

History, Status, and Taxonomic Identity of Caribou (*Rangifer tarandus*) in Northwest Greenland¹

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ABSTRACT. Historical references indicate that caribou (*Rangifer tarandus* L.) numbers drastically declined throughout the Thule District during the early part of this century, and that the primary causes were: 1) the influx of polar explorers and their distribution of firearms to the Thule Eskimos which initiated extensive hunting pressure on caribou; and 2) a series of relatively mild, wet winters resulting in snow conditions which restricted access to forage and caused several catastrophic die-offs.

No live caribou were seen during six hours of aerial surveys over Inglefield Land, Thule District, Northwest Greenland, during July 1978. No fresh caribou sign was found during five days of searching in the Rensselaer Bay area of Inglefield Land. Unless some individuals were not detected or subsequent emigration from Ellesmere Island has occurred, the Inglefield Land caribou population has been extirpated.

The Thule District caribou population apparently originated from barren-ground caribou (*R. t. groenlandicus* Gmlin) which emigrated from Southwest Greenland, rather than from Peary caribou (*R. t. pearyi* Allen) from Ellesmere Island.

Key words: caribou, *Rangifer*, Greenland, Thule District, Inglefield Land, High Arctic

RÉSUMÉ. Les ressources historiques signalent que le nombre de caribous (*Rangifer tarandus* L.) a diminué de façon radicale à travers le district de Thule au début du siècle, et que les causes primaires ont été 1) l'afflux d'explorateurs polaires et leur distribution d'armes à feu parmi les Esquimaux du Thule, ce qui précipita une hausse importante dans la chasse au caribou; et 2) une série d'hivers relativement doux et mouillés entraînant des conditions neigeuses qui avaient pour effet de restreindre l'accès au fourrage, causant ainsi un taux de mortalité catastrophique.

Aucun caribou vivant ne put être observé au cours des six heures d'inventaire aérien tenu dans la terre d'Inglefield dans le district de Thule, dans le nord-ouest du Groenland, en juillet 1978. Aucune trace fraîche de caribou ne put être discernée pendant cinq jours de recherche dans la région de la baie Rensselaer en terre d'Inglefield. A moins d'avoir manqué de déceler certains animaux ou sauf s'il y eut plus tard une migration de l'île Ellesmere, la population de caribous de la terre d'Inglefield a été extirpée.

La population de caribous du district de Thule traçait ses origines apparemment du caribou des landes (*R. t. groenlandicus* Gmlin) qui émigra du sud-ouest du Groenland, plutôt que du caribou de Peary (*R. t. pearyi* Allen) sur l'île Ellesmere.

Mots clés: caribou, *Rangifer*, Groenland, district de Thule, terre d'Inglefield, nord de l'Arctique

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INTRODUCTION

Indigenous caribou (*Rangifer tarandus* L.) presently occur in only two disjunct areas of Greenland. A large population (c. 100 000 in 1970) of barren-ground caribou (*R. t. groenlandicus* Gmlin) inhabits Southwest Greenland between Frederikshåb (c. 62°N) and Disko Bay (c. 69°N) (Fig. 1). During the 1970s this population rapidly declined to a present size of about 8000 (Clausen *et al.*, 1980; Thing, 1980, 1981). Caribou also occur in Inglefield Land (c. 79°N), northern Thule District, Northwest Greenland (Fig. 1). Little is known about this population because of its small size and remoteness. There is even disagreement concerning the taxonomic identity of Inglefield Land caribou. Degerbøl (1957) concluded that they were the same subspecies as Southwest Greenland caribou (*R. t. groenlandicus*); whereas Vibe (1967) referred to the population as Peary caribou (*R. t. pearyi* Allen), a smaller, high arctic subspecies. Banfield (1961) described this population as intergrades between *groenlandicus* and *pearyi*. In this paper we attempt to clarify the origin, taxonomic identity, and population status of caribou in Northwest Greenland.

