

ARCTIC INSTITUTE OF NORTH AMERICA

TECHNICAL PAPER NO. 2

# THE MAMMALS OF BANKS ISLAND

*By*

T. H. MANNING AND A. H. MACPHERSON



PUBLISHED AUGUST 1958



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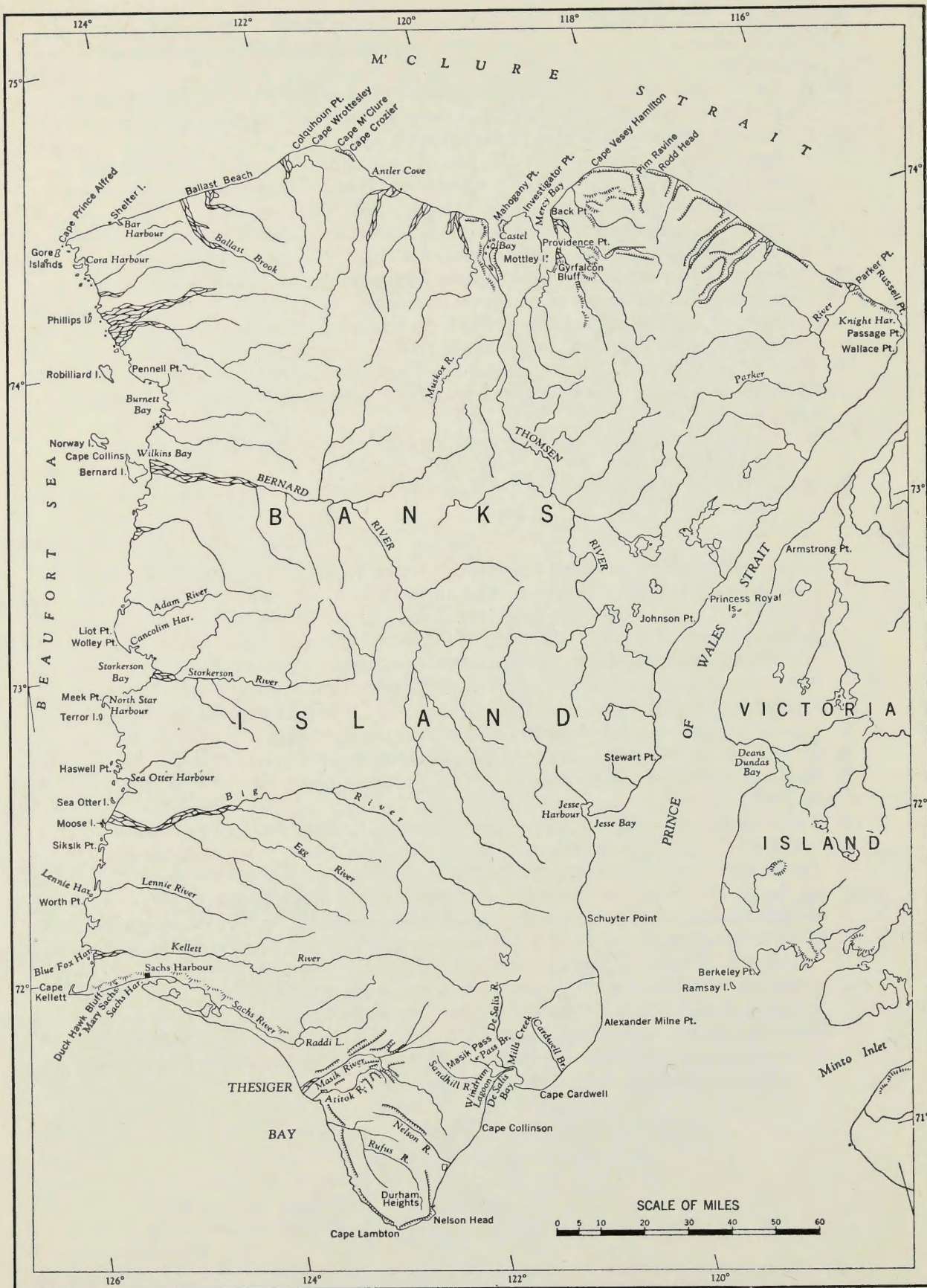


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Sketch-map of Banks Island



# THE MAMMALS OF BANKS ISLAND

T. H. Manning and A. H. Macpherson

## Abstract

A record of field observations made during brief stops on Banks Island in 1951 and during the full summer seasons of 1952 and 1953 is given together with those observations of previous authors which aid in estimating the past or present abundance and distribution of the mammals. Thirteen species of mammals are or have been regular inhabitants of Banks Island or the surrounding seas; two other species have been recorded once. In 1952 and 1953, 128 skins and 274 skulls of mammals were collected, and the results of taxonomic studies of these and of other material (about 160 specimens) from Banks Island in the National Museum of Canada are given. A new race of *Lepus arcticus* and of *Lemmus trimucronatus* are described.

## Introduction

**I**N 1951, while engaged on a hydrographic and oceanographic expedition for the Defence Research Board in C.G.M.V. *Cancolim* (Hattersley-Smith, 1952), we landed for a few hours at Storkerson Bay, Cape Kellett, Sachs Harbour, and De Salis Bay. In 1952 we were flown to De Salis Bay by R.C.A.F. Dakota aircraft on May 10 to attempt the circumnavigation of the island as part of a coastal reconnaissance study for the Defence Research Board. We left our spring camp at De Salis Bay by canoe on July 4, but did not actually leave the bay until July 20. We then travelled along the south coast, reaching Cape Kellett on August 1, Cape Prince Alfred on August 11, and Mahogany Point, where ice prevented farther progress along the coast, on August 19. On August 29 we took the canoe twelve miles up the Thomsen River and from there walked back to Sachs Harbour. We left for the mainland by Eskimo schooner on September 22 (*see* Manning, 1953, for narrative). In 1953 Macpherson was unable to go north and Manning was accompanied by Capt. I. M. Sparrow, R.E. Manning and Sparrow were landed near Sachs Harbour on May 10, and on June 28 began an overland walk to Thomsen River, where the canoe had been cached the previous year. On August 2 the ice opened sufficiently for them to leave Mahogany Point. They passed Russell Point on August 29, and crossed to Victoria Island by way of the Princess Royal Islands on September 1 (*see* Manning, 1956a, for narrative).

In 1952 and 1953 zoological work was carried out in spring and early summer while awaiting break-up, and later in the summer at times when bad weather or pack ice prevented travel. The main camps and walks are given in Table 1, and the country in their vicinity is described by Manning *et al.* (1956). An account of the history of exploration of the island is given in Manning (1956a), and an account of previous ornithological and, by inference, mammalogical work in Manning *et al.* (1956).



Prior to our collection of 128 mammal skins and 274 skulls, the National Museum had about 95 specimens (70 are foxes) obtained by G. H. Wilkins and other members of the Canadian Arctic Expedition from the Cape Kellett region between 1914 and 1916, and it has since obtained 29 specimens collected by E. O. Höhn of the University of Alberta, who was engaged in ornithological work in southwest Banks Island in 1953, 21 collected or purchased from Eskimos by E. H. McEwen, who was making studies for the Canadian Wildlife Service in the same area from 16 March to 23 July 1955, and 21 purchased from the Eskimos Bernard Pokiak, Pat Herschel, and Fred Carpenter in 1953 and 1954 under an agreement made with Manning. The large collection of fox skulls taken by McEwen, which has not yet been incorporated into the National Museum collection and which he proposes to study himself, has not been examined.

### *Acknowledgments*

The study of the collections was made possible by grants from the Northern Research Coordination Centre, Department of Northern Affairs and National Resources, and from the Arctic Institute of North America to one of us (Manning), who assembled the past records and did most of the taxonomic comparisons. We both have checked and take responsibility for the whole paper, including the new names, which are proposed by us jointly. We are indebted to Dr. E. O. Höhn and Mr. E. H. McEwen for making their Banks Island mammal collections available, and to Dr. R. Thorsteinsson for a special collection of comparative material from the Queen Elizabeth Islands; also to Mrs. T. H. Manning for checking the calculations and typing the manuscript. We wish to thank Dr. F. J. Alcock, Dr. L. S. Russell, and Dr. A. W. Cameron for the facilities of the National Museum, and Miss Elizabeth Menzer, now Mrs. A. H. Macpherson, for her assistance while employed under the grant from the Department of Northern Affairs and National Resources. Mr. T. Donald Carter (American Museum of Natural History=AMNH), Dr. I. McTaggart Cowan (University of British Columbia=UBC), Dr. C. O. Handley, Jr. (United States National Museum=USNM), Dr. R. L. Peterson (Royal Ontario Museum of Zoology=ROMZ), and Dr. Robert Rausch (United States Arctic Health Research Center=R) have generously cooperated by arranging loans of comparative material from their respective institutions.

### *Notes on the tables and figures*

All linear measurements are in millimetres.

The standard deviations have been calculated from the formula:

$$\sqrt{\frac{Sx^2}{n-1}}.$$

One, two, and three stars against the *F* ratio used in the tables indicate significant differences at the 5 per cent, 1 per cent, and .5 per cent level respectively. Four stars have been used to indicate a significant difference at the .1 per cent level when there is a single degree of freedom for the greater mean square.



In Figs. 1-9 and 11-15 the heavy base line represents observed range. The distance from the mean (black triangle) to the outer edge of the line terminating the white rectangle is one standard deviation. The distance from the mean to the extremity of the black rectangle is two standard errors of the mean.

The method used to divide adults from subadults is given in the text under the species concerned.

### Topography

Banks Island has an area of 24,600 square miles. Its southern extremity is 150 miles north of the tree limit. About 20 per cent of the island is grass or marsh, with occasional patches of scrub willow which, in the sheltered Masik River valley, reach a height of two and a half feet. Fifty per cent is moderately well vegetated, with *Dryas* predominating, and 30 per cent consists of barren or near-barren uplands or hill slopes. Rolling hills and plateaus from 800 to 1,200 feet high are a common feature in the central and eastern part of the island. In the northeast, a hard sedimentary rock plateau of Devonian age is cut by deep ravines. In other areas the rivers have often made wide, flat valleys through unconsolidated deposits. Most of the drainage is towards the lower west coast. The highest part of the island is the 2,400-foot Durham Heights, which lie above the 1,100-foot cliffs of Precambrian sediments and volcanics at Nelson Head. More details of the topography and geology of Banks Island are given in Manning (1956a), and the botany is covered in Porsild (1955).

**Table 1.** Main camps and walks on Banks Island, 1952 and 1953.

| <i>Camps</i>                       | 1952                            | 1953            |
|------------------------------------|---------------------------------|-----------------|
| De Salis Bay area                  | May 10-June 17, June 29-July 20 | —               |
| Valley of Nelson R.                | July 21-7                       | —               |
| Sachs Har.-C. Kellett region       | July 29-Aug. 2, Sept. 15-22     | May 10-June 28  |
| Antler Cove                        | Aug. 12-18                      | —               |
| 12 miles up Thomsen R.             | Aug. 29-Sept. 2                 | July 15-18      |
| Mahogany Pt.                       | Aug. 19-29                      | July 18-Aug. 2  |
| Investigator Pt.                   | —                               | Aug. 3-8        |
| Back Pt.                           | —                               | Aug. 12-22      |
| Pim Ravine                         | —                               | Aug. 23-8       |
| <i>Walks</i>                       |                                 |                 |
| De Salis B. to Sachs Har. and back | June 17-29                      | —               |
| Thomsen R. to Sachs Har.           | Sept. 2-15                      | —               |
| Sachs Har. to Thomsen R.           | —                               | June 28-July 15 |



## SYSTEMATIC LIST

### *Lepus arcticus banksicola*, new subspecies. Arctic Hare.

**Type.** NMC 20973. Adult male. Taken by T. H. Manning on Banks Island, at 71°35'N., 123°30'W., on 24 June 1952. Skin lacks front feet; otherwise skin and skull in good condition.

**Measurements of type in millimetres.** Total length, 670; tail, 60; hind foot, 155; inion-incisor length, 105.2; alveolar length, 20.3; zygoma length, 42.3; nasal length, 45.0; nasal breadth, 21.6; zygomatic breadth, 51.2; cranial breadth, 34.9; cranial depth, 31.4; radius of curvature of incisors, 18.

**Diagnosis. Adults.** Similar in size to *L. a. hubbardi*, but radius of curvature of upper incisors much smaller (Table 12, Fig. 9). Summer pelage probably less white. Distinguished from *L. a. andersoni* by large skull size (Tables 4-11, Figs. 1-8) and by greater radius of curvature of incisors (Table 12, Fig. 9). In summer pelage head and face mottled with more buff and less black. Colour of the buff hairs variable, but averaging Light Ochraceous-buff<sup>1</sup> instead of Pale Ochraceous-buff of *L. a. andersoni*. Base of ears mottled, with more buff and pale grey, less purely black. Dorsum with more white or pale grey mottling, sometimes more buff, less black, particularly on the rump. **Subadults.** In summer pelage, paler, less black, more buffy on back, head, and face than *L. a. andersoni*.

**Comparison of skins.** The Banks Island series includes no winter skins. They would probably be indistinguishable from those of *L. a. hubbardi* and *L. a. andersoni*. The large grey male collected by MacDonald (1954) on Prince Patrick Island could not be found and we have seen no skins of *L. a. hubbardi* or *L. a. monstrabilis* in summer pelage, but, judging by the descriptions given by Handley (1952) and Howell (1936), it is either whiter or less fully developed in these northern races than it is in *L. a. banksicola*. All Banks Island hares probably develop a nearly complete summer pelage of greyish fur. In some it is concealed by old white winter hair until the new winter hair has started to show in other individuals. Thus, some more or less white hares can be seen at any period of the summer. Females appear to turn grey earlier and more regularly than males. Höhn (1953) noted a partly grey hare on May 29. Judging by the mainland specimens seen and by Anderson (1937), *L. a. andersoni* develops a still more perfect summer pelage. This, however, may not be a genetic character.

Eight of the 11 adult Banks Island skins are readily separable by facial 'brown-ness' from all ten specimens in the mainland series of *L. a. andersoni*, which is more uniform for this character. One of the three overlapping Banks Island specimens, NMC 21085, is too far advanced into winter pelage for the other diagnostic characters to be seen. The other two, NMC 21084 and 20982, are readily separable from three of the five complete mainland skins in full summer pelage by their paler, less blackish backs, and from five out of the six

<sup>1</sup>Capitalized colours are from Ridgway (1912).



**Table 2.** Weights and measurements of adult and subadult *L. a. banksicola*.

| NMC No.          | Sex | Date     | Place                    | Wt. (lb.) | Total length     | Tail             | Hind foot        | Remarks                                   |
|------------------|-----|----------|--------------------------|-----------|------------------|------------------|------------------|-------------------------------------------|
| <b>Adults</b>    |     |          |                          |           |                  |                  |                  |                                           |
| 21729            | ♂   | Apr. 20  | Sachs Har.               |           | 620              | 50               | 154              | (E. H. McEwen).                           |
| 20973            | ♂   | June 24  | 71° 35N., 123° 30W.      |           | 670              | 60               | 155              |                                           |
| 20978            | ♂   | June 27  | 71° 30N., 123° 00W.      |           | 640              | 70               | 157              |                                           |
| 20979            | ♂   | June 28  | 71° 13N., 122° 35W.      |           | 680              | 62               | 174              |                                           |
| 20988            | ♂   | July 9   | 10 miles up Bernard R.   | 8½        |                  |                  |                  |                                           |
| 20981            | ♂   | Aug. 26  | Mahogany Pt. (Castel B.) |           | 620              | 75               | 155              |                                           |
| 20982            | ♂   | Aug. 26  | Mahogany Pt. (Castel B.) |           | 600              | 70               | 155              |                                           |
| 20983            | ♂   | Aug. 26  | Mahogany Pt. (Castel B.) |           | 610              | 75               | 153              |                                           |
| Mean             | ♂ ♂ |          |                          | 8½        | 634              | 66               | 158              |                                           |
| No spec.         | ♀   | May 26   | Sachs Har.               |           | 660 <sup>a</sup> | 51 <sup>a</sup>  | 153 <sup>a</sup> | } Wt. gutted,<br>9 lb. each (Höhn, 1953). |
| No spec.         | ♀   | May 26   | Sachs Har.               |           | 660 <sup>a</sup> | 51 <sup>a</sup>  | 155 <sup>a</sup> |                                           |
| No spec.         | ♀   | June 9   | Sachs Har.               | 14        | 711 <sup>a</sup> | 101 <sup>a</sup> | 178 <sup>a</sup> |                                           |
| No spec.         | ♀   | June 10  | Sachs Har.               | 12        | 635 <sup>a</sup> | 50 <sup>a</sup>  | 152 <sup>a</sup> | Pregnant (Höhn, 1953).                    |
| 21084            | ♀   | June 19  | 71° 35N., 123° 30W.      |           | 628              | 60               | 152              | Lactating. Uterus large.                  |
| 21076            | ♀   | June 19  | Sachs Har.               |           | 685              | 62               | 158              |                                           |
| 20970            | ♀   | June 19  | 71° 35N., 123° 30W.      |           | 700              | 62               | 158              | Lactating. Uterus large.                  |
| 20971            | ♀   | June 19  | 71° 35N., 123° 30W.      |           | 685              | 65               | 162              | Lactating. Uterus large.                  |
| 20974            | ♀   | June 24  | 71° 35N., 123° 30W.      |           | 623              | 51               | 164              | Lactating. Uterus smaller.                |
| 20975            | ♀   | June 24  | 71° 35N., 123° 30W.      |           | 690              | 69               | 162              | Lactating. Uterus smaller.                |
| 21077            | ♀   | June 24  | Sachs Har.               | 11¼       | 650              | 70               | 160              | Lactating.                                |
| 21078            | ♀   | June 25  | Sachs Har.               | 11½       | 640              | 77               | 163              | Lactating.                                |
| 20976            | ♀   | June 25  | 71° 35N., 123° 30W.      |           | 640              | 70               | 154              | Lactating. Uterus smaller.                |
| 20996            | ♀   | June 26  | Sachs Har.               | 11        | 665              | 68               | 160              |                                           |
| 21205            | ♀   | July 10  | Sachs Har.               | 12        | 635 <sup>a</sup> | 51 <sup>a</sup>  | 152 <sup>a</sup> | (Fred Carpenter).                         |
| 20989            | ♀   | July 14  | 6 miles up MuskoX R.     | 11½       | 645              | 90               | 163              | Lactating.                                |
| 20995            | ♀   | Aug. 11  | Gyr Falcon Bluff         | 10½       | 645              | 85               | 154              |                                           |
| 20980            | ♀   | Aug. 24  | Mahogany Pt. (Castel B.) |           | 635              | 90               | 146              |                                           |
| 20984            | ♀   | Sept. 17 | Sachs Har.               |           | 672              | 90               | 159              |                                           |
| 20986            | ♀   | Sept. 20 | Sachs Har.               |           | 700              | 100              | 158              |                                           |
| 21445            | ♀   | ?        | Probably Sachs Har.      | 8         | 605              | 40               |                  | Not pregnant.<br>(E. H. McEwen).          |
| Mean             | ♀ ♀ |          |                          | 11.3      | 658              | 69               | 158              |                                           |
| <b>Subadults</b> |     |          |                          |           |                  |                  |                  |                                           |
| 20972            | ♂   | June 22  | Sachs Har.               |           | 200              | 11               | 80               |                                           |
| 20977            | ♀   | June 25  | 71° 35N., 123° 30W.      |           | 240              | 30               | 72               |                                           |
| 20990            | ♂   | July 25  | Mahogany Pt. (Castel B.) | 3         | 450              | 52               | 120              |                                           |
| 20991            | ♂   | July 29  | Mahogany Pt. (Castel B.) | 3½        | 470              | 53               | 132              |                                           |
| 20992            | ♀   | July 29  | Mahogany Pt. (Castel B.) | 3         | 465              | 55               | 132              |                                           |
| 20993            | ♀   | July 29  | Mahogany Pt. (Castel B.) | 3¼        | 470              | 55               | 130              |                                           |
| 20994            | ♀   | Aug. 11  | Gyr Falcon Bluff         | 6¼        | 560              | 70               | 150              |                                           |
| 20985            | ♂   | Sept. 17 | Sachs Har.               |           | 600              | 90               | 155              |                                           |
| 20987            | ♀   | Sept. 21 | Sachs Har.               |           | 560              | 62               | 150              |                                           |

a. Original measurements in inches and eighths.



heads, by the reduced amount of black at the base of the ears. Using a combination of characters, 19 out of the combined series of 21 skins could probably be correctly identified. Familiarity with their individual make-up prevented this from being tested objectively.

Seven skins in summer or early autumn pelage from Pelly Bay (6) and Bellot Strait (1) have also been examined. One Pelly Bay skin (Macpherson No. G79) is an adult; the others (Macpherson Nos. G131, G140, G215, G216, G219) are young. The Bellot Strait specimen (ROMZ 19584) is probably young. All entirely lack the 'brown' facial character of *L. a. banksicola*, but have not been included in the *L. a. andersoni* series as intergradation with *L. a. arcticus* or *L. a. labradorius* is possible.

The backs of the two new-born young *L. a. banksicola*, NMC 20972, 20977, are rather more buffy than those of the adults. NMC 20972 is mottled with Light Ochraceous-buff, 20977 with a rather paler colour. Both are distinctly more buffy than the single comparable *L. a. andersoni*, NMC 5993, from Hanbury Lake at the headwaters of the Thelon River. The dorsum of this specimen is mottled with pale grey, and has no long buff hair. The ears of the young of both races are solid black at the tips only. In the two *L. a. banksicola* the lower parts of the ears are mottled with Light Ochraceous-buff, in the single *L. a. andersoni* they are less buffy and more black. The four older subadult *L. a. banksicola* (NMC 20990–20993) are very similar to adults in full summer pelage, but their ears, like those of the still older NMC 20994, which was turning white on August 11, are black at the tips only. They are distinctly paler and less black on the dorsum and have more buffy heads and faces than the comparable *L. a. andersoni*, AMNH 29061, taken at Aylmer Lake on August 19, which has mottled black ears.

**Comparison of body measurements.** The individual body measurements of *L. a. banksicola* are given in Table 2, and the mean of the combined male and female measurements compared with those of *L. a. andersoni* and *L. a. hubbardi* in Table 3. The three weighed specimens of *L. a. andersoni* were taken near Beechey Lake, Back River, in April, and Howell (1936) suggests that in the autumn they would be two to four pounds heavier. This, however, is probably too great an increase. Part of the difference in weight between the three Back River specimens and the Banks Island series is undoubtedly due to the inclusion of pregnant and lactating females in the latter. Much of the apparent variation in length of the tail vertebrae in the Banks Island series may be accounted for by the difficulty of taking this measurement accurately. There was probably a consistent difference between the method used by Handley and that used by us.

**Comparison of skulls.** For the purpose of this study, all specimens collected after the end of the calendar year in which they were born are considered adult, as by then it has become difficult to distinguish the age groups. The criterion most used for the separation of the young and adults was the degree of development of the anterior portion of the supraorbital process and of the notch formed by it. Adults and young of the three races here discussed appear easier to separate than those of the smaller eastern races.

Figures 1–9 show that for the measurements taken and the material available sexual dimorphism is not statistically significant. The figures also show that the Banks Island series of *L. a. banksicola* is significantly larger than the eastern



Table 3. Mean weights and measurements of combined male and female adults for three races of *L. arcticus*.

| Race                      | Wt. (lb.) | Total length | Tail    | Hind foot  |
|---------------------------|-----------|--------------|---------|------------|
| <i>L. a. banksicola</i>   | 11.0 (10) | 652 (28)     | 68 (28) | 158 (27)   |
| <i>L. a. andersoni</i>    | 8.3 (3)   | 632.5 (11)   | 61 (11) | 158.8 (11) |
| <i>L. a. hubbardi</i> (a) | —         | 626 (8)      | 100 (8) | 158 (8)    |
| <i>L. a. hubbardi</i> (b) | —         | 655 (5)      | 68 (5)  | 153 (5)    |

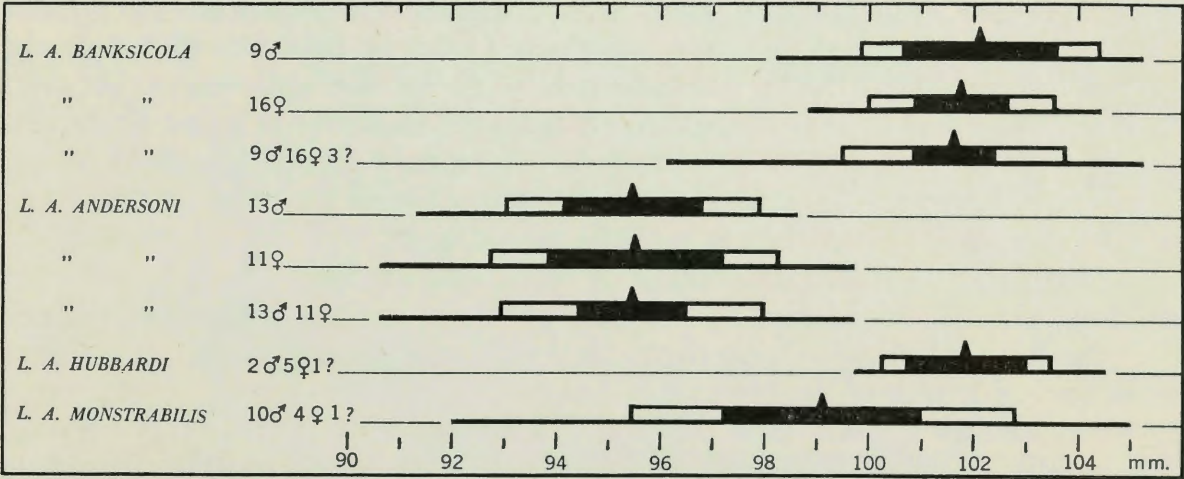
Weights and measurements of *L. a. banksicola* are from Table 2; those of *L. a. andersoni* from Howell (1936), and those of *L. a. hubbardi* (a) from Handley (1952) and (b) from Macpherson's field notes. Handley's specimens are from Prince Patrick Island; Macpherson's from Melville Island. Figures in brackets give the number of specimens.

Table 4. Inion-incisor length of adult *L. arcticus*.

| Race                      | No.              | Range                    | Mean $\pm$ SE     | SD $\pm$ SE     | CV $\pm$ SE   |
|---------------------------|------------------|--------------------------|-------------------|-----------------|---------------|
| <i>L. a. banksicola</i>   | 9 ♂♂             | 98.2-105.2               | 102.12 $\pm$ .762 | 2.29 $\pm$ .539 | 2.2 $\pm$ .53 |
|                           | 16 ♀♀            | 98.8-104.4               | 101.73 $\pm$ .450 | 1.80 $\pm$ .318 | 1.8 $\pm$ .31 |
|                           | 9 ♂♂, 16 ♀♀, 3 ? | 96.1 <sup>a</sup> -105.2 | 101.58 $\pm$ .408 | 2.16 $\pm$ .289 | 2.1 $\pm$ .28 |
| <i>L. a. andersoni</i>    | 13 ♂♂            | 91.3-98.6                | 95.44 $\pm$ .676  | 2.44 $\pm$ .478 | 2.6 $\pm$ .50 |
|                           | 11 ♀♀            | 90.6-99.7                | 95.51 $\pm$ .848  | 2.81 $\pm$ .600 | 2.9 $\pm$ .63 |
|                           | 13 ♂♂, 11 ♀♀     | 90.6-99.7                | 95.47 $\pm$ .522  | 2.56 $\pm$ .369 | 2.7 $\pm$ .39 |
| <i>L. a. hubbardi</i>     | 2 ♂♂, 5 ♀♀, 1 ?  | 99.7-104.5               | 101.84 $\pm$ .580 | 1.64 $\pm$ .410 | 1.6 $\pm$ .40 |
| <i>L. a. monstrabilis</i> | 10 ♂♂, 4 ♀♀, 1 ? | 92.1-105.0               | 99.11 $\pm$ .952  | 3.69 $\pm$ .673 | 3.7 $\pm$ .70 |

a. NMC 3088, next smallest, measures 98.2 mm. See p. 12.

Fig. 1. Inion-incisor length of adult *L. arcticus* plotted from figures given in Table 4. (See p. 7 for explanation).



District of Mackenzie series of *L. a. andersoni* in eight of the nine measurements. Only in nasal breadth, which is highly variable in the mainland series, is the difference not significant. The measurement which most consistently separates the two races is evidently inion-incisor length. Using the means and standard deviations as recommended by Mayr *et al.* (1953, p. 146), the coefficient of difference is found to be 1.3, and the joint non-overlap 90 per cent.



The non-overlap would be increased to 92 per cent if NMC 3088 were omitted. The inion-incisor length of this skull is 2.1 mm. less than the next smallest in the Banks Island series. According to the label it was collected on 4 December 1914 at Cape Kellett, and it is the only hare from Banks Island in the National Museum taken prior to 1952. It does not appear to be a young animal, although this cannot be definitely ruled out, neither can the possibility that it is a mainland specimen which has had its label mixed. The small radius of curvature (15 mm.) of the incisors would favour either of these possibilities. However, as the inion-incisor length is not significantly aberrant ( $R_3=3.25$ ,  $n=28$ ,  $P>.05$ ) according to the test recommended by Bliss and Calhoun (1954, p. 70), it has been retained in the series and occasional checks have been made to determine the effect of omitting it.

Figures 1-8 show the close agreement of *L. a. banksicola* and *L. a. hubbardi* in skull size. In most measurements the former is slightly larger, but in three, including inion-incisor length, the relationship is reversed, and in no case is the difference even bordering on significant. However, the radius of curvature of the incisors is much greater in *L. a. hubbardi*, and it is clear from Fig. 9 that, even allowing for lack of precision in the measurements, overlap in adults must be very rare. *L. a. banksicola* is closer to *L. a. monstrabilis* in incisor curvature, but distance precludes a direct genetic relationship, although a relationship through the much smaller *L. a. arcticus* is possible.

From Fig. 10 it is apparent that when *L. a. banksicola* is used as a standard, the means of the zygoma length, nasal breadth, and zygomatic breadth of *L. a. andersoni* show the greatest discrepancy relative to inion-incisor length. Nasal breadth was not considered because of its large standard error, but the relationship of zygoma length and zygomatic breadth to inion-incisor length was investigated by covariance analysis. The results, together with those for the covariance of curvature with inion-incisor length, are given in Table 13. Differences significant at the five per cent level should be treated with caution in view of the small range of inion-incisor length (cf. McIntosh, 1955), and certainly changes in the regression coefficient may be expected if the young animals are included. It is possible that some of the differences between *L. a. andersoni* and *L. a. banksicola* result from the inclusion of a few specimens amongst the six *L. a. andersoni* taken between January 20 and March 25 which were not full grown. However, the mean incisor length for these six specimens is only .05 mm. less than the mean of the whole series.

The National Museum has skulls of three adults from Victoria Island: two are from Holman Island post on the west coast and one from Mackenzie Creek near the Richardson Islands on the central part of the south coast. The mean inion-incisor length of the Holman Island specimens (♂ 98.8 mm., ♀ 98.0 mm.) is almost exactly midway between that of *L. a. andersoni* and *L. a. banksicola*. The incisors of the male are broken; the radius of incisor curvature of the female is 14 mm. This is outside the range of the Banks Island series, but it must be remembered that the measurement is not precise and is taken only to the nearest millimetre. The Mackenzie Creek male has an inion-incisor length of 96.1 mm., and a radius of incisor curvature of 19 mm. The first measurement fits well with *L. a. andersoni*, and is equalled by Banks Island specimen No. 3088 only; the second is outside the range of the mainland series of *L. a. andersoni*, and only just equalled by the straightest-toothed *L. a. banksicola*. The other



Table 5. Alveolar length of maxillary tooth row of adult *L. arcticus*.

| Race                    | No.              | Range                   | Mean ± SE  | SD ± SE  | CV ± SE |
|-------------------------|------------------|-------------------------|------------|----------|---------|
| <i>L. a. banksicola</i> | 9 ♂♂             | 19.2 -20.6              | 20.14±.258 | .78±.183 | 3.8±.91 |
|                         | 15 ♀♀            | 19.1 -20.7              | 19.95±.115 | .45±.814 | 2.2±.41 |
|                         | 9 ♂♂, 15 ♀♀, 3 ? | 18.6 <sup>a</sup> -20.7 | 19.99±.119 | .62±.084 | 3.1±.42 |
| <i>L. a. andersoni</i>  | 13 ♂♂            | 18.0 -19.5              | 18.72±.125 | .45±.088 | 2.4±.47 |
|                         | 11 ♀♀            | 17.3 -19.9              | 18.65±.214 | .71±.151 | 3.8±.81 |
|                         | 13 ♂♂, 11 ♀♀     | 17.3 -19.9              | 18.68±.117 | .57±.082 | 3.1±.44 |
| <i>L. a. hubbardi</i>   | 2 ♂♂, 5 ♀♀, 1 ?  | 19.2 -20.3              | 19.75±.140 | .40±.099 | 2.0±.50 |

a. NMC No. 3088, next smallest, measures 19.1 mm. See p. 12.

