorage much colder than it would naturally encounter.

There are other indications that under domestication birds do not adjust their critical temperature to the climate in which they are placed by man. Domestic geese at Strasbourg and Belgrade had critical temperature near 0° C., according to the figures of Terroine and Trautmann (1927) and Giàjà (1931). The critical temperature of domestic geese was above the midwinter temperatures of central Europe, but birds of the genus *Anser* would seldom encounter below freezing temperatures in their natural range, which usually extends only as far north as water remains unfrozen.

Domestic fowl (*Gallus*) (Terroine and Trautmann, 1927; Mitchell and Haines, 1927) and pigeons (*Columba*) (Kayser, 1930; Terroine and Trautmann, 1927; Falloise, 1900) have high critical temperatures in the temperate climate of central Europe and North America. Domesticated fowl are considered to be derived from wild ancestors living in warm climates and they appear to have retained the critical temperatures appropriate to tropical birds. Nevertheless, fowl live with some shelter in Alaska and we have kept pigeons outdoors during winter in Barrow. In captivity the birds have an unlimited supply of food available without effort on their part and they are protected by cages from being disturbed. While relieving an animal of the need for exertion to obtain food does not mitigate the cold, it may reduce the effort necessary for existence so that the full natural influence toward evoking climatic adaptation is lacking in captivity.

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Although we have not yet found any birds having the adaptability for seasonal cold which shows so clearly in the seasonal changes in the fur of mammals, it does appear that birds of some arctic species are adapted to cold, as is shown by their low critical temperatures.

Physiological Analysis of Insulation

Arctic land mammals, if they are large enough, are well protected from cold by the thick covering of fur characteristic of land mammals adapted to arctic life, and in some cases the ability to produce this thick fur is an inherited character not determined by the environment. Some breeds of dogs, like the German shepherd can thicken their fur in northern cold weather. Others, like short-haired pointers, do not noticeably thicken their coat in cold seasons or when transported to the Arctic. Collie dogs in warm climates still have thick fur and arctic sled dogs retain thick coats when taken to warm climates. So the climatic adaptability of fur length varies among the breeds of dogs selected under domestication.

We found seasonal adjustment of insulation to environmental temperature in the arctic red fox and porcupine (L. Irving, H. Krog, and M. Monson, 1955). In summer fur the red fox, with a critical temperature of 8° C., was adapted to an environment only 30° colder than its body. In winter at Anchorage its critical temperature was −15° C., or 53° colder than its body. Arctic white foxes in winter, with a critical temperature of −40° C., have insulation adaptive to a temperature about 80° colder than their bodies. The winter insulation of the arctic white fox and the summer insulation of the red fox at Anchorage compare as 80 to 30. Some good-sized tropical mammals had critical temperatures only 10° colder than their bodies, and the effectiveness of their insulation compared with the winter arctic white fox was as 10 to 80. The difference in these examples adapted by natural distribution can be related to the thickness of fur, a condition which varies with the climates in which they occur (Scholander, Walters, Hock, and Irving, 1950).

It is quite possible for large arctic mammals to have fur ten times thicker than that of tropical animals without hindering their movements. By measurements of heat conductance through samples of fur as much as 10-fold differences in physical insulation distinguished the fur of well adapted arctic mammals from those in tropical Panama (Scholander, Walters, Hock, and Irving, 1950). The critical temperatures of the arctic glaucous gull and domestic fowl differ by nearly 70°. The combination of all the physiological processes which make up animal insulation must differ some 8-fold in these two species. But arctic gulls do not have a feather cover which is eight times thicker than that of hens, as would be necessary if thickness of

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feathers alone were the reason for the gull's superior insulation. In these two examples we must evidently look for other factors which can modify the escape of heat.

It seems to be a common opinion that the feathers of arctic birds are much thicker than those of tropical birds, for the effectiveness of a physical insulator varies with its thickness. By inspection of systematically related arctic and tropical birds in the museum, I could not find much difference in the thickness of contour feathers in the prepared skins from related land birds of the warmest and coldest regions or seasons.

In winter small arctic birds at rest erect their feathers until they appear much enlarged and nearly spherical. It would not be possible for a bird to keep this shape in flight, but I find that the individual contour feathers of birds from the arctic are distinguishable from those of a warm climate in having less rigid terminal barbs with softer barbules containing extended fine processes. William Rowan remarked to me upon this distinction of arctic feathers that a given mass of them would retain more air than those from warm climates. When erected on the bird, the arctic feathers retain air among the soft interlocking barbules, whereas the feathers from warm climates readily separate.

Taking this characteristic of feathers as a criterion for arctic birds, I numbered several contour feathers from birds of twelve species of migratory and resident Fringillidae taken at Anaktuvuk, and arranged them in order of apparent usefulness for insulation as follows:

1. Pinicola enucleator alascensis	Resident in winter
2. Acanthis hornemanni exilipes	Resident in winter
3. Acanthis flammea flammea	Resident of interior Alaska in winter
4. Plectrophenax nivalis nivalis	Resident of interior Alaska in winter
5. Calcarius lapponicus alascensis	First arrival date April 29
6. Spizella arborea ochracea	First arrival date May 8
7. Junco hyemalis hyemalis	First arrival date May 9
8. Zonotrichia leucophrys gambelii	First arrival date May 13
9. Passerculus sandwichensis anthinus	First arrival date May 13
10. Passerella iliaca zaboria	First arrival date May 19
11. Leucosticte tephrocotis tephrocotis	First arrival date May 22
12. Calcarius pictus	First arrival date May 27

I found that the winter resident birds ranked first and that the migrants followed about in the sequence of their arrival dates in spring.

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Several other judges to whom I explained the idea placed the feathers in about the same order, so that it appears to have some significance. It should be noticed that these comparisons were made with the feathers of birds which had reached their summer condition and when the arctic weather was warm enough to have the migratory examples present for comparison, so that if this is an insulating characteristic of feathers, it is retained in summer. The dissipation of heat, which must be important for birds in summer is not facilitated by as much thinning of the feathers as would anywhere near compensate for the heat of the arctic summer. The heat is dissipated by some other postural disposition of the feathers or through other physiological channels.

Neither geographical nor seasonal variation in feather thickness clearly adapts the insulation of birds to their climates, although differences in structure exist which would permit the feathers to function by erection when at rest, with various effects useful in different temperatures.

Fur can be regarded as freely modifiable for insulation, and that seems to be its common function, but feathers serve primarily for flight. Birds fly alike in all climates, and the requirements of aerodynamics which they encounter are unaffected by temperature. It is to the specific mechanical and power characteristics of internal muscular and bony mechanisms, and probably to the metabolic provision of power, characteristics not related to climate, that the feathers must conform. Probably little modification of the thickness of a given bird's feathers is possible during flight; only when at rest is the bird free to modify the insulation value, utilizing the finer structure and regulating the position of the feathers to vary the thickness. As I have said, however, this adaptive use for insulation is obscured and perhaps repressed by the primary integration of the feathers into mechanisms for flight that operate unaffected by climate or weather.

I suspect, too, that the necessity for the contour of diving and swimming birds to conform to the requirements of the aquatic medium as well as to flight may limit the climatic modifiability of the thickness of their feathers for insulation. The combination of these various functions in the feathers of birds precludes any simplified view that their main use is for insulation.

Variability of Insulation in Animals

The fur clothing made by Eskimos preserves comfortable warmth in arctic cold when the wearer is inactive or even at rest, but in a warm house, or during the sunny part of a warm winter day, adequate arctic clothing is unbearably hot, and even Eskimos, with all their skill in the preparation and use of clothing, have not succeeded in

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making garments that serve well both purposes. If clothing is warm enough for rest it seriously hampers heat dissipation during activity. Arctic animals have solved this problem, for while wearing feathers or fur sufficient for rest in cold they can endure heat and violent prolonged activity without apparent overheating. Just after they have come out in spring with thick fur arctic grizzly bears (*Ursus arctos*) when alarmed can run far up the steep rough slope of a mountain with undiminishing speed. Wolves and caribou run at high speed for long distances. Late in winter the sun shining on the mountain cliffs where mountain sheep (*Ovis dalli*) rest in their thick fur is uncomfortably warm for a well clothed man. Arctic ptarmigan are the swiftest flying grouse and make long flights during migration at high speed.

This flexibility of the arctic animal's insulation, designated one of the important characteristics of physiological insulation (Scholander, Hock, Walters, Johnson, and Irving, 1950), arouses the envy of arctic man uncomfortably and even dangerously sweating from small exertion in his clothing. How animals can in effect reduce their insulation without removing their covering, and through what avenues heat can escape in such variable and well regulated fashion, has been one of the most interesting problems of physiology in the Arctic.

Sweating effectively regulates the disposal of surplus heat for some animals in warm climates. In the Arctic, man, physiologically a tropical animal, sweats violently during exertion, but under heavy clothing the process is inefficient and not very useful. The ability to sweat varies among mammalian species and its use is difficult to measure, but my impression is that it is not much employed by arctic animals in cold weather, although in warm weather they probably make some use of it, because at no time have I found their fur or feathers moist, nor does frost collect on them as it does with such embarrassment on the clothing of sweating man.

The Canidae utilize evaporative cooling by well regulated panting in the Arctic, and in winter the cloud of moisture above a dog team, like the "water smoke" over an open lead in the sea ice, is sometimes visible at great distance. Caribou, reindeer, and men exhale moisture which cools them in amounts varying with the amount of air breathed. But without the well regulated cooling system involved in dogs' panting, evaporation from the lungs does not serve as a flexible, well regulated means for disposing of excess heat. With their air sacs birds have large surfaces, but it is not clear that these surfaces are employed for regulated cooling. In fact, the whole important subject of regulated cooling for arctic animals is obscure. However, one system for varying the escape of heat has not until recently received much consideration. In it I can see some interesting uses and important consequences for arctic life.

