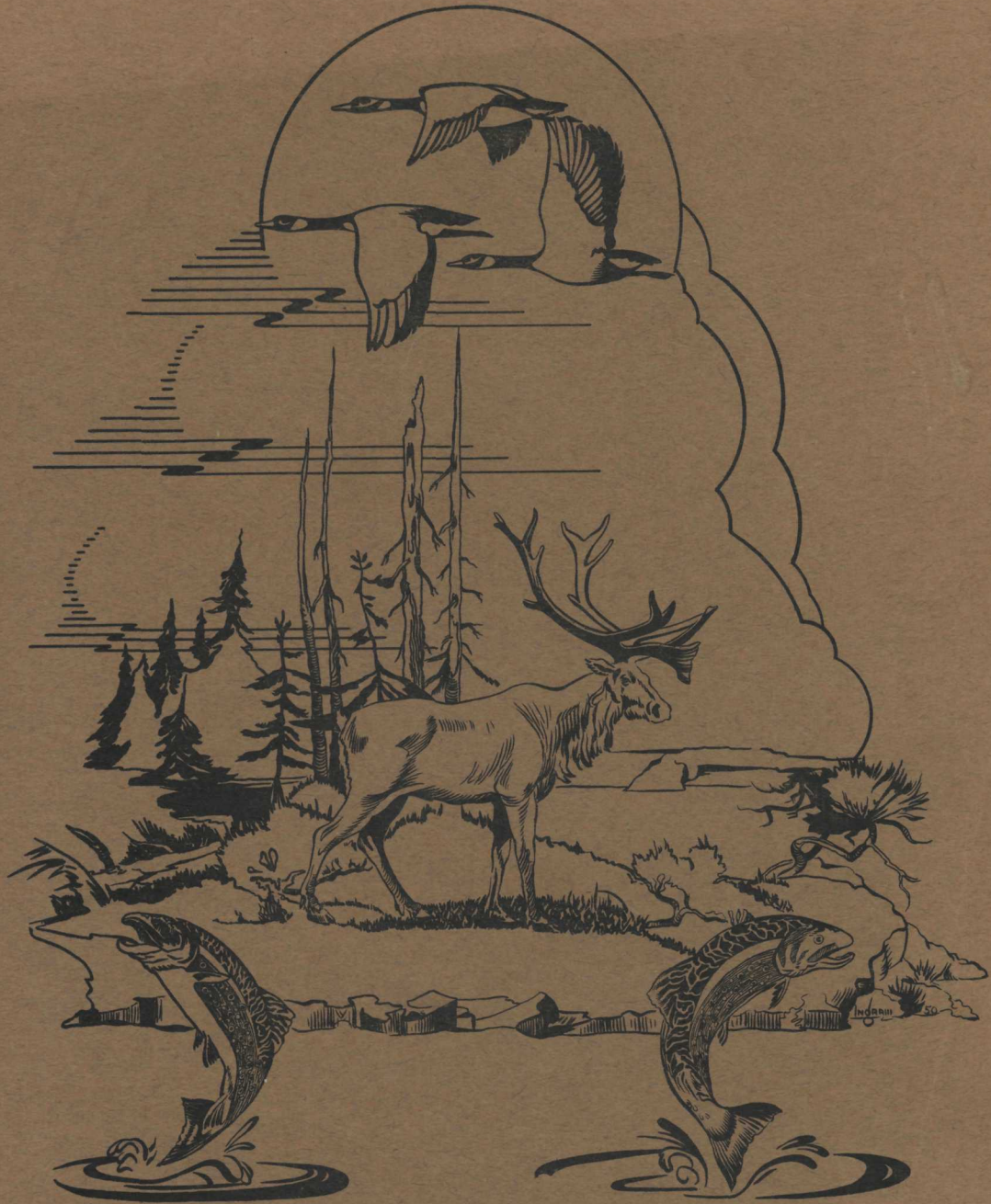


WILDLIFE MANAGEMENT BULLETIN



DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES
NATIONAL PARKS BRANCH
CANADIAN WILDLIFE SERVICE

SERIES I

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CANADA
DEPARTMENT OF
NORTHERN AFFAIRS AND NATIONAL RESOURCES
NATIONAL PARKS BRANCH
CANADIAN WILDLIFE SERVICE

PRELIMINARY INVESTIGATION
OF THE BARREN GROUND CARIBOU

In Two Parts

PART II. LIFE HISTORY, ECOLOGY,
AND UTILIZATION

by
A. W. F. Banfield

WILDLIFE MANAGEMENT BULLETIN
SERIES 1 NUMBER 10B

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Wildlife Management Bulletins are produced to make available to wildlife administrators the information contained in reports which are submitted by officers of the Canadian Wildlife Service.

The reports do not, in most cases, cover extensive studies and are not written primarily for publication. Recommendations arising from the studies are not included.

Physical Description

The caribou is adapted physically in various ways to enable it to cope with its Arctic environment. The hoofs are large and broad and this assists in supporting the weight of the animal on crusted snow. The concavity of the sole of the hoof makes the animal more sure-footed on ice; on wind-packed snow or on ice, caribou tracks consist only of the outlines of the outer edges of the hoofs. The ears, tail, and muzzle are short and well furred, and so are protected from frost-bite. The pelage is long, dense, and light, providing insulation against low temperatures. In late winter and early spring the pelage is greyish-white as a result of bleaching and wearing, and provides some camouflage against the snow.

The rigour of the Arctic climate is emphasized by a unique observation made by Stefansson (1913)^{*}. During the extreme low temperatures of midwinter, his party learned to look for small clouds of condensed vapour, forming trails above the stunted spruce of timber-line, for these indicated the presence of bands of caribou among the scattered trees.

Measurements

The measurements taken from specimens and carcasses examined during the present investigation are given in Table 18. From the table it may be noted that the adult bulls are about 7 per cent larger than adult cows, although there is little difference in hind foot length or shoulder height. Some indication of the growth of the young animals is given by the measurements of the younger age classes. The animals nearly reach adult stature at about three years of age. Eight adult bulls averaged 222 pounds in weight (178-264); four adult cows averaged 149 pounds in weight (130-165); and four yearlings averaged 113 pounds in weight (105-125). Five foetuses examined in early May, 1948, averaged 516 mm. in total length and 246 mm. in length of hind foot. The close similarity in their measurements suggested that the conceptions occurred within a relatively short period, as did the births.

Three calves approximately two months old averaged 1,025 mm. in total length, 687 mm. in shoulder height and 373 mm. in length of hind foot. One fawn weighed 26 pounds at the age of about three weeks, another 43 pounds at approximately six weeks, and a third 75 pounds at about three months.

Pelage

The hair of the caribou is dense and relatively long for a species of deer. There is one annual moult, occurring during July. The hairs of the new coat continue to grow in length and diameter during autumn and early winter. This causes a change in their position; whereas in late summer they are depressed and lie parallel to the hide, by winter, in consequence of the continued growth, they stand erect and form an exceedingly thick, long pelage.

^{*} Note: The bibliography is included in Part I of this report.

In its new coat in late August, an adult bull is rich clove-brown dorsally and on the flanks. The coloration is darker on the mid-dorsal line, crown, and face. It may be almost black around the eyes and lips. The broad muzzle is covered with short white hairs. The chest and legs are darker, almost black. Sprinkled among the dark hairs are reddish brown ones. The area around each foot immediately above the hoofs, the inside of the thighs, the rump, the belly and the ventral surface of the tail are white. The dorsal surface of the tail has a narrow clove-brown strip. On the side of the neck is a broad area of light grey which extends posteriorly to the shoulder and farther to the flank in a narrow strip. The extent of this pale grey strip depends upon the individual bull; the older animals appear to have more extensive light flank strips.

In autumn, before the rut commences, the hairs that form a fringe along the mid-ventral line of the neck increase in length to about six inches, forming a ventral "mane". The pale grey neck patch turns white. This patch extends as a band posteriorly across the shoulder and along the flank. Below the white band is a clove-brown band.

The new coat of the adult cow is similar to that of the bull in general pattern and in its general clove-brown colour but has less tendency to blackish coloration on face and limbs. The leg colour is generally reddish-brown. The cows, also, have greyish neck patches, but less extensive and more greyish ones than those of bulls.

On the backs of animals of all classes one frequently finds small circular areas of brownish fur. These spots are caused by the presence of warble fly scars on the hide underneath. Yearlings in new coats are very dark in coloration. The pelage is a rich, dark seal-brown dorsally and on the face, chest, and limbs. There is little tendency towards the grey neck patches in the second autumn. Only the belly and rump are clear white.

As the winter progresses, all classes seem to become lighter in colour, until by late winter they appear salt and pepper coloured. Since the tips of the hairs alone are clove-brown and the bases are grey, the continued growth of the hair, accompanied by breakage of the tips, causes this change. There may be some bleaching. In late spring most adults appear whitish at a distance. By early summer the fur becomes loosened at the base and starts to fall off in patches. It seems to wear off first on the face and around the eyes, where the new dark brown pelage showing through gives the appearance of black eye-rings. It soon wears off the legs and flanks with rubbing and remains longest on the back and rump.

A tremendous amount of hair is shed by the caribou annually in June and July on the tundra. Clarke (1940) remarked on the amount of caribou hair along the Hanbury River. In August, 1949, the upper Hanbury River was visited by the writer. Along the banks of the river for many miles below favourite crossing points was a wide swath of matted caribou hair.

Although the moult generally commences in July there is wide variation in the time when the different age and sex classes assume the new, clean,

autumn pelage. The yearlings are generally the first to complete the moult. The young mature bulls also complete it about the same time and they are followed by old bulls and then barren cows. Most adult cows which bear fawns in spring moult much later than the other animals in the following summer. Even in early September one often sees cows in ragged moulting pelage that are followed by calves. The bearing of a calf seems to delay the period of moult.

During the period August 15 to 18, 1949, at Contwoyto Lake, a sample count of caribou was made to indicate the relative stages of the moult. The figures obtained are shown in Table 19.

At birth the calves are reddish-brown above with white underparts, black muzzle, and grey legs. Their natal coat continues to grow during the summer and by late July it may be long, curly, and pale brown as a result of fading. They keep this pelage until the middle of August, when they moult into their first winter pelage.

The first winter coat is chocolate brown above, with grey flanks, ears, and neck. The belly, rump, and ventral tail surface are white. A dark slate-coloured band extends between the fore and hind limbs on the flank, and above it is a greyish band. The crown may remain rusty, the muzzle is black. This coat continues to grow like the coat of the adult. By spring it is generally paler than the adult pelage.

Albinism seems to be rare among caribou. During the investigation, three albinos were observed among about 200,000 animals. One was an adult bull shot by an Eskimo at Contwoyto Lake. The hides of albinos are eagerly sought by natives for fancy parkas.

Antlers

Description.- The barren-ground caribou carries an impressive set of antlers. The average length of the beams of adult bulls is greater than the average shoulder height. Besides great size, the antlers are characterized by great individual variation. No two sets of antlers are exactly the same. Indeed, the right antler is probably never the mirror image of the left. In the subspecies under discussion, the bulls carry the largest antlers. Cows generally carry antlers, but these are much smaller, simpler in development, and often unsymmetrical. Sometimes only one antler grows, and a few cows never develop antlers.

Despite the great individual variation in the antlers of adult bulls, there is a characteristic pattern on which the variations are superimposed. From a rugose burr the main beam of the antler extends upwards for a very short distance and then turns posteriorly and laterally for about one half its total length and finally turns upwards for the remainder of its length. Above the burr, the beam is somewhat compressed in cross-section, but beyond this it is generally oval or round in cross-section until the terminal portion is reached. The antlers of females and of senile bulls

occasionally have compressed beams. The possession of this long, round or oval beam is one of the characteristics which distinguishes the barren-ground caribou from the woodland caribou, which has a flattened beam.

A short distance above the burr the brow tine extends forward and down over the frontal and nasal region of the face. A short distance farther along the beam, the bezel tine extends forward and curves in towards the mid-line. It remains approximately horizontal and does not descend. After these two branches close to the burr, the beam continues laterally backward. At the position where the beam turns upward, a single posterior tine generally appears. Along the ascending ramus of the beam, several terminal tines are found. These arise on the posterior surface of the beam and turn in towards the mid-line.

Individual variation is found in length of the beam, presence or absence of a posterior tine; structure of the brow, bezel, and terminal tines; development of the left and right brow tines; and spread of antlers. The brow tine is generally widely palmate, with numerous terminal buttons, but it may be forked or simply flattened at the tip. Usually one brow tine is dominant and extends vertically over the facial region, while the opposite member is reduced or absent. In 35 sets of antlers of adult bulls, 69 per cent had the left brow tine dominant, and 23 per cent the right, and in 8 per cent they were equally developed, lying parallel along the mid-line about an inch apart. The bezel tines may be simple, flattened, forked, or palmate with numerous buttons. The terminal tines may be distinct or the whole terminal portion of the beam may be palmate with the terminal tines forming finger-like processes.

Generally the bezel tine and the terminal tines are simultaneously palmate or digitate. This allows a classification of the antler sets as either digitate or palmate. Of 35 antler sets examined, 54 per cent were digitate and 46 per cent palmate. There is also considerable variation in spread. In a few younger animals the set may be very high and narrow with the beams parallel and close together. In a few cases exceedingly wide-spreading antlers were seen.

The antlers of adult cows are much smaller than those of adult bulls. Although basically similar in pattern, they are simpler in development. From a much smaller burr a beam of smaller diameter leads upwards, then curves posteriorly and laterally. Both brow and bezel tines may be short, forked, small flattened plates, or absent. The terminal tines, if present, are generally simple. There are many irregularities: some cows have no antlers, others have one; some carry only spikes, others carry small replicas of the bulls' racks. The antlers of young bulls are easily confused with those of a cow with a well-developed set.

The measurements of antlers examined during the investigation are given in Table 20.

Development with Age.- Small boney nobs may be palpated on the frontal bones of a two-month-old calf. These continue to grow during the first summer. By

early autumn all the calves are carrying small spikes. The velvet is tardy in rubbing off, but by late winter young male calves have spikes about ten inches long, while those of the females are about six inches long. A few precocious males may have forked antlers during the first season.

During the second season there is considerable development in antler growth. The young bulls generally have a miniature rack, with brow, bezel, and beam formation. The young cows may have spikes 18 inches or so in length, forked antlers, or curving beams with small brow and bezel units. By the third season the antlers are generally adult in form, although probably the maximum development for bulls has not yet been reached.

Maximum development probably takes place during the years from the fourth to the seventh. With senility and increasing bodily debility, the antler growth is less. Old bulls tend to have fewer tines and simple, long, curved beams. With cows the maximum development may terminate even earlier. Annual pregnancies seem to cause a physical drain and old pregnant cows are frequently found to have dwarfed, asymmetrical antlers or only velvet nobs.

Annual growth.- At the time of the rut, in late October, both sexes have antlers. The bulls' are clean and polished. The antlers of many cows still have velvet strips hanging from them. Soon after the termination of the rut, by the early part of November, the adult bulls begin to shed their antlers, oldest bulls first. By mid-December only the younger bulls still retain their antlers. Usually by February all bulls except the yearlings and a few two-year-olds have shed their antlers. By March the first velvet growths appear on the older bulls. These antlers in velvet grow rapidly from May; so that by July the adult bulls have antlers two to three feet in length, with the main tines showing beneath the velvet. The growth of the antlers of the young animals is delayed until late spring. The yearlings do not drop their spikes until early summer.

By August the adult bulls have large, cumbersome antlers in velvet. These appear to be completely developed but probably some terminal growth occurs later. The bony cores are remarkably flexible; when a large bull trots by, the great velvet rack springs in and out with each step. At this time the antlers seem to be very sensitive and tender: the bull frequently turns his head to the side and scratches his antlers carefully with a rear hoof; insects alighting on the rack are shaken off; and the head is handled carefully when the rack is lowered among shrubs when feeding.

By mid-September the antlers have hardened and the velvet is being rubbed off. Lawrie reported seeing the first rubbed antlers on September 7, 1948. By September 20, the majority of bulls had bloody antlers with hanging velvet. Bulls often rub their antlers against small spruce saplings to remove the velvet. Along the Lockhart River, in June, 1949, several spruce that had been used for this purpose were found. The branches and strips of bark had been stripped off by the rubbing of caribou

antlers. At this time the velvet may hang in long strips from the antlers. The stripping of the velvet leaves the antlers streaked with blood, but by October they are polished clean and smooth.

The annual growth of the antlers on the cow is about four months out of phase with that of the adult bull. This fact greatly facilitated identification of sexes from aerial photographs during the investigation. The velvet is rubbed off the cows' antlers during late October. They then carry their antlers until April or May. The older cows shed their antlers early in April, while the younger ones retain theirs until late May or early June. The new antlers develop in the velvet during the early summer, and growth continues during late summer.

The discarded antlers are chewed by caribou and rodents during the winter months. In spring most antlers found on the ground have had their tines and beams chewed.

Dentition

The dentition of the caribou may be classified as buno-selenodont, which indicates that they are mainly browsers in food habits. As is typical with all deer, they do not show the high selenodont modifications reached by the bovids, which are almost completely grazing animals. The normal dental formula for the species is $\frac{I.0}{3} : \frac{C.1}{1} : \frac{P.3}{3} : \frac{M.3}{3} = 34$.

The lower incisors and lower canines are loosely set in their alveoli and are flexible, which may be of some significance in the feeding habits of the animals. These teeth wear unevenly; the greatest wear occurs on the central pair (I.1), causing the incisors of older animals to be notched in the median line. The upper canines are vestigial; normally they are not cut, and they may be lacking altogether. In one bull skull examined, there were two canines in one alveolus, probably the deciduous tooth and the permanent tooth. It seems likely that development and replacement of these teeth are highly irregular in this species.

During the field work an effort was made to examine as many skulls as possible, in order to determine the replacement of the teeth and, if possible, use the tooth wear as a method of age determination. Three hundred and two skulls were examined and single mandibles were collected.

It was found that the species exhibited some variation. In two specimens examined, the lower pair of permanent incisiform canines was absent. One yearling specimen examined had a single small deciduous premolar in front of the row of cheek teeth. This was a relict first premolar which is absent in most caribou.

As a basis for describing the normal growth and replacement of the teeth, 144 mandibles of caribou between the ages of one month prior to birth and about three years were used. Of these, the approximate age was known for

35 mandibles, from specimens and hunters' kills, consisting of 23 fawns, 8 yearlings, 2 two-year-olds, and 2 three-year-olds. The ages of these specimens were determined by date of death, measurements, antler development, and location. Since collections were made on both summer and winter ranges, it was possible to assign approximate ages to many of the other specimens of younger caribou as they were either at the whole year or the half. The 107 mandibles were fitted into the series by study of comparative eruption and wear of the teeth. A further check was provided by comparison with 12 mandibles of reindeer (Rangifer arcticus asiaticus) of known age from the departmental herd at the Reindeer Station, Mackenzie District. It was found that the eruption and wear of the reindeer teeth was similar to that of the teeth of the caribou known age.

Following the work of Severinghaus (1949), measurements were made on the lingual side of the tooth row from gum line to the highest point of the tooth crown. In the case of the molars with two lingual cusps, the measurements were made on the anterior cusp. The gum line is indicated by a line of heavy pigmentation, which does not always correspond to the enamel line. In addition, the wear on each tooth and the relative width between the dentine and the enamel on the lingual crest of the anterior cusp of the first molar, were noted. It was found that the eruption and wear on the posterior cusp on the third molar was also noteworthy because this cusp was the last part of the dentition to be worn.

It was found that the wear was generally similar on all the cheek teeth. There was also fair similarity in the eruption and wear of teeth on specimens of comparable age. A few cases of irregular heavy wear and broken teeth were noted; some of these were associated with infections of actinomycosis. Three complete skulls of young animals were examined and it was found that the replacement of upper and lower teeth was similar.

For convenience, the date of birth for all calves was assumed to be June 1. An analysis of the 144 specimens examined in this study is presented in Table 21. The average measurements and observations on teeth eruption and wear are given for each age class. The data have also been presented in graph form in Figure 18, where the dates of eruption and wear on the teeth up to the age of 38 months may be more easily observed. A series of mandibles from animals of different ages is shown in Figures 19 and 20.

The eruption and wear of the reindeer cheek teeth of animals of known age are listed in Table 22. These measurements have also been shown in graph form in Figure 21 to indicate the increasing wear with age.

It is likely that at birth the deciduous incisors are erupted. The deciduous premolars are erupted within the first two weeks after birth. At the age of two to three weeks the fawns already have a complete set of deciduous teeth. The first wear on the deciduous premolars is at the age of about one and a half months. The first permanent molar is erupted in the third month, the second in the tenth month, and the third in the seventeenth

month. There was an insufficient number of critical specimens to indicate the replacement sequence of the permanent incisors. The replacement occurs rapidly between the tenth and twelfth months from incisor 1 to 3, and the lower canines follow suit. The early stages of the eruption of the permanent premolars are not well documented, as they are fully erupted at an earlier date than shown, but carry the worn deciduous premolars on their crowns. These are finally shed and the permanent premolars come into wear in the eighteenth month.

The first wear on the permanent dentition occurs on the first molar at approximately twelve months of age. The last portion to show wear is the posterior cusp of the third molar at approximately 26 months. From the twentieth to the thirty-eighth month the even wear on the cheek teeth is noteworthy. The rate of wear for M1 has been calculated to be about 1.4 mm. for 20 months.

From the data presented above it is possible to list the following changes in the dental formula at various ages.

At birth	$\frac{0.}{3d}$	$\frac{0.}{1d}$	$\frac{0.}{0.}$	$\frac{0}{0}$	=	8 total
At 1 week	$\frac{0.}{3d}$	$\frac{0.}{1d}$	$\frac{3d.}{3d}$	$\frac{0}{0}$	=	20
At 10 weeks	$\frac{0.}{3d}$	$\frac{0.}{1d}$	$\frac{3d.}{3d}$	$\frac{1}{1}$	=	24
At 10 months	$\frac{0.}{3pd}$	$\frac{0.}{1d}$	$\frac{3d.}{3d}$	$\frac{2}{2}$	=	28
At 16 months	$\frac{0.}{3}$	$\frac{0.}{1}$	$\frac{3dp}{3dp}$	$\frac{2}{2}$	=	28
At 18 months	$\frac{0.}{3}$	$\frac{1(?)}{1}$	$\frac{3}{3}$	$\frac{3}{3}$	=	34

It may be noted that the eruption of teeth of the subject species follows closely that of the white-tailed deer (Odocoileus virginianus) as presented by Severinghaus (op. cit.) although the eruption of the dentition of young caribou is more precocious than that of young white-tailed deer. The eruption of the permanent incisors is quite different from that of the wapiti (Cervus canadensis).

Body Form

During the summer months the caribou appear rangy in form. The legs are relatively longer than those of the reindeer, and thus caribou can be distinguished easily in a herd of reindeer, which seem thick-bodied and short-legged in comparison. During late autumn, the caribou appear more sturdy because of lengthening pelage and fat storage.

As is characteristic of the deer family, the caribou possess several prominent glands. The infraorbital gland on the face is well developed. There is also a pair of inter-digital glands between central digits of the hind limb. The use of these glands is not known. The glands which are prominently situated on the metacarpals of white-tailed deer are absent on the caribou.

Feet

A characteristic sound associated with the passage of a herd of caribou is the loud clicking of their foot bones. This clicking has been attributed to the inter-play of carpal bones or sesmoid bones in the foot when the weight of the animal is placed on it. This peculiar noise may be of social significance, helping to keep the herd together when moving.

The single foot-print made upon firm snow, sand, or mud consists of the imprint of the four hoofs, because the dew claws are low on the foot and carry some of the body weight. The central hoofs on each foot are pointed at the anterior tip and rounded behind. They leave wide crescent marks with the two points facing in towards the mid-line. The dew claws leave two crescentic marks close behind the anterior hoofs. A large bull leaves a foot-print approximately 185 mm. long and 125 mm. wide. The foot-print of a cow is approximately 145 mm. in length and 90 mm. in width.

The foot-print of a calf in summer generally lacks the impression of the dew claws and measures about 60 mm. in length and 65 mm. in width. The pace is about 36 inches in length for an adult animal.

Storage of Fat

Part of the stocky appearance of caribou in autumn, is caused by fat storage. Some fat is stored in the coelom, greater omentum, and mesenteries and around the rectum; but more important is the deposition of a layer of fat over the saddle and rump. This layer may reach three inches in thickness and weigh up to 30 pounds. It was referred to as the "dépouille" (spoils) by the early Canadian voyagers and is often mentioned by early writers as an important dietary factor.

There is a different cycle of fat storage between the two sexes. Adult bulls commence building a layer of back fat in late summer. This deposition grows during September and October until the rutting period is reached. During the rut, bulls rarely eat and the layer of fat is soon used up, with the result that they enter the winter in lean condition. During spring there may be some deposition of fat on omenta and mesenteries, but throughout spring and early summer bulls generally remain lean.

The accumulation of back fat on the cows occurs later in the season than on the bulls. Deposition seldom starts until September and reaches its maximum thickness in late autumn or early winter. Cows with calves are usually very lean, and do not commence to accumulate fat until late in the season. On

the other hand, barren cows often remain fat throughout the winter and start to accumulate new back fat by mid-August. Calves are lean throughout their first winters. Yearlings and two-year-olds generally start to accumulate fat deposits in midsummer. In autumn a fat animal may often be picked out of a group of thinner animals by the stubby appearance of its tail when the animal is running.

The annual cycle of fat deposition outlined above is subject to many variations caused by environmental factors. If the bands spend the winter on rich ranges, they may retain heavy layers of back fat during the spring migration. Specimens collected at Churchill in April, 1948, were all in excellent condition. Even the pregnant cows had fat about 20 mm. thick on the rump. The hordes of biting insects upon the tundra have a great effect upon the accumulation of fat during the summer months. Under the attacks of black flies and mosquitoes, caribou feed irregularly and are continually moving. It was noted that soon after the early disappearance of biting flies in 1948, the caribou commenced to store mesenteric fat. In 1949 the fly season was more prolonged and the caribou taken showed little deposition of fat in late August. Stefansson (1921) noted that the caribou on Banks Island had rich deposits of fat during the summer in comparison with the mainland herds with which he was familiar. He correlated this observation with the lack of mosquitoes on the Banks Island summer range.

Range Vegetation Studies

In order to obtain quantitative data on the food preferences of the caribou, it was necessary to study forage availability and production in the various plant communities seasonally frequented. Besides providing quantitative data on available food, the observations gave a quantitative picture of some of the plant communities typical of the caribou range.

Observations were made at two locations in the taiga and four on the tundra all in Mackenzie District. The tundra stations were on typical summer range and the taiga stations on typical winter range. The stations and the periods during which studies were carried out were as follows:

- | | |
|-----------------------------|---|
| 1. Fort Reliance. | Dry wooded hillside community.
June, 1949. |
| 2. Fort Reliance. | Damp, low sphagnum bog community.
June, 1949. |
| 3. Bathurst Inlet. | Damp, Arctic sea-coast tundra
community. July, 1949. |
| 4. Contwoyto Lake. | Dry, flat interior tundra
community. August, 1949. |
| 5. Lake Clinton-
Colden. | Dry, rocky tundra community.
August, 1948. |
| 6. Muskox Lake. | Moist snowbank tundra community.
July, 1948. |

Data were obtained by means of a Raunkiaer's circle, using a systematic sampling technique. Random line transects were laid across the communities. At each tenth place, the plants which fell within the circle immediately in front of the observer were tallied. At each stop observations were made on the different tree, shrub, and ground vegetation strata present, and the average height of each stratum was estimated. The data tallied for each "throw" of the Raunkiaer's circle included species and approximate coverage of their leaves and stems. For each station, between 100 and 300 "throws" of the Raunkiaer's circle were made. Information concerning the spacing of the individual plants of each species was recorded. This was indicated as a figure on a sociability scale which was a modification of that of Braun-Blanket.

- | | |
|----------------|-----------------------------------|
| Sociability 5. | Plants growing in pure stands. |
| 4. | Plants growing in small colonies. |
| 3. | Plants growing in small cushions. |
| 2. | Plants growing in small groups. |
| 1. | Plants occurring singly. |

The forage production studies were made only at Lake Clinton-Colden. Here in late August, after the completion of the season's growth, 15 clip-quadrats, each one square yard in area, were laid out systematically across a tundra community being utilized by caribou. All the new seasonal growth, leaves, berries, and twigs, was clipped to within one inch of the ground. The ground lichens were also collected. The forage was segregated by species in paper bags, air-dried for one week, and then weighed.

The quantitative data derived from these studies for each community studied, are listed in Tables 23 to 28, inclusive. Under frequency index is recorded the number of times each species occurred, expressed as a decimal fraction of the total number of samples. Similarly, under coverage is recorded the total coverage of each species, expressed as a decimal fraction of the total area surveyed.

A pictorial comparison of the total coverages of the various strata at certain taiga and tundra communities is given in Figure 22. The absence of trees and tall bushes and the scarcity of shrubs on the tundra are evident. The lesser total coverage of vegetation in the tundra communities is also noteworthy.

On the white spruce of the taiga several arboreal lichens are found. Two of the more common species, Evernia prunastri and Alectoria jubata, are important sources of winter food for the caribou.

Where caribou were known to spend the winter in the taiga, little evidence of utilization was noted, aside from light browsing of willow and birch twigs and arboreal lichens. On many of the tundra areas visited, however, there were signs of heavy utilization. This was particularly evident at Lake Clinton-Colden where the shrubby willows and dwarf birch were heavily browsed. The lichen growth was also heavily utilized. Over large portions of the central tundra lichen growth is restricted by heavy caribou use; in these areas luxur-

iant lichens are found only in inaccessible rocky crevasses. These conditions are different from those in the Eskimo Lake area where the lichen growth is rich, and reports from east of Hudson Bay also indicate a luxuriant lichen growth. In these areas the caribou population has been severely reduced. In the taiga communities visited there was a heavier lichen growth than on the tundra. It is likely that the caribou are attracted to these areas in winter.

Food Requirements

During the investigation 16 samples of caribou stomach contents were preserved. These came from 14 caribou specimens taken on the tundra in summer and two taken in winter at localities in the taiga.

The volumetric analysis of the summer stomach contents is presented in Table 29 with the availability of the plant species taken from the previous range studies. From these data the preference ratios for the various species have been calculated. Since most of the stomachs came from Lake Clinton-Colden, the plant coverage figures from Table 27 were used. In this report the palatability of each species of plant is derived from the formula:

$$\text{Palatability} = \frac{\text{Relative Occurrence of Plant in Stomach Samples}}{\text{Relative Occurrence of Plant on Range}}$$

If the palatability of a plant is greater than one it means that caribou show a preference for this species. A low palatability figure for a plant indicates that it is seldom sought by the caribou.

From the analysis of stomach contents and from observations of feeding caribou, it was found that the following plants had a high summer palatability: mushrooms (Lactorius sp., Hygrophorus sp., Russula sp.); lichens (Cladonia rangiferina, Cladonia alpestris, Cetraria nivalis, Cetraria islandica); willows (Salix pulchra, S. reticulata, S. cordifolia, S. planifolia, S. aretophila); grasses (Calamagrostis canadensis, C. purpurascens, C. deschampsoides, Deschampsia caespitosa, Agrostis borealis, Poa glauca, Hierochloa alpina); Sedges (Carex concolor, C. membranacea, C. rariflora); cottongrass (Eriophorum vaginatum); dwarf birch (Betula glandulosa); and horsetails (Equisetum).

