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PNE-418

PROJECT CHARIOT - PHASE III
PROGRESS REPORT

MASTER

TERRESTRIAL MAMMAL INVESTIGATIONS,
OGOTORUK CREEK - CAPE THOMPSON AND VICINITY

William O. Pruitt, Jr., Peter C. Lent
and
Ernest A. Carl

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University of Alaska

December, 1960

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December, 1960

William O. Pruitt, Jr., Peter C. Lent, and Ernest A. Carl

INTRODUCTION

This report covers the work done on the Terrestrial Mammal Investigation since the previously submitted Interim Final Report of June, 1960. The report is divisible into three main sections: 1) general mammal investigations, 2) ecological investigations of the Arctic Ground Squirrel, and 3) caribou investigations. The third section on caribou investigations is reproduced separately from this main report.

Personnel and Itineraries

William O. Pruitt, Jr., Senior Investigator. In Ogotoruk—Point Hope—Cape Lewis region 8-13 June 1960. Attended meetings of American Society of Mammalogists, Tacoma, Washington, 16-22 June; presented paper entitled "Mammals of the Ogotoruk Valley, Northwestern Alaska." In the field on Baldwin Peninsula, 8-13 July. In the field in the Cape Dyer—Cape Lewis region, 13 July - 8 August. In the field in the Ogotoruk region, 9-26 August. In the field on Wulik River for study of caribou behavior during rut, 11-21 October. Otherwise at College.

Peter C. Lent, Senior Research Assistant (caribou). In the field in northwestern Alaska 15 April to 27 August. In College and Anchorage 23 August to 14 September. Attended Alaska Science Conference and presented paper entitled "Caribou calving study, northwestern Alaska." In the field in northwestern Alaska, 15 September to 27 November.

Ernest A. Carl, Senior Research Assistant. In the field in Ogotoruk region 9 June to 26 August; 28 September to 17 October.

At College the remainder of the time.

Robert S. Spooner, Summer Field Assistant. In the field in the Ogotoruk region, 9 June - 30 August.

Barbara Murray, Part-time Research Assistant. At College from 15 September to present.

A total of about 310 man-days was spent in the field in northwestern Alaska during the period covered by this report. A total of 150 specimens of mammals was collected, including caribou.

Objectives and Current Status

The originally stated objectives for the 1960 phase of the Terrestrial Mammal Investigations are listed below:

1. To record the state of the mammal populations in the Ogotoruk Valley and related regions, and to relate these data to the previous work in these regions.
2. To record the state of the mammal populations in the control area.
3. To assess the efficiency of survival adaptations of small mammals to times of ecological stress, either natural and seasonal or man-made.
4. To continue the caribou investigations begun last year.
5. To refine our knowledge of the routes of energy flow through the ecosystem.

Objective 1 has been accomplished. All sample plots established in 1959 were resampled in 1960 at the proper times. The plots on the Baldwin Peninsula were resampled. Budgetary restrictions prevented resampling of the permanent plot on St. Lawrence Island, and the plot on the Meade River has been discontinued for biological reasons.

In the Kipaloq Valley ("Kapaloa" on USGS maps) at Cape Dyer, three plots were established and trapped during 15 - 27 July. In

the Ukinyik Creek region north of Cape Lewis, three plots were established during 28 July - 6 August. One additional plot was established on Angmakroq Mountain adjacent to ANG-1.

This summer of 1960 was extremely interesting as regards small mammal populations in Alaska. Briefly, the populations at Ogotoruk "crashed," with certain notable exceptions. The populations in the Cape Dyer—Cape Lewis area were also very low. As is well known, the Lemmus population on parts of the Arctic Slope was extremely high this summer. The populations on the Baldwin Peninsula plots were slightly increased over the 1959 sample. Near Fairbanks, the population of Clethrionomys that has been sampled yearly since 1954 underwent a great reduction from 1959, but it could hardly be called a "crash." Population trends will be covered in greater detail under individual accounts of species.

Objective 2 was accomplished within budgetary allowances, with the establishment of the above-mentioned new plots in the Cape Dyer-Cape Lewis control area.

Objective 3 was not accomplished in its original connotation. Originally we had planned to establish several small mammal live-trap plots around selected snap-trap plots. After the resident population was marked and the home ranges of the individuals was determined, then the snap-trap plot was to be sampled. From this procedure we could obtain information on the population by a different method, home ranges, efficiency of the snap-trap sampling technique, reaction of a population to decimation of a part of it, and, by repeating the method in subsequent years, determine the natural overwintering mortality.

Between 10 June and 13 June a 20-acre plot was surveyed, including plot OTK-4, and gridded for placement of 100 trap sites. A 10-acre plot was surveyed to include OTK-9, a 5-acre plot at OTK-7 and a 5-acre plot at OTK-12. The plot at OTK-4 was live-trapped from 15 June to 11 July. Some 2,400 trap-nights on this plot produced only one Dicrostonyx.

When it became clear that the population drop was of such magnitude and included enough species to make further work useless

along these lines, Mr. Carl transferred his full-time attention to the study of the Arctic Ground Squirrel (See page 25).

Objective 4, of a continuing nature, is being accomplished (See Mr. Lent's report on Caribou Investigations).

The field phase of Objective 5 was accomplished by the collection of a large number of scats, pellets, castings, stomachs, and rumina. In addition, a number of ground squirrel food caches, nests, and feeding observations was collected.

Miscellaneous Activities

Publicity posters and form letters about the tagged caribou fawns have been widely disseminated.

Search of the literature for pertinent references on northern mammals has been continued.

In the Ogotoruk and in the Cape Dyer—Cape Lewis areas many scats, droppings and castings of mammals and carnivorous birds were collected this summer. Probably the most significant information will come from an examination of those collected at the same sites which were cleaned of scats during the summer 1959.

Stomachs of all small mammals collected were preserved and we plan to continue efforts to satisfactorily identify their contents. Samples of rumen contents of caribou were also collected. Part of each rumen sample has been sent to Dr. R. E. Hungate of the University of California at Davis with whom we are arranging a cooperative project to study the protozoan fauna of caribou rumina. The remainder of each sample of rumen contents will be used by Mrs. Murray to obtain information on caribou food habits. The method originated by Courtright (unpubl. research reports, Alaska Coop. Wildl. Res. Unit) and modifications thereof will be used.

Lord (1959) has found that the dry weight of the lens of the eye changes with age in most mammals. We have arranged a cooperative program with Dr. Lord (of the Illinois State Natural History Survey) to test this method in comparison with our usual morphometric and tooth-wear methods of aging. Accordingly, preserved

eyes of all mammals collected, with the exception of caribou, have been sent to Dr. Lord for processing. The caribou eyes will be processed by Mr. Lent at a future date.

A number of fleas from small mammals were collected and have been sent to Dr. Cluf Hopla of the University of Oklahoma for identification.

We have started a cooperative project with Dr. J. J. Davis and his colleagues at the Hanford Laboratory to determine the levels of intensity of radiation, by individual isotopes, in caribou from northwestern Alaska. We feel that this project is of extreme importance in the overall environmental picture. Briefly the scheme of the study is as follows. Mr. Lent, who is making systematic collections of caribou for our own purposes, sends samples of bone, muscle, antler, prostate, thyroid and rumen contents to Hanford. About three does and three fawns per month, plus several bucks during October, will comprise the collection. Not only are these specimens to be used for radiological analysis, but they are the same samples used for food habits, aging, taxonomic work, reproductive status, and, moreover, usually considerable behavioral information is taken on each individual before collection.

Perhaps this is the place to urge that persons desiring caribou specimens for whatever purposes utilize these animals we are already collecting. Because Mr. Lent already knows a great deal about these specimens, the data of others using these specimens will be greatly enhanced.

COMPILATIONS OF GENERAL MAMMAL INVESTIGATIONS

William O. Pruitt, Jr.

Species Accounts

Under each of the nineteen species of land mammals of the Ogotoruk region will be found an account of its known status in 1960, comparison where possible of this status in 1959 and pertinent comments on behavior, natural history, and other aspects of its biology.