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Heat Loss through the Extremities

Some parts of birds and mammals protrude bare or but thinly insulated, for in the Arctic, as in the Tropics, free movement of the extremities is necessary, and certain sensory surfaces upon them must be fully exposed to the environment which they are to perceive. The bare foot pads of dogs and porcupines have been found to be near 0° in cold weather, as have the hooves of caribou and the feet of gulls and several other arctic birds (L. Irving and J. Krog, 1955). Noses of mammals were also found to be cold.

The extremities derive most of their heat through the circulation from the body, so that their low temperature is not by itself evidence that the extremities are thereby saving heat. In the legs of gulls (*Larus glaucescens*) a rapid decline in tissue temperature was found to occur along the tibia under a thick covering of feathers, and the location of the temperature change suggested that heat was not escaping through the thick feathers, but that it was transferred from warm arterial blood to the venous blood returning cool from the foot (L. Irving, 1951; L. Irving and J. Krog, 1955).

In the legs and noses of arctic mammals and in the legs of other arctic birds were found temperature gradients similar to those observed in the gulls. The extremities of mammals possess vascular arrangements which appear suitable to act as heat exchangers for the conservation of heat (Scholander, 1955, 1958). The bare tail of the muskrat is cold, and aquatic mammals, in order to reduce their loss of heat to the surrounding cold water, may have such vascular schemes for heat conservation extending over as much of their surface as is bare. These vascular heat exchangers probably vary in effectiveness and in morphology among the species of birds and mammals.

That a vascular heat exchanger can change from a conserver to a dissipator of heat is shown by the occurrence of temperatures almost as warm as the body in the extremities of animals active in cold air (L. Irving and J. Krog, 1955). In fact, given an efficient vascular heat exchanger, the variation in surface temperature is a direct measure of its usefulness in the regulation of heat loss. The range of variation in surface temperatures known to be possible for arctic animals is:

At the surface of the central part of the body	2°
At the surface of the skin over the body proper	6°
At the surface of the bare extremities	40°

By effecting these changes in temperature the "vascular insulation" can vary the rate of heat conductance from a unit area of surface of each of these regions in the relation 1 : 3 : 20. Where the bare surface is large, as in the gull's feet, there is provided an important component in the total variable insulation of animals. The only physiological

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insulation available to the hairless surfaces of swine (L. Irving, 1956), for example, or of aquatic animals lies in the vascular system of insulation (L. Irving and Hart, 1956), for the insulation of fat and tissue, while of some significance for heat conservation, is invariable and is of no value in regulating dissipation of heat.

In the physiological insulation of the body, the vascular system can have its greatest effectiveness at the freezing temperature, for the tissue cannot become much cooler without freezing, and it provides one of the means for regulated variation of the superficial insulation on the extremities, unprotected by thick fur and feathers.

Adaptation of Tissue Function to Low Temperatures

In order that the extremities may be utilized in the economy of animal heat their tissues must keep in normal operation such functions as sensitivity at temperatures too cold for the tissues of the homoiothermous body to survive. An example of the adjustment of warm-blooded tissues to functioning while cold was provided in the demonstration that the metatarsal portion of the peroneal nerve of herring gulls (*Larus argentatus*) continued to show excitation and conduction at 8° C. The central part of the nerve from within the warm body failed at a higher temperature. These gulls had been kept out of doors in winter at Boston. When they were kept in a warm room and with warm water to swim in, the distal parts of the peroneal nerves failed at about the same temperature as the central parts. Evidently the lowest temperature at which these peripheral nerves will function is modifiable by environmental temperature. It is, therefore, a clear-cut adaptation which can be anatomically located in the terminal fiber from centrally located nerve cells and can be defined in terms of electrical measurements (Chatfield, Lyman, and L. Irving, 1953).

The homologous nerves of domestic hens kept with the gulls showed no modifiability of their peripheral nerves by cold, nor were the legs and feet of the hens cold, as were those of the gulls. It is interesting to consider that these domesticated fowl, derived from tropical ancestry appear to retain, along with their high critical temperature (table 18), legs and feet scarely adapted to cold climates.

The properties of some substances of warm-blooded tissues, such as the high-melting-point fats common in the mammalian body, are critically affected by cold. Fats from within the body of caribou melt near 50° C. At body temperature, which is about 10° cooler, the fats must be sufficiently fluid for normal functions. But at 0° C. these fats are brittle hard. Since the marrow fat from the distal parts of the caribou's leg bones is found to melt at 10° C. it seems that this distinction of peripheral from body fats would allow for the

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needed plasticity at the cold temperature often observed in the peripheral tissues (L. Irving, Schmidt-Nielsen, and Abrahamsen, 1957).

A similar gradient of melting points was observed in the fats from the legs of herbivorous reindeer and porcupines, as well as in the carnivorous fox, dog, and wolf from arctic Alaska. Among the large arctic mammals it appears common that fats of low melting point are selectively deposited in the parts of extremities where the tissues are known to be cool. But a similar distribution of low melting fats has also been found in the legs of cattle from temperate regions, and the distribution of fats in the leg of a Panamanian brocket deer (*Mazama americana*) was found to be identical with that observed in homologous bones of arctic herbivores and carnivores. Selective distribution of fats appears useful or even essential for arctic life, but since it also occurs in temperate and tropical regions, it cannot be an adaptation recently evoked for arctic life nor can it be a bad condition for life in a warmer climate.

In the deposition of fats, selection, according to melting point, takes place differentially in different anatomical parts. Since the difference between a high and low melting fat is commonly based upon the proportion of saturated to unsaturated fatty acid in the natural mixture of fats, and since change in hardness is often effected by the relative amounts of oleic and stearic acids, which differ only in hydrogenation, the difference in properties of fats is ascribable to a biochemical step in fat synthesis.

Biological Significance of Tissue Modification

The composite function of insulation, described in terms of metabolism and temperature, shows, in proper physiological terms, that the common metabolic economy of warm-blooded life in all climates can be maintained in arctic cold. By comparison with tropical forms adaptation to cold shows very clearly among arctic animals. But this kind of adaptation does not provide explicit characters, by the selective inheritance of which arctic races might become naturally differentiated. The composite physiological functions are useful to the animal, and the view of them is useful for the physiologist, but they are not expressed in terms useful for the natural philosopher speculating upon the methods which have established the adaptive differentiation of animals. Hair, fur, and feather structures, on the other hand, are visible characters produced by tissues, and inheritance can be observed in them.

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The adaptability of the herring gull's nerve to function in cold, for example, is a necessity for the normal operation of the cold feet of the gull, and it was not found in the nerves of hens. This condition is an important character of the composite insulative function, and since it can be localized within a portion of a nerve cell and is measurable by several physical dimensions, the systematic and geographical relations of animals might be nicely definable on this basis. A character of this sort could be viewed as a unit in a system of inheritance upon which natural selection could operate.

Similarly, the selective deposition of low melting fats in distal parts of appendages follows a good morphological pattern. It is attributable to the biochemical reaction of dehydrogenation, and is accordingly distinguishable in the tissue chemistry. It is not demonstrated as an adaptation to arctic life, but it represents the type of modification which tissue substances of warm-blooded animals must undergo to suit them for operation when cold. It is also the sort of character which might turn out to suit the terms of genetics.

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10.—Retrospect

Observations during 12 years in northern Alaska have confirmed my original opinion that Anaktuvuk Pass would be an ideal location for studying the adaptation of animal populations to arctic life. The Pass acts as a funnel through which move the bulk of the terrestrial vertebrate fauna of the region each spring and autumn, and it also provides breeding sites and environment for many species. It was the easily visible movement of birds and the obvious nature of their biological purposes that lead me to deal primarily with them, and to study them in other localities which, together with Anaktuvuk, would illustrate their adaptation to all of interior arctic Alaska and Yukon. In the prosecution of these studies, the native peoples of the Arctic have played an important role. Their hospitality has greatly eased the burden of working in remote regions, while their extensive knowledge of the movements of the various birds has helped me to distinguish the regularity common to populations from the deviations of occasional individuals.

I have found by observations in the field that the physiological condition of birds can be correlated with season and behavior. Many arctic nesting populations of migratory birds arrive fat after rapid flights from distant wintering places. Each species arrives on its own schedule. The individuals are in similar physiological preparation for breeding; they promptly separate into pairs and produce young which grow to adult size; and then as individuals the parents and young rejoin the populations ready to migrate southward. Within each population the physiological states of individuals are synchronized and the dependent social processes keep each population distinct and in order, with little apparent conflict.

It is evident that the cycle of migration and nesting is physiologically anticipated and that the anticipatory processes are correlated to meet the normal progress of the seasons. Normal seasonal cycles vary geographically and have changed even in historic times. As demonstrated in the early chapters, the geographical and temporal extent of my observations have made possible an analysis of the kind and degree of correlation that must exist between the lives of birds and the environment in which they live. For many parts of the world, the factors involved in such an analysis are so numerous and their variations often so subtle that it would be difficult to develop

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a properly analytic approach. In the Arctic the situation is simplified. The number of species is small, none are passing through on their way to higher latitudes, and the entire avifauna faces measurable and apparently irresistible external influences—a short summer, extreme seasonal changes in temperature, and a resulting variation in food supply. These factors impel arctic-nesting birds to regulate their lives with strict regard for time and place.