Fig. 2. Alveolar length of maxillary tooth row of adult *L. arcticus* plotted from figures given in Table 5.

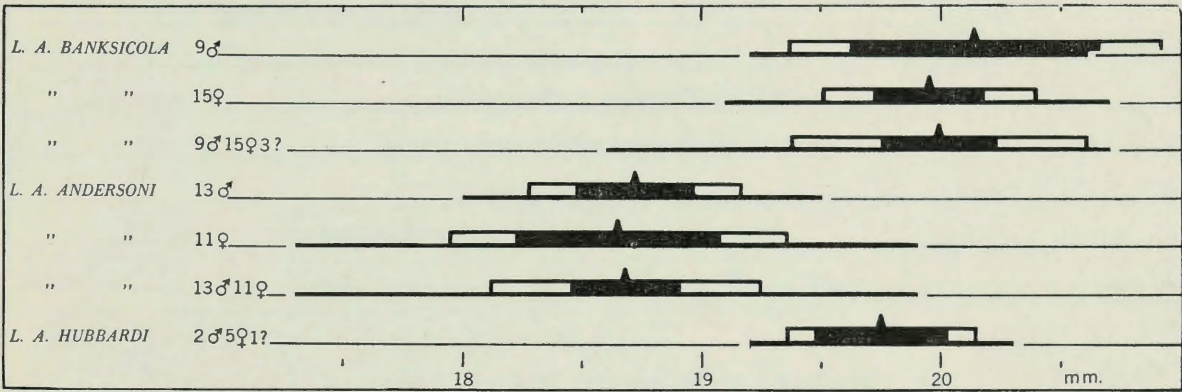
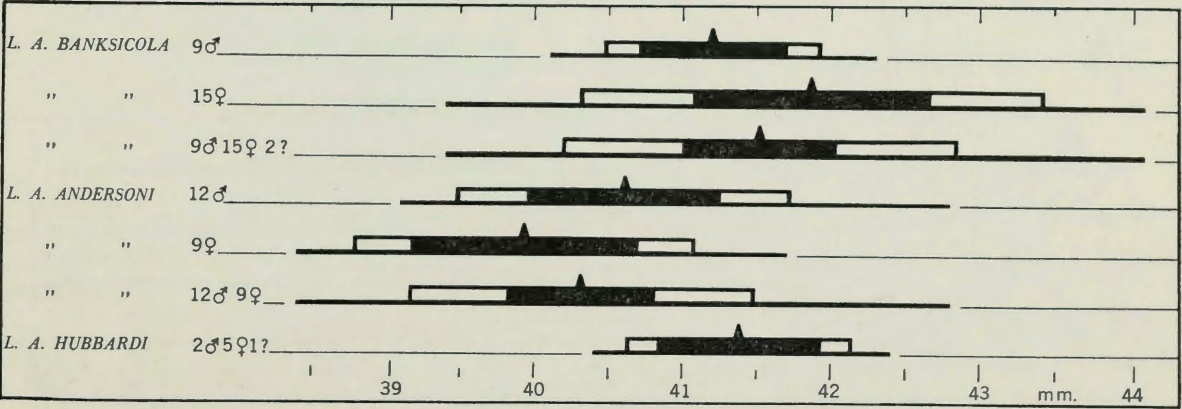


Table 6. Zygoma length of adult *L. arcticus*.

| Race                    | No.              | Range     | Mean ± SE  | SD ± SE   | CV ± SE |
|-------------------------|------------------|-----------|------------|-----------|---------|
| <i>L. a. banksicola</i> | 9 ♂♂             | 40.1-42.3 | 41.20±.246 | 0.74±.174 | 1.8±.42 |
|                         | 15 ♀♀            | 39.4-44.1 | 41.87±.403 | 1.56±.285 | 3.7±.68 |
|                         | 9 ♂♂, 15 ♀♀, 2 ? | 39.4-44.1 | 41.52±.260 | 1.33±.184 | 3.2±.44 |
| <i>L. a. andersoni</i>  | 12 ♂♂            | 39.1-42.8 | 40.59±.325 | 1.13±.230 | 2.8±.57 |
|                         | 9 ♀♀             | 38.4-41.7 | 39.93±.386 | 1.16±.273 | 2.9±.68 |
|                         | 12 ♂♂, 9 ♀♀      | 38.4-42.8 | 40.31±.253 | 1.16±.179 | 2.9±.44 |
| <i>L. a. hubbardi</i>   | 2 ♂♂, 5 ♀♀, 1 ?  | 40.4-42.4 | 41.38±.273 | 0.77±.193 | 1.9±.47 |

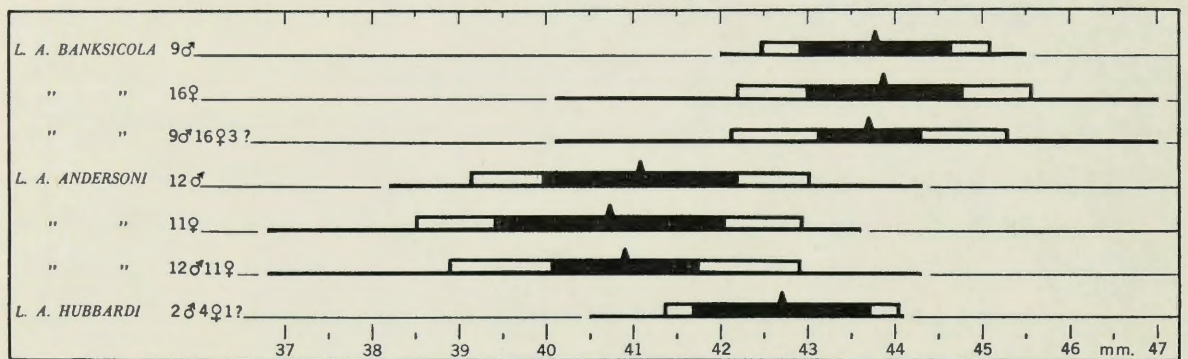
Fig. 3. Zygoma length of adult *L. arcticus* plotted from figures given in Table 6.





**Table 7.** Nasal length of adult *L. arcticus*.

| Race                    | No.              | Range     | Mean $\pm$ SE    | SD $\pm$ SE     | CV $\pm$ SE    |
|-------------------------|------------------|-----------|------------------|-----------------|----------------|
| <i>L. a. banksicola</i> | 9 ♂♂             | 42.0-45.5 | 43.78 $\pm$ .441 | 1.32 $\pm$ .312 | 3.0 $\pm$ 0.71 |
|                         | 16 ♀♀            | 40.1-47.0 | 43.88 $\pm$ .427 | 1.71 $\pm$ .302 | 3.9 $\pm$ 0.69 |
|                         | 9 ♂♂, 16 ♀♀, 3 ? | 40.1-47.0 | 43.70 $\pm$ .304 | 1.61 $\pm$ .215 | 3.7 $\pm$ 0.49 |
| <i>L. a. andersoni</i>  | 12 ♂♂            | 38.2-44.3 | 41.07 $\pm$ .560 | 1.94 $\pm$ .396 | 4.7 $\pm$ 0.96 |
|                         | 11 ♀♀            | 36.8-43.6 | 40.72 $\pm$ .667 | 2.21 $\pm$ .472 | 5.4 $\pm$ 1.16 |
|                         | 12 ♂♂, 11 ♀♀     | 36.8-44.3 | 40.90 $\pm$ .424 | 2.04 $\pm$ .300 | 5.0 $\pm$ 0.73 |
| <i>L. a. hubbardi</i>   | 2 ♂♂, 4 ♀♀, 1 ?  | 40.5-44.1 | 42.70 $\pm$ .513 | 1.36 $\pm$ .363 | 3.2 $\pm$ 0.85 |

**Fig. 4.** Nasal length of adult *L. arcticus* plotted from figures given in Table 7.**Table 8.** Nasal breadth of adult *L. arcticus*.

| Race                    | No.              | Range     | Mean $\pm$ SE    | SD $\pm$ SE     | CV $\pm$ SE    |
|-------------------------|------------------|-----------|------------------|-----------------|----------------|
| <i>L. a. banksicola</i> | 9 ♂♂             | 21.0-22.6 | 21.80 $\pm$ .194 | 0.58 $\pm$ .137 | 2.7 $\pm$ 0.63 |
|                         | 16 ♀♀            | 20.0-23.0 | 21.71 $\pm$ .247 | 0.99 $\pm$ .175 | 4.5 $\pm$ 0.80 |
|                         | 9 ♂♂, 16 ♀♀, 3 ? | 20.0-23.0 | 21.72 $\pm$ .153 | 0.81 $\pm$ .108 | 3.7 $\pm$ 0.50 |
| <i>L. a. andersoni</i>  | 12 ♂♂            | 19.9-24.9 | 21.51 $\pm$ .436 | 1.51 $\pm$ .309 | 7.0 $\pm$ 1.43 |
|                         | 11 ♀♀            | 18.3-22.8 | 20.74 $\pm$ .466 | 1.55 $\pm$ .330 | 7.5 $\pm$ 1.59 |
|                         | 12 ♂♂, 11 ♀♀     | 18.3-24.9 | 21.14 $\pm$ .322 | 1.54 $\pm$ .228 | 7.3 $\pm$ 1.08 |
| <i>L. a. hubbardi</i>   | 2 ♂♂, 5 ♀♀, 1 ?  | 20.4-23.0 | 21.65 $\pm$ .367 | 1.04 $\pm$ .259 | 4.8 $\pm$ 1.20 |

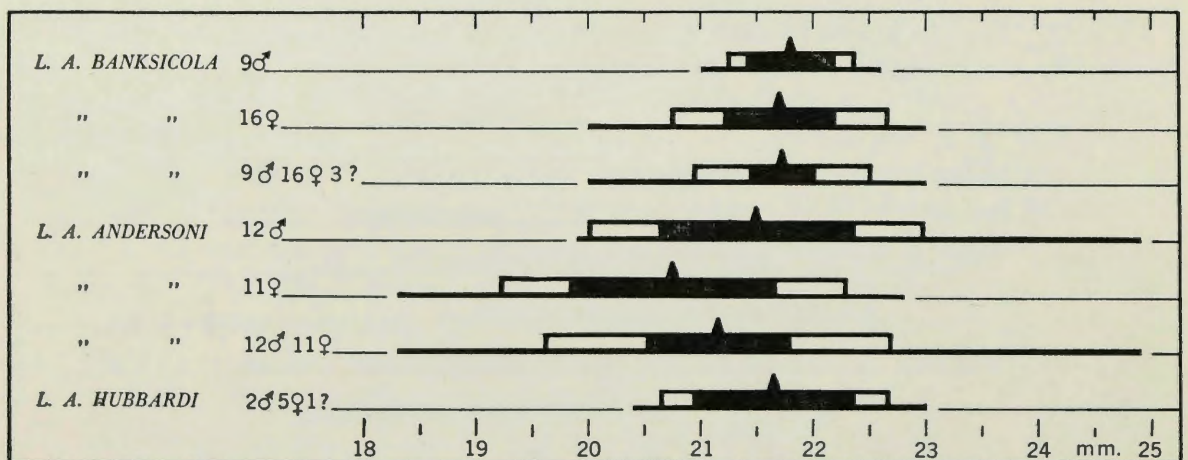
**Fig. 5.** Nasal breadth of adult *L. arcticus* plotted from figures given in Table 8.



Table 9. Zygomatic breadth of adult *L. arcticus*.

| Race                    | No.              | Range     | Mean $\pm$ SE    | SD $\pm$ SE     | CV $\pm$ SE   |
|-------------------------|------------------|-----------|------------------|-----------------|---------------|
| <i>L. a. banksicola</i> | 7 ♂♂             | 50.5-52.6 | 51.41 $\pm$ .246 | 0.65 $\pm$ .174 | 1.3 $\pm$ .34 |
|                         | 16 ♀♀            | 49.8-53.2 | 51.57 $\pm$ .273 | 1.09 $\pm$ .193 | 2.1 $\pm$ .37 |
|                         | 7 ♂♂, 16 ♀♀, 3 ? | 49.8-53.2 | 51.42 $\pm$ .189 | 0.96 $\pm$ .134 | 1.9 $\pm$ .26 |
| <i>L. a. andersoni</i>  | 12 ♂♂            | 47.5-51.3 | 49.58 $\pm$ .324 | 1.12 $\pm$ .229 | 2.3 $\pm$ .46 |
|                         | 11 ♀♀            | 47.6-51.5 | 49.95 $\pm$ .374 | 1.24 $\pm$ .265 | 2.5 $\pm$ .53 |
|                         | 12 ♂♂, 11 ♀♀     | 47.5-51.5 | 49.76 $\pm$ .243 | 1.17 $\pm$ .172 | 2.3 $\pm$ .35 |
| <i>L. a. hubbardi</i>   | 2 ♂♂, 5 ♀♀, 1 ?  | 50.5-52.4 | 51.60 $\pm$ .232 | 0.66 $\pm$ .164 | 1.3 $\pm$ .32 |

Fig. 6. Zygomatic breadth of adult *L. arcticus* plotted from figures given in Table 9.

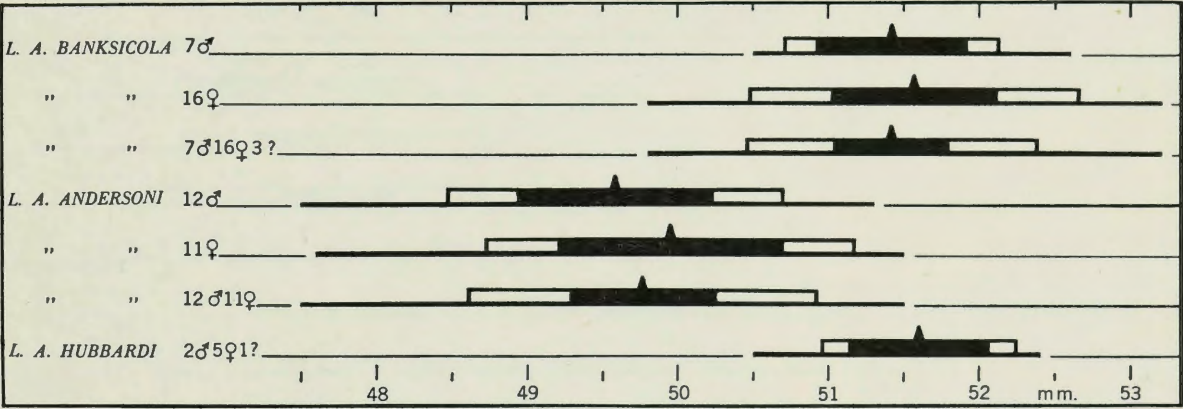
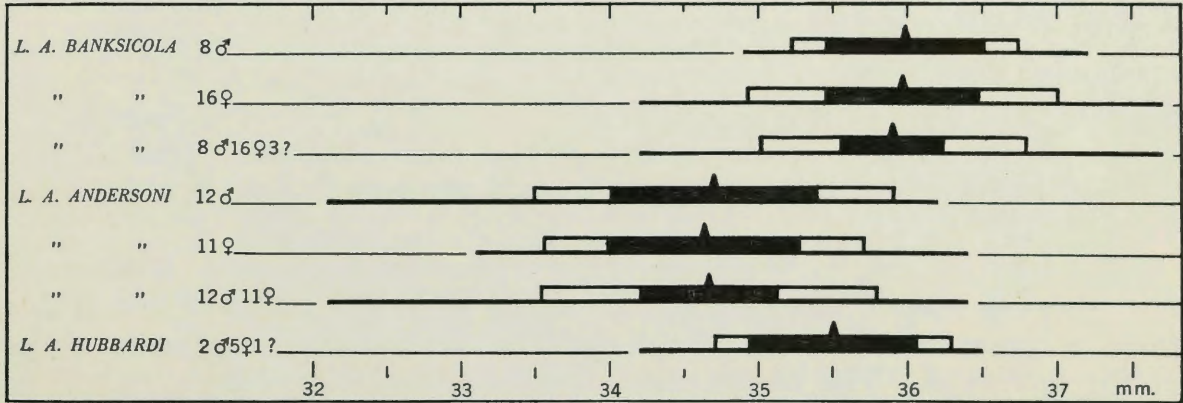


Table 10. Cranial breadth of adult *L. arcticus*.

| Race                    | No.              | Range     | Mean $\pm$ SE    | SD $\pm$ SE     | CV $\pm$ SE   |
|-------------------------|------------------|-----------|------------------|-----------------|---------------|
| <i>L. a. banksicola</i> | 8 ♂♂             | 34.9-37.2 | 35.98 $\pm$ .269 | 0.76 $\pm$ .190 | 2.1 $\pm$ .53 |
|                         | 16 ♀♀            | 34.2-37.7 | 35.96 $\pm$ .262 | 1.05 $\pm$ .185 | 2.9 $\pm$ .52 |
|                         | 8 ♂♂, 16 ♀♀, 3 ? | 34.2-37.7 | 35.90 $\pm$ .175 | 0.91 $\pm$ .124 | 2.5 $\pm$ .34 |
| <i>L. a. andersoni</i>  | 12 ♂♂            | 32.1-36.2 | 34.70 $\pm$ .353 | 1.22 $\pm$ .249 | 3.5 $\pm$ .72 |
|                         | 11 ♀♀            | 33.1-36.4 | 34.64 $\pm$ .326 | 1.08 $\pm$ .230 | 3.1 $\pm$ .67 |
|                         | 12 ♂♂, 11 ♀♀     | 32.1-36.4 | 34.67 $\pm$ .236 | 1.13 $\pm$ .167 | 3.3 $\pm$ .48 |
| <i>L. a. hubbardi</i>   | 2 ♂♂, 5 ♀♀, 1 ?  | 34.2-36.5 | 35.50 $\pm$ .282 | 0.80 $\pm$ .199 | 2.2 $\pm$ .56 |

Fig. 7. Cranial breadth of adult *L. arcticus* plotted from figures given in Table 10.

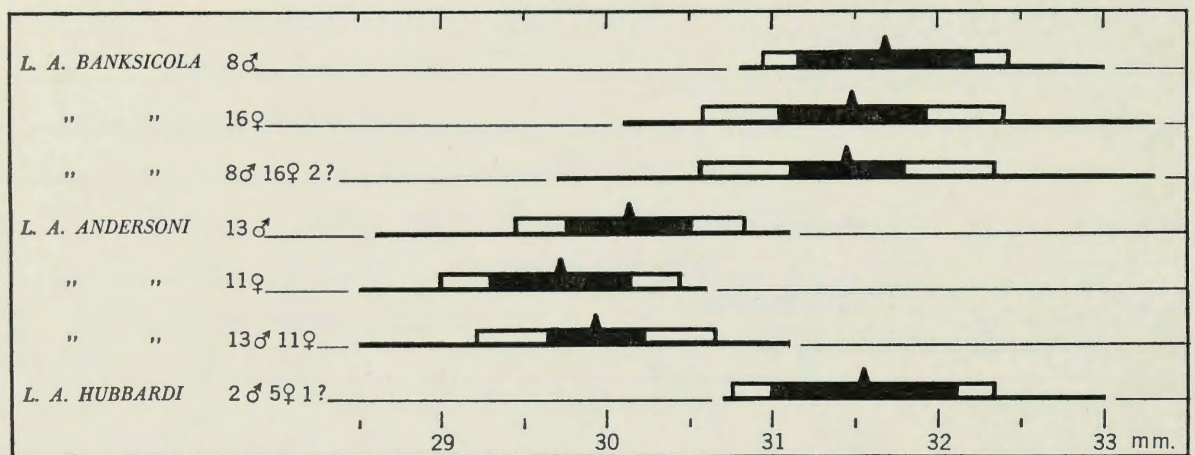




**Table 11.** Cranial depth of adult *L. arcticus*.

| Race                    | No.              | Range                   | Mean $\pm$ SE    | SD $\pm$ SE    | CV $\pm$ SE   |
|-------------------------|------------------|-------------------------|------------------|----------------|---------------|
| <i>L. a. banksicola</i> | 8 ♂♂             | 30.8–33.0               | 31.68 $\pm$ .267 | .75 $\pm$ .188 | 2.4 $\pm$ .60 |
|                         | 16 ♀♀            | 30.1–33.3               | 31.49 $\pm$ .228 | .91 $\pm$ .161 | 2.9 $\pm$ .51 |
|                         | 8 ♂♂, 16 ♀♀, 2 ? | 29.7 <sup>a</sup> –33.3 | 31.45 $\pm$ .177 | .90 $\pm$ .125 | 2.9 $\pm$ .40 |
| <i>L. a. andersoni</i>  | 13 ♂♂            | 28.6–31.1               | 30.14 $\pm$ .193 | .70 $\pm$ .136 | 2.3 $\pm$ .45 |
|                         | 11 ♀♀            | 28.5–30.6               | 29.71 $\pm$ .220 | .73 $\pm$ .156 | 2.5 $\pm$ .52 |
|                         | 13 ♂♂, 11 ♀♀     | 28.5–31.1               | 29.94 $\pm$ .149 | .73 $\pm$ .105 | 2.4 $\pm$ .35 |
| <i>L. a. hubbardi</i>   | 2 ♂♂, 5 ♀♀, 1 ?  | 30.7–33.0               | 31.55 $\pm$ .280 | .79 $\pm$ .198 | 2.5 $\pm$ .63 |

a. NMC No. 3088, next smallest, measures 30.1 mm. See p. 12.

**Fig. 8.** Cranial depth of adult *L. arcticus* plotted from figures given in Table 11.**Table 12.** Radius of curvature of incisors of adult *L. arcticus*.

| Race                      | No.              | Range               | Mean $\pm$ SE    | SD $\pm$ SE     | CV $\pm$ SE     |
|---------------------------|------------------|---------------------|------------------|-----------------|-----------------|
| <i>L. a. banksicola</i>   | 9 ♂♂             | 16–19               | 17.44 $\pm$ .338 | 1.01 $\pm$ .239 | 5.8 $\pm$ 1.37  |
|                           | 16 ♀♀            | 17–19               | 18.06 $\pm$ .214 | 0.85 $\pm$ .151 | 4.7 $\pm$ 0.84  |
|                           | 9 ♂♂, 16 ♀♀, 3 ? | 15 <sup>a</sup> –19 | 17.68 $\pm$ .200 | 1.06 $\pm$ .141 | 6.0 $\pm$ 0.80  |
| <i>L. a. andersoni</i>    | 13 ♂♂            | 13–18               | 15.54 $\pm$ .439 | 1.58 $\pm$ .310 | 10.2 $\pm$ 2.00 |
|                           | 11 ♀♀            | 13–17               | 15.09 $\pm$ .369 | 1.23 $\pm$ .261 | 8.1 $\pm$ 1.73  |
|                           | 13 ♂♂, 11 ♀♀     | 13–18               | 15.33 $\pm$ .286 | 1.40 $\pm$ .202 | 9.1 $\pm$ 1.32  |
| <i>L. a. hubbardi</i>     | 1 ♂, 5 ♀♀, 1 ?   | 24–29               | 25.71 $\pm$ .680 | 1.80 $\pm$ .481 | 7.0 $\pm$ 1.87  |
| <i>L. a. monstrabilis</i> | 10 ♂♂, 4 ♀♀, 1 ? | 18–25               | 21.20 $\pm$ .500 | 1.94 $\pm$ .353 | 9.1 $\pm$ 1.67  |

a. NMC No. 3088, next smallest, measures 16 mm. See p. 12.

measurements were plotted on scatter diagrams, but yielded no evidence of the race represented. It is evident, therefore, that more material is required from Victoria Island before the boundary between *L. a. banksicola* and *L. a. andersoni* can be drawn.

The skull of a male, AMNH 34522, was excluded from the *L. a. andersoni* series because Cape Parry, immediately south of Banks Island, where it was taken, was considered too far west of the type area and origin of the remainder of the specimens. The measurements (mean inion-incisor length, 98.0 mm.,



Fig. 9. Radius of curvature of incisors of adult *L. arcticus* plotted from figures given in Table 12.

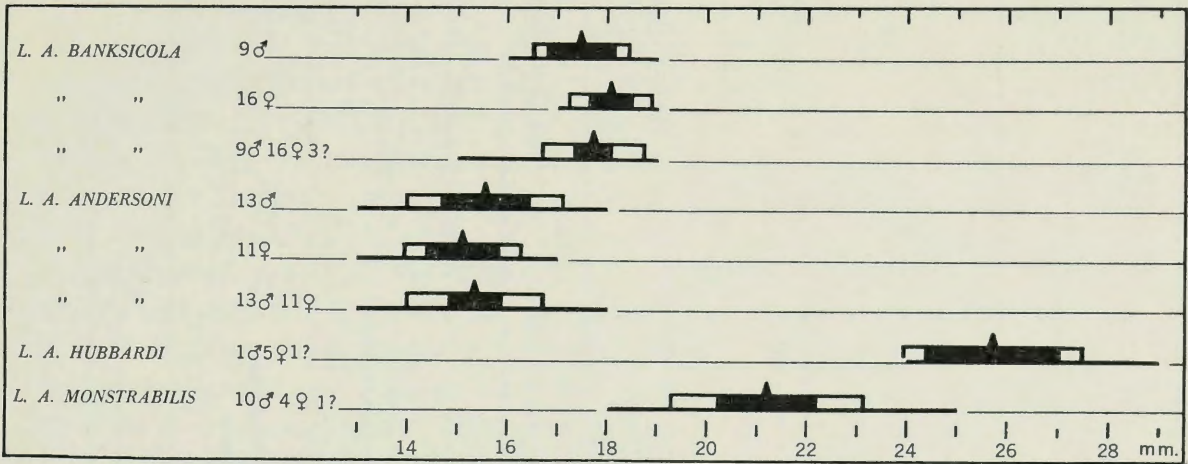


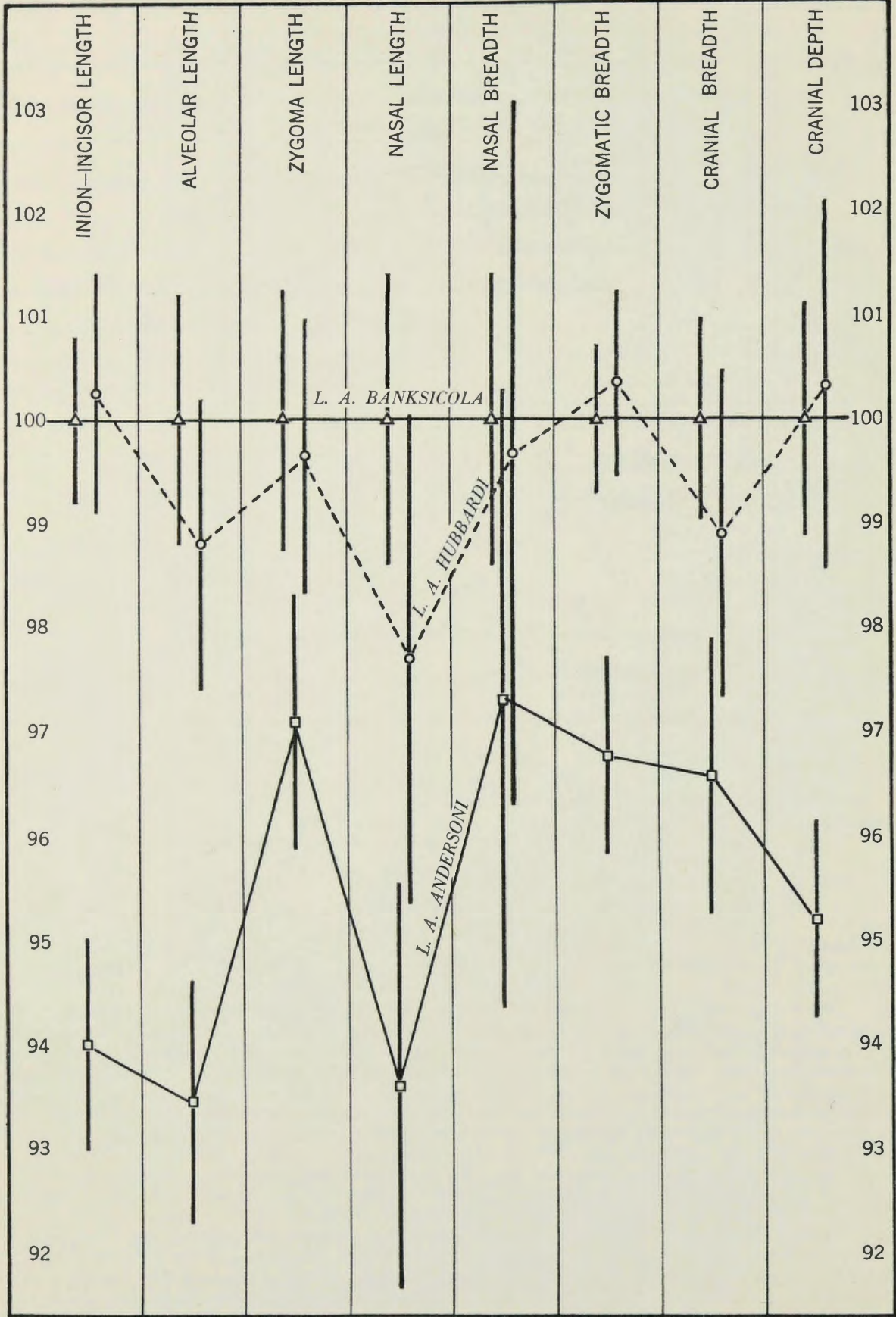
Table 13. Results of covariance analysis of adult *L. arcticus*. Independent variate: inion-incisor length.

| Dependent variate<br><i>Y</i> | Race                    | No. | Adjusted mean <i>Y</i> | Correlation coefficient<br>( <i>r</i> ) | Regression coefficient | <i>F</i><br>(Slope diff.) | <i>F</i><br>(Position diff.) |
|-------------------------------|-------------------------|-----|------------------------|-----------------------------------------|------------------------|---------------------------|------------------------------|
| Zygoma length                 | <i>L. a. andersoni</i>  | 21  | 41.16±0.23             | .76                                     | .34±.07                | 0.23                      | 5.11*                        |
|                               | <i>L. a. banksicola</i> | 26  | 40.21±0.26             | .69                                     | .36±.06                |                           |                              |
|                               | <i>L. a. hubbardi</i>   | 8   | 40.01±0.38             | .65                                     | .39±.09                |                           |                              |
| Zygomatic breadth             | <i>L. a. andersoni</i>  | 23  | 50.47±0.22             | .63                                     | .37±.08                | 0.36                      | 0.26                         |
|                               | <i>L. a. banksicola</i> | 26  | 50.49±0.25             | .52                                     | .25±.16                |                           |                              |
|                               | <i>L. a. hubbardi</i>   | 8   | 50.57±0.35             | .78                                     | .36±.06                |                           |                              |
| Incisor curvature             | <i>L. a. andersoni</i>  | 24  | 15.84±0.29             | .78                                     | .36±.06                | 3.08                      | 0.01                         |
|                               | <i>L. a. banksicola</i> | 28  | 16.97±0.33             | .78                                     | .28±.03                |                           |                              |
|                               | <i>L. a. hubbardi</i>   | 8   | 50.57±0.35             | .38                                     | .17±.09                |                           |                              |
| Incisor curvature             | <i>L. a. andersoni</i>  | 24  | 15.84±0.29             | .39                                     | .21±.11                | 0.01                      | 0.10                         |
|                               | <i>L. a. banksicola</i> | 28  | 16.97±0.33             | .38                                     | .20±.07                |                           |                              |
|                               | <i>L. a. hubbardi</i>   | 7   | 22.72±1.23             | .36                                     | .17±.09                |                           |                              |
|                               |                         |     |                        | —                                       | —                      | 5.34*                     | 282.61****                   |
|                               |                         |     |                        | .76                                     | .78±.29                |                           |                              |

The *F* ratios for slope and position differences of the regression lines are from tests made between *L. a. banksicola* and *L. a. andersoni* and between *L. a. banksicola* and *L. a. hubbardi*. The correlation and regression coefficients on lines between two races are for single lines of the combined series unless there is a significant position difference, in which case they are for two parallel lines. When zygoma length and zygomatic breadth were dependent variates, the adjusted means were obtained by using the regression coefficients for the parallel lines of the three races, 0.356 and 0.269 respectively. When incisor curvature was the dependent variate, the means of *L. a. andersoni* and *L. a. banksicola* were adjusted along their parallel regression lines, and the mean of *L. a. hubbardi* along its own regression line. When parallel lines were used for adjusting the means, standard errors of the adjusted means were obtained from the

formula  $Sy.x \sqrt{1/k + x^2/Sx^2}$  where *Sy.x* is the standard error of estimate for the parallel regression lines, *Sx*<sup>2</sup> the sum of the squares associated with these lines, *k* the number of specimens in the individual series, and *x*<sup>2</sup> the square of the deviation of the individual series mean from the standard mean (98.00 mm.) of the independent variate to which the dependent means were adjusted. Standard errors obtained thus are appropriate for calculating confidence limits of the adjusted means or for the testing of significance of a difference from the mean of an independent series adjusted to the same standard mean. The *F* ratio in the last column is more efficient in estimating the significance of the difference between the adjusted means of the paired series in the present table.