Sorex arcticus Arctic Shrew

During the 1959 sampling all shrews collected were of this species. The skulls and skeletons from the 1960 sampling are not yet available so final identification of these is not available. There is a possibility that a second species was present this year. The shrews collected fall into two size groups with little or no overlap. Bailey and Hendee (1926) recorded S. cinereus from Wainwright. Bee and Hall (1956) recorded S. cinereus from a number of localities in the Brooks Range and the Arctic Slope. In the December 1959 Mammal Report we predicted that the shrew population would be high in 1960. This prediction was based on the fact that most gravid females carried far more than the average number of embryos. Consequently it was a source of considerable satisfaction to find that the shrew population of the Ogotoruk region was indeed high in 1960.

In 1959 shrews were found on plots OTK-4, 7, and 19. These plots were examples of Eriophorum tussock, Eriophorum-Carex solifluction slope, gravel bar and bench types. In 1960 shrews were found on plots OTK-12, 45, 48, 4, 42, 46, 36, 9, 28, 19, and 47, representing Eriophorum-Carex wet meadow, Eriophorum tussock, Eriophorum-Carex solifluction slope, snow-bed and gravel bar and bench types. This year nine plots were added to the list of those used by shrews and three subtracted. Two major vegetation types were added: Eriophorum-Carex wet meadow and snow-bed types.

The vegetation types used by shrews in 1959 were those characterized by moist stable conditions without an excess of water. In 1960, shrews also used habitats that were considerably drier, or wetter, or less stable (Table 1). This is a further confirmation of my hypothesis (Pruitt, 1959) that during times of low populations a species is restricted to habitats that offer optimal environmental conditions, while during high populations a species "spills over" into more marginal or even submarginal habitats.

Ursus horribilis. Grizzly Bear

Our primary source of information on this mammal comes from a knowledge of its food habits through scat analysis and observations. Its place in the food chain is fairly well established - that of ultimate consumer.

The following direct Grizzly Bear observations were made during the summer 1960:

Ogotoruk region—

- 17 July - Spooner reported tracks in the mud at the mouth of Kissimilouk Creek.
- 19 July - Spooner observed a bear digging ground squirrel burrows near plot OTK-3. Melchior made more detailed observations and took motion pictures until the animal was frightened away by the untimely arrival of a vehicle from Chariot camp.
- 27 July - Spooner recorded observations by the drilling crew that fresh tracks were seen near their rig. Lent observed one adult bear in the middle Ogotoruk Valley.
- 20 August - Spooner recorded observations by the botanical party of a grizzly in the erosional area on the Kukpuk side of the "ponds."
- 24 August - The weathermen reported one adult and three young, about the same size, in the valley. They were observed digging ground squirrel burrows.

Table 1. Comparison of ecological distribution of small mammals in Ogotoruk Creek area, 1959 and 1960. (See Table 2 for resume of vegetation type nomenclature.)

Species	1959 plots	1959 Veg. Types	1960 plots	1960 Veg. Types	Plots added	Changes Subtr.	Veg. Types
<u>Sorex</u>	4,7,9	III,V,XI	12,45,48,4, 42,46,36,9, 28,19,47	II,III,V,X,XI	nine	three	add II,X
<u>Lemmus</u>	33,32,13, 25,5	I,III, IV,XI	1,32	II,III	one	four	add II, subtr. I, IV,XI
<u>Dicrostonyx</u>	13,35,49, 15,28	IV,VI,X	1,32,7,49	II,III,V,VI	three	four	add II,III, V Subtr. IV,X
<u>M. oeconomus</u>	1,12,34,48, 42,46,36,32, 13,7,9,5,47	II,III,IV,V,XI	45,9,49,47	II,V,VI,XI	two	eleven	add VI subtr. III, IV
<u>M. miurus</u>	ANG-1	X	ANG-1	X	-	-	same
<u>Clethrionomys</u>	45,4,42,46, 36,32,49	II,III,VI	4,36	III	0	five	subtr. II, VI

Other regions—

- 16 April - Lent observed a male near the head of Kokolik River.
- 6 May - Lent observed an adult on the upper Nimiuktuk River.
- 13 May - Lent observed a female with two yearling cubs, a male and a subadult east of Aniuk River in the Howard Pass region.
- 20 May - Lent observed a female with a tiny cub near the headwaters of the Colville River, a male west of Carbon Creek, and two adults at Desperation Lake.
- 31 May - Lent and McWilliams observed grizzly-caribou interactions near Carbon Creek. Lent observed an adult on the Utukok River.
- 1 June - Lent observed an adult on Elusive Creek.
- 2 June - Lent observed a subadult on Elusive Creek, an adult on Carbon Creek, a female with two cubs on the Kokolik River.
- 16 June - Lent observed a large male on Disappointment Creek.
- 20 June - McWilliams observed subadult near Driftwood airstrip.
- 23 June - McWilliams observed subadult three miles from previous observation.
- 24 June - Lent observed adult near the head of Driftwood Creek.
- 2 July - Warren Thompson of Kotzebue observed two grizzlies on the Kelly River.
- 3 July - Lent observed an adult on the Kugururok River.
- 13 July - Lent observed an adult swimming in a small pond near the Anisak River. Lent observed a female with two cubs and a male near Feniak Lake.
- 16 July - Lent observed tracks at mouth of Nyak Creek, Cape Lisburne region.

- 19 July - Pruitt observed fresh tracks in Kipaloq Valley.
- 25 July - Pruitt and Foote observed fresh signs in Akalolik Valley.
- 1 August - Lent observed a female with one cub, and a yearling, near Isiak Lake. Nelson Walker observed a female with three cubs near Matcharak Lake.
- 3 August - Anore Bucknell encountered a Grizzly in the upper Ukinyik Valley. When the bear persisted in attempts at closer investigation Miss Bucknell started to sing at it. When she began to yodel the bear departed in haste.
- 7 August - Lent observed female with three cubs 40 miles from the 1 August observations. Lent observed, also on the Cutler River, a subadult.
- 11 August - Lent observed a female with two cubs on the Nimiuktuk River and two subadults east of the mouth of the Kugururok River.
- 13 August - Lent, Carl and Pruitt observed, from the air, a total of six Grizzlies (4 adults, a female and one cub) behind Cape Beaufort.
- 10 October - Lent observed an adult male on the Kugururok River.
- 30 October - Lent observed one adult and one subadult on the Noatak, near the mouth of the Nimiuktuk River.
- 31 October - Lent observed an adult male on Kopshesut Creek (Kobuk River region).
- 5 November - Lent observed two adults and many tracks at a lake west of Kelly River.

Thalarctos maritimus. Polar Bear.

Since this mammal is fairly well restricted to moving sea ice, a lack of summer records is expected. On 14 July Pruitt found a skull at the mouth of Angowlik Creek, near Kipaloq Creek. On 17 July Pruitt found a skull at Kilyitongawk Creek.

Canis lupus. Wolf.

Only two known records occurred in the Ogotoruk region this summer. On 17 July Spooner reported fresh tracks going upstream at Kissimilouk Creek. On 24 July Ron Boyce saw tracks of two Wolves at Sinroalik Creek. Other observations on wolf ecology are to be found in the caribou report.

Vulpes fulva. Red Fox.

Numerous observations on Red Foxes have been made, not only in the Ogotoruk Valley but wherever the investigators have been. The fox den on Sahligvik Ridge, being within the Ground Squirrel study plot, was under daily scrutiny. Numerous observations of Red Fox - Ground Squirrel interactions have been made.

On 17 July Spooner collected scats and refuse items from an active den at the mouth of Kissimilouk Creek. On 15 July Pruitt recorded Red Fox at Kipaloq, on 28 July at Ukinyik Creek and on 2 August Viereck observed one near Ukinyik-3 plot.

Of considerable interest was the fact that a Cross Fox captured alive in a junk pile near Chariot camp by Harry Spencer and Amos Lane on 5 May 1960 was infected with rabies (fide letter, Robert Rausch, Arctic Health Research Center, dated 12 July 1960).

Alopex lagopus. Arctic Fox.

The only recorded observation of Arctic Fox since the tracks noted on 27 April at the mouth of Ogotoruk Creek was the discovery of an active den at the headwaters of Kissimilouk Creek on 6 May by Lent.