The known geological history of arctic Alaska, moreover, indicates that the populations of migratory land birds now breeding there could not have existed in their present ranges until after the last extensive glaciation had subsided about 10,000 years ago. This implies that their present migratory routes are recent and that the characters by which many arctic nesting populations are distinguished taxonomically must have developed within that time span.

I have found no evidence, however, that the taxonomic characters distinguishing these arctic population of birds are adaptive responses to their arctic environment. Apparently these characters are the result of isolation of the breeding populations. Such isolation could lead to the production and establishment of characters which are ecologically indifferent and not necessarily adaptive—which survive because they impose no important hardship on their bearers. These characters may result from variability in a limited gene pool, such as would be available to a fragment of a species isolated regularly during the reproductive season, and they would not have become established except under the special condition of isolation. In each of several interglacial periods since the Pleistocene, new arctic populations of the several species of birds must have been reestablished without essential modification, and it would appear that adaptability to arctic conditions may have remained latent in many species during glacial periods when it could not be fully expressed. Such cases do not argue against the general probability of adaptive evolution. They do illustrate the fact that visible characters distinguishing geographical races do not necessarily demonstrate an ever-present progress toward adaptive evolutionary modification. The development by warm-blooded creatures such as birds of an adaptability to the rigorous demands of arctic conditions must have taken place long ago, or it would not have been possible for many of these species dwelling in more temperate latitudes to have extended their ranges northward in the last post-glacial period.

Our studies have demonstrated in physiological terms the nature of some of this adaptation to cold. Although the Arctic may seem unfavorable to the human observer, arctic animals are adapted to cold by insulation and behavior, so that they can, in most cases maintain their normal body temperature without expending special

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metabolic effort. This physiological adaptability obviates environmental stress. No animals, least of all small birds, can act in conflict with arctic conditions. Individual and social behavior must direct animals to localities, and at those seasons, when conditions are well within the physiological tolerance of the population.

Our studies are still in progress. From them we can expect continuing contributions to our knowledge of animal adaptation to the arctic environment. Some of this knowledge, we can hope, will have special meaning for the citizens of our newest State, Alaska, and for all others who dwell in regions of intense cold.

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Appendix

(*See chapters 2 and 8, pp. 322–324*)

The weights, size of testes or ovaries, and fatness of common migratory birds at Anaktuvuk are shown in the following figures, of which 21 to 32 (top) are for males and 32 (bottom) to 36 are for females.

On the left-hand ordinate weights have been referred to base 100 as the average of all weights of a species. On the right-hand ordinate is shown weight in grams.

Testes and eggs are graded as big when near the maximum size for the species.

Fatness ranges from fat (F), medium fat (MF), little fat (LF), to very little fat (VLF).

Explanation of symbols used within the plot:

- (m.) average weight
- (s.d.) standard deviation
- (c.v.) coefficient of variation = s.d. x 100%
- (F) mean of dates of first migrants' arrival
- (L) date of start of egg laying

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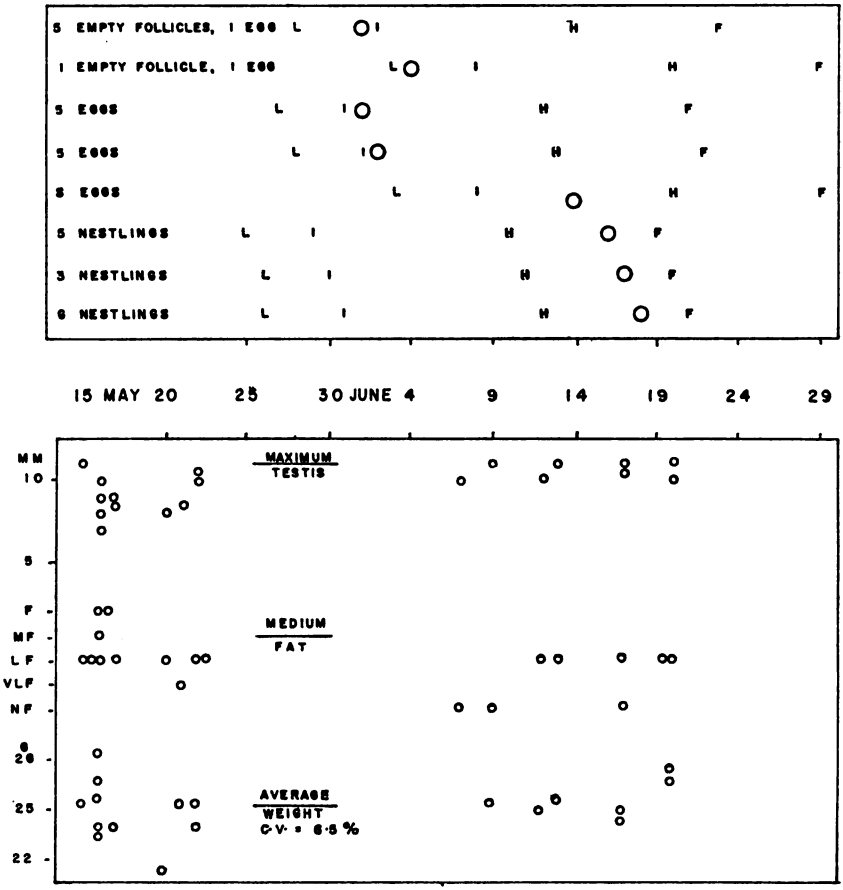

FIGURE 19.—Schedule and condition of *Zonotrichia leucophrys gambelii* during the breeding cycle at Old Crow. Schedule is estimated from the date of observation (marked by large open circle), allowing 1 day interval between each egg laid from date of first (L) to date of beginning of incubation (I), 12 days to hatching (H), and 9 days to fledging (F).

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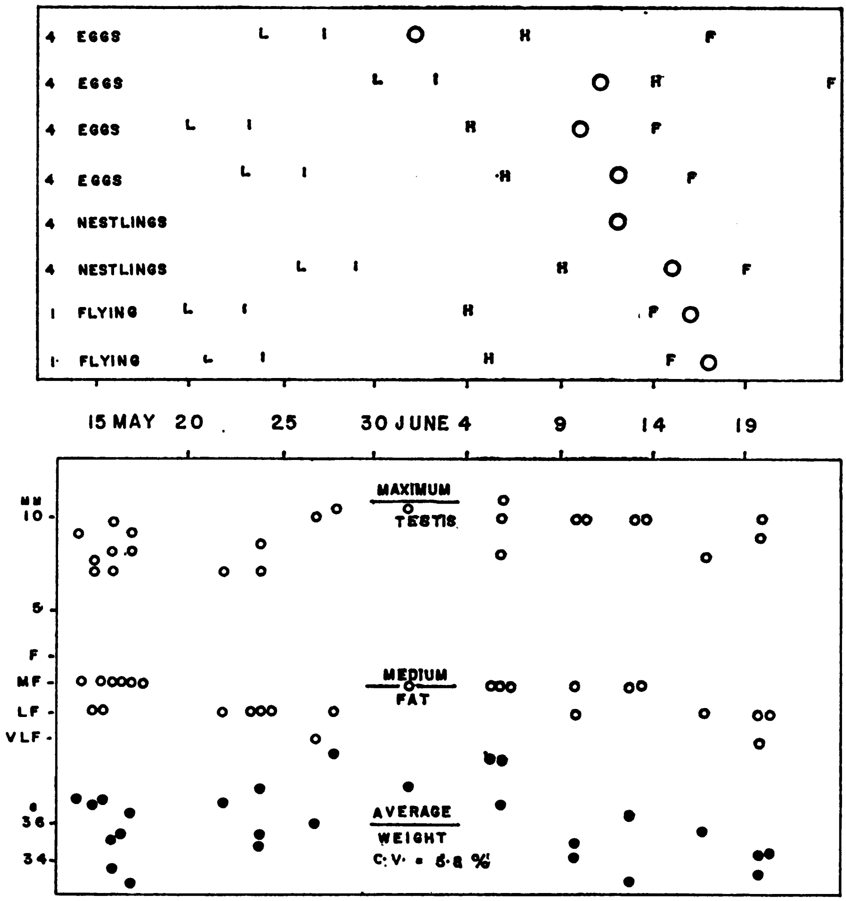

FIGURE 20.—Schedule and condition of *Passerella iliaca zaboria* during the breeding cycle at Old Crow. Schedule is estimated from date of observation, marked by large open circle, allowing 3 days from laying of first egg (L) to date of beginning of incubation (I), 12 days to hatching (H), and 10 days to fledging (F).

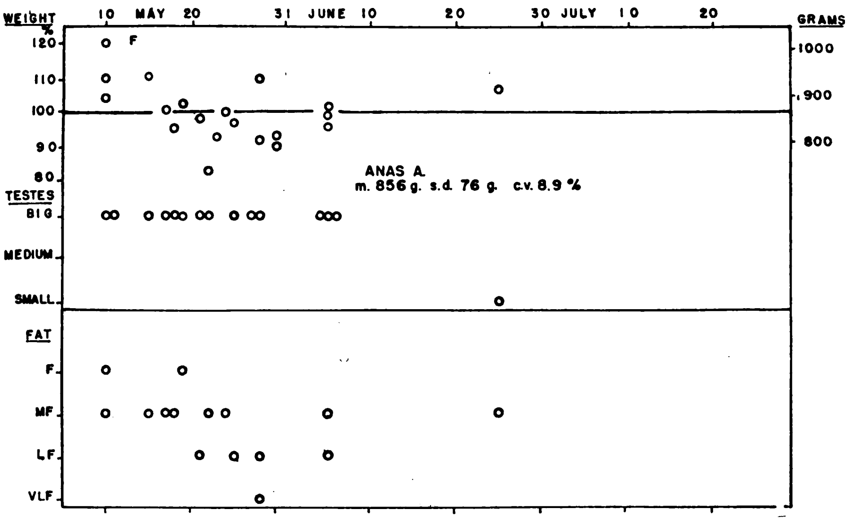

FIGURE 21.—Pintail, ♂ (*Anas acuta*).