**Fig. 10.** The means of measurements of *L. a. andersoni* (squares) and of *L. a. hubbardi* (circles) shown as percentages of the means of *L. a. banksicola* (triangles). The heavy vertical lines on each side of the mean equal one standard error of the mean. The standard errors are also converted to a percentage of the mean of *L. a. banksicola* in order to appear on the same scale.



radius of incisor curvature, 13 mm.) of this skull are, however, reasonable for that race, and it is probable that Amundsen Gulf is too wide for hares to cross with any frequency.

**Conclusions.** Most of the skull differences between *L. a. banksicola* and *L. a. andersoni* are attributes of the greater size of the former, and, although all measurements, except incisor curvature, of *L. a. banksicola* examined agree better with *L. a. hubbardi* than with *L. a. andersoni*, it is probable that *L. a. banksicola* is distinctly more closely related to the mainland form than to that of the Queen Elizabeth Islands. *L. a. banksicola* undoubtedly intergrades with *L. a. andersoni*, probably on Victoria Island, but the great difference between both the absolute and the adjusted means of incisor curvature of *L. a. banksicola* and *L. a. hubbardi* suggests that either M'Clure Strait and Melville Sound form a complete barrier to hares or that the Queen Elizabeth Islands population is a separate allopatric species. Before the latter view can be accepted, however, it will be necessary to investigate the relationship of *L. a. monstrabilis* and *L. a. arcticus*, as a preliminary scatter diagram of inion-incisor length against radius of incisor curvature suggests that the relationship between these races may be much closer than that between *L. a. banksicola* and *L. a. hubbardi*.

#### *Description of skull measurements*

*Inion-incisor length.* Measured from the posterior tip of the inion to the posterior border of the alveolus of the incisors. This measurement was decided upon after experiments to find one which could easily and consistently be taken with standard calipers and which would give as near the full skull length as possible without being affected by incisor curvature.

*Alveolar length of maxillary tooth row.* Measured on the right side.

*Zygoma length.* The maximum length of the zygomatic arch; measured on the right side in complete skulls.

*Nasal length.* The greater diagonal of the left nasal, or, if broken, right nasal.

*Nasal breadth.* The greatest breadth of the nasals near their posterior end.

*Zygomatic breadth.* Measured with the calipers held vertically at the centre of the suture between the zygomatic process of the squamosal and the jugal.

*Cranial breadth.* Measured across the squamosals with the calipers held vertically and touching the posterior process of the jugal.

*Cranial depth.* The depth from the bregma to the basisphenoid immediately posterior to the pterygoid process and avoiding as far as possible with 2.2 mm.-thick caliper jaws the ridge formed at the junction of the basisphenoid and basioccipital.

*Radius of curvature of incisors.* This is the outer curve of the anterior upper incisors. It was taken by superimposing the incisors still in the skull over concentric circles 1 mm. apart and viewing through a 6-power microscope.

#### *Specimens examined*<sup>1</sup>

##### *L. a. banksicola*

*Summer skins. Adults. Banks Island.* 71°35'N., 123°30'W.: 21084 ♀ June 19; 20973 ♂ June 24; 20974 ♀ June 24; 20975 ♀ June 24. *Sachs Harbour:* 21077 ♀ June 24; 21205 ♀ July 10. *Mahogany Point (Castel Bay):* 20981 ♂ Aug. 26; 20982 ♂ Aug. 26. *Muskox River:* 20989 ♀ July 14. *Gyr Falcon Bluff:* 20995 ♀ Aug. 11. *Cape Vesey Hamilton:* 21085 ♀ Aug. 16. *Subadults. Banks Island.* 71°35'N., 123°30'W.: 20977 ♀ June 25. *Sachs Harbour:* 20972 ♂ June 22. *Mahogany Point (Castel Bay):* 20990 ♂ July 25; 20991 ♂ July 29; 20992 ♀ July 29; 20993 ♀ July 29. *Gyr Falcon Bluff:* 20994 ♀ Aug. 11.

*Skulls. Adults. Banks Island.* Southeast Banks Island, 1 ♂, 1 ♀, 2 ?; Sachs Harbour, 1 ♂, 6 ♀ ♀; 71°35'N., 123°30'W., 1 ♂, 5 ♀ ♀; 71°30'N., 123°00'W., 1 ♂; 71°13'N., 122°35'W., 1 ♂; Mahogany Point (Castel Bay), 3 ♂ ♂, 1 ♀; 10 miles up Bernard River, 1 ♂; Cape Kellett,

<sup>1</sup>All numbers refer to specimens in the National Museum of Canada unless specified otherwise.



1 ♂ ?; Cape Vesey Hamilton, 1 ♀; 6 miles up Muskox River, 1 ♀. *Subadults. Banks Island.* Sachs Harbour, 3 ♂ ♂, 1 ♀; Mahogany Point (Castel Bay), 2 ♂ ♂, 2 ♀ ♀; Gyrfalcon Bluff, 1 ♀.

*L. arcticus* subsp.

*Skulls. Adults. Victoria Island.* Holman Island post, 1 ♂, 1 ♀; Mackenzie Creek, 1 ♂. *Subadults. Victoria Island.* Holman Island post, 1 ♂, 2 ♀ ♀, 1 ♀?, 1 ?.

*L. a. andersoni*

*Summer skins. Adults. Coronation Gulf.* Cape Barrow: 2858 (type) ♀ Aug. 14; 2859 ♂ Aug. 14; uncatalogued head ♂ Aug. 14; 2860 ♀ Aug. 14. Cape Kendall: 2870 ♂ June 21. Port Epworth: 2857 ♂ Aug. 11. **Bathurst Inlet:** 2861 ♀ Sept. 3. **Dolphin and Union Strait.** Near Cape Krusenstern: 2872 ♂ July 3. **Inland.** Aylmer Lake: AMNH 29060 ♀ Aug. 14. District of Keewatin: 5924 sex ? date ?. *Subadults. Inland.* Aylmer Lake: AMNH 29061 ♀ Aug. 19. Hanbury Lake: 5993 ♂ July 5.

*Skulls. Adults. Coronation Gulf.* Cape Barrow, 2 ♂ ♂, 3 ♀ ♀; Port Epworth, 1 ♂; Cape Kendall, 1 ♂; Grays Bay, 2 ♂ ♂; Sandstone Rapids, Coppermine River, 2 ♀ ♀. **Bathurst Inlet,** 1 ♀. **Dolphin and Union Strait.** Bernard Harbour, 3 ♂ ♂, 4 ♀ ♀; Mt. Barrow, Cape Krusenstern, 1 ♂; Liston Island, 1 ♂. **Amundsen Gulf.** Cape Parry, 1 ♂. **Inland.** South of Dismal Lakes, 1 ♂; Aylmer Lake, 1 ♀.

*L. a. hubbardi*

*Skulls. Adults. Prince Patrick Island.* Mould Bay, 1 ♂, 1 ♀, 1 sex ?. **Melville Island.** Comfort Cove, 1 ♂, 4 ♀ ♀.

*L. a. monstrabilis*

*Skulls. Adults. Axel Heiberg Island.* Diana (=Buchanan) Lake, 1 ♂. **Devon Island.** Dundas Harbour, 1 ♂, 1 ♀. **Ellesmere Island.** Craig Harbour, 2 ♂ ♂, 1 ♀, 1 sex ?; Eureka, 5 ♂ ♂, 1 ♀; Bay Fiord, 1 ♂. *Subadults. Ellesmere Island.* Craig Harbour, 1 ♂, 2 sex ?; Eureka, 1 ♂; Slidre Fiord, 1 ♂, 2 ♀ ♀.

### *Previous records and field observations*

There is probably no part of Banks Island where Arctic Hares may not be met with occasionally, particularly in winter when they are more apt to be found on the lowlands. On 5 May 1851, a party from the *Investigator* shot four hares and saw many others "in groups of six and seven, wonderfully tame" on that part of Banks Island which lies opposite the Princess Royal Islands (Armstrong, 1857, pp. 315-6). Table 14, taken from Armstrong (1857, p. 601), shows the number of hares shot at Mercy Bay by the officers and crew of the *Investigator* between October 1851 and April 1853. It will be noted that the largest numbers were killed during the first October, and Armstrong remarks how rapidly they became wild and were driven from their usual haunts by a day's shooting. The small number killed in mid-winter was probably due to the cold, dark days when little hunting was done. Hares were numerous at the head of Mercy Bay, particularly near "The Bluff" (now called Gyrfalcon Bluff) and about cliffy headlands and ravines, but in spring and winter they were frequently found on the ice two or three miles

**Table 14.** Hares shot at Mercy Bay between October 1851 and April 1853 from Armstrong (1857, p. 601).

|      | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|------|------|------|------|-------|-----|------|------|------|-------|------|------|------|
| 1851 | —    | —    | —    | —     | —   | —    | —    | —    | —     | 50   | 1    | 0    |
| 1852 | 2    | 1    | 20   | 18    | 9   | 13   | 14   | 5    | 0     | 9    | 3    | 3    |
| 1853 | 6    | 9    | 19   | 0     | —   | —    | —    | —    | —     | —    | —    | —    |



from land. (Armstrong, 1857, pp. 474, 479-80, 557). Collinson (1889, p. 200) appeared to think that groups of hares, the tracks of which were seen at Peel Point, northwest Victoria Island, had crossed the ice, presumably from Banks Island. Osborn (1856, p. 219) says that some groups at Mercy Bay numbered at least 150. Stefansson (1921, p. 227) saw eight hares on Norway Island on 25 June 1914.

In the summer of 1952 we noted large areas where hares were apparently absent and a few places where they were abundant. Before the snow went we saw no hare tracks at De Salis Bay either near the coast or at the edge of the hills to the north and west, but after the snow had gone old droppings were found in abundance on the vegetated spits at the south and east of the harbour and in a few other places near the bay. According to the Banks Islanders, as many as 200 Arctic Hares can sometimes be seen together in the valley of the Masik River in winter (early spring ?), but on our walks through the valley, June 17-19 and June 26, we saw only two. However, they were abundant on the north side of a valley, about  $71^{\circ}35'N.$ ,  $123^{\circ}30'W.$ , just east of Raddi Lake, where 30 were seen while we walked about four miles on June 19, and on our return, June 24-6, we estimated that there were 100 to 200 adults within an area of five square miles. Between Raddi Lake and Sachs Harbour, June 20-4, we saw nine hares, mostly along the ridge south of the Sachs River. On June 27 we saw two on the hills north of the Masik River, and, on the next day, 17 while travelling about two miles along the hills bordering the north side of the Nelson River. We saw four hares, very likely young ones, around the houses at Sachs Harbour between July 29 and 31 (the Eskimos had left ten days previously), and there were a few near there and along the ridge toward Cape Kellett when we returned in mid-September, although the Eskimos had shot about six near the houses on their return the day before. Porsild (1949, p. 20) also saw several hares near the then unoccupied houses at Sachs Harbour on 30 July 1949. On the north coast, the first hare was seen about 15 miles east of Antler Cove on August 18. On the east side of Castel Bay hares were fairly plentiful, and in 60 hours walking between August 20 and 28 about 30 were seen in spite of camouflaging snow on most days. On our way overland to Storkerson Bay and Sachs Harbour we saw a few hare tracks along the Muskox River but none after leaving it.

In 1953 one or two hares were occasionally seen between May 15 and June 24 near Cape Kellett and along the mud cliff towards Mary Sachs. At the end of June two or three could usually be seen in an hour's walk along the ridge behind Sachs Harbour. None was seen on our walk up the west coast from Sachs Harbour to the Bernard River (June 28-July 9). One was seen about ten miles up on the north side of the Bernard River on July 9, and two along the Muskox River on July 14. At Mahogany Point (July 20-August 2) hares appeared a little less plentiful than in the preceding autumn, probably because at this season they were more scattered. Two were seen in about two hours spent at Gyr Falcon Bluff on August 11, and two at Cape Vesey Hamilton on August 16. Between August 24 and 27 several tracks were seen in the snow near the entrance to Pim Ravine and along the cliffs bordering the coast to the east. One hare was seen about ten miles west of Parker Point on August 29.



*Breeding season*

The Banks Island hares probably drop their young within a short period in mid-June. Höhn (1953) examined a pregnant female shot by the Eskimos at Sachs Harbour on June 10. The uteri of three lactating females collected on 19 June 1952 were very enlarged; those of three others taken on June 24 and 25 were much smaller. The first young Arctic Hare, NMC 20972, seen was killed on June 22 by the Eskimos at Sachs Harbour. It had a total length of 200 mm. (Table 2) and an inion-incisor length of 41.5 mm. The same measurements for NMC 20977, taken three days later, were 240 mm. and 48.2 mm. A specimen of *L. a. andersoni*, NMC 5993, from Hanbury Lake has an inion-incisor length of about 47 mm., and was apparently about the same age as NMC 20977 when taken on July 5. Possibly that race breeds a little later than *L. a. banksicola*. Armstrong's statement (1857, p. 557) that the Arctic Hare breeds three or four times a year and has eight to ten to a litter is doubtless an error and not based on his own observations on Banks Island. Osborn (1856, p. 219) gives the number in a litter as six or seven.

***Dicrostonyx groenlandicus kilangmiutak* Anderson and Rand.** Varying Lemming.

**Taxonomy.** The Canadian races of *D. groenlandicus* have been described and distinguished primarily on pelage colour, skull differences being referred to only in general terms unsupported by comparative figures. A systematic study of the large collections of skulls now available from different parts of the Arctic (about 115 from Banks Island alone) is badly needed but it would be a major undertaking, and beyond the scope of the present paper.

On the basis of the small collection then available, Anderson and Rand (1945) referred the Banks Island population to *D. g. kilangmiutak*, the type region of which is De Haven Point, at the extreme southeast of Victoria Island. Our new Banks Island series clearly supports this classification, and shows the range of colour variation in a large series from a comparatively isolated population of that race. An adult taken on the east side of Banks Island on May 30 still has a little winter hair, but another, taken at the same place five days earlier is a good match for the June skins. There is considerable individual variation, but in series the chestnut hair<sup>1</sup> about the shoulders and flanks of the July skins is less bright and less abundant than in the June skins, presumably because of wear and fading. Possibly the unusually red July skins are those of young animals which have only recently attained their adult pelage, whereas some of the less chestnut June skins are of young animals still lacking full adult pelage. By August, the chestnut is still further reduced. Three September skins from Banks Island are in poor condition, and are unsuitable for close comparison, but they are certainly much more uniformly brown than summer skins, and have little or no chestnut on the shoulders.

There is no seasonal variation in the colour of the subadults over the period, May 30 to August 26, for which Banks Island specimens are available. There is some individual difference irrespective of age in the concentration of tawny

<sup>1</sup>This hair is closely matched by the Chestnut of Ridgway (1912), with a tendency towards Burnt Sienna or Mahogany Red in some concentrations and directions of light. In the more worn skins it tends to Sanford's Brown.



**Table 15.** Summer and autumn skins of *D. g. kilangmiutak* from Banks Island in the National Museum collection. Adults and subadults were separated by pelage.

| Place                                                                | Date       | Adults | Subadults |
|----------------------------------------------------------------------|------------|--------|-----------|
| E. Banks Id. (Prince of Wales Str.)                                  | May 25-30  | 2      | —         |
| SW. Banks Id. (Sachs Har.)                                           | May 30     | —      | 1         |
| SW. Banks Id. (Sachs Har., near C. Kellett)                          | June 6-30  | 33     | 5         |
| SW. Banks Id. (Sachs Har.)                                           | July 3-12  | 10     | —         |
| SW. Banks Id. (near C. Kellett)                                      | Sept. 5-8  | 3      | —         |
| S. Banks Id. (Masik R. valley)                                       | June 18    | 1      | —         |
| N. Banks Id. (Mahogany Pt., (Castel B.))                             | July 20-30 | 9      | 3         |
| N. Banks Id. (Mahogany Pt. (Castel B.),<br>Mercy B., near Rodd Head) | Aug. 2-26  | 8      | 21        |

tones. A few are almost pure grey on the back posterior to the shoulders; in others, there is sufficient Ochraceous-Tawny to give a general Drab appearance to the back.

The adult specimens from southwest Banks Island taken in July closely match comparable skins from the north of the island, and there appears to be no geographical variation in pelage colour within the confines of the island. Moreover, the type of *D. g. kilangmiutak*, although taken in late summer (July 28) nearly 500 miles southeast of Banks Island, falls well toward the chestnut end of the Banks Island series. Two other July<sup>1</sup> adults from Taylor Island (near De Haven Point) are a good match for comparable Banks Island specimens. This is also true for an adult from Armstrong Point (June 4), northwestern Victoria Island, and for three summer adults from the mainland coast south of Victoria Island. Four other west Victoria Island specimens, made up after preservation in alcohol, clearly show the reddening effect of this treatment and emphasize the necessity of recording this or other unusual preserving processes on the label.

Two immatures from the type locality and one from Taylor Island nearby match the centre of the Banks Island immature series. One Armstrong Point specimen, two from Coppermine, and one from Bernard Harbour, Coronation Gulf, match the Drab end. However, four very young ones, probably from one litter, taken on July 4 at Bernard Harbour, are distinctly darker, more brown, than any of the Banks Island series.

The new Banks Island collections, together with a few new specimens from near the mouth of the Mackenzie River, help to confirm the supposition (Anderson and Rand, 1945) that this river forms the boundary between *D. g. kilangmiutak* and *D. g. rubricatus*. Thus, the immature from Herschel Island, taken on July 28 and tentatively referred to *D. g. rubricatus* by Anderson and Rand (1945), is much browner than any of the Banks Island series, and an adult taken there by Macpherson on 17 August 1952 is distinctly more chestnut than comparable Banks Island specimens. The single July Aklavik<sup>2</sup> adult referred

<sup>1</sup>Another, labelled "October 10", is very similar.

<sup>2</sup>Labelled "Aklavik, July 1938, from Eskimo". There are probably no lemmings in the immediate vicinity of the settlement.



to *D. g. kilangmiutak* by Anderson and Rand (1945) is a good match for comparable Banks Island specimens. One mid-September skin from Tuktoyaktuk and one from Richards Island, near the centre of the mouth of the Mackenzie River, match three comparable skins from farther east (Baillie Island, Holman Island post, Taylor Island), but four others from Tuktoyaktuk and Richards Island are browner and may be tending toward *D. g. rubricatus*. However, only one of them is definitely browner than the single Cape Bathurst skin. They cannot be satisfactorily compared with the three poorly preserved September Banks Island skins and one equally poor, August 30, Dolphin and Union Strait skin, though there do not seem to be any large differences.

The new Banks Island material does not help to place the two inland immature specimens, one from Clinton-Colden Lake and one from Sifton Lake, tentatively referred to *D. g. kilangmiutak* by Anderson and Rand (1945), and the presumed southern boundary of that race therefore still rests on Allen's identification of three Aylmer Lake specimens as intermediate between *D. g. richardsoni* and *D. g. rubricatus* (Anderson and Rand, 1945). Specimens from Perry River, on the mainland coast immediately south of the type locality of *D. g. kilangmiutak*, have been referred to that race (Hanson *et al.*, 1956), but its eastern boundary is unknown. The flat skin, NMC 19991, of an adult obtained from the Eskimos at Wager Bay, is distinctly chestnut on the shoulders, and, although not typical of *D. g. kilangmiutak*, appears closer to it than material from northern Foxe Basin (Piling and Igloodik), southern Melville Peninsula (Repulse Bay), and west Hudson Bay (Chesterfield and Baker Lake) which is tentatively referred to *D. g. lentus*. Baker Lake specimens are a little browner than more northern specimens of *D. g. lentus*, and thus show some gradation towards *D. g. richardsoni* (cf. Manning, 1948), but it is difficult to tell whether the brown (or chestnut) on the shoulders is due entirely to this relationship or partly to intergradation with *D. g. kilangmiutak*.

Anderson and Rand (1945) referred two Queen Elizabeth Islands specimens (Borden Island, Melville Island) to *D. g. kilangmiutak*. Since then, Handley (1953) has described a new race, *D. g. clarus*, from the western Queen Elizabeth Islands. A comparison of the present Banks Island series with the large collection of topotypes of *D. g. clarus* taken at Mould Bay, Prince Patrick Island, by S. D. MacDonald, clearly shows the differences between the two populations. Eleven adults, taken between June 26 and August 31 at Mould Bay, have distinctly less chestnut on the shoulders, flanks, and backs than comparable Banks Island specimens. They also average whiter (less chestnut and less grey) faces and paler underparts, so that if care is taken to match individuals comparable for age and season, almost all specimens in a mixed series could be separated. Nevertheless, there is enough chestnut on the Prince Patrick Island lemmings to show their relationship to the Banks Island population, and it is interesting to note that seven Ellesmere Island specimens, taken between July 1 and July 13, have at least an equal amount of chestnut colouring, thus showing that, in this character at least, the Queen Elizabeth Islands population is homogeneous and has a western origin.

The backs of 13 immatures from Mould Bay, taken between May 28 and September 1, are similar to comparable Banks Island specimens. Eight young from Parr Bay, Ellesmere Island, taken between July 1 and July 5, average a little paler, but they may well be a closely related group. The lower flanks and



underparts of the Mould Bay subadult series average distinctly paler than comparable Banks Island specimens. The Parr Bay series are uniformly paler. September skins from Mould Bay average a little paler, less brown, than comparable *D. g. kilangmiutak* specimens, although one taken on October 10 is almost as brown as the average of the six Tuktoyaktuk and Richards Island skins.

It seems best (cf. Bee and Hall, 1956) to await further evidence before following Rausch (1953) in classifying *D. groenlandicus* and *D. torquatus* as a single species.

#### *Previous records and field observations*

Varying Lemming were evidently abundant at Mercy Bay, at least at some period while M'Clure's party was there (September 1851 to May 1853). Armstrong (1857, pp. 557-8) says, "... I have frequently known them to eat each other. They generally bring forth from two to six at a birth; in a few instances as many as eight or nine. The flesh is delicate and tender, and was gladly eaten when it could be procured." Domville (1855, p. 677), apparently speaking of northern Banks Island, says that lemming were found in great numbers, both on the shore and on the floe during late May (1853) when the thaw water inundated their holes and sometimes drowned them; they were very pugnacious when cornered. In 1949 Porsild (1950, p. 54) noted an abundance of lemming burrows on Banks Island, but saw Varying Lemming only on a strand flat about 20 miles south of Russell Point.

On 2 September 1951 two lemming of unidentified species were seen on the surface during some twenty hours of walking at De Salis Bay, but 12 traps left out for about six hours on the same day were unproductive, and only one lemming, *D. groenlandicus*, was obtained from about 25 burrows which were dug out. This large number of apparently recently made but unoccupied burrows, together with the abundance of Snowy Owls, indicated that lemming had been numerous early in the summer but were rapidly decreasing. In 1952 we saw no lemming tracks in the snow at De Salis Bay, and 536 trap nights between June 2 and July 2 were completely unproductive although the traps were set in the most likely places over an area of about four square miles. The bait was usually raisins, which we had previously found to be most successful with lemmings; a few traps were baited with a mixture of raisins and bacon fat. We set five traps at the entrance to burrows near our camp on June 17 and 18 in the Masik River valley, and five in another suitable area just north of the Nelson River valley on June 27, but again none was touched. However, on June 18 we caught one lemming by hand amongst dwarf willow in the Masik River valley. Two sets of lemming tracks were seen in the snow between Castel and Mercy bays on August 21, and another group was observed near our camp the following day. Traps were set near the latter tracks and elsewhere near our camp, but in 125 trap nights none of the bait was touched. A few lemming tracks were seen on our walk from Castel Bay to Sachs Harbour, September 2 to 15, and we thought that the cycle was probably on the up-swing.

During the winter of 1952-3 the Varying Lemming evidently increased more evenly over Banks Island than did the Brown Lemming. On 6 June 1953 about ten were seen in five hours walking over the peaty tundra of the



**Table 16.** Trap nights in 1953. Traps were baited with raisins and usually set near lemming burrows which had either been recently dug or showed other signs of occupation.

| <i>Place</i>                | <i>Date</i>    | <i>No. of trap nights</i> |
|-----------------------------|----------------|---------------------------|
| Cape Kellett                | June 7-20      | 30 (approx.)              |
| Near mouth of Kellett River | June 10-17     | 200 (approx.)             |
| Sachs Harbour               | June 24-8      | 150 (approx.)             |
| Mahogany Point (Castel Bay) | July 20-Aug. 2 | 290                       |
| Investigator Point          | Aug. 5-8       | 20                        |
| Back Point                  | Aug. 17-21     | 44                        |
| Pim Ravine                  | Aug. 26-8      | 30                        |

Kellett River valley. The land was then a quarter bare. When the same area was visited on June 10 they seemed scarcer, perhaps because the thaw water had forced them to move to dryer ground. However, between that date and June 17, 16 (about .08 per trap night) were trapped and one (.03 per trap night) was taken at Cape Kellett between June 7 and 20. At Sachs Harbour we caught 21 between June 24 and 28 (.14 per trap night), but some of the trapping was done by Eskimo children, who took great care to find burrows which were definitely occupied. About five Varying Lemming were seen on our walk to the Thomsen River between June 28 and July 15. There were also a fair number of recently dug holes in some places. Thirteen Varying Lemming (.04 per trap night) were trapped at Mahogany Point between July 20 and August 2; six (.20 per trap night) at Investigator Point between August 5 and 8; seven (.16 per trap night) at Back Point between August 17 and 20; and 12 (.40 per trap night) near Rodd Head (Pim Ravine) between August 26 and 28.

#### *Aberrant colouration*

A female Varying Lemming (NMC 20645, total length, 138 mm.) taken at Mahogany Point on July 30 lacks all black pigment, even the irides were brown. The usual chestnut of the shoulders, ears, and flanks is distinctly paler and resembles Sanford's Brown, and the black on the tips of the dorsal fur is replaced by the same colour. The under fur is also much paler, being Light Mouse Gray rather than Dark Mouse Gray. Five days earlier the same or a similar lemming had been seen about a quarter mile distant from where this was taken.

#### *Breeding data*

Five female Varying Lemming taken at Cape Kellett and Sachs Harbour between June 10 and 26 were pregnant and contained 7, 7, 8, 6, and 5 embryos respectively. One of these females also had degenerating mammary tissue (cf. Manning, 1954, p. 44). Only one female taken on the north coast was pregnant (five embryos), but three young dug from their burrow on August 6 still had their eyes closed, and four dug from another burrow the day before were not much older. The mothers of both litters showed no evidence of a new pregnancy.



*Sex ratios*

The sex ratio of Varying Lemmings collected by Manning and by Höhn on southern Banks Island between 6 June and 16 July 1953 was  $53.0 \pm 6.1$  per cent male (66 specimens), and of those collected on northern Banks Island by Manning between July 5 and August 28,  $36.8 \pm 6.4$  per cent male (57 specimens). The figures given previously by Manning (1954, p. 45) for these two areas were incorrect, as 26 specimens, of which 21 were female, had been mislaid. The new figures, like the old, do not differ significantly from 50 per cent male, the new adjusted chi-squares being respectively 0.1 and 3.4. When the corrections mentioned above are made to Table 6 of Manning (1954), the total of feral specimens from various parts of arctic Canada is increased to 462, with a sex ratio of  $48.3 \pm 2.3$  per cent male. This still does not differ significantly from 50 per cent male.

***Lemmus trimucronatus phaiiocephalus*, new subspecies.** Brown Lemming.

**Type.** NMC 20705. Pregnant female (four embryos). Collected by T. H. Manning at Mahogany Point, Castel Bay, north coast of Banks Island, on 29 July 1953. Skin and skull in good condition. Skin recorded as prime by collector.

**Measurements of type in millimetres.** Total length, 150; tail, 14; hind foot, 20; condylobasal length, 32.4; braincase breadth<sup>1</sup>, 10.5. (Age index, 97°).

**Range.** Banks Island and Victoria Island.

**Diagnosis. Adults in summer pelage.** Head and shoulders much greyer, less brown, than *L. t. trimucronatus*. Non-black hairs on forehead typically Pale Olive-Beff, occasionally some Deep Olive-Beff, changing on shoulders and upper back to Dark Olive-Beff and Buckthorn Brown. Centre of rump patch between Chestnut and Burnt Sienna, at least as bright, possibly brighter, than mainland specimens of *L. t. trimucronatus*, definitely brighter than Baffin Island material. Division between Chestnut rump and grey forward half of back sharper, and contrast greater than in *L. t. trimucronatus*. Top of feet paler, hair brown to Fuscous rather than Fuscous to Fuscous-Black. **Subadults in summer pelage.** Non-black hairs of head and shoulders averaging paler than in *L. t. trimucronatus*, but difference less obvious than in adults. Hair around the eyes greyer, less buffy. Underparts and sides of face and body paler, more grey, less buff and tawny. Contrast

<sup>1</sup>Measured as in Bee and Hall (1956) between the supratympanic fenestrae.

**Table 17.** Comparison of body measurements of adult *L. trimucronatus*.

| Race                        | No.         | Total length    | Tail         | Hind foot    |
|-----------------------------|-------------|-----------------|--------------|--------------|
| <i>L. t. phaiiocephalus</i> | 6 ♂♂, 10 ♀♀ | 137.9 (120–152) | 14.4 (13–15) | 20.3 (18–22) |
| <i>L. t. trimucronatus</i>  | 5 ♂♂, 4 ♀♀  | 138.1 (126–150) | 17.6 (14–24) | 20.4 (19–22) |

All specimens were measured by us. The specimens of *L. t. phaiiocephalus* are from Banks Island; those of *L. t. trimucronatus* are from the eastern part of Keewatin, south of Chesterfield Inlet.