Forbs thinly distributed on the tundra, which were eaten by caribou were: Hedysarum alpinum, vetch (Astragalus alpinus), and Oxytropis Maydelliana. Foxberry (Vaccinium Vitis-Idaea) was eaten in about the same ratio as it occurred on the range.

Plants which were found to have a low summer palatability were: Labrador tea (Ledum decumbens), bearberry (Arctostaphylos alpina), bilberry (Vaccinium uliginosum), crowberry (Empetrum nigrum), alpine azalea (Loiseleuria procumbens), dryas (Dryas integrifolia), Lapland rosebay (Rhododendron lapponicum), Phyllodoce caerulea, and mosses.

From winter observations of feeding caribou in northern Manitoba in 1948, the lichens of the spruce-lichen woodland were thought to have a high winter palatability. These included species of Cetraria and Cladonia as well as the previously mentioned arboreal lichens. Cured grasses and twigs of willows and aspen (Populus tremuloides) were browsed.

Discarded antlers are avidly chewed during the winter months.

Behaviour

The behaviour of caribou may be classified as individual, social, or ecological. The actions that a caribou makes as an individual, such as walking and feeding, are classified as individual behaviour. Any related action of two or more individuals for mutual benefit, is classified as social behaviour. The behaviour patterns exhibited by caribou in relation to other species of the community are classified as ecological behaviour. The reactions of caribou to the attacks of insects and predators fall under this last heading, but will be discussed in separate sections.

Individual Behaviour

It is difficult to discuss animal behaviour without using words which seem to have an anthropomorphic connection. When dealing with the higher groups of mammals, this is perhaps less reprehensible than generally held. Many "human emotions", such as fear, curiosity, and playfulness, are probably basic mammal emotions. In the following discussion such words are used as descriptive terms.

Locomotion.- The caribou uses a variety of gaits. It appears to be a restless animal by nature. While slowly feeding along a ridge, it may suddenly break into a trot, only to resume a walk again after a few paces. It uses a leisurely walking pace when feeding, browsing a willow shoot here, a bunch of blue grass farther on. The head is occasionally lifted to scan the surroundings. When alarmed, or aroused by curiosity, the caribou trots with a loose gait, the head held high, the line of the forehead approximately paralleling the ground, and the short tail held stiffly erect. This gait can be changed to a fast pace with which the caribou may cover great distances with seemingly little effort. The legs are then stiffened and the animal progresses with a long spring-like stride. When hard pressed, it breaks into a laboured rolling gallop, but this gait is not maintained for a long period.

Caribou appear to travel at high speed when pursued by a snowmobile on a frozen lake. It is usually necessary to drive between 45 and 50 m.p.h. to overtake them. The most reliable estimate of their top speed was obtained by J. Staunton and R. Shewfelt, former Manitoba Game Guardians, in November, 1948, near Gillam, Manitoba. While they were travelling along the Hudson Bay Railway in a gas-car, a band of caribou tried to cross the track ahead of them. One young bull galloped along the roadbed ahead of the gas-car for about a quarter of a mile before turning off. They adjusted their speed to that of the caribou and found it was travelling at approximately 37 m.p.h.

An excellent opportunity to observe the migration rate of travel arose in the autumn of 1948, as the route lay southward along the Hudson Bay Railway south of Churchill. During frequent trips by gas-car between Churchill and Ilford, it was possible to note the location of the vanguards of the herds. These observations are given in Table 30. The average daily distance advanced was 19.4 miles. Forty miles is probably near the maximum distance covered in one day.

Often the rate of travel is slow, and the caribou may travel during only a short period of the day. During a 24-hour period on August 4 and 5, 1948, a caribou herd was followed from Lake Clinton-Colden to Deville Lake, Mackenzie District, a distance of ten miles. During the spring migration of 1949, a very large herd of caribou was observed entering the western end of Ghost Lake, Mackenzie District, on April 24. On April 28 the area was revisited and the vanguard of the herd had moved only 12 miles eastward along the frozen lake.

The daily distance travelled depends on the season and weather. From August 20 to 25, 1948, three bull caribou remained within an area of about 50 acres, on the shores of Lake Clinton-Colden. In the vicinity of Bathurst Inlet, a herd of about 4,000 caribou was under constant observation from July 11 to 15, 1949. During this period the herd drifted about five miles. A usual observation, however, is to see a small band of feeding caribou appear on the horizon and drift gradually out of sight a mile or two away, in about two hours.

Caribou are strong swimmers and take readily to water as a means of escape from predators and insect pests and in order to cross lakes and rivers in their line of travel. In water they float higher than most mammals, with the head, shoulders, back, and tail held well above water. The height at which they float depends on the condition of the pelage, the antlers, and the amount of fat stored. During the summer a cow generally floats higher than a bull, which is generally weighed down by heavy antlers in velvet. A group of heavily antlered bulls was observed to hesitate at crossing a small lake along with the rest of a large herd. Finally the bulls trotted around the shore of the lake. Calves take readily to water at a very early age, but they cannot swim as fast as their parents and frequently on reaching land, must run ahead, searching for their mothers.

On August 15, 1948, a band of 20 caribou were watched swimming across Caribou Narrows, Lake Clinton-Colden. They swam the distance of 1,000 yards in 8 minutes, 25 seconds, or at a speed of about four miles per hour. This speed was attained without special exertion. When pursued by a canoe, they can swim faster for short periods. It is difficult to overtake swimming caribou, even in a light canoe with two strong paddlers. Under these conditions, the caribou can probably attain a speed of approximately six miles per hour.

On leaving the water, the caribou lowers its head and shakes the water from its fur in the same manner as a dog does.

Voice.- Caribou are usually silent, but this does not mean that they are voiceless. When surprised at close range, or annoyed by insects, both sexes give a loud snort. When in large groups caribou may frequently be heard uttering belch-like grunts which resemble the grunts of swine. The calves bawl frequently during the first few months of their lives. Because of the bawling of calves and the low short belching grunts of the adults, there is a great deal of noise associated with a large herd.

During early July, 1949, it was noted that a significant variation in the amount of clamour of a large herd was associated with the daily activity. The peak was reached in the early morning and evening, at the height of the feeding periods. During the afternoon, when most of the caribou were resting, there was little clamour.

Senses.- The caribou possesses a keen sense of smell and relies largely on this sense for warning. When stalking caribou it is necessary to be sure that the wind is favourable, since they react quickly and violently upon catching human scent. If feeding, the head is jerked up upon the scent of danger and a shudder is sometimes observed to run down the animal's frame; the head is then turned towards the wind and the nostrils are dilated. If the scent is confirmed, the animal breaks into a trot. If an animal is lying down, it usually leaps to its feet on catching human scent. This reaction to human scent is shown by calves when they are about two months old.

It is difficult to calculate the distance human scent carries with strength sufficient to alarm the animals. On August 5, 1948, at the Hanbury River portage from Ptarmigan Lake the author lay among some boulders to watch an advancing herd of several thousand caribou. The herd was advancing across the wind carrying the scent of the observer, who was soon surrounded, except for a corridor directly downwind, which was clear of caribou, and which was about one mile in length and subtended an angle of about 15 degrees from his position. Any bands attempting to cross this segment were immediately repelled by the human scent and made their way around it by travelling upwind. These bands often passed within 20 yards to the windward of the observer's position.

The caribou's sense of hearing is good, but not as keen as that of some other species. Often they did not pay any particular attention to twigs crackling or to soft voices. While stalking a herd of caribou, on August 6, 1948, the author was followed by a screaming herring gull (Larus argentatus). It was noted that the nearest caribou watched the screaming gull apprehensively, frequently lifting their heads to stare in the author's direction. This observation was repeated at other times with ravens (Corvus corax) and gulls. It was believed that the caribou took warning from the cries of these scavengers, which often follow hunting wolves or men.

It seems that the barren-ground caribou has not yet definitely associated a rifle shot with danger. When a hunter fires at a caribou herd, animals not hit appear startled. They usually peer towards the sound of the shot and then circle to get the scent of the hunter. This behaviour trait makes the species particularly vulnerable to the modern hunting rifle.

The eyesight of caribou may be described as poor compared with that of other species of big game such as the pronghorn antelope (Antilocapra americana). It is possible to crawl upwind to within 15 yards of a resting caribou by the simple device of moving when the animal's head is turned away and "freezing" when it is not. It is usually possible to walk unobserved to within about 150 yards of a herd of caribou on the open tundra. Within 100 yards, caribou are quick to notice movement. A hunter usually experiences more difficulty in approaching a herd of caribou on the tundra in winter than in summer because of the scarcity of cover. Moving objects are more quickly perceived against the white background of snow.

On April 22, 1948, bands of migrating caribou were observed passing northwest along the shore-ice at Churchill, Manitoba. The ground was covered with heavily crusted snow and the sky was clear, causing severe glare from the surface of the snow. The caribou were observed to be travelling in strings, with their heads down and their eyes closed to mere slits. It is possible that they suffer from snow-blindness during the clear days of early spring.

"Curiosity".- The barren-ground caribou is well known for its so-called "curiosity". Many have found that it can be attracted by unusual behaviour of the hunter. The normal reaction when suspicious of danger is to circle to a position downwind from the object of suspicion. When alarmed they flee for a short distance, only to pause and look over their shoulders at the intruders. It is interesting to note that Frobisher mistook these actions for an attack (page 9, Part I).

Docility.- Caribou are generally docile animals which cannot be provoked into making an offensive move and usually try to outrun their adversaries. Occasionally during the rutting season a wounded or cornered bull will defend himself. At Fort Reliance a wounded bull turned on a pursuing dog and sparred with its antlers.

Temperature.- The preferred temperature range for the species seems to be lower than the high summer temperatures reached in the Arctic. At that season, snowbanks may remain on the northern hillsides, and often a large herd may be observed bedded down on a snowbank during the summer afternoon. This may also be an effort to obtain relief from insect pests.

Diel Activity.- From many hours of continuous observation of caribou during the summer months the following generalizations have been drawn.

Caribou feed casually during the entire 24-hour period, but there are peaks in their feeding activity during the forenoon and evening. At other periods feeding is desultory, being interrupted by long rest periods. During mid-afternoon there is a general lessening of activity and long rest periods are taken. From observations made during August, 1949, at Hanbury River, it seems that there may also be a period of relative inactivity at night.

During these rest periods the animals usually lie with their backs to the wind, with heads erect, facing downwind, and legs either tucked under the body or extended. To sleep, the head is brought around and tucked into the flank. Several cows were observed lying flat, with heads on the ground and legs extended. Bulls are unable to assume this position in summer because of their growing antlers. During the winter, caribou usually spend the afternoons lying on frozen lakes. While resting, they chew their cuds.

When migrating, movement is usually made at dawn and dusk. At these times very little feeding is done and the herd progresses at a steady walk, or with frequent short trots. During the feeding periods there may be a general drift in the direction of travel.

The general periods of maximum feeding, migrating, and resting are given in graph form in Figure 23. These data are derived from the analysis of 83 caribou-hours of constant observation during various times of day.

Social Behaviour

The barren-ground caribou is a gregarious animal and is usually met in small bands or loose herds. The herd is a social group, consisting of different age and sex groups at different times of the year.

Herd Organization.- The observed actions of individual caribou in a herd appear to be governed by a force of attraction analogous to a magnetic force. From the air, the individuals in a large herd of moving caribou are observed to be arranged in parallel strings like iron filings in a magnetic field. If alarmed while feeding, dispersed individuals quickly run together to form a band. In rapid movement, the herds appear to travel with a flowing motion over the well-beaten trails and to funnel through natural defiles.

Bands of caribou consist of about five to 100 individuals. A herd is composed of several loosely associated bands, with a total from 100 to about 2,000 or 3,000 animals. During migratory periods large migrating herds of more than 100,000 have been observed, but these large masses are clearly divided into individual small herds composed of approximately 1,000 animals each. The amount of available forage along the route probably governs the size of the herds.

Being a gregarious species, the barren-ground caribou has no individual home range. It is possible that the herd to which the individual belongs has a home range. Since the caribou is a nomadic species, the herd home range is many miles in extent. It may extend up to 800 miles in length between the summer and winter ranges.

There seems to be very little sign of a sense of territoriality in the species. Probably the only behaviour pattern due to this sense is shown by the bulls in the rutting season, when they may attempt to intimidate nearby rivals. It is doubtful if there is any spatial relation in this pattern, as the herd may be in movement at the time. Only the proximity of the rival seems

intolerable. A similar intolerance of certain classes to the proximity of other classes at certain periods was noted in both sexes. On August 7, 1948, a yearling was observed to stab at a calf with a foreleg and then try to bunt it out of the way. Cows were observed to turn half-way round and lower their heads against strange calves trying to find their cows. It is probable that similar actions are used by the cows to drive off the yearlings at the time of the birth of the calves.

Aside from the close association of the cows and their calves there seemed to be no fixed organization of the group. Small bands might join and then break up into bands with different compositions. There seemed to be no established leader. Bands were usually led by adult females, but sometimes by younger animals, even calves. In a summer herd one frequently observed a small group of bulls and a group of barren cows in the vanguard, with cows and calves in the rear. The leader might be any animal that moved off first in the direction in which most of the herd wanted to go.

There was no evidence to suggest that Sdobnikov's (1935) biological structure of reindeer herds is found in the caribou herds. He stated that reindeer assumed a hereditary position in the herd in fringe, middle, vanguard, tail, or side groups. In contrast, the caribou herd seems to be composed of a series of parallel strings rather than a solid front, each animal finding food to its flank. Family and friendship groups seem to be represented only by cow and offspring associations and loose band associations.

Behaviour at Crossings.- Caribou trails frequently lead to river crossings at rapids or waterfalls. These locations seem to be favourite crossing points, yet they are often associated with considerable danger, which will be discussed later under mortality. An observation of migrating caribou helps to explain the habit of using favourite crossing points.

On August 5, 1948, at the Hanbury portage, a large herd of caribou was under observation from the north shore of a small lake. By late evening it had grown to about 4,000 animals. The lake lay across the general line of movement and the bands gradually moved down valleys to the shore where several hundred caribou were feeding. Several small groups were at the water's edge and a few animals were standing in the water. Often one of the animals would gaze over to the south shore of the lake, about 150 yards away at the narrowest point. At 8.35 p.m. a large band of about 200 trotted rapidly down the bank and the leaders plunged into the water and started to swim in single file toward the south shore. This caused a great deal of splashing, to which was added the clamour of the animals. Other nearby bands now joined the procession and it was soon evident that many bands were racing over the undulating ground towards the crossing point; it seemed that the whole herd was soon in movement as if at a signal. By 9.50 p.m., 2,760 animals had swum across the narrows. It was evident that the majority of these bands, although at first they could not see the crossing point, had been stimulated, by hearing the splashing and clamour of the others, to make the crossing.

It is therefore believed that the noise of rushing water at rapids and waterfalls attracts caribou to cross the rivers at those points.

Approachability in Large Herds.- Many writers have reported that caribou are less wary in large herds than in small bands. J.B. Tyrrell (1898) photographed a large herd of caribou at close range on the shores of Cary Lake, Keewatin District, during the summer of 1893. Stefansson (1913) writes of his guides attempting to spear caribou with knives tied to poles, when the caribou were passing in large columns.

On April 24 and 28, 1949, the opportunity arose to observe closely-packed columns of migrating caribou on Ghost Lake, Mackenzie District. The herds were sighted from the air, and the aeroplane was landed among the herds on the frozen lake. It was found that the caribou were not greatly alarmed by the presence of humans. It was possible to walk to within 25 yards of large herds (Fig. 24). Often, when the animals were bedded down, they remained lying on the ice, watching the approach of the observers until it was evident that they would pass through the herd, when those on the line of approach would rise and trot off. In this way it was possible to walk down cleared corridors among herds of approximately 5,000 animals.

By manoeuvring with four men, it was possible to herd the caribou past a photographer at a range of ten yards. At such times the men appeared to be in the midst of galloping herds. Eventually the pilot even succeeded in lassoing a yearling with a piece of mooring rope as a herd rushed by him at a distance of about five yards.

It was found that in a galloping herd of several thousand caribou each animal was under perfect, co-ordinated control. One could walk across the path of such a herd only to have it divide and pass on each side, leaving a space about 20 yards in diameter. At one point, the writer, by crouching on the snow, obtained excellent photographs when a large herd was manoeuvred by the other men to pass near him. The animals, at full gallop, swerved to pass on each flank; some passed within a few yards. From the many observations made on those days it was evident that caribou in large herds are less wary and more easily approached than those in small groups. It seems that the caribou are conscious of individual safety in numbers.

Dependence on Wind Direction.- It is commonly believed by trappers and natives that caribou invariably feed and migrate into the wind. This dependence upon the wind direction during migration was repeatedly mentioned by early writers, such as Richardson (1829) and others. Critchell-Bullock (1930) kept meteorological data with his caribou records and gave a table which indicated that the direction of travel was independent of wind direction. His observations were made during the period including autumn, winter, and spring, in the vicinity of the Hanbury River.

During the present investigation daily meteorological records were kept simultaneously with the caribou observations. It was found that the

travelling caribou were moving in a predetermined direction towards the summer, winter, or rutting range, depending upon the season and irrespective of wind direction. Quite often this path of movement is into the wind. The wind may have a secondary effect on movement, as wind is usually associated with a storm, which might cause more rapid movement. During the summer, insect pests were reduced during and following a storm and this often caused movements of the herds. Winter storms often caused the herds to move more rapidly and to travel deeply into the forested area. The analysis of the correlation between direction of travel and wind direction for 210 observations is given in Table 31.

Milling.- Clarke (1940), writing of the summer migration of the Hanbury herd, reported that he observed large milling herds from which smaller herds would split off and race down to the river bank to ford the river. This is a well-known trait of reindeer which is used in controlling the animals when they are being driven to the corral.

Herd Segregation.- Differences in herd composition may be due to changes in tolerance between various sex and age classes at different seasons, such as the rejection of yearlings by cows and the association of bulls and cows during the rutting season.

Starting with Richardson and Franklin, most scientists and naturalists writing about the caribou have described the segregation of the sexes during migration. It was stated that the bulls trailed the cows north in the spring. The majority of northern trappers also hold this opinion. Hoare (1930) stated that the bulls preceded the cows during migration. As a result of his summer observations on the Hanbury River, Clarke (1940) decided that the sexes travelled together, although they might be segregated into bands of about 1,000 animals of one sex or the other.

During the present investigation it was ascertained that the majority of the mature bulls follow the cows and yearlings from the winter ranges to the tundra summer range in the spring. During the aerial investigations carried out in Keewatin and Manitoba during April and May, 1948, 10,548 caribou were photographed. Of these, 2,866 were at such range as to be classifiable by age and sex. The herds spread over a route about 150 miles long were composed of 18.8 per cent bulls, 56.4 per cent adult cows, and 24.8 per cent yearlings. The leading bands were composed of adult cows, yearlings, and a few young bulls. By May 15 these bands were spread from timber-line far out on the tundra (Fig. 25). At that date the rearguard bands of bulls were moving northward in the area between the Nelson and Churchill Rivers (Fig. 26) about 100 miles behind the cows. As explained previously, the difference in antler development at this time made recognition possible.

It was possible that the cows were accompanied by significant numbers of bulls which were missed, and therefore a check on the class percentages was desirable. An opportunity arose to check these data when the Hanbury herd, containing all sex and age classes, was observed moving southward in August, 1949. At that time a classification of 2,753 animals indicated that the herd was composed

of 19.1 per cent adult bulls, 54.8 per cent adult cows, and 26.1 per cent calves and yearlings. This supports the herd composition figures of the spring count and the accounting of the bulls' location in migration.

During April, 1949, additional observations on the Snare River, Mackenzie District, confirmed this analysis. Large herds composed mostly of cows and yearlings were observed in the vicinity of Ghost Lake, while large bands of bulls were observed in the vicinity of Lac la Martre, trailing the large herds of cows and young animals ascending the Snare River towards the tundra.

During his investigations in the winter of 1948-49, Lawrie noted that there was some evidence of a partial sex group segregation on the winter ranges in northern Manitoba. The northward migration in early spring was initiated by a movement of cows and calves in late January and early February. This was not as rapid as a later April movement. He also noted that cows and yearlings first appeared at Nueltin Lake in May, and were followed by most of the bulls in June.

Many adult bulls which spend the winter in the forested part of the range do not travel as far out on the tundra in summer as do the cows and young. During late June and July, bands of bulls are frequently observed at or near timber-line. Bands of bulls have been reported in summer in the vicinity of the Coppermine River, east of Great Bear Lake (Stefansson, 1913). Others have been reported from the Lockhart and Hanbury Rivers. On July 1, 1949, 219 bulls in small bands were observed between Fletcher Lake and Aylmer Lake. Trappers also reported the occurrence of bulls in summer on the upper Thelon River.

Most of the bulls which accompany the herds of cows are two- or three-year-olds, but there are usually a few old bulls which form small groups on the outskirts of the herd. During a flight to Arctic Sound, Mackenzie District, from Bathurst Inlet on July 24, 1949, several groups of mature bulls were observed northwest of Arctic Sound. Clarke (1944) reported that bulls reached the Arctic coast in the vicinity of Bernard Harbour. Stefansson (1913) reported that the herds crossing Dolphin and Union Straits to Victoria Island on May 1, 1911, were composed of cows and yearling bulls.

As the bands of cows and calves move towards timber-line in late July or early August they gradually pick up the summering bands of bulls. Groups of bulls, yearlings, and a few barren cows seem to move during the midsummer migration at a faster pace than the cows with calves. During late summer, at more southerly points, bands of bulls usually form the vanguard of the movement towards timber-line. These advance groups of bulls may be a day's distance or more ahead of the main herd. At the camp on Contwoyto Lake, Mackenzie District, in 1949, the first bull caribou was observed on August 10. A few scattered bulls were observed daily until August 15, when 200 caribou, many of them cows, were observed. In September, the northern backwash from the midsummer migration brings all the sex and age classes together before the commencement of the rutting season.

In winter the bulls penetrate farthest into the forested parts of the caribou range. The hunting lodge maintained by Saskatchewan Government Airways at Missi Lake, Saskatchewan, is situated near the normal limit of winter penetration. During the first three hunting seasons out of several hundred animals taken, only one or two were cows. During the winter of 1948-49, caribou penetrated to an area about 45 miles north of Fort Simpson, N.W.T.; it was reported that the majority of animals taken there by local residents were bulls. Since the winter of 1945-46, caribou have frequently reached the vicinity of Gods Lake, Manitoba, during the winter; these animals also have been reported to be mostly bulls.

During the months of April and May, yearlings follow the cows closely, but by July the cows have new-born calves and the yearlings are in small bands on the outskirts of the large summer herds. During July, 1949, long periods were spent in close observation of herds on the summer grounds. It was frequently noticed that the yearlings foraged by themselves singly, in small groups, or in the company of barren cows or bulls. It is concluded that during June, before the birth of the calves, the yearlings are driven off by the cows. Observations in August and September, 1948, at Lake Clinton-Colden, suggested that the yearlings may rejoin the cows. Frequently groups composed of a cow, a calf, and a yearling were seen.

Many summer observations of herd composition indicated that barren cows associated together on the outskirts of the main herd and often formed the vanguard in movement.

Rutting Behaviour.- The rut occurs during the last part of October and the first part of November. The peak in rutting activity lasts for about two weeks in late October. During this season most of the herds are on the tundra in the vicinity of timber-line. The bulls do not segregate and defend harems of cows as has been reported for the Newfoundland caribou (Rangifer caribou terranovae) by Dugmore (1913). In the area studied, rutting occurs in large herds or smaller bands containing all sex and age classes.

Lawrie observed the rut at Nueltin Lake in October, 1948. He reported the first sparring by bulls on October 12. On October 17, he observed a young bull, in a group of three cows, a large bull, and two younger bulls, attempt coitus. Later in October he observed that the adult bulls in a herd grazed only intermittently and dashed about, sparring with each other and uttering long belching roars. On one occasion he observed marshalling activities of several adult bulls in a herd. They walked back along the flank of a large herd and made short rushes at grazing groups, hastening them on.

The bulls serve the cows in the herd indiscriminately. Only when bulls come into close proximity with one another do they become antagonistic. The sparring matches are usually of short duration; a bull is seldom injured in one of these tests. On November 29, 1949, the migrating herds had reached Ilford, Manitoba. A small group composed of two young bulls, a cow, and calf were observed at close range crossing a frozen lake. The two

bulls sparred with each other and pursued the cow, nuzzling her back. The adult bulls had shed their antlers by that date and were not taking part in sexual activities.

There are no special locations in which the herds rut since the location of rutting area depends upon the progress of the autumn migration. The rut occurs wherever the herds happen to be at the rutting season.

Calving Behaviour.- Because of poor Arctic travelling conditions during June, when the calves are born, few data on calving behaviour were obtained. It is known that there are no special geographic calving grounds. The calves are dropped wherever the herd or band happens to be at the appropriate season. This in turn depends upon whether the spring was early or late and upon the progression of the spring migration. There are, however, general locations which the herds usually reach during the spring movement in time for the calves to be dropped. The calving of the Churchill herds usually takes place near Kaminak and Kaminuriak Lakes, Keewatin District. The upper Back River is frequently the site of calving for the Hanbury and Yellowknife herds. The Rae herd cows frequently drop their calves near the Burnside River.

Female caribou are solicitous for their calves and seldom abandon them. On August 14, 1948, a calf was killed by a wolf near the camp at Lake Clinton-Colden. The cow remained in the vicinity for two days and was observed to peer towards the calf carcass several times.

There is evidence that the cows withdraw from the bands to rough country to bear their young. The young are precocious and are soon able to get about. In a few days they can run as fast as the rest of the band. Calves are playful during the summer and are frequently seen romping in small groups, chasing each other, or prancing about the cows. They suckle at frequent intervals during the first month or six weeks, often bunting the udder of the cows vigorously like many other young ungulates. By the end of the first month they are grazing for themselves. The calves continue to suckle regularly throughout the winter. On April 25, 1948, at Churchill, Manitoba, a yearling attempting to suckle was observed. It had to bend its carpal joints to get under the cow and when it rose, it lifted the hind legs of the cow off the ground. Two females examined in November and December were both lactating. Delayed weaning probably assists the calves to survive their first winter.

Warning Behaviour.- Caribou in a herd may take warning from the actions of one of their number. A cow may become suspicious of a stalking observer and peer towards the intruder. Other caribou lift their heads and watch the apprehensive one. If the danger is confirmed by sight or odour, the animal on guard will snort and turn, whereupon the whole band will take flight, following whichever animal takes the lead.

In a large resting herd there are always some animals awake and watchful. Their action seems to be purely random, since there are always some individuals which awake, stand up, stretch, feed, and then lie down and chew the cud while others are asleep.

Ecological Relations

Position in the Food Chain.- The caribou is a primary source of food for local carnivorous animals. It is a central link in some of the more important northern food chains and occupies a central position in the biological pyramid.

Some of the more important predators of caribou are: wolf (Canis lupus), man (Homo sapiens), barren-ground grizzly bear (Ursus richardsoni, etc.), and golden eagle (Aquila chrysaetos). Species of this group normally kill caribou for food, and any of them will eat caribou killed by some other agency, if the carrion suits the taste or urgency of the predator.

A second group of species do not normally kill caribou for food, but normally eat the meat of caribou found dead. These scavengers are as follows: Arctic fox (Alopex lagopus), lynx (Lynx canadensis), wolverine (Gulo luscus), bald eagle (Haliaeetus leucocephalus), herring gull (Larus argentatus), raven (Corvus corax), and long-tailed jaeger (Stercorarius longicaudus).

There are other herbivorous mammals which belong to the same communities and which might be considered competitors of the caribou if the available vegetation were not sufficient for all. Since the food requirements of the various species are not known in detail, it is not possible to assess the exact degree of competition between caribou and these species. A list of possible competitors is as follows: musk-ox (Ovibos moschatus), arctic hare (Lepus arcticus), collared lemming (Dicrostonyx groenlandicus), brown lemming (Lemmus trimucronatus), tundra vole (Microtus oeconomus), red-backed vole (Clethrionomys rutilus). Some of the more important food chains involving the larger tundra vertebrates are indicated in Fig. 28. The central position of the caribou is to be noticed, as well as the fundamental position of the vegetation and soil. The solid lines indicate direct predation, the broken lines indicate the use of carrion. The chemicals used in the community are ultimately returned to the soil upon the death of the peripheral organisms, such as the wolf and man, by a host of smaller organisms involved in the degenerative processes. The interdependence of the various species of the community is to be noted.

Actions Detrimental to Other Species.- Since the caribou is gregarious and equipped with sharp hoofs, it regularly damages much vegetation by trampling when feeding or migrating. The range of the species is criss-crossed by numerous trails along which the caribou travel and so prevent the growth of vegetation. Trampling is probably also harmful to the burrows and runways of the small rodents.

A unique relationship is the one between the caribou and the muskrat (Ondatra zibethica). During the winter months, the caribou invades the

range of the muskrat in the timbered areas. In northern Canada muskrats build feeding "forms" for use during the winter. They chew holes in the thin autumn ice, bring up submerged vegetation and pile it on the ice around the holes, and keep the holes open all winter. These piles of vegetation are called "push-ups". Caribou travelling on the lakes in winter seek the muskrat push-ups and paw them apart to eat. This often causes the holes to freeze over and the muskrats are unable to reopen them. Caribou trails leading to destroyed push-ups were observed near Ilford, Manitoba, in December, 1948.

It was reported that caribou frequently do considerable damage on winter traplines. On the tundra they seem to be attracted to traps set for Arctic foxes, which they paw up. Other damage is done by trampling. They are also attracted to animal urine in the snow.

Observed Behaviour Towards other Species.— There are few observations on the behaviour of caribou towards species other than predators. Some observations made during the investigation are of interest in this connection.

On August 14, 1949, at about 8.00 a.m. a band of about 50 caribou was observed feeding on the shores of Lake Clinton-Colden. Over the ridge behind, a bull musk-ox suddenly appeared at a distance of about 200 yards. The wind was in favour of the musk-ox. When the caribou saw the slowly approaching musk-ox, they became greatly agitated and circled about. Finally the herd split in two and the sections ran over the hill in different directions. The musk-ox leisurely walked down to the water's edge, drank, and then turned and retraced its steps over the hill. It does not seem likely that this was the first musk-ox these caribou had ever seen or that this was a normal reaction to the species. Probably the caribou were unable to identify the beast by odour and feared, because of bulk and colour, that it might be a barren-ground grizzly. On July 24, 1949, a band of 40 musk-oxen was observed northwest of Arctic Sound. Scattered bands of caribou were feeding within a few hundred yards of them without showing any concern.

On August 31, 1948, while the writer was watching the actions of Arctic fox whelps at a den entrance near Lake Clinton-Colden, a cow and calf were noted feeding across the wind towards the den. They gradually approached to within about 25 feet of the whelps and 50 feet of the observer. When the calf received the scent from the den it was momentarily startled and ran off a few paces, then turned and looked towards the whelps, which made no cry. Both caribou then continued to feed towards the observer. A few moments later the calf caught the human scent and bounded away. The cow, after a moment's hesitation, followed the calf. The fox scent did not seem to convey the idea of danger to the caribou, but human scent did.