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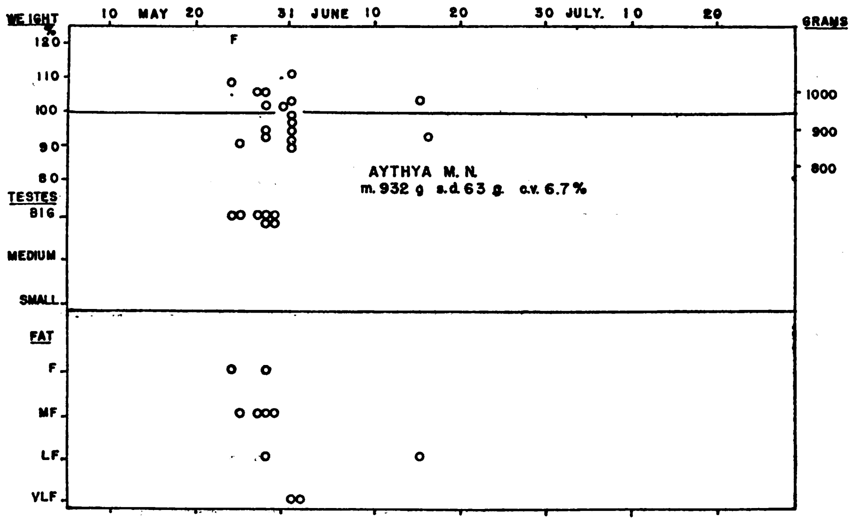

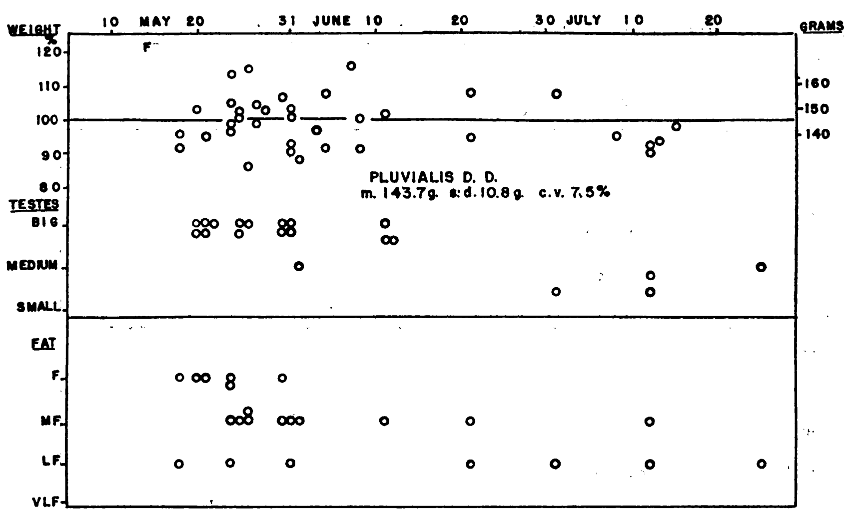

FIGURE 22.—Top: Greater scaup, ♂ (*Aythya marila nearctica*). Bottom: American golden plover, ♂ (*Pluvialis dominica dominica*).

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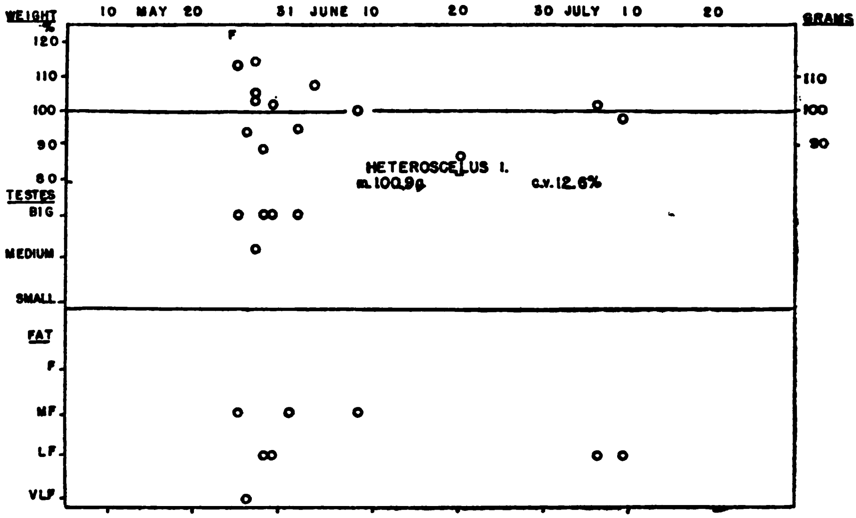

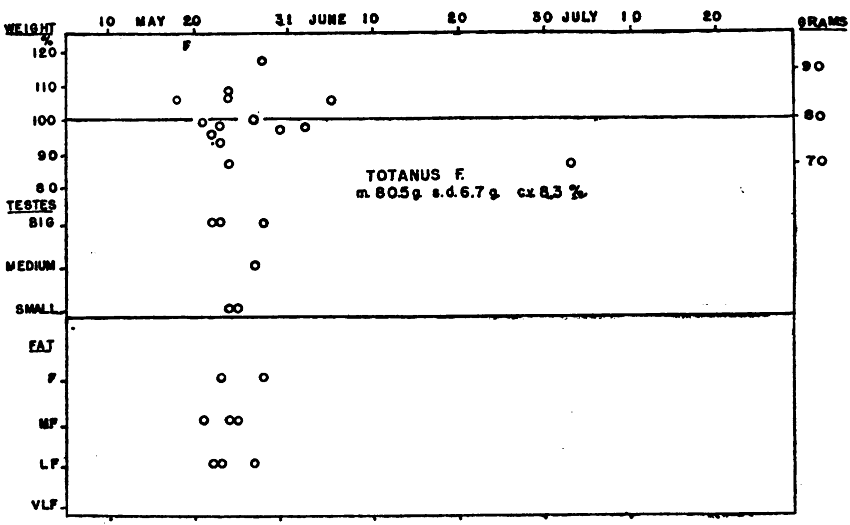

FIGURE 23.—Top: Wandering tattler, ♂ (*Heteroscelus incanum*). Bottom: Lesser yellowlegs, ♂ (*Totanus flavipes*).

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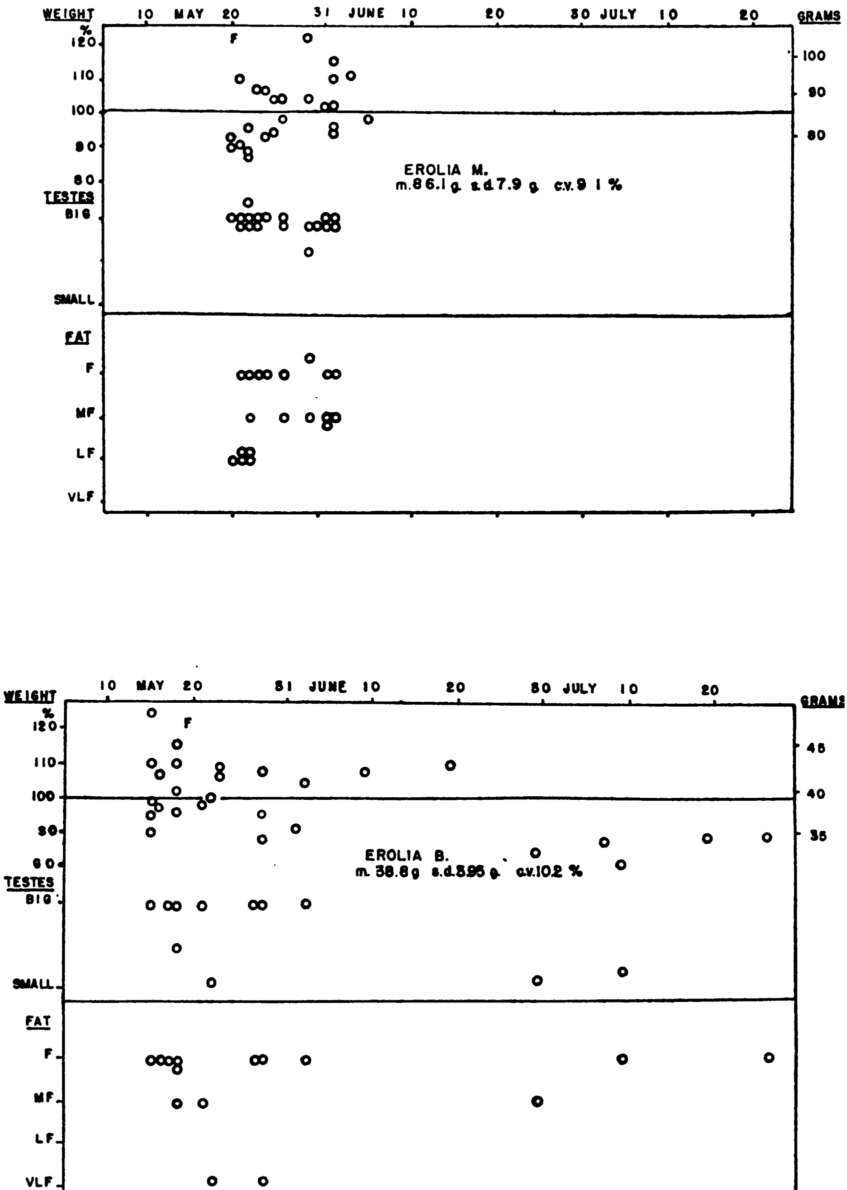

FIGURE 24.—Top: Pectoral sandpiper, ♂ (*Erolia melanotos*). Bottom: Baird's sandpiper, ♂ (*Erolia bairdii*).