Gulo luscus. Wolverine.

The Ogotoruk region continues to be an excellent place for Wolverine observations. Reported observations were on 20 July by Wayne Hanson north of Mad Mountain, 25 August by the weathermen near weather station no. 10 and on 21 October by Pruitt in the upland between Ogotoruk and Kissimilouk creeks. In addition, Pruitt saw tracks in the Kipaloq Valley on 19 July. One was

collected in the Ogotoruk region by Hanford Laboratory investigators, but unfortunately I was not able to obtain complete data from it.

Mustela erminea. Weasel (Ermine).

On 8 July Spooner observed a Weasel chasing two Snow Buntings on a talus slope above Slate Creek. His notes contain an interesting behavior observation. "When the weasel approached within 5 to 10 feet, the bird would fly 20 or 30 feet and alight on another rock. The weasel again approached the bird and the bird again flew a short distance before alighting. The birds did not fly in a direction directly away from the nest, but always at some angle away from the nest. After 8 or 10 attempts the weasel stopped chasing the birds and disappeared in a small gully." On 20 July Pruitt collected a Weasel on plot KIP-2 in the Kipaloq Valley. On 21 July he observed one north of Cape Dyer and on 31 July one at plot UKN-2 in the Ukinyik Valley.

Mustela rixosa. Least Weasel.

No Least Weasels were collected this year, although several had been collected in 1959.

Citellus parryi. Arctic Ground Squirrel.

The next major section of this report is concerned solely with this species. On 28 July Spooner observed one swim across the mouth of Ogotoruk Creek where the creek was dammed up by the beach ridge. At this point the water was 2.5 to 3 feet in depth and the squirrel swam a distance of about 50 or 60 feet. On 9 August Spooner observed 2 Jaegers feeding on the remains of a Ground Squirrel. Pruitt collected several squirrels which had fallen onto the shingle and cobble beach beneath sea-cliff bird colony 4.

Marmota caligata. Marmot.

No Marmots have as yet been taken in the immediate vicinity of Ogotoruk Creek. Lawrence Sage, whose father herded reindeer

in the Ogotoruk region, and who lived as a boy at the mouth of Innutat Creek (6 miles east-southeast of the mouth of Ogotoruk Creek) reports that a prominent mountain on the divide between Ogotoruk and Kissimilouk creeks bears the name of Sigrikpuk Mountain (Marmot Mountain). He recalls several instances when hunters brought in Marmots killed on this mountain.

Erethizon dorsatum. Porcupine.

The odd Porcupine continues to turn up in the Ogotoruk region. During the summer and fall of 1959 several were taken at or near Point Hope village, while on 1 October 1959 Otto Geist collected one at Chariot camp. On 12 August the sea-cliff bird party collected one at Emmikroak Creek. On 15 August they brought one to Chariot camp where it was tagged and later released at the site of capture. Carl collected one on 28 September at Chariot camp. Amos Lane, of Point Hope, killed one about 12 miles southeast of Point Hope in October.

Clethrionomys rutilus. Red-Backed Vole.

Because of the presence of Red-Backed Voles in a wide range of habitats, including several apparently unfavorable ones, and because the population showed an unbalanced sex ratio, in the December 1959 Mammal Report I predicted that the vole population would crash before the summer 1960. It did. The vole population on both Baldwin Peninsula plots, however, held its own in relation to the 1959 level.

In 1959 Red-Backed Voles occurred on plots OTK-45, 4, 42, 46, 36, 32, and 49 in the Ogotoruk Valley. These were in Eriophorum-Carex wet meadow, Eriophorum tussock and Carex bigelowii high-center polygon types. In the 1960 sampling, Red-Backed Voles were taken only on plots OTK-4 and 36. These were both in Eriophorum tussock type vegetation (Table 1). Thus, it appears that this vegetation type offers optimal habitat requirements in the Ogotoruk region. It may be the "refuge" into which the population shrinks at the time of a "low."

Ondatra zibethica. Muskrat.

On 11 August John Hines collected two Muskrats (one an adult lactating female and one young of the year) at the mouth of Kissimilouk Creek. They were from a group variously reported as four or five. The route by which this valuable fur-bearing species gained access to the Ogotoruk region is unknown, and it is highly unlikely that it could become established there because of lack of suitable habitat, and, intensive Eskimo hunting in the region.

Microtus oeconomus. Tundra Vole.

In the December 1959 Mammal Report we predicted, on the basis of sex ratio, that the Tundra Vole population of the Ogotoruk Valley would be less in 1960 than in 1959. We were correct. While a total of 99 Tundra Voles were taken from the sample plots in 1959, the same technique produced only five Tundra Voles in 1960. In 1959 Tundra Voles were found on plots OTK-1, 12, 3, 8, 42, 46, 36, 32, 13, 7, 9, 5, and 47. These encompassed Eriophorum-Carex wet meadow, Eriophorum tussock, Ecotone communities (formerly called Carex bigelowii frost scar), Eriophorum-Carex solifluction slope, gravel bars, and bench types. In 1960 the Tundra Voles were restricted to plots OTK-45, 9, 49, 47. These encompassed Eriophorum-Carex wet meadow, Eriophorum-Carex solifluction slope, Carex bigelowii high center polygon and gravel bars and benches types. Two plots were added to the listing of Tundra Vole habitat, OTK-45 and 49, while eleven plots were subtracted (Table 1). In terms of vegetation types inhabited, Carex bigelowii high center polygon type was added, but Eriophorum tussock and Ecotone communities types were subtracted.

Microtus miurus. Alaska Vole.

In 1959 only one plot, Angmakroq Mountain, produced Alaska Voles. At that time their extremely high biomass (1,553 grams per acre) and high numbers of individuals (51 per acre) led us

to believe that the population was at a peak. No predictions were offered, however. Since ANG-1 plot produced only six Alaska Voles in 1960 it is clear that there had been a drastic drop in their population since the preceding sample. Once again, Alaska Voles were found only on Angmakroq Mountain plot (ANG-1), although old signs were found in certain restricted areas of Sahligvik Ridge. It is clear, however, that in the Ogotoruk region, Alaska Voles are markedly limited in the range of habitats utilized by them (Table 1). Since the plot where they have been found exhibits snow-bed vegetation and has a tremendous zaboys over it (see June 1960 Mammal Report, Fig. 24, p. 47) one may reasonably speculate that Alaska Voles in the Ogotoruk region are near the pessimum for some factor or factors in their environment. I suspect that the factors are temperature-related.

Lemmus trimucronatus. Brown Lemming.

Although in 1959 the sampling produced only 12 Brown Lemmings, the 1960 sampling produced even fewer — two. This number of individuals is of course too small to use as a base for calculations. It should be noted, however, that in 1959, Brown Lemmings were characteristically found only in vegetation types that had the cover broken, either by protruding rocks, frost scars or fluvial action. Of the two plots that produced Brown Lemmings in 1960 one typically possessed broken vegetational cover (Eriophorum tussocks with frost scars, OTK-32) while the other was a ridged wet meadow of the Eriophorum-Carex wet meadow type (Table 1). It is significant, I believe, that this subtype, although classified botanically as wet meadow, contains many active frost scars (see December 1959 Botanical Report, pp. 26-27). Just what the relationship is of this mammal (and the one following), the typically "Arctic mammals," to such a characteristic Arctic phenomenon as solifluction, is not known, but here is a subject worthy of further attention.

The very low state of the Brown Lemming population in the Ogotoruk region in 1960 is of great interest when considered in

the light of the extremely high population on parts of the Arctic Slope of Alaska. The situation on the Arctic Slope was studied this year, as in several preceding years, by Dr. Frank Pitelka of the University of California.

Dicrostonyx groenlandicus. Collared Lemming.