On several occasions feeding herds of caribou were observed to flush flocks of willow ptarmigan (Lagopus lagopus). These flew zig-zagging through the herd without causing any observable excitement. It has been observed that these birds feed in winter in the areas pawed up by the caribou in their feeding.

On April 29, 1949, large numbers of ravens accompanied the large herds on Ghost Lake. It was noted that the caribou occasionally glanced up at particularly raucous ravens flying overhead. Caribou are warned of the approach of predators by the calls of avian scavengers. Lawrie reported seeing three swimming bulls turn back when they saw three gulls on the water in their path. Unusual incidents easily cause panic among caribou.

The Caribou Community.- It has already been indicated that there are usually several other species of animals accompanying a herd of caribou during certain seasons; among these are wolves which kill caribou for food, and ravens, gulls, and eagles which feed on the carrion. As the caribou herd migrates this group of species forms a mobile community. On the tundra during the summer months the land appears particularly lifeless when caribou are absent.

It was so during the first three weeks of July, 1948, on a canoe trip from Lake Clinton-Colden to Muskox Lake on the Back River. The mammals observed were of the smaller kinds, such as the Parry's ground squirrel (Citellus parryi). Few raptorial birds were seen. On July 25, one peregrine (Falco peregrinus) and one golden eagle were observed on Sussex Lake. On July 26, at Aylmer Lake, on arising in the morning, a fresh wolf track was observed in front of the tent, and later in the day ravens were seen. On July 27, ravens were numerous and the first caribou bands were observed moving southward. That morning, 17 musk-oxen were observed at Thanokoie Narrows. On July 29, the first wolf was observed at the same locality.

On August 1, the return to the base camp on Lake Clinton-Colden to await the arrival of the caribou was made. On August 3, several ravens were observed. At 8.45 that evening a wolf was heard howling in the distance. It later appeared and swam across Caribou Narrows, on the exact route that was later used by bands of caribou. At 8.30 p.m., August 4, a herd of approximately 2,600 caribou was sighted on the opposite side of the narrows where the wolf had appeared the evening before. A second wolf was following the herd.

In the vicinity of the large herd on Ghost Lake on April 23, 1949, were also seen about 20 wolves, 100 ravens, one golden eagle, and two bald eagles. During the winter months, groups of these predators and scavengers remain with the caribou herds. Probably unmated individuals, or those which have brought off their young, accompany caribou herds during the early summer months.

Possibility of Hybridization.- The introduction of the domestic reindeer (Rangifer arcticus asiaticus) to the caribou range in northern Canada gives rise to a serious problem. Were the reindeer to hybridize with the caribou the results might be catastrophic. The wild virility of the native stock might be so impaired by dilution as to render it more susceptible to the attacks of predators or other environmental pressures. Also, exotic diseases might be introduced and have serious effects. At present it is impossible to forecast the final results of hybridization, but, observing the present situation in Alaska, it is assumed that they would be detrimental and could possibly lead to the extermination of the native race.

Fortunately such hybridization in Canada is unlikely at present. The government reindeer herds are situated at the mouth of the Mackenzie and Anderson Rivers, in areas where the native caribou have been extirpated, or reduced to very low numbers. In addition, these herds are under constant supervision. During the winter of 1948-49, south of the Reindeer Preserve east of the Mackenzie River, two animals tentatively identified as hybrids were shot.

A second possible location for hybridization was in the vicinity of Fort Smith after 1912. During the summer of that year several Lapland reindeer (Rangifer tarandus tarandus) escaped. There were several local observations of these animals subsequently (Harper, 1932). It was concluded, however, that they soon succumbed in the foreign environment. Since they escaped on the winter range of the native caribou it seems unlikely that they had the opportunity to mate with the native form.

There is some indication that a barrier may exist between the Asiatic reindeer and the barren-ground caribou on a sexual level. The majority of reindeer calves of the government herd at the mouth of the Mackenzie River are born in April, while the native caribou calves are born in June. Assuming a similar gestation period, it seems likely that the rutting seasons are also two months apart. This indicates a temporal barrier which would cause the two forms to be sexually isolated.

During the winter months the barren-ground caribou invades the range of the western woodland caribou (Rangifer caribou sylvestris) in Manitoba, Saskatchewan, Alberta, and the Mackenzie District (Banfield, 1949). This introduces the problem of interbreeding between the two forms. However, among the barren-ground caribou, rutting takes place on the tundra or in the vicinity of tree-line after a northward movement in autumn. At this time they are therefore several hundred miles from known populations of woodland caribou. The two forms are, therefore, separated by a spatial barrier causing sexual isolation. It is possible that individual barren-ground caribou isolated in the taiga belt during the summer by water might transcend this barrier, but the survival probability and autumn movements of these individuals are unknown at present.

Relations with Small Birds.- A host of small birds inhabits the tundra in summer and by consuming biting flies as food is of assistance to the caribou.

Relations with Mosses.- An interesting ecological relationship into which the caribou enter is the peculiar micro-habitat which their dung and bones offer for certain specialized mosses. The following mosses were identified by Dr. William C. Steere of Stanford University, from a series of lower mandibles collected from the tundra. Those typical of a calcareous niche were: Tortula ruralis, Tetrapledon mnioides, and Orthotrichum killiasii. Others attracted by the moist situation were Tomenthypnum nitens, and Campylium stellatum. The remainder were weeds - Bryum caespitium, Bryum argenteum, and Ceratodon purpureus.

Concepts of Causes of Migration

Murie (1944) has stated briefly some of the more important theories regarding the causes of migration of Alaska-Yukon caribou. One of the earliest theories developed was that the caribou migrated north and south with the seasons, seeking the shelter of the southern taiga in winter and migrating north in summer to the tundra. This conception fits well under the "seasonal migration" classification of Heape (1931); indeed the movements of caribou are discussed by Heape under this heading. This theory places the emphasis on seasonal changes in weather.

A slight variation of this theory is that seasonal movements are caused by food requirements: the tundra in winter fails to supply the food requirements of the species. This concept fits into the "alimentary migration" classification of Heape (op. cit.).

A theory among northern residents is that the summer movements are caused by the seasonal occurrence of hordes of mosquitoes and black flies. It is said that the herds move out of the forest just before the flies become intolerable, and go north to the Arctic Coast to seek relief from these pests. In late summer they return to the southern tundra when the flies are waning.

Other writers maintained that the migrations were instinctive; that modern herds perhaps retraced ancestral routes by which the caribou populated the extreme summer range. It was pointed out that caribou bands inhabiting the eastern shore of Foxe Basin, Baffin Island, migrated northwest in the autumn, towards Fury and Hecla Straits, where it was supposed that their ancestors had crossed from Melville Peninsula.

Starting with the writings of Hanbury (1904), an increasing amount of factual information difficult to explain under these migration concepts was presented. It was found that several large herds of caribou do not leave the tundra in winter. Few caribou herds migrate on a north-south axis. The majority of caribou do not reach the Arctic Coast in summer and herds are widely distributed on the tundra in the height of the fly season. The mid-summer southward migration described by Clarke (1940) and in this report, is difficult to account for by any of the above theories.

It seems unlikely that one factor alone determines the migrations. Certain factual considerations which bear upon this problem are presented below.

During the summer months, the diet consists chiefly of the green foliage of willows and birch along with grasses and sedges. In winter there is a change in the diet. Lichens, twigs of willows, and a certain amount of cured sedges are preferred. Studies have indicated that large areas of the central continental tundra produce only a small crop of lichens and shrubby growth. The taiga, on the other hand, has a rich understory of shrubs and a good ground cover of lichens, as well as arboreal lichens. It is probable that on the tundra winter ranges near water there is greater growth of vegetation - lichens and willows - due to increased moisture. Also, winds

are known to blow the hillsides bare of snow. Food requirements, therefore, play an important role in determining the location of the winter quarters.

Weather also affects the location and rate of migration. The caribou seldom leave the tundra in late autumn until the advent of the first severe winter storms. During mild winters they often remain near timber-line. During early, severe winters the herds tend to migrate deeper into the taiga. Similarly, an early spring will usually be associated with an early spring migration, while during a prolonged winter the spring movement to the tundra is generally delayed.

With reference to important life history periods, both rutting and calving take place upon the tundra. The rut occurs in autumn after the first frosts. The midsummer migration carries the majority of caribou to timber-line about the time of the first frosts. It is possible that the killing of the summer foliage by frost may be associated with this movement. In the second phase of the midsummer migration, the herds retrace their paths back to the tundra prior to the rut. It seems reasonable to suppose that this later movement is associated with the rut. In this case it could be classified as a "gametic migration" of Heape (op. cit.).

The early spring migration from the taiga to the far tundra summer range takes place long before the fly season begins. On the tundra the flies seldom reach plague numbers until the middle of July. Towards the end of July, at the height of the black fly season, the herds commence their movement towards timber-line. They must pass through a wide belt of tundra swarming with flies before they reach timber-line late in August, when the flies have declined in number. These summer migrations were observed, during the investigation, both when the biting flies were most dense and when there were few insect pests on the wing. It was easily observed that the flies had a profound effect on the daily activity of the animals, making them greatly agitated. The flies also seemed to increase the speed of migration. However, there was no indication that insects were a primary cause in the major cycle of caribou movements.

From an inspection of the figures in which the seasonal migration routes are drawn, it is evident that there is no general north-south axis of seasonal movement. Some herds move northeast in spring, others northwest; some east, others west. The herds paralleling the western shore of Hudson Bay travel north for a considerable distance. Yet, in all these cases there is a rough correlation: the route is generally at a right angle to the nearest tree-line. Thus, the herds between Great Bear and Great Slave Lakes migrate on a general east-west axis, and those in the Thelon-Kazan area migrate on an axis more nearly north-south.

The foregoing discussion has been based on the assumption that caribou movements may be classified as "migrations" as conceived by Heape. There is another possible concept.

From the previous description of the population and annual movements it is evident that caribou are migrating during the greater part of

the year. Even when on summer or winter ranges the bands are drifting along continually. The barren-ground caribou is a gregarious species and characteristically occurs in large herds at all seasons of the year. In order that the individuals in the herd may obtain their food requirements, it is necessary that the herd keep in motion and so it continually changes its feeding range.

Heape (op. cit.), in his discussion of nomadism, gave as examples the movements of whales, other aquatic mammals, wolves, and certain tribes of man. He thought of their wanderings as haphazard. It is generally accepted that although the movements in any brief period of time may be random, yet there are seasonal aspects to the movements of these nomadic mammals. Most of them return to chosen habitats for the birth of the young, or return regularly to certain localities in the pursuit of certain kinds of food. Thus the nomadic tribes of herders take their flocks to fresh winter and summer ranges. In dealing with a nomadic species one may, therefore, expect to note a long-time regularity, with random local movements.

The movements of the barren-ground caribou are best described as nomadic. As a gregarious species, the herds are continually in random movement, seeking an adequate supply of food. Superimposed upon these local random movements are annual travel requirements. Annual shifts in food preferences and available forage encourage travel. In summer the herds seek the relatively cool, dry tundra, with its lush green foliage. In winter most herds seek the taiga, where the snowfall is less, the temperature is milder, and lichens and twigs are plentiful. The rut and the fawning seem to require a tundra location. Local weather and physiography affect routes and periods of movement.

This concept of the causes of movements of caribou seems to fit the annual movements of the species. It also explains the occasional absence of animals from their usual ranges and migration routes, which has frequently caused hardship for the natives depending on their arrival. As a nomadic species, they are easily caused to deviate from common routes by a variety of environmental factors discussed previously. This view also explains the caribou's habit of suddenly appearing in large numbers in a new area, either in winter or in summer. It has been noted, too, that where the species has been reduced in numbers to small bands, these bands make only local movements and cease to perform the long migrations characteristic of the large herds.

From the data accumulated in the present study, it seems probable that the barren-ground caribou is fundamentally both gregarious and nomadic in behaviour. Seasonal changes in meteorological factors, food preferences, food production, and reproductive requirements cause a superposition of annual cyclic spatial movements over the territories occupied by the herds.

Vital Statistics

In order to assess the effects of human utilization and predation, it is important to have quantitative data on the annual calf increment of the

herds as well as certain other statistics. The calculations would be much easier if the human harvest was taken only from one age class such as mature animals. As will be shown later, however, calves and yearlings are sought for their hides for clothing and these age classes also suffer disproportionate mortality from other factors such as predators and weather. The survival rate to maturity, therefore, offers no easy basis for the estimation of harvestable surplus. The chosen basis must be the produced calf increment. The caribou population will remain relatively constant if annual losses to all age classes from all factors do not exceed the annual increment of calves.

To obtain the necessary field data, caribou observed were segregated when conditions were ideal for observation. The classes tallied were mature bulls, mature cows, calves, yearlings and, under certain conditions, two-year-olds. After January 1, animals born in the previous calving season were classified as yearlings and those born a year before as two-year-olds. The animals were therefore separated into annual classes. Segregated counts were made from aerial photographs taken in spring and counts made on the ground in other seasons. In 310 photographs, 48,070 caribou were counted, but of these only 6,496 were clear enough to be segregated under a binocular microscope. During ground observations, 7,239 were segregated. The segregated counts made of the various herds are given in Table 32. Post mortem examination yielded further data.

Sex Ratios.- It was hoped to examine a great number of young calves soon after birth, but unfortunately, because of travelling difficulties in June, the youngest calves observed were about three weeks old. Of eleven calves under one month of age observed at close range, seven were males. This small sample gives the secondary sex ratio of 175 males:100 females.

The sex ratio at maturity was determined from a segregated count of 12,023 adult animals to be 35.8 males:100 females. This indicates a greater mortality among males than among females.

Age at Maturity.- In April, 1948, a young pregnant female was examined at Churchill, Manitoba. The animal was classed as a two-year-old by antler development, tooth eruption and wear, and body measurements. This means that the animal was sexually mature as a yearling and bred when it was approximately 17 months old. From trappers reports it seems that yearling cows rut regularly. It appears from observations at Ilford, Manitoba in November, 1948, that young caribou bulls two or three years old are sexually mature. It is unlikely, however, that they are successful in servicing many cows.

Twinning.- Of nine cows examined following the rut, six, or 67 per cent, were pregnant. No instances of twinning were observed among autopsied cows, nor were any reported by trappers interviewed. Two or more calves are frequently observed following a single cow in the summer, but this is not a positive indication of twinning, for calves frequently play together and may follow a single cow for a short period.

Annual Increment.- The observations regarding the annual increment of calves and their survival to maturity are recorded in Table 33. It will be noted that the annual calf increment which is recorded as a percentage of the adult cows, varied from season to season and from herd to herd. The annual increment varied from 31.6 to 79.6 per cent of the cows. The latter count was from a relatively small sample. Some counts of yearlings were as high as 50 per cent which may indicate a high calf increment in the previous season. The average calf increment at the age of two to four months was 40.2 per cent of adult cows. In a segregated tally of 13,566 caribou, 7,266 cows were counted. They formed 53.8 per cent of the herds. The annual calf increment therefore composes 21.6 per cent of the herds. In a total estimated population of 670,000, this amounts to an estimated annual increase of 145,000 calves.

The observations are too scattered to form a clear picture of the progressive mortality of the calves in the various herds. There are some figures on mortality of the 1947 calf class and the 1948 calf class of the Brochet herd. The average survival of calves to the age of one year was found to be approximately 64.3 per cent, and to the age of two years approximately 40.5 per cent, of the original crop. This latter figure gives the approximate average number of calves which survive to bear young.

Mortality Studies

Ideally, the numerical effect of each mortality factor should be determined. Unfortunately, under field conditions and with the techniques available, it was impossible to obtain this information. When considering each reduction factor, some information about the age classes affected can, however, be furnished.

The lower mandibles picked up from caribou carcasses found during the investigation provided interesting information on differential age mortality. A total of 292 were aged approximately according to the reindeer tooth wear graph given in Figure 21. An analysis of the approximate age classes is given in Table 34. It will be noted that approximately 53.1 per cent of the mortality occurred during the first three years of life. A great deal of this early mortality was due to selective hunting by humans for hides, as many of the carcasses were found about native camps.

In order to study the diseases and parasites of caribou, post mortem examinations were made on 77 animals. These specimens were animals killed by hunters, carcasses found, disabled and sick animals killed for examination, and specimens taken for museum purposes. It was found that the caribou population was quite healthy, compared with populations of elk (Cervus canadensis) and moose (Alces americana) which have been studied in the national parks.

External Parasites

Warble Fly

The most prevalent parasite of the barren-ground caribou is the warble fly (Oedamagena tarandi). This fly is common throughout the entire range of the species, as well as in the reindeer ranges of Alaska and the Mackenzie Delta. Every trapper and native is familiar with its larvae, which lie beneath the hide, and with the holes which they pierce through the hide. It is of economic importance because of the damage caused to the hides.

The warble fly is a large orange and black, hirsute, bee-like fly, which, as an adult, is on the wing on the tundra for about three weeks in the months of July and August. The exact period during which it is active depends upon the weather. In 1948, there was a warm early summer on the tundra and warble flies were observed on the wing from about July 10 to August 4. After the latter date no flies were observed among the caribou bands. The summer of 1949 was delayed and cold, and warble flies were not observed until August 1. From then until August 19 they were very common at Contwoyto Lake.

The fly makes a low buzz in flight and progresses in rapid darts, often alighting on rock surfaces. It usually flies at an elevation of one to five feet above the ground. On August 4, 1948, at Lake Clinton-Colden a female warble fly alighted on the ground at a distance of about three feet. After extending its ovipositor, it flew up and struck the writer's elbow with enough force to cause a brief sharp tingle. Its buzz and strike may be enough to draw the attention of the caribou.

Males flies were frequently observed and collected from the faces of wounded and freshly killed caribou. The sexes probably meet at the caribou. Copulation on caribou antlers and on rocks in direct sunlight was noted.

Flies were observed to alight on the caribou's hocks, rump, flanks, back, and antlers. The eggs, which are about 1.5 mm. in length, are deposited on the hair, in small groups of two to five. They are attached in a series near the base of the hair, which is short at this time. Females in the act of depositing eggs are shown on the leg of a wounded animal in Figure 27.

Some time later the eggs hatch and the larvae bore through the hide and migrate between the flesh and the hide towards the back region. According to Dove and Cushing (1933) the larva of the caribou warble fly travels directly to the back region under the skin without penetrating the body cavity as does larva of the cattle warble fly (Hypoderma sp.). No internal evidence of larvae during late summer and early autumn was found during the present investigation.

In carcasses examined in Manitoba during November and December, 1948, the majority of larvae were found already attached to the under-surface of the hide, while other small, slender larvae were found burrowing through the fascia.

Even in late January, 1949, three small larvae were found still free in the fascia, in a specimen examined in northern Saskatchewan.

By autumn most of the larvae take up a position against the under-surface of the hide. A small round hole is bored through the hide to act as a breathing orifice. The host tissues deposit a tough integument about each larva, because of the irritation it causes, and it thus becomes encapsulated. The location of the attachment includes the back, shoulders, and rump, except on the mid-dorsal line, where the dorsal spines of the vertebrae cause friction against the hide (Fig. 29).

During winter and spring the larvae grow within their capsules and gradually assume a position perpendicular to the hide. The breathing orifice is enlarged. Until early May the larvae are creamy white in colour. By May, they start to turn brown. Parallel rows of spines are developed on the segments. At this time the larvae are about the size of a man's terminal thumb joint. They are exceedingly active and pulsate within the capsules, probably causing great irritation to the host. In June, or early July (Palmer, 1926), the larvae enlarge the breathing orifices and squirm out, dropping onto the caribou trails, where they pupate. Pupation takes two to three days (Sdobnikov, 1935). The pupae are dark brown, segmented, ovoid, chitinous capsules. During August, 1948, three pupal cases were picked up on the caribou trails at Clinton-Colden Lake. The length of the pupal stage varies from 18 to 42 days depending on the temperature (Sdobnikov, 1935). The pupae are subject to losses in snow, water or excessive rain. The adult flies emerge from the pupal cases.

During the months of July, August, and September, the caribou are either free of the parasites, or the larvae are moving freely through subcutaneous layer of fascia. During this period the punctures from the previous season's larvae heal and become replaced by small round spots of scar tissue. It is during this period, when the warble scars are of little significance, that the hides are taken by Eskimos and Indians for winter clothing.

Late autumn and winter hides are useless as winter clothing because of the density of the hair. Hides taken at this time are generally used for sleeping robes, beds, igloo insulation, etc., and the warble punctures do not greatly affect these uses. Warble damage to the hides affects human interests significantly only in connection with the Indian production of "buckskin" which is chiefly obtained by tanning hides taken in winter. At this time the numerous warble punctures limit the size of unblemished pieces of hide.

Warble fly infection is universal among the caribou herds. Twenty-five specimens examined during the period when the larvae were evident were all infected to a greater or lesser degree. The least number of warbles counted was five, the greatest, approximately 300. On one hide it was estimated that there were 40 larvae per 20 square inches of the most heavily infected portion of the hide. The average number was 70 per hide, on 15 specimens on which the number of warbles was counted or closely estimated.

The warble scars on a hide may be counted easily. On a mature bull examined, there were approximately 350 scars from shoulders to tail. On another there were 135 scars. On yearling hides there are rarely more than five scars. The sexes do not seem to be similarly infected. In general, adult bulls seem to have the heavier infestations. This is probably accounted for by the migratory habits of the bulls. They usually follow the cows northward in spring and spend the summer farther south than the cows. In this way they pick up the warble flies which emerge as larvae from the leading cows.

Calves generally are lightly infected by warbles. They may carry only four or five larvae or be free of this parasite during the first winter. It seems likely that the flies show a preference for adults.

Heavy infestations of warbles have no significance as a mortality factor, unless as one of a series of factors causing general debility of the host. In two specimens examined there had been infection of single larval capsules by pyemic bacteria, with the resulting formation of a pustule. In other cases some of the larvae had died and had been encapsulated. In a couple of old caribou specimens the superficial back muscles were pitted from former bacterial infections of the larval capsules.

When adult warble flies are on the wing the caribou are exceedingly restless and they react violently to the attacks of the flies. During the height of the summer fly season much of the behaviour of the animals is action intended to evade the attacks of flies. At this period it was found possible to creep within 20 yards of animals and see the warble flies through binoculars. Often it was impossible to determine if the evasive action was due to the attacks of warble flies or to the hordes of mosquitoes and black flies. In general, it seemed that the warble flies were the main cause of alarm.

Under attack by these flies, the caribou spend little time in feeding and dash about wildly. They collect on promontories, where a slight breeze may keep the insects down. The caribou stand with their rumps to the wind and their heads down. Often the face is held in the shelter of a large rock. At other times animals will stand in wet sedge meadow with the legs deep in the ooze, and the head lowered into the sedges.

When a warble fly approaches, the animal stiffens; the muzzle is pointed stiffly down. The head, antlers, and hide are shaken. The feet are stamped and the head may be quickly turned to bite at a flank. If the attacks become unbearable, the animal races wildly away. Occasionally a caribou may dash wildly past a human, passing within a few paces; apparently it is oblivious to everything except the insect tormentors.

Often the caribou seek relief in the ponds and marshes, splashing through the shallow water or swimming into the deeper water.

On August 15, 1949, at Contwoyto Lake, the migrating bands were tormented by warbles and hosts of black flies. A group of about 20 bulls was observed on an esker, where they were gathered in a tight circle, with their

heads lowered in the centre. The circle rotated slowly, with the animals moving sideways. Occasionally one would toss its antlers. Individuals would suddenly dash away, the circle would close, or other animals would join the formation. At one period there were two such milling bands. Finally the circles were broken as the animals broke away. In this formation, the caribou probably protected their forequarters and flanks from the attacks of warble flies. It resembled the "tandara" formation used by reindeer herders to protect the reindeer.

At this season the caribou receive some respite during the twilight hours, since the flies are diurnal in activity. It is at this time that the caribou migrate and feed.

Nostril Fly

The barren-ground caribou is also host to a second parasitic fly, the nostril fly (*Cephenomyia nasalis*). During the investigation little information about the life history of this fly was obtained. It is known that the adult fly is a large, black, hirsute, bee-like insect. The adults are on the wing during a short period in the summer. They are viviparous, the eggs hatching in the oviduct. The female deposits minute larvae in the nostrils of the caribou. These immediately migrate into the nasal passages. In late winter they become attached to the nasal mucosa in the naso-pharynx region where they appear in small clusters in pockets in the mucosa behind the hard palate. By April the larvae are about an inch long and one quarter of an inch in diameter. They are very active and pulsate in their attached positions. When mature they detach themselves and are coughed out by the host. They fall to the ground and pupate. This takes place from May 16 to August 6 (Sdobnikov, 1935). Pupation takes five to six hours. The pupal stage lasts from 16 to 56 days depending on temperature. The first emergence of adults reported is July 17 (Sdobnikov, op. cit.).

Of 25 specimens examined when larvae were evident, 24 per cent were infected. The number of individual larvae per host varied from 10 to 40. Infected animals were observed at Ghost Lake, Mackenzie District; Nueltin Lake, Keewatin District; and Churchill, Manitoba. It seems that the effects of this parasite are local and that the rate of infection may vary from year to year.

Heavy infection of nostril flies causes severe distress. In late spring infected caribou were observed coughing and sneezing. It does not seem likely that this parasite is a direct mortality factor. It may have a secondary effect in relation to predation. During late spring it was noted that when the caribou bands were forced to run, many ran with mouths open and tongues out. Examination showed that some of these animals had their nasal passages almost blocked by parasites. It seems likely that such animals would be at a physical disadvantage in a long pursuit and that heavy infestations of nasal fly larvae might lead to greater mortality by predation.

No adult nostril flies were found. It is likely that, during the period when they implant their larvae, they harry the caribou in the same way as the warble flies do. On July 13, 1949, at Bathurst Inlet, a calf and a young bull were observed to react violently when they wandered independently into a small wet depression. Both animals shook their heads violently, sneezed, and raced down wind. The calf stood on its hind legs and pawed at its muzzle with its forelegs. No warbles were observed on the wing at this date. It was thought likely that the animals had been attacked by a nose bot fly.

Mosquitoes and Black Flies

The hordes of mosquitoes and black flies (Simulium sp.) which are found upon the tundra during the summer months are well known through the writings of northern travellers. The torment they inflict upon all warm-blooded creatures is difficult to describe. Lemmings, ground squirrels, nesting birds, and caribou are surrounded by clouds of these insects during calm days.

These insects attack the caribou where the fur is thin. Favourite objectives are lips, muzzle, ears, eyes and other parts where the hair has been rubbed off. Summer specimens examined had the ears swollen with numerous small blood scabs and the eyes and lips ringed with hundreds of mosquitoes and black flies. In the fur were thousands of flies. During July the caribou are moulting and generally have areas devoid of hair, and this makes them extremely vulnerable to the insects.

Munn (1932) wrote that he observed that when the caribou migration passed in late summer, the mosquitoes followed the herds, deserting the area behind the caribou. Although this is an interesting explanation, in reality he probably experienced the termination of the tundra fly season, as the caribou investigation party did at Clinton-Colden Lake on August 4, 1948, just prior to the arrival of the caribou in that area.

Mange

On two specimens examined there were large areas of hide devoid of hair and covered by scabby flakes. The areas involved were the brisket and flank. The symptoms suggested a case of sarcoptic mange caused by an infection of mange mites (Sarcoptes scabii). At present, examinations have failed to demonstrate the presence of mites from the specimens.

Internal Parasites

The barren-ground caribou serves as an intermediate host for a series of cestode parasites of native Canidae.

Dog Tapeworms

The commonest internal parasitic infection of the caribou is that of the dog tapeworm (Taenia hydatigena), in the cysticercus larval stage. It occurs as a creamy fluid-filled vesicle with a yellow head, encysted in the liver, mesenteries, or heart. It has been previously reported under the name Cysticercus tenuicollis in the Newfoundland caribou (R. caribou terranova) by Dikmans (1932). This is the name under which the intermediate cysticercus was formerly known. The liver may carry a single vesicle or in heavy infections several vesicles may be found. The average number of larvae was 2.6 per animal. The highest count was 14 in a single liver.

This parasite occurs as an adult tapeworm in the intestines of the wolf (Canis lupus), the Arctic fox (Alopex lagopus), the red fox (Vulpes fulva), and the sleigh dog. The eggs leave the body of the terminal host in its faeces. They are extremely resistant and viable for a long period. In the course of weathering they wash out of the faeces and are splashed on the surrounding vegetation. They are then eaten by the caribou as it grazes on the low vegetation.

The eggs pass through the stomach and hatch in the intestine. The larvae penetrate the intestinal mucosa and probably enter the venous blood system, by which they are generally carried to the liver through the hepatic portal vein. In the liver they become encysted in the glandular tissue, and continue their development into cysticerci. The host tissue builds tough integument about the vesicles, forming cysts.

The caribou must carry a certain resistance to this parasite, for three examples were found where the cysticerci had died and the host tissues had re-organized the area, leaving a tough white necrotic patch. Light infestations of this parasite probably have little effect upon the general health of the caribou. With heavy infestations, the function of the affected organ may be impaired, leading to general debility of the animal.

If, upon the death of the caribou, the liver, lungs, or entrails are eaten by a wolf, fox, or dog, the vesicle is opened and the scolex is released into the intestine of the carnivore. Here the scolex attaches itself to the intestinal wall and proliferates the series of proglotids that make up the adult tapeworm.

This is a natural cycle in the wolf and caribou populations of northern Canada. Heavy infestations of tapeworms in the wolves also cause debility, which makes them more vulnerable to the effects of other mortality factors.

This parasite is of economic importance as a parasitic disease of northern sleigh dogs. The feeding of sleigh dogs with caribou viscera infects them with the dog tapeworm. Heavy tapeworm infestations cause weakness and lassitude in dogs and leave them more vulnerable to other diseases. The natives habitually feed such offal to their dogs. The Eskimo method of cacheing caribou

carcasses with the liver and thoracic viscera intact, as observed at Contwoyto Lake, permits widespread infestation of their dogs.

The caribou also functions as the intermediate host for a second dog tapeworm (Taenia krabbei). The cysticerci of this tapeworm appear as small vesicles about 5 mm. in diameter, encysted in somatic muscles and diaphragm. They are frequently found in the superficial muscles of the rump and shoulders. Of 54 animals critically examined, 28 per cent were infected. The life history and economic importance of this tapeworm are similar to those of T. hydatigena.

A specimen of caribou muscle sent from Baffin Island was found to have a multiple infection of Taenia ovis, another of the same group of canine tapeworms.

Granular Tapeworm

Of importance was the discovery of two caribou with coenuri of the granular tapeworm (Echinococcus granulosus). One specimen was killed on the Hudson Bay Railway, Manitoba, on November 23, 1948, the other at Nueltin Lake on September 7, 1948. The adult form of this tapeworm is about one-half inch long, is composed of a scolex and three segments, and is located in the upper small intestine of Canids. It has been reported from wolves and coyotes (Canis latrans) in Canada by Cowan (1949). The life history of this tapeworm is similar to that of the dog tapeworm, except for the location of the coenurus in the intermediate host. Large game animals such as moose (Alces alces), and elk (Cervus canadensis) are the usual intermediate hosts. To this list can now be added the barren-ground caribou. The coenurus is a large, fluid-filled vesicle which may vary in size from that of a walnut to that of a grapefruit. It is generally located in the lungs. It contains many independent scolices. The manner in which the larva reaches the lungs is probably different from that of the Taenia group.