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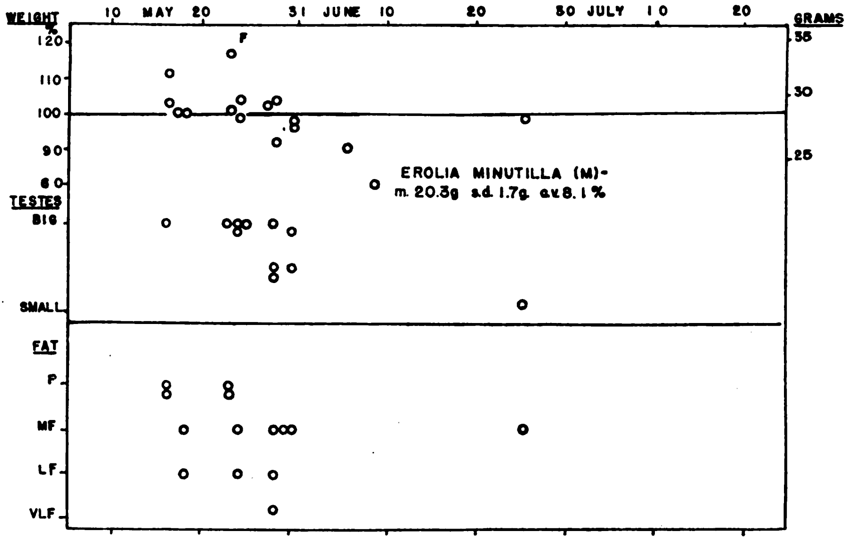

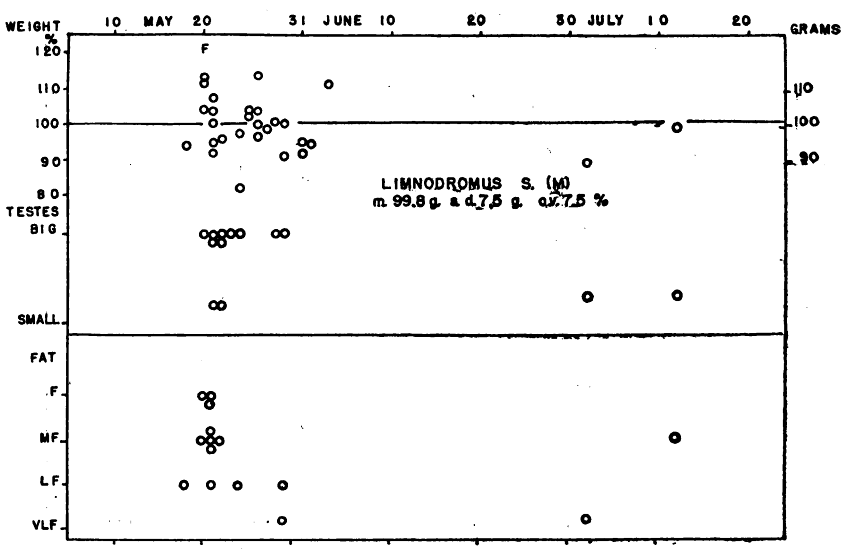

FIGURE 25.—Top: Least sandpiper, ♂ (*Erolia minutilla*). Bottom: Long-billed dowitcher, ♂ (*Limnodromus scolopaceus*).

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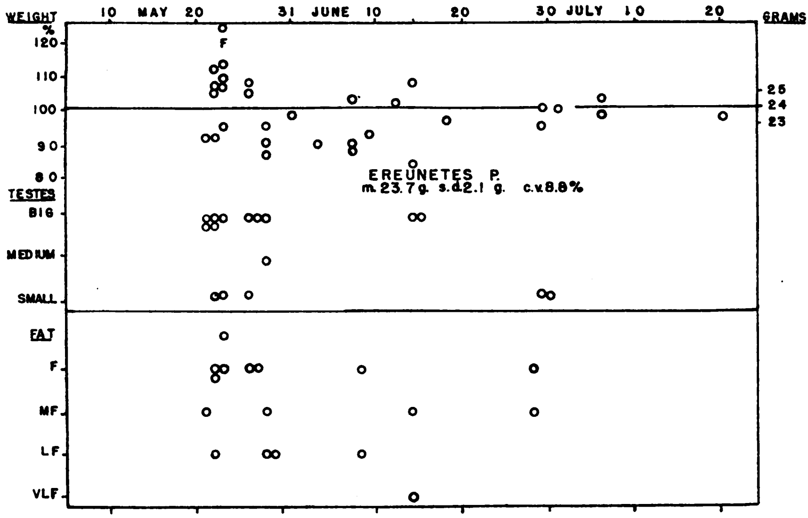

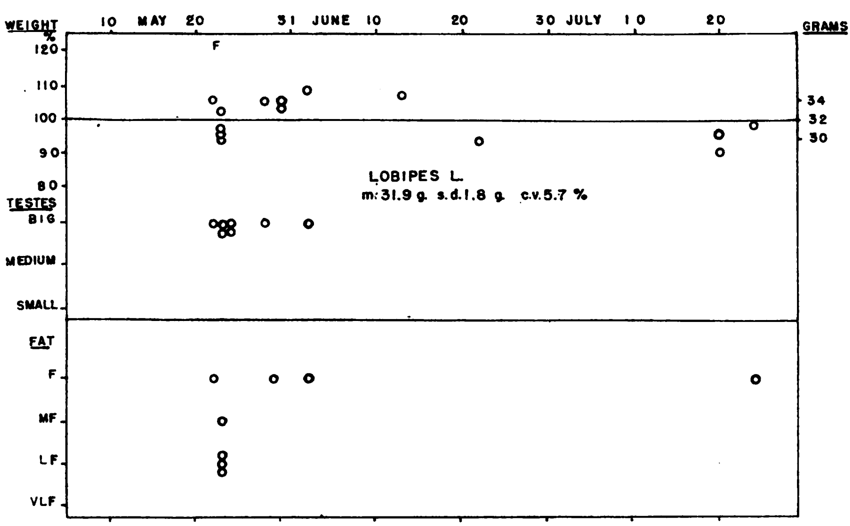

FIGURE 26.—Top: Semipalmated sandpiper, ♂ (*Ereunetes pusillus*). Bottom: Northern phalarope, ♂ (*Lobipes lobatus*).

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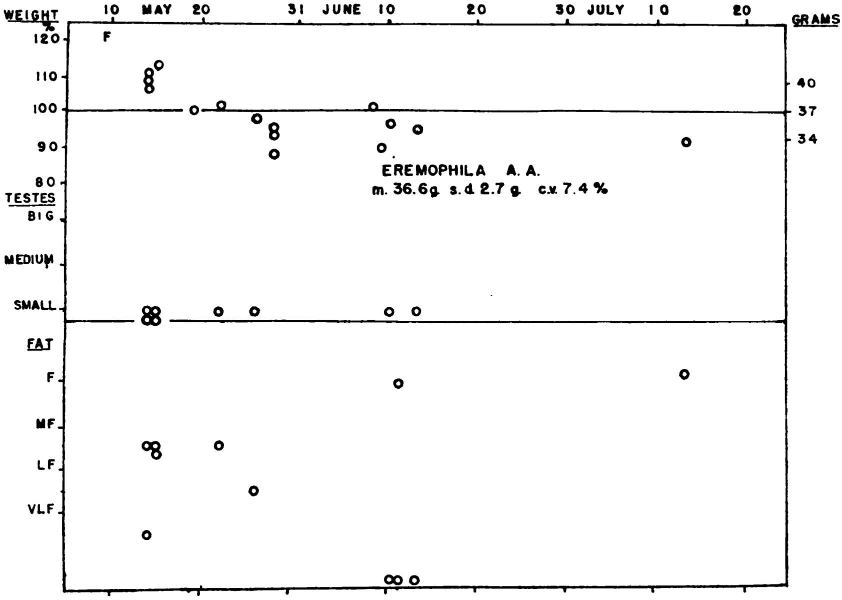

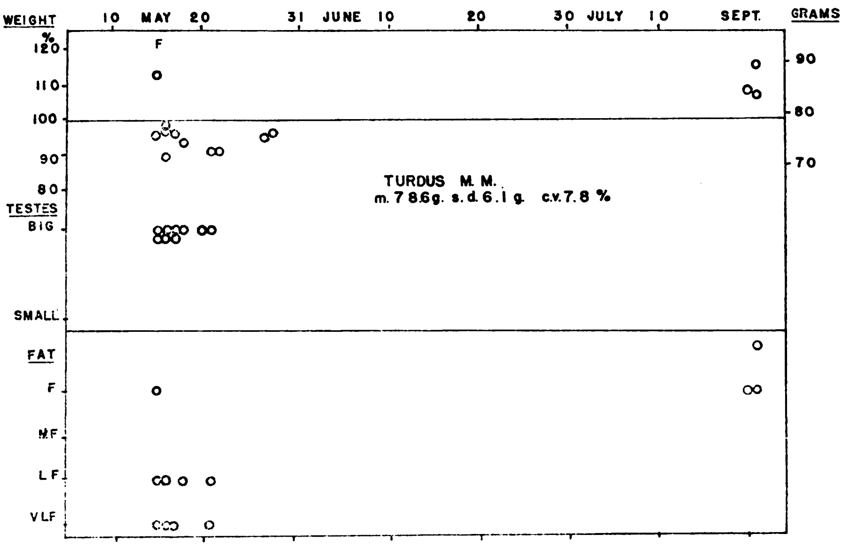

Figure 27.—Top: Arctic horned lark, ♂ (*Eremophila alpestris arctica*). Bottom: Robin, ♂ (*Turdus migratorius migratorius*).