In 1959 Collared Lemmings were taken on plots OTK-13, 35, 49, 15, and 28, encompassing Ecotone communities, Carex bigelowii high center polygon and snow-bed vegetation types. Only 6 were taken in 1959. During the 1960 sampling a total of nine Collared Lemmings were taken on the Ogotoruk sampling plots. Several others were taken by other sampling means not on the plots. Collared Lemmings were taken on plots OTK-1, 32, 7, and 49, encompassing Eriophorum-Carex wet meadow, Eriophorum tussock, Eriophorum-Carex solifluction slope and Carex bigelowii high center polygon vegetation types. Eriophorum-Carex wet meadow, Eriophorum tussock, and Eriophorum-Carex solifluction slope types were added to the list of habitats used by this species, while Ecotone communities and snow-bed types were subtracted (Table 1).

Until cleaned skeletons and skulls are available, age-grouping of the specimens of Collared Lemmings is not possible. However, superficial examination indicates that seven of the nine specimens are very young individuals; the remaining two, while in adult pelage, are quite small.

As I noted in the December 1959 Mammal Report (p. 11), my experience has shown that the Collared Lemming is a creature of rocky uplands or of areas where the soil and vegetation cover is disturbed by frost action, in direct contrast with the "Eriophorum-Dicrostonyx Association" postulated by some workers.

Therefore, if one may use the shifting ecological associations of the small mammals of the Ogotoruk Valley as guides to a general principal of habitat selection, the resultant is that expressed earlier: Dicrostonyx is a creature of habitats characterized by solifluction phenomena, but when the population is high it "spills over" from this optimum habitat into those characterized by more

mesic conditions and with more complete vegetation cover. One may thus postulate that these latter habitats are less than optimal and proceed in an attempt to segregate the factors causing them to be so.

As I noted in the June 1960 Mammal Report (p. 17), in some cases the environmental factors which govern the distribution and constitution of the vegetational associations are not necessarily those that govern the distribution and constitution of the mammalian associations. This problem has been emphasized by the botanical re-classification of Vegetation Type IV (Carex bigelowii frost scar type) to a transition or ectonal zone between Dryas Fellfield and wetter, less steep types (Eriophorum tussock or Eriophorum wet meadow types, for example). From the vegetational point of view this re-classification appears justified. From the view of mammalian ecology, however, there is a considerable degree of unity within the type now being called Ecotone communities. For example, contrast the biomass change between 1959 and 1960 [December 1959 Mammal Report, Fig. 4 (p. 15b)] and present report Figure 17 or the change in numbers of individuals per species between 1959 and 1960 [December 1959 Mammal Report, Table 1 (pp. 3 and 4), June 1960 Mammal Report, Fig. 36 (p. 60), Table 5 (p. 18), and present report Table 2 (p. 17b)].

Consider also the species composition of the mammals in Ecotone communities as contrasted with the other vegetational types. In 1959 the Brown Lemming was found only on plots OTK-33, 32, 13, 25, 19, and 47, all of which were characterized by having the vegetational cover broken by protruding rocks, frost scars or fluvial action. In the 1960 sampling Brown Lemmings occurred on only two plots, both of which possessed broken vegetational cover. The Collared Lemming in 1959 occurred on five plots, all characterized by broken vegetational cover, by protruding rocks, frost scars or by the cracking of the surface around Carex tussocks on dry polygons. In 1960 Collared Lemmings occurred on plots where the vegetational cover was, typically, not broken. The detailed descriptions of the plots where it did occur in 1960, reveals,

Figure 1. Small mammal biomass per trap night, Ogotoruk Creek region, 1960.

TABLE 2. Comparison of Ogotoruk sample plot small mammal biomasses, 1959 and 1960.

Vegetation Type and Plot	Small Mammal Biomass (gms.)	
	1959	1960
I - <u>Dryas</u> fellfield #33	19.5	0
II - <u>Eriophorum-Carex</u> wet meadow		
#1	157.5	65.5
#12	256.2	31.8
#45	17.0	41.8
#34	172.4	0
#48	91.7	8.2
III - <u>Eriophorum</u> tussock		
#4	113.5	45.8
#42	39.9	18.8
#46	155.0	3.7
#36	686.0	34.1
#32	295.2	83.0
IV - Ecotone communities		
#13	518.4	0
#25	13.5	0
#35	0	0
V - <u>Eriophorum-Carex</u> solifluction slope		
#7	192.8	22.0
#9	566.6	95.1
VI - <u>Carex bigelowii</u> high center polygons		
#49	72.1	64.8
VII - Ericaceous shrub polygons		
#40	0	0
X - Snow-bed communities		
#15	121.6	0
#28	58.9	5.8
ANG-1	1553.8	130.9
XI - Gravel bars and benches		
#5	95.5	0
#19	363.4	10.2
#47	75.6	25.6

however, that frost action was important in our concept of the nature of the plots — a ridged wet meadow, Eriophorum tussocks with frost scars, Eriophorum-Carex solifluction slope and Carex bigelowii high center polygons. The fact that Collared Lemmings disappeared from the sampling of the Ecotone communities even though they were present in the total sampling picture leads me to believe that from the mammal point of view there is some unity within the Ecotone communities.

Rangifer arcticus. Barren-Ground Caribou.

In the third, but separate, section of this report will be found complete records of occurrences of this species, as well as a discussion of the events observed in the field during 10-21 October 1960 (See report on Caribou Investigations).

Alces americana. Moose.

It has been well established that Moose are extending their range into Arctic areas. The Ogotoruk region is no exception. In early September, 1959, an adult male Moose was observed from the air near the mouth of Kuropuk Creek (4 miles east-southeast of the mouth of Ogotoruk Creek) by Nathan Henry of Kotzebue. In late summer, 1960, two Moose were observed in the vicinity of Kivalina. Moose have become fairly regular inhabitants of the lower Noatak country.

Ovis dalli. White Sheep.

The closest observations of White Sheep to the Ogotoruk region have been in the mountains between the Noatak and Eli rivers and on the upper Kugururok River and Trail Creek (Lent's observations). Several flights and foot trips in the Lisburne Hills have revealed no sheep, but the presence of old trails resembling sheep trails. Sheep have been found on the Cape Thompson cliffs within the memory of extant humans.

Other mammals:

(a) Mammoth. In the summer of 1959 Lent and Pruitt discovered the skeleton of an unidentifiable large Proboscidean in the Ogotoruk valley. This skeleton was later excavated by Dr. Otto W. Geist of the University of Alaska. In 1960 Carl discovered a fragment of a mammoth tooth in the bed of Ogotoruk Creek near its mouth. In 1960 Howard Smith of the University of Washington discovered a complete mammoth tooth near the mouth of Singroalik Creek (Cape Seppings).

(b) Marine mammals. The following miscellaneous observations of marine mammals have been made by University of Alaska people and others:

- 11 June 1960 - Porter Lockhart reported many Beluga at Tuckfield. Pruitt observed 4 Ringed Seals resting on the sea ice off the mouth of Ogotoruk Creek.
- 12 June - Pruitt observed 3 Ringed Seals and 1 Bearded Seal on the ice off the mouth of Ogotoruk Creek.
- 14 July - Pruitt collected Walrus skull on the beach at Angowlik Creek (near Cape Dyer).
- 16 July - Spooner observed about 30 Beluga, adults and young, moving west past the mouth of Ogotoruk Creek, 100 to 200 yards offshore. Schene counted 82 Beluga moving past the sea-cliff bird camp.
- 17 July - Pruitt collected Walrus skull on the beach of Kilyitongawik Creek. He observed a number of skulls and bones of large baleen whales above the beach between Kilyitongawik and Cape Dyer. He also collected fresh Grey Whale baleen on the beach here.

Spoooner reported a "young Hair Seal" picked up on the beach near Ogotoruk Creek by a helicopter crew and brought to Chariot camp. Wayne

Hanson examined it and released it. Unfortunately no measurements were recorded nor was the animal tagged.

- 18 July - Spooner reported 2 adults and 1 young Beluga as well as a porpoise (unidentified as to species) between Kissimilouk and Cape Seppings.
- 27 July - Spooner reported 2 unidentified large whales off Ogotoruk Creek. They traveled at a rate slightly in excess of 4 miles an hour.
- 31 July - Spooner recorded an observation by the geological party of a Grey Whale near Lagoon No. 9.
- 2 August - Pruitt observed a large baleen whale, unidentified as to species, close to shore at Ukinyik Creek.
- 3 August - A Fur Seal (Callorhinus) reported beached at Point Hope.
- 4 August - Viereck observed a large and a very small black whale, unidentified as to species, off Ukinyik Creek. The animals had white markings on flukes and head, (possibly Killer Whales?).
- 8 August - Spooner found Walrus mandible in the gravel in Snow Patch Creek.
- 21 August - Ornithologists observed from the air a Grey and a Killer Whale near the mouth of Ogotoruk Creek.
- 11 August - Pruitt and others observed and photographed a young Walrus on the beach near Kissimilouk Creek.