HISTORIC STATUS OF CARIBOU IN NORTHWEST GREENLAND

From accounts of late nineteenth-century explorers in Northwest Greenland the following conclusions can be drawn:

1) Caribou were present throughout the Thule District from

Humboldt Glacier in the north to Pítugfik Glacier in the south (Fig. 1) (Kane, 1856; Peary, 1898; Freuchen, 1912) and were relatively abundant at Olrik Fjord and western Inglefield Land (Hayes, 1867; Peary, 1898; Rasmussen, 1921). Caribou were either absent or rare along the Greenland coast northeast of Inglefield Land and along the Kane Basin portion of the Ellesmere Island coast to the west of Inglefield Land (Nares, 1878; Greely, 1888; Jensen, 1928). This suggests no major exchange between caribou in the Thule District and either *R. t. pearyi* on Ellesmere Island or the dwindling population of *R. t. eogroenlandicus* from Northeast Greenland.

2) Native Polar Eskimos had little or no effect on caribou numbers prior to 1864 when the bow and arrow were introduced by Eskimo emigrants from Baffin Island (Kane, 1856; Hayes, 1867; Rasmussen, 1921). The introduction of firearms to the Eskimos by Peary in the 1890s and the dependence of various expeditions on caribou meat substantially increased caribou mortality (Winge, 1902; Rasmussen, 1921; Jensen, 1928). Expeditions led by Hayes and Peary killed several hundred caribou prior to 1900 (Hayes, 1867; Peary, 1898).

3) Severe snow conditions which restricted availability of caribou forage occurred during the winter of 1860-61 (Hayes, 1867; Freuchen, 1912).

The status of the herd during the early part of this century can be summarized as follows:

By 1910 caribou were rare in the vicinity of the settlement of

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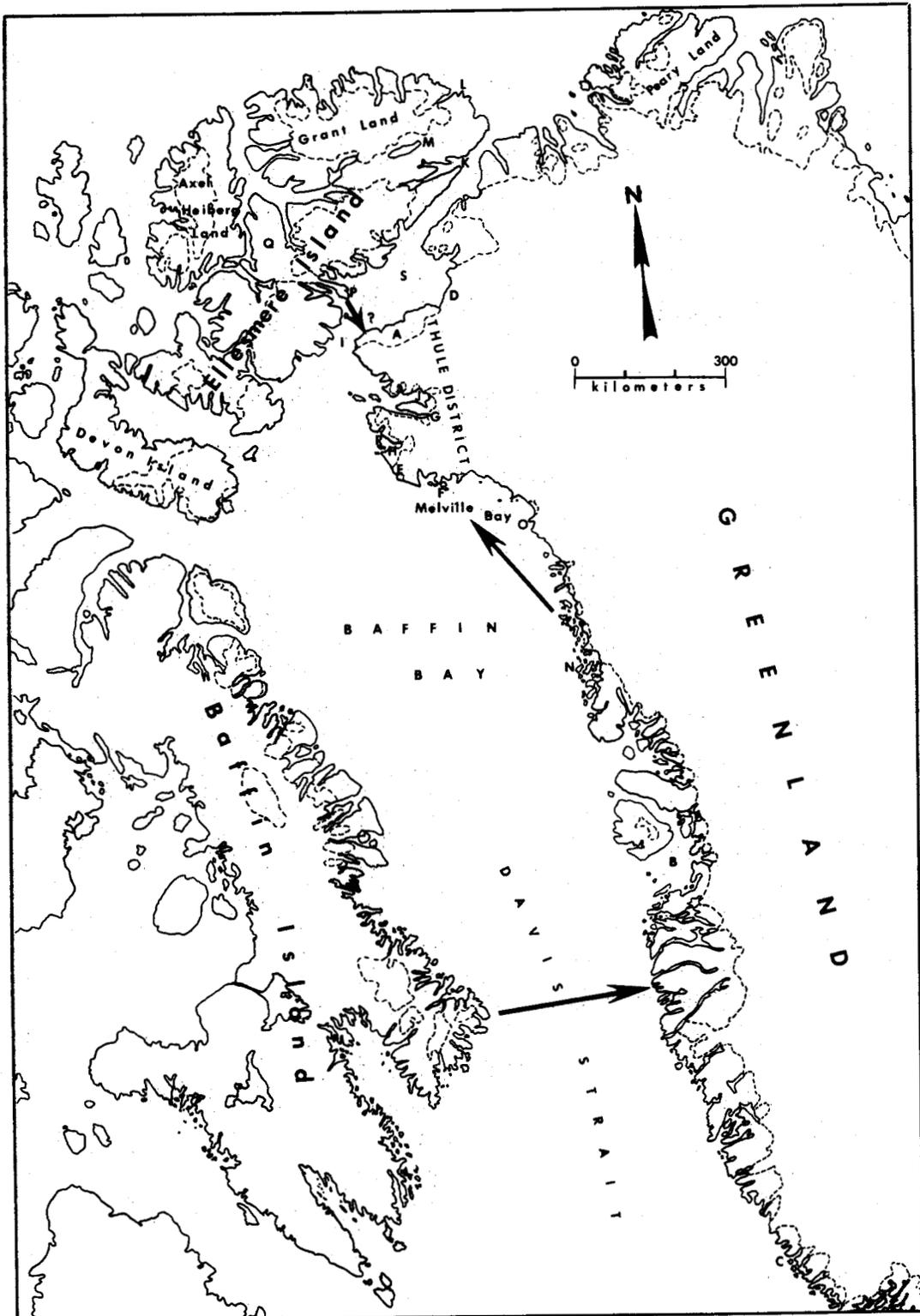