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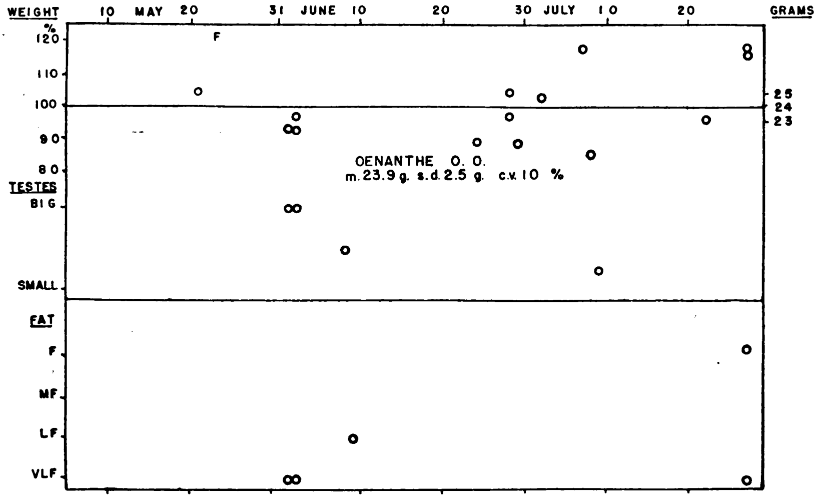

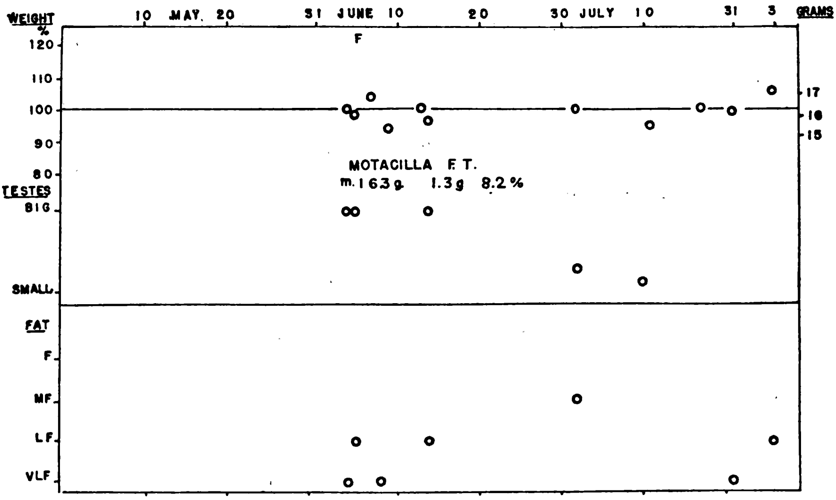

FIGURE 28.—Top: Wheatear, ♂ (*Oenanthe oenanthe oenanthe*). Bottom: Yellow wagtail ♂ (*Motacilla flava tschutschensis*).

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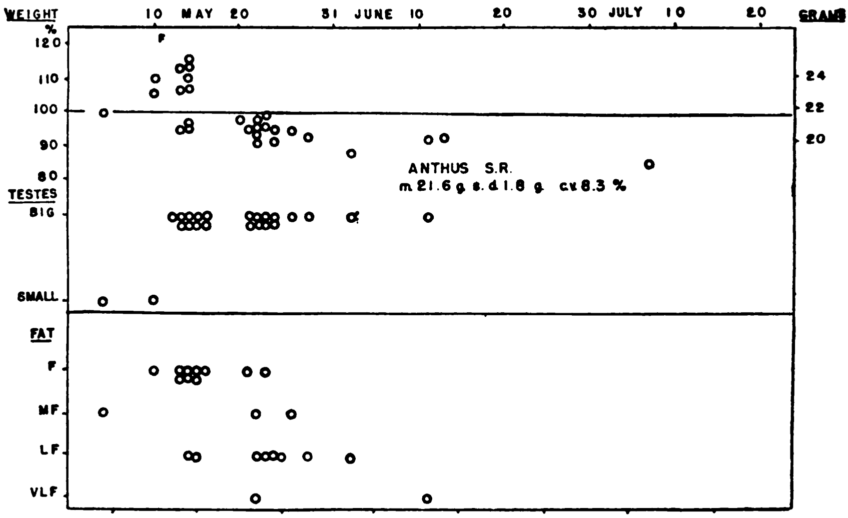

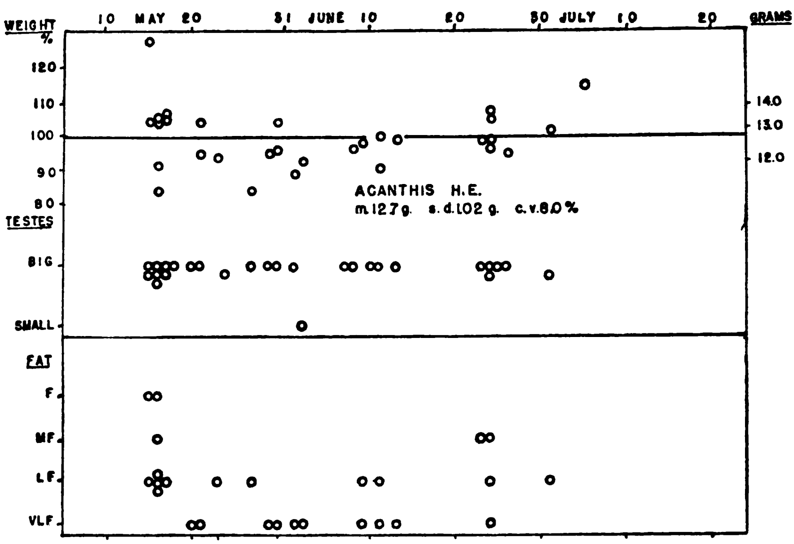

FIGURE 29.—Top: Water pipit, ♂ (*Anthus spinoletta rubescens*). Bottom: Hoary redpoll, ♂ (*Acanthis hornemanni exilipes*).

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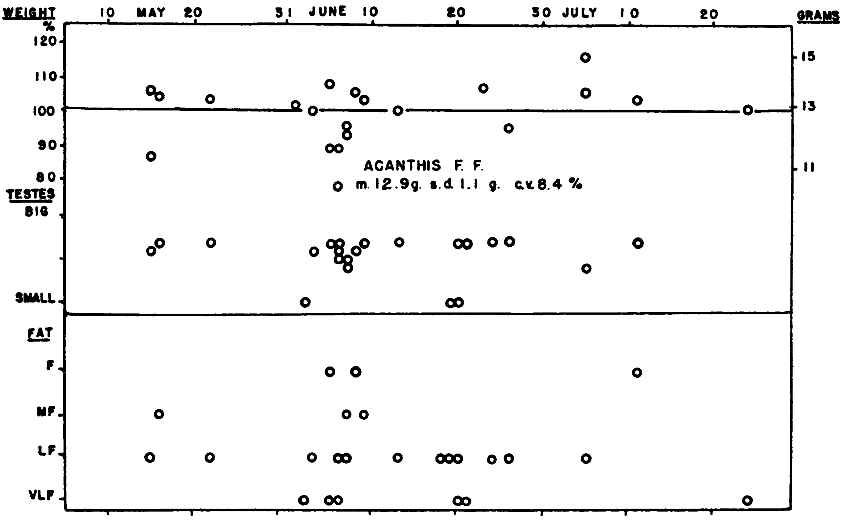


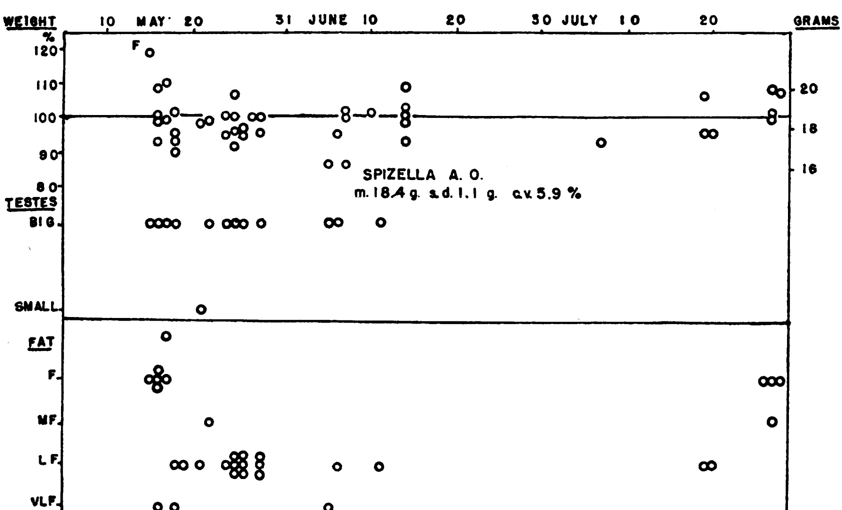
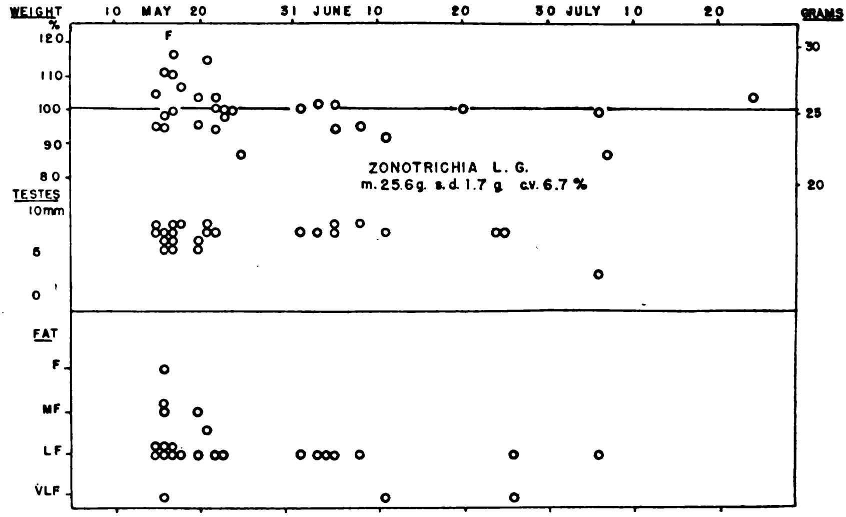