Table 18. Condylobasal length of adult *L. trimucronatus*.

| Race                                              | No.             | Range     | Mean $\pm$ SE    | SD $\pm$ SE     | CV $\pm$ SE    |
|---------------------------------------------------|-----------------|-----------|------------------|-----------------|----------------|
| <i>L. t. phaioccephalus</i><br>(Banks Id.)        | 6 ♂♂            | 27.8-32.3 | 30.17 $\pm$ .647 | 1.59 $\pm$ .458 | 5.3 $\pm$ 1.52 |
|                                                   | 11 ♀♀           | 29.3-34.0 | 31.64 $\pm$ .447 | 1.48 $\pm$ .316 | 4.7 $\pm$ 1.00 |
|                                                   | 6 ♂♂, 11 ♀♀     | 27.8-34.0 | 31.12 $\pm$ .397 | 1.64 $\pm$ .281 | 5.3 $\pm$ 0.90 |
| <i>L. t. phaioccephalus</i><br>(SE. Victoria Id.) | 9 ♂♂            | 28.5-34.4 | 31.83 $\pm$ .699 | 2.10 $\pm$ .494 | 6.6 $\pm$ 1.55 |
|                                                   | 8 ♀♀            | 31.5-35.0 | 32.58 $\pm$ .428 | 1.21 $\pm$ .302 | 3.7 $\pm$ 0.93 |
|                                                   | 9 ♂♂, 8 ♀♀, 1 ? | 28.5-35.0 | 32.16 $\pm$ .396 | 1.68 $\pm$ .280 | 5.2 $\pm$ 0.87 |
| <i>L. t. trimucronatus</i>                        | 9 ♂♂            | 28.5-33.6 | 30.38 $\pm$ .514 | 1.54 $\pm$ .363 | 5.1 $\pm$ 1.20 |
|                                                   | 8 ♀♀            | 28.4-32.2 | 29.50 $\pm$ .440 | 1.24 $\pm$ .311 | 4.2 $\pm$ 1.05 |
|                                                   | 9 ♂♂, 8 ♀♀, 1 ? | 28.4-33.6 | 29.88 $\pm$ .339 | 1.44 $\pm$ .240 | 4.8 $\pm$ 0.80 |

Fig. 11. Condylobasal length of adult *L. trimucronatus*: see figures given in Table 18.

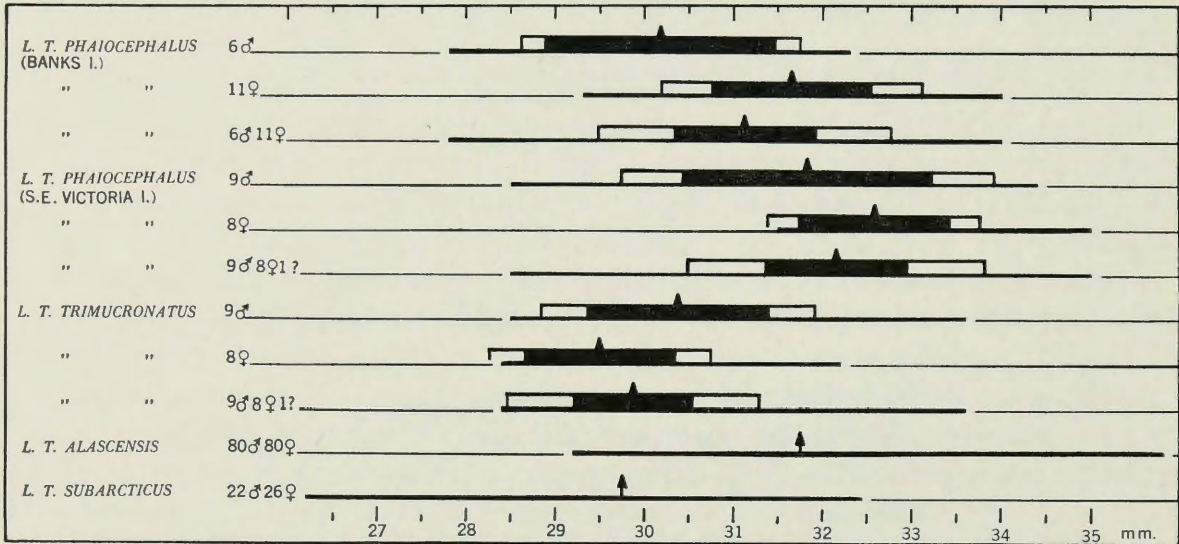


Table 19. Age index of adult *L. trimucronatus*.

| Race                                              | No.             | Range  | Mean $\pm$ SE     | SD $\pm$ SE     | CV $\pm$ SE   |
|---------------------------------------------------|-----------------|--------|-------------------|-----------------|---------------|
| <i>L. t. phaioccephalus</i><br>(Banks Id.)        | 6 ♂♂            | 90-96  | 92.50 $\pm$ 0.885 | 2.17 $\pm$ .626 | 2.3 $\pm$ .68 |
|                                                   | 11 ♀♀           | 90-98  | 94.36 $\pm$ 0.650 | 2.16 $\pm$ .460 | 2.3 $\pm$ .49 |
|                                                   | 6 ♂♂, 11 ♀♀     | 90-98  | 93.71 $\pm$ 0.554 | 2.29 $\pm$ .392 | 2.4 $\pm$ .42 |
| <i>L. t. phaioccephalus</i><br>(SE. Victoria Id.) | 9 ♂♂            | 91-101 | 95.33 $\pm$ 1.155 | 3.46 $\pm$ .816 | 3.6 $\pm$ .86 |
|                                                   | 8 ♀♀            | 92-98  | 95.63 $\pm$ 0.731 | 2.07 $\pm$ .517 | 2.2 $\pm$ .54 |
|                                                   | 9 ♂♂, 8 ♀♀, 1 ? | 91-101 | 95.44 $\pm$ 0.643 | 2.73 $\pm$ .455 | 2.9 $\pm$ .48 |
| <i>L. t. trimucronatus</i>                        | 9 ♂♂            | 92-100 | 94.67 $\pm$ 0.913 | 2.74 $\pm$ .645 | 2.9 $\pm$ .68 |
|                                                   | 8 ♀♀            | 91-96  | 93.25 $\pm$ 0.526 | 1.49 $\pm$ .372 | 1.6 $\pm$ .40 |
|                                                   | 9 ♂♂, 8 ♀♀, 1 ? | 91-100 | 93.94 $\pm$ 0.527 | 2.24 $\pm$ .373 | 2.4 $\pm$ .40 |

greater between posterior and anterior dorsum. Feet as in adults. **Adults in winter pelage.** Non-black hairs of head and upper part of back greyer, less buffy than in *L. t. trimucronatus*. **Measurements.** Total length and hind foot length similar to *L. t. trimucronatus*. Tail possibly shorter (Table 17). Condylobasal length (Table 18, Fig. 11) and braincase breadth (Table 20, Fig. 13) probably greater.



Fig. 12. Age index of adult *L. trimucronatus*: see figures given in Table 19.

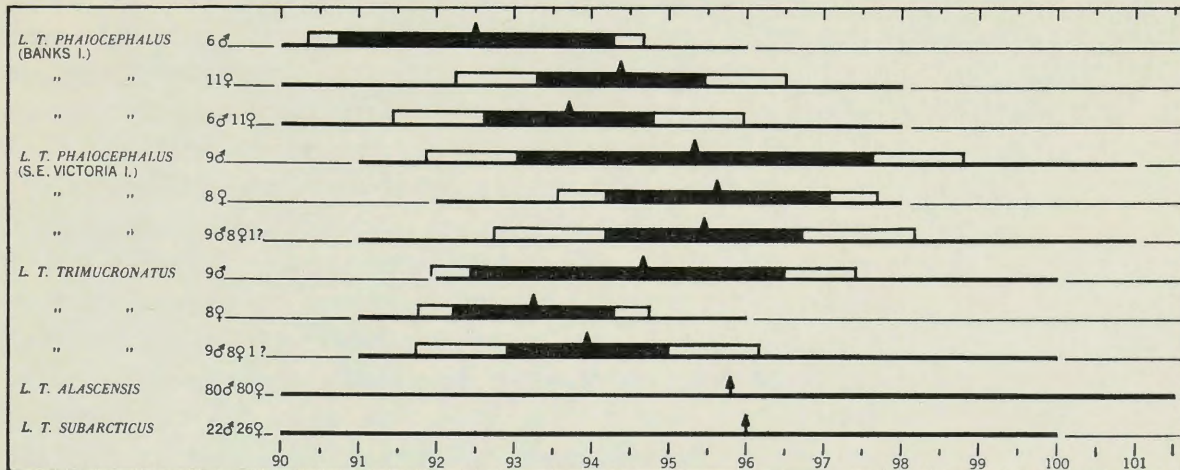
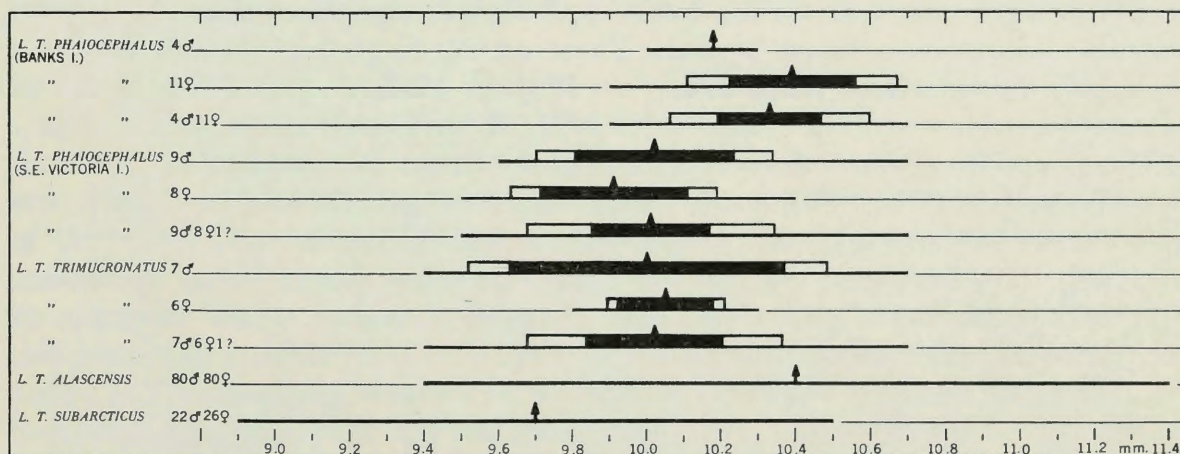


Table 20. Braincase breadth of adult *L. trimucronatus*.

| Race                                              | No.             | Range     | Mean $\pm$ SE    | SD $\pm$ SE    | CV $\pm$ SE    |
|---------------------------------------------------|-----------------|-----------|------------------|----------------|----------------|
| <i>L. t. phaiiocephalus</i><br>(Banks Id.)        | 4 ♂♂            | 10.0-10.3 | 10.18 $\pm$ .076 | .15 $\pm$ .054 | 1.5 $\pm$ 0.53 |
|                                                   | 11 ♀♀           | 9.9-10.7  | 10.39 $\pm$ .086 | .29 $\pm$ .061 | 2.7 $\pm$ 0.58 |
|                                                   | 4 ♂♂, 11 ♀♀     | 9.9-10.7  | 10.33 $\pm$ .069 | .27 $\pm$ .049 | 2.6 $\pm$ 0.48 |
| <i>L. t. phaiiocephalus</i><br>(SE. Victoria Id.) | 9 ♂♂            | 9.6-10.7  | 10.02 $\pm$ .107 | .32 $\pm$ .075 | 3.2 $\pm$ 0.75 |
|                                                   | 8 ♀♀            | 9.5-10.4  | 9.91 $\pm$ .099  | .28 $\pm$ .070 | 2.8 $\pm$ 0.71 |
|                                                   | 9 ♂♂, 8 ♀♀, 1 ? | 9.5-10.7  | 10.01 $\pm$ .079 | .34 $\pm$ .056 | 3.4 $\pm$ 0.56 |
| <i>L. t. trimucronatus</i>                        | 7 ♂♂            | 9.4-10.7  | 10.00 $\pm$ .184 | .49 $\pm$ .130 | 4.9 $\pm$ 1.30 |
|                                                   | 6 ♀♀            | 9.8-10.3  | 10.05 $\pm$ .066 | .16 $\pm$ .047 | 1.6 $\pm$ 0.46 |
|                                                   | 7 ♂♂, 6 ♀♀, 1 ? | 9.4-10.7  | 10.02 $\pm$ .093 | .35 $\pm$ .066 | 3.5 $\pm$ 0.65 |

Fig. 13. Braincase breadth of adult *L. trimucronatus*: see figures given in Table 20.



**Comparison of skins of adults.** No topotypes of *L. t. trimucronatus* have been seen, but 14 adults from Marble Island and Mistake Bay, taken between October 1 and 4 and still in summer pelage, are a good match for two June specimens from Bernard Harbour on the south side of Dolphin and Union Strait and one June specimen from Port Epworth, Coronation Gulf. Also matching the Hudson Bay and arctic coast material are four adult or



near adult August specimens from the mouth of the Dubawnt River, two August specimens from Yathkyed Lake, three August specimens from Baker Lake, six specimens (spring, August, and September) from Chesterfield Inlet, and three September specimens from Southampton Island. It therefore appears that the pelage characters of *L. t. trimucronatus* are constant across the mainland, at least from Dolphin and Union Strait to Hudson Bay. The only comparable skins that differ appreciably are two taken on August 15 at Victory Lake, about 80 miles west of Tavani, and one taken on July 26 at Tavani on the Hudson Bay coast. The two Victory Lake skins are rather worn, and their generally darker appearance may be caused by this. The non-black hair about the head of the Tavani specimen, NMC 10995, and of one, NMC 18865, of those from Victory Lake is less buffy than in the Marble Island-Mistake Bay series.

Seven cased skins from Cape Bathurst, southwest of Banks Island, are labelled winter 1912-13, but only three are in winter pelage. The non-black hair on the head and shoulders of the other four averages darker, more Ochraceous-Tawny, than specimens from farther east. The Cape Bathurst skins and one of the two cased skins from Tuktoyaktuk were examined and referred to *L. t. trimucronatus* by Bee and Hall (1956). Previously, Cape Bathurst had been considered within the range of *L. t. alascensis* (Davis, 1944; Anderson, 1946; Hall and Cockrum, 1953). Sufficient Alaskan material is not available to confirm the conclusions of Bee and Hall (1956) on this matter. Two skins from Herschel Island and one from Richards Island, at the mouth of the Mackenzie, are a little darker on the head and shoulders than the four Cape Bathurst skins in summer pelage, and are therefore tentatively referred to *L. t. subarcticus*.

The 15 adults taken at Mahogany Point between 22 July and 2 August 1953, are very uniform in the diagnostic characters, although the series is made up of unprime (NMC 20701: flesh side of skin almost all dark with obviously growing hair on the back) and completely prime skins. Most are prime. The female taken at Back Point on 21 August 1953, and the male collected in the Masik River valley on 27 June 1952, do not differ from this series. A rather shabby skin, NMC 2977, from Cape Kellett, taken 6 July 1915, is apparently the only specimen from Banks Island prior to 1952. It closely matches the Mahogany Point series in greyness of the head and shoulders, but has a paler rump. NMC 20690, taken 12 June 1952, at De Salis Bay, has more buff on the head than other Banks Island specimens, but still it is greyer about the eyes than all mainland adults referable to *L. t. trimucronatus* except the Tavani skin and NMC 18865 from Victory Lake.

The date of capture of the only Banks Island winter specimen, NMC 21203, is unknown. It is much greyer, less buffy, on the head and shoulders, and rather paler on the rump than three winter Cape Bathurst and two Tuktoyaktuk specimens, also of unknown date, but less distinct from the National Museum's large late October east Baffin Island series, a few of which closely match it.

Eight July, August, and September adults from southeast Victoria Island (Cape Adelaide, De Haven Point, Taylor Island), referred to *L. t. phaeocephalus*, are more variable than the Banks Island series and average rather less grey, more buff.



The National Museum's large Baffin Island series is definitely referable to *L. t. trimucronatus* rather than to *L. t. phaioccephalus*, although it averages slightly less buffy on the head and shoulders than the mainland series. The rumps of specimens from Baffin Island average duller than either Banks Island or mainland material. Closely matching the Baffin Island series are one adult from Igloolik Island and three smaller specimens from the nearby Abverdjar Island off northeastern Melville Peninsula.

Tentatively referred to *L. t. trimucronatus* are 19 specimens (six nestlings, seven subadults, six adults) taken by Macpherson between 5 June and 17 September 1956, at Pelly Bay. These resemble the Baffin series in having reduced and duller rump patches.

**Comparison of skins of subadults.** Variation in subadult pelage is considerable (cf. Bee and Hall, 1956), and makes satisfactory subspecific identification difficult. The five Banks Island specimens, taken on the north coast between July 24 and August 19, are in dull, rather worn, probably subadult pelage. For comparison, there are 14 specimens in similar pelage from the District of Keewatin south of Chesterfield Inlet and one from the eastern District of Mackenzie (Clinton-Colden Lake). The sides and underparts of the Banks Island series are paler, greyer, less tawny than this mainland series (no exceptions). The non-black hairs of the head, particularly around the eyes, are greyer, less buff and tawny (one Chesterfield specimen excepted). There is more contrast between the rump and shoulders (two Chesterfield specimens excepted). The colour of the heads and shoulders of Baffin Island subadults is intermediate between that of the mainland and the Banks Island series, but, as with the adults, the rump patch is reduced and duller.

**Comparison of body measurements.** Body measurements of small mammals taken in the field must be used with caution (cf. Manning, 1956b). The short tail of a lemming is particularly difficult to measure precisely, and the difference between the tail lengths of the two races in Table 17 could result from a slight change in method of measurement over the years between 1945 and 1953.

**Comparison of skulls.** Bee and Hall (1956, p. 112) have suggested that skulls of *L. trimucronatus* may be aged by an angle obtained in the following manner: "Place the skull (minus lower jaw) on a horizontal surface in such a position that the skull rests on the tips of the incisors and ventral surfaces of the tympanic bullae. Project a vertical line through the highest elevated central part of the parietal bone. Project a second line anteriorly from this point to the top of a frontal tubercle. Ascertain the inferior angle between this second line and the vertical line. The angle is more than 90 degrees in adults and less than 90 degrees in younger individuals." They do not, however, say how the angle was actually measured. For the present paper, it was obtained by placing the skull on its side with the tympanic bullae and tips of the incisors against a flat surface, and measuring the angle to the nearest degree through a 6-power binocular microscope against a background of a paper protractor. The dorsal surface of the skull of most microtinae and, indeed, of many other mammals, flattens with age. But unfortunately for the efficiency of the above age index, the size of the angle obtained depends more on the length of the incisors than on the flattening of the skull, and it is possible that a direct measurement of incisor length would be as satisfactory.



**Table 21.** Results of covariance analysis of *L. trimucronatus*. Independent variate: condylobasal length.

| <i>Dependent<br/>variate Y</i> | <i>Race</i>                 | <i>Age</i>   | <i>No.</i> | <i>Adjusted<br/>mean Y</i> | <i>Correlation<br/>coefficient (r)</i> | <i>Regression<br/>coefficient</i> | <i>F (Slope<br/>diff.)</i> | <i>F (Position<br/>diff.)</i> |
|--------------------------------|-----------------------------|--------------|------------|----------------------------|----------------------------------------|-----------------------------------|----------------------------|-------------------------------|
| Braincase breadth              | <i>L. t. phaiiocephalus</i> | Ad.          | 15         | 10.20±.09                  | .50                                    | 0.09±.04                          | 0.11                       | 3.06                          |
|                                | <i>L. t. trimucronatus</i>  | Ad.          | 14         | 10.03±.08                  | .32                                    | 0.10±.03                          |                            |                               |
|                                | <i>L. t. phaiiocephalus</i> | Ad. + subad. | 19         | 10.27±.07                  | .57                                    | 0.05±.02                          | 0.97                       | 3.58                          |
|                                | <i>L. t. trimucronatus</i>  | Ad. + subad. | 22         | 10.09±.07                  | .42                                    | 0.06±.02                          |                            |                               |
| Age index                      | <i>L. t. phaiiocephalus</i> | Ad.          | 17         | 92.43±.38                  | .77                                    | 1.07±.23                          | 0.20                       | 9.70**                        |
|                                | <i>L. t. trimucronatus</i>  | Ad.          | 18         | 94.08±.33                  | .78                                    | 1.14±.16                          |                            |                               |
|                                | <i>L. t. phaiiocephalus</i> | Ad. + subad. | 21         | 92.07±.33                  | .79                                    | 1.22±.24                          | 5.86*                      | 4.21*                         |
|                                | <i>L. t. trimucronatus</i>  | Ad. + subad. | 26         | 92.58±.41                  | .91                                    | 1.33±.14                          |                            |                               |
|                                |                             |              |            |                            | .89                                    | 1.93±.20                          |                            |                               |

The correlation and regression coefficients on the lines between races are for single lines of the combined series except in the case of age index of adults, when there is a positional difference of the regression lines and the coefficients are therefore those for parallel lines. In this case the means of the dependent variates were adjusted along the parallel lines, and the formula used for calculating their standard errors is given under Table 13. The same formula, adapted to a single line, was used for calculating the errors of the adjusted means when braincase breadth was the dependent variate. The *L. t. phaiiocephalus* series is made up of Banks Island specimens only.



A more serious objection is that the size of the angle is closely correlated with condylobasal length (see Table 21) and presumably other skull measurements, so that some arbitrary point on any measurement that increases rapidly with age could be used with equal justification. Naturally the separation of 'young' and 'adults' at the age index of  $90^\circ$  means that the distribution of any measurement correlated with the age index is dissected and the distribution of the two halves is likely to be skewed. Nevertheless, for the sake of conformity, Bee and Hall (1956) have been followed and a  $90^\circ$  age index has been used to separate 'adults' and 'subadults'. Some skewness is apparent, but it does not seem excessive, and formal tests and corrections did not appear worth while.

The Banks Island skull series was collected between June 12 and August 21; the mainland series between May 25 and October 4; and the Victoria Island series between July 7 and September 1. They are therefore all summer (in the broad sense) specimens, and the variation in skull size and shape with season which Bee and Hall (1956) observed in *Microtus oeconomus* and Manning (1956b) in *Clethrionomys rutilus*, and which probably affects most microtinae, should not cause differences between the groups. However, there is still a possibility that other factors, such as the stage in the population cycle (cf. Manning, 1956b), may have an effect. Therefore, before differences in skull measurements can be considered genetic, a thorough study of the species is needed, preferably with a large series taken in different years and at different seasons at one place. As such a study is beyond the scope of this paper only two linear and one angular skull measurements are discussed.

Figures 11-13 show that there is no significant difference between the sexes for the three measurements considered. Bee and Hall (1956, p. 95), dealing with 62 'adult' males and the same number of females, found that the males had a 1.3 per cent greater condylobasal length and a 0.5 per cent greater braincase breadth. These differences are small, and also probably not significant. For the present study, the sexes may therefore be considered together. The Banks Island series is significantly larger ( $F = 5.63$ ,  $P < .05$ ) in condylobasal length than the mainland series, and the Victoria Island series averages a little larger still. In braincase breadth also the Banks Island series is significantly larger ( $F = 7.46$ ,  $P < .05$ ) than that from the mainland, but surprisingly the southeast Victoria Island series agrees with that of the mainland. As pointed out by Bee and Hall (1956, pp. 110-11), differences in braincase breadth between two series of specimens is a good indication of a real difference in the two populations, as this measurement varies little with age (see Table 21).

Covariance analysis was used to test the difference in slope and position of the regression lines for braincase breadth and age index (which may be treated as any other measurement) on condylobasal length. The results are given in Table 21. There is no significant difference for slope or position in braincase breadth, either in the whole series or for those specimens with an age index of  $90^\circ$  or above. Differences in the age index suggest that for a given condylobasal length *L. t. trimucronatus* has longer incisors than *L. t. phaioccephalus*. The increase in the regression coefficients when specimens with an age index of less than  $90^\circ$  are included may be caused by more rapid growth of the teeth, relative to condylobasal length, in young animals, and the difference



in slope between the two races when all specimens are used may in part be the result of a larger number of young being included in the *L. t. trimucronatus* series. No test has been made of the Victoria Island series, but a scatter diagram clearly indicates agreement with *L. t. phaioccephalus*.

**Summary.** The characters which distinguish *L. t. phaioccephalus* may be best developed in northern Banks Island, the northern extremity of the known range of the species, but it is probable that the population of the whole island is fairly homogeneous, and the fact that one of the specimens from the south tends towards *L. t. trimucronatus* is probably due to chance. There are no specimens from northern Victoria Island, but presumably it is within the range of typical *L. t. phaioccephalus*. In the extreme southeast of Victoria Island some specimens tend towards *L. t. trimucronatus*. Baffin Island specimens tend slightly towards *L. t. phaioccephalus* in some characters, but it is not clear if this implies a genetic relationship. The rump patch of Baffin Island specimens is, on the average, reduced and less bright than that of those from the mainland and Banks Island. Further investigation might show the Baffin Island population to be subspecifically distinct, but without a good series of topotypical *L. t. trimucronatus* this division appears unwise on rump character alone. The Pelly Bay series resembles that from Baffin Island in reduction and dullness of the rump patch.

#### *Specimens examined*

##### *L. t. phaioccephalus*

**Skins. Banks Island.** Mahogany Point (Castel Bay), 18 (July–Aug.); Providence Point, 1 (Aug.); Back Point, 2 (Aug.); Cape Kellett, 1 (July); Sachs Harbour, 1 (winter); Masik River valley, 1 (June); De Salis Bay, 1 (June). **Victoria Island.** De Haven Point, 6 (July–Aug.); Cape Adelaide, 1 (Aug.); Taylor Island, 3 (Aug.–Sept.).

**Skulls. Banks Island.** Mahogany Point (Castel Bay), 6 ♂♂, 12 ♀♀; Providence Point, 1 ♂; Back Point, 1 ♂, 1 ♀; Masik River valley, 1 ♂; De Salis Bay, 1 ♀. **Victoria Island.** De Haven Point, 7 ♂♂, 13 ♀♀; Taylor Island, 5 ♂♂, 2 ♀♀, 2 sex ?.

##### *L. t. trimucronatus*

**Skins. District of Mackenzie.** Tuktoyaktuk, 2 (winter); Cape Bathurst, 7 (winter ?); Bernard Harbour, 2 (June); Port Epworth, 2 (June); Clinton-Colden Lake, 1 (Aug.). **District of Keewatin.** Pelly Bay, 19 (June–Sept.); Mouth of Dubawnt River, 5 (Aug.); Baker Lake, 3 (Aug.); Chesterfield Inlet, 8 (spring to Sept.); Tavani, 2 (July); Victory Lake, 2 (Aug.); Marble Island, 3 (Oct.); Morso Island, Mistake Bay, 12 (Oct.); Kazan River, 10 (Aug.); Yathkyed Lake, 3 (Aug.); Twin Lake, 1 (Aug.). **Southampton Island,** 3 (Sept.). **Baffin Island,** 138 (spring to late Oct.). **Northwest Foxe Basin,** 4 (June–Sept.).

**Skulls. District of Mackenzie.** Bernard Harbour, 1 ♂; Port Epworth, 1 ♀. **District of Keewatin.** Tibielik Island, Thelon River, 2 ♂♂, 1 ♀; Baker Lake, 1 ♂, 2 ♀♀; Kazan River, 1 ♂, 1 ♀; Chesterfield Inlet, 2 ♀♀, 1 ?; Twin Lake, 1 ♂; Victory Lake, 1 ♂; Marble Island, 1 ♂, 2 ♀♀; Morso Island, Mistake Bay, 5 ♂♂, 7 ♀♀. The Pelly Bay skulls were not cleaned when this study was made.

#### *Field observations*

In 1952 a female Brown Lemming was dug from its hole at De Salis Bay on June 12, and on June 27 a male was captured by hand amongst some low vegetation south of the Masik River (see Varying Lemming for 1953 trap nights).

In 1953 Brown Lemming, although evidently on the increase, were plentiful only locally. None was obtained or seen during the spring and early summer in southwest Banks Island although one (NMC 21203) had been caught by the Eskimos before our arrival. None was seen on our walk north (June 28–July 15), but a few newly dug holes were thought to be those of this species.



Seven males and 13 females (.07 per trap night) were trapped at Mahogany Point. A male was collected by hand at Providence Point on August 9. A male and a female (.05 per trap night) were trapped at Back Point.

Ten out of the 1952-3 catch of 25 Brown Lemmings were males. Five, all from Mahogany Point, of the 15 females collected, were lactating. Two, taken on July 29 and July 31 respectively, contained four embryos each.

***Delphinapterus leucas* (Pallas).** White Whale.

While crossing the Beaufort Sea ice to Banks Island in 1914, Stefansson (1921, pp. 208, 217) saw large numbers of White Whales going northward during the two or three weeks following May 21 when the first school was observed.

On 12 August 1952, when we were near Cape Crozier, a school of 50 to 100 White Whales was seen travelling westward. Later the same day a school of 30 to 50 travelling in the same direction was seen just east of Cape Crozier. On August 23 a school of several hundred passed westward amongst the loose ice off the northeast point of Castel Bay. A few hours earlier the pack had been tightly pressed against this point; it was still pressed against Investigator Point. Manning saw no White Whales in 1953.

White Whales also go into Amundsen Gulf, at least as far west as Holman Island near where the Rev. Roger Buliard shot one about 1 August 1949 (Porsild, 1949, p. 32).

***Balaena mysticetus* Linnaeus.** Bowhead Whale.

The Eskimos who occupied Banks Island some 500 years ago undoubtedly hunted the Bowhead, the bones of which are plentiful in their house ruins on the south coast. At one group of houses about seven miles north of Nelson Head we saw four skulls built into the walls. On 17 August 1851 several [Bowhead] Whales were observed from the *Investigator* going westward between Prince of Wales Strait and Cape Lambton, and on September 19 two others were seen near Colquhoun Point also travelling westward (Armstrong, 1857, pp. 381, 443). Between 1888 and 1912, the Bowhead was hunted commercially in the southern Beaufort Sea and in the western entrance to Amundsen Gulf and its numbers severely reduced (Anderson, 1946, p. 91). During this period, according to Pedersen (1953), many whales were taken between Nelson Head and Cape Kellett, as well as on the west coast of Banks Island when ice conditions would permit. Anderson (1913, p. 498) says that in August whales usually seemed to be going south along the west side of Banks Island and west between Banks Island and Cape Parry, although they were often seen in Franklin Bay until September. Since the end of commercial whaling, Bowheads have probably become slightly more numerous. In 1914 Stefansson (1921, p. 285) found a carcass washed ashore ten to twelve miles southeast of Mary Sachs. On 25 August 1949 Porsild (1950) saw a large Bowhead in Amundsen Gulf while he was flying from De Salis Bay to Walker Bay. In 1951 three or four Bowheads were seen together from the *Cancolim* about 80 miles north-northwest of Tuktoyaktuk. The Banks Island Eskimos usually see a few at the floe near Sachs Harbour in late spring or early summer. In 1953 they saw three on July 4, two on July 19, and two off Cape Lambton on July 29 (Höhn, 1953).



***Canis lupus arctos* Pocock. Wolf.**

**Comparison of skulls.** Skulls of 26 Banks Island wolves, all in the National Museum, have been examined. For reasons which will be explained below they are divided into the 1914-16 series, which consists of eight specimens including the type of *C. l. bernardi*, and the recent 1953-5 series of 16 specimens; the remaining two are old skulls from Eskimo ruins. The main comparative material was ten skulls from Prince Patrick Island, 22 from Ellesmere Island, 24 from northern Alaska, seven from the Coronation Gulf area, and 32 from the more eastern barrens or near barrens. The northern Alaska specimens are grouped as *C. l. tundrarum*, the Coronation Gulf specimens as *C. l. mackenzii*, and the others from the Canadian mainland barrens or near barrens as *C. l. hudsonicus*. The Prince Patrick Island and Ellesmere Island series are considered referable to *C. l. arctos*, but throughout most of the paper they are called the Prince Patrick Island or the Ellesmere Island series or jointly the Queen Elizabeth Islands series. The subspecific names mentioned above for the mainland wolves are used following current practice. This does not imply acceptance of the races, nor does the subsequent grouping together of the mainland series for comparison with those from Banks Island and the Queen Elizabeth Islands mean rejection of them. The matter requires more study, preferably with additional material from the Coppermine area and from northern Keewatin.