FIG. 1. Western Greenland and the eastern Canadian Arctic Islands. Arrows indicate immigration routes of caribou to the Thule District, Northwest Greenland.

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|----------------------|----------------------------|--------------------------|
| A — Inglefield Land | H — Thule (Thule Air Base) | O — Cape Seddon |
| B — Disko Bay | I — Smith Sound | P — Bache Peninsula |
| C — Frederikshaab | J — Inglefield Gulf | Q — Fosheim Peninsula |
| D — Humboldt Glacier | K — Lady Franklin Bay | R — Wolstenholme Fjord |
| E — Pitugfik Glacier | L — Cape Hecla | S — Kane Basin |
| F — Savigsivik | M — Lake Hazen | ----- = edge of ice caps |
| G — Olrik Fjord | N — Upernavik | |

Thule (Freuchen, 1912). The decline was apparently due to snow and ice-crust conditions during the winter of 1901-02 which caused catastrophic starvation in the Wolstenholme Fjord-Inglefield Gulf area (Freuchen and Salomonsen, 1958). Rasmussen (1921), however, believed that the major cause of the decline was the introduction of firearms, and referred to successful caribou hunts until 1912. This suggests that caribou in the central Thule District were reduced by natural causes followed by sustained hunting pressure from Eskimos which resulted in rapid extirpation. After 1910 caribou were common only in the eastern part of Inglefield Land (Rasmussen, 1921) and hunting pressure shifted to this area (MacMillan, 1925, 1927; Rasmussen, 1928) (Fig. 2). By 1920 the Inglefield Land population had sharply declined as a result of excessive hunting in 1916-17 (Jensen, 1928), a winter with unusually heavy snowfall (MacMillan, 1925). However, after 1920 regular fall hunting trips to eastern Inglefield Land continued and were usually successful (MacMillan, 1927; Rasmussen, 1928).