FIGURE 30.—Top: Common redpoll, ♂ (*Acanthis flammea flammea*). Bottom: Tree sparrow, ♂ (*Spizella arborea ochracea*).



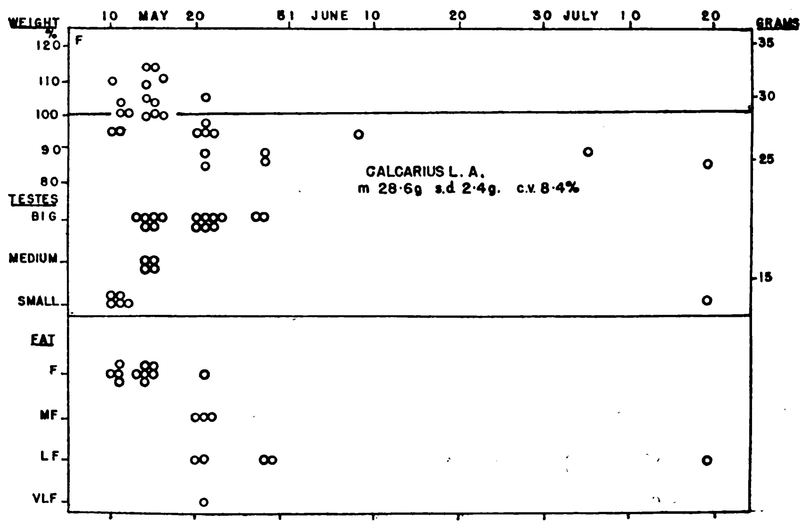


FIGURE 31.—Top: Gambel's white-crowned sparrow, ♂ (*Zonotrichia leucophrys gambelii*). Bottom: Alaskan longspur, ♂ (*Calcarius lapponicus alascensis*).

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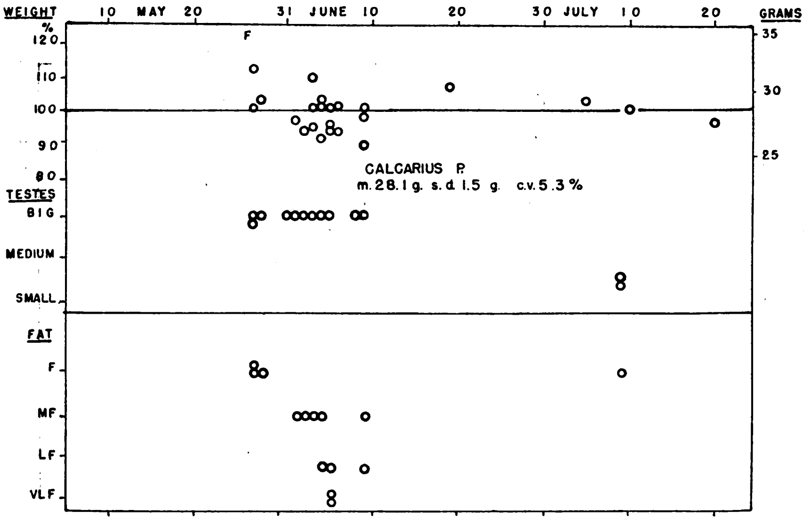

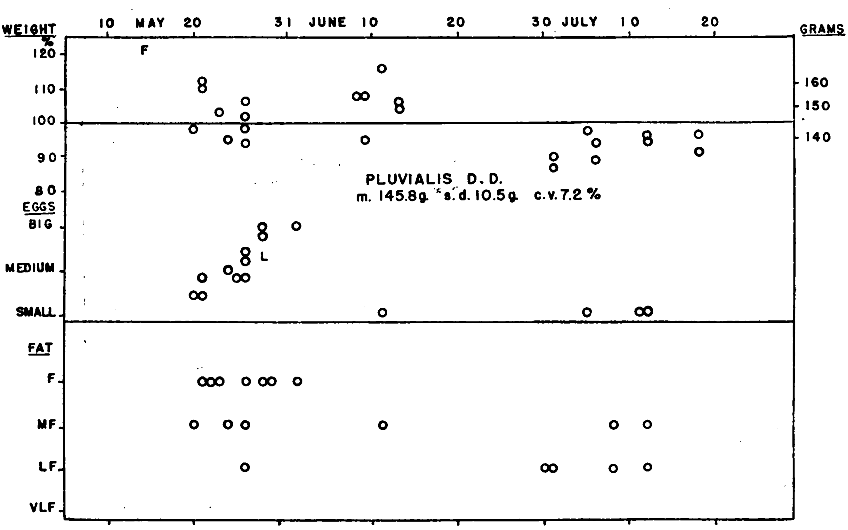

FIGURE 32.—Top: Smith's longspur, ♂ (*Calcarius pictus*). Bottom: American golden plover, ♀ (*Pluvialis dominica dominica*).

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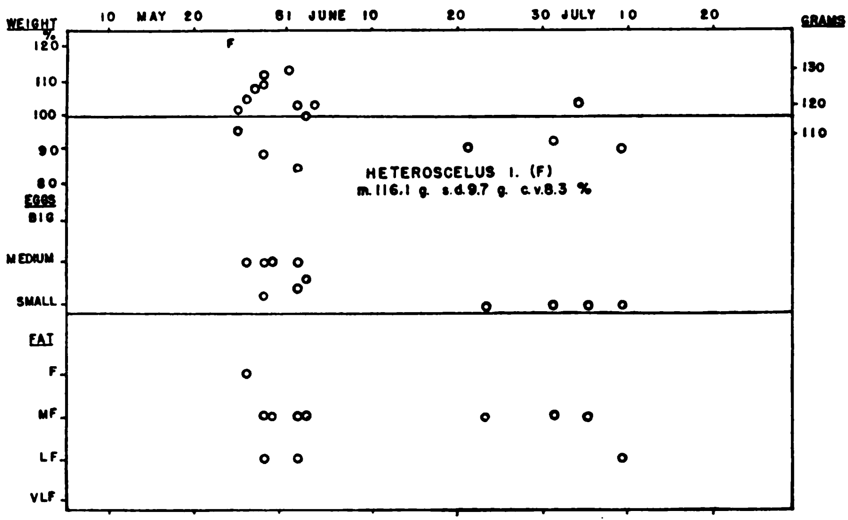

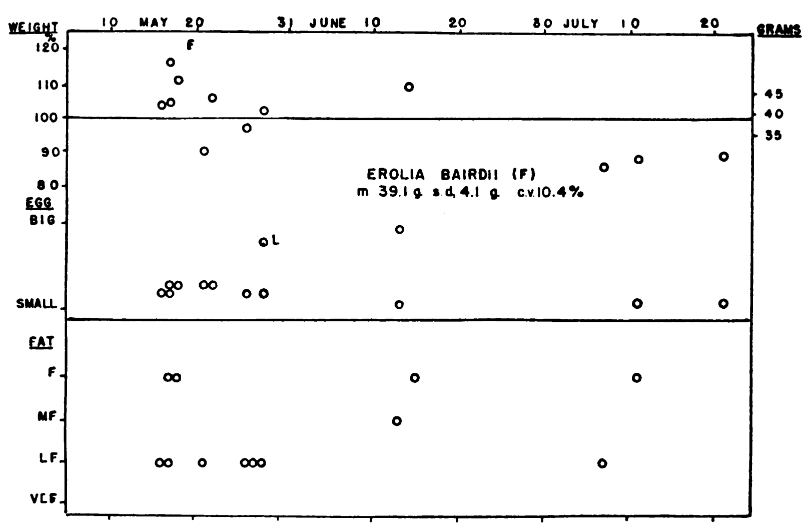

FIGURE 33—Top: Wandering tattler, ♀ (*Heteroscelus incanum*). Bottom: Baird's sandpiper, ♀ (*Erolia bairdii*).