Same party observed two unidentified Porpoises travelling northwest about 40 yards offshore. Bee and Hall (1956) cite two specimens of Porpoises from Arctic Alaska as well as several sight records from the memory of Pete Sovalik. They were all identified by these authors as Phocaena vomerina (Pacific Harbor Porpoise).

- 18 August - Pruitt observed and tried unsuccessfully to collect a young Walrus on the beach 2 miles southeast of the sea-cliff bird camp. Because of characteristic scars this was almost certainly the same animal observed on 11 August.

Biomass

Figure 1 shows the biomass of small mammals per trap-night on the sample plots. By reference to Figure 4 (page 15b) of the December 1959 Mammal Report one may see the magnitude of the difference between the two years sampled. Note that Figure 1 in this report has a different scale from the earlier report cited. A direct comparison is made in Table 2. From previous experience in sampling arctic and subarctic small mammal populations, I believe that 1959 was a "high" and 1960 was a "low" in the Ogotoruk region. The exceptions of Sorex and Dicrostonyx have been noted. Therefore, the average biomass throughout the cycle, what one may call the "small mammal biomass standing crop" of the Ogotoruk region, will fall somewhere between the extremes of 1959 and 1960, closer to the 1959 figures than to the 1960 set.

Table 3 gives a detailed breakdown of biomass data for each plot and vegetation type. Perusal of this table, as well as Figure 4 and Table 7 (page 16c) of the December 1959 Mammal Report leads to the conclusion that although in times of a population high there are great differences in the biomass of various vegetational types, in the time of the low population these differences are minimized. The biomass of all appears knocked down to about the same low level (or disappears). This, along with the complete lack of synchrony over large geographic areas, argues for some local or regional environmental control of population state. It is clear, then, that the environmental factors affecting populations, and the interactions of these factors, should be thoroughly understood in advance of schemes to modify or alter the environment.

TABLE 3. Vegetation type biomass, 1960.

Veg. Type and Plot No.		Catch	Total Biomass	#/TN	Gms. Biomass /TN	Indiv./A	Indiv./ Sp./A	Indiv./ A of Type
I								
#33		0	0	300	0	0	0	0
		Sum	0					
II				1500				
#1		34.0 gm <u>Dicrostonyx</u>						
		31.5 gm <u>Lemmus</u>	65.5		.21	2	1D, 1L	
#12		31.8 gm <u>Sorex</u>	31.8		.10	4	4S	
#45		12.3 gm <u>Sorex</u>						
		2915 gm <u>Microtus</u>	41.8		.13	3	2S, 1M	
#34		0	0		0	0	0	
#48		8.2 gm <u>Sorex</u>	8.2		.02	1	1S	
		Sum	147.3		.09			2
III				1500				
#4		8.3 gm <u>Sorex</u>						
		37.5 gm <u>Clethrionomys</u>	45.8		.15	3	1S, 2C	
#42		18.8 gm <u>Sorex</u>	18.8		.06	4	4S	
#46		3.7 gm <u>Sorex</u>	3.7		.01	1	1S	
#36		7.1 gm <u>Sorex</u>						
		27.0 gm <u>Clethrionomys</u>	34.1		.11	3	2S, 1C	
#32		56.4 gm <u>Dicrostonyx</u>						
		26.6 gm <u>Lemmus</u>	83.0		.27	4	3D, 1L	
		Sum	185.4		.12			3
IV				900				
#13		0	0		0	0	0	
#25		0	0		0	0	0	
#35		0	0		0	0	0	
		Sum			0	0		0
V				600				
#7		22.0 gm <u>Dicrostonyx</u>	22.0		.07	1	1D	
#9		6.0 gm <u>Sorex</u>						
		89.1 gm <u>Microtus</u>	95.1		.31	3	1S, 2M	
		Sum	117.1		.19			2
VI				300				
#49		49.1 gm <u>Dicrostonyx</u>						
		15.7 gm <u>Microtus</u>	64.8		.21	3	2D, 1M	
		Sum	64.8		.21			3

TABLE 3. Continued.

Veg. Type and Plot No. Catch		Total Biomass	#/TN	Gms. Biomass /TN	Indiv./A	Indiv./ Sp/A	Indiv./ A of Type
VII #40		0	100	0	0	0	0
Sum		0		0			
X #15		0	900	0	0	0	2.33
#28 5.8 gm <u>Sorex</u>		5.8		.01	1	1	
ANG-1 130.9 gm <u>M. miurus</u>		130.9		.43	6	6 M.m.	
Sum		136.7		.15	7		
XI			900				1.33
#5 (10 Citellus, not incl.)		0		0	0	0	
#19 10.2 gm <u>Sorex</u>		10.2		.03	2	2S	
#47 5.6 gm <u>Sorex</u>							
20.0 gm <u>Microtus</u>		25.6		.08	2	2S, 1M	
Sum		35.8		.03	4		

Population Size

Table 3 gives the distribution of small mammals by plots and vegetation types on the basis of individuals caught. Comparison of Table 1 with Table 1 (page 3) of the December 1959 Mammal Report shows the difference in number of individuals as well as the shift in habitats utilized. The difference in numbers of individuals is most striking in the cases of Microtus oeconomus and M. miurus while the difference in habitats utilized is most striking in the cases of Sorex, Dicrostonyx and Lemmus. Some basic population data are presented in Tables 4 and 5 which should be compared with Table 5 (page 18) of the December 1959 Mammal Report.

Fertilization Plots

Some of the most reasonable hypotheses brought forward in explanation of cyclic fluctuation of certain northern vertebrates, particularly microtines, concern environmental productivity, especially as it concerns food supply and cover. One explanation is that the habitat is periodically exhausted by the animals' feeding activities and further population build-ups are delayed until the habitat can recover. This explanation could be tested by artificially fertilizing a considerable area so that the vegetation, for example, did not become grazed and clipped to the point of exhaustion.

An opportunity arose this past summer to begin to gather data on this subject. At several points along the coast the vast numbers of cliff-dwelling sea-feeding birds pass overland on their trips to and from their nest sites. At these points there is a constant rain of excretory products from the flying birds onto the land. Two small mammal sampling plots were established so that one was directly under the pathway of birds flying over the projecting land area of Cape Thompson itself (Ibrulikhoruk) while the other was several hundred yards inland over which the birds rarely ventured. In addition to the trap plots, on each plot a 5 x 7 foot rubberized tarpaulin was staked out flat on the ground and left in place for 48 hours. Plot CT-1, under the flight path, received 63 "splatters"

TABLE 4. Some basic population data, Ogotoruk plots, 1960.