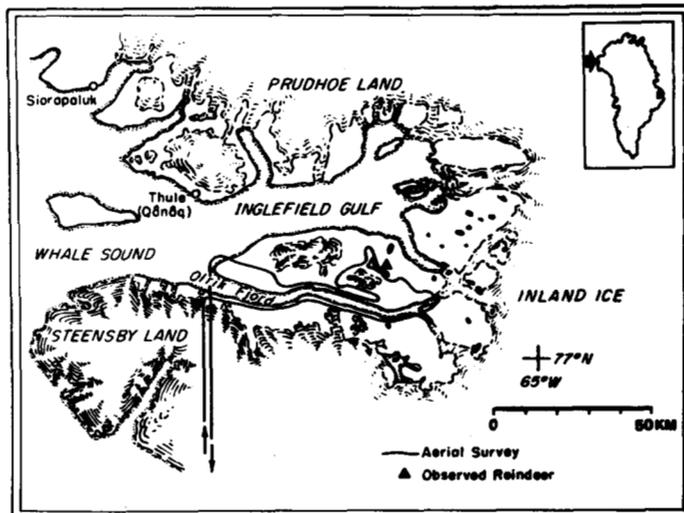


FIG. 2. Inglefield Land, showing routes of aerial and ground surveys (scale 1:1 000 000).

Around 1940 the last three caribou recorded in the Thule District south of Inglefield Land were collected from the Olrik Fjord area (Vibe, 1948). After 1960, caribou in Inglefield Land were so scarce that Inuit no longer undertook trips with caribou hunting as the object.

In 1965 nine semi-domesticated reindeer were introduced to the Olrik Fjord area (Fig. 1) from central Southwest Greenland. These animals were introduced to replace indigenous caribou which had been extirpated from the central Thule District. The size and status of this population of feral reindeer is presently unknown.

Wolves (*Canis lupus* L.) were probably present in Inglefield Land throughout the period when caribou numbers were declining, but their status during that period is unknown (Dawes, 1978). Certainly during severe winters, wolves could have appreciably enhanced mortality among weakened caribou. However, wolves are presently rare vagrants in Inglefield Land (Dawes, 1978).

SURVEY AREA

Inglefield Land is situated in the northernmost part of the Thule District, Northwest Greenland, between 78°10'N and 79°10'N (Fig. 2), and consists of about 6600 km² of ice-free land. It is bounded by Humboldt Glacier on the north, Dodge Glacier on the south, the Greenland Inland Ice on the east, and Kane Basin and Smith Sound to the northwest and west, respectively. These adjoining waters are ice-covered about 10 months of the year; the shortest distance from Inglefield Land to Ellesmere Island, N.W.T., Canada, is about 45 km.

The geomorphology of inland and coastal areas of Inglefield Land is markedly different. The landscape changes from a relatively flat and elevated inland plateau (700-1000 m) formed by extensive moraines near the Inland Ice to a hilly coastal region where the rivers have cut deep canyons in the Precambrian bedrock. This bedrock consists of gneisses and granites with thick units of supracrystal rocks, and underlies Proterozoic and Cambrian nonmetamorphic sediments which form the flat-topped plateaus (P. Dawes, pers. comm. 1978). These geological differences have important consequences for terrestrial productivity as discussed below.

No record of annual precipitation exists for the area; however, the mean annual precipitation for the years 1961-70 at Thule Air Base, 220 km to the south, was 138 mm. At Thule Air Base the mean annual temperature from 1961-70 was -10.5°C and the mean monthly temperature for the warmest month (July) was +3.7°C.

No written report on the vegetation in Inglefield Land is available and very few plant collections have been made.

SURVEY METHODS AND OBSERVATIONS

Aircraft Survey

A single-engine, low-winged Ralley aircraft, stationed at Thule Air Base, was used for aerial surveys over the Olrik Fjord area and Inglefield Land. A survey was flown over the Olrik Fjord area to gain information on summer distribution of feral reindeer. An attempt was made to survey all of Inglefield Land. However, because of limited time and the presence of large expanses of polar desert which appeared unsuitable as caribou range, most of the survey was conducted over areas where green vegetation was apparent.

Aircraft logistics and inclement weather permitted only three surveys to be flown in July 1978.