For the purposes of the present paper the skulls were divided into adults and subadults according to the formation of the angle of the mandible. In the young this process is smoothly rounded, rather soft, and imperfectly ossified; in the adult it is hard, well ossified, angular, and often pointed. The separation of individuals is subjective, but has given relatively little difficulty. Unfortunately, much of the comparative material examined is undated, and it is not known definitely at what season or age the change takes place. However, it is thought to be April or May of the first year for barren ground and arctic island wolves, but earlier, January, February, or March, in southern Canada. It could possibly be at these periods but in the second year.

All comparisons have been made between adults except in the case of the 1914-16 Banks Island series, for which only two adults were available. This was considered necessary, even when regressions were used, because, although there may or may not be any differences between change in slope due to growth (heterauxesis) and change in slope due to different adult sizes (individual allomorphosis) when the paired measurements do not involve teeth, there must be a difference if one measurement is that of a tooth and the other some part of the skull which continues to grow after the tooth has been formed.

Except in one case, mentioned below, there appeared from scatter diagrams to be no appreciable difference between males and females in skull shape, and the sexes have therefore been combined for all covariance treatments.

*Covariance analysis of three pairs of skull measurements selected to differentiate arctic island wolves from mainland wolves.* In general appearance the skulls of the 1953-5 Banks Island series resemble specimens from the Queen Elizabeth Islands, particularly from Prince Patrick Island. They are short, especially at the rostrum, and relatively broad and high. Also, the rostro-frontal region is unusually concave, and this gives the skulls a very dog-like



**Table 22.** *C. lupus*. Results of covariance analysis of three pairs of measurements taken on skulls from Banks Island, Prince Patrick Island, and Ellesmere Island.

|                                                    | Slope diff. |     | Position diff. |        |
|----------------------------------------------------|-------------|-----|----------------|--------|
|                                                    | d.f.        | F   | d.f.           | F      |
| Breadth at M1 <i>on</i> length C to M2             | 2:35        | 0.5 | 2:37           | 9.1*** |
| Length C to M2 <i>on</i> breadth at M1             | 2:35        | 1.1 | 2:37           | 8.1*** |
| Palatal breadth at M2 <i>on</i> length C to P4     | 2:34        | 0.6 | 2:36           | 2.0    |
| Length C to P4 <i>on</i> palatal breadth at M2     | 2:34        | 2.6 | 2:36           | 0.7    |
| Nasal length <i>on</i> palatal-supraorbital height | 2:35        | 2.1 | 2:37           | 2.7    |
| Palatal-supraorbital height <i>on</i> nasal length | 2:35        | 2.6 | 2:37           | 0.2    |

appearance. These characters also serve to distinguish the 1953–5 Banks Island skulls from those of Alaskan and Canadian barren ground wolves. As a working hypothesis the 1953–5 Banks Island series was therefore grouped with the Prince Patrick Island series, but for each pair of measurements discussed, checks were made to determine how far this was justified. Similar tests for each pair of measurements were made before combining the three mainland series.

The concavity of the forehead could not be satisfactorily measured. A number of measurements could have been used to demonstrate the other characters, but of the 26 linear measurements (Tables 30 and 31) taken, the most suitable pairs appeared to be: 1) breadth at M1 and length C to M2, 2) palatal breadth at M2 and length C to P4, and 3) nasal length and palatal-supraorbital height.

The results of the covariance analyses given in Table 22 show that there is no significant difference in the slope of the regression lines of the three series, Banks Island<sup>1</sup>, Prince Patrick Island, and Ellesmere Island, which together make up the island series, but that there are two highly significant ( $P < .005$ ) differences in the positions of these lines. Similar calculations for the three mainland series, *C. l. mackenzii*, *C. l. tundrarum*, and *C. l. hudsonicus*, gave differences which were not significant for slope or position in any instance.

Table 23 gives the results of comparisons of the combined island series, Banks Island, Prince Patrick Island, and Ellesmere Island, with the combined mainland series. It is not strictly legitimate to combine the island series for the paired measurements, breadth at M1 and length C to M2, as significant differences amongst the island series for these paired measurements are demonstrated in Table 22. However, it is clear that if unweighted means had been used, or if the three island series had contained equal numbers of specimens, the *F* ratios for difference of position, and the percentage of joint non-overlap of the adjusted means would have been increased.

It was evident from scatter diagrams that, for the two pairs of measurements used to show the relationship between length and breadth of the front part of the skull, the Ellesmere Island series was closer to the mainland series than was either of the other island series. This fact, which on geographical

<sup>1</sup>Where the Banks Island series is mentioned without qualification it refers only to the 1953–5 series, and the 1914–16 series has in no instance been included in the combined island series.



**Table 23.** *C. lupus*. Comparisons of the combined island series with the combined mainland series for three pairs of skull measurements.

|                                             | Slope diff. |       | Correlation coefficient (r) |          |      | Regression coefficient |          |      | Position diff. |           | Standard mean X | Adjusted Mean Y |          | % Joint non-overlap |
|---------------------------------------------|-------------|-------|-----------------------------|----------|------|------------------------|----------|------|----------------|-----------|-----------------|-----------------|----------|---------------------|
|                                             | d.f.        | F     | Island                      | Mainland | Mean | Island                 | Mainland | Mean | d.f.           | F         |                 | Island          | Mainland |                     |
| Breadth at M1 on length C to M2             | 1:90        | 2.2   | 0.40**                      | 0.76**   | —    | 0.32                   | 0.50     | 0.44 | 1:91           | 38.8****  | 105.46          | 81.78           | 78.53    | 76                  |
| Length C to M2 on breadth at M1             | 1:90        | 8.2** |                             |          |      | 0.51                   | 1.15     | —    | 1:91           | 43.3****  | 80.16           | 103.42          | 108.10   | 77                  |
| Palatal breadth at M2 on length C to P4     | 1:90        | 0.1   | 0.45                        | 0.69     | 0.57 | 0.41                   | 0.44     | 0.43 | 1:91           | 46.3****  | 44.62           | 43.30           | 39.99    | 81                  |
| Length C to P4 on palatal breadth at M2     | 1:90        | 6.8*  |                             |          |      | 0.49                   | 1.07     | —    | 1:91           | 105.5**** | 41.65           | 42.01           | 47.62    | 87                  |
| Nasal length on palatal-supraorbital height | 1:89        | 0.4   | 0.60                        | 0.72     | 0.68 | 0.91                   | 1.09     | 1.03 | 1:90           | 45.1****  | 73.39           | 81.86           | 87.12    | 76                  |
| Palatal-supraorbital height on nasal length | 1:89        | 0.6   |                             |          |      | 0.39                   | 0.48     | 0.45 | 1:90           | 33.8****  | 84.49           | 74.96           | 71.82    | 74                  |

The mean coefficients of regression are the equivalent of the regression of parallel lines obtained by the formula  $b = \frac{Sxy_1 + Sxy_2}{Sx^2_1 + Sx^2_2}$ . When the slope of the two regression lines did not differ significantly, the mean regression coefficient was used for calculating the adjusted means, and the difference between these adjusted means is the distance apart of the parallel regression lines along the Y axis. The coefficient of difference (Mayr *et al.*, 1953) for the adjusted means was then calculated from the formula  $\frac{\hat{y}_1 - \hat{y}_2}{2 Sy.x_{12}}$ . When the slope of the regression lines did differ significantly, the appropriate individual regression coefficient was used for calculating the adjusted means, and the formula  $\frac{\hat{y}_1 - \hat{y}_2}{Sy.x_1 + Sy.x_2}$  was used to obtain the coefficient of difference. In all cases the standard means of the independent variates X are the unweighted means of the means of the two series, island and mainland. The percentage of joint non-overlap corresponding to the coefficient of difference was obtained from the table in Mayr *et al.* (1953, p. 146), or, for values outside that table, from the table in Cazier and Bacon (1949, p. 375).



**Table 24.** *C. lupus*. Comparisons of the combined Banks Island 1953-5 and Prince Patrick Island series with the combined mainland series for three pairs of skull measurements. For explanation see Table 23.

|                                             | Slope diff. |         | Correlation coefficient (r)    |          |      | Regression coefficient         |          |      | Position diff. |          | Standard mean X | Adjusted mean Y                |          | % Joint non-overlap |
|---------------------------------------------|-------------|---------|--------------------------------|----------|------|--------------------------------|----------|------|----------------|----------|-----------------|--------------------------------|----------|---------------------|
|                                             | d.f.        | F       | Banks Id. + Prince Patrick Id. | Mainland | Mean | Banks Id. + Prince Patrick Id. | Mainland | Mean | d.f.           | F        |                 | Banks Id. + Prince Patrick Id. | Mainland |                     |
| Breadth at M1 on length C to M2             | 1:68        | 1.7     | .37*                           | .76*     | —    | 0.29                           | 0.50     | 0.47 | 1:69           | 65.0**** | 104.91          | 83.24                          | 78.24    | 88                  |
| Length C to M2 on breadth at M1             | 1:68        | 4.7*    |                                |          |      | 0.48                           | 1.15     | —    | 1:69           | 62.0**** | 80.74           | 102.09                         | 108.77   | 86                  |
| Palatal breadth at M2 on length C to P4     | 1:68        | 0.0     | .32                            | .67      | .58  | 0.42                           | 0.44     | 0.44 | 1:69           | 44.9**** | 44.70           | 44.07                          | 40.01    | 86                  |
| Length C to P4 on palatal breadth at M2     | 1:68        | 10.9*** |                                |          |      | 0.25                           | 1.07     | —    | 1:69           | 68.0**** | 42.04           | 42.25                          | 48.04    | 90                  |
| Nasal length on palatal-supraorbital height | 1:67        | 0.0     | .81                            | .72      | .74  | 1.25                           | 1.09     | 1.12 | 1:68           | 29.3**** | 73.44           | 81.98                          | 87.24    | 77                  |
| Palatal-supraorbital height on nasal length | 1:67        | 0.1     |                                |          |      | 0.52                           | 0.48     | 0.49 | 1:68           | 24.7**** | 84.61           | 75.07                          | 71.81    | 76                  |



grounds is rather surprising, is also demonstrated by Table 26. As there were other reasons, which are discussed below, for considering the Ellesmere Island wolves distinct from those of Prince Patrick and Banks islands, it seemed reasonable to compare the combined Banks Island and Prince Patrick Island series with the combined mainland series. This is done in Table 24, which shows that, while the decrease in the number of specimens due to the elimination of the Ellesmere Island series has slightly reduced the  $F$  ratios for some measurements and hence confidence in the differences of the adjusted means, these differences are all still highly significant ( $P < .001$ ), and the percentage of joint non-overlap, which is independent of the number of specimens involved, has been increased for all measurements.

*Comparison of the two Banks Island series, 1953-5 and 1914-16, using the same three pairs of measurements selected to differentiate arctic island and mainland wolves.* In the comparisons made above, the series which was collected by members of the Canadian Arctic Expedition between 1914 and 1916 at Cape Kellett has been omitted because the skulls of which it is composed, including the type of *C. l. bernardi*, are strikingly different from the 1953-5 Banks Island series. This is obvious from a visual comparison of the specimens, from scatter diagrams, and from the original description (Anderson, 1943), which emphasizes the relative narrowness of the skull of *C. l. bernardi* as compared with that of *C. l. tundrarum*. Thus, whereas the recent Banks Island collection is characterized by very broad skulls, the earlier type series is characterized by narrow skulls. Unfortunately only two of the 1914-16 series were completely adult. However, nine skulls of moderately young *C. l. hudsonicus*, when plotted on scatter diagrams, appeared to lie along the extensions of the regression lines of the mainland series, and, as the six young specimens taken by the Canadian Arctic Expedition were of similar age, it seemed reasonable to place them with the two adults and to run a covariance test against the 1953-5 series which, except for five cubs still with deciduous teeth and not included in any series of measurements, consisted entirely of adults. The results, given in Table 25, show clearly that the 1914-16 and the 1953-5 series are almost certainly from different populations and cannot, therefore, be combined. Table 26 also demonstrates the marked difference between these two series, and the separate means calculated for the two adult 1914-16 specimens show that these differences are not caused by the inclusion of the subadult specimens.

*Three combinations of length C to P4 and crown length of P3 selected to separate arctic island wolves from the mainland wolves.* It has been shown above that the length C to P4 is less, relative to palatal breadth, in the arctic island than in mainland skulls. It is also absolutely shorter. The mean (males and females combined) of the arctic island series is  $42.34 \pm .42$  and of the mainland series  $46.76 \pm .44$ . The difference is significant at the .1 per cent level ( $d.f. 1:89, F = 52.6$ ) and the joint non-overlap is 78 per cent. Reduced tooth size is not associated with this reduced jaw length in the island series; indeed, some of the teeth are larger. For instance, the crown length of P3 is  $17.46 \pm .11$  in the island series and only  $16.21 \pm .13$  in the mainland series. Again, the difference is significant at the .1 per cent level ( $d.f. 1:89, F = 52.0$ ),



**Table 25.** *C. lupus*. Comparisons of the Banks Island 1953–5 series with the Banks Island 1914–16 series for three pairs of skull measurements.

|                                                    | Position diff. |          | % Joint<br>non-overlap<br>of adjusted<br>means |
|----------------------------------------------------|----------------|----------|------------------------------------------------|
|                                                    | d.f.           | F        |                                                |
| Breadth at M1 <i>on</i> length C to M2             | 1:16           | 29.9**** | 89                                             |
| Length C to M2 <i>on</i> breadth at M1             | 1:16           | 4.3      | 76                                             |
| Palatal breadth at M2 <i>on</i> length C to P4     | 1:16           | 15.5***  | 83                                             |
| Length C to P4 <i>on</i> palatal breadth at M2     | 1:16           | 0.2      | 55                                             |
| Nasal length <i>on</i> palatal-supraorbital height | 1:16           | 14.3***  | 92                                             |
| Palatal-supraorbital height <i>on</i> nasal length | 1:16           | 56.6**** | 96                                             |

There was no significant difference in the slope of the regression lines, and the *F* ratios for these tests have therefore not been given. The coefficients of regression and correlation are included in Table 26 with the adjusted means.

and the joint non-overlap is 78 per cent. The teeth from C to P4 must therefore be closer together, and the sum of the gaps between them would probably provide an excellent means of separating island and mainland skulls. This was realized too late to take measurements for the present paper, but it seemed reasonable that combinations of the two measurements distance C to P4 and crown length of P3 could be used as a substitute. Covariance analysis was inappropriate, as the correlation coefficient for two parallel regression lines, arctic island and mainland, was only .20, and the reduction in error due to regression was not significant. The analyses of variance of three other combinations are given in Table 27, and the means and ratios resulting from these combinations in Table 28.

Analysis of variance showed no significant differences amongst the three mainland series for any of the three combinations of measurements in Table 28, but amongst the three island series there were significant differences at the 5 per cent level for length C to P4 minus twice the crown length of P3 and for length C to P4 divided by the crown length of P3. In this case, the populations fall into the order which would be expected on geographical grounds (Table 28). The means for the Ellesmere Island and Prince Patrick Island series are close together, and the Prince Patrick Island and Banks Island 1953–5 series are separated by a difference which is significant at the 5 per cent level and of approximately the same magnitude as that between the Banks Island 1953–5 and the *C. l. mackenzii* series. As there is little difference between the Prince Patrick Island and the Banks Island 1953–5 means for length C to P4 (Tables 30 and 31), the differences between these two series are evidently due to the difference in the crown length of P3. However, it should be noted that, although the crown length of P3 is small in the Banks Island series, the crown breadth is exceptionally great in some Banks Island specimens (Table 30), so that the mean for crown length of P3  $\times$  crown breadth in the Banks Island series is slightly greater than in the Prince Patrick Island series, and possibly the total crown area is a better indication of relationship than length alone.



**Table 26.** *C. lupus*. Adjusted means of skull measurements.

Independent variate: length C to M2. Standard mean: 105.308 mm. Number of specimens: 102. Dependent variate: breadth at M1. Mean regression coefficient:  $0.464 \pm .051$ . Correlation coefficient ( $r$ ): 0.681.

| Population                      | <i>C. Cardwell skull</i> | <i>Banks Id. 1953-5</i> | <i>Prince Patrick Id.</i> | <i>Ellesmere Id.</i> | <i>tundrarum</i> | <i>hudsonicus</i> | <i>Banks Id. 1914-16</i> | <i>mackenzii</i> | <i>Banks Id. 1914-16 Ad.</i> |
|---------------------------------|--------------------------|-------------------------|---------------------------|----------------------|------------------|-------------------|--------------------------|------------------|------------------------------|
| No. specimens                   | (1)                      | 11                      | 8                         | 22                   | 25               | 21                | 8                        | 7                | (2)                          |
| Adjusted mean $\pm$ SE          | 84 approx.               | $83.97 \pm 0.66$        | $82.66 \pm 0.75$          | $80.31 \pm 0.45$     | $78.66 \pm 0.44$ | $78.54 \pm 0.48$  | $77.53 \pm 0.78$         | $77.23 \pm 0.81$ | 75.2                         |
| Regression coefficient          |                          | 0.36                    | 0.16                      | 0.53                 | 0.46             | 0.56              | 0.46                     | 0.15             |                              |
| Correlation coefficient ( $r$ ) |                          | 0.49                    | 0.13                      | 0.70                 | 0.72             | 0.82              | 0.74                     | 0.40             |                              |

Independent variate: breadth at M1. Standard mean: 79.69 mm. Number of specimens: 102. Dependent variate: length C to M2. Mean regression coefficient:  $0.999 \pm .111$ .

| Population             | <i>C. Cardwell skull</i> | <i>Banks Id. 1953-5</i> | <i>Prince Patrick Id.</i> | <i>Ellesmere Id.</i> | <i>Banks Id. 1914-16</i> | <i>mackenzii</i>  | <i>tundrarum</i>  | <i>hudsonicus</i> | <i>Banks Id. 1914-16 Ad.</i> |
|------------------------|--------------------------|-------------------------|---------------------------|----------------------|--------------------------|-------------------|-------------------|-------------------|------------------------------|
| Adjusted mean $\pm$ SE | 95 approx.               | $99.25 \pm 0.98$        | $101.62 \pm 1.13$         | $104.44 \pm 0.66$    | $105.29 \pm 1.19$        | $106.79 \pm 1.23$ | $107.55 \pm 0.62$ | $107.64 \pm 0.68$ | 110.0                        |
| Regression coefficient |                          | 0.66                    | 0.11                      | 0.92                 | 1.19                     | 1.04              | 1.11              | 1.19              |                              |

Independent variate: length C to P4. Standard mean: 44.671 mm. Number of specimens: 102. Dependent variate: palatal breadth at M2. Mean regression coefficient:  $0.427 \pm .064$ . Correlation coefficient ( $r$ ): 0.568.

| Population                      | <i>Prince Patrick Id.</i> | <i>Banks Id. 1953-5</i> | <i>Ellesmere Id.</i> | <i>C. Cardwell skull</i> | <i>mackenzii</i> | <i>tundrarum</i> | <i>Thomsen R. skull</i> | <i>hudsonicus</i> | <i>Banks Id. 1914-16</i> | <i>Banks Id. 1914-16 Ad.</i> |
|---------------------------------|---------------------------|-------------------------|----------------------|--------------------------|------------------|------------------|-------------------------|-------------------|--------------------------|------------------------------|
| No. specimens                   | 7                         | 11                      | 22                   | (1)                      | 7                | 26               | (1)                     | 21                | 8                        | (2)                          |
| Adjusted mean $\pm$ SE          | $44.57 \pm 0.73$          | $43.69 \pm 0.57$        | $42.73 \pm 0.43$     | 42.5                     | $40.23 \pm 0.70$ | $40.10 \pm 0.40$ | 39.9                    | $39.86 \pm 0.44$  | $39.25 \pm 0.69$         | 38.5                         |
| Regression coefficient          | 0.14                      | 0.70                    | 0.38                 |                          | 0.07             | 0.44             |                         | 0.57              | 0.29                     |                              |
| Correlation coefficient ( $r$ ) | 0.09                      | 0.57                    | 0.60                 |                          | 0.15             | 0.70             |                         | 0.77              | 0.35                     |                              |



Independent variate: palatal breadth at M2. Standard mean: 41.253 mm. Number of specimens: 102. Dependent variate: length C to P4. Mean regression coefficient:  $0.756 \pm 0.113$ .

| Population             | <i>C. Cardwell skull</i> | <i>Prince Patrick Id.</i> | <i>Banks Id. 1953-5</i> | <i>Thomsen R. skull</i> | <i>Ellesmere Id.</i> | <i>Banks Id. 1914-16</i> | <i>mackenzii</i> | <i>Banks Id. 1914-16 Ad.</i> | <i>tundrarum</i> | <i>hudsonicus</i> |
|------------------------|--------------------------|---------------------------|-------------------------|-------------------------|----------------------|--------------------------|------------------|------------------------------|------------------|-------------------|
| Adjusted mean $\pm$ SE | 39.3                     | $40.26 \pm 0.97$          | $41.66 \pm 0.77$        | 41.7                    | $41.88 \pm 0.53$     | $43.92 \pm 0.96$         | $45.48 \pm 0.94$ | 46.6                         | $47.22 \pm 0.49$ | $47.51 \pm 0.54$  |
| Regression coefficient |                          | 0.06                      | 0.47                    |                         | 0.94                 | 0.42                     | 0.32             |                              | 1.11             | 1.04              |

Independent variate: palatal-supraorbital height. Standard mean: 72.594 mm. Number of specimens: 101. Dependent variate: nasal length. Mean regression coefficient:  $1.015 \pm 0.118$ . Correlation coefficient ( $r$ ): 0.665.

| Population                      | <i>Prince Patrick Id.</i> | <i>Ellesmere Id.</i> | <i>Banks Id. 1953-5</i> | <i>Thomsen R. skull</i> | <i>mackenzii</i> | <i>hudsonicus</i> | <i>tundrarum</i> | <i>Banks Id. 1914-16</i> | <i>Banks Id. 1914-16 Ad.</i> |
|---------------------------------|---------------------------|----------------------|-------------------------|-------------------------|------------------|-------------------|------------------|--------------------------|------------------------------|
| No. specimens                   | 8                         | 22                   | 11                      | (1)                     | 6                | 20                | 26               | 8                        | (2)                          |
| Adjusted mean $\pm$ SE          | $80.53 \pm 1.32$          | $80.95 \pm 0.80$     | $81.70 \pm 1.13$        | 83.0                    | $84.74 \pm 1.54$ | $85.70 \pm 0.83$  | $87.12 \pm 0.75$ | $87.37 \pm 1.63$         | 91.1                         |
| Regression coefficient          | 1.92                      | 0.59                 | 1.11                    |                         | 1.15             | 0.69              | 1.09             | 1.46                     |                              |
| Correlation coefficient ( $r$ ) | 0.78                      | 0.40                 | 0.89                    |                         | 0.70             | 0.41              | 0.79             | 0.88                     |                              |

Independent variate: nasal length. Standard mean: 84.261 mm. Number of specimens: 101. Dependent variate: palatal-supraorbital height. Mean regression coefficient:  $0.435 \pm 0.051$ .

| Population             | <i>Prince Patrick Id.</i> | <i>Ellesmere Id.</i> | <i>Banks Id. 1953-5</i> | <i>tundrarum</i> | <i>hudsonicus</i> | <i>mackenzii</i> | <i>Thomsen R. skull</i> | <i>Banks Id. 1914-16 Ad.</i> | <i>Banks Id. 1914-16</i> |
|------------------------|---------------------------|----------------------|-------------------------|------------------|-------------------|------------------|-------------------------|------------------------------|--------------------------|
| Adjusted mean $\pm$ SE | $75.19 \pm 0.86$          | $74.84 \pm 0.52$     | $74.56 \pm 0.73$        | $72.26 \pm 0.53$ | $71.37 \pm 0.54$  | $70.79 \pm 0.99$ | 69.4                    | 67.1                         | $66.63 \pm 0.89$         |
| Regression coefficient | 0.32                      | 0.27                 | 0.71                    | 0.58             | 0.25              | 0.43             |                         |                              | 0.53                     |

The populations are placed in order of increasing or decreasing magnitude of the adjusted means according to whether the means of the island series are smaller or larger.

The standard means of the independent variates to which the means of the dependent variates were adjusted are in each case the mean of all specimens used except the two from Eskimo ruins. The means of the dependent variates are adjusted along the mean regression lines, which are obtained by the formula given in Table 23. The individual regression coefficients do not differ significantly from this mean, although there are differences, as indicated in the preceding tables, between the regression coefficients for the grouped island and grouped mainland series. The mean correlation coefficients were obtained from the sums of squares and products associated with the 7 parallel regression lines. The individual correlations probably do not differ significantly from the means, but this has not been tested.



**Table 27.** *C. lupus*. Comparison of the combined mainland series of skulls with the combined island series and also with the combined Banks Island 1953-5 and Prince Patrick Island series.

|                                                        | Mainland | Island | Position diff. |           | %                 | Banks                         | Position diff. |          | %                 |
|--------------------------------------------------------|----------|--------|----------------|-----------|-------------------|-------------------------------|----------------|----------|-------------------|
|                                                        | Mean     | Mean   | d.f.           | F         | Joint non-overlap | Id. + Prince Patrick Id. Mean | d.f.           | F        | Joint non-overlap |
| Length C to P4<br>minus crown<br>length of P3          | 30.55    | 24.89  | 1:89           | 89.3****  | 84                | 25.36                         | 1:67           | 47.7**** | 83                |
| Length C to P4<br>minus twice<br>crown length<br>of P3 | 14.33    | 7.43   | 1:89           | 117.4**** | 87                | 8.13                          | 1:67           | 57.5**** | 85                |
| Length C to P4<br>divided by<br>crown length<br>of P3  | 2.891    | 2.429  | 1:89           | 119.9**** | 88                | 2.476                         | 1:67           | 54.8**** | 85                |

The paired measurements, length C to P4 and crown length of P3, cannot be used for comparing subadults as the second measurement is fixed from the time the tooth erupts while the first continues to increase until the animal is approximately full grown. Therefore only the two adults of the 1914-16 Banks Island series are used in Table 28. Males and females have been considered together in the calculations for Tables 27 and 28. This is not entirely justified, for, although there is not much sexual difference in length C to P4, crown length of P3 averages less in the females. Therefore the remainder and the ratio would tend to be less in males or in a series in which males predominated. According to the sexes marked on the specimens, there were 29 males and ten females from the arctic islands, and 20 males and 16 females from the mainland, the remaining 16 being unsexed. However, the similarity in means for most measurements of the 11 males and 11 females of *C. l. tundrarum*, as well as the large size of some individual females, suggest that there may have been some confusion in the specimens or errors in sexing.

*The relationship of the Banks Island, Prince Patrick Island, and Ellesmere Island wolves, and covariance analysis of measurements selected to differentiate them.* Judging from the linear measurements listed in Tables 30 and 31, there appears to be a series of clines from Ellesmere Island to Banks Island, with the Prince Patrick Island population occupying a position which is usually fairly central although for several measurements closer to that of Ellesmere Island. This is just what might be expected on geographical grounds. However, when laid out in series, the Banks Island and Prince Patrick Island skulls appeared to match each other more closely in general shape than did those of Prince Patrick Island and Ellesmere Island. This was mainly because of the slightly greater relative breadth, the greater curve of the forehead, and the more upturned rostrum of Banks Island and Prince Patrick Island skulls. In all three characters mainland skulls resemble those from Ellesmere Island rather than those from the neighbouring Banks Island. A fourth character, visible to the



**Table 28.** *C. lupus*. Means of remainders and ratios with their standard errors for three combinations of a pair of skull measurements.

|                                                                   | <i>Ellesmere Id.</i> | <i>Prince<br/>Patrick Id.</i> | <i>Banks Id.<br/>1953-5</i> | <i>Banks Id.<br/>1914-16</i> | <i>mackenzii</i> | <i>tundrarum</i> | <i>hudsonicus</i> |
|-------------------------------------------------------------------|----------------------|-------------------------------|-----------------------------|------------------------------|------------------|------------------|-------------------|
| No. specimens                                                     | 15 ♂♂, 5 ♀♀, 2 ?     | 7 ♂♂, 2 ♀♀                    | 7 ♂♂, 3 ♀♀, 1 ?             | 1 ♂, 1 ?                     | 3 ♂♂, 2 ♀♀, 2 ?  | 11 ♂♂, 11 ♀♀     | 6 ♂♂, 3 ♀♀, 11 ?  |
| Length C to P4 <i>minus</i><br>crown length of P3                 | 24.46±.62            | 24.48±.70                     | 26.08±.67                   | 27.75                        | 28.59±1.04       | 30.78±.56        | 30.97±.75         |
| Length C to P4 <i>minus</i><br><i>twice</i> crown length<br>of P3 | 6.80±.59             | 6.78±.72                      | 9.23±.76                    | 11.00                        | 12.44±1.11       | 14.71±.56        | 14.58±.86         |
| Length C to P4 <i>divided</i><br><i>by</i> crown length of P3     | 2.385±.033           | 2.383±.041                    | 2.552±.049                  | 2.67                         | 2.777±.075       | 2.920±.039       | 2.899±.061        |



**Table 29.** *C. lupus*. Comparison of Banks Island, Ellesmere Island, and Prince Patrick Island series for two pairs of skull measurements.

|                                            | Slope diff. |     | Correlation coefficient (r) |               |      |                    | Regression coefficient |               |       |                    | Position diff. |          | Standard mean X | Adjusted mean Y  |                    |               | % Joint non-overlap |
|--------------------------------------------|-------------|-----|-----------------------------|---------------|------|--------------------|------------------------|---------------|-------|--------------------|----------------|----------|-----------------|------------------|--------------------|---------------|---------------------|
|                                            | d.f.        | F   | Banks Id. 1953-5            | Ellesmere Id. | Mean | Prince Patrick Id. | Banks Id. 1953-5       | Ellesmere Id. | Mean  | Prince Patrick Id. | d.f.           | F        |                 | Banks Id. 1953-5 | Prince Patrick Id. | Ellesmere Id. |                     |
| Crown length of P3 on supraorbital breadth | 1:28        | 1.5 | 0.80                        | 0.52          | 0.61 | -0.81              | 0.14                   | 0.08          | 0.100 | -0.05              | 1:29           | 32.2**** | 65.066          | 16.63            | 17.50              | 17.91         | 88                  |
| Supraorbital breadth on crown length of P3 | 1:28        | 0.4 |                             |               |      |                    | 4.51                   | 3.32          | 3.756 | -12.35             | 1:29           | 28.7**** | 17.270          | 68.87            | 67.39              | 61.25         | 87                  |
| Length P4 to M2 on mastoid breadth         | 1:28        | 0.2 | 0.82                        | 0.65          | 0.74 | 0.02               | 0.29                   | 0.25          | 0.272 | 0.01               | 1:29           | 45.9**** | 81.740          | 46.65            | 48.47              | 49.17         | 91                  |
| Mastoid breadth on length P4 to M2         | 1:28        | 0.9 |                             |               |      |                    | 2.33                   | 1.67          | 2.007 | 0.06               | 1:29           | 29.7**** | 47.910          | 84.84            | 81.99              | 78.64         | 88                  |

The Prince Patrick Island series has not been included in covariance analysis, and the adjusted means for that series are derived from its own regression. Those for the other two series have been derived from the mean of their regression as given in the table. The standard means of the independent variates are the mid-points between the means of the Banks Island and Ellesmere Island series. For further explanation see Table 23.



eye, in which there was agreement between the Banks Island and Prince Patrick Island series, but a difference between them and the Ellesmere Island series, was the degree of inflation of the auditory bulla. This was measured by filling the bulla with mercury and then weighing the mercury when it was poured out. The results are given in Tables 30 and 31. A slightly better separation is obtained by using the cube roots of the weights, but the joint non-overlap for males between the Ellesmere Island series and the combined Banks Island and Prince Patrick Island series is still only 74 per cent.