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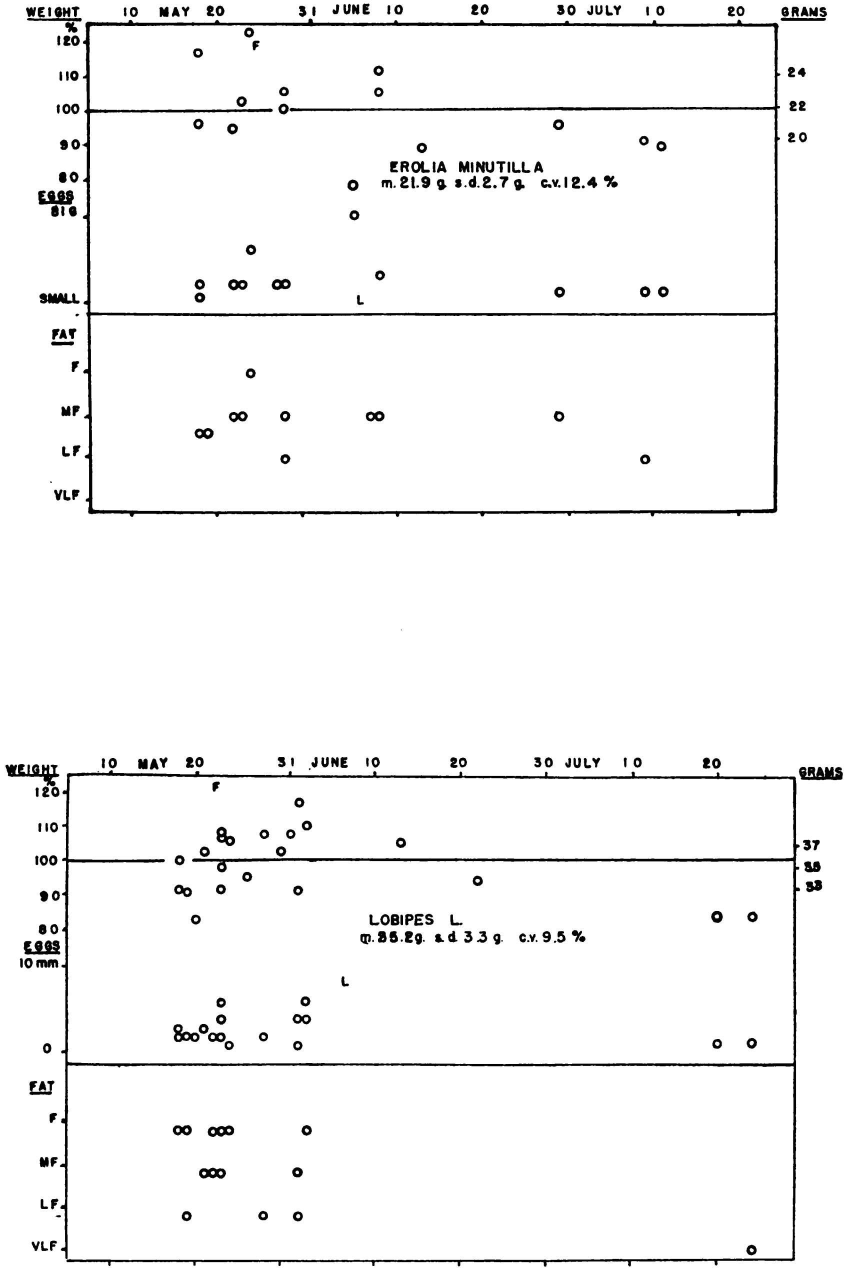
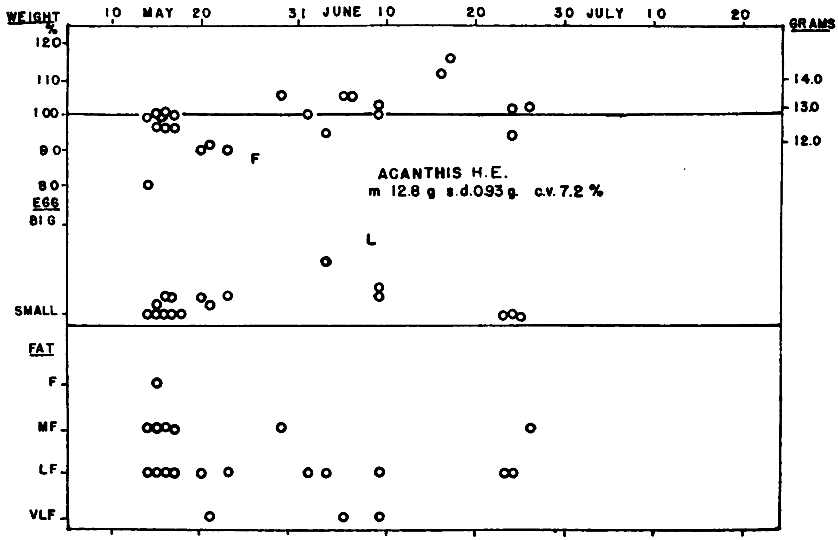


FIGURE 34.—Top: Least sandpiper, ♀ (*Erolia minutilla*). Bottom: Northern phalarope ♀ (*Lobipes lobatus*).



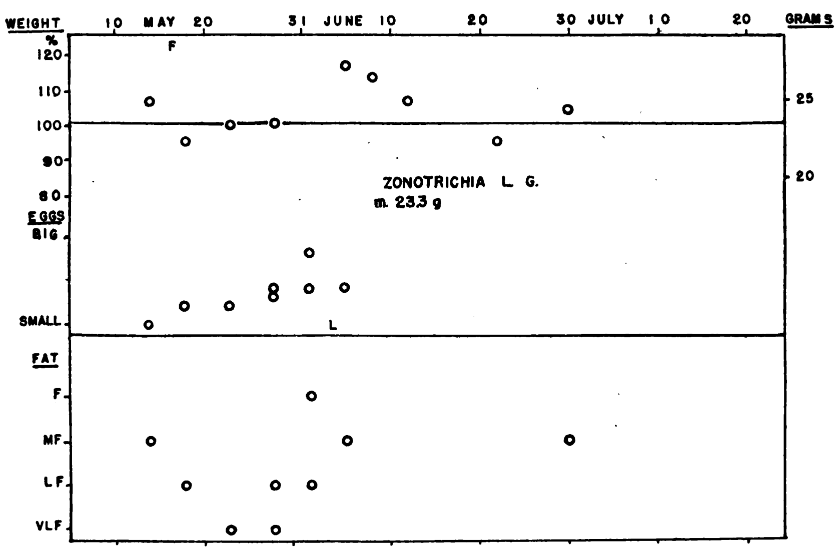
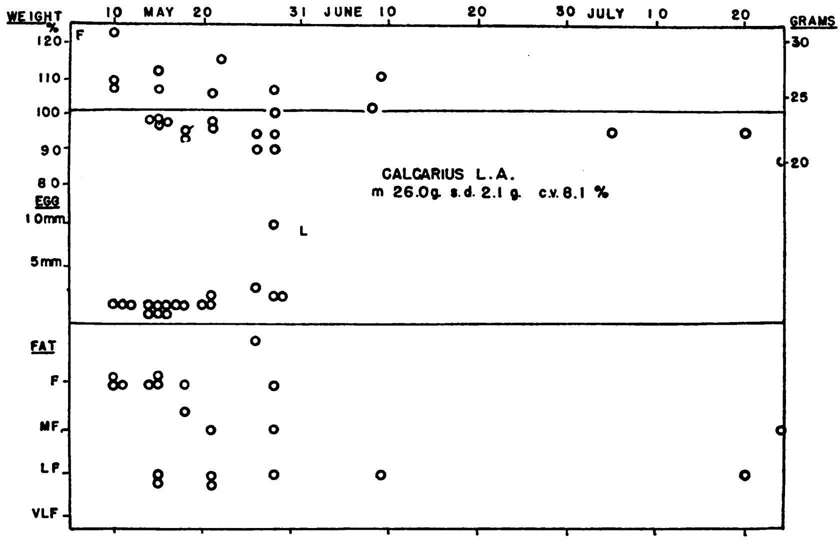


Figure 35.—Top: Hoary redpoll, ♀ (*acanthis hornemanni exilipes*). Bottom: Gambel's white-crowned sparrow, ♀ (*Zonotrichia leucophrys gambelii*).



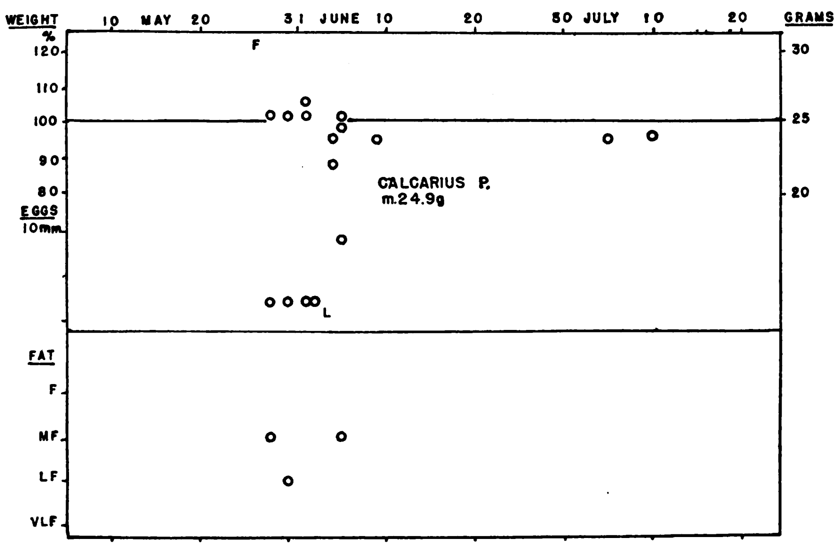


FIGURE 36.—Top: Alaskan longspur, ♀ (*Calcarius lapponicus alascensis*). Bottom: Smith's longspur, ♀ (*Calcarius pictus*).

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