On 1 July a 1.5-hour survey was flown in the Olrik Fjord region (Fig. 3). Three feral reindeer bulls were observed on the shore of a long lake between Olrik Fjord and Inglefield Gulf. Two had the piebald coloration pattern common in semi-domestic reindeer. Several sets of fresh tracks were seen on snow patches near the lake.

On 9 July we flew for two hours over Inglefield Land. The survey was flown as far north as 79°N but mostly in coastal areas (Fig. 2) because of inclement weather further inland. Two caribou skeletons were seen. The bones appeared clean but were not scattered, suggesting the carcasses were not wolf kills.

On 12 July we flew for four hours over Inglefield Land. The

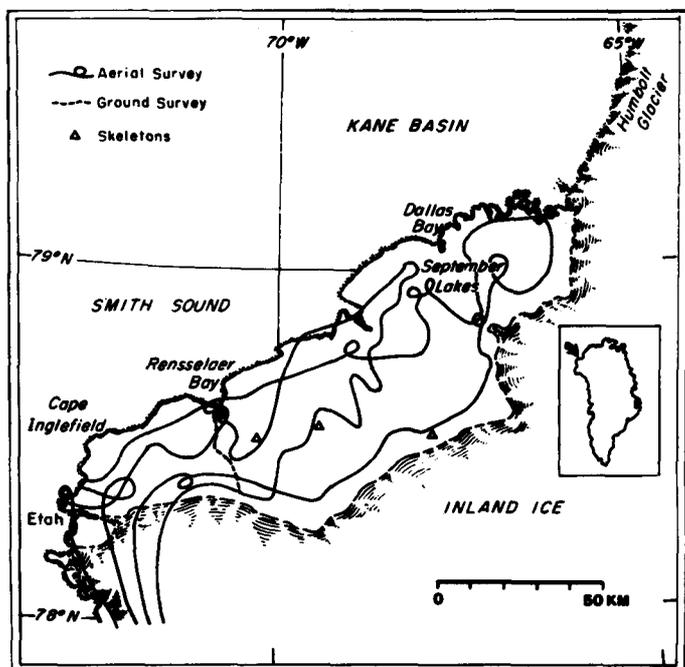


FIG. 3. Olrik Fjord region, showing the aerial survey route (scale 1:1 000 000).

survey extended north to Humboldt Glacier and included both inland and coastal areas (Fig. 1). Only one articulated caribou skeleton was spotted.

Ground Survey

Unusual ice conditions along the coast of Inglefield Land during the summer of 1978 prohibited the planned access to the area by boat, but two of us were able to fly to Rensselaer Bay, Inglefield Land, in a Greenland Geological Survey Bell 204 helicopter. During 5-10 July 1978, we hiked along Rensselaer River from Rensselaer Bay to within a few kilometers of the Inland Ice (Fig. 2). Plants were collected and notes kept on the relative abundance and distribution of vegetation, habitat types, and caribou tracks and feces. Plant specimens were identified by Dr. B. Fredskild, University of Copenhagen. All caribou antlers and bones were either measured or collected for deposition at the University of Copenhagen Museum.

No caribou, tracks, or other recent signs were seen. Sixteen old, lichen-encrusted, shed antlers were found, all within 8 km of the head of Rensselaer Bay. Most were lying on or adjacent to moist sedge meadows. All of the antlers appeared to be at least 20 years old and some were obviously much older. Eight of the antlers were brought back to Denmark for detailed measurements; the others were too decomposed to be of use.

Two caribou carcasses were found near the shore of Rensselaer Bay, but the bones were scattered and decayed. Two fragmentary skulls were among the two sets of bones. One was from an adult female with antlers and the other from an adult male whose antlers had been shed. Both apparently had died during late winter. The bull had apparently not been killed by either wolves or Inuit since the long bones were intact. The skulls were too fragmentary for taxonomic comparisons.