From Tables 30 and 31 it can be seen that Ellesmere Island skulls average narrower but tend to have larger teeth than those from Banks Island. The two pairs of measurements showing these opposing characters selected for covariance analysis were supraorbital breadth and crown length of P3, and mastoid breadth and length P4 to M2. The difference (Table 30) between the Banks Island and the Ellesmere Island male series was significant at the 5 per cent level for the first measurement of each pair, and at the 1 per cent level for the second measurement. The results of covariance analysis and the joint non-overlap for the adjusted means are given in Table 29. The marked differences between the coefficients of regression and correlation for Banks Island and Ellesmere Island series and those for Prince Patrick Island are evident from this table, and, when the Prince Patrick Island series was included in the covariance analysis, a significant difference in slope of both regression lines (*d.f.* 2:32,  $F = 5.7$ ,  $P < .01$ ; and  $F = 6.6$ ,  $P < .01$ ) was found for the first pairs of measurements, though not for the second. The two regressions of the three means of the first pair of measurements are:  $-1.18$  and  $-5.39$ , and it is tempting to suggest that the resemblance of the regressions of the Prince Patrick Island series to these may reflect the mixed character of the Prince Patrick Island population. The regression coefficients of the three means for mastoid breadth and length P4 to M2 are:  $-0.65$  and  $-1.33$ , and again there is a similarity to the regression coefficient for the Prince Patrick Island series.

There was a definite relationship between each of the two components of the paired measurements used above to distinguish the mainland and island series. For instance, palatal breadth at M1 and length C to M2 are clearly measurements of the relation of breadth to length of the palatal-maxillary region of the skull. The components of the two pairs of measurements used to distinguish the Banks Island and Ellesmere Island skulls, however, bear little relationship to each other, and were selected mainly because it was evident that when paired they would give a good separation. Obviously the reliability of the statistics has been very materially decreased, and fresh sets of specimens are required to prove satisfactorily the correctness of the deductions. Although the pairing of unrelated measurements for covariance treatment or to obtain ratios may have limited use and justification for separating two populations, it clearly has little or none for judging the degree of relationship amongst a number of populations. Thus, the adjusted means for the mainland series for the two pairs of measurements of Table 29 would agree quite closely with those for Prince Patrick Island, but this is because *both* the teeth *and* the skull breadth are less relative to total size. For the Ellesmere Island and Banks Island series the correlations in Table 29 are surprisingly high (both significant at the 1 per cent level), but this is almost certainly due to mutual correlation with total size. The same may well be true of the correlations in Tables 23 and 24, which



**Table 30.** Statistics of adult<sup>a</sup> male *C. lupus* skulls from the arctic islands.

|                             | <i>Banks Id.</i><br>1914-16 |                  | <i>Banks Id.</i><br>1953-5 |                    | <i>Prince Patrick Id.</i> |                     | <i>Ellesmere Id.</i> |                     | <i>Banks Id. 1953-5 + Prince Patrick Id. + Ellesmere Id.</i> |           |                  |                  |                  |
|-----------------------------|-----------------------------|------------------|----------------------------|--------------------|---------------------------|---------------------|----------------------|---------------------|--------------------------------------------------------------|-----------|------------------|------------------|------------------|
|                             | No.                         | Mean             | No.                        | Mean $\pm$ SE      | No.                       | Mean $\pm$ SE       | No.                  | Mean $\pm$ SE       | No.                                                          | Range     | Mean $\pm$ SE    | SD $\pm$ SE      | CV $\pm$ SE      |
| Condylobasal length         | 1                           | —                | 8                          | 235.4 $\pm$ 2.67   | 5                         | 237.0 $\pm$ 0.96    | 14                   | 237.7 $\pm$ 1.77    | 27                                                           | 222-249   | 236.9 $\pm$ 1.20 | 6.25 $\pm$ 0.85  | 2.64 $\pm$ 0.36  |
| Occipital length            | 1                           | 253 <sup>b</sup> | 8                          | 252.9 $\pm$ 3.24   | 5                         | 259.5 $\pm$ 1.76    | 14                   | 257.0 $\pm$ 2.06    | 27                                                           | 241-269   | 256.3 $\pm$ 1.50 | 7.77 $\pm$ 1.06  | 3.03 $\pm$ 0.41  |
| Zygomatic breadth           | 1                           | 135.0            | 8                          | 141.0 $\pm$ 1.78   | 5                         | 141.1 $\pm$ 2.54    | 14                   | 141.5 $\pm$ 1.46    | 27                                                           | 130-149   | 141.3 $\pm$ 1.00 | 5.19 $\pm$ 0.71  | 3.67 $\pm$ 0.50  |
| Mastoid breadth             | 1                           | 78.0             | 8                          | 84.61 $\pm$ 1.44*  | 5                         | 82.92 $\pm$ 1.16    | 14                   | 81.42 $\pm$ 0.62*   | 27                                                           | 77.5-90.8 | 82.64 $\pm$ 0.62 | 3.20 $\pm$ 0.44  | 3.87 $\pm$ 0.53  |
| Breadth of condyles         | 1                           | —                | 8                          | 50.65 $\pm$ 1.03   | 5                         | 49.30 $\pm$ 0.41    | 14                   | 50.95 $\pm$ 0.28    | 27                                                           | 45.1-54.5 | 50.56 $\pm$ 0.35 | 1.83 $\pm$ 0.25  | 3.63 $\pm$ 0.49  |
| Least cranial breadth       | 1                           | 42.0             | 7                          | 42.19 $\pm$ 0.78*  | 5                         | 40.76 $\pm$ 1.09    | 13                   | 40.12 $\pm$ 0.57*   | 25                                                           | 36.6-45.0 | 40.83 $\pm$ 0.45 | 2.23 $\pm$ 0.32  | 5.46 $\pm$ 0.77  |
| Supraorbital breadth        | 1                           | 56.0             | 8                          | 68.08 $\pm$ 1.41*  | 4                         | 63.78 $\pm$ 2.90    | 14                   | 63.44 $\pm$ 1.27*   | 26                                                           | 54.0-73.3 | 64.92 $\pm$ 0.98 | 4.98 $\pm$ 0.69  | 7.67 $\pm$ 1.06  |
| Interorbital breadth        | 1                           | 41.6             | 8                          | 47.56 $\pm$ 1.07   | 5                         | 45.02 $\pm$ 1.38    | 14                   | 46.79 $\pm$ 1.15    | 27                                                           | 40.9-58.3 | 46.69 $\pm$ 0.72 | 3.73 $\pm$ 0.51  | 7.99 $\pm$ 1.09  |
| Palatal breadth at M2       | 1                           | 37.2             | 8                          | 43.26 $\pm$ 0.90   | 4                         | 41.90 $\pm$ 1.57    | 14                   | 42.23 $\pm$ 0.58    | 26                                                           | 38.4-47.4 | 42.50 $\pm$ 0.47 | 2.39 $\pm$ 0.33  | 5.62 $\pm$ 0.78  |
| Breadth at M1               | 1                           | 77.8             | 8                          | 83.26 $\pm$ 0.86   | 5                         | 82.66 $\pm$ 1.07    | 14                   | 81.20 $\pm$ 0.67    | 27                                                           | 76.6-88.4 | 82.08 $\pm$ 0.49 | 2.56 $\pm$ 0.35  | 3.11 $\pm$ 0.42  |
| Palatal breadth at P2       | 1                           | 32.0             | 8                          | 34.18 $\pm$ 0.88   | 5                         | 34.58 $\pm$ 0.29    | 14                   | 33.86 $\pm$ 0.64    | 27                                                           | 30.0-38.7 | 34.09 $\pm$ 0.41 | 2.15 $\pm$ 0.29  | 6.31 $\pm$ 0.86  |
| Breadth at canines          | 1                           | 45.0             | 8                          | 48.33 $\pm$ 0.80   | 5                         | 48.84 $\pm$ 1.07    | 14                   | 49.00 $\pm$ 0.89    | 27                                                           | 44.5-59.3 | 48.77 $\pm$ 0.54 | 2.80 $\pm$ 0.38  | 5.74 $\pm$ 0.78  |
| Palatal-supraorbital height | 1                           | 70.8             | 8                          | 75.01 $\pm$ 1.22   | 5                         | 75.36 $\pm$ 0.77    | 14                   | 75.04 $\pm$ 0.64    | 27                                                           | 70.2-81.4 | 75.09 $\pm$ 0.49 | 2.56 $\pm$ 0.35  | 3.41 $\pm$ 0.46  |
| Nasal length                | 1                           | 93.2             | 8                          | 84.83 $\pm$ 1.42   | 5                         | 84.98 $\pm$ 1.35    | 14                   | 83.86 $\pm$ 1.06    | 27                                                           | 75.1-91.1 | 84.35 $\pm$ 0.72 | 3.72 $\pm$ 0.51  | 4.41 $\pm$ 0.60  |
| Incisive foramen length     | 1                           | 16.1             | 8                          | 13.31 $\pm$ 0.28*  | 4                         | 12.88 $\pm$ 1.01    | 13                   | 14.36 $\pm$ 0.34*   | 25                                                           | 10.7-16.7 | 13.79 $\pm$ 0.27 | 1.35 $\pm$ 0.19  | 9.82 $\pm$ 1.39  |
| Length C to M2              | 1                           | 111.0            | 8                          | 102.9 $\pm$ 1.45   | 5                         | 104.8 $\pm$ 0.63    | 14                   | 106.4 $\pm$ 0.95    | 27                                                           | 96-112    | 105.0 $\pm$ 0.71 | 3.68 $\pm$ 0.50  | 3.51 $\pm$ 0.48  |
| Length C to P4              | 1                           | 45.8             | 8                          | 42.71 $\pm$ 0.83   | 5                         | 42.54 $\pm$ 0.62    | 14                   | 42.80 $\pm$ 0.95    | 27                                                           | 35.1-47.5 | 42.73 $\pm$ 0.55 | 2.85 $\pm$ 0.39  | 6.68 $\pm$ 0.91  |
| Length P4 to M2             | 1                           | 49.6             | 8                          | 47.56 $\pm$ 0.56** | 4                         | 48.90 $\pm$ 0.28*   | 14                   | 49.23 $\pm$ 0.27**  | 26                                                           | 45.3-50.7 | 48.67 $\pm$ 0.27 | 1.36 $\pm$ 0.19  | 2.79 $\pm$ 0.39  |
| Crown length of P3          | 4                           | 17.13            | 8                          | 17.00 $\pm$ 0.26** | 5                         | 17.62 $\pm$ 0.18*   | 14                   | 17.94 $\pm$ 0.17**  | 27                                                           | 16.0-18.7 | 17.60 $\pm$ 0.14 | 0.75 $\pm$ 0.10  | 4.23 $\pm$ 0.58  |
| Crown breadth of P3         | 4                           | 7.45             | 7                          | 8.20 $\pm$ 0.60    | 5                         | 7.52 $\pm$ 0.34     | 14                   | 7.31 $\pm$ 0.12     | 26                                                           | 6.6-11.3  | 7.59 $\pm$ 0.19  | 0.98 $\pm$ 0.14  | 12.91 $\pm$ 1.79 |
| Crown length of P4          | 4                           | 26.60            | 8                          | 27.33 $\pm$ 0.39   | 4                         | 27.48 $\pm$ 0.20    | 14                   | 27.69 $\pm$ 0.23    | 26                                                           | 26.0-29.6 | 27.54 $\pm$ 0.17 | 0.87 $\pm$ 0.12  | 3.16 $\pm$ 0.44  |
| Crown breadth of P4         | 4                           | 14.95            | 8                          | 15.53 $\pm$ 0.32   | 4                         | 15.55 $\pm$ 0.10    | 14                   | 15.64 $\pm$ 0.25    | 26                                                           | 13.0-16.8 | 15.59 $\pm$ 0.16 | 0.84 $\pm$ 0.12  | 5.38 $\pm$ 0.75  |
| Crown length of M1          | 4                           | 17.03            | 8                          | 17.40 $\pm$ 0.19   | 4                         | 17.68 $\pm$ 0.23    | 14                   | 17.74 $\pm$ 0.16    | 26                                                           | 16.8-18.9 | 17.63 $\pm$ 0.11 | 0.57 $\pm$ 0.08  | 3.22 $\pm$ 0.45  |
| Transverse diameter of M1   | 4                           | 24.00            | 8                          | 24.16 $\pm$ 0.39   | 4                         | 24.40 $\pm$ 0.18    | 14                   | 23.69 $\pm$ 0.20    | 26                                                           | 22.6-26.6 | 23.95 $\pm$ 0.17 | 0.87 $\pm$ 0.12  | 3.61 $\pm$ 0.50  |
| Crown length of m1          | 3                           | 30.50            | 8                          | 31.34 $\pm$ 0.27   | 4                         | 31.05 $\pm$ 0.29    | 14                   | 31.21 $\pm$ 0.24    | 26                                                           | 30.0-33.2 | 31.23 $\pm$ 0.15 | 0.77 $\pm$ 0.11  | 2.47 $\pm$ 0.34  |
| Coronoid height             | 1                           | 69.91            | 8                          | 73.01 $\pm$ 0.95   | 4                         | 73.33 $\pm$ 0.25    | 14                   | 72.46 $\pm$ 0.60    | 26                                                           | 67.7-77.0 | 72.77 $\pm$ 0.43 | 2.19 $\pm$ 0.30  | 3.01 $\pm$ 0.42  |
| Bulla 'volume'              | —                           | —                | 7                          | 53.33 $\pm$ 3.55*  | 5                         | 49.76 $\pm$ 3.79*†† | 13                   | 62.40 $\pm$ 2.22*†† | 25                                                           | 42.2-81.7 | 57.33 $\pm$ 1.97 | 9.83 $\pm$ 1.39  | 17.15 $\pm$ 2.43 |
| Cube root bulla 'volume'    | —                           | —                | 7                          | 3.751 $\pm$ .083*  | 5                         | 3.666 $\pm$ .091*†† | 13                   | 3.960 $\pm$ .046*†† | 25                                                           | 3.48-4.34 | 3.843 $\pm$ 0.44 | .221 $\pm$ .031  | 5.75 $\pm$ 0.81  |
| Skull weight                | —                           | —                | 7                          | 331.7 $\pm$ 7.65   | 4                         | 320.8 $\pm$ 10.31   | 13                   | 349.9 $\pm$ 8.39    | 24                                                           | 292-354   | 339.8 $\pm$ 5.70 | 27.95 $\pm$ 4.03 | 8.23 $\pm$ 1.19  |

In order that ratios of most measurements with condylobasal length could be obtained from the means given in this table, skulls too badly broken for condylobasal length to be measured have been omitted.

<sup>a</sup> Except that the tooth measurements of three subadult Banks Island 1914-16 specimens are included.

<sup>b</sup> Approx.

\*Beside means for Banks Island and Ellesmere Island indicates a significant difference between these series when tested against each other; beside means for Prince Patrick Island it indicates a significant difference when the three populations are tested simultaneously by covariance.

†Indicates a significant difference between a Prince Patrick Island mean and the mean of either of the other series.



**Table 31.** Statistics of adult female *C. lupus* skulls from the arctic islands.

|                             | <i>Banks Id.</i><br>1953-5 |       | <i>Prince</i><br><i>Patrick Id.</i> |       | <i>Ellesmere Id.</i> |       | <i>Banks Id.</i> 1953-5 | +          | <i>Prince Patrick Id.</i> | +                | <i>Ellesmere Id.</i> |
|-----------------------------|----------------------------|-------|-------------------------------------|-------|----------------------|-------|-------------------------|------------|---------------------------|------------------|----------------------|
|                             | No.                        | Mean  | No.                                 | Mean  | No.                  | Mean  | No.                     | Range      | Mean $\pm$ SE             | SD $\pm$ SE      | CV $\pm$ SE          |
| Condylobasal length         | 2                          | 223.6 | 2                                   | 224.0 | 4                    | 225.4 | 8                       | 217-229    | 224.6 $\pm$ 1.62          | 4.59 $\pm$ 1.15  | 2.0 $\pm$ 0.51       |
| Occipital length            | 3                          | 239.9 | 2                                   | 242.5 | 5                    | 244.5 | 10                      | 235-250    | 242.7 $\pm$ 1.70          | 5.37 $\pm$ 1.20  | 2.2 $\pm$ 0.49       |
| Zygomatic breadth           | 3                          | 138.4 | 2                                   | 134.2 | 5                    | 135.8 | 10                      | 132-146    | 136.3 $\pm$ 1.29          | 4.09 $\pm$ 0.91  | 3.0 $\pm$ 0.67       |
| Mastoid breadth             | 3                          | 78.77 | 3                                   | 79.80 | 5                    | 78.44 | 11                      | 75.1-84.1  | 78.90 $\pm$ 0.91          | 3.01 $\pm$ 0.61  | 3.8 $\pm$ 0.77       |
| Breadth of condyles         | 2                          | 47.00 | 3                                   | 49.40 | 4                    | 47.05 | 9                       | 45.8-50.4  | 47.82 $\pm$ 0.50          | 1.49 $\pm$ 0.35  | 3.1 $\pm$ 0.73       |
| Least cranial breadth       | 3                          | 40.60 | 2                                   | 41.05 | 4                    | 37.90 | 9                       | 34.2-43.6  | 39.50 $\pm$ 0.98          | 2.95 $\pm$ 0.70  | 7.5 $\pm$ 1.76       |
| Supraorbital breadth        | 3                          | 65.33 | 2                                   | 63.40 | 5                    | 62.80 | 10                      | 61.0-69.4  | 63.68 $\pm$ 0.79          | 2.49 $\pm$ 0.56  | 3.9 $\pm$ 0.88       |
| Interorbital breadth        | 3                          | 46.90 | 3                                   | 44.63 | 5                    | 44.44 | 11                      | 42.7-50.8  | 45.16 $\pm$ 0.65          | 2.15 $\pm$ 0.46  | 4.8 $\pm$ 1.02       |
| Palatal breadth at M2       | 3                          | 42.10 | 2                                   | 42.90 | 5                    | 40.06 | 10                      | 37.2-48.6  | 41.24 $\pm$ 1.10          | 3.49 $\pm$ 0.78  | 8.5 $\pm$ 1.89       |
| Breadth at M1               | 3                          | 80.20 | 2                                   | 77.40 | 5                    | 76.76 | 10                      | 75.6-84.2  | 77.92 $\pm$ 0.78          | 2.47 $\pm$ 0.55  | 3.2 $\pm$ 0.71       |
| Palatal breadth at P2       | 3                          | 32.33 | 2                                   | 33.30 | 5                    | 33.32 | 10                      | 30.7-35.4  | 33.02 $\pm$ 0.45          | 1.43 $\pm$ 0.32  | 4.3 $\pm$ 0.97       |
| Breadth at canines          | 3                          | 45.70 | 1                                   | 46.3  | 5                    | 45.94 | 9                       | 43.7-49.2  | 45.90 $\pm$ 0.59          | 1.78 $\pm$ 0.42  | 3.9 $\pm$ 0.92       |
| Palatal-supraorbital height | 3                          | 71.70 | 3                                   | 70.67 | 5                    | 71.26 | 11                      | 67.6-75.7  | 71.22 $\pm$ 0.81          | 2.68 $\pm$ 0.57  | 3.8 $\pm$ 0.80       |
| Nasal length                | 3                          | 79.00 | 2                                   | 76.25 | 5                    | 78.40 | 10                      | 73.4-81.4  | 78.15 $\pm$ 0.78          | 2.45 $\pm$ 0.55  | 3.2 $\pm$ 0.70       |
| Incisive foramen length     | 3                          | 12.43 | 2                                   | 11.55 | 5                    | 13.96 | 10                      | 9.6-15.0   | 13.02 $\pm$ 0.54          | 1.72 $\pm$ 0.38  | 13.2 $\pm$ 2.95      |
| Length C to M2              | 3                          | 99.6  | 2                                   | 101.4 | 5                    | 101.5 | 10                      | 97.3-103.7 | 100.9 $\pm$ 0.25          | 0.78 $\pm$ 0.17  | 0.8 $\pm$ 0.17       |
| Length C to P4              | 3                          | 43.53 | 2                                   | 42.50 | 5                    | 41.02 | 10                      | 37.8-45.4  | 42.07 $\pm$ 0.68          | 2.16 $\pm$ 0.48  | 5.1 $\pm$ 1.15       |
| Length P4 to M2             | 3                          | 45.50 | 3                                   | 47.90 | 5                    | 48.16 | 11                      | 44.5-50.3  | 47.36 $\pm$ 0.48          | 1.58 $\pm$ 0.34  | 3.3 $\pm$ 0.71       |
| Crown length of P3          | 3                          | 16.47 | 2                                   | 17.45 | 5                    | 17.16 | 10                      | 16.0-17.5  | 17.01 $\pm$ 0.15          | 0.48 $\pm$ 0.11  | 2.8 $\pm$ 0.63       |
| Crown breadth of P3         | 3                          | 7.53  | 2                                   | 7.30  | 5                    | 6.62  | 10                      | 6.3-8.3    | 7.03 $\pm$ 0.24           | 0.75 $\pm$ 0.16  | 10.7 $\pm$ 2.39      |
| Crown length of P4          | 3                          | 25.60 | 2                                   | 26.80 | 5                    | 26.48 | 10                      | 24.8-27.1  | 26.28 $\pm$ 0.23          | 0.73 $\pm$ 0.16  | 2.8 $\pm$ 0.62       |
| Crown breadth of P4         | 3                          | 14.13 | 2                                   | 14.65 | 5                    | 14.62 | 10                      | 13.5-15.2  | 14.48 $\pm$ 0.16          | 0.50 $\pm$ 0.11  | 3.4 $\pm$ 0.77       |
| Crown length of M1          | 3                          | 16.70 | 3                                   | 17.43 | 5                    | 17.46 | 11                      | 16.2-18.3  | 17.25 $\pm$ 0.16          | 0.53 $\pm$ 0.11  | 3.1 $\pm$ 0.66       |
| Transverse diameter of M1   | 3                          | 22.77 | 3                                   | 24.00 | 5                    | 22.60 | 11                      | 21.9-24.3  | 23.03 $\pm$ 0.23          | 0.77 $\pm$ 0.16  | 3.3 $\pm$ 0.71       |
| Crown length of m1          | 3                          | 29.40 | 3                                   | 29.80 | 5                    | 29.98 | 11                      | 29.1-31.0  | 29.77 $\pm$ 0.17          | 0.58 $\pm$ 0.12  | 1.9 $\pm$ 0.41       |
| Coronoid height             | 3                          | 66.33 | 3                                   | 69.30 | 5                    | 67.14 | 11                      | 62.9-71.9  | 67.51 $\pm$ 0.73          |                  |                      |
| Bulla 'volume'              | 3                          | 50.93 | 3                                   | 54.27 | 3                    | 59.40 | 9                       | 46.3-66.9  | 54.87 $\pm$ 2.71          | 8.14 $\pm$ 1.92  | 14.8 $\pm$ 3.49      |
| Cube root bulla 'volume'    | 3                          | 3.703 | 3                                   | 3.780 | 3                    | 3.890 | 9                       | 3.59-4.06  | 3.79 $\pm$ 0.062          | 0.19 $\pm$ 0.044 | 4.9 $\pm$ 1.16       |
| Skull weight                | 3                          | 285.3 | 1                                   | 293   | 3                    | 282.7 | 7                       | 254-333    | 285.3 $\pm$ 9.49          | 25.1 $\pm$ 6.71  | 8.8 $\pm$ 2.35       |

In view of the small number of female skulls available, as many measurements as possible have been obtained, even from badly broken skulls. The significance of the differences between populations have not been tested.



are roughly of the same order and which might be entirely removed by partial correlation with condylobasal length or some similar measure of total size. This, however, would not alter the fact that there is a more natural relationship between these measurements than there is between those of Table 29.

The selection of measurements which, in combination, will give a high order of separation may be taken further than in Table 29. For instance, if the ratio, supraorbital breadth/crown length of P3 for the individual specimens is added to the ratio mastoid breadth/length P4 to M2 inclusive and divided by the cube root of the weight of mercury held by the auditory bulla, the mean for the Banks Island 1953-5 series (ten specimens) is  $1.55 \pm .020$  and for the Ellesmere Island series (17 specimens),  $1.32 \pm .025$ . The joint non-overlap is 92 per cent. The Prince Patrick Island mean, 1.43 for four specimens, is again intermediate.

*Description of measurements used in Tables 30 and 31<sup>1</sup>*

- ◊†\* *Condylobasal length.* From the centre of the posterior plane of the occipital condyles to the anterior tip of the premaxillae above or between the incisors.
- ◊†\* *Occipital length.* From the inion to the anterior extremity of the premaxillae.
- ◊†\* *Zygomatic breadth.* Greatest breadth across the zygoma.
- \* *Mastoid breadth.* Greatest breadth across the mastoid processes.
- \* *Breadth of condyles.* Greatest breadth across the occipital condyles.
- †\* *Least cranial breadth.* The calipers were tilted as necessary to obtain the least measurement.
- \* *Supraorbital breadth.* Greatest breadth across the supraorbital processes.
- \* *Interorbital breadth.* Least breadth across the frontals between the orbits.
- \* *Palatal breadth at M2.* Least breadth between the inner borders of the alveoli of M2.
- \* *Breadth at M1.* The greatest breadth between the outer sides of M1 immediately below the cingulum. Except in some old skulls where the bone has retreated, this measurement is virtually the same as the breadth between the outer borders of the alveoli, and, if the teeth were loose or missing, that measurement was substituted. It is perhaps slightly greater than Haag's "width of palate at M1" as he seems to have taken this between P4 and M1, whereas the greatest width is slightly farther back.
- \* *Palatal breadth at P2.* The least breadth between the inner borders of the alveoli of P2.
- \* *Breadth at canines.* The greatest breadth across the maxilla at or above the alveoli of the canines.
- \* *Palatal-supraorbital height.* The height obtained by placing one arm of the calipers across the palatal processes behind the posterior extremity of the maxilla and the other arm immediately above the supraorbital process. This is not a very precise measurement as some skulls slope considerably at the supraorbital process, but it avoids the bias introduced by the increasing height of the sagittal crest with age if the measurement is taken at the bregma. The measurement was normally taken on the right side of the skull.
- \* *Nasal length.* From posterior tip to the anterior central notch. When there was a difference in length between the two nasals the longer was measured.
- \* *Incisive foramen length.* The slot, or backward projection, of the foramen, present in some skulls at the junction of the maxilla and premaxilla, was not included.
- ◊ \* *Length C to M2.* From the anterior edge of the alveolus of the canine to the alveolus of the outer posterior root of M2. Goldman uses crown length; Anderson apparently measured the type, as here, at the alveolus.

<sup>1</sup>The symbols ◊†\* indicate that the measurements or their equivalents have been used respectively by Anderson (1943), Goldman (Young and Goldman, 1944), and Haag (1948). Haag gives excellent diagrams to show his measurements, Goldman a brief description, and Anderson no description. The last two authors therefore leave the exact method of measurement used in doubt. Where necessary a check was made on the three type specimens measured by Anderson.



*Length of C to P4.* Measured from posterior edge of the alveolus of C to the anterior edge of the alveolus of P4.

*Length P4 to M2.* Measured from the anterior extremity of the cingulum of P4 to the posterior extremity of the cingulum of M2.

*Crown length of P3.* Measured at the cingulum.

*Crown breadth of P3.* Measured at right angles to the tooth length at the cingulum above the posterior root.

°†\* *Crown length of P4.* The calipers were held in a vertical plane and the tips placed on the most anterior and most posterior extremities of the tooth at the mid-line or on the labial side. The bar of the calipers therefore sloped in an anterior direction towards the dorsal surface of the skull.

°† *Crown breadth of P4.* The maximum horizontal width (not necessarily between opposite points) of the tooth measured at the cingulum and at right angles to the mid-line of the tooth. The calipers, with their points facing posteriorly, were held as near to the horizontal plane as the other teeth would permit. This is not a satisfactory measurement as some teeth are badly worn on the lingual side.

°† *Crown length of M1.* The maximum length obtainable near a line joining the two outer cusps. The calipers may be held vertically or horizontally with their tips facing inward. In either case, P4 appears to prevent measurement to the extreme anterior point of the cingulum; the amount unmeasured is, however, apparently reasonably constant from skull to skull, and the measurement can be repeated consistently on the same skull.

°† *Diagonal crown length of M1.* The maximum measurement obtainable when one point of the calipers is placed on the cingulum at the outer side of the tooth near the anterior border and the other on the cingulum at the inner side of the tooth.

°†\* *Crown length of m1.* The distance between the cingulum on the outer posterior border and that on the inner anterior border; measured by holding the calipers vertically and pressing one tip against the outer side of m2 and the other against the inner side of p4.

°† *Height of coronoid process.* One arm of the calipers was placed on the highest point of the coronoid process, and the other moved along the lower border of the jaw until the least measurement was obtained. This measurement proved surprisingly accurate, and could be repeated consistently. Anderson apparently took his measurements in a similar manner, but those of Goldman are probably two or three millimetres greater. *Bulla 'volume'.* The weight of mercury required to fill the auditory bulla. With the skull flat on the table the right bulla (or left if the right was broken) was filled with mercury until it could be seen through the auditory meatus when the observer's eye was at table level. The mercury was then shaken out and weighed to the nearest tenth of a gram. The method is rather laborious and not entirely satisfactory owing to variation in slope of the meatus and to the meniscus on the surface of the mercury. Repeat measurements can be made to within about two grams.

*Skull weight.* The skull, less mandible, was weighed to the nearest gram. Unfortunately a large number of skulls had broken teeth or other small pieces missing. Allowance was made for these, but it undoubtedly decreased the accuracy of the results.

**Comparison of skins.** The 92 wolf skins in the National Museum from northern, central, and western Canada were examined. They appeared to fall into three distinct colour phases: black, grizzled, and grey. There is one black skin from Artillery Lake, on the edge of the barren grounds, and one which is probably black (although, being in poor pelage, it cannot be distinguished with certainty from the grizzled phase) from Port Epworth on Coronation Gulf. A number of black and grizzled skins were also seen by Manning in 1946 at the Hudson's Bay Company's warehouse at Coppermine on Coronation Gulf. However, we know of no records of any black or grizzled skins from the arctic islands, including Baffin Island.

The 72 skins of the grey phase were divided into classes 0 to 10 according to the amount of black or grey in the pelage, and then into classes 0 to 6



**Table 32.** Skins of grey-phased *C. lupus* classed for blackness and redness.

| Grades | Ellesmere<br>Id. | Prince<br>Patrick<br>Id. | Banks<br>Id.<br>1953-5 | Banks<br>Id.<br>1914-16 | Baffin<br>Id. | <i>mackenzii</i> | <i>hudsonicus</i> | Wood<br>Buffalo<br>Park | Prince<br>Albert<br>National<br>Park |
|--------|------------------|--------------------------|------------------------|-------------------------|---------------|------------------|-------------------|-------------------------|--------------------------------------|
| 0      | 2 <b>3</b>       | - -                      | - -                    | - <b>1</b>              | 2 <b>2</b>    | - <b>1</b>       | 2 <b>1</b>        | - <b>1</b>              | - -                                  |
| 1      | 5 <b>4</b>       | - <b>1</b>               | 1 <b>1</b>             | 1 <b>2</b>              | 2 <b>2</b>    | 1 -              | - <b>1</b>        | - -                     | - <b>1</b>                           |
| 2      | 3 <b>2</b>       | - -                      | - -                    | 2 -                     | 1 <b>1</b>    | - -              | - -               | - <b>2</b>              | - <b>2</b>                           |
| 3      | - <b>1</b>       | - -                      | - -                    | 1 -                     | 2 -           | - <b>1</b>       | - -               | 1 <b>6</b>              | 2 <b>2</b>                           |
| 4      | - -              | 1 -                      | 2 <b>1</b>             | 1 <b>1</b>              | - <b>1</b>    | 1 -              | - -               | 8 <b>3</b>              | 1 <b>1</b>                           |
| 5      | - -              | - -                      | - -                    | 1 <b>1</b>              | - <b>1</b>    | - -              | - -               | 8 <b>3</b>              | 4 -                                  |
| 6      | - -              | - -                      | - <b>1</b>             | - <b>1</b>              | - -           | - -              | - -               | - <b>2</b>              | - <b>1</b>                           |

Blackness is graded from 0 to 5 and the number of specimens indicated by figures in Roman type; redness from 0 to 6 and specimens indicated by figures in bold type.

according to the amount of red. Those in class 0 entirely lacked the colour being considered. The differences between classes were about the maximum which could be distinguished, and, as a small difference in the amount of red or black on two nearly white skins is much more easily seen than a similar difference in two dark skins, the progression from class to class was not arithmetic. The results for the groups concerned in the present study are given in Table 32 with the number of black classes reduced by combining classes 1 and 2, 3 and 4, etc. Two woodland series were also included for comparison. They average distinctly darker, due more to an increase in the black than in the red hair, although there was often a difference between the woodland and barren ground skins in shade of red and in the manner in which it occurred. In the darker woodland skins the red may have been partly concealed by black.