This parasite naturally completes its life cycle in the barren ground caribou and the wolf, in the tundra and northern taiga regions of Canada, taking advantage of the predator - prey relationship between these two animals. Under average conditions it probably has little effect upon the individual's general health; with heavy infestations it probably causes general debility.

The importance of this parasite is that it is also known as a parasite of man. The form which occurs in man is the coenurus, the same that occurs in the caribou. The location of the vesicle may be different from that in game mammals, as it has been found in the liver, lungs, kidney, abdominal wall, and brain of man. Frequently there is a variation in the life history, with the formation of secondary vesicles, called brood capsules, containing scolices which bud off from the primary vesicle. This parasitic disease is sometimes lethal, especially when the vesicle forms in the brain. The cysts can be removed only by surgery, if and where that is possible. The fluid from the vesicle is highly toxic and the danger of anaphylactic shock is great. This parasitic disease of man is more common in Canada than is generally believed. There have been about 37 cases reported in Canadian hospitals in the past 15 years (Davies, 1946).

Future medical examinations of northern Eskimos and Indians will probably show a high incidence of this parasitic disease. A case has already been reported in a young Indian girl from northern Ontario (Bartlett, 1948). Officials of the Indian Affairs Medical Services reported a case of a Northwest Territories Indian in a Vancouver hospital for surgery early in 1949.

Humans become infected by swallowing the eggs that occur in canid faeces. It is probable that humans are infected from domestic dogs, which in turn become infected by eating the viscera of caribou. Because of the general lack of sanitation in northern camps and the close association of natives with their dogs, the way is open for the infection of the adults and children through the fur of the dogs and from the ground in the vicinity of the dog lines. Recent medical investigations (Saunders, 1949; Brown, 1949; Wherrett, 1945) have indicated that northern groups of natives support a relatively high infection of parasitic diseases. This is correlated with their close association with the natural fauna and their domestic animals and their primitive level of sanitation and food preparation.

Besides the natural cycle of the granular tapeworm in wolves and caribou, there seems to be a secondary domestic cycle developed to a small extent through caribou, sleigh dogs, and man.

The Nueltin Lake party reported the finding of an intestinal tapeworm in a caribou specimen. At the time of writing there has been no further determination of this specimen. It is probably a member of the genus Monezia, the species of which are intestinal parasites of ungulates.

Thread Lungworm

Besides the previously mentioned cestode parasites of caribou, there is a prevalent nematode infestation. Infestations of a thread lungworm possibly (Dictyocaulus viviparus) are widespread in the caribou herds. The adults are thin roundworms, of creamy colour, about one or two inches in length. They may be found in the bronchioli and in terminal portions of the lung lobes. Light infestations are probably of little significance as a mortality factor. Heavy infestations may cause lung hemorrhages and edema. This condition among big game mammals is known as verminous pneumonia.

Of 58 animals critically examined, 24.2 per cent were found to carry infestations of adult stages of this nematode. Gross examination of the lungs showed light to moderate infestations of adults. From five to twenty adult worms were found. Had microscopic examinations of the lung tissues been made, it is likely that eggs and larvae would have been found in other specimens.

The animals become infected by eating vegetation which carries the larvae of the nematode. The larvae are splashed on the vegetation by the coughing and sneezing of heavily infected animals and through faecal contamination. The larvae are extremely resistant to freezing and drying but do not survive putrefaction of a carcass. Heavy infestations of this parasite are

usually associated with crowded conditions on the ranges of big game species. The caribou infestations were much lighter than those observed in the elk of certain national parks.

Other Internal Parasites

Hadwen and Palmer (1922) reported the discovery of a protozoan Sarcosporidia infection in one caribou. It produced lesions of "pitting" on the surface of bones and tendons. Hadwen (1922) also reported the discovery of a new nematode, Nematodirus tarandi, in the Alaskan reindeer. It is possible that these parasites may also be present in the barren-ground caribou. Lawrie reported finding two infections of nematodes in the alimentary tracts of caribou he examined. These specimens have not yet been identified.

Bacterial Diseases

Attempts were made in the field examination of carcasses to take note of any gross lesions which might point to bacterial infections. About 20 blood smears were obtained, but examination of these specimens failed to yield any evidence of protozoan or bacterial infections. Seven bulk blood samples were also secured. Poor success in keeping the specimens was experienced under aseptic field conditions. All but two of the samples hemolysed before reaching the laboratory. The remaining two blood samples were examined at the Animal Diseases Research Institute, Hull, P.Q., and were pronounced to be negative for contagious abortion (brucellosis).

Tuberculosis

On January 3, 1949, the warden at Fort Simpson, Northwest Territories, bought from the natives five thighs of caribou which showed tuberculous lesions. A specimen was sent to the Alberta Department of Agriculture Laboratory at Edmonton, Alberta, where it was diagnosed as an infection of tuberculosis. The discovery of this probable infection of Mycobacterium tuberculosis var. bovis suggests that bovine tuberculosis is endemic in the barren-ground caribou herds of northern Canada. It seems unlikely that caribou taken near Fort Simpson would have come in contact with buffalo (Bison bison) at Wood Buffalo Park, or with domestic stock during previous migrations. This condition is under continued study.

Joint Ill

On August 13, 1948, a very lame old bull caribou was observed on the shore of Lake Clinton-Colden, Northwest Territories. The animal limped badly and rose on its hind legs stiffly to turn about. On post mortem examination it was found to have two large pyemic vesicles, one in the right tarsal joint and the other in the right carpal joint. The posterior one was suppurating to the exterior through an orifice. In foals such localization of pyemia is known as joint ill. The pathogenic factors involved are a complex of pyogenic bacteria

including Staphylococcus aureus and Corynebacterium pyogenes. On a later occasion a limping calf with swollen joints was observed. It is likely that it was suffering from a similar bacterial condition. Caribou affected with joint ill would be more vulnerable to the attacks of predators.

Actinomycosis

Examination of 380 caribou skulls found during the investigation, as well as of the specimens killed, indicated a widespread infection of a disease resembling lumpy jaw (actinomycosis). Two organisms are involved in the formation of the lesions of this disease; Actinomyces bovis attacks the teeth alveoli and the bony tissues, and Actinomyces necrophorus attacks the soft tissues of the tongue, gums, and cheeks. These organisms are universal in distribution. It is believed that they find entry to the tissues through abrasions to the gums and cheeks caused by abrasive vegetable foods. In the case of the caribou the identity of the causative forage plants is unknown.

There is still considerable confusion about this disease. In reality there are two or three closely related diseases. Actinomycosis is a chronic disease of ungulates, such as sheep, cattle, and deer. It is caused by infections of the ray fungus, Actinomyces bovis. This organism attacks the bones of the skull, especially the maxillae and the mandibles, causing necrosis of the alveoli and exostosis of the mandibles. The resulting malocclusion and loss of teeth interfere with normal feeding (Fig. 30).

Necrotic stomatitis is an acute disease of ungulates and man. The causative organism is Actinomyces necrophorus, which attacks the soft tissues of the mouth-gums, tongue, and cheeks, causing the formation of ulcers and caseo-necrotic areas. Other focal points for infection may be on the internal alimentary organs. The disease usually pursues a rapid course resulting in death.

A third disease, actinobacillosis, also known as wooden tongue, is caused by Actinobacillus lignierisi which causes ulcers on lymph nodes, skin, muscles, and tongue.

Of 65 specimens examined, one exhibited the gross lesions of the cheek typical of an infection of Actinomyces necrophorus. Of 380 skulls examined from the caribou range, eight exhibited typical lesions of necrosis of alveoli and exostosis of the mandibles indicating a ratio of infection of approximately 2.1 per cent of a disease, similar to actinomycosis. This incidence of infection is lower than that in national park ungulates. Lawrie also reported finding lesions in the heart valves of one specimen and a pyemic lesion on the antler of another which seemed to indicate bacterial infections.

It is difficult to give a quantitative assessment of the significance of the above pathological conditions as factors in the mortality of caribou. Probably the animal parasites described are seldom the primary cause of death for caribou. Heavy infestations, however, by causing general debility, open the way to other lethal factors, such as predation, severe climatic and

forage conditions, as well as more serious diseases. It was generally observed that the heaviest parasitic infections were found in old animals, which could often be picked out of a herd by their poor coat, slight antler development, and lagging gait. Resistance and immunity are also important.

Bacterial and fungus diseases, such as tuberculosis and actinomycosis, are probably lethal. Occasionally the deaths of caribou whose carcasses are found on the range cannot be assigned to causes other than disease. In the present investigation, at least five carcasses of these were found. They seemed to be the carcasses of old animals.

Accidents

Accidents cause the deaths of many caribou annually. Several trappers reported finding bulls with antler punctures. It is not likely that many bulls succumb from rutting wounds because the sparrings of the bulls are mostly bluff. Sgt. W. Morris of the R.C.C. Signals, Fort Reliance, N.W.T., reported that in November, 1948, a young bull caribou was watched crossing the newly formed ice of Great Slave Lake. It fell through a weak spot and spent about three quarters of an hour threshing about in the freezing water. It finally succeeded in clambering out onto the ice. The animal was exhausted and crossed the ice slowly, lying down frequently to rest. Because of their habit of crossing frozen lakes and rivers during migration it seems likely that some caribou perish by breaking through new ice and are so weakened thereby as to fall prey to the attacks of wolves. In November, 1948, Lawrie reported seeing two carcasses frozen in the thin ice of lakes.

An old Indian chief from Slit Lake, Manitoba, confided during a discussion that the only caribou he had secured during the autumn of 1948 was found lying with broken legs at the foot of a cliff. He said this was not an unusual discovery. Considering the rough nature of much of their range, it seems likely that a few caribou suffer broken limb bones. Seton (1911) reported observing a lone caribou with a broken leg on an island in Lake Clinton-Colden. He speculated that it might have sought sanctuary on the island.

Although the above-mentioned accidents probably cause the death of a few caribou annually, observations indicated that the majority of accidental deaths are caused by drowning at rapids and waterfalls. Clarke (1940) reported the finding of more than 500 caribou carcasses at the foot of Helen Falls on the Hanbury River, by a police patrol. During the present investigation it was found that other large rivers take a significant toll of caribou. In the course of a patrol, on July 5, 1949, up the Lockhart River from the site of old Fort Reliance to Tyrrell Falls, about 10 caribou carcasses were found stranded on gravel bars. Along the shore of the pool at the base of the falls were the skeletal remains of 31 more caribou. It was concluded that these animals had been carried over the falls to their death, or had perished along the river bank and had been washed down stream (Fig. 31). On July 29, 1949, the fresh carcasses of two adult bulls were observed below the falls at the mouth of the Burnside River.

The attraction of rapids and waterfalls for migrating caribou herds has already been discussed under migratory behaviour. It seems probable that the many large, swift rivers which transect the caribou range take an annual toll of some thousands of caribou. It seems likely that all age and sex classes suffer from this factor.

Weather also plays an important role as a mortality factor for the caribou population. The greatest losses are suffered by newborn calves when exceptionally severe weather conditions occur during the calving season. During June, 1947, there were unseasonable blizzards on the southern tundra. Mr. Turner of Eskimo Point, Keewatin District, reported finding the tundra about Kaminak Lake littered with the carcasses of newborn calves. He estimated an 80 per cent calf loss in the Keewatin District herds that season.

Severe weather conditions during the rutting season may affect the number of fertilizations. Trappers reported finding fewer fetuses in some years than in others. Severe winter conditions, such as blizzards and crusting of snow, may cause local heavy mortality by making foraging difficult.

There is no way of estimating accurately the annual mortality due to disease, accidents, and weather. This mortality probably varies from year to year, and from herd to herd. Few carcasses were found which were assigned to these mortality factors, yet at times these factors exert a powerful influence on the caribou population. Based upon the results of other big game investigations, it is estimated that these factors take an annual toll at least as large as predation. Sdobnikov (1935) reported a 6.4 per cent loss among the Siberian reindeer herds from disease.

Predation

The biotic communities of the tundra and taiga are relatively little influenced by civilized man. The populations of the various species are kept below the saturation point of the environment by a combination of natural controls. One of the most obvious of these is predation.

The most important natural predators of the caribou are man and the wolf. The record provided by Pleistocene drawings from western Europe confirms that these three species have existed together for thousands of years. This is a comment on the productivity and resistance of the caribou. Primitive man was a member on the same footing with other members in the biotic community.

Wolf Predation

Next to man, the wolf (Canis lupus) is the most important predator of the barren-ground caribou. The relationship between the wolf and the caribou is a close one. In consequence, the wolves of the caribou range are nomadic during the greater part of the year.

Distribution of Wolves.- During the late spring and early summer months, wolves are relatively static. The family packs stay within a days travel from the dens. In late summer the whelps are old enough to travel and the pack wanders in search of food, and during this period the whelps are taught to hunt. For the remainder of the year, autumn, winter, and early spring, most of the wolves follow the migrating herds of caribou. A few old or outcast individuals may lead a nomadic life all year. During the present investigation practically all the wolves observed from the air (Figs. 32 and 33) were associated with herds of caribou.

During the early summer months, the wolf population is scattered over the tundra and the northern regions of the taiga. Clarke (1940) thought that the distribution was fairly even over this vast area, and estimated that there were approximately 40,000 wolves in the caribou range. During the aerial reconnaissance flights of the present investigation only 81 wolves were observed. Over large portions of the tundra, wolves were exceedingly rare or absent. The observations and information indicated that they were rare east of Bathurst Inlet to Hudson Bay, north of the Back River, and on the Peninsulas. This is confirmed by Manning (1943). On the more southerly portions of the tundra, near timber-line, wolves were fairly common. Wolves den commonly in the vicinity of Muskox, Aylmer, Clinton-Colden, and Nueltin Lakes, and the Hanbury, Upper Thelon, Dubawnt, and Kazan Rivers.

During the spring migration, the herds of caribou are followed by packs of wolves. On April 24, 1949, about 100,000 caribou were observed on Ghost Lake. Among the caribou herds approximately 20 wolves were observed. These were seen feeding on carcasses and in pursuit of caribou. As the migration continues, the wolf packs drop off and seek denning sites to rear their young. In July, the same herd was under close scrutiny for three weeks upon the calving grounds at Bathurst Inlet. During this period, wolf predation was negligible; one wolf and the tracks of a second were all that were observed. At this time there was very little calf mortality caused by wolves. Calf mortality generally occurs later in the summer, when the herds travel towards timber-line.

Home Life of Wolves.- Studies were carried out in 1948 by Mowat at two wolf dens near Nueltin Lake, Keewatin District, in an area where no caribou were present during the early part of the summer when the whelps were being raised. One den site was on one of the terminal knolls of a large esker which spilled into Windy Bay. Across Windy Bay and six miles from the first den, a second pack had a den on the same esker. (Eskers may be the sites of the majority of wolf dens on the tundra; the writer also discovered a den on an esker at Sussex Lake, Mackenzie District on July 13, 1948.)

The entrance of the natal den at the first den site had diameters of 19 and 15 inches. The burrow sloped down for 14 feet and then turned into a nest cavity about four feet below the surface. Besides the natal burrow, there were three more; one of these had been used in 1947; the two others had caved in. On nearby knolls were fresh "beds". According to C. Schweder, a trapper whose cabin was approximately three-quarters of a mile away, the location had been used by

wolves for at least ten years. On another knoll nearby there were 12 discarded dens in an area of about five acres. The den site was near a major caribou crossing point, much frequented during migration periods.

There were three adult wolves, a mated pair, and a second young male, as well as four whelps, at the den during the summer of 1948. The territory hunted by the pack during the summer, estimated to be approximately 90 square miles, was bounded on the south by Windy Bay. The den was on the edge of the territory. The hunting area of the pack at the site across the bay was estimated to be approximately 84 square miles.

The territory of the first pack was used from May to October. The snow still lay deep on the ground when the wolves arrived in May. The length of the den burrow was increased by a three-foot burrow through the snow.

Observations at the natal den were commenced on June 13, 1948. On June 23, between 5.00 p.m. and 9.16 p.m., the bitch carried the pups from the natal den to a summer den, three-quarters of a mile away. She carried the first two pups, one at a time, by the scruff of the neck, but on the last trip carried two with difficulty. The summer den was in a rock crevasse in a talus slope under a 20-foot rock fault. In the boulder pile were numerous crevasses and small caves.

Mowat used a small tent as a blind and made 40 hours of observations of the dens, distributed through the 24-hour day, in the period from June 13 to July 6. A 12-power binocular was used. The presence of the blind which was in clear view of the den at a distance of approximately three-quarters of a mile, seemed to have no effect upon the activity of the wolves.

During the early afternoon, two adult wolves were usually resting at the lookout. They seemed to rest fitfully, frequently raising their heads for a quick glance about the horizon. In late evening there seemed to be an increase in hunting activity. From midnight until morning, one or more wolves were away from the den on extended hunting forages. There was much companionship shown between the different wolves, and some frolicking. The pups played together in a small glade near the den. During the observations meat was thought to have been brought to the den on only one occasion. Generally the wolves hunted individually and fed by themselves away from the dens.

There were very few caribou remains about the dens. Fragments, mainly of limbs, of seven animals about the den may have been several years' accumulation. From June 13 to September 24, nine caribou carcasses were found upon the tundra within the range of the hunting wolves. Some of these also were several years old and some may have died from causes other than wolf predation. All appeared to have been utilized by wolves.

From June 17 to August 20 it was known that there were no caribou in the vicinity, as the herds had continued farther north. During this period the wolves were observed hunting for lemmings and mice in the swales and eating dead fish found along the lake shore and a dead herring gull. On two occasions

wolves were observed to swim into the lake in pursuit of ducks. The wolves also gnawed the antlers and bones of old caribou carcasses and consumed sections of caribou hide and hair. This is a cause of confusion in the analysis of wolf scats, since the presence of caribou hair may indicate consumption of old carcasses as well as fresh kills. Mowat's observations are in direct contradiction to the hunting observations made at Ghost Lake, Mackenzie District, and indicate drastic change in diet between the denning and winter nomadic periods.

Hunting Activities of Wolves.- During the investigation there were several opportunities to observe the hunting activities of the wolves among migrating caribou bands in late summer. On August 11, 1948, Lawrie and Mowat observed, across a wide valley, the hunting tactics of a pack of three wolves at Angikuni Lake, Keewatin District. The wolves were in line abreast and 200 to 300 yards apart. They were in plain view of eight scattered bulls, which they passed at ranges of 200 to 600 yards. Caribou farther than 300 yards from the wolves ignored them, even though the wind was favourable. The nearer caribou snorted, jumped a few paces, and watched the wolves passing. The wolves later drew together forming a sociable group, then spread out again. One of them explored a small draw and flushed a calf out of a clump of willows at a range of 100 yards. The wolf gave pursuit while its companions sat on their haunches and watched the chase. In the first 50 yards of the chase, a cow and a calf were flushed from the willows and these ran beside the wolf on a converging course until about 50 feet separated them. The wolf then gave up the pursuit of the first calf and swung towards the second. It seemed likely that the wolf could have overtaken it, but after another 50 yards it stopped, after having run only about 100 yards in all.

The first calf had stopped and watched the chase. At this point a second wolf trotted in his direction. When it was about 100 yards away, the calf turned and fled. The second wolf made a quick burst of speed for about 25 yards, but then slackened to a walk and sauntered on. In the meantime the cow and calf circled back and passed within 100 yards of their former pursuer, which ignored them. The wolves continued abreast across the swale. One stalked a yearling, which let it approach within 75 yards before fleeing in a circle. The wolf did not follow, but joined its companions.

A similar observation was made by the writer at 8.30 p.m. on August 4, 1948, at Lake Clinton-Colden. The migration of several large bands of caribou was being watched, when suddenly a large group was observed to become agitated, many peering towards a knoll and others trotting about restlessly. Upon a second glance through the binocular a large white wolf was seen to come out from behind the knoll. The caribou turned and fled in a compact group of about 50. Both wolf and caribou maintained top speed for about 100 yards, during which time the wolf seemed to be losing ground. It quickly gave up the chase. Other bands to the flank ignored the chase.

On other occasions the pursuit may be continued for a much longer period. On August 14, 1948, Wilk observed a calf run past him at Lake Clinton-

Colden. The animal was winded, with heaving flanks and open mouth. It passed Wilk at a distance of about 30 yards without paying any attention to him. He watched it gallop down to the shore of the lake, wade into the water, take a drink, then pick its way slowly along the rocky shore. About five minutes later a yellowish wolf came over the hill at a fast trot, with its nose close to the ground, following the calf's trail. The observer tried to hide behind a rock, but the wolf noticed the movement and, after a brief pause, wheeled and trotted off. From the appearance of the calf, the chase had probably been a long one; had it not been interrupted, the calf would probably have taken to the water and escaped.

Wolves use two techniques in hunting caribou. The first method is a patrol, by which the wolves flush caribou at close range and then pursue them. The second method is my stalking when the wind is favourable and the caribou are sighted.

On August 8, 1949, Wilk was searching for caribou on the Hanbury River. Glancing up, he saw a lone wolf trotting along a ridge which approached his path at an angle. As the paths converged, the wolf assumed a stalking position, crouching, and with head and tail extended, and continued to stalk Wilk. As both were travelling into the wind, the wolf could not catch the human scent. Both continued their paths until they were about 100 yards apart. At this point the wolf caught the human scent. It sniffed at the trail, arose and looked at Wilk, and abruptly galloped off -- a case of mistaken identity.

No wolf was actually observed to kill a caribou during the investigation, but the act barely missed observation in the following instance. At 8.00 a.m. on August 14, 1948, a band of about 20 cows and calves was observed across a narrow bay of Lake Clinton-Colden. Most of the caribou were feeding, but several were lying down. A few minutes later the band was noted trotting up wind, about 100 yards from the first position. Some were feeding, but several cows were staring backward at the first position. Glancing in that direction, the writer noticed for the first time a large white wolf crouched over a caribou carcass, tearing strips of meat from it. A lone cow was standing on a small promontory, down wind from the wolf and watching it. At 8.30 a.m. the wolf left the carcass and trotted after the departed band. It paused several times to look at the carcass and the cow near by.

Upon examination of the site, two calf carcasses were found. Short blood trails led about 12 yards from each carcass. From the evidence it seems likely that the wolf stalked the band and caught the calves after a short chase. The first carcass had a broken front leg, and a slashed shoulder and rump. The second carcass, on which the wolf was observed feeding, was reduced to skeleton and hide. It appeared that the wolf had run alongside the first calf and had pulled it down by a crushing bite on the shoulder.

Wolves are popularly supposed to hamstring their prey, but from reports by trappers and observations upon carcasses, it is concluded that this is seldom done. The method that the wolf generally uses for killing a caribou is to race alongside of it and pull it down by grasping the flank, shoulder, or

throat, with the jaws. Once the caribou is down, the wolf usually seizes it by the throat.

According to trappers' reports, wolves often, during the winter months, band together in large packs, each comprising several family groups, to hunt caribou. The law of diminishing returns probably controls the size of these packs. Wolves in large packs are reported to co-operate in driving caribou bands over promontories or onto glazed ice.

When caribou are abundant, wolves often kill in excess of their immediate needs. In the observation cited above, two calves were killed within about 25 yards of each other in one attack. One calf was consumed except for the intestinal viscera, lower limbs, hide, and vertebral column, but from the other carcass only the tongue and throat were removed. On August 27, the same wolf returned to the second kill and ate it. Similarly, the wolf which stalked Wilk on the Hanbury River was found, upon later investigation, to be returning to a kill several days old. The Nueltin Lake pack also returned regularly to old kills.

What may appear to be excessive killing by wolves seldom goes unutilized in the long run. When caribou are scarce in the district, the wolves return to their old kills. Other scavengers, such as Arctic fox, wolverine, barren-ground grizzly bears, and raptorial birds, also utilize wolf kills.

Wolves have been known to cache pieces of meat for later use (A. Murie, 1944). Upon the tundra and in the taiga, partially utilized wolf kills should be considered as caches, for the wolves usually return to them. During migratory periods the wolves may move on. On these occasions following wolves or other scavengers usually clean up the carcasses. Wolf caches are probably revisited about as commonly as the caches of the human hunters. Unutilized carcasses cached by humans were found more frequently than unused predatory kills.

Caribou Reaction to Predation.- It is often supposed that caribou are terrified and unable to carry out normal feeding routine when wolves are present. Also, it is sometimes supposed that caribou are defenseless against predators and fall easy prey to wolves. Many observations of wolves and caribou during the present investigation tend to refute these beliefs. When caribou sense the approach of wolves, they become alert and watchful. If the wolves are not actually in pursuit of one of the caribou, they will watch the wolves until they are out of sight. Even if the wolves are approaching, the caribou generally do not move until the wolves are about 100 yards away. If the wolves have been scented, the caribou may gallop off down wind, otherwise they will circle to get wind of the wolves.

In large herds, caribou are particularly unruffled by the approach of wolves, and will sometimes remain bedded down while wolves pass through the herd within 50 yards of them. During the winter, caribou seem to become accustomed to the presence of wolves associated with the herd. On April 17,

1948, northwest of Eskimo Point, Keewatin District, a herd of 25 caribou was noted bedded down upon a ridge. As the aeroplane passed overhead, the caribou were watched as they jumped to their feet and raced away. Only then were two other animals seen about 150 yards behind the caribou band. As they arose and followed the caribou, it was discovered that they were wolves.

Among the many herds of caribou migrating across Ghost Lake, Mackenzie District, on April 24, 1949, several wolves were observed trotting along the trails behind the caribou. In one case, a second band of caribou followed about 200 yards behind a wolf. On the same day, a herd of about 3,000 caribou in the shape of a doughnut was observed on a frozen lake. On closer inspection from the air, it was found that there was a single wolf in the centre of the ring. As the wolf ran in one direction the line of caribou fanned out in front. Those behind stood and watched.

The pursuit of a band of caribou by a single wolf was photographed from the air (Fig. 33). It will be noted in the photograph that the animals immediately in front of the wolf are in full gallop, those to the flank are trotting, those behind are standing and watching, and others are still lying down.

When an animal has been singled out for pursuit, it makes a maximum effort to outdistance the wolf. If the pursuit is continued the caribou will generally make for the water. Upon reaching the shore, it will plunge in and swim away. During the early winter, caribou which race onto the glare ice to escape the wolves, generally find themselves at a disadvantage. Throughout the winter months the caribou persist in seeking safety upon the frozen lakes.

From a study of wolf hunting techniques and the caribou reaction to pursuit it may be concluded that single animals, sleeping individuals, inexperienced calves, and wounded, sick, and aged animals would be most likely to succumb to the stalking and flushing type of pursuit. The gregarious habits of the caribou are advantageous to the individual in providing warning and relative safety in numbers from attack.

General Considerations on Predation.- A. Murie's work (1944) on the predator-prey relationship between wolves and Dall sheep (*Ovis dalli*) indicated that weak and aged classes suffered greatest mortality, including wolf mortality.

During the present investigation attempts were made to note the age and physical condition of the carcasses believed to result from wolf predation. It was difficult to assign the cause of death of many of the carcasses observed. Of the kills which were classified by age, there were six adult bulls, nine adult cows, thirteen calves, seven yearlings, nine aged bulls, and six aged cows. Three of the aged animals showed lesions of actinomycosis. Those carcasses showing poor antler development and broken and greatly worn teeth were called aged. This small sample of 50 carcasses shows higher proportions of calves and aged bulls than one would expect in a random sample of the normal population. The data suggest that these classes receive the heaviest wolf pressure. Of the 698 carcasses discovered,

483 were ascribed positively to human kills, 174 apparently to wolf kills, 36 to accidental deaths, and five to natural deaths.

The Nueltin Lake party collected 62 wolf scats which were analysed. Since the scats were picked up on the tundra, there was no way of knowing their age. Some may have been from a period when caribou were abundant. Of the 70 items recorded in the scats, 41 were caribou remains, 15 were lemmings and voles, three were birds, two were arctic hares, two were fish, and seven were vegetation (grass and twigs).

The quantitative information gathered during the present investigation is insufficient to give a reliable estimate of the effect of wolf predation upon the caribou population of the area under study. All the observations indicate that the total amount of wolf predation has been greatly over-estimated. It has been previously recorded that on April 24, 1949, 20 wolves were observed associated with a herd of approximately 100,000 caribou on Ghost Lake. From that point the migration route was traced back to Lac la Martre. Along the route 113 caribou carcasses were observed on the ice of the lakes. Several wolves were seen feeding upon these carcasses. Probably more carcasses were hidden in the timber. From other records the herd was believed to have taken about a month to travel this distance. During this period it suffered a loss of approximately 0.25 per cent, if the observed number of carcasses is doubled to cover those in the woods. In the course of a year predation loss might be about 2.5 per cent of the total herd from 10 months wolf predation.

During the investigation, it was common to see crippled caribou, many with broken limbs or flesh wounds, trailing the migrating bands. Also a few carcasses of caribou undisturbed by predators were found. These had died from wounds or disease. Two lame caribou showing symptoms of bacterial infection which must have rendered speedy movement impossible were collected. Had wolf predation been severe these animals would probably have succumbed. In southern Keewatin District packs of wolves could probably live through the winter on caribou killed by hunters and left on the tundra; they would not need to kill for themselves. Trappers and natives report that wolves in this area cause heavy losses of cached meat.

From historical records (MacFarlane, 1905) it is known that the population of wolves varies greatly in the course of years in northern Canada. All reports seem to point to a recent decrease from a peak. The work of Plummer (1947) suggests that rabies may be a controlling factor. The carcass of a wolf which had died naturally was found at Sussex Lake.

The annual loss from wolf predation is probably not greater than 5 per cent of the total population, even during periods of wolf abundance. In a population of 670,000 caribou this would amount to about 34,000 animals. Sdobnikov (1935) reported an annual loss of 5.7 per cent of Siberian reindeer herds from predation.

Lesser Predators

Seton (1929) gives a record of wolverine (Gulo luscus) killing a caribou in the "north". It is not clear what subspecies of caribou was involved. None of the trappers or natives interviewed during the present investigation knew of wolverines killing caribou, and all stated that the wolverine affected the caribou only as a scavenger. Under these circumstances, there is no reason to consider the wolverine an important predator of the caribou.

Throughout the range of the barren-ground caribou, the barren-ground grizzly bear (Ursus richardsoni) is extremely rare. It is likely that bears secure a few new-born calves annually, as bears usually do in the range of other species of deer. This carnivore likewise is of little significance as a predator of caribou.

The golden eagle (Aquila chrysaetos) has been reported by A. Murie (1944) to have killed new-born calves upon the calving grounds in Alaska. One Eskimo hunter at Bathurst Inlet reported that he had seen an eagle kill a caribou calf many years ago, and gave a convincing description of the attack and the fate of the calf. Other persons interviewed also reported that eagles occasionally capture calves.

On April 24, 1949, in the vicinity of Ghost Lake, two animals were observed on a caribou carcass on a frozen lake. At first glance, the animals appeared to be wolves. Upon circling lower in the aeroplane, it was found that the animals were two golden eagles which flushed from the carcass. It is probable that they were eating a wolf kill, but the observation suggests that some golden eagles follow the caribou herds in winter.

Golden eagles are too scarce on the caribou range to be significant predators on the caribou.

Human Utilization

The caribou formed the cornerstone in the economy of two great peoples -- the Athabascan Indians and the Eskimos. These two nations inhabiting the sub-Arctic taiga and the tundra of the Arctic sea coasts, built much of their culture about this animal.