A single, complete caribou mandible was found hanging in

an Inuit sod hut on the southwest shore of Rensselaer Bay. The mandible was from a recent carcass of an adult approximately three years old, judging from tooth wear. Total length was 178 mm. The size of this mandible falls outside the range of mandible measurements of Canadian barren-ground caribou (*R. t. groenlandicus*) (Miller, 1974). We concluded that the mandible probably belonged to a specimen of *R. t. pearyi*. The mandible of the adult bull found near Rensselaer Bay was considerably larger than the presumed Peary caribou mandible, but decomposition precluded measurements of total length or diastema length.

DESCRIPTION OF CARIBOU HABITAT

Aircraft Surveys

The inland area of Inglefield Land appeared completely barren of plant life except along major rivers where sparse vegetation was evident. The inland area east of Dallas Bay appeared more vegetated, especially around the numerous lakes north of September Lakes. This area consists of exposed metamorphic bedrock, unlike most of the western part of Inglefield Land (P. Dawes, pers. comm. 1978). Several bays along the coast, including Rensselaer Bay, were the sites of local wet sedge meadows which extend inland along stream valleys where the granite and gneiss bedrocks are exposed. However, the remainder of the coastline was extremely rugged with unvegetated talus slopes rising from the water's edge to sparsely vegetated uplands (polar desert), similar to the inland moraines.

Ground Survey

Near Rensselaer Bay there were scattered wet sedge meadows, the most productive terrestrial habitat type. These meadows only occur where nonporous Precambrian bedrock is exposed. The meadows were dominated by *Carex stans*, *Eriophorum triste*, *E. angustifolium*, *E. scheuchzeri*, *Luzula confusa*, and *L. arctica*, all potentially important summer forage species for caribou. Wet sedge meadows were smaller and sparser further inland from Rensselaer Bay and were limited to stream drainages and lake shores. Other potentially important forage species found growing on the slightly raised portions of these meadows were *Pedicularis langsдорфii*, *P. capitata*, *Poa abbreviata*, and *Festuca brachyphylla*. *Salix arctica* was widespread but, except in the wettest areas, annual production appeared to be so low as to preclude grazing by caribou. In the inland polar desert, *Saxifraga oppositifolia* was the only common forb while *Draba* spp., *Oxyria digyna*, and *Papaver radicum* were very sparse.

North-facing rocky slopes near Rensselaer Bay had the highest standing crop of fruticose lichens. *Cetraria nivalis*, an important caribou winter forage species, grew in small clumps among the rocks where *Cassiope tetragona* was the dominant vascular species. *Stereocaulon* spp. and *Alectoria* spp. were also present in the same habitat but were less abundant.

Potential summer forage was extremely limited in the Rensselaer Bay area and would probably be restricted to relatively

moist habitats along the shores of the bay and inland along streams. All caribou sign was found in or adjacent to those relatively productive areas. Aerial surveys indicate that the eastern part of Inglefield Land supports considerably more of these favorable habitats. Winter forage of *R. t. groenlandicus* consists primarily of fruticose lichens (Miller, 1976). Consequently, winter feeding in the Rensselaer Bay area would be concentrated on *Cassiope*-lichen heaths near the shores of the bay.

TAXONOMIC IDENTITY OF CARIBOU IN NORTHWEST GREENLAND

The taxonomic identity and distribution of caribou in Northwest Greenland has been the source of considerable disagreement in the literature (see Banfield, 1961; Burt and Grossenheider, 1964; Bergerud, 1978; Remmert, 1980; Hall, 1981). This section reviews the arguments and presents a new hypothesis for the origin of Thule District caribou: this population was derived from barren-ground caribou (*R. t. groenlandicus*) which emigrated from the larger Southwest Greenland population.