Plot	Species	Catch			Total	No./100 TN	Sex Ratio
		Night #1	Night #2	Night #3			
I							
#33	0	0	0	0	0	0	-
II							
#1	<u>Lemmus</u>	0	0	1			L=1 ♀
	<u>Dicrostonyx</u>	0	1	0	2	0.66	D=1 ♂
#12	<u>Sorex</u>	0	2	2	4	1.33	3 ♂ : 1 ♀
#45	<u>Sorex</u>	2	0	0			S=2 ♂
	<u>Microtus</u>	0	1	0	3	1.00	M=1 ♂
#34	0	0	0	0	0	0	-
#48	<u>Sorex</u>	0	0	1	1	0.33	1 ♂
III							
#4	<u>Sorex</u>	1	0	0		0.33	S=1 ♂
	<u>Clethrionomys</u>	2	0	0	3	1.00	C=2 ♂
#42	<u>Sorex</u>	0	3	1	4	1.33	3 ♂ : 1 ♀
#46	<u>Sorex</u>	1	0	0	1	0.33	?
#36	<u>Sorex</u>	1	0	1			S=2 ♂
	<u>Clethrionomys</u>	1	0	0	3	1.00	C=1 ♂
#32	<u>Lemmus</u>	0	1	0			L=1 ♂
	<u>Dicrostonyx</u>	0	1	3	5	1.66	D=4 ♂
IV							
#13	0	0	0	0	0	0	-
#25	0	0	0	0	0	0	-
#35	0	0	0	0	0	0	-
V							
#7	<u>Dicrostonyx</u>	0	1	0	1	0.33	1 ♀
#9	<u>Sorex</u>	0	0	1			S=1 ♂
	<u>Microtus</u>	1	1	0	3	1.00	M=1 ♂ : 1 ♀
VI							
#49	<u>Microtus</u>	0	1	0			M=1 ♂
	<u>Dicrostonyx</u>	0	0	2	3	1.00	D=1 ♂ : 1 ♀
VII							
#40	0	0	0	0	0	0	-
X							
#15	0	0	0	0	0	0	-
#28	<u>Sorex</u>	0	1	0	1	0.33	1 ♂
ANG-1	<u>M. miurus</u>	5	1	0	6	2.00	4 ♂ : 2 ♀
XI							
#5	0	0	0	0	0	0	-
#19	<u>Sorex</u>	0	1	1	2	0.66	1 ♂ : ?

TABLE 5. Some basic population data, plots other than Ogotoruk Valley, 1960.

Plot	Species	Catch			Total	No./100 T/N	Sex Ratio
		Night #1	Night #2	Night #3			
<u>Baldwin Peninsula:</u>							
BPW	<u>Clethrionomys</u>	1	0	0	4	1.33	C=1♂ ¹ M=3♂
	<u>M. oeconomus</u>	1	1	1			
BPD	<u>Clethrionomys</u>	1	2	0	3	1.00	2♂:1♀
<u>Kipaloq Valley (Control Area):</u>							
KIP-1	<u>M. oeconomus</u>	0	2	0	2	0.66	2♂
KIP-2	<u>Mustela erminea</u>	0	1	0	1	0.33	1♀
KIP-3	<u>Lemmus</u>	0	1	0	1	0.33	1♂ ¹
<u>Ukinyik Valley (Control Area):</u>							
UKN-1	no catch					0	-
UKN-2	no catch					0	-
UKN-3	no catch					0	-
<u>Cape Thompson:</u>							
CT-1	no catch					0	-
CT-2	<u>Sorex</u>	0	1	0	5	1.66	S=1♀ M=4♂ ¹
	<u>M. oeconomus</u>	2	2	0			
<u>Fairbanks region:</u>							
SPR	<u>Clethrionomys</u>	3	4	2	9	3.00	4♂:5♀

of excretory products in the first 24 hours and a total of 211 "splatters" during the total 48 hours exposure. Plot CT-2, several hundred yards inland from CT-1, received no direct hits but was completely covered with a stippling a fine white spots after 48 hours exposure. Apparently the fecal component drops immediately, while the urinary component breaks up into a fine spray and may be transported considerable distances, depending on wind speed and length of time spent in falling. The tarps were sealed into plastic bags and now await some cooperative arrangement with a biochemist for analysis. Freuchen and Salomonsen (1958) commented on the striking effects on vegetation of wind-blown excretory material from Greenland bird cliffs. Such effects might be of considerable importance to the terrestrial herbivores feeding on the fertilized vegetation.

Future of Ogotoruk Sample Plots

As I have repeatedly pointed out in previous reports, the value of the small mammal population investigation depends on the analysis and understanding of population trends over a complete cycle from low to high. Moreover, although the small mammal investigations were not designed to furnish information on the radiological aspects of Chariot, any hope of gathering data on the radiological aspects depends on a valid before-and-after sampling.

Therefore it was a distinct disappointment to learn on 9 August 1960 that 17 of the 23 plots in the Ogotoruk Valley will be buried or covered with at least 2 cm. of ejected material. The only plots outside the 2 cm. circle are OTK-19, 36, 35, 32, 33, and 34. Plot OTK-19 (Tall willow grove) is only a few yards outside the 2 cm. circle. The other plots are situated in what is probably the 1 cm. zone. Only the plots on Angmakroq Mountain (Kukpuk River) and the new plots at Cape Thompson and in the Cape Dyer-Cape Lewis control area are outside the ejecta zone.

The effects of this disruption of continuity as well as methods of taking it into consideration must receive considerable thought in the future.

Summary

The known terrestrial mammalian fauna of the Ogotoruk region now stands at 19 species (Arctic Shrew, Grizzly Bear, Polar Bear, Wolf, Red Fox, Arctic Fox, Wolverine, Ermine, Least Weasel, Arctic Ground Squirrel, Porcupine, Red-Backed Vole, Muskrat, Tundra Vole, Alaska Vole, Brown Lemming, Collared Lemming, Barren-Ground Caribou, and Moose). Two additional species (Marmot and White Sheep) have been reported within the life span of extant humans but the intensive Eskimo utilization of the Ogotoruk Valley and environs has probably been the factor resulting in their disappearance from the immediate region.

The populations of most small mammals were much lower in 1960 than in 1959. The great differences in population states in parts of western and northern Alaska in 1960 are noted and some of the implications discussed. In the Ogotoruk Valley marked changes in frequency of several species in different habitats occurred. The probable significance of this is discussed.

The opportunity for a natural experiment on the effects of fertilization of vegetation and the significance of data from it toward our understanding of population fluctuations are noted.

We note that if Chariot were to be completed all of the small mammal sampling plots in the Ogotoruk Valley would be covered with varying thicknesses of ejecta. Only the plots on the Kukpuk River, Cape Thompson, and the Cape Dyer-Cape Lewis area would be saved. Methods of resolving this problem have not been worked out.

ECOLOGICAL INVESTIGATIONS ON THE
ARCTIC GROUND SQUIRREL, CITELLUS PARRYII

Ernest A. Carl

A study was initiated on the population dynamics and ecological implications of behavior of the Arctic Ground Squirrel in the Ogotoruk Creek region in 1960. The squirrels are a conspicuous and abundant part of the mammalian fauna. This, as well as their readily identifiable mounds and trails and their tendency to enter traps make them particularly amenable to study. As they are the only hibernator occupying the area, they become particularly interesting in an evaluation of the effects of artificial habitat disturbances occurring during the winter months, as the impact of any change would be displaced to the following spring and the squirrels would face the changes not as they occurred, but rather as they existed at the time of the squirrel's emergence. With the prevailing winds known to the Ogotoruk Valley during the winter, the pattern of winter-wrought change may be significantly different at such a later time.

Methods

A single pilot study area was defined during 1960, encompassing 72 acres and located on the eastern slope of Crowbill Ridge about 1/2 mile west of the Chariot campsite (Figure 2). The area was initially judged to support a relatively large population of squirrels in a wide spectrum of environmental situations and to be at least partially isolated from other areas occupied by squirrels.

A system of live-trapping and marking was initiated on 15 June 1960 and was continued intermittently until 16 October 1960. Nine by nine by thirty inch wire mesh traps, obtained from the National Live-trap Company of Tomahawk, Wisconsin, were used, baited with sliced apple. Fifty-three traps were rotated on the 115 permanent trap-sites located near evidences of habitat alteration by the squirrels. The trap-sites were marked with colored flags, and their locations were determined by triangulation with a Brunton transit and plotted on an aerial photograph. Marking of animals was

Figure 2. Map of ground squirrel pilot study area, Ogotoruk Creek, Northwestern Alaska.

Scale: 1"= 500'

- · — · — Boundary of study area
- Boundary of area occupied by squirrels
- Boundry of defended territories

accomplished by a combination of ear-punching and toe-clipping. Only the hind toes were clipped in order to avoid hampering the many manipulatory functions of the forefeet.