Although most Eskimos lived on the coasts, there were inland groups who lived in the valleys of the Back, Thelon, Dubawnt, and Kazan Rivers. The culture of the coastal groups was based on a marine economy and seals and walrus played important roles. The inland groups were more dependent upon the caribou. The coastal groups made hunting excursions inland in summer to obtain caribou hides for clothing.

The Athabascan Indians were divided into several tribes, the most important of which was the Chipewyans. All these tribes were more or less

dependent upon the caribou; the Chipewyan culture was based entirely upon this natural resource and so they were called "Caribou-eaters". They lived in the northern edge of the taiga from Churchill to Great Bear Lake. During the summer they made long excursions to the tundra to live upon the caribou and obtain hides for clothing. During the autumn there was often a second tundra hunt for musk-ox hides.

The approximate distribution of native tribes in the taiga and tundra range of the barren-ground caribou, at the arrival of the first European explorers, about 1825, is indicated in Figure 34. This map is based upon the writings of Hearne (1795), Franklin (1823, 1828), Richardson (1829, 1851), Back (1836), Simpson (1843), Pike (1892), Hanbury (1904), and J.B. Tyrrell (1898), and is modified from Jenness (1937).

Hunting Methods

The early explorers remarked upon the ingenious primitive hunting methods employed by natives to kill caribou, and gave many colourful accounts of them. In general the Indians and the Eskimos employed similar techniques. The Eskimos lacked wood for the construction of their traps, but they made effective use of materials at hand, such as snow blocks. For a complete account of primitive Eskimo hunting techniques consult Jenness (1922). Mason (1902) describes Indian hunting techniques.

Pounds.- Within the taiga the Indians were able to construct pounds to capture bands of caribou. Hearne (1795) described pounds used by the Chipewyans in the vicinity of Churchill. These circular pounds were built of brushy trees with a gate placed upon a well-worn trail. Inside were counter hedges arranged in a maze. At intervals were openings containing thong snares tied to growing spruce poles. Drift fences extended from the gate to a lake shore or along a valley border. An Indian family or two would pitch their tents near by and maintain these pounds during the winter; during good winters it might not be necessary to move camp from such a pound. Varieties of this kind of pound were constructed from Churchill to the Mackenzie delta. The remains of a drift fence were said to be still visible on Pike's Portage, between Artillery Lake and Great Slave Lake. Often the trap consisted of a brush fence barring a migration route. In the fence were openings with snares attached to trees. Photographs of similar fences used in Alaska were presented by O.J. Murie (1935). Stone (1900) presented a diagram of a pound used by the Loucheux Indians of the lower Mackenzie River.

During the winter months small spruce trees were frozen in line across a lake. The caribou, upon reaching the line of spruce saplings, refused to cross it and followed it to shore, where the hunters were hidden.

The Eskimos employed the same techniques to drive caribou, but with materials at hand on the tundra. Long drift fences were constructed of pillars made of two or three stones piled upon one another, or a section of sod placed upon an upturned columnar stone. The columns were placed from 10 to 20 feet apart, and fences were sometimes as much as a mile or two in length. They gener-

ally crossed well-worn trails at right angles and led to natural defiles or lake crossings. Back (1836) reported stone columns at crossings on the Back River.

Several stone fences were examined at the south end of Contwoyto Lake, Mackenzie District, in August, 1949 (Fig. 35). They were composed of upturned stones with sod tops. The average height of the pillars was about 24 inches and the average distance between pillars was about 12 feet. One fence was about 400 yards long and another was about a half-mile long. Near the stone fences were many old skulls and skeletons of caribou.

When using these drift fences during a caribou migration, several families of Eskimos would hunt together. The women, children, and aged would space themselves along the fence, hiding behind the stone columns. The hunters, armed with bows and spears, would take up their position at the apex of the fence or, if the fence led to a lake, in kyaks at the water's edge. Those on land remained hidden behind large boulders or in shallow trenches. When a herd of caribou reached the fence, the scattered non-hunters arose, shouted and waved their arms. The caribou, mistaking the unfamiliar stone columns for crouching humans, were reluctant to cross the line and raced along the fence to the defile or lake shore, where the hunters slaughtered them at close quarters with bow, spear, and knife.

Such fences are known from the Back, Thelon, and Kazan River valleys, as well as from the Keewatin coast. They are not used now and have fallen into disrepair. The shallow trenches, however, are frequently used as blinds by Eskimo hunters armed with rifles, and may be found frequently at favourite caribou crossing points or on summits from which good views of the surrounding territory may be obtained. They are usually about ten feet long and about two feet deep. A row of small stones along the front increases concealment (Fig. 36).

Traps.- During the winter months the Eskimos sometimes constructed pitfalls in snow banks to capture caribou. A good description of such a snow trap was given by Hanbury (1904). A pit large enough to hold a caribou was dug in the side of a crusted snowbank and the walls were sometimes strengthened by soaking them with water. The pit was roofed with thin sheets of crusted snow and baited with a sprinkling of dog urine or vegetation. It was necessary to visit the traps frequently in order to dispatch trapped animals as soon as possible, before they died from their own efforts, which generally caused tainting of the meat.

In the taiga the Indians constructed deadfalls, snares, and pitfalls along the game trails. In these traps caribou as well as moose were taken.

Spearing.- The most popular primitive method of securing caribou, used by both Indians and Eskimos, was spearing swimming caribou from canoes and kyaks. These hunts usually took place during late summer and autumn migration towards timberline. The natives congregated on rivers at favourite caribou crossings or at points where caribou swam across lakes during migration. The hunters hid their boats and themselves on the bank opposite that on which the caribou bands were

expected to appear and remained concealed until a migrating caribou band had swum more than half the distance across. Then they jumped into their canoes or kyaks, and gave pursuit. The swimming caribou, turning to try to make the other shore, were quickly surrounded and dispatched with thrusts of spears and knives into the back.

The spears were constructed of straight spruce saplings about eight feet long, tipped with copper, iron, or bone blades. Now steel blades are used. It is reported that blades fashioned from iron files are used by the Chipewyans in northern Manitoba.

Hearne (1795) observed such a slaughter of caribou by his Chipewyan companions at a crossing on the Kazan River near Yathkyed Lake. Other well-known crossings, where caribou were regularly speared, were on the lower Thelon, Back, Dubawnt, and Kazan Rivers, and on the Hudson Bay coast of Keewatin at the mouths of the Ferguson, Maguse, and Thlewiaza Rivers. In Mackenzie District caribou were speared at crossings on the Coppermine and Lockhart Rivers, on the arms of Great Bear Lake, and at Fort Rae on Great Slave Lake. In Saskatchewan, favourite spearing points were at Fond-du-lac and Stoney Rapids on Lake Athabasca; and in Manitoba, at crossings on the Cochrane and Nelson Rivers.

This method of killing caribou is still used by natives in northern Canada. H. Brown of the Hudson's Bay Company reported that when he visited a crossing point on the lower Kazan River several years ago, there were piles of caribou skulls and leg bones about four feet high on the banks. On that occasion he watched 12 hunters kill about 250 caribou at the crossing. At crossing points at the southern end of Contwoyto Lake, 170 skulls of caribou were counted near three abandoned camp sites. These were the remains of a few of the animals killed at this crossing point in recent years.

The spearing method is favoured by the natives because no rifle shells are needed. The most important point where Indians spear caribou during the southward migration is at Nejanilini Lake, immediately north of Duck Lake Post, Manitoba. J. Staunton of Ilford, Manitoba, formerly a provincial game guardian, who visited the post during the winter of 1947-48, reported that many caribou were speared annually while crossing the lake. The bodies floated down the river past the post and were hauled ashore and cached in piles near camp for winter use.

On August 18, 1948, Lawrie accompanied a group of four I-halmuit Eskimos on a spearing hunt at Nueltin Lake, Keewatin District. He describes the incident as follows:

"The canoe was held in readiness on the south shore of the bay where the caribou had a half-mile swim to make. As the animals neared the shore after this swim the canoe was urged towards them at the first sign of their turning aside. They were thus faced with an equally long swim back to the north shore to escape. Initially more than a match for four paddles, they were overtaken in mid-bay and the spearing began with the canoe driven right among the panic stricken animals, often with the prow riding up on one.

"The spear consisted of a diamond-shaped blade two inches long and one and a half inches wide, affixed by a socket to a five-foot wooden shaft. The heads were obviously of commercial manufacture but the rusted iron betrayed no trademark; the shafts were cut from native spruce, on the spot. The weapon is held very close to the butt and jabbed single-handedly into the small of the caribou's back like an overgrown dagger. The stroke, properly delivered, severs the dorsal aorta, penetrates the spleen, or opens the chest cavity. In any event death is rapid and efficiently speared animals do not reach shore. However the Eskimos became wildly excited in the process and the spearman laid about him at any animal within reach with the inevitable result that many animals were more or less severely wounded. Many of these lived to reach shore and those which had merely been slashed over the rump went free while the badly wounded either died on the beach or escaped to die in the hills. Twenty caribou were secured in this way, including two animals which were tracked down and shot by the writer. There is no doubt that at least as many more were wounded, some of them probably fatally. A single dead caribou, bearing the mark of the spear, was found inland two days later. The Eskimo made no attempt to pursue the wounded and contented themselves with skinning out those which had reached the shore (the writer had insisted that they spear only animals which were prime) and ensuring that those in the water would float to drift ashore. This latter is apparently a common practice designed to save the trouble of towing kills ashore - the head is turned back and dorsally and the antlers hooked under the fore-legs in such a way that the muzzle is held above the surface and the lungs do not fill with water.

"To the credit of the Eskimo it must be said that all of these animals were recovered the following day but the fate of the meat and the hides is an excellent illustration of their failings - perhaps, too, of their difficulties. Tongues and marrow bones were taken for immediate use, the balance piled in a heap on the beach. The suggestion that some of this meat should be dried was met with the assurance that it would serve as dog food in the winter. In deference to the writer's plea that it be properly cached, a few dead willows were flung over the pile. In the fall the water rose and the whole, long since putrid, was frozen in. The hides were dutifully staked out to dry and totally ruined by a subsequent five-day rain which brought no action from the Eskimo. Quite probably they had never seriously intended to use them - it was a long walk home and hides are heavy."

According to residents of Churchill and Eskimo Point, caribou are probably still speared on the lower Kazan River and at the mouths of the Maguse and Thlewiaza Rivers.

The Eskimos at Contwoyto Lake reported using this method regularly to obtain caribou when there was a good crossing. One of the hunters had a caribou skin kayak, measuring 20 feet 4 inches long, with a 16-inch beam, which carried on the deck an armament of two 9-foot 2-inch wooden spears with steel blades (Fig. 37).

On August 16, 1949, the writer accompanied two hunters with kyaks to a crossing point to await the crossing of a band of caribou at a point where the lake was about a quarter of a mile wide. Finally, a small group of three bulls

entered the water and swam towards the hunters' position. When the animals were more than half way across the strait, the hunters took to their kyaks and gave pursuit. The caribou turned, but the nearest one was overtaken by the swift kyaks. One hunter paddled alongside the swimming animal, seized his spear and dispatched the animal with two swift jabs. The carcass was then towed ashore and dragged onto the tundra (Fig. 38) for butchering.

The Eskimo method of butchering differs from the European way and deserves notice. First the head is severed at the atlas and the tongue is excised through the bow of the lower jaw. Next a mid-ventral incision is made through the hide and extended up the inside of each leg (Fig. 39). The carcass is skinned with little aid from a hunting knife; the hide being pulled off by the hands. The hide is separated from the flesh by repeatedly thrusting the closed fist down the flank. After the hide is removed from one flank, the animal is rolled over on the hide and the other side is skinned out. The abdominal viscera are removed through a transverse cut in the groin. The thoracic organs are left intact. On the occasion mentioned the four limbs were disjointed and carried back to camp in a large bag of caribou hide. The remainder of the carcass was covered with the hide to protect the meat from the attacks of blow-flies until it could be carried to camp. On other occasions the vertebral column is disarticulated ahead of the sacrum and the hindquarters are severed from the body. The hind-quarters, weighing 40 to 50 pounds in all, are easily carried on the shoulders, one leg projecting forward over each shoulder of the carrier. Sometimes the disjointed forelimbs are thrown across the projecting hind legs to balance the load.

Bow and Arrows.- Originally the bow was the chief weapon with which Eskimos and Indians hunted the caribou. It is still used in isolated areas of the Arctic as a matter of economy rather than of necessity. Many opportunities arise to kill caribou at close range and the cost of rifle shells may be saved by using bows and arrows.

The bows in use by the Eskimos of Bathurst Inlet are about four feet long and are made of spliced sections from the bases of musk-ox horns. The bow is strengthened with woven caribou sinews and strung with caribou thong. The arrows are made of willow shafts, feathered and tipped with ground steel, caribou rib bone, or native copper. The quiver is made of caribou leg hide. An Eskimo hunter and his bow are shown in Figures 40 and 41.

Ruses.- In early times, special hunting techniques were sometimes used to bring caribou within range of the bow and arrow. Lyon (1824) described how two Eskimo hunters would walk away from a caribou herd in close single file. One hunter would quickly drop behind a rock and the other would keep walking. The "curious" caribou would gradually feed after the departing human and so pass the hidden one at close range.

Richardson (1829) described the method by which the Dog-rib Indians

approached the caribou herds. Two hunters hidden beneath a caribou hide would gradually creep towards the caribou herd. They tried to mimic the movements of caribou and gradually worked their way closer. At the opportune moment the hide was discarded and the caribou shot.

The use of modern rifles has made such elaborate ruses unnecessary. Sometimes, however, it is necessary to take advantage of cover and wind to approach caribou within rifle shot.

Firearms.- Although there are still isolated used of primitive hunting methods, almost every native hunter in the caribou range owns one or two rifles. The rifles used against caribou are both old-fashioned and modern. In most cases the shooting of caribou takes place at ranges less than 100 yards.

The 30.30 carbine is a weapon well adapted for hunting caribou: the lever action allows several animals to be shot out of a herd, and the mechanism seems to function satisfactorily at low temperatures. Finally, it is relatively cheap and the cartridges are universally available.

The .22 rifle is an indispensable weapon of northern trappers and natives for the dispatching of trapped animals and the shooting of Arctic hares, ptarmigan, waterfowl, and ground squirrels. It is light and the ammunition is inexpensive. A great deal of caribou hunting by Eskimos and Indians is therefore done with this rifle. Some men use it and almost all caribou hunting by women and children is done with it.

The number of caribou killed or wounded by women and children is considerable. Harper (1949) described the hunting activities of a ten-year-old Eskimo lad and his sixteen-year-old hunting companion at Nueltin Lake, Keewatin District. On August 16, 1949, at Contwoyto Lake, two youthful Eskimo hunters of the ages of about six and eleven were met returning from a successful hunt, laden down with a caribou hide and a .22 rifle. Several traders stated that the activities of children are not always so practical or successful. At times they fire into passing caribou herds with .22 rifles in sport without any intention of utilization.

During August, 1949, several Eskimo hunting caribou at Contwoyto Lake were using .22 rifles. On two occasions, caribou were seen to fall from shots from these rifles. Both animals were shot at ranges less than ten yards. One fell several minutes after a single hit in the heart, the other after three hits in the chest (Fig. 42).

These were exceptional cases. Many other caribou were wounded at greater ranges and escaped. Each day from August 10 to 20, while about ten Eskimos were shooting animals for hides, several wounded animals were observed in the bands being hunted. On August 15, four wounded animals were hobbling around the scene of a slaughter while Eskimos skinned carcasses without attempting to kill the wounded animals.

Generally neither Eskimos nor Indians make any effort to conserve

caribou when hunting. As many caribou as possible are killed from each band as the opportunity arises. Little or no attempt is made, when killing adult animals, to select suitable animals for hides or for meat; but large numbers of calves and yearlings are selectively killed because their hides are preferred for clothing. As long as other animals are available, rarely are attempts made to kill wounded animals which escape, or to find wounded animals which may have died at a distance.

Intensive survey of the locations of regular hunts in both the taiga and tundra always resulted in discovery of the remains of numerous caribou, whose intact condition, hide punctures, or broken bones, indicated that they were unutilized animals killed by gunfire. Such carcasses were found at Churchill, Manitoba, and at Nueltin Lake, Eskimo Point, Fort Reliance, Contwoyto Lake, Muskox Lake, and Bathurst Inlet, Northwest Territories.

A typical example of such hunting wastage was observed on August 15, 1949, at Contwoyto Lake. A band of approximately 20 animals was feeding in a small swale about half a mile from the camp. Two Eskimo hunters approached to about 75 yards range before opening fire. Of eight animals shot, two were wounded and escaped. Later the scene was visited to observe skinning and cacheing techniques. On the side of the swale was the carcass of a large adult stag whose pelage was in delayed moult and unsuitable for clothing. The hide and the velvet on the antlers had been slashed by the hunters' knives and the already bloating carcass had been abandoned.

On August 16, a herd of about 125 caribou were observed to swim a narrow part of the lake and reach a long peninsula on which four Eskimo hunters had taken up positions about 25 yards apart. On the report of the first rifle, the leading animals turned and the band hesitated for a few moments. Then the band ran the gauntlet past the hunters, who blazed away at a range of about 20 yards, knocking many caribou down. The band continued down the point past the Eskimo tents and dog lines. It was a spirited scene, with the dogs howling and jumping on their chains and the women rushing out of the tents searching for rifles.

Two days later the camp was visited and more than 75 carcasses lying on the peninsula were counted -- the results of several hunts such as the one described. Most of the carcasses were within 150 yards of the tents and some of these had been skinned and eviscerated. About 10 unutilized carcasses were observed. Four bloated carcasses were lying in shallow water. No attempt to utilize these animals had been made. Other wounded animals had dropped too far from the hunting scene to be easily located by the Eskimos. Two wounded cows hobbling about the scene were ignored by the natives.

Lawrie also reported on the extravagant use of ammunition by Eskimos when hunting caribou. Between the middle of August and the middle of October, 1948, 3,000 rounds of 30.30 ammunition, 500 rounds of .303 ammunition, and 120 rounds of 44.40 ammunition were issued to eleven heads of families at Nueltin Lake. On November 5, 1948, five of these families had no ammunition left. The expenditure of so much ammunition probably resulted in heavy and wasteful

slaughter of caribou. The local trader reported that he found caribou cached everywhere throughout the surrounding country during the following winter -- "the hills were full of dead deer".

Such wastage has been reported by many writers during the last century and the early part of the present century. It is regrettable that these conditions still exist. From interviews with wardens, traders, missionaries, and trappers in the northern parts of the provinces and the Northwest Territories it is known that excessive wastage is widespread throughout the whole range of the caribou and is indulged in by Indians, Eskimos, and some European trappers.

Storage of Meat

Various methods are used to preserve the meat for future use and protect it from the depredations of large predators, depending largely upon the resources at hand.

Eskimo Methods.— On the tundra the skinned and eviscerated carcasses of animals killed in late summer by Eskimos are usually cached by covering with a pile of large rocks, leaving the antlers or limbs protruding. If there are no rocks where the animals are killed, they are often covered with large sods, as shown in Figure 43.

Occasionally elaborate rock caches are constructed. At Bathurst Inlet a group of eight stone caches was examined. They were formed of limestone slabs. The cache cavities were rectangular, with dimensions approximately four feet by two feet. The walls were formed of rocks set on edge. Outside of these were two to three feet of slabs laid on their sides. The caches were covered with exceptionally large slabs. The caches were approximately seven feet square over all (Fig. 45).

In Keewatin District during the autumn and early winter, the Padleimuit Eskimos cache their caribou by the simple device of turning the head down so that the antlers project upwards. When the carcasses become drifted over with snow in winter, the antlers guide the hunters back to their caches. An Eskimo's supply of meat consists of many groups of carcasses, cached at the points where they were shot -- five here, ten there.

These caches suffer from depredation by scavengers, such as wolves, Arctic foxes, wolverines, and barren-ground grizzly bears, which may consume a considerable part of a trapper's meat supply. It is difficult to obtain an estimate of such losses. From discussions with many trappers it is estimated that losses from caches due to scavengers may be about 10 to 20 per cent. Individual trappers reported losses up to 75 per cent under exceptional conditions.

During the winter months more secure caches may be made by building a snowhouse around the meat supply and then pouring water over the snowhouse

to transform it into an icehouse. A second method is to cut a hole in the ice of a lake and suspend the meat in the water (Pike, 1892). A more satisfactory method is to place the meat in the ice and cover with ice blocks or to pour water over the meat and build up a thick layer of ice.

Method Used in the Taiga.-- Within the taiga lumber may be used to construct caches. The most popular wooden cache is a platform supported by four poles and reached by a ladder (Fig. 46). To protect the meat from the depredations of scavengers the poles are often peeled, wrapped with tin, and ringed with cod hooks or spikes. The platform is usually located so that snow will not drift too deeply around it, and arboreal scavengers cannot drop onto it. If the platform overlaps the supports by three feet, it is additionally difficult for an animal to climb to the platform.

European residents in the caribou range have utilized all of these methods. In addition, some trappers have constructed storehouses or root houses at their base camps. To construct a cellar in an area of permafrost is a difficult task, but it repays the effort by its refrigerating effect in summer.

Much wastage of caribou meat occurs as a result of the native habit of killing caribou and caching them along the trail for future use. Unfortunately, the hunters may never return that way again. Lawrie reported that 58 carcasses were known to have been cached near the camp on Nueltin Lake in 1948, and that not more than a dozen of them were used. Some of them were cached so early in the autumn that the meat rotted.

Utilization of the Carcass

The caribou was once the cornerstone of the economy of the native tribes in Arctic and sub-Arctic Canada, providing them with all the necessities of life. In modern times, the products of civilization have replaced many of the products of caribou. In times of emergency, however, caribou products are still used in remote areas as in primitive times, and small groups of Eskimos and Indians are almost completely dependent upon the caribou even yet.

Use of Meat for Human Food.-- The primary use of caribou is as a vital supply of meat of superior quality. There is quite a variation in tastes for meat cuts. White trappers prefer the hind quarters, while the Eskimos prefer such portions as the head and rib basket. All are agreed, however, that the tongue is the greatest delicacy, and that it is only slightly superior to the liver. The back fat, known to the early explorer as the "depouille", is a valuable addition to the larder. It is an important part of pemmican, and added to lean meat, provides carbohydrates for energy. The fat is rendered and used as fuel oil in the small stone lamps of the Eskimos.

Other portions used are the tips of antlers in velvet, stomach contents, and blood, which is allowed to jell in bags made of the lining of

the intestine. The marrow in the leg bones is considered a delicacy by natives and Europeans alike. The leg bones are heated over hot stones, and when cooked, are split open by pounding with stones.

Three main methods of meat preparation are in common use among the natives. With freshly killed caribou, or when there is an abundant fuel supply, the meat is boiled. During the spring and late summer months, large amounts of meat are dried in some areas. Long, thin strips of meat are cut from the flanks and hind quarters for drying and hung over long poles. On the tundra, these poles are often supported by the antlered heads of freshly killed bulls, or on stone columns as shown in Figure 47. Upon drying, the meat becomes black and flaky. It is used during midsummer and early winter if caribou are absent. Lawrie reported that the Kazan I-halmuit dry no caribou meat.

The third method of preparation is freezing. During the winter, cached meat is eaten in the frozen state. Strips of meat are flaked off the frozen carcass with a penknife.

Use of Meat for Animal Food and for Bait.- Caribou meat is universally used as dog food by Eskimos and Indians during the winter months throughout the caribou range. Where caribou are available, few natives make the effort needed to obtain a winter's supply of fish. The amount of caribou meat consumed by a hunter's dogs may easily be 50 per cent of his total winter requirements. A team of ten to fourteen dogs can easily dispose of a medium-sized caribou each day; few teams, however, are so fortunate as to receive that much. Lawrie estimated that a team of six dogs would require about 50 caribou per year.

There are no statistics of the average number of dogs in the caribou country, but it is estimated to be about eight to ten dogs per family. The Indians' teams are generally composed of from four to eight animals, while Eskimo teams may number up to fifteen.

The early explorers, such as Hearne (1795), wrote of the dogs possessed by both Eskimos and Indians. From a study of their reports it is concluded that the natives formerly had fewer dogs than they have now. Even at the beginning of the present century the Eskimos of the Arctic coast possessed fewer dogs. The average dog-team was probably composed of four or five animals. At that time the Eskimos travelled little from the coast. Without doubt the fur industry caused a great increase in the dog population by requiring long journeys on winter trap lines and to trading posts.

A growing number of natives about the posts have been instructed by police, traders, and missionaries to put up a winter's supply of fish for dog feed. Most of the European trappers also dry fish for dog feed. Away from the centres of population, however, more caribou meat and less fish are fed to dogs. Many caribou caches made in early autumn are not fit for human consumption by winter. These carcasses are used for dog feed, as are the less palatable portions of other carcasses. Often because of necessity, and sometimes by preference, putrid carcasses are eaten in winter by Eskimos and dogs alike.

It has been reported that certain individuals, both native and European, leave caribou carcasses along their trap lines to act as fox bait. It is difficult to obtain a clear-cut picture of this use, since many carcasses are present on the traplines, some well cached, others lying on the ground unprotected. Undoubtedly foxes utilize many of these carcasses.

Use of Hides.- The second important product of the caribou is the furred hide, which serves as superior quality Arctic winter clothing. The Eskimo method of preparing hides for clothing was noted at Contwoyto Lake. The green hides were pegged out upon the tundra with the hair side down. If the weather became damp, care was taken to cover them. They were scraped free of excess meat and fat. When dry, they were roughly tanned by scraping with an ulu, while the hide was rolled over a smooth rock. When the process is complete, the hide is flexible, white, and thin.

A complete Eskimo winter caribou-hide outfit consists of an inner and an outer suit. The inner suit comprises a parka-like garment, inner trousers, and stockings with the hair inside. Worn over those are outer garments, including parka, trousers, high boots, and mitts, which have the hair facing outward. This is the ideal outfit; not every Eskimo is so fitted. Generally the hunters in the family have complete outfits, but women and children rarely possess both suits. Ideally, this clothing is renewed each summer, but in many localities where caribou are uncommon, the Eskimos have to make their caribou clothing last two or three years. In some localities the women and children may be observed in tattered garments years old, in many cases handed down from the men. Sealskin outer boots are preferred by coastal Eskimos. These are worn over caribou-hide stockings.

In localities where caribou are still plentiful, the Eskimos may make extra outfits for trading to the Hudson's Bay Company for sale in regions where caribou are scarce. Several trading posts, such as Coppermine, Bathurst Inlet, Baker Lake, Eskimo Point, and Duck Lake, are referred to as "caribou posts" by the traders and from them tanned hides, sinews, babiche, and ready-made caribou outfits are secured for distribution at such posts as Cambridge Bay, King William Island, Spence Bay, and Igloolik. At Bathurst Inlet, in July, 1949, there were between 3,000 and 4,000 caribou hides secured from the natives during the previous winter, for distribution to eastern posts.

The recorded number of caribou hides traded annually in the Northwest Territories since 1938-39 is presented in Table 35. The amounts of various caribou products traded at Duck Lake, Manitoba, in recent years, as reported by Kelsall, are indicated in Table 36.

Modern European garments are replacing certain garments of caribou hide. Woollen and horsehide mitts are generally worn, since they wear better. Woollen underwear, stockings, and shirts, and work trousers are generally worn in place of the inner caribou garments by most Eskimos.

The number of hides necessary for a complete outfit varies, depending upon the pattern, the sex and age class of the hides, and the completeness of the outfit. At Baker Lake it was reported that the hides of young cows were

favoured for clothing. At Bathurst Inlet young bulls were reported used for clothing. At Contwoyto Lake it was noted that calf and yearling hides were preferred. The average number of hides needed for a complete outfit may be estimated as follows: inner parka, three; outer parka, four; inner trousers, two; outer trousers, two; mitts, stockings, and boots, one; total, 12.

Some hides and parts of hides have special uses. The hide from the bull's forehead makes the best soles for boots. Calf skins are frequently used for stockings and the inner parka. The hide from the legs is used for boot leggings and for quivers. It is probable that a total of 25 hides annually would clothe satisfactorily a family of two adults and two children.

By September, the hair has grown so long and thick that the hides are no longer in prime condition for clothing. Where caribou are scarce, the natives will, if necessary, use winter hides for clothing. At these times the hides are clipped.

Hides from caribou killed in autumn or early winter are used for various purposes. The most important use is for sleeping robes, four or six hides being sewed together to make a robe. They are also used for beds, for igloo doors and roofs in early spring when the snow is melting, for covers to throw over caches, to line the sides of carioles, and to throw over sleigh loads.

At one time an important Eskimo use of winter hides was for tepees. Richardson (1829) estimated that 60 to 70 hides were needed for a single tepee. The Indian tribes also used tanned hides for tepees when travelling upon the tundra. Although modern canvas tents have practically everywhere replaced the skin tents, a few caribou-hide tents are still used in such remote areas as Contwoyto Lake (Fig. 48) and Kazan River. It is interesting to note that some of these tents are now fashioned after the pattern of wall tents. Lawrie estimated that 20 or more hides were needed to build a tent at Kazan River.

Winter hides are also used to insulate winter homes. Cracks in log walls may be stuffed with strips of hide, as observed at Fort Reliance, or the whole interior may be lined with hides, as observed at the tundra camp of M. Murphy at Muskox Lake.

Tanned hides from which the hair has been soaked off are used in various ways. The Eskimos sometimes sew two small hides together to serve as a hunting bag. A hide may be cut into long strips and used in lashings of all kinds. It was interesting to note that the caribou-thong lashings of the wooden supports for the clay chimney built by Captain Back at Fort Reliance in 1833 were still intact and functional in 1949. The inland Eskimos, lacking access to seals, use dehaired caribou hides to cover their kyaks (Fig. 37). It may be necessary to use as many as 12 hides to cover a kyak. Tanned hides are also used to make summer moccasins.

The Chipewyan Indians of Fond-du-lac and Stoney Rapids and the Dog-ribs of Fort Rae tan a great many dehaired hides for use in the manufacture of

moccasins and jerkins. These articles are much inferior to those of moose hide because of the thinness of caribou hide and the numerous warble scars and perforations. It is likely that nearly all these hides are taken during the winter and are unsuitable for furred winter clothing. Within the past five years or so there has sprung up a small business of supplying these hides to tourists.

Before thread was obtainable the sinews along the dorsal spine were used by Eskimos and Indians for sewing or for braiding into lines. After skinning the animal, a slit was made with a knife beneath the superficial muscle fibres and sinews in the sacral region. A short thong was threaded under these layers, looped, and then pulled forward, stripping off the muscle sheath. This was allowed to dry and was then separated into narrow slivers of sinew. The sinews were used as thread for sewing garments. Braided, they were used to reinforce bows, as fishlines, and to form a net-work for snowshoes. Even today sinews are widely used for sewing. At Bathurst Inlet there is a considerable trade in sinews for export to other northern posts.

Use of Antlers.- The antlers also provided many useful tools for the natives. Some of these have been replaced by imported European tools, but others are still in use. Sections of the tines are used for the handles of certain tools, such as the ulu. The beams are used as dog stakes and tent stakes. The beams and palmate terminal tines are fastened upon sleighs in Keewatin District and used as brakes. When a foot is pushed upon the inverted beam, the tines dig into the snow. Occasionally in cabins, antler beams are used to construct chairs and to support ridge-poles. Caribou ribs are sometimes used for drill bows.