The type of *C. l. bernardi* is unusually dark for an arctic island skin, and, as Anderson (1943) remarks, is almost entirely without any yellowish (or red) tinge. However, the 1914-16 Banks Island series is, on the whole, more, rather than less, red than the small available series of *C. l. mackenzii* from Coronation Gulf and of *C. l. manningi* from Baffin Island. The three 1953-5 Banks Island skins average still redder, and the reddest skins of both Banks Island series are well matched and quite distinct from any other skins in the arctic island or barren ground series. However, a wolf seen by Manning (1943) on Baffin Island appeared very similar, and it is tentatively suggested that wolves of the southern arctic islands and possibly of the northern mainland may have similar colour ranges without this necessarily implying close relationship. Table 32 indicates that Ellesmere Island wolves are less pigmented. The significance of this was tested by analysis of variance of the four series, Ellesmere Island, Banks Island 1953-5 and 1914-16, and Baffin Island. The grades were considered as units of measurement, and the probable skewness of the distribution ignored. The result showed a difference, presumably caused by the Ellesmere series, which was significant at the 5 per cent



level for both redness and blackness. No useful information can be deduced from the limited number of mainland barren ground specimens seen, and it is suspected that the white, near white, and black wolves which make up the *C. l. hudsonicus* series and which were taken at Artillery Lake during the winter of 1924-5 are not a random sample.

**Summary and discussion.** From the foregoing text and tables it is concluded that the wolves now occupying Banks Island, Prince Patrick Island, and Ellesmere Island are subspecifically distinct from the population occupying the mainland barrens of Canada and Alaska. The present Banks Island population (1953-5 series) is, however, very different from that which apparently occupied the island forty-five years ago (1914-16 series) and which was described by Anderson (1943) as *C. l. bernardi*. These wolves had relatively long, narrow, flat skulls, whereas the present population (1953-5 series) has exceptionally short, broad, high skulls. The present Banks Island population is closely related to that of Prince Patrick Island which, from geographical position, is almost certainly similar to that of Melville Island, the type locality of *C. l. arctos*. Moreover, Melville Island is closer to Banks Island than is Prince Patrick Island, and the ice between Banks Island and Melville Island is probably solidly frozen for a longer period in the winter, so that any connection between the fauna of Prince Patrick Island and Banks Island may be expected to lie through Melville Island. The present Banks Island wolves may therefore be assigned to *C. l. arctos* with confidence. They may represent a recent invasion of Banks Island either from Melville Island or from northern Victoria Island.

The relationship of the wolf represented by the 1914-16 Banks Island series is more mysterious, as, for the measurements analysed in detail, it not only resembles the wolves of the mainland barren grounds, *C. l. tundrarum* and *C. l. hudsonicus*, but appears to have the characters which separate these from the arctic island series accentuated, whereas the mainland race nearest to Banks Island, *C. l. mackenzii*, tends towards the island series. Moreover, the means of the *C. l. mackenzii* series examined would be closer to those of the island series if the two specimens of the former taken in 1946 some distance inland from the coast were eliminated and the five taken on or near the mainland coast of Coronation Gulf between 1915 and 1917 were considered separately. The obvious first thought is that the original *C. l. mackenzii* series and the *C. l. bernardi* series might have become confused at some time. Certainly there has been some confusion within the latter series as far as skulls, mandibles, and skins are concerned, but in view of the difference in numbers, a complete interchange of the series seems unlikely, and a partial interchange appears improbable because of the similarity of the skulls within the 1914-16 Banks Island series. However, neither possibility can be ruled out completely, nor can the possibility that the 1914-16 series, which all came from the Cape Kellett region, represents a small group which came across the ice at about that time from Cape Bathurst or Cape Parry. Unfortunately, the only specimen from that part of the mainland is a badly broken skull from the Eskimo Lakes, and about all that can be said about it is that it is not obviously different from the 1914-16 Banks Island series. However, three large skulls from the Reindeer Station suggest that *C. l. occidentalis* may occupy the country about the mouth of the Mackenzie, and the 1914-16



Banks Island skulls certainly resemble those of that race in general form although they are much smaller and lighter. It is possible that until very recently the Banks Island wolf was a long, narrow, low-skulled form, and that after some epidemic or other natural disaster it was replaced by migrants from Melville Island or northern Victoria Island.

The broken skull of a young wolf picked up at an Eskimo camp at the Thomsen River and estimated to be about 100 years old agrees best with the 1914-16 Banks Island series (Table 26), and therefore suggests that a population of that form may have occupied the whole island for a long period. However, another broken skull, also from a young wolf, dug from an old Eskimo house at Cape Cardwell, estimated at 400 years old, tends more towards *C. l. arctos*. Neither skull is in any way conclusive, and more old material is most desirable, as, indeed, is also another series of modern specimens.

Some possibilities relative to the significance and origin of the 1914-16 series have been pointed out in the above paragraphs. No more can be done until the supposed races occupying the northern mainland are better known. For this, good series are required from the region to the south and southwest of Banks Island, from Coronation Gulf, and from the Back River area. In the meantime, the status of the name *bernardi* must remain in doubt. It certainly cannot be considered a synonym of *arctos*, but may well prove to be a synonym of one of the mainland barren ground races which may themselves have to be united as a single race, *C. l. tundrarum*.

There are a number of significant differences between the Banks Island and the Ellesmere Island series. The Prince Patrick Island series, and therefore, presumably, the population of Melville Island, the type region of *C. l. arctos*, falls between the two. When unadjusted linear measurements (Tables 30 and 31) are considered, the Prince Patrick Island series is often a little nearer to that of Ellesmere Island than to that of Banks Island. However, the size of the auditory bullae of the Prince Patrick Island specimens, as well as their general appearance, agrees better with the Banks Island 1953-5 series than with the Ellesmere Island series, and it is considered that, if at a future time a racial division between the Banks Island and the Ellesmere Island populations proves desirable, the dividing line will lie east of Melville Island, so that the Banks Island, Prince Patrick Island, and Melville Island populations will remain *C. l. arctos*. No specimens have been seen from Greenland, but on geographical grounds it seems quite likely that they may be very similar to those from Ellesmere Island, in which case, the latter may prove referable to *C. l. orion*.

It has been shown (Table 26) that for some characters the Ellesmere Island population tends towards that of the mainland. Whether this implies any direct relationship or recent contact, or is merely coincidence, can be judged only when specimens from the northeastern mainland barrens, Boothia Peninsula, and Prince of Wales Island or Somerset Island become available. They are urgently needed, as the decreasing caribou population will make wolves harder to obtain and will increase the likelihood of invasion of one area by populations from another. More material is also needed from Baffin Island, but from a casual examination of the small series available, it seems unlikely that there has been any direct contact between the wolves of that island and those of Ellesmere Island.



The wolf skins in the National Museum collection can be divided into three distinct colour phases, but only the grey phase has been recorded from the arctic islands. Within this phase there is great individual variation, and the available skins did not aid materially in the classification of the Banks Island population.

*Skins and skulls examined*<sup>1</sup>

*C. l. arctos*. **Banks Island 1953-5.** *Adult males*: 21100, 21458, 21464, 21466, 21545\*, 21546\*, 22025, 22026. *Adult females*: 21465, 21544\*, 22024. *Subadults*: ? Thomsen River skull 21468. *Cubs* (with deciduous teeth still present): 21459, 21460, 21461, 21462, 21463. **Prince Patrick Island.** *Adult males*: 21455, 21520\*, 21564, 21565, 21566, USNM 291008, USNM 291009. *Adult females*: 21472, 21563, USNM 291010.

*C. l. arctos* ? **Ellesmere Island.** *Adult males*: 8802, 8803, 8804, 21454\*, 21456, 21519\*, 21521\*, 21522\*, 21523\*, 21524†, 21526†, 21527†, 21528, 21530, 21604, 21730, USNM 282818, USNM 283586. *Adult females*: 21731, 21732, 21733, USNM 282817, USNM 282819. *Sex* ? : 21457, 21525†, 21529. *Subadults*: 21836†.

*C. l. bernardi*. **Banks Island 1914-16.** *Adult males*: 3507\*. *Adult females*?: 3506\*. *Subadults*: 2793\*, 2794\*, 2795\*, 2796\* (type), 3504, 3505, ?Cape Cardwell skull 21467.

*C. l. tundrarum*. *Adult males*: Point Barrow R 11574; Noatak River USNM 264415, USNM 274486, USNM 274487; Anaktuvuk Pass USNM 294404; Arctic Village R 11409; Upper John River USNM 290421, USNM 290423, USNM 290424, USNM 290426, USNM 290427, USNM 290433. *Adult females*: Noatak River USNM 274485; Anaktuvuk Pass USNM 290425, R 10500, R 11455; Arctic Village USNM 294403; Upper John River USNM 290420, USNM 290422, USNM 290429, USNM 290431; Tulugak Lake USNM 290430; Lake Schrader USNM 292928; Ikiakpuk Creek R 10513.

*C. l. mackenzii* ? *Adult males*: Coronation Gulf 2789, 2791\*, 2792\* (type). *Adult females*: Coronation Gulf 2790, 4868\*. *Sex* ? : Head of Hood River 19173, 19174.

*C. l. hudsonicus* ? *Adult males*: Back River 17165; Artillery Lake 5980†, 5981†, 6005, 6006; Eskimo Point area UBC 6893, UBC 6902; Tern Point area UBC 6896. *Adult females*: Artillery Lake 5982†, 6004; Tern Point area UBC 6894, UBC 6895. *Adults Sex* ? : Artillery Lake 6003, 14916, 14919, 14920, 14923; Clinton-Colden Lake 17043; Eskimo Point area UBC 6897, UBC 6898, UBC 6899, UBC 6901, UBC 6903, UBC 6904. *Subadults*: Artillery Lake 14917, 14918, 14921, 14922; Ptarmigan Lake 17039, 17040, 17041, 17042; Eskimo Point area UBC 6900, UBC 6905, UBC 6906.

*C. l. manningi* ? Baffin Island 94†, 15489†, 15490†, 17236† (type), 21469†, 21470†, 21471†.

*Previous records and field observations*

Wolves are moderately plentiful throughout Banks Island, but are probably commonest on the north coast, although in summer they may follow the caribou to the interior grasslands. In the winter of 1851-2 the members of M'Clure's expedition found wolves both numerous and troublesome, although apparently seldom seen in groups of more than seven, and usually difficult to approach within shooting distance (Armstrong, 1857, particularly pp. 484, 488, 556). Only two were killed (M'Clure, 1854, p. 54). They were both males and weighed 80 lb. and 70 lb. respectively. The larger, which was 5 feet 10 inches long, had a skin of "spotless white" (Armstrong, 1857, pp. 556-7). Stefansson (1921, p. 255) notes that in 1914 wolves became numerous on the flat land inland from Bernard Island at about the

<sup>1</sup> \* denotes skin and skull examined, † skin only; unmarked numbers refer to skulls only. Baffin Island skulls were not measured and therefore are not included in the list. Ninety-two skins of wolves were examined, but only those from north of the tree-line are listed. All specimens are in the National Museum of Canada unless otherwise indicated.



time the does and small buck caribou arrived there. That was apparently about the beginning of August. Later that autumn wolves were numerous in the southwest part of the island, and packs of up to ten were frequently seen (Stefansson, 1921, p. 281).

According to the Eskimos, wolves were particularly plentiful in southern Banks Island in November 1951 when an unusually large number of caribou came south. On 27 June 1952 we saw two wolves near their empty den on the south side of the Masik River valley about fifteen miles from the coast. Two were seen on the west side of De Salis Bay on July 11, and one at the same place on July 17. On September 5 we saw two wolves near the source of the Muskox River. Wolf tracks were seen in many places along the shore, particularly on the north coast.

Wolves were apparently fairly numerous in southwest Banks Island during the winter of 1952-3. Manning saw two together near the Bernard River on 9 July 1953, and two singly next day. On July 14 he saw one near the Muskox River. On July 22 five or six were within about 400 yards of his camp at Mahogany Point and were chased by his three dogs. Much to Manning's surprise there was no fighting, and, after fraternizing for a few minutes, the dogs trotted back to camp and the wolves went off.

***Alopex lagopus innuitus* (Merriam).** Arctic Fox.

**Taxonomy.** Merriam (1902) based his description of *A. l. innuitus* on skull differences, and, as summer skins show considerable individual variation and are not easily obtained in large numbers, it is likely that any further division or regrouping of the North American races will also result from skull comparison.

Our collection of Banks Island Arctic Fox skulls consists of 33 males, 28 females, 11 probable females, and 13 unsexed. Most of them were obtained from carcasses of foxes trapped by the Eskimos in previous winters, and, while the males could be sexed with certainty by the presence of a baculum (22 collected), some of the more decayed carcasses could only be assumed female by its absence. The National Museum also has 62 skulls from Banks Island, obtained by the Canadian Arctic Expedition, and McEwen's uncatalogued collection. Comparative material from the Eastern Arctic is less plentiful, and specimens of the doubtful race, *A. l. ungava*, are particularly needed. As the major revision required is beyond the scope of this paper, the skulls have not been studied.

We obtained ten summer and early autumn skins of foxes one year or more old, 12 young from one litter, and three from another. While still fresh, they were compared with the Canadian Arctic Expedition's summer or early autumn Banks Island series and with scattered summer specimens from other parts of Canada. However, too few of the latter were available for possible geographical variation to be detected. Although taken forty years ago, most of the Canadian Arctic Expedition's specimens do not seem to have changed colour seriously. Besides the summer specimens in the Canadian Arctic Expedition's series from Banks Island, there are two blue-phased December skins, two white winter skins, and a number of uncatalogued white skins, probably from Banks Island.



**Table 33.** Weights in pounds and measurements in millimetres of adult *A. l. innuitus* from Banks Island.

| NMC No. | Place          | Date          | Wt. | Total length | Tail        | Hind foot | Testis |
|---------|----------------|---------------|-----|--------------|-------------|-----------|--------|
|         |                |               | ♂ ♂ |              |             |           |        |
| 20997   | De Salis Bay   | 11 June 1952  | —   | 875          | 308         | 152       | 23     |
| 21008   | Mahogany Point | 26 Aug. 1952  | —   | 900          | 315         | 161       | —      |
| 21048   | Mahogany Point | 20 July 1953  | 8   | 890          | 340         | 147       | —      |
| 21060   | Mahogany Point | 25 July 1953  | —   | 880          | 320         | 150       | —      |
| Mean    |                |               | 8   | 886          | 321         | 153       | 23     |
|         |                |               | ♀ ♀ |              |             |           |        |
| 20999   | Nelson River   | 21 July 1952  | —   | 830          | 305         | 142       |        |
| 21007   | Mahogany Point | 24 Aug. 1952  | —   | 790          | 282         | 139       |        |
| 21009   | Mahogany Point | 27 Aug. 1952  | —   |              | tail broken | 139       |        |
| 21010   | Cape Kellett   | 20 Sept. 1952 | —   | 835          | 315         | 147       |        |
| 21046   | Thomsen River  | 17 July 1953  | 7   | 820          | 230         | 142       |        |
| 21047   | Mahogany Point | 20 July 1953  | 7½  | 820          | 300         | 140       |        |
| Mean    |                |               | 7½  | 819          | 286         | 142       |        |

The mean weight and measurements of the 12 young in the Mahogany Point litter taken between 22 and 25 July 1953 are: weight (8 ♂♂, 4 ♀♀) 2.5 (2–3) lb., total length (7 ♂♂, 4 ♀♀) 562 (540–580) mm., tail (7 ♂♂, 4 ♀♀) 191 (180–205) mm., hind foot (6 ♂♂, 4 ♀♀) 112 (105–117) mm.; and of the Back Point litter (3 ♂♂) taken 20 August 1953: weight 1.8 (1½–2) lb., total length 436 (420–453) mm., tail 135 (125–140) mm., hind foot 85 (83–88) mm.

**Pelage changes and comparisons of summer skins.** On 3 June 1952 one fox was seen in full white winter pelage, and one which was white except for its dark rump. A fox in patchy pelage was seen on June 5, and a male, NMC 20997, in similar pelage was shot on June 11. The white fur on this specimen was quite loose, and most of it rubbed off during the skinning. All foxes seen after that date in 1952 were in summer pelage, but one seen on 13 July 1953, near the Muskox River, was still half white. The two lactating females, NMC 21046, taken 17 July 1953, and 21047, taken July 20, are in perfect summer pelage. Judging from the limited material available from Banks Island and elsewhere, the adult female Arctic Fox develops a more perfect summer coat and retains it longer in good condition than the male. There may also be some colour difference, but sufficient suitable skins are not available to be sure of this. In prime summer pelage the dorsum is usually between Natal Brown and Bone Brown. In NMC 21744, a male from James Bay, it is Mars Brown. In some specimens a varying amount of the dorsal hair has a band of Warm Buff near the tip, which gives the back a flecked appearance. This flecking does not seem to be correlated with geography, as there are flecked specimens in the Banks Island series, and NMC 21744 from James Bay is heavily flecked, whereas flecking is absent on NMC 14982 from the Gulf of St. Lawrence. In one Banks Island male, NMC 21048, taken July 20, most of the dorsal hair has pale, Light Buff, tips or bands, and the general dorsal surface



colour is Drab or Light Drab, which shades to Light Buff, rather than to the usual Warm Buff, on the sides.

The adult autumn pelage is much bluer than the summer, and appears quite distinct from it, a fact which does not seem to have been recorded, although Manniche (1910, p. 49) says that two young foxes shot in northeast Greenland were bluish grey. The only specimens in the National Museum showing this autumn pelage fully developed are 21007 and 21009. Both are females taken at Mahogany Point on August 24 and 27. On the surface their backs are a little browner than Deep Quaker Drab. This shades to Pallid Mouse Gray near the skin. The sides are tinted with Pale Ochraceous-Buff; the belly is white. The dorsum of a male, NMC 21008, taken at Mahogany Point on August 26, averages Smoke Gray and shades to white on sides and belly without any buff tinting. Thus it is much paler than the females taken on August 24 and 27. Presumably it is farther advanced towards winter pelage. A female, NMC 21010, taken at Cape Kellett on September 20, is paler than Smoke Gray, that is to say, nearly white.

Young of the year are usually later in changing into winter pelage than the adults. The backs of nine skins, which, from their small size, are clearly those of young foxes, taken by the Canadian Arctic Expedition at Cape Kellett between October 1 and 29, still average Cinnamon Drab to Benzo Brown, with little or no change between these dates. The belly and sides of this series are, however, much whiter and the backs rather paler than those of the litter taken at Mahogany Point between July 22 and 25. The centre of the backs of this litter is Benzo Brown or a little darker. The still younger foxes taken at Back Point on August 20 have a bluer, less rusty tone, both on the back and on the sides and belly. Their backs are best matched by Deep Brownish Drab; their bellies, by Pale Brownish Drab. It is not clear if this difference between litters is individual or if it is due to season or to age. The belly of a young blue-phased specimen, NMC 6244, of similar age from Baffin Island is quite different; it is the same colour as the back, as in the adults.

#### *Previous records and field observations*

Some of the largest catches of Arctic Fox made by individual trappers in Canada come from Banks Island. This is partly explained by the fact that the relatively few trappers on the island use more traps than the Eskimos farther east, but there can be little doubt that Banks Island supports a relatively large fox population.

Foxes were apparently quite plentiful during the winter of 1850-1 at the Princess Royal Islands and during the following two winters at Mercy Bay (Armstrong, 1857), where about 50 were killed by the crew of the *Investigator* (p. 601). In the summer of 1949 Porsild (1950, p. 54) reported that foxes were scarce on Banks Island.

The lemming crashed on Banks Island in the spring or early summer of 1951, probably too late to affect adversely the breeding of young foxes. During the following winter foxes were at a peak and, as lemmings were scarce, the foxes were easily trapped, and the natives, about eight hunters, caught an estimated 2,000. In the spring of 1952 we saw a fair number of fox tracks at De Salis Bay and, after the snow had gone, an occasional fox, but in spite of the scarcity of lemmings the bait was not touched in 80 trap nights. At Castel Bay



foxes were plentiful, and two were caught in 12 trap nights; another was shot. While walking from twelve miles up the Thomsen River to Storkerson Bay on September 2 to 5, we saw numerous tracks for the first forty miles, after that they were scarcer, and between Storkerson Bay and Sachs Harbour, September 11 to 15, tracks were plentiful in the valley of the Egg River only.

Four fox burrows were found near De Salis Bay between June 3 and July 17, and one between there and Sachs Harbour in late June. A fox was in the burrow found on June 3, but when it was visited again on July 5 there was no sign of occupation. The other three burrows were unoccupied. From this and from the fact that the four foxes collected in the autumn were adults, we concluded that few Banks Island foxes bred during 1952. The Sachs Harbour Eskimos had also observed empty burrows and were of the same opinion. Next winter foxes were scarcer than in 1951-2, and the Eskimos caught fewer, although more than they had expected.

All five burrows found in 1953 were occupied. They were: 1) Near Sachs Harbour: adult seen, May 12. 2) Bernard Island: adult and five cubs seen, July 8. 3) Fifteen miles up the Thomsen River: female collected; four or more cubs seen, apparently about half grown, July 17. 4) Near Mahogany Point: male, female, and 12 young collected; at least one more cub remained in the burrow<sup>1</sup>, July 20-5. 5) Near Back Point: adult seen; three young collected, at least two remained, August 19-20.

A few of the Banks Island foxes are traded at Holman Island and a few at Aklavik, but most go to Tuktoyaktuk, and the fluctuations shown by records for this post are doubtless influenced by whether or not Eskimos have wintered on Banks Island. The percentage of blue-phased foxes on Banks Island is probably similar to the percentage at Holman Island and Tuktoyaktuk, which Fetherston (1947, p. 16) gives as .5 and .4 respectively. The "black Fox (*Canis Argentatus*)" seen at Mercy Bay on 11 November 1851 (Armstrong, 1857, p. 491), was almost certainly a blue Arctic Fox.

### *Ursus arctos richardsoni* Swainson. Grizzly Bear.

Following Ellerman and Morrison-Scott (1951) and Rausch (1953), the nearctic and palearctic forms of the Grizzly Bear are considered conspecific. If, as is reasonable to suppose, the barren ground form is subspecifically distinct from *U. a. horribilis*, the appropriate name will be *U. a. richardsoni*.

During the winter of 1951-2 the Banks Island Eskimo, Fred Carpenter, killed a Grizzly Bear in the Masik River valley. Unfortunately the skull was carried away by wolves, but the dried skin was seen at Sachs Harbour.

### *Thalarctos maritimus* (Phipps). Polar Bear.

**Taxonomy.** The most recent taxonomic study of *T. maritimus* appears to be that of Birula (1932). He recognized three races: *T. m. maritimus* (Phipps), west Spitsbergen, *T. m. marinus* (Pallas), western Siberia, and *T. m. groenlandicus* (Birula), west Greenland. Lack of specimens prevented Birula

<sup>1</sup>It appears (Braestrup, 1941, pp. 13-14) that more than 13 cubs to a litter are not infrequent in good lemming years. Twenty embryos have sometimes been found (cf. Clarke, 1938, p. 69).



from reaching any conclusion on the status of *T. m. eogroenlandicus* (Knottnerus-Meyer), east Greenland, or *T. m. labradorensis* (Knottnerus-Meyer), Labrador, although he says that the measurements given by Knottnerus-Meyer did not show any important differences between these supposed races and specimens from Novaya Zemlya and Siberia. The Siberian and west Greenland populations may be expected to isolate the Canadian and Alaskan population from the Spitsbergen population, and, if *T. m. marinus* and *T. m. groenlandicus* are recognized, it is hardly likely that the Canadian and Alaskan Polar Bears are referable to the typical race. However, the criteria given by Birula for the separation of *T. m. marinus* and *T. m. groenlandicus* are not very convincing. A regrouping of his data does indicate a possibility that the palaearctic and Atlantic populations may be separable from the remainder of the nearctic population, but until this is investigated further it seems best to consider *T. maritimus* as a monotypic species.

#### *Previous records and field observations*

The 19 Polar Bear skulls from Banks Island in the National Museum are here listed under "other records". Seven of these were collected by the Canadian Arctic Expedition; the remainder have been obtained since 1951 by McEwen and by us, chiefly by purchase from Eskimos. The largest, NMC 17028, which also appears to be the largest in the whole National Museum collection, was taken by G. H. Wilkins, and has a condylobasal length of 411 mm. and zygomatic breadth of 247.5 mm. The total length of the animal as given on the label is 240 cm.

The Polar Bear is fairly common on all coasts of Banks Island, and may doubtless be met occasionally on all parts of the island. Our experience suggests that they may be commonest on the south coast in the Nelson Head region, and, according to Stefansson (1913, p. 289), it was in that vicinity that the Victoria Island Eskimos used to hunt them in winter (actually, March and April). At times, bears must also be numerous in Prince of Wales Strait. Armstrong (1857, pp. 304-46) makes passing mention of 11 seen by the crew of the *Investigator* near the Princess Royal Islands between 29 March and 5 June 1851, but this is clearly not the total, for, writing of a period in early June (p. 342), he says, "Several Bears were daily seen making their way to the northward . . ." Several were also seen going northward by a hunting party in early May (p. 322). On 20 May 1941, when between the Princess Royal Islands and Berkeley Point, Larsen (1945, p. 76) recorded "numerous bear tracks".

On 19 August 1851 ten bears were sighted from the *Investigator* between the region of Storkerson Bay and Ballast Beach, and near the latter place at least seven, including two cubs, were seen between August 20 and September 9 (Armstrong, 1857, pp. 391, 407, 426). However, at Mercy Bay they were apparently scarce, and Armstrong (1857, pp. 485, 492, 529, 537) mentions only six (although others were very likely seen) for the entire period between September 1851 and June 1853. Probably more would have been observed had the *Investigator* been at the entrance to the bay instead of about ten miles up it. Frank Hennessey (Bernier, 1910, p. 512) says that members of the Bernier expedition who visited the northern coast of Banks Island, between Russell Point and Mercy Bay in the spring of 1909, reported that bears were abundant.



**Other records.** *East of De Salis Bay near floe-edge*: mid-January 1915, 2 killed, one seen, numerous tracks (Stefansson, 1921, pp. 289-90). *Off Cape Cardwell*: 1 September 1851, one killed (Collinson, 1889, p. 155); 1 September 1951, adult ♀ NMC 21156. *Off Nelson Head*: 17 August 1851, 2 seen (Armstrong, 1857, p. 381); 30 July 1953, one seen (Höhn, 1953). *Near Cape Lambton*: 23 August 1914, adult ♂ NMC 17029. *Between Cape Lambton and Sachs Harbour*: 5 September 1851, ♀ and cub killed, cub seen (Collinson, 1889, pp. 156-7); 2 September 1914, adult ♂ NMC 17028; 8 December 1914, ♀ cub NMC 17037; 10 December 1914, adult ♂ NMC 17027, adult ♀ NMC 17033. *Ten or twelve miles southeast of Mary Sachs* (near a whale carcass): 6 seen during one day, probably in November 1914, and 12 or more killed during the winter (Stefansson, 1921, pp. 286-7). *Near Sachs Harbour*: winter 1952-3, 2 adult ♂♂ NMC 21159, 21160, young ♀ NMC 21204, 2 ♂♂ cubs NMC 21157, 21158; 21 July 1953, adult ♀ NMC 21721, ♂ cub NMC 21722. *Near Cape Kellett*: 1914-16, adult ♂ NMC 17034; 8 December 1914, young ♀ NMC 17036. *Southeast Banks Island*: 1952, 3 adults NMC 21760, 21761, 21762, one cub NMC 21763. *Near Storkerson Bay*: early September 1914, one seen (Stefansson, 1921, p. 262). *Near Rodd Head*: 3 June 1909, one seen and many tracks to east and north (Bernier, 1910, pp. 172-4). *Near Russell Point*: 28 April 1909, 2 seen, bears had also visited the tent, destroyed sleeping bags, and eaten provisions (O. J. Morin in Bernier, 1910, pp. 133-4); 23 May 1852, one adult and 2 cubs seen and one adult killed (Collinson, 1889, p. 198). *Near the Princess Royal Islands*: 26 April 1852, one seen; 28 April 1852, tracks of an adult and cub seen; 28 and 30 May 1852, tracks seen (Collinson, 1889, pp. 190-1, 201-2).

We saw no bear tracks at De Salis Bay in the spring of 1952. On July 22 a small bear, probably about two and a half years old, walked along the shore towards our tent near the Nelson River. We chased it into the sea, but during the night it came back and, judging by the torn and chewed tarpaulin, must have climbed into the canoe, which was anchored in a small creek. In the afternoon the bear appeared once more, and unconcernedly rolled, apparently to scratch its back, within 50 yards of us. Between Nelson Head and the Masik River, August 27 and 28, we counted 15 bears, four of which were cubs of the year. On the following morning, one adult was seen half-way between the Masik River and Sachs Harbour. On August 6 a bear was seen on the ice just north of Storkerson Bay, and on August 11 one was sleeping on the shore 20 miles east of Cape Prince Alfred. At almost every place on the north coast where we landed in 1952 there were bear tracks in the sand or mud along the shore. Our cache, left for the winter of 1952-3 twelve miles up the Thomsen River (Manning, 1953, p. 191), was not touched by bears, but they knocked over the gasoline kegs left at Mahogany Point and chewed into the quart tins of engine oil. In 1953 Manning saw fewer bear tracks, partly because the shore east of Castel Bay is more stony and therefore less suitable for the preservation of foot prints. On August 30 a bear visited his camp at Wallace Point, and on the next day what was probably the same animal was seen on the ice nearby.

During the winter of 1952-3 the eight Sachs Harbour hunters killed 22 bears on southwest Banks Island (Höhn, 1953).

### *Mustela erminea arctica* (Merriam). Ermine.

There are four Ermine skulls from Banks Island in the National Museum: a young unsexed specimen, NMC 3525, taken at Cape Kellett by August Masik of the Canadian Arctic Expedition on 10 July 1917; an adult male, NMC 21096, taken by Macpherson on 13 July 1952 at Cape Cardwell; and one adult female, NMC 21746, and one young female, NMC 21745, taken by McEwen at the Egg River on 24 June 1955. The measurements of the adult female fit



those given by Hall (1951) for *M. e. arctica*; those of the male are unusually small and are closer to *M. e. semplei*. Following Hall's grouping, they must on geographical grounds be referred to *M. e. arctica*, at least until more material from Banks Island and the central arctic islands becomes available.

The month in which the young of the northern races of *M. erminea* are born does not appear to have been recorded. In the northern United States the young of *M. e. cicognanii* are born between mid-April and the second week in May (Hamilton, 1933, p. 316); those of the British form, *M. e. stabilis*, are generally born in April, and lactation ends during May (Deanesly, 1935, p. 490). Cowan and Guiguet (1956) give mid-April to early May as the period of birth in British Columbia. A specimen, NMC 20264, from Kluane Lake, Yukon Territory, taken on July 2, has not lost all its milk teeth, which, allowing 75 days for acquiring permanent dentition (Hamilton, 1933, p. 326; Hall 1951, p. 25), would mean that it was born in mid-April. In the two young Banks Island specimens, the sutures separating the nasals from the maxillae and premaxillae are clearly visible, and these specimens must therefore be young of the year (*see* Deanesly, 1935, p. 468; Hall, 1951, p. 25), but, as no milk teeth are present, they are probably two and a half to three months old. This would mean that the specimen taken on June 24 was born in early April or late March. However, Sutton (Sutton and Hamilton, 1932, p. 21) caught an apparently lactating female on July 5, and mentions four family groups, seen between then and July 27, which appear to have been distinctly younger than the two young Banks Island specimens. Evidently more information is required, and the report recorded by Freuchen (1935, p. 194) that more than one litter is born in good lemming years needs investigation, particularly as ovulations and infertile matings are known to occur during and after lactation (Deanesly, 1935, p. 491).