A system of color-marking the squirrel's fur was attempted using "Marks-a-lot" felt pens marketed by the Carter Ink Company. Fifty-six squirrels were marked as individuals distinguishable up to 200 feet with 8X binoculars. This dye, however, wore off the fur in four to eight days and the method was abandoned. Red and white enamel paint delivered from an aerosol spray can was attempted as a marking method, but this compound caused the hairs to stick together and both hair and paint were subsequently removed by the squirrels. Ten squirrels were color-marked by painting their fur with a saturated aqueous solution of picric acid with a brush. This stain proved to be permanent until the fall molt. It resulted in a yellow mark, however, similar to the natural color of the animal's fur and could not be distinguished from a useful distance. Research is continuing on color-marking methods

As each animal was initially trapped, it was marked as an individual by toe- and ear-clipping, sexed, and observations were made on the pelage stage. When a given animal was retrapped it could be recognized and changes in pelage and location noted. Traps were checked at least three times per day on a varying schedule in an effort to delimit conditions of maximum and minimum activity as reflected in trapping success. Some trapping mortality was encountered. General behavior was observed during trap-checking operations and at scheduled times between trap checks. Color-marked individuals were of great importance in this phase of the study and observations were hampered by the limited success of the color-marking program. Some individuals were identifiable by virtue of naturally acquired marks and scars.

On 15 October 1960 six thermistors were planted in one of the burrow systems at various depths; these are being read by the members of the Chariot winter caretaker crew.

Population Size, Density, and Structure

One hundred and seventy-five squirrels were trapped and marked. Of these, 17 were adult males, 23 adult females, and 135 young of the year. The sex of the young could not be determined by external criteria. Two

unmarked adult males and five unmarked young were found dead during the course of the summer. The known population of the study area was therefore 41 animals at the beginning of the season. The emergence of the young between 29 June and 2 July brought the total population up to 182 individuals. Consideration of the rate of capture of unmarked animals as a function of time (Figure 3) shows that no unmarked animals were captured after 3 August. Extrapolation from a normalized curve of these data (mean 19.2; standard deviation 6.9) indicated that one can reject with great confidence the possibility of unmarked animals existing in the study area at the time of termination of trapping. The overall trapping success did not decline after the last unmarked animal was trapped.

The fresh carcasses of 19 squirrels were recovered on the study area during the summer (six males, three females, and ten young); however, this probably represents only a small part of the actual mortality. Early season trapping, planned for next spring, will be necessary to establish a more realistic mortality figure. In view of the systematic squirrel hunting being conducted by the Holmes and Narver Inc. winter caretaker crew at the present time, as well as the expected kill by the Chariot campsite dogs which have been allowed to run loose since September, any mortality figure may be subject to considerable error. Observed mortality and cause are shown in Table 6.

The gross population increase observed during the summer was 443.9 per cent. Considering the minimum possible mortality outlined above, the net increase would be 388.1 per cent. The mean number of young per female was 6.1. Since at least one female was known not to have produced a litter and the pre-emergence mortality cannot be estimated from the available data, the mean litter size must have been somewhat larger than 6.1. No detectable immigration or emigration of squirrels in the study area occurred.

It was the opinion of several informants from the Point Hope village that the population of squirrels underwent a sharp increase in numbers in the vicinity of the Point during the present season. These people reported that the squirrels had moved into previously unoccupied areas

FIGURE 3. Trapping schedule, trapping success, and pelage changes, 14 June to 15 October 1960.

TABLE 6. Observed ground squirrel mortality, pilot study area, Ogotoruk Creek, 15 June to 24 August 1960.

Squirrel number	Sex	Date of death	Cause of death
none	♂	15 June	Killed by domestic dogs
13	♂	21 June	Exposure to rain and cold in trap
40	♂	22 June	Unknown. Being eaten by Long-tailed Jaeger.
21	♀	23 June	Exposure to rain and cold in trap
32	♀	25 June	Exposure to rain and cold in trap
22	♂	25 June	Exposure to rain and cold in trap
none	young	2 July	Unknown. Being eaten by adult*
none	young	2 July	Unknown. Being eaten by adult*
110	young	13 July	Exposure to rain and cold in trap
114	young	19 July	Unknown
4	♂	21 July	Killed by domestic dogs (in trap)
none	♂	26 July	Exposure to excessive heat in trap
none	young	26 July	Exposure to excessive heat in trap
1	♀	26 July	Exposure to excessive heat in trap
143	young	26 July	Exposure to excessive heat in trap
none	young	27 July	Lacerations on chest and abdomen
205	young	28 July	Exposure to rain and cold in trap
331	young	28 July	Exposure to rain and cold in trap
452	young	13 August	Killed by fox.

* Observed by Herbert Melchior, University of Alaska

west of the village and that squirrel trapping had been unusually successful in the vicinity of the village and near Jabbertown to the east. Squirrels are regularly collected for their pelts, mostly by the women with traps and by children who shoot or club them. The majority of the pelts are apparently used by the family that originally caught the squirrels; some, however, are traded around the village and some are sold to the village store for export. The store records show that 62 pelts were bought during the fiscal year 1957, none in 1958, 56 in 1959, and 150 in 1960. The number of pelts sold to the store reflects more than squirrel population fluctuations; for example, current price (\$.45 in 1960) and local consumption. Although circumstantial evidence tends to indicate a rise in the squirrel population during the current season, more direct data gathered over a longer period of time are needed to establish the existence of any such fluctuations. It was the opinion of Mayer (1953), based on data collected at Point Barrow, that the squirrel populations do not fluctuate in size.

Territoriality, Home Range and Social Structure

The squirrels of the study area were observed to be organized into nine groups. Each group centers its activities on a territory, a defended geographical area used only by members of that group. The nine territories are shown in Figure 2. The area enclosed by the movements of an individual as determined by direct observation and by retrap records is considered to be the home range of that individual. The home ranges of the individual members of a group may vary, but they all include at least part of the group territory and do not overlap the territory of any other group. Group 1 shows most of the features which appear to be present in a complete group organization and will be considered first and in detail.

Group 1 holds a territory of 12,800 square feet and consists of one male (the Territorial Male), two females and fourteen young. In addition, four adult males occupied home ranges immediately adjacent to this territory but were held off the territory itself. (The methods of territorial defense are not well understood at this time.) These

Satellite Males have a home range, but no territory. Mayer (1953) observed solitary males, which he termed "Bachelor Males," in the squirrel population at Point Barrow. Since the social role of these individuals is presently unknown, I feel that such a designation is unwarranted. The members of Group 1 occupy various home ranges averaging $28,125 \pm 10,100$ square feet (the second figure is $\pm$ one standard deviation in all cases) and overlapping the home ranges of the satellite males and those of some of the members of Group 2, Group 3, and Group 9. Squirrels from the latter groups were observed wandering unmolested just outside the territory of Group 1 but on the home ranges of some of the members of Group 1. When such a wanderer attempted to enter the territory proper, however, it was attacked by a resident squirrel and driven off both the territory and the resident individual's home range, even though much of the chase occurred over area common to the home range of both animals.

Group 2 consisted of one territorial male, one female, and no young at the beginning of the summer. Two satellite males were being held off the territory, which encompassed 34,400 square feet. The home ranges of these animals averaged $102,350 \pm 44,500$ square feet. The female of this group did not produce a litter in 1960. On 21 June the territorial male died in a trap and by 9 July one of the satellite males had established himself as the territorial male on the territory, which he continued to occupy with the original female for the remainder of the season.

Group 3 consisted of one territorial male, five females and twenty-two young. The group held a territory of 85,600 square feet and its members held home ranges averaging $87,600 \pm 44,500$ square feet. They held one satellite male off the territory. On 21 July the domestic dogs from Chariot campsite killed the territorial male while he was in a live trap. It is not clear whether or not he was replaced by another male.

Group 4 consisted of one territorial male and three young, and it held a territory of 79,200 square feet. The members occupied home ranges averaging $165,000 \pm 143,500$ square feet. Although no female was identified with this territory, the remainder of the social structure

seems to be intact, hence it may be that such a female existed early in the season and was subsequently killed or moved off the area. One satellite male was being held off the territory.

Group 5 consisted of one territorial male, one female and five young; the group held a territory of 55,600 square feet. The members occupied home ranges averaging $131,700 \pm 95,000$ square feet. No satellite males were observed in connection with this group, and it may be significant that the territory is located on two raised islands of Dryas fellfield surrounded by wet meadow. Thus no habitable area was available near the boundaries of the territory.