Human Population in the Caribou Range

In order to obtain an estimate of the annual human kill of caribou, it was necessary to ascertain as nearly as possible the number of human beings living in its range. This information is not easily obtained because there are different classes of residents -- Eskimos, Treaty Indians, half-breeds, and whites, and because the settlements are small and scattered and the native population is largely nomadic.

The basic data for the Treaty Indian population were derived from the census of Indians in Canada by the Department of Mines and Resources in 1944, which gave the number of males more than 16 years of age in each band. The total population figures were revised to July, 1950, by the Membership Division of the Indian Affairs Branch. Since the number of males more than 16 years of age in 1950 was not available, it was necessary to adjust the 1944 figures in order to have an estimate of the total number of hunters in each band for calculation of total kill. It was assumed that all non-treaty Indians would be accounted for by the returns of trapping permits issued to them.

The basic data for the estimation of the Eskimo population were

derived from the 1941 census of Canada. No age analysis by trading posts was available, but a total analysis was given. It was noted that males more than 15 years of age composed 29 per cent of the total population. From this the number of hunters at each post was estimated. Such complete data were not available for any later date. From the Vital Statistics Division of the Northwest Territories Administration was obtained a statement, revised to January, 1950, of the total number of Eskimos in the total study area. It was not possible, however, to analyse this to post populations. The 1941 Eskimo total kill was therefore revised upwards proportionally to the increased population.

Many difficulties were encountered in associating native bands with trading posts and determining whether their hunting areas were within the range of the caribou.

In the times of Hearne (1795), Franklin (1823), Back (1836), Simpson (1843), and Pike (1892), the Chipewyan Indians spent a good deal of the summer upon the tundra with the caribou herds and in autumn there were frequent musk-ox hunts on the tundra. During the present century this pattern of life has been greatly altered. The introduction of manufactured tools and weapons removed the necessity of visiting the lower Coppermine River. The close season on musk-oxen from 1918 put an end to the autumn hunt. Not knowing how to make snowhouses or fires on the tundra, the Indians never did visit it in winter. When the fur industry encouraged winter trapping, the Athabaskan people maintained traplines in the taiga at no great distance from the main Athabasca-Mackenzie River system or the Churchill River system and near the trading posts on these routes. Briefly, the cycle of Indian activity is to operate traplines, usually near the trading post, during the winter months, and in summer to come in to the settlements to fish on the large lakes and rivers or seek casual employment as labourers about the posts.

Civilization had an opposite effect upon the Eskimos. Originally a typical maritime race, they were encouraged to travel inland to trap Arctic foxes. This movement of Eskimos inland from the Arctic and Hudson Bay coasts is continuing. Such regions as the upper Kazan River, upper Back River, Contwoyto Lake, Coppermine River and Dismal Lakes, considered Chipewyan territory in the time of Hearne, are now inhabited by Eskimos, few of whom have ever seen an Indian in their area. The central tundra region of northern Canada has thus become almost entirely the home of Eskimos only.

It is difficult to obtain factual data on the populations of Eskimos and Indians in the past. Only within the past few years were the first counts of remote Eskimo bands obtained. The native population seems to be generally increasing after a severe decline in the 19th century. With improved medical facilities, this trend may be expected to continue. This is an important factor in connection with the management of the caribou.

It seems likely that the utilization of caribou by Eskimos has increased since primitive times because the movement inland to trap has made caribou available over a long period of the year, and because of the increase in size of dog teams and the introduction of firearms.

It is more difficult to analyse the trend in Indian utilization. It has probably shown a gradual decline, because of the movement of the Indians towards the settlements on the Athabasca-Mackenzie drainage system and the Nelson and Churchill Rivers and because the shift in Indian dependence to manufactured tools and clothes is more pronounced than in the case of the Eskimos. Continuous trapping has made an auxiliary meat supply available from the carcasses of trapped animals. On the other hand the use of firearms and larger dog teams has tended to maintain the level of caribou destruction. It can be assumed that these trends will continue in the future, since the causative factors will probably continue in effect.

The total number of trappers - European and half-breed -- living within the caribou range was ascertained with the aid of the provincial game authorities as follows: the Alberta Department of Lands and Forests reported 90 trappers; the Saskatchewan Department of Natural Resources reported 705 trappers; and the Manitoba Department of Mines and Natural Resources reported approximately 300 northern trappers. In the Northwest Territories 395 trappers living in the barren-ground caribou range were reported.

It is probable that approximately 20,000 people, including Eskimos, Indians, European and half-breed trappers and their families, and European traders, missionaries, and government officials, are dependent to a greater or lesser extent upon the barren-ground caribou for meat and winter clothing.

Returns from Hunting Licences

In the Northwest Territories, trappers have been required to report annually the number of caribou killed during the previous licence year. Similarly in Manitoba hunters have been asked since 1941-42 to report on their hunting licences the number of caribou secured. The totals are given in Table 37 which also includes the numbers of caribou killed by hunters in Saskatchewan in the 1947-48 and 1948-49 seasons, calculated on the basis of the three and subsequently two animals allowed on each licence in that province. No statistics from the Province of Alberta were available.

Analysis of Native Game Returns

From 1932 to 1950, the Northwest Territories Administration of the Department of Resources and Development circulated Game Return forms for the purpose of recording the number of fur-bearers and game birds and mammals taken in each licence year by natives authorized under the regulations to hunt and trap in the Northwest Territories. These forms were completed by the Royal Canadian Mounted Police after individual interviews with the natives, made during field patrols, at treaty payment meetings, or when the natives visited the posts. An attempt to interview the majority of local hunters, or the chief hunters, was made annually.

These returns are subject to two main sources of error. Firstly, natives are not in the habit of counting the number of animals they kill; it

must be remembered that many of the older natives cannot count beyond 20. When questioned, many natives really do not know how many caribou they killed during the year. Secondly, some natives do not report all animals killed because they fear the penalty for excessive killing. The errors introduced by these factors are undoubtedly large, and cannot be calculated accurately. From comparing actual Eskimo hunting take with their reports, it is estimated that the number of kills reported on Native Game Returns may be approximately 15 per cent below actual kill.

The returns are, nevertheless, of great importance, and the analysis of data from them produced information which increased appreciation of their worth and reliability. The system was in effect long enough to encourage confidence and veracity on the part of the natives, since they were not punished for killing excessive numbers. The analysis shows reasonable constancy in the number of caribou reported by the hunters year by year. Variation in the number of caribou killed per hunter was found to correspond with known fluctuations in the local availability of caribou, owing to changes in migration routes and ranges. An independent survey carried out by Manitoba Game Guardian A. Sinclair at Oxford House, Manitoba, during 1946 and 1947 produced data of the same order as that for similar posts in the Mackenzie River valley.

The analysis of the Native Game Returns record of number of caribou killed in the Northwest Territories for the period 1932-48, is given in Table 38, which also includes the data from Oxford House, Manitoba. The first column gives the number of years for which records are available. The average number of caribou killed per hunter at each settlement is presented in the second column.

Annual Kill

The data used in estimating the total average annual kill of caribou is summarized in Table 39. In calculating average annual kill by natives at trading posts the caribou per hunter figures from Table 38 were used: for posts for which no data were available figures for posts similarly located in the caribou range were taken. The scarcity of factual statistics of the kill by white and half-breed hunters and trappers in the provinces necessitated arbitrary estimates in some cases. Many registered trappers in Manitoba and Saskatchewan are half-breeds living the life of Indians. It was observed that they depended to a large extent upon the caribou and their annual kill is probably similar to that of their Indian neighbours.

The total obtained is approximately 86,000, and considering the 15 per cent probable error on the conservative side, the total annual human kill is probably nearly 100,000 animals. This total is thought to comprise approximately 50,000 killed by Indians, 30,000 killed by Eskimos, and 20,000 killed by European and half-breed trappers and hunters.

Some observations of human utilization were made during the present investigation. At Contwoyto Lake, eight hunters of a group of 26 Eskimos killed 161 caribou in a period of eight days during the August hunt for clothing. This

amounts to 2.5 caribou per day per hunter. From the known movements of caribou, it is estimated that the hunters would have about 50 hunting days per year and would therefore kill approximately 125 caribou each per year. This is a reasonable estimate of an average hunter's annual kill for isolated inland bands of Eskimos and Indians; the figure is substantiated by many traders and missionaries. Undoubtedly there are a few hunters who kill more (up to 500 caribou), but this is balanced by the fact that many hunters kill less than 125 per year. After an acquaintance of several weeks, one Eskimo at Bathurst Inlet reported that he had killed 67 caribou during the previous year, but could have used 100. Lawrie reported that an I-halmuit Eskimo hunter of the Kazan needed approximately 100 caribou per year to satisfy all family needs.

Four European trappers in the Northwest Territories reported killing, on an average 65, 50, 50 to 60, and 45 animals per year, respectively. The records of another barren-ground caribou trapper indicated that he killed 278 caribou between September 11 and November 3, 1947. At present, owing to poor fur prices and restrictive measures of the Northwest Territories game regulations, the number of trappers, other than natives, on the tundra is decreasing rapidly.

Summary of Part II

The caribou provides nutritious meat in areas remote from sources of domestic meat. The hides provide superior Arctic clothing. They are also used for bedding, tents, kyaks, bags, and covers. The caribou also provides other domestic products.

The introduction of the fur industry to the caribou range has caused the native population to remain scattered over a vast area of northern Canada during the winter months and has encouraged winter travel, which has led to the development of large dog teams. These changes have been particularly noteworthy among the Eskimo population. Once a basically coastal people dependent upon a marine economy, these people have been encouraged to remain inland and trap during the winter months. These changes have led to increased caribou utilization.

In recent years, with the introduction of new industries along the Mackenzie River valley, the closed season on musk-oxen, and the decline in fur-bearers and fur prices, the Indian populations have withdrawn from the tundra and timber-line areas in summer and have taken up trapping areas nearer the trading posts. This fact has alleviated the drain on caribou to some extent, as has the gradual reduction in the number of barren-ground trappers. The introduction of European clothing and the local availability of imported food supplies have also reduced the utilization of caribou.

In future the steadily growing population of native groups and the development of mineral, forest, and other resources must be taken into account.

The caribou range will be increasingly restricted by mineral developments, logging, forest and tundra fires, and human settlement. With this change there will be increased demand for caribou products by a growing population of non-native residents of the caribou range and a heavy native utilization of caribou at a level which provides the minimum basis of their economy.

The present annual human utilization of caribou has been estimated to be about 100,000 animals by groups as follows: Indians, 50,000; Eskimos, 30,000; other trappers and hunters, 20,000. Next to man, the wolf is the most important predator of the caribou. Scanty data indicated that wolf predation accounted for approximately 2.5 per cent of the population in one year in one instance. Maximum wolf predation was estimated to account for 34,000 animals annually. Disease was thought to be of less importance as a mortality factor but accidents and weather losses were believed to have an appreciable effect: losses caused by disease, accidents, and weather might account for another 34,000 animals annually. The annual increment has been estimated to be approximately 145,000 calves. The mortality figures indicate an approximate annual loss of 178,000 animals, resulting in a deficit of about 32,000 animals per year.

The present population of caribou is large enough to supply all the basic needs of the dependent human population on a continuing basis if only sufficient caribou for basic needs are killed and if there is no wastage. At present the wastage of this resource by humans is great enough to account for the excessive utilization of the caribou beyond the annual crop. The wastage may be comparable to the loss by predators. A large part of it is caused by the improvident and wasteful hunting techniques of the native population. Chief sources of wastage are: (1) loss by putrefaction of meat of animals taken in the late summer for the hides; (2) theft of meat by scavengers from poorly made caches; (3) wounding of animals and failure to trail them; (4) slaughter of caribou beyond the actual need; (5) cacheing of meat along a route subsequently not revisited; (6) use of caribou meat for dog food when other foods, such as fish, are available; (7) failure to utilize the whole carcass.

Certain factors in the northern economy have encouraged the natives to kill caribou in excess of their own needs. The reduction in the number or extermination of the native caribou in certain Arctic regions has placed a premium on the hides of caribou from regions where they are still plentiful. The natives of these regions kill many caribou beyond their needs in late summer and autumn, solely for trading purposes. Hides, complete suits of clothing, sinews and thongs are traded. The meat from the carcasses generally spoils or is used for dog food.

So far, the activities of the native population and the advance of civilization in the range of the barren-ground caribou have had little effect upon its habitat. There seems little likelihood that agriculture will ever menace the range or movements of the caribou. Lumbering activities in this region have been insignificant; future demands may result in an increase in this industry along transportation routes, but it is unlikely that the timber

resources of large regions of the sub-Arctic forests of white spruce will ever merit exploitation. During the recent period of mineral exploration, there has been some caribou range destruction by forest fires. During the subsequent period of mineral production it is unlikely that the habitat will be affected as much. Since the caribou is a member of the climax-taiga community, fire is one of the most destructive ways by which man affects the caribou population. Large areas of winter range have already been destroyed by fire. Because of the slow sub-Arctic growth, these conditions may be of a semi-permanent nature.

Man exerts his heaviest influence upon the barren-ground caribou as a direct predator. Management of this resource must therefore be directed primarily towards controlling the number of caribou killed annually, so that the utilization will be less than the annual surplus over environmental mortality. With wise management the resource will continue to supply food and clothing to residents of Arctic and sub-Arctic Canada.

Table 18. Measurements of Caribou Specimens Examined

Class	Number Examined	Total Length		Shoulder Height		Hind Foot Length		Average Tail Length
		Average	Range	Average	Range	Average	Range	
Bull - Adult	9	1,809	1,890-1,725	1,101	1,195-1,050	521	540-457	127
Cow - Adult	9	1,663	1,780-1,590	1,049	1,140-980	511	540-485	125
Bull - 2 to 3 yrs.	8	1,708	1,780-1,640	1,051	1,170-875	511	540-497	---
Cow - 2 to 3 yrs.	3	1,611	1,650-1,585	1,030	1,030-1,030	540	550-530	---
Yearling	2	1,390	1,390-1,390	910	930-890	470	480-460	---
Calf	3	1,023	1,070-1,000	687	750-650	370	390-335	---
TOTAL	34							

Note: - All measurements are in millimeters.

Table 19. Stage of Moulting, August 15 to 18, 1949

Adult Bulls		Adult Cows		Yearlings		Total
New Coat	Old Coat	New Coat	Old Coat	New Coat	Old Coat	
65 83%	13 17%	25 52%	23 48%	14 93%	1 7%	141

Table 20. Measurements of Antlers

Class	No.	Length of Beam		Spread of Antlers		Diameter above Burr		Spike	Animals with	
		Average	Range	Average	Range	Average	Range		Brow Tine only	Brow and Bezel Tines
								%	%	%
Adult bull	44	1,087	1,350-690	741	1,025-500	53.2	70-42	0	2	98
Adult cow	23	346	550-75	278	400-200	24.7	32-18	17	62	17
Bull, Rising Two	5	599	780-345	498	700-323	40.4 x	40.4	0	20	80
Yearlings	7	151	325-25	150	150	--	--	100	0	0
	79									

Note: - All measurements are in millimeters.

x One specimen only.

Table 21. Eruption and Wear of Teeth

Age	No Spec.	I1	P2.	P3.	P4.	M1.	M2.	M3.	D/E	Eruption	Wear
-1	1	-	0	0	0	0	0	0	-	dI's	-
1	2	-	13.0	d5.3	8.0	0	0	0	-	dP's	-
1	8	15.4	5.1	6.8	8.0	0	0	0	-	-	-
1 1/2	5	7.2	5.1	7.1	8.8	0	0	0	-	-	dP3 light
2 1/2	7	-	4.8	6.5	7.8	p3.8	0	0	0	pM1	dP3,4 lt.
3	4	4.9	4.9	6.4	7.0	6.2	0	0	0	pM1	dP2 light; P3,4 mod.
5	7	-	4.8	5.2	5.7	8.7	0	0	0	-	dP's mod.
3	4	-	4.8	5.8	6.3	9.9	0	0	1 1/2	-	dP's mod.
10	4	p7.3	4.8	5.5	6.7	9.7	p4.1	0	1 1/2	pI1,2, M2.	dP's heavy
12	2	-	4.0	4.4	4.6	8.6	8.3	0	1	pI3,C M2	dP's heavy
14	4	7.1	4.7	4.9	5.2	10.4	9.5	0	1	-	dP's heavy
16	4	-	4.2	4.6	5.7	10.4	11.0	0	1	-	dP's heavy
17	6	7.0	5.0	4.4	5.0	10.3	12.1	p6.1	1	pP's M3	pM1 light
18	7	-	p7.8	p11.2	p12.2	10.6	11.3	9.3	1	M3	pM1 light
20	7	-	8.1	11.4	12.9	10.5	12.0	11.7	1	-	pM1 light
22	8	6.5	8.9	11.6	12.4	10.2	11.0	12.2	1	M3pc	P3,4,M1,2 light
24	10	-	8.4	11.7	12.0	10.1	11.6	10.8	1	M3pc	P3,4,M1,2, 3 light
26	9	6.0	6.8	11.3	12.5	10.0	11.3	10.5	1 1/2	-	M3 pc. lt.
29	14	6.4	8.0	11.2	12.2	9.8	10.8	10.9	1 1/2	-	M3 pc. lt.
33	14	6.1	8.4	10.8	10.9	9.4	10.6	10.7	2	-	P2,3,4, M1, 2,3 pc.mod.
36	12	5.5	7.3	11.0	11.2	9.3	10.7	9.6	2	-	" " "
38	5	5.7	7.1	10.2	11.7	9.2	10.3	9.4	2 1/2	-	" " "
Total	144										

Note: - All measurements are in millimeters; ages in months.

Table 22. Eruption and Wear of Reindeer Cheek Teeth

Age	No. Spec.	P2	P3	P4	M1	M2	M3	D/E	Erup- tion	Wear
Yrs.										
$\frac{1}{2}$	2	d4.9	d5.4	d6.9	10.5	-	-	1	M1	dP's moderate
$1\frac{1}{2}$	2	4.8	5.5	6.0	10.5	11.8	8.5	1	M3	dP's heavy; M1 light
3	1	p8.4	p10.9	p12.1	9.2	10.5	8.3	1.5	M3pc	P's light; M1, 2. mod.
$3\frac{1}{2}$	3	7.0	10.4	11.9	9.3	11.2	10.8	2.5	-	M3pC mod.; P's light
$4\frac{1}{2}$	1	6.4	9.6	10.7	8.3	10.1	9.1	3	-	All moderate
7	1	6.1	9.6	10.1	7.0	8.4	8.5	4	-	All heavy
$7\frac{1}{2}$	1	7.3	8.4	9.5	7.3	8.3	6.5	5	-	All heavy
$8\frac{1}{2}$	1	5.5	7.0	8.5	6.7	8.3	7.8	5	-	All heavy

Table 23. Range Vegetation Studies. Station 1 - Dry Hillside at Fort Reliance. 115 throws.

Species		Freq. Index	Coverage	Socia- bility
<u>Trees 20 ft.</u>				
White spruce	(<u>Picea glauca</u>)	.14	.068	5
White birch	(<u>Betula papyrifera</u>)	.16	.093	2
Aspen	(<u>Populus tremuloides</u>)	T	T	2
Total			.161	
<u>Bushes 10 ft.</u>				
White spruce	(<u>Picea glauca</u>)	.06	.031	5
White birch	(<u>Betula papyrifera</u>)	.03	.015	2
Willows	(<u>Salix</u> spp.)	.07	.030	2
Alders	(<u>Alnus</u> spp.)	.04	.023	2
Total			.099	
<u>Shrubs 2 ft.</u>				
Buffalo-berry	(<u>Shepherdia canadensis</u>)	.08	.038	1
Willows	(<u>Salix</u> spp.)	.10	.030	2
Dwarf birch	(<u>Betula glandulosa</u>)	.02	.004	4
Labrador tea	(<u>Ledum decumbens</u>)	.34	.110	5
Bilberry	(<u>Vaccinium uliginosum</u>)	.10	.027	4
Crouching juniper	(<u>Juniperus communis</u>)	.04	.016	1
Lapland rose-bay	(<u>Rhododendron lapponicum</u>)	.03	.008	3
White spruce	(<u>Picea glauca</u>)	.03	.026	5
Total			.259	
<u>Ground Vegetation</u>				
Foxberry	(<u>Vaccinium Vitis-Idaea</u>)	.60	.150	4
Crowberry	(<u>Empetrum nigrum</u>)	.44	.166	2
Labrador tea	(<u>Ledum decumbens</u>)	.17	.021	5
Bearberry	(<u>Arctostaphylos alpina</u>)	.13	.032	4
Pyrola	(<u>Pyrola</u> sp.)	.07	.041	1
Bilberry	(<u>Vaccinium uliginosum</u>)	.03	.003	1
Grass	(<u>Calamagrostis purpurascens</u>)	.04	.014	5
Mosses	(<u>Musci</u>)	.51	.276	5
Lichen	(<u>Gladonia alpestris</u> var. <u>sylvatica</u>)	.14	.027	2
Lichen	(<u>Gladonia rangiferina</u>)	.05	.011	2
Lichen	(<u>Cetraria nivalis</u>)	.07	.014	2
Total			.755	

Table 24. Range Vegetation Studies. Station 2 - Bog at Fort Reliance.
100 throws.

Species		Freq. Index	Coverage	Socia- bility
<u>Trees 20 ft.</u>				
Black spruce	(<u>Picea mariana</u>)	.21	.092	4
Tamarack	(<u>Larix laricina</u>)	.03	.020	1
White birch	(<u>Betula papyrifera</u>)	.04	.010	1
Total			.122	
<u>Bushes 10 ft.</u>				
Tamarack	(<u>Larix laricina</u>)	.01	.002	1
Willows	(<u>Salix spp.</u>)	.03	.006	1
Total			.008	
<u>Shrubs 2 ft.</u>				
Black spruce	(<u>Picea mariana</u>)	.09	.034	4
Dwarf birch	(<u>Betula glandulosa</u>)	.02	.005	4
Tamarack	(<u>Larix laricina</u>)	.02	.006	1
Willows	(<u>Salix spp.</u>)	.12	.017	1
Crouching juniper	(<u>Juniperus communis</u>)	.01	.006	1
Lapland rose-bay	(<u>Rhododendron lapponicum</u>)	.04	.018	3
Labrador tea	(<u>Ledum decumbens</u>)	.33	.063	5
Bilberry	(<u>Vaccinium uliginosum</u>)	.22	.041	4
Rosemary	(<u>Andromeda polifolia</u>)	.01	.004	2
Total			.194	
<u>Ground Vegetation</u>				
Crowberry	(<u>Empetrum nigrum</u>)	.23	.065	2
Foxberry	(<u>Vaccinium Vitis-Idaea</u>)	.42	.067	4
Bearberry	(<u>Arctostaphylos alpina</u>)	.14	.029	4
Labrador tea	(<u>Ledum decumbens</u>)	.17	.022	5
Mosses	(<u>Musci</u>)	.75	.325	5
Lichen	(<u>Gladonia rangiferina</u>)	.40	.145	3
Lichen	(<u>Cetraria nivalis</u>)	.15	.027	2
Lichen	(<u>Gladonia alpestris</u> var. <u>sylvatica</u>)	.28	.055	2
Horsetail	(<u>Equisetum sp.</u>)	.07	.007	2
Lycopod	(<u>Lycopodium sp.</u>)	.01	.005	2
Sedge	(<u>Carex Williamsii</u>)	.03	.014	2
Sedge	(<u>Carex concolor</u>)	.05	.013	3
Grass	(<u>Calamagrostis canadensis</u>)	.01	.003	5
Rosemary	(<u>Andromeda polifolia</u>)	.06	.006	1
Willows	(<u>Salix spp.</u>)	.09	.020	2
Cottongrass	(<u>Eriophorum sp.</u>)	.04	.019	5
Bilberry	(<u>Vaccinium uliginosum</u>)	.02	.008	2
Dryad	(<u>Dryas integrifolia</u>)	.01	.004	2
Total			.834	

Table 25. Range Vegetation Studies. Station 3 - Tundra at Bathurst Inlet. 123 throws.

Species		Freq. Index	Coverage	Socia- bility
<u>Shrubs 2'6"</u>				
Willows	(<u>Salix spp.</u>)	.08	.021	2
Alder	(<u>Alnus sp.</u>)	.04	.014	4
Dwarf birch	(<u>Betula glandulosa</u>)	.04	.011	4
Total			.046	
<u>Ground Vegetation</u>				
Dryad	(<u>Dryas integrifolia</u>)	.10	.014	3
Bilberry	(<u>Vaccinium uliginosum</u>)	.61	.105	4
Mosses	(<u>Musci</u>)	.60	.177	5
Dwarf birch	(<u>Betula glandulosa</u>)	.27	.069	4
Foxberry	(<u>Vaccinium Vitis-Idaea</u>)	.09	.007	4
Willows	(<u>Salix spp.</u>)	.43	.060	2
Lichen	(<u>Cetraria nivalis</u>)	.42	.072	3
Lichen	(<u>Alectoria ochroleuca</u>)	.17	.013	3
Crowberry	(<u>Empetrum nigrum</u>)	.23	.034	2
Labrador tea	(<u>Ledum decumbens</u>)	.20	.013	5
Cassiope	(<u>Cassiope tetragona</u>)	.32	.083	1
Lupine	(<u>Lupinus arcticus</u>)	.18	.017	1
Lapland rose-bay	(<u>Rhododendron lapponicum</u>)	.18	.019	3
Lousewort	(<u>Pedicularis labradorica</u>)	.07	.002	1
Lichen	(<u>Stereocaulon Paschale</u>)	.13	.018	2
Lichen	(<u>Thamnolia vermicularis</u>)	.08	.003	2
Lichen	(<u>Gladonia rangiferina</u>)	.12	.014	2
Lichen	(<u>Cetraria islandica</u>)	.09	.006	2
Lichen	(<u>Dactylina arctica</u>)	.04	.001	2
Bearberry	(<u>Arctostaphylos alpina</u>)	.10	.017	4
Rosemary	(<u>Andromeda polifolia</u>)	.03	.001	1
Bluegrass	(<u>Poa glauca</u>)	.01	.002	5
Grass	(<u>Calamagrostis purpurascens</u>)	.02	.003	5
Cottongrass	(<u>Eriophorum sp.</u>)	.02	.008	5
Sedge	(<u>Carex concolor</u>)	.34	.045	3
Sedges	(<u>Carex spp.</u>)	.06	.038	5
Total			.841	

Table 26. Range Vegetation Studies. Station 4 - Dry Tundra at Contwoyto Lake. 125 throws.

Species		Freq. Index	Coverage	Socia- bility
<u>Shrubs 2'6"</u>				
Dwarf birch	(<u>Betula glandulosa</u>)	.07	.050	4
<u>Ground Vegetation</u>				
Dwarf birch	(<u>Betula glandulosa</u>)	.32	.083	4
Labrador tea	(<u>Ledum decumbens</u>)	.26	.057	5
Mosses	(<u>Musci</u>)	.32	.067	5
Lichen	(<u>Cetraria nivalis</u>)	.13	.002	3
Foxberry	(<u>Vaccinium Vitis-Idaea</u>)	.18	.026	4
Bilberry	(<u>Vaccinium uliginosum</u>)	.30	.058	4
Bearberry	(<u>Arctostaphylos alpina</u>)	.05	.006	4
Lichen	(<u>Alectoria ochroleuca</u>)	.02	T	3
Sedge	(<u>Carex concolor</u>)	.38	.072	5
Crowberry	(<u>Empetrum nigrum</u>)	.06	.010	2
Willows	(<u>Salix spp.</u>)	.27	.029	2
Cottongrass	(<u>Eriophorum sp.</u>)	.15	.069	5
Lichen	(<u>Cetraria islandica</u>)	.06	.002	3
Rosemary	(<u>Andromeda polifolia</u>)	.01	T	1
Cloudberry	(<u>Rubus Chamaemorus</u>)	.02	.001	1
Sedge	(<u>Carex membranacea</u>)	.01	.002	5
Lichen	(<u>Cladonia rangiferina</u>)	.01	T	2
Sedges	(<u>Carex spp.</u>)	.19	.089	5
Knotweed	(<u>Polygonum sp.</u>)	.02	.001	1
Bluegrass	(<u>Poa sp.</u>)	.02	.003	3
Lousewort	(<u>Pedicularis lapponica</u>)	.02	.002	1
Alpine azalea	(<u>Loiseleuria procumbens</u>)	.02	.002	3
Milk vetch	(<u>Astragalus alpinus</u>)	.02	.001	1
Bluegrass	(<u>Poa glauca</u>)	.04	.009	3
Holy grass	(<u>Hierochloe alpina</u>)	.08	.016	3
Total			.607	

Table 27. Range Vegetation Studies. Station 5 - Tundra at
Lake Clinton-Colden. 300 throws

Species		Freq. Index	Coverage	Produc- tion Kgms. Acre	Socia- bility
<u>Shrubs 2'6"</u>					
Willows	(<u>Salix spp.</u>)	.09	.018	252.	2
Dwarf birch	(<u>Betula glandulosa</u>)	.21	.033	282.	4
Total			.051		
<u>Ground Vegetation</u>					
Labrador tea	(<u>Ledum decumbens</u>)	.55	.084	827.	5
Bilberry	(<u>Vaccinium uliginosum</u>)	.30	.040	465.	4
Foxberry	(<u>Vaccinium Vitis-Idaea</u>)	.30	.024	1,148.	4
Bearberry	(<u>Arctostaphylos alpina</u>)	.27	.041	255.	4
Crowberry	(<u>Empetrum nigrum</u>)	.17	.029	1,028	2
Rosemary	(<u>Andromeda polifolia</u>)	.04	.002	17.5	1
Alpine azalea	(<u>Loiseleuria procumbens</u>)	T	T	126.	2
Cloudberry	(<u>Rubus Chamaemorus</u>)	.04	.002	141.	1
Oxytropis	(<u>Oxytropis Maydelliana</u>)	.01	.001	-	1
Saxifrage	(<u>Saxifraga tricuspidata</u>)	.03	.005	-	3
Moss Campion	(<u>Silene acaulis</u>)	.05	.009	-	3
Cottongrass	(<u>Eriophorum vaginatum</u>)	.07	.023	570.	5
Sedge	(<u>Carex concolor</u>)	.17	.022	113.	3
Sedge	(<u>Carex membranacea</u>)	T	T	290.	4
Sedge	(<u>Carex pariflora</u>)	T	T	78.	4
Bent reed grass	(<u>Calamagrostis purpurascens</u>)	.01	T	437.	5
Wood rush	(<u>Luzula Wahlenbergii</u>)	T	T	14.	4
Mosses	(<u>Musci</u>)	.18	.042	-	5
Lichen	(<u>Cetraria nivalis</u>)	.37	.014	150.	3
Lichen	(<u>Cladonia rangiferina</u>)	.01	T	42.	2
Lichen	(<u>Alectoria ochroleuca</u>)	.13	.022	289.	3
Lichen	(<u>Cetraria sp.</u>)	.01	.004	185.	2
Lichen	(<u>Cetraria islandica</u>)	T	T		3
Total			.364		

Table 28. Range Vegetation Studies. Station 6 - Tundra at
Muskox Lake. 100 throws