Only two Ermine skins from Banks Island have been seen. Although both were taken in mid-July, they are remarkably different. The dorsum of NMC 3525 is Buckthorn Brown, one of the 'reddest' skins of either *arctica* or *semplei* in the National Museum collection. The dorsum of NMC 21096, one of the least red, is almost Raw Umber.

According to the Eskimos, Ermine are seldom seen on Banks Island except in the vicinity of Nelson Head. However, the Eskimos do not now visit the hilly north coast. Two Ermine were killed at Mercy Bay by members of M'Clure's expedition (Armstrong, 1857, p. 537).

***Gulo luscus luscus* (Linnaeus).** Wolverine.

During the winter of 1951-2, the Eskimos saw a wolverine track near the Nelson River.

***Phoca hispida beaufortiana* Anderson.** Ringed Seal.

Anderson (1942) separated *P. h. beaufortiana* from *P. h. hispida* on the basis of 15 Western Arctic specimens, one of which was from Banks Island. As the Wisconsin glaciation must have separated the Atlantic and Pacific populations of *P. hispida*, it is reasonable to suppose that differentiation took place at that time and that *P. h. beaufortiana* may be more closely related to one of the eastern Siberian forms, either *P. h. birulai* or *P. h. krascheninikovi*,



than to *P. h. hispida* of the Atlantic side. In 1952-3 we obtained 13 skulls from Banks Island, and a further 11 have since been sent to the National Museum by the Eskimos Bertram Pokiak and Pat Herschel. McEwen collected eight skulls from Banks Island, and in 1951, we obtained 22 skulls from Herschel Island through the kindness of the Royal Canadian Mounted Police and five from western Victoria Island. One was obtained from Toker Point in 1952. In 1954 Macpherson collected a further nine skulls from Prince Patrick Island. Almost all are undamaged. They have not been studied for the present paper as Mr. Ian MacLaren of the Fisheries Research Board is working on the taxonomy of this seal.

Ringed Seals are doubtless present in the sea surrounding Banks Island throughout the year. They are plentiful about De Salis Bay and the Cape Kellett region, but are perhaps most abundant just south of Cape Prince Alfred. Armstrong (1857, pp. 242, 245) records that a few seals were seen in the open water amongst the pack near the Princess Royal Islands on 30 September and 5 October 1850, and on 2 May 1851 one was killed in the fire hole (p. 315). On 23 May 1852 Collinson (1889, pp. 198-202) saw a seal, apparently the first, on the ice about seven miles northeast of Russell Point on his way south down Prince of Wales Strait. He mentions five others before May 31, and several on June 1. At Mercy Bay (Armstrong, 1857, p. 538) on 23 July 1852 one seal was killed in the open water surrounding the *Investigator*, and another on the ice; a third was obtained in August (p. 601).

In view of the warm weather immediately following our arrival at De Salis Bay on 10 May 1952 we expected a few seals to be up on the ice. However, none was seen until May 20, when seven were observed near the northwest corner of the bay. On May 23, 18 seals were counted from the sandhills at the west side of De Salis Bay, and on the next day a number of others were observed along a stretch of smooth ice which ran southward toward Cape Collinson. On May 29, 35 seals were counted with 8 x 50 binoculars on patches of smooth ice off Cape Cardwell, and on June 7 there were 28 in one group and 12 in another about 8 miles east of that cape. Nineteen were counted from one stand on Cape Cardwell on June 8. A few others could be seen, but most of the ice was too rough for them to bask on. It was in this area that Stefansson (1921, p. 289) shot seals at the floe-edge in mid-January 1915. We saw no seals at the eastern end of De Salis Bay (that is, in the harbour area proper) until June 13, when two were sighted within about 200 yards of the shore. On June 29 we counted 60 seals while we were walking across De Salis Bay from about three miles south of Windrum Lagoon to the spit at the southeast side of the bay. The above figures are given to show the numbers which could usually be seen on fine days from different points, and do not include all the seals seen on the ice at De Salis Bay. On 15 May 1953 four seals were seen on the ice between Sachs Harbour and Cape Kellett. Between Cape Kellett and Mary Sachs the ice is usually rough, and only once were as many as five seals seen during Manning's stay from May 15 to June 24. On his walk up the coast, July 2-9, from the Lennie to the Bernard River, often along the beach, on sand bars paralleling the shore, and occasionally over the ice, about 25 seals were seen. More might have been expected, but the weather was rather cold. On August 13 one of the dogs caught a small silver jar in a shallow water lagoon at Back Point.



*Seals seen in 1952 from the canoe between De Salis Bay and Mahogany Point, and in 1953 between Mahogany Point and Russell Point*

*De Salis Bay to Nelson River:* July 20, dead calm, in loose pack ice, 6 hrs., **20** (half probably silver jars). *Nelson River to Cape Lambton:* July 27, moderately calm to rough, 5½ hrs., **7** (2 probably silver jars). *Cape Lambton to Sachs Harbour:* July 28–9, moderately calm to rough, 11½ hrs., **3**. *Sachs Harbour to Cape Kellett:* August 1, moderately rough to rough, 4 hours., **0**. *Cape Kellett to Storkerson Bay:* August 2–3, moderately calm, 16 hrs., seals scarce but no count made. *Storkerson Bay to Bernard Island:* August 6–10, rough to calm, in pack ice, 13 hrs., **1**. *Bernard Island to Cape Prince Alfred:* August 10–11, calm, a little ice, 10 hrs., **10**. *Cape Prince Alfred to Antler Cove:* August 11–12, calm, in loose pack ice, 18 hrs., **7**. *Antler Cove to Castel Bay:* August 18, calm in heavy pack, 12 hrs., **1**. *Castel Bay, seen from Mahogany Point camp:* 19–29 August 1952, **1**; 18 July–2 August 1953, **2** (appeared scarce both at entrance and within the bay). *Mercy Bay, canoeing around bay inside ice:* August 8–12, 24 hrs., **2** seen on a floe and **1** at the head of the bay. *Back Point to Russell Point:* August 22–9, weather and ice conditions variable, 21 hrs., **5**. *Fifteen miles south of Russell Point to Princess Royal Islands:* August 31–September 1, calm to moderately rough, 16 hrs., **20**.

***Erignathus barbatus nauticus* (Pallas).** Bearded Seal.

**Taxonomy.** Osgood (1904) stated that skulls of *E. b. nauticus* from Bering Sea had on the average shorter and broader nasals, wider braincase, palate, basisphenoid, and basioccipital, and heavier and thicker rostrum than skulls of *E. b. barbatus* from Greenland and northeast America. Also, in the western skulls, there was less space between the last two upper cheek teeth. Anderson, (1930, p. 99) considered these characters to be juvenal and inconstant, and later (1946) he synonymized the two races. However, measurement of the 12 (including two foetal) cleaned and moderately complete skulls in the National Museum suggests that Osgood was correct in considering the Pacific population more brachycephalic than the Atlantic. In particular, the mastoid breadth is less and the maxillary tooth row length greater relative to condylobasal length in the western form. An analysis of the measurements will be published elsewhere when additional specimens recently obtained have been cleaned.

*Previous records and field observations*

In spring and summer Bearded Seals occur on all coasts of Banks Island, but, as they do not normally live under thick, solid ice (cf. Vibe, 1950, p. 56), it is unlikely that they remain throughout the winter in M'Clure and Prince of Wales straits. Amundsen Gulf, however, is probably sufficiently broken for them, and Larsen (1945, p. 76) secured one near the Princess Royal Islands on 26 May 1941, and, according to the Eskimos, they come up on the De Salis Bay ice prior to break-up. In 1951 three Bearded Seals were seen on August 27 while we were anchored for a few hours off Cape Kellett, and three or four were observed on pieces of ice just off De Salis Bay on September 1.

During our canoe journeys in 1952 the following numbers of Bearded Seals were seen: *De Salis Bay to Nelson River:* July 20, 6 hrs., **5**. *Nelson River to Cape Lambton:* July 27, 5½ hrs., **5**. *Sachs Harbour to Cape Kellett:* August 1, 4 hrs., **1**. *Bernard Island to Cape Prince Alfred:* August 10–11, 10 hrs., **30**. *Cape Prince Alfred to Antler Cove:* August 11–12, 18 hrs., **15**. *Extreme head of Castel Bay, very shallow water:* August 29, **2**. A young



female Bearded Seal (total length, 134 cm.), which had died from unknown causes, was found on the beach at the south side of Storkerson Bay on August 5 (Skull, NMC 21597).

No Bearded Seals were seen in 1953 by Manning, but during Höhn's stay at Sachs Harbour, May 10–July 29, the Eskimos secured four, and another was seen off the harbour on July 29.

***Rangifer arcticus* subsp.** Barren Ground Caribou.

Caribou range throughout Banks Island, and it is probable that a few may be found in all areas at every season, the large bucks being particularly inclined to wander over wide areas during the summer. However, most of the caribou probably summer on the comparatively flat grasslands of the northern interior, and perhaps a fair number of does remain in the broad valleys near the north coast until July or August. In October and November both sexes move toward the more hilly country of the north and south coasts; perhaps also to the east, and, to a lesser extent or for a short time, to the west coast. Stefansson (1921, p. 448) says that in winter caribou seemed to be more plentiful at the northern end of Banks Island than in the south, and we saw more shed antlers along the north coast west of Castel Bay than elsewhere on the island. They were particularly abundant at Antler Cove, where most were those of large bucks, indicating that caribou are plentiful there in November.

Stefansson (1921, p. 225) estimated that the summer caribou population of Banks Island was 2,000 or 3,000, and thought that a few more might cross from Victoria Island in the winter. The latter supposition appears unlikely, at least at the present time. Our estimate of the summer population for 1952–3 is about 4,000, or approximately one caribou to six square miles. This may be compared with Banfield's estimate (1954, p. 20) of 2.3 caribou per square mile on the mainland winter range and 2.2 per square mile on the mainland summer range, and with Manning's estimate (1943, p. 51) of one caribou to two square miles in the 20,000-square mile area of virtual sanctuary in central west Baffin Island.

During the winter of 1850–1 the *Investigator*, frozen in the ice off the Princess Royal Islands, was too far from Banks Island for the crew to do much hunting (Armstrong, 1857, p. 476), but the infrequent mention of caribou during the spring sledge journeys suggests that they were not particularly numerous on the east side of the island at that time, and Stefansson (1921, p. 640) also evidently found them scarce along that coast at the end of July and beginning of August, 1917. However, on 6 January 1851 three caribou were seen, apparently coming from Banks Island, and on May 31 a small herd was observed starting across Prince of Wales Strait (Armstrong, 1857, pp. 297, 336). On 26 May 1852 Collinson (1889, p. 200) saw several caribou tracks a few miles south of Peel Point, all apparently coming from Banks Island. At Mercy Bay, the officers and crew of the *Investigator* killed 111 caribou between October 1851 and April 1853. The numbers killed in each month are given in Table 34. These figures give an indication only of relative abundance of caribou in different months because of the difficulty of hunting during the winter darkness and the lack of information on how much



**Table 34.** Caribou killed at Mercy Bay between October 1851 and April 1853 from Armstrong (1857, p. 601).

|      | <i>Jan.</i> | <i>Feb.</i> | <i>Mar.</i> | <i>April</i> | <i>May</i> | <i>June</i> | <i>July</i> | <i>Aug.</i> | <i>Sept.</i> | <i>Oct.</i> | <i>Nov.</i> | <i>Dec.</i> |
|------|-------------|-------------|-------------|--------------|------------|-------------|-------------|-------------|--------------|-------------|-------------|-------------|
| 1851 | —           | —           | —           | —            | —          | —           | —           | —           | —            | 9           | 0           | 0           |
| 1852 | 2           | 6           | 13          | 19           | 10         | 8           | 3           | 0           | 0            | 2           | 1           | 6           |
| 1853 | 12          | 10          | 8           | 2            | —          | —           | —           | —           | —            | —           | —           | —           |

In the above table the total number of caribou killed is 111, not 112 as stated by Armstrong. M'Clure (1854, p. 54) gives the total caribou kill during their stay in the arctic regions as 110.

hunting was done during the summer. The small kill in November of 1852 was due to the wildness of the caribou rather than to their scarcity, for M'Clure (1854, p. 52), writing on November 18, says, "... The deer for the last few days have been coming from the southward to their winter quarters amongst the ravines and sand hills; ninety have been met with at one time and forty at another, but so very wild that few have been shot . . ." (Armstrong (1857, p. 473) mentions a herd of 50 or 60 caribou on 10 October 1851, and towards the end of that month or the beginning of the next caribou were frequently seen crossing Mercy Bay, usually pursued by wolves (p. 488). In 1853 the caribou had almost abandoned Mercy Bay by April, but in 1852 they were most abundant in that month (Armstrong, 1857, pp. 568-9). In May and June, Armstrong (p. 477) says the does left the more barren highlands and resorted to the ravines and valleys bordering the coast.

On 4 June 1909 O. J. Morin (Bernier, 1910, p. 174) saw caribou near Cape Vesey Hamilton, where he says the pasturage of moss was plentiful.

Stefansson (1921) frequently refers to caribou on Banks Island, but seldom gives locality, date, or the actual number seen. He saw one band of about 200, but herds of that size were very rare. On 25 June 1914 he saw six on Bernard Island (pp. 228-9). Inland to the east of there (probably on the flat land we crossed in September 1952) large bucks were fairly numerous, and later, probably about the beginning of August, small bucks and does, apparently coming from the north or northeast, also became plentiful, but not more than 20 or 30 caribou were seen in a day (p. 255). In March 1915 caribou were numerous on the north coast west of Mercy Bay, and particularly about Castel Bay (pp. 475-6).

Porsild (1950, p. 54) says that caribou appeared relatively plentiful on Banks Island, and fresh tracks were seen everywhere. On 10 August 1949 he saw about 35 in herds numbering up to seven from the air about 30 miles west of Russell Point, and a few from the ground during the next few days. On the flat land west of the plateau area about 100, mostly does and fawns, were seen in small herds on August 21 (Porsild, 1949).

The Sachs Harbour Eskimos told us that large numbers of very fat caribou passed there in November of 1951, and soon after, tracks were seen leading out on to the ice from the south Banks Island coast. Later in the winter some of the caribou returned to Banks Island, and a number were found dead. According to a letter from a Holman Island Eskimo, some Banks Island caribou crossed to Victoria Island that winter, and the mainland Eskimos saw



a few on Baillie Island and killed one on the mainland near Herschel Island. The Banks Island caribou are paler than the mainland races<sup>1</sup>, and could therefore easily be distinguished; it is less certain if they can be distinguished from the Victoria Island animals. We saw a fair number of caribou carcasses in southern Banks Island between Alexander Milne Point and Sachs Harbour. All were in winter pelage, and most were adult bucks which had shed their antlers. They were commonest in the lower part of the Masik River valley, where, on June 19, we counted 12 in four miles of walking. As the Eskimos believe that it was chiefly the animals which had been out on the ice which died, it seems possible that they were too weak from starvation to find food under the snow after their return, but the cause of the original migration is unknown. It seems probable that the migration and subsequent death of many is in some way related to the scarcity of fawns in 1952 and 1953. In 1952 only three fawns were seen amongst 174 caribou, and in 1953 no fawns amongst 142 caribou. In both years about a third of the caribou seen were does. The Eskimos also reported that they had found no foetuses in the caribou killed during the winter and spring of 1952-3, and one of them, Bertram Pokiak, mentioned in a letter dated 23 March 1955 that the caribou had again been dying in the winter of 1954-5.

*Caribou seen during the summers of 1952 and 1953*

**1952.** *De Salis Bay (east)*: no tracks were seen in the spring snow; June 8, 2 together; June 10, 3 probably ♀ ♀ together; June 11, 2 ♂ ♂ together. *Between Raddi Lake and Sachs Harbour*: June 20, 3 ♂ ♂ together; June 21, 1 ♂. *Between Raddi Lake and Masik River valley*: June 26, 1 ♂. *On highland south of Masik River valley*: June 27, 5 in one herd; June 28, ♀ + fawn. *De Salis Bay (west)*: July 6, 1 ♀; July 7, 8 in one herd, all probably ♂ ♂. *Near Alexander Milne Point*: July 13, 2 ♂ ♂, singles; July 14, 2 ♂ ♂, singles. *Storkerson Bay*: August 3, 1 ♀ + fawn + yearling together; August 5, 1 ♀ + fawn + yearling + 2 ♂ ♂ together. *Half-way between Cape Prince Alfred and Cape McClure*: August 11, 1 ♂. *Castel Bay*: August 26, one track. *Twelve miles up Thomsen River*: August 30, 20 in one herd; August 31, 40 in two herds. *Valley of Thomsen and Muskox rivers*: September 2-4, a few tracks. *Between Muskox River and Storkerson Bay*: September 5, 23 together, mixed sexes + 6 together + numerous tracks; September 6, 1 ♂ + 8 ♀ ♀ and/or young males + numerous tracks; September 7, 6 ♂ ♂ + 3 ♀ ♀ and/or young ♂ ♂, a few tracks; September 8, 6. *About 15 miles inland of Sea Otter Harbour*: September 12, 20.

**1953.** *Cape Kellett*: May 19, young ♀ collected. *Sachs Harbour to Bernard River*: June 28-July 8, occasional tracks seen in snow. *South side of Storkerson Bay*: July 4, 1. *Bernard Island*: July 8-9, very fresh tracks in snow. *Bernard River*: July 9-11, 38 in small groups of both sexes. *Northeast branch of Bernard River*: July 12-13, 8. *Muskox and Thomsen rivers*: July 13-18, 66 in small groups of both sexes. *Mahogany Point*: July 29, one herd of 9 large ♂ ♂ + one small ♂. *Back Point*: August 14 and 16, herd of 9 ♂ ♂ (?) seen on each day, fresh tracks fairly numerous.

***Ovibos moschatus wardi* Lydekker. Muskox.**

**Taxonomy.** The single Muskox we saw at the Thomsen River was too far distant for us to judge if it were referable to the northern white-faced race, *O. m. wardi*, or to the mainland form, either *O. m. moschatus* or the apparently intermediate (Allen, 1913, p. 179) and doubtfully valid (cf. Anderson, 1930; 1947) northeastern race, *O. m. niphoecus*. As it is just possible that the present Banks Island Muskoxen have recently migrated to the island from

<sup>1</sup>Armstrong (1857, p. 478) describes them in winter as pure white with a patch of light brown on the back.



the Queen Elizabeth Islands, the identification of these will not establish the racial identity of the endemic form with certainty, and it is desirable to obtain a good series of the skulls now available on the island before they deteriorate further. Unfortunately, we did not have room in the canoe for whole skulls, and were able to bring out only one palate and one half palate with complete sets of molars and premolars, one palate with a nearly complete set, two left mandibles, and one horn, all apparently from adult males. The palatal breadths at M2 and the maxillary and mandibular tooth row lengths are given in Table 35. A check measurement on NMC 1427 and 1428 indicated that Allen (1913, p. 182) took "palatal breadth at M2" at the widest part of the anterior root of M2. Our measurements have therefore been taken at the same place. His tooth measurements, like ours, appear to cover the full length of the row.

According to Allen (1913, p. 179), the skull of *O. m. wardi* differs from that of the mainland forms in having narrower<sup>1</sup> horn bases, both absolutely and in proportion to horn length. It also differs in having longer maxillary and mandibular tooth rows. The single male horn available from Banks Island has a basal breadth of 228 mm., which agrees well with Allen's mainland series and is outside the range of any of his 31 'Grant Land' (northern Ellesmere Island) specimens (*see* Fig. 14). The difference, however, is not great enough to be significant in a single specimen ( $t = 1.5$ ,  $P$  about .15)<sup>2</sup>. Also, its breadth is exceeded by two specimens of *O. m. wardi* in the National Museum (NMC 1427, Melville Island: left, 237 mm., right, 224 mm.; and 8801, Ellesmere Island: left, 240 mm., right, 247 mm.), and by the larger of a pair of horns from Prince Patrick Island in the possession of Macpherson (233 mm.). Basal breadth relative to horn length has not been considered because of the difficulty in duplicating the length measurements given by Allen (1913, p. 182) for NMC 1427 and 1428.

Comparison of tooth row measurements is likely to be more efficient than horn measurements, for, once a full set of maxillary teeth have been cut, there are comparatively slight changes, at least until old age. Figure 15 shows that the means of the maxillary and mandibular tooth rows of the Banks Island specimens agree well with those of Allen's series of *O. m. wardi* from 'Grant Land'. Also, the mean of the maxillary tooth row measurements of the Banks Island specimens is just significantly different ( $t = 2.20$ ,  $P < .05$ ) from the combined mainland series (Allen, 1913, pp. 144, 181). On the strength of this, the Banks Island Muskoxen are tentatively referred to *O. m. wardi*, although it should be noted that, if the three measurements (131 mm., 133 mm., 145 mm.) which Allen correctly quotes from Kowarzik (1910, pp. 122-3) are included in the mean of Allen's mainland series, the difference between these and the Banks Island series ceases to be significant.

In the foregoing it has been assumed that the Ellesmere Island Muskoxen are not only referable to, but more or less typical of, *O. m. wardi*. This is contrary to the opinion of Degerbøl (1935), who separates them from the

<sup>1</sup>Measured parallel to the long axis of the skull.

<sup>2</sup>The difference might have been greater if the Banks Island specimen had been a complete skull rather than a single horn, as Allen (1913, p. 148) measured the "total breadth of the horn at the base on the mid-line of the skull", and this measurement must be at least as great and usually slightly greater than that of the broadest horn base.



Table 35. Measurements of palates and mandibles of *O. moschatus* from Banks Island.

|           | Palatal breadth | Maxillary tooth row | Mandibular tooth row |
|-----------|-----------------|---------------------|----------------------|
| NMC 21179 | 82.4            | 137.0               | —                    |
| NMC 21178 | 79.3            | 139 approx.         | —                    |
| NMC 21176 | 86 approx.      | 142.8               | —                    |
| NMC 21177 | —               | —                   | 143.8                |
| NMC 21175 | —               | —                   | 146.0                |

Fig. 14. A comparison of measurements of the breadth at the base of the horns of Banks Island specimens of *O. moschatus* with measurements given by Allen (1913).

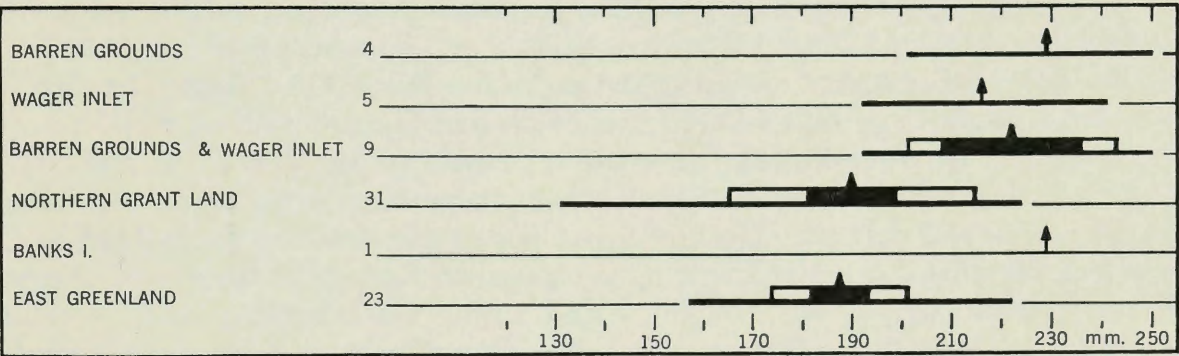
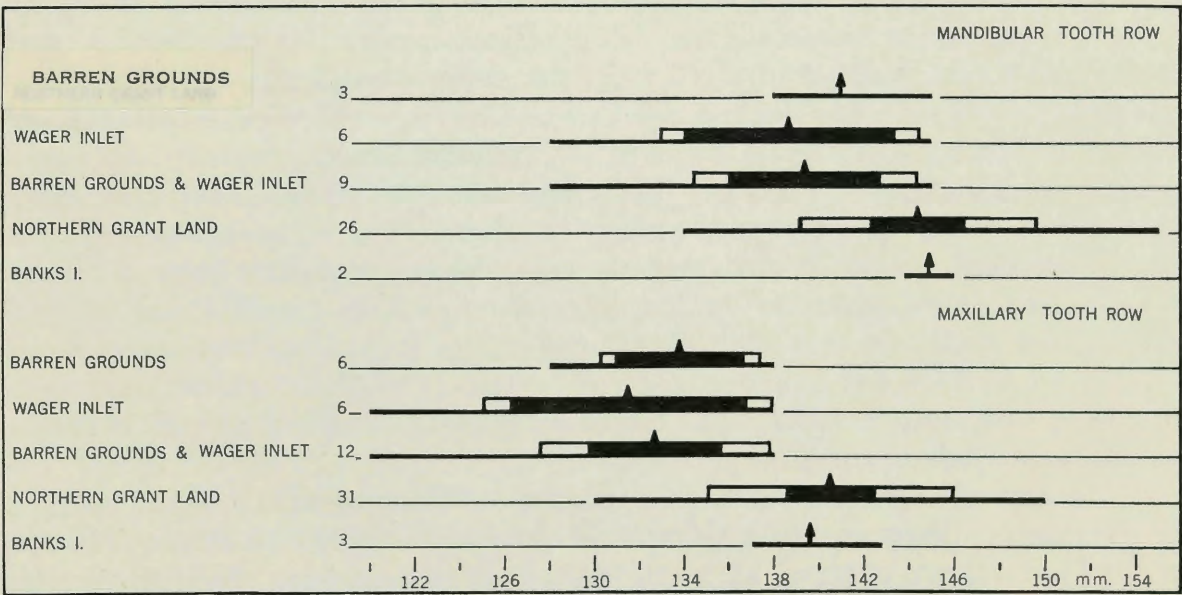


Fig. 15. A comparison of the measurements of Banks Island *O. moschatus* with measurements given by Allen (1913).



topotypical east Greenland population and places them with *O. m. moschatus*, principally on the basis of the shape and breadth of the horn base. Without comparative east Greenland material little can be said of the shape of the horn base, but it can be seen from Fig. 14 that the mean of the measurements given for the breadth of the horn base of east Greenland specimens by Degerbøl is not significantly different from the mean of the measurements



given by Allen (1913) for his northern 'Grant Land' series which, Degerbøl says, consists of similar-aged animals. East Greenland Muskoxen may have shorter maxillary tooth rows and smaller skulls than the 'Grant Land' population, but Degerbøl gives insufficient measurements for comparison. Evidently a taxonomic revision of the species is needed.

*Previous records and field observations*

In 1911 Stefansson (1921, p. 240 (cf. p. 370)) was told by the Prince Albert Sound Eskimos that they occasionally saw Muskoxen on Banks Island and that about March of that year they had killed a small band at the southeast corner of the island. No Muskoxen, however, were seen by any of Stefansson's party on their many journeys across Banks Island between 1914 and 1917, and their extinction was naturally assumed by Anderson (1946, p. 184), although Stefansson thought that there might be a few left (*see* Stefansson, 1921, p. 249). On 22 August 1949 Porsild (1950, p. 54) saw tracks of a small number of Muskoxen at Mercy Bay. On 2 September 1952 we saw a single large bull about 15 miles up the Thomsen River, and one of the Eskimos, Bertram Pokiak, in a letter dated 5 September 1954, said that quite a few Muskox tracks had been seen, presumably in the southwest part of the island, and that two Muskoxen had been right down to Sachs Harbour. It is possible that some Muskoxen have crossed to Banks Island from northern Victoria Island or perhaps Melville Island within the last thirty years, but it seems more likely that a few remained in the deep valleys amongst the rugged hills at the northeast end of the island. In either case, a gradual increase may be expected providing absolute protection from the Eskimos can be assured.

There can be no doubt that in the past Banks Island supported a large Muskox population. Storkerson (Hoare, 1930, p. 47) stated that skeletons were ten times as numerous on Banks Island as on Melville Island, and Stefansson (1921, p. 239) inferred from the skeletons and the greater fertility of Banks Island that the Muskox population "thirty or forty years" previously must have been ten times as great as on Melville Island. Perhaps the comparative abundance of bones on Banks Island can be accounted for to some extent by better preservation owing to the Eskimos having driven the Muskoxen deliberately or inadvertently on to higher and drier ground before slaughtering them, whereas on Melville Island, where most of the animals presumably died a natural death, Stefansson (1921, p. 240) says bones were most abundant in the grassiest country. The few skulls which we found in wet, grassy situations on Banks Island were usually marked by only a single rotten horn sticking up through the turf.

Most of the Muskox remains we saw in 1952 consisted of skulls, usually in groups of three to eight. On a 75-mile walk from the Masik Pass to Sachs Harbour we counted 24 Muskox skulls in five groups. Near the southeast coast they were more plentiful, and the Eskimos told us of one place near the headwater of the Sachs River above Raddi Lake where there were 50 or more skulls together. Muskox remains are not plentiful in the Cape Kellett region, and in 1953 Manning and Sparrow saw only four on their walk up the west coast to the Bernard River. On the north side of the valley of the Bernard River they counted 15 and saw another eight near the head of the Muskox River. In the spring, Sparrow found a large number of skulls



on the hilltop in the northwest angle of the junction of the Muskox and Thomsen rivers. This proved to be an old Eskimo campsite with about 200 Muskox skulls in the immediate vicinity as well as some scattered over the hills to the north.

Stefansson (1921, pp. 239-41, 367) is no doubt correct in considering that the nearly complete skeletons he found in groups of 15 to 20 between Mercy Bay and Sachs Harbour were those of Muskoxen killed by Eskimos attracted to Banks Island between 1855 and 1890 (p. 361) by the discovery of M'Clure's depot, and that the influx of these Eskimos at that time contributed to a reduction of the Muskox population. He (1921, p. 367) found wood shavings from the *Investigator* at most of the Eskimo camps he saw, and at the Muskox-Thomsen rivers campsite Manning found two pieces of wood, also obviously from the *Investigator* or M'Clure's cache at Mercy Bay (see Manning, 1956a, p. 17). There can be little doubt, therefore, that some of the skulls at that campsite were from animals killed by Eskimos who had been to Mercy Bay after 1854, when Krabbé (1855) visited the *Investigator*. Some of the remains, however, seemed older, and the frequent mention of old heads by M'Clure (1854), Armstrong (1857), and Collinson (1889) suggests that skulls may have been as abundant in 1851-3 as they are now. It is certainly possible that the very old skulls that we saw in the valley of the Nelson River were some of those which Collinson (1889, p. 156) found near a lagoon just east of Nelson Head. Likewise, other groups of skulls seen by us on the southeast coast, although not obviously associated with campsites, may have been identical with those reported by Creswell (M'Clure, 1854, p. 41) to have been common about old Eskimo campsites in southeastern Banks Island. Another reason for thinking that a good number of the skulls still to be seen on Banks Island belonged to animals killed over 100 years ago is that the best preserved skull (with almost perfect horn sheaths) seen by us in either 1952 or 1953 was on top of M'Clure's beacon at Mercy Bay. This skull may have been that of a Muskox killed by Eskimos who visited M'Clure's depot, but it also may well have been one of the two killed by M'Clure's party in 1853. Stefansson (1921, p. 240) says that M'Clure reported that Muskoxen were numerous on Banks Island. However, during the entire period between 1850 and 1853, when the *Investigator* was wintering at the Princess Royal Islands and at Mercy Bay, only two Muskoxen were killed on Banks Island, both at Mercy Bay on 8 July 1852 (Armstrong, 1857, pp. 533, 601), while sight records of only four others, two near Ballast Beach on 25 August 1851, and two at Mercy Bay on October 16 of the same year (Armstrong, 1857, pp. 414-5, 485) are given. An additional four bulls were seen by Krabbé (1855, pp. 713, 718) three miles west of Cape Vesey Hamilton on 4 May 1854. Muskoxen therefore, do not appear to have been particularly numerous at that period.



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