Group 6 consisted of one territorial male, three females and twenty young, and it held a territory of 195,200 square feet. Its members occupied home ranges averaging $181,700 \pm 124,000$ square feet. No satellite males were observed in connection with this group. However, one female without young occupied a burrow near the boundary of the territory and was treated in a fashion similar to a satellite male by the group members. This was the only case of a "satellite female" observed on the study area.

Group 7 consisted of three females and twenty-four young and held a territory of 122,000 square feet. Its members occupied home ranges averaging $226,400 \pm 120,000$ square feet. No territorial male was observed in this group. It should be noted that this territory is located on the edge of the study area and observations may concern only part of the group. Some of the members of this group were observed to have home ranges that extended outside the study area, and this fact was not taken into consideration in calculating the mean home range size for the group. No satellite males were observed in connection with this group.

Group 8 consisted of four females, and twenty-five young, and held a territory of 142,800 square feet. Its members occupied home ranges averaging $144,600 \pm 93,800$ square feet. Here, as in Group 7, no territorial male was observed, but again the territory is located on the boundary of the study area and the comments concerning Group 7 are probably appropriate here. One satellite male was being held off the territory.

Group 9 consisted of one territorial male, two females and twenty-one young, and held a territory of 71,600 square feet. Its members occupy home ranges averaging $41,700 \pm 26,400$ square feet. Two satellite males were being held off the territory.

The mean home ranges of members of Group 1 and Group 9 are not statistically different from one another, but differ from the other mean home range sizes at the 0.1 per cent confidence level on a t distribution. Likewise, the mean home ranges of Groups 6, 7, and 8 are not different from each other but differ from those of Groups 1, 3, and 9. The mean home range of members of Group 3 is different from all others. The existence of these distinct means suggests that the home range size is not species dependent, although species dependent factors could still set widely separated maximum and minimum values. A frequency distribution of the observed home range sizes results in a semi-logarithmic least squares mean beginning at the smallest home range size observed (18,000 square feet) and intersecting an arithmetic least squares line near a home range size of 80,000 square feet. This straight line, which theoretically represents the summation of an infinite series of normal distributions, continues through the largest observed home range of 530,000 square feet. A species dependent maximum would be expected to be normally distributed due to individual variation within the species. Such a distribution would interact with the observed straight line to produce a semi-logarithmic mean near the maximum home range size (see Figure 4). As no such relation was evident, it is supposed that the maximum home range size tolerated by the species was not observed on the study area.

Habitat selection

Only the gross features of habitat selection have been considered in this pilot study. It was observed that ground squirrels were essentially missing from the Eriophorum-Carex wet meadow and Eriophorum tussock vegetation types and from talus slopes and the gravel beach. On the study area all territories were located on broken, sloped ground, and southwestern exposures were avoided. (See December 1960 Botanical Report, Figure 6, for a map of the vegetation of the ground squirrel study area.)

————— Least squares average of observed home ranges

(1) From 18,000 sq. ft. to 100,000 sq. ft.

(2) From 40,000 sq. ft. to 530,000 sq. ft.

----- Least square average expected from model (explanation in text).

FIGURE 4. Model of ground squirrel home range size distribution.

Group 1 and Group 9, with the smallest home ranges, are located on snow-bed depression communities. Group 3, with the next larger home range, is located on snow-bed depression, mixed meadow (= subtype of Ecotone communities; see December 1960 Botanical Report) and Dryas fellfield. Groups 6, 7, and 8, with the largest home ranges, are located in Dryas fellfield and mixed meadow. Groups 2, 4, and 5, which contain too few members for size comparison are located on Dryas fellfield and mixed meadow. It would appear that there is a trend toward smaller home ranges in the snow-bed depression communities and suggests that this vegetation community presents the squirrel with its basic requirements in a smaller area than the Dryas fellfield or mixed meadow. More data are needed to establish the validity of this apparent trend.

During the heavy rains of 8-10 August and 28 September to 3 October, drainage patterns on the study area were noted. Large thin sheets of water flowed over the Dryas fellfield, Dryas step, and mixed meadow. However, the water was observed to be channeled through and around snow-bed depression communities, a large percentage of the surface of the latter areas being free of flowing water. These drainage patterns were judged to be largely due to slope and soil characteristics, not primarily to the vegetation cover. A check of the burrow systems of the study area revealed that no burrow was flooded during these two storms. This is not surprising since no new burrows were constructed in the study area this year, although many existing ones were refurbished. The question of whether the squirrels are able to avoid constructing burrows in flood-prone locations, or whether such burrows have been constructed in the past and have been eliminated by former floods cannot be answered at this time.

Pelage Change

The first evidence of pelage change was observed on 16 June when several individuals were seen with small patches of dark brown fur on the dorsal surface of the neck. These darker patches continued to increase in size, extending caudally, always with a definite border,

until the last squirrel with any remnant of the lighter winter pelage was observed on 7 July (see Figure 3). The pelage change was generally synchronous between individuals on the study area.

The young of the year emerged in late June and early July with a pelage distinct from either adult pelage. It was somewhat lighter than the adult summer pelage and had a "fuzzy" appearance. The juvenile pelage gradually came to be indistinguishable from the adult summer pelage by mid-August.

The beginning of the change from summer to winter pelage was first observed on 13 August with the appearance of light silver-grey guard hairs on the sides of the neck. By 24 August most of the squirrels were observed to possess large greying areas about the neck and shoulders. Observations were discontinued between 24 August and 30 September. All squirrels observed between 30 September and 16 October appeared to be in full, light brown and grey winter pelage (Figure 3).

General Discussion

The present pilot phase of this study has produced a basis for the design of definitive research on the ecology of the Arctic Ground Squirrel in the Ogotoruk Creek region. The pilot study area was chosen on the sole basis of availability of animals and its boundaries were drawn arbitrarily. It now appears that this area represents near optimal conditions and at least two more study areas should be established in marginal types for comparative purposes. One of these areas should include areas of Dryas fellfield and mixed meadow adjacent to a squirrel population, but not currently occupied by squirrels. If the trend toward population increase continues, such an area would provide considerable insight into the factors limiting the squirrels' exploitation of the habitat.

The figures presented by Dr. Gary Higgins at the 9 August 1960 meeting at Chariot campsite indicate that the study area is located near the 1 meter throwout depth zone of the proposed nuclear explosion. It would seem unlikely that the squirrels of the study area could survive such a disruption unless considerable wind erosion of the

ejecta occurred between the time of detonation and the time of the squirrels' emergence from hibernation. New study areas should be located in parts of the valley that will be less severely disrupted.

The census technique used in the pilot study, being a non-time-limited system, and being premised on a biological rather than a statistical model, offers a dynamic interpretation of population structure not possible with sampling techniques necessarily used on the rest of the mammalian fauna. In the study area the premises of the biological model were met at a high level of confidence.

With the collection of more data on the correlation between vegetation type and squirrel numbers, a reliable assessment of the squirrel population of the entire valley should be possible. The botanists are presently producing a detailed description of the vegetational distribution.

The implications of hibernation are not known in detail, as the squirrels were active at the commencement of field work on 15 June and continued so until the last observation on 16 October. Data on the ecological conditions necessary for hibernation are lacking. It is known that hibernators can be aroused by mechanical stimuli (Lyman, 1955). In an assessment of the effects of a winter detonation, the limits of mechanical concussion tolerable without arousal, as well as the effects of winter arousal should be known.

The exploitation of the habitat by the squirrels has been considered in the pilot study and the broad outlines of this exploitation have been determined (see also the December 1960 Botanical Report). Data on the detailed habitat utilization by the squirrels are needed if the fine points of the effect of artificial habitat alteration are to be predicted. It is implied in the pilot data that such an understanding of the squirrels' economy is obtainable through an expansion of the present methods of study. Thus, if ways can be developed to accurately predict the physical effects of the proposed explosion, it should be possible to predict the effects of these upon the economy of the squirrels.

Analysis of the field data collected in the summer of 1960 is still in process and the status of the present report is preliminary. A more complete treatment is anticipated in the projected report of June, 1960.

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