Species		Freq. Index	Coverage	Socia- bility
<u>Shrubs 2'6"</u>				
Willows	(<u>Salix</u> spp.)	.07	.008	2
Dwarf birch	(<u>Betula glandulosa</u>)	.40	.130	4
Total			.138	
<u>Ground Vegetation</u>				
Labrador tea	(<u>Ledum decumbens</u>)	.38	.091	5
Bilberry	(<u>Vaccinium uliginosum</u>)	.19	.056	4
Foxberry	(<u>Vaccinium Vitis-Idaea</u>)	.16	.029	4
Crowberry	(<u>Empetrum nigrum</u>)	.12	.047	2
Bearberry	(<u>Arctostaphylos alpina</u>)	.10	.019	4
Rosemary	(<u>Andromeda polifolia</u>)	.08	.014	1
Cloudberry	(<u>Rubus Chamaemorus</u>)	.01	.001	1
Butterwort	(<u>Pinguicula villosa</u>)	.01	T	3
Knotweed	(<u>Polygonum viviparum</u>)	.02	.004	1
Sedge	(<u>Carex concolor</u>)	.16	.032	3
Cottongrass	(<u>Eriophorum vaginatum</u>)	.31	.184	5
Bent reed grass	(<u>Calamagrostis purpurascens</u>)	.04	.014	5
Holy grass	(<u>Hierochloe alpina</u>)	.02	.014	3
Bent grass	(<u>Agrostis borealis</u>)	.01	.008	3
Lichen	(<u>Cetraria nivalis</u>)	.21	.022	3
Lichen	(<u>Cetraria islandica</u>)	.09	.023	3
Sphagnum	(<u>Sphagnum</u> sp.)	.08	.039	5
Mosses	(<u>Musci</u>)	.12	.024	3
Total			.621	

Table 29. Summer Stomach Analysis

Species	Volume c.c.	Decimal Occur- ence	Plant Cover- age	Decimal Coverage of Plant Cover	Palata- bility
Mushrooms	15	.012	T.	T.	High
<u>Equisetum sp.</u>	8	.006	T.	T.	High
<u>Cladonia rangiferina</u>	44	.034	T.	T.	High
<u>Cladonia alpestris</u>	10	.008	T.	T.	High
<u>Cetraria nivalis</u>	301	.230	.014	.030	7.66
<u>Cetraria islandica</u>	52	.040	T.	T.	High
<u>Salix spp.</u>	206	.157	.018	.039	3.98
<u>Grasses and Sedges</u>	368	.281	.045	.096	2.92
<u>Betula glandulosa</u>	216	.165	.033	.071	2.36
<u>Vaccinium Vitis-Idaea</u>	47	.036	.024	.056	0.67
<u>Ledum decumbens</u>	16	.012	.084	.180	0.67
<u>Arctostaphylos alpina</u>	19	.013	.041	.088	0.15
<u>Vaccinium uliginosum</u>	3	.002	.040	.086	0.02
<u>Alectoria ochroleuca</u>	1	.001	.022	.047	0.02
<u>Empetrum nigrum</u>	1	.001	.029	.062	0.02
<u>Loiseleuria procumbens</u>	1	.001	T.	T.	Low
<u>Dryas integrifolia</u>	T.	T.	T.	T.	Low
<u>Rhododendron lapponicus</u>	T.	T.	T.	T.	Low
<u>Phyllodoce caerulea</u>	T.	T.	T.	T.	Low
Mosses	T.	T.	.042	.090	Low
Totals	1,308	.999	.392		

Table 30. Distances Advanced Daily along the Hudson Bay
Railway during Autumn Migrations, 1948

Date	Location of Vanguard	Miles per Day
Nov. 14	Churchill River	--
Nov. 18	Mile 432	12
Nov. 19	Mile 412	20
Nov. 20	Mile 372	40
Nov. 22	Mile 349	23
Nov. 23	Mile 337	12
Nov. 27	Split Lake	16
Nov. 28	Moosenose Lake	20
Nov. 29	Mile 261	12
Dec. 1	Bigstone River	20

Table 31. Relation between Movement and Wind Direction

Direction of Wind	0°(In Front)	22.5°	45°	67.5°	90°	112.5°	135°	157.5°	180° (Behind)
Observa- tions	28	14	40	12	42	9	30	11	24
Per cent	13.3	6.7	19.0	5.7	20.0	4.3	14.3	5.2	11.4

Table 32. Segregation of Caribou Herds

Herd	Date	Total	Bulls	Per Cent	Cows	Per Cent	Calves	Per Cent	Year- lings	Per Cent	2-yr. olds	Per Cent
Rae	Spring, 1949	3,163	90	2.8	2,077	65.7	--	--	668	21.1	328	10.4
Rae	Summer, 1949	1,254	164	13.1	697	55.6	269	21.5	124	9.9	--	--
Hanbury	Summer, 1948	2,753	525	19.1	1,506	54.7	476	17.3	246	8.9	--	--
Hanbury	Spring, 1949	536	5	0.9	310	57.8	--	--	154	28.7	67	12.5
Churchill- Brochet	Spring, 1948	2,775	540	19.6	1,574	56.7	--	--	412	14.8	249	9.0
Brochet	Summer, 1948	249	77	30.9	78	31.3	62	24.9	32	12.9	--	--
Brochet	Autumn, 1948	1,650	861	52.2	451	27.3	247	15.0	91	5.6	--	--
Brochet	Rutting, 1948	541	98	18.1	259	47.9	135	25.0	49	9.1	--	--
Saskatchewan	Summer, 1949	792	243	30.7	314	39.6	135	17.0	100	12.6	--	--

Table 33. Annual Increment and Survival

Herd	Date	Survival in Per Cent of Cows for Age Classes in Months					
		2	4	10	14	16	22
Rae	Spring, 1949	--	--	32.2	--	--	15.8
Rae	Summer, 1949	38.6	--	--	17.8	--	--
Hanbury	Summer, 1948	31.6	--	--	16.3	--	--
Hanbury	Spring, 1949	--	--	50.0	--	--	21.6
Saskatchewan	Summer, 1949	43.1	--	--	31.9	--	--
Churchill, Duck L., Brochet	Spring, 1948	--	--	26.2	--	--	15.8
Brochet	Summer, 1948	79.6	--	--	41.0	--	--
Brochet	Autumn, 1948	--	54.8	--	--	20.2	--
Brochet	Rutting, 1948	--	52.2	--	--	18.9	--
Aberdeen	Spring, 1948	--	--	12.9	--	--	17.6
Weighted Average		40.2			25.8		16.3
Survival of Young		100.0			64.3		40.5

Table 34. Analysis of Caribou Mortality

Approximate Age in Years	Carcasses Found	Per Cent Mortality
1	44	15.1
2	51	17.5
3	60	20.5
4	22	7.5
5	23	7.9
6	12	4.1
7	15	5.1
8	17	5.8
9	13	4.5
10	12	4.1
11	13	4.5
12	10	3.4
Total	292	100.0

Table 35. Recorded Number of Caribou Hides
Traded in the Northwest Territories

License Year	Mackenzie District	Keewatin District
1938-9	1,429	13
1939-40	422	47
1940-1	740	16
1941-2	249	9
1942-3	386	553
1943-4	3,408	148
1944-5	2,957	857
1945-6	2,027	553
1946-7	2,851	--
1947-8	1,253	--
1948-9	* 1,697	* 512

* - Incomplete return

Table 36. Recorded Amounts of Caribou Products Traded
Recently at Duck Lake, Manitoba

Year	Hairless tanned hides	Haired hides	Babiche
1947-48	865	108	684 lbs.
1948-49	654	341	516 lbs.
1949-50	* 51	--	728 lbs.

* - Incomplete return

Table 37. Number of Caribou Reported Killed by European
and Half-Breed Hunters and Trappers

Year	N. W. T.	Manitoba	Saskatchewan
1932-3	2,472	--	--
1933-4	2,629	--	--
1934-5	2,648	--	--
1935-6	2,723	--	--
1936-7	2,332	--	--
1937-8	1,939	--	--
1938-9	2,665	--	--
1939-40	1,969	--	--
1940-1	2,030	--	--
1941-2	1,730	15	--
1942-3	1,557	7	--
1943-4	1,138	18	--
1944-5	2,506	11	--
1945-6	2,539	20	--
1946-7	2,422	38 (240)	--
1947-8	1,269	65 (133)	366 (122)
1948-9	* 1,325	--	980 (490)
1949-50	--	--	550

* - Incomplete return

The numbers in brackets indicate the numbers
of caribou licences sold.

Table 38. Analysis of Native Game Returns

Settlement	Number of Years Recorded	Average Yearly Utilization Caribou per Hunter
Oxford House, Man.	2	10.2
Fort Chipewyan, Alta.	1	6.7
Fort Fitzgerald, Alta.	2	17.7
Wood Buffalo Park	5	0.9
Fort Smith, N. W. T.	10	8.5
Fort Resolution, N. W. T.	11	11.4
Snowdrift, N. W. T.	10	23.2
Fort Rae, N. W. T.	16	43.5
Fort Reliance, N. W. T.	5	29.7
Fort Providence, N. W. T.	16	1.4
Fort Simpson, N. W. T.	13	1.4
Fort Wrigley, N. W. T.	3	2.3
Fort Norman, N. W. T.	8	8.6
Fort Franklin, N. W. T.	2	25.7
Fort Good Hope, N. W. T.	15	3.5
Arctic Red River, N. W. T.	15	5.7
Pearce Point, N. W. T.	2	2.7
Baillie Island, N. W. T.	4	2.1
Coppermine, N. W. T.	16	21.0
Bathurst Inlet, N. W. T.	3	43.5
Cambridge Bay, N. W. T.	10	5.9
Perry River, N. W. T.	1	16.6
Repulse Bay, N. W. T.	2	8.5
Baker Lake, N. W. T.	7	54.3
Wager Bay, N. W. T.	1	12.6
Chesterfield Inlet, N. W. T.	3	11.3
Tavanni, N. W. T.	1	50.0
Eskimo Point, N. W. T.	6	44.1
Padlei, N. W. T.	1	25.0

Table 39. Total Average Annual Kill

Trading Post	Population		Caribou Killed	
	Total	Males Over 16 Years	Per Hunter	Total
<u>Indians</u>				
York Factory, Man.	491	126	15.0	1,890
Split Lake, Man.	521	170	20.0	3,400
Duck Lake, Man.	199	62	50.0	3,100
Nelson House, Man.	732	245	20.0	4,900
Gross Lake, Man.	842	225	9.0	2,050
Gods Lake, Man.	496	130	10.0	1,300
Oxford House, Man.	474	135	10.2	1,330
Brochet, Man.	346	94	75.0	7,050
Pukatawagan, Man.	408	125	11.0	1,375
Pelican Narrows, Sask.	707	187	2.0	374
Stanley, Sask.	509	177	5.0	885
Fond-du-lac, Sask.	540	140	30.0	4,200
Fort Mackay, Alta.	94	57	4.0	228
Fort Chipewyan, Alta.	590	174	6.7	1,170
Fort Smith, N.W.T.	181	66	8.5	562
Fort Resolution, N.W.T.	400	113	22.0	2,486
Yellowknife, N.W.T.	164	42	30.0	1,260
Fort Rae, N.W.T.	731	235	43.5	10,700
Fort Simpson, N.W.T.	336	112	1.4	157
Fort Norman, N.W.T.	316	90	8.6	760
Arctic Red River, N.W.T.	150	38	5.7	217
Fort Good Hope, N.W.T.	207	65	3.5	227
Total, Indians	9,434			49,621
<u>Eskimos</u>				
Aklavik, N.W.T.	377	109	0.5	55
Tuktoyaktuk	121	35	1.0	35
Baillie Island	115	33	2.1	70
Pearce Point	19	5.5	2.7	15
Coppermine	186	54.0	21.0	1,135
Bathurst Inlet	43	12.5	41.8	5,125
Cambridge Bay	157	45.5	5.9	260
Perry River	131	38.0	16.6	630
King William Island	139	40.3	5.9	237
Boothia	182	53	8.5	450
Pelly Bay	82	23.7	8.5	202
Repulse Bay	64	18.6	8.5	154
Wager Bay	49	14.2	12.6	179
Baker Lake	267	77.0	54.3	4,160
Chesterfield	201	58.0	11.3	672
Tavanni	100	29.0	50.0	1,450
Padlai	112	32.5	50.0	1,625
Eskimo Point	288	83.8	44.1	3,690
Kazan Band	48	20.0	150.0	3,000
Total, Eskimos, 1941	2,681			23,144
1950	3,135		(Adjusted)	27,050

Table 39. Total Average Annual Kill (cont.)

Others	No.	Caribou Killed	
		Per Hunter	Total
N.W.T. Trappers	395	-	2,210
N.W.T. Hunters	66	5	330
Man. Trappers	300	6	1,800
Sask. Trappers	705	6	4,230
Alta. Trappers	90	4	360
Sask. Hunters	-	-	550
Man. Hunters	-	-	130
Total, Others			9,610
Grand Total			86,281

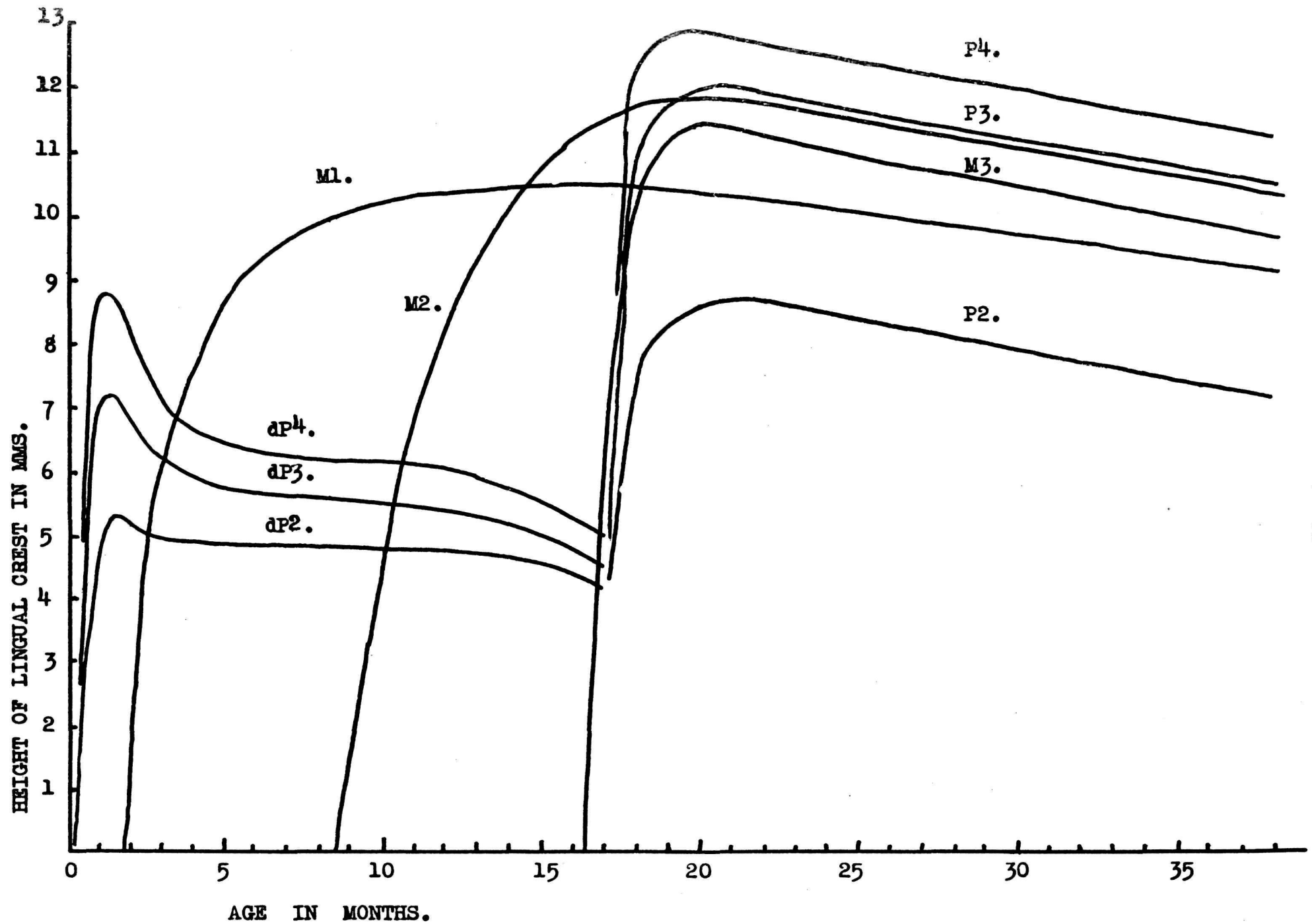


FIGURE 18 DIAGRAM OF TOOTH ERUPTION AND WEAR.

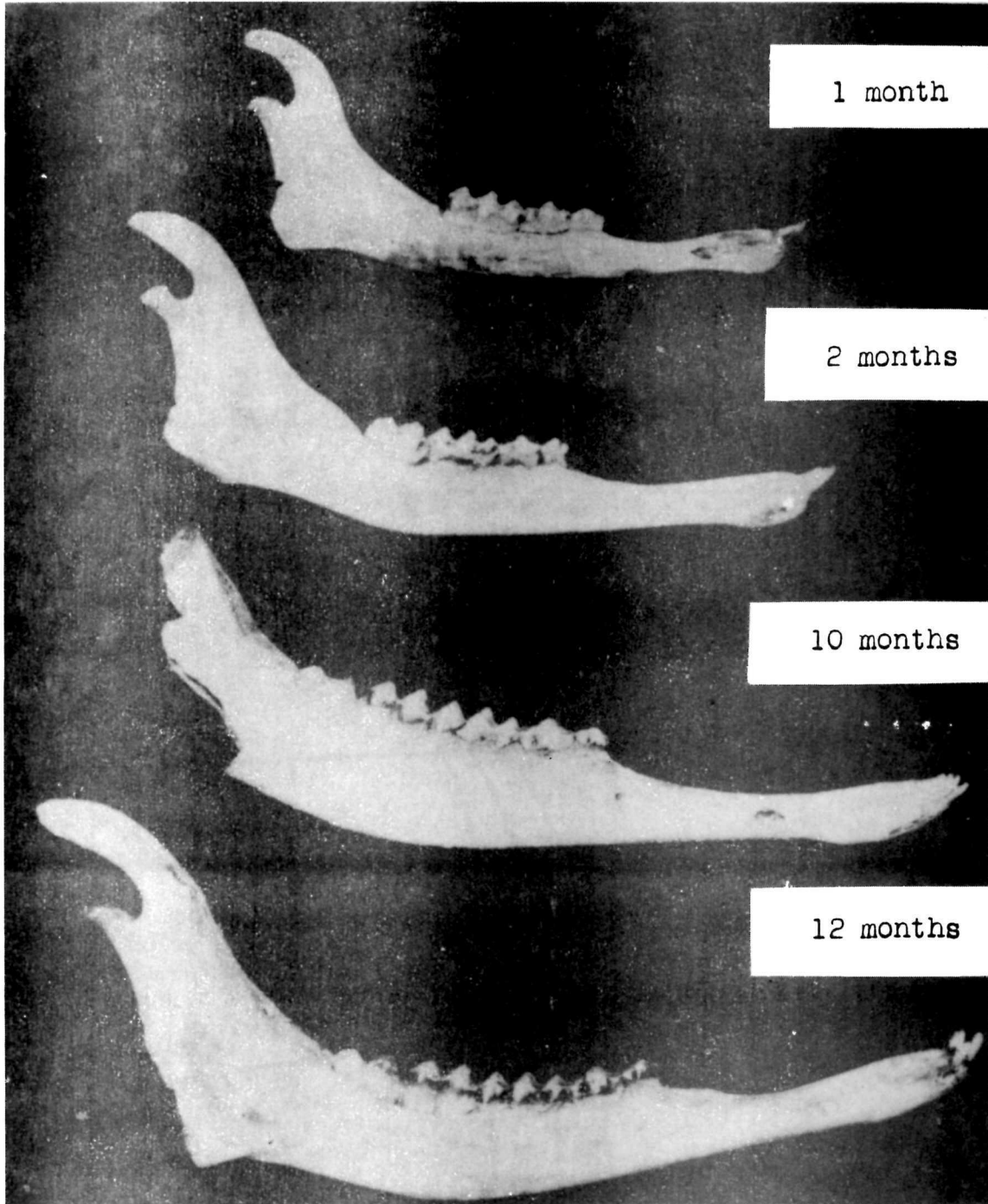


Fig. 19. A series of caribou mandibles to show replacement of teeth in animals up to one year of age.

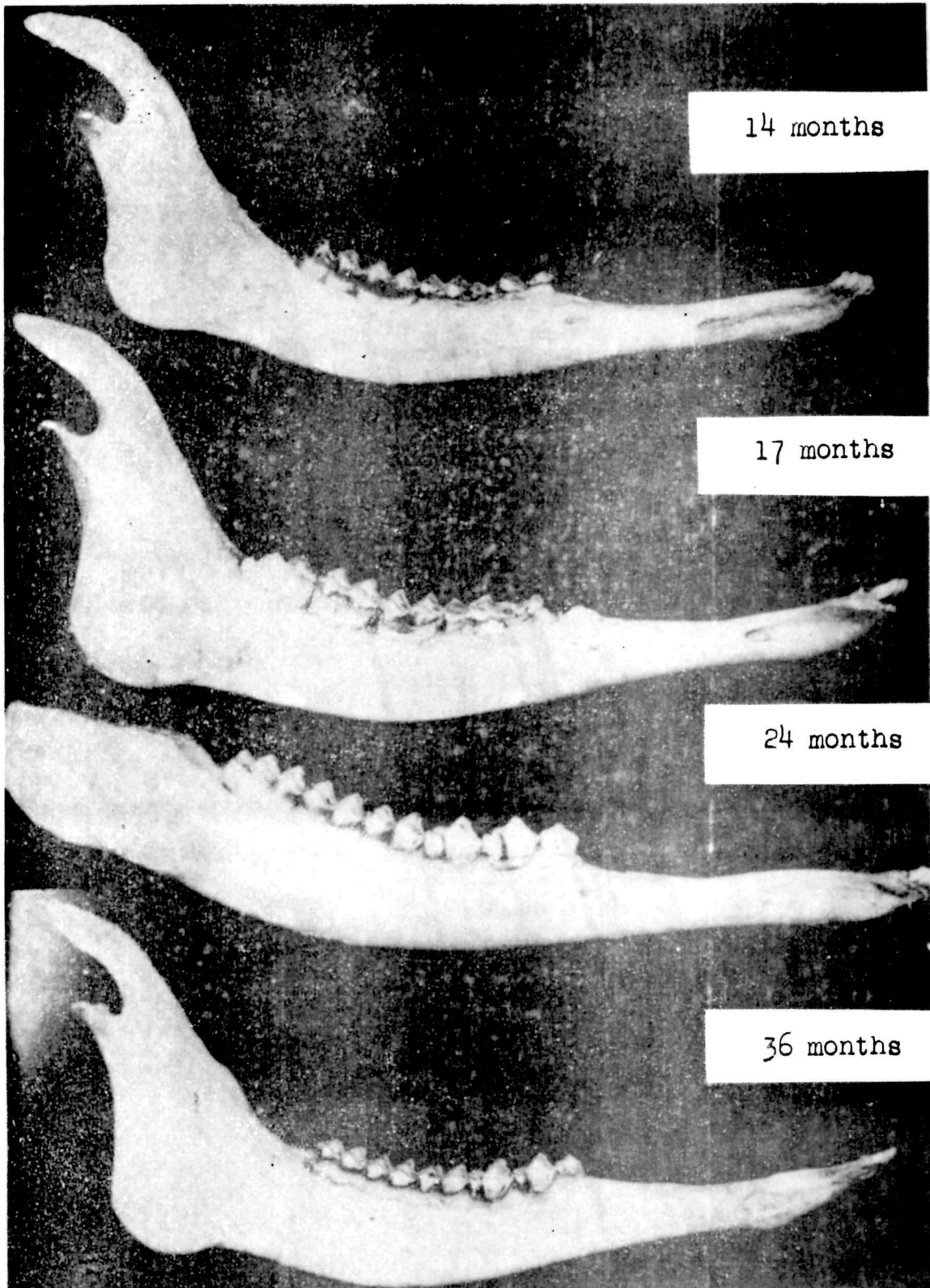
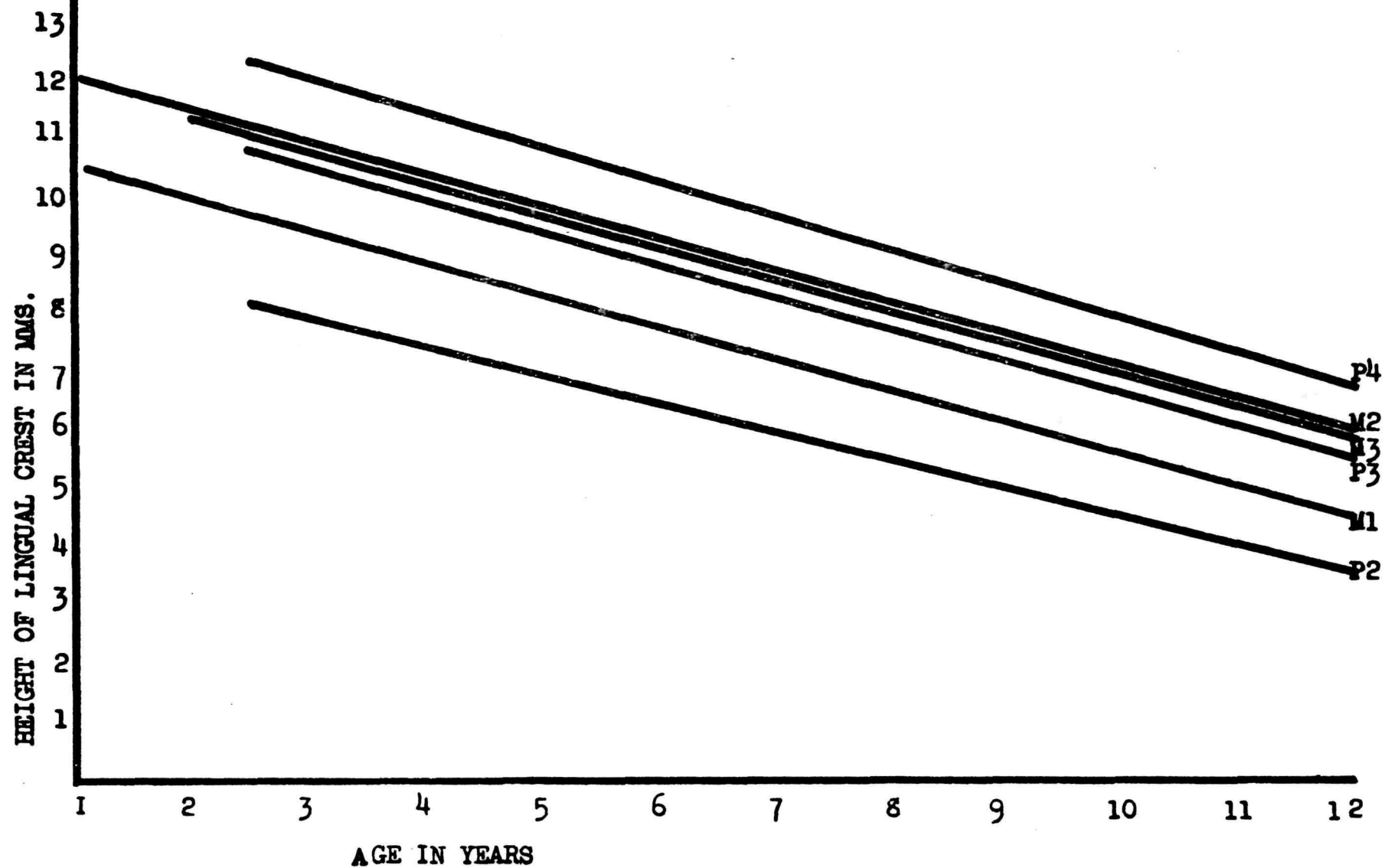


Fig. 20. A series of caribou mandibles to show replacement of teeth in animals more than one year of age.

Fig. 21. Diagram of reindeer tooth wear.



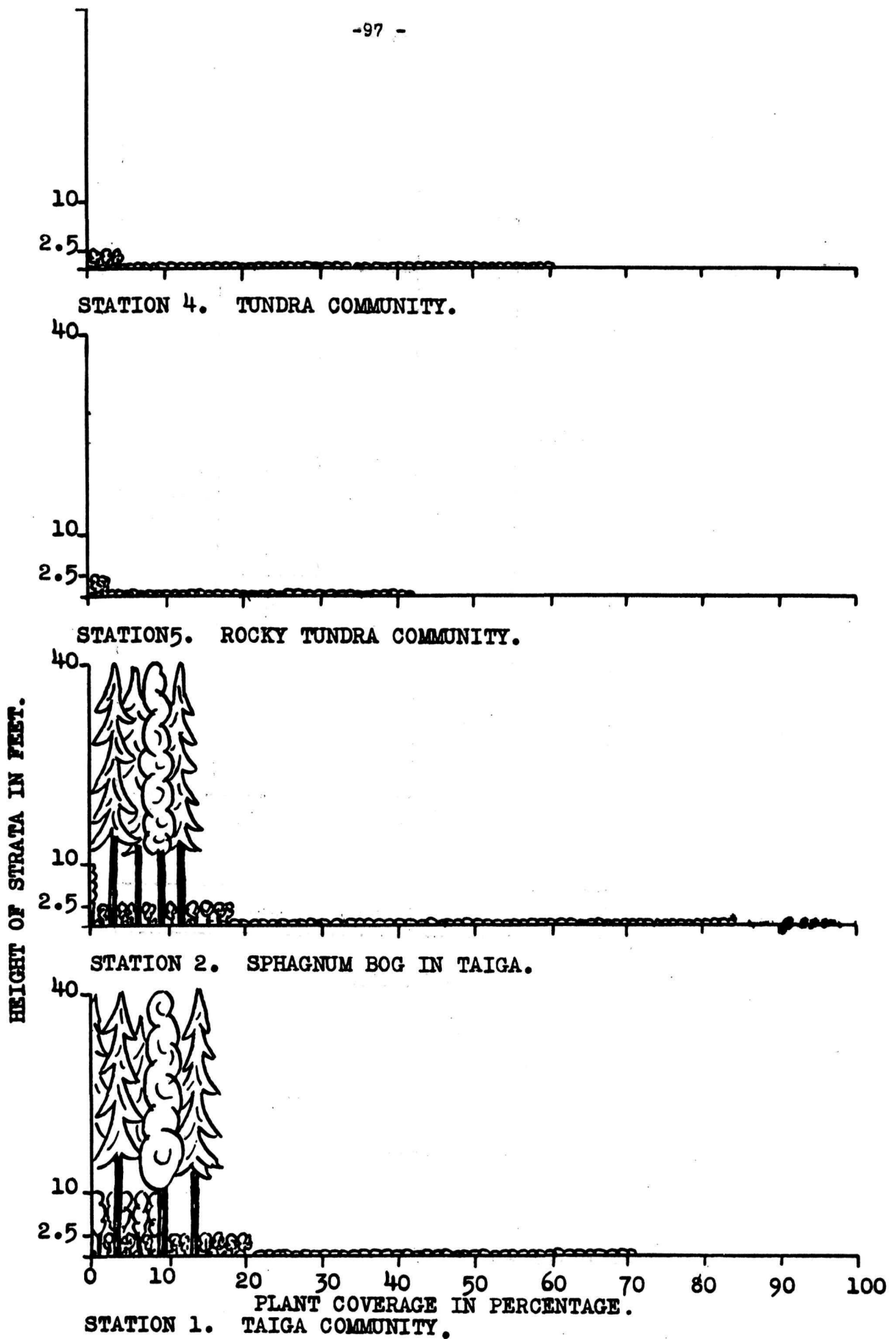
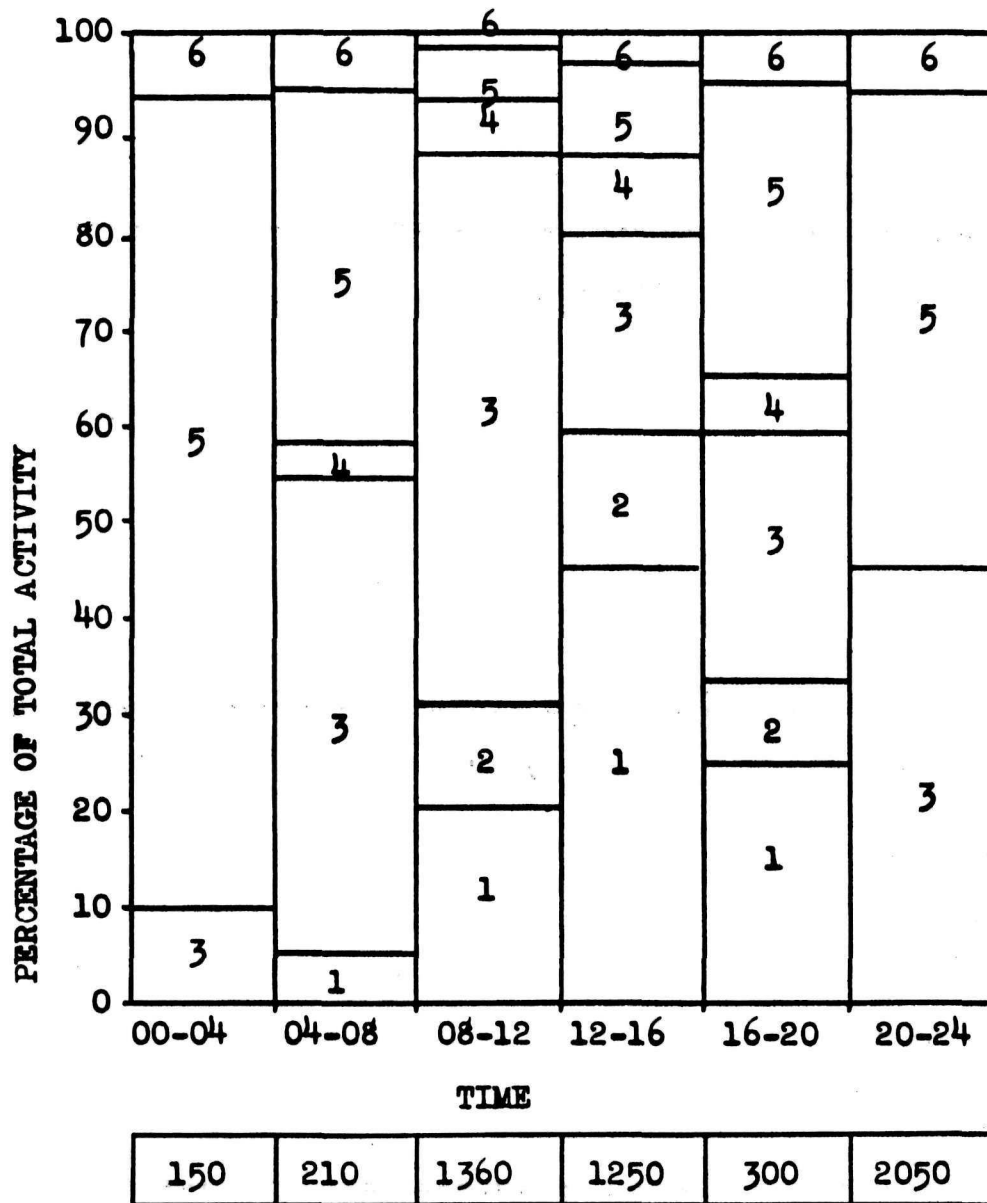


FIG. 22 COMPARISON OF PLANT COVERAGE AT VARIOUS STATIONS.



CARIBOU-MINUTES

1. LYING.
2. STANDING.
3. FEEDING.
4. FIGHTING INSECTS.
5. TRAVELLING.
6. RUNNING.

FIG. 23 CHART OF DAILY ACTIVITY

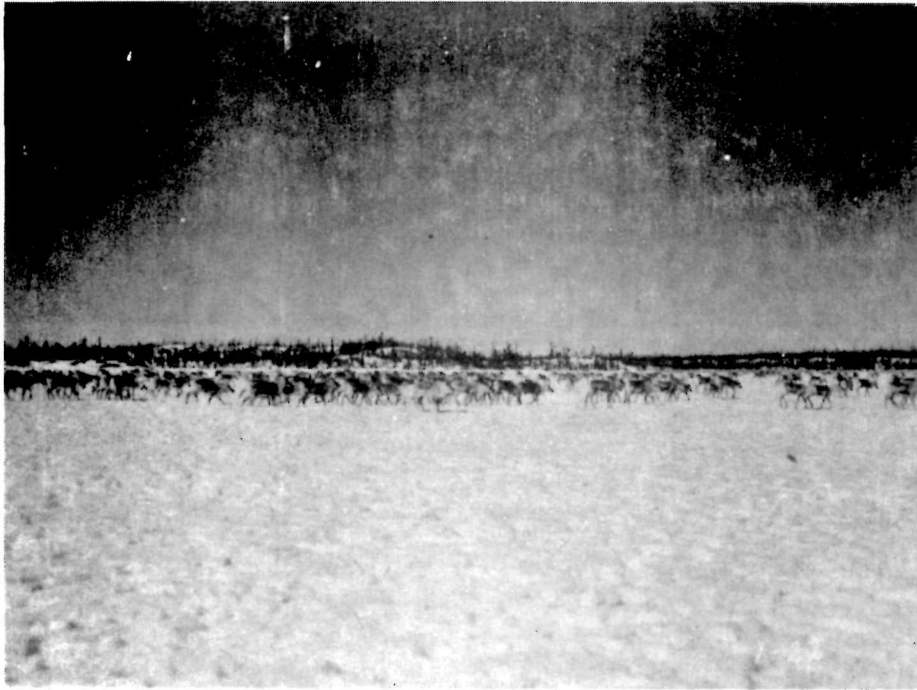


Fig. 24. Unwary migrating herds of caribou, Ghost Lake, N.W.T.



Fig. 25. Bands of cows and calves migrating on the tundra in April, 1948.

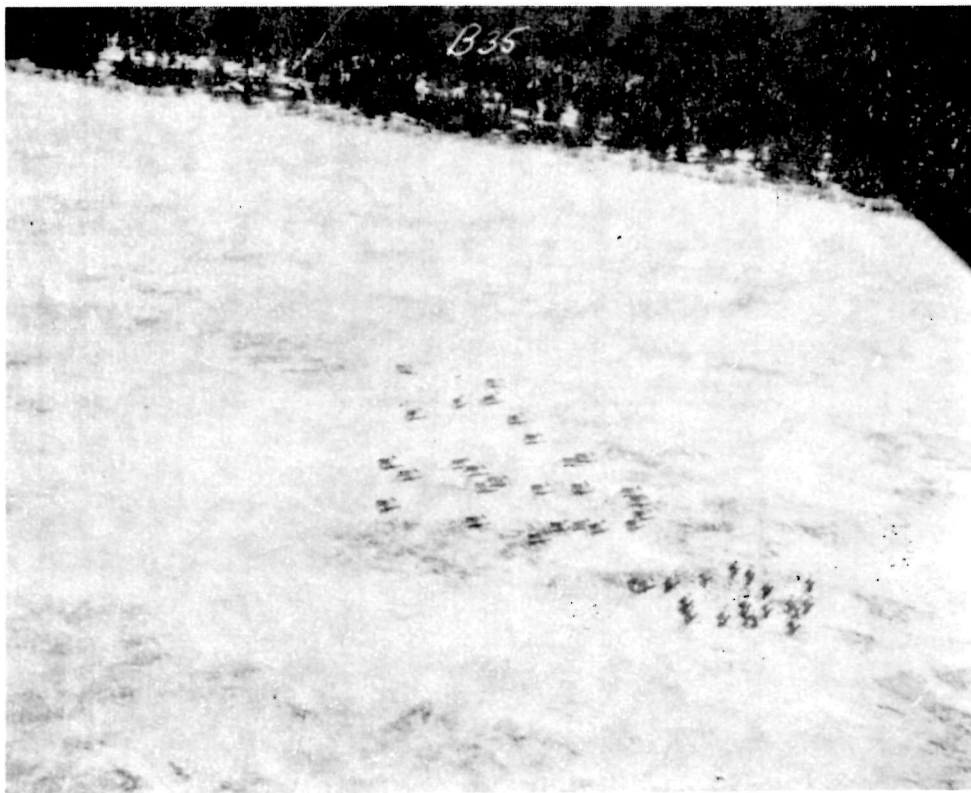


Fig. 26. Bands of bulls on a taiga lake following cows northward, May, 1948.



Fig. 27. Female warble flies laying eggs on the rump of a caribou.

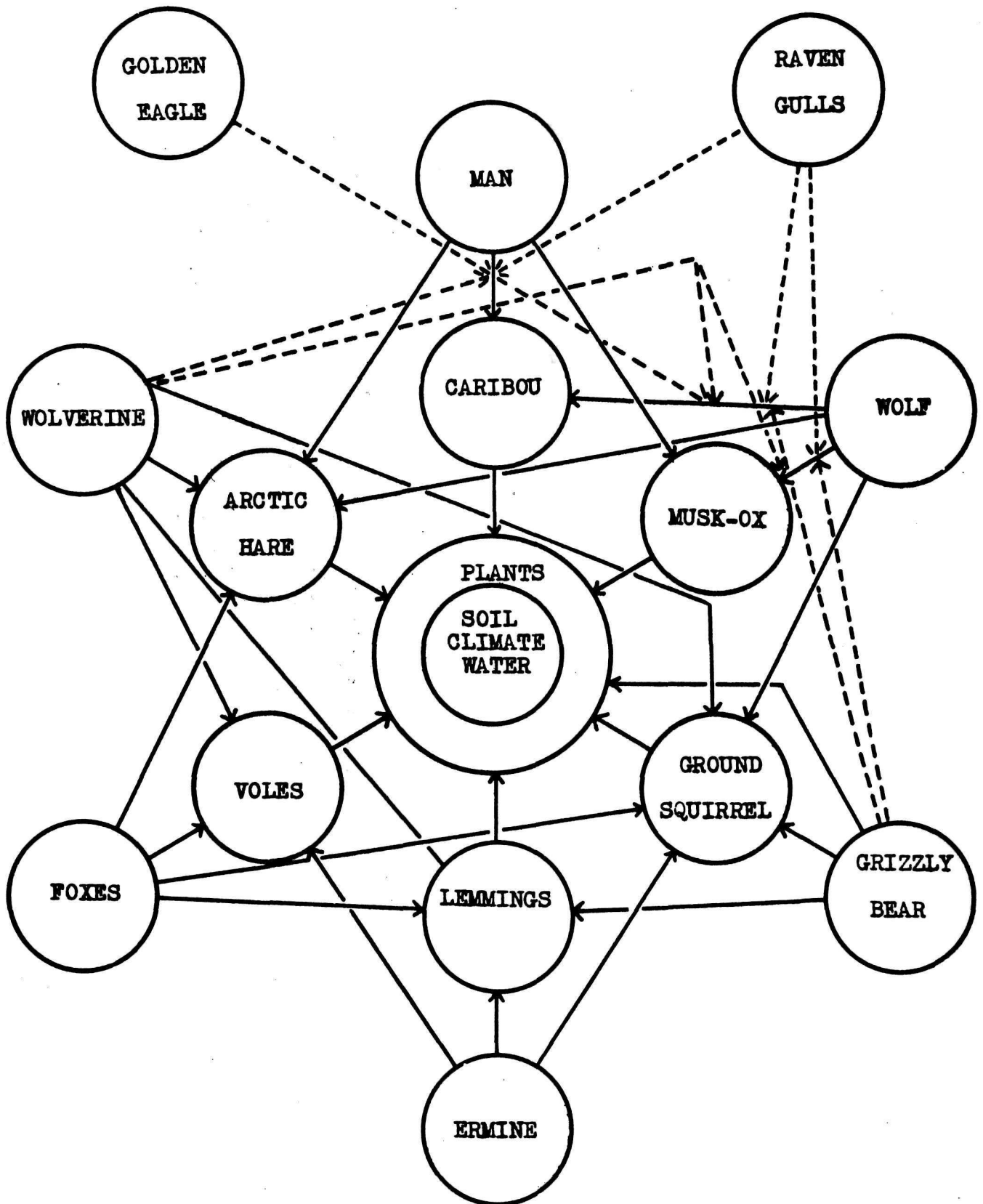


FIGURE 28. SOME VERTEBRATE FOOD CHAINS OF THE TUNDRA.

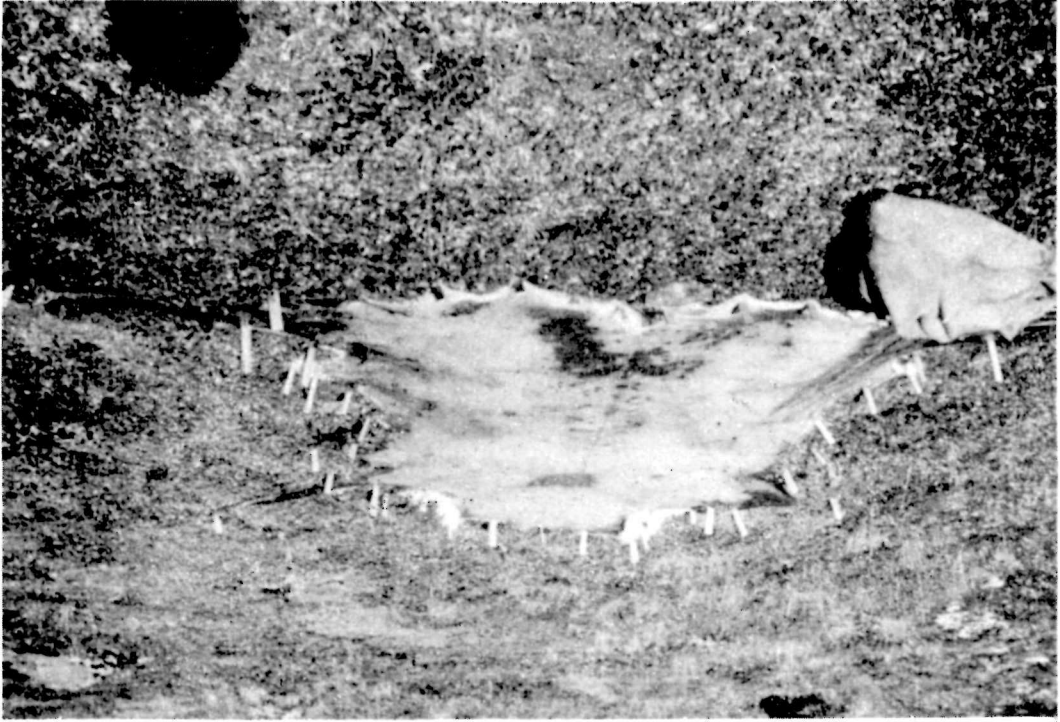


Fig. 29. A caribou hide stretched on tundra to dry. Note the warble scars.

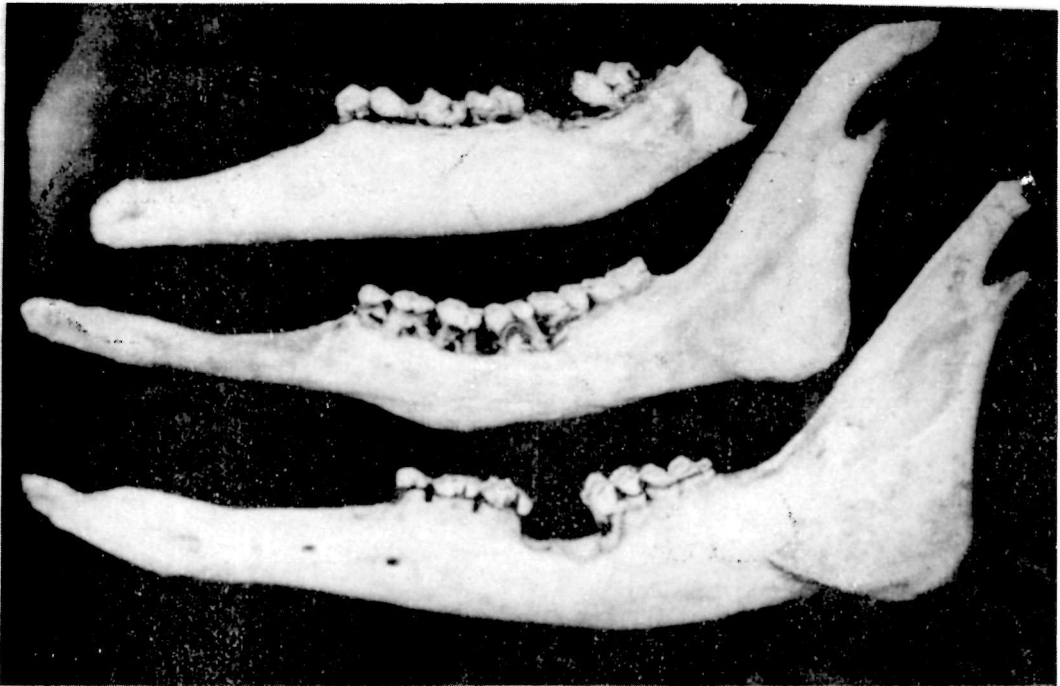


Fig. 30. Caribou mandibles showing lesions of actinomycosis.



Fig. 31. Bones of caribou washed over Tyrrell Falls, Lockhart River, N.W.T.



Fig. 32. A pack of four wolves crossing a frozen tundra pool.

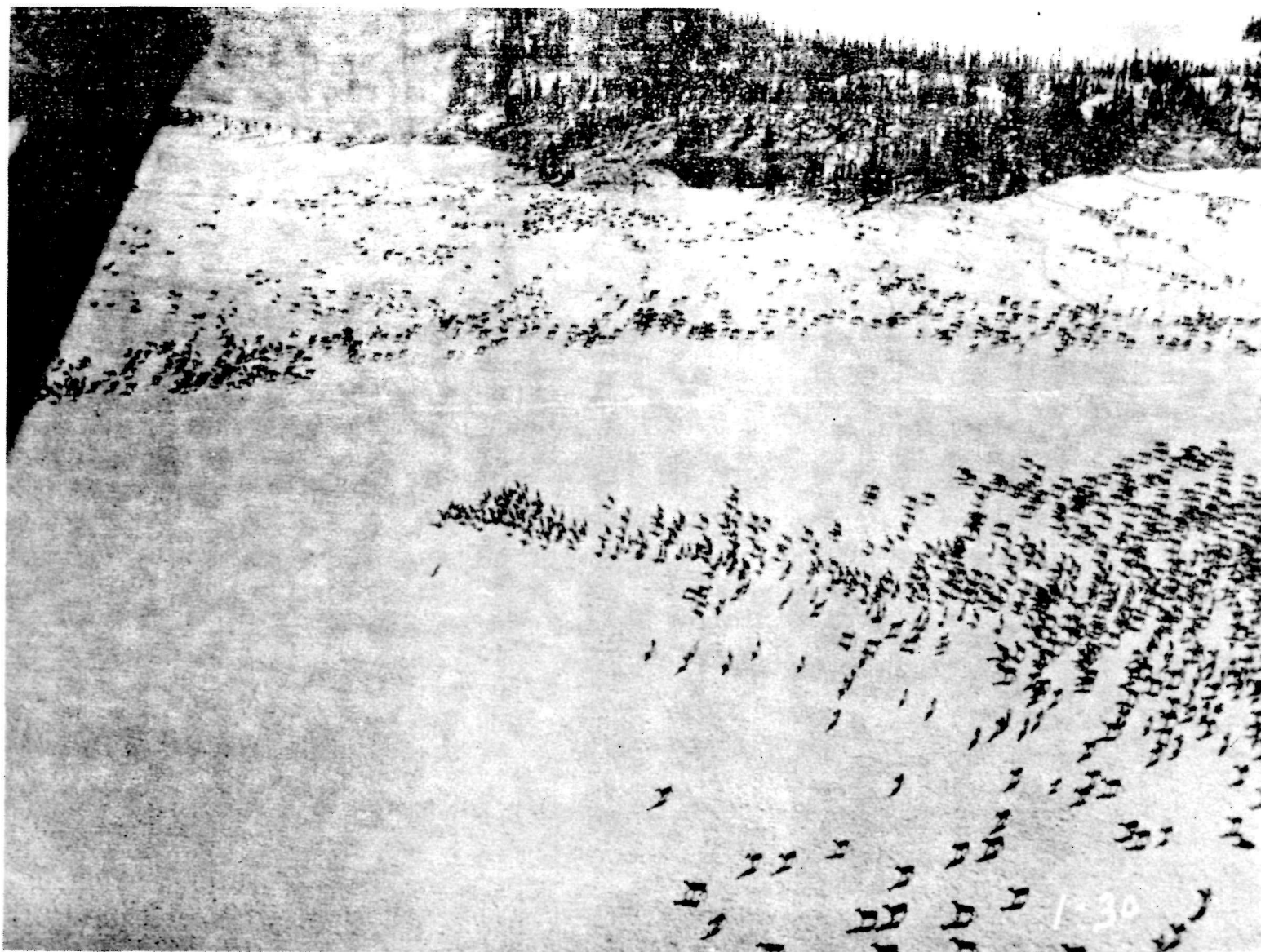
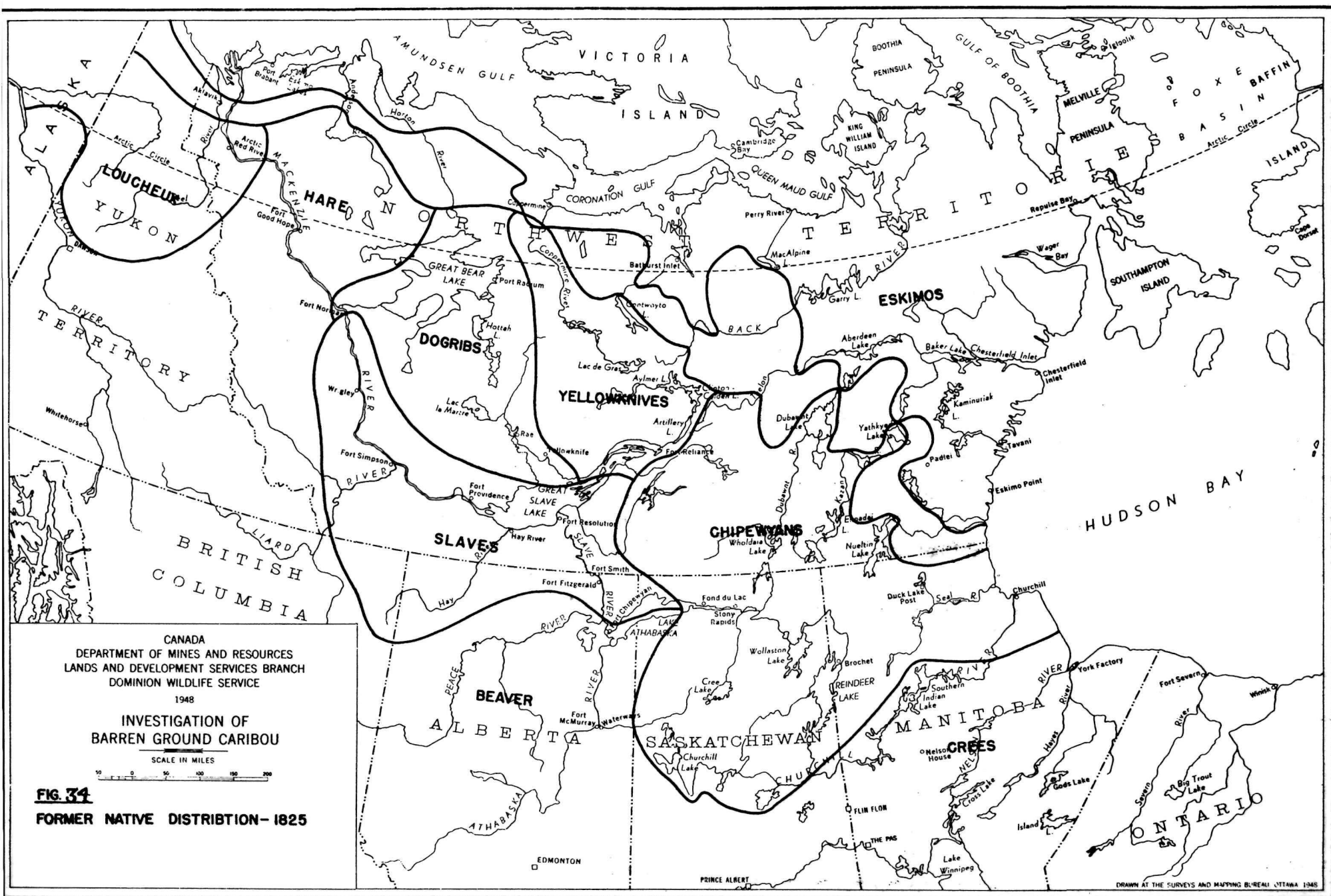


Fig. 33. A wolf pursuing a band of caribou, Ghost Lake, N.W.T.



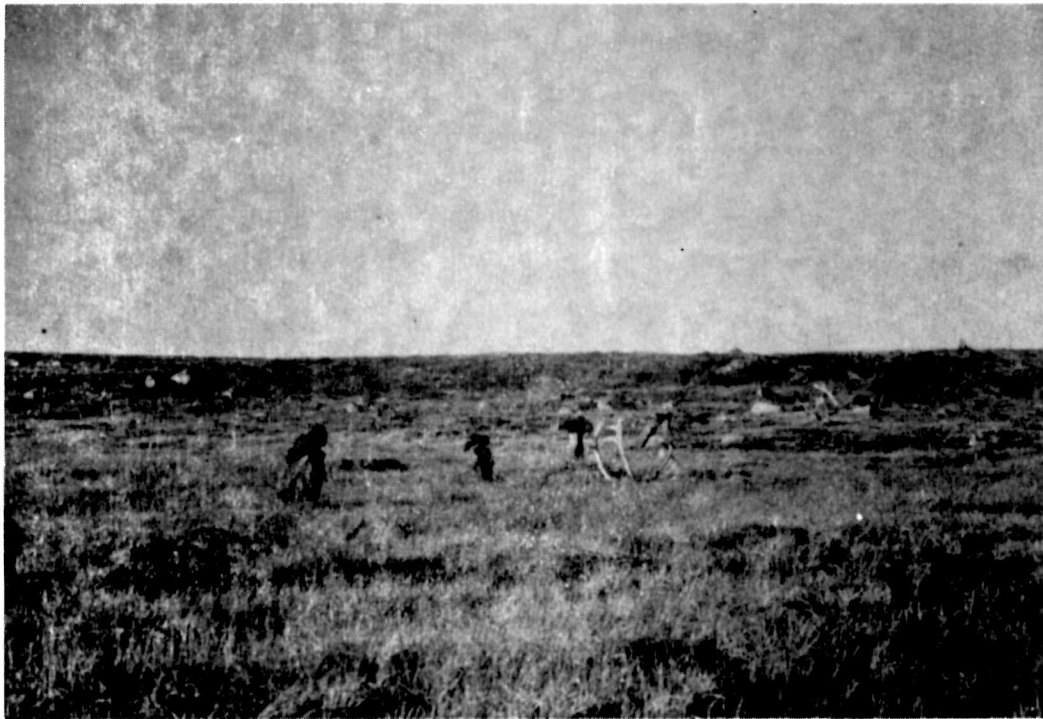


Fig. 35. Eskimo stone and sod drift fence.



Fig. 36. Eskimo hunting trench.



Fig. 37. Eskimo kyak of caribou hides with two caribou spears on the deck.



Fig. 38. Bull caribou speared from the kyak.



Fig. 39. Eskimo skinning caribou.



Fig. 40. Eskimo bow of musk-ox horn, caribou hide quiver and copper tipped arrows.



Fig. 41. Eskimo hunter with bows.



Fig. 42. A bull caribou approaching an Eskimo hunter.



Fig. 43. Eskimo cacheing carcass under sods.



Fig. 44. Transporting meat by dog sled in summer.

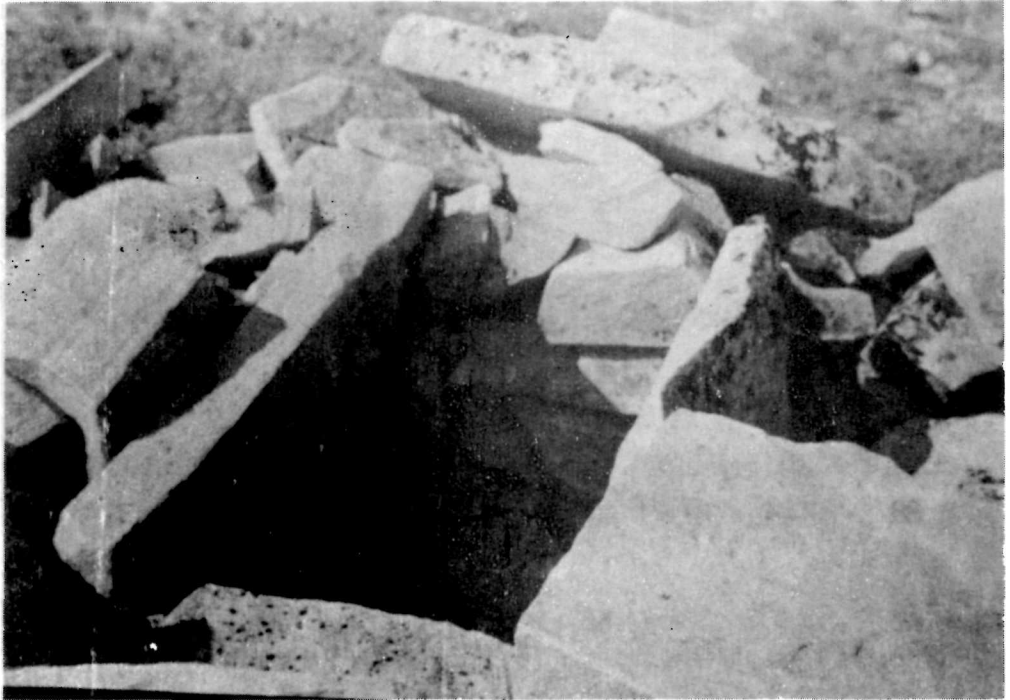


Fig. 45. A stone cache on the tundra.



Fig. 46. An Indian platform cache, Fort Reliance, N.W.T.



Fig. 47. Drying caribou meat on the tundra.



Fig. 48. An Eskimo tent of caribou hides, Contwoyto Lake, N.W.T.