Allen (1902) wrote, "The large series of skins of *R. t. groenlandicus* here used for comparison was collected in November by Commander Peary, at Inglefield Gulf, on the Greenland side of Baffin Bay, opposite Ellesmere Land. These skins greatly resemble in coloration the ordinary woodland [barren-ground?] caribou, being dark brown with the neck much lighter and the ventral area white. They thus give no suggestion of the whiteness of pelage shown by their relatives on the opposite side of Baffin Bay (*R. t. pearyi* J. A. Allen)". While Allen's use of "*R. t. groenlandicus*" was in a geographic rather than a taxonomic sense, it is clear that he recognized a distinct difference between caribou from the Thule District and Peary caribou from Ellesmere Island. The difference was also obvious to Peary who first collected *R. t. pearyi* (Peary, 1907). He found Peary caribou near Lady Franklin Bay, and scattered individuals from Cape Hecla to Lake Hazen and along the north coast of Grant Land (northern Ellesmere Island) (Fig. 1). Thus, at the beginning of this century, the known range of *R. t. pearyi* on the east coast of Ellesmere Island was far removed from Inglefield Land with gla-

TABLE 1. Skull measurements of caribou from Northwest Greenland (Thule District) compared^a with those of *R. t. groenlandicus* and *R. t. pearyi*

Measurement (mm)	Males				Females			
	<i>groenlandicus</i>	N.W. Greenland ^d	<i>pearyi</i>	<i>groenlandicus</i>	N.W. Greenland	<i>pearyi</i>		
\bar{x}	334.1	* 313.0 [n.s.] [323.2]	n.s. [*] 304.6	296.9	** 276.3	* 265.4		
sd	15.63	18.29 [21.30]	12.53	12.12	8.46	5.48		
Basal Length ^b	range	290-334 [290-347]	279-343	273-326	267-287	257-272		
n	108	4 [6]	64	82	4	14		
\bar{x}	164.8	n.s. 160.3	n.s. 157.7	149.9	n.s. 148.3	* 142.0		
sd	7.21	6.40	5.63	3.99	4.79	4.09		
Orbital Width ^b	range	146-183	152-167	145-169	144-155	134-149		
n	105	4	65	82	4	14		
\bar{x}	367.0	* 346.3	** 305.4	314.3	* 299.3	** 281.2		
sd	12.91	22.63	10.35	10.11	8.30	5.50		
Condylobasal Length ^c	range	340-386	312-369	290-319	305-323	290-310	277-289	
n	15	6	9	4	4	5		

^aThe significance of differences between sample means was determined using Student's t-test:

** = highly significant difference between adjacent means ($P < 0.01$)

* = significant difference between adjacent means ($P < 0.05$)

n.s. = non-significant difference between adjacent means ($P > 0.05$)

^bMeasurements of *groenlandicus* and *pearyi* skulls from Banfield (1961); measurements of Northwest Greenland caribou skulls from Degerbøl (1957).

^cAll measurements from Degerbøl (1957).

^dStatistics in brackets include two basal lengths not included in Banfield's (1961) sample from Northwest Greenland: male 10244 from Inglefield Gulf (American Museum of Natural History); and male 6659 from Inglefield Gulf (Zoological Museum in Oslo).

ciated terrain or sea ice between (Greely, 1888; Peary, 1907).

Allen's description is supported by MacMillan's (1925) account of the animals he hunted at Etah in western Inglefield Land: "This is not the white caribou (*Rangifer pearyi*) which we killed on the northern shores of Axel Heiberg Land in 1914, but a variety of the European [North American] (*Rangifer groenlandicus*) once existing in vast numbers from Humboldt Glacier, latitude 79°10'N, throughout the whole stretch of coastline southward to Cape Farewell, latitude 59°49'N."

Degerbøl (1957) also concurred with Allen. He wrote: "the considerable size of the Inglefield [caribou] here published clearly separates these animals from the [caribou] from Ellesmere Island." Degerbøl examined the available skeletal material from Northwest Greenland and concluded that caribou from the Thule District were most closely akin to caribou from Southwest Greenland and consequently he referred to them as barren-ground caribou *R. t. groenlandicus*.

In the most recent attempt to classify the genus *Rangifer*, Banfield (1961) compared the skulls of four adult males from the Thule District measured by Degerbøl with his own collection of measurements from adult male *R. t. pearyi* and *R. t. groenlandicus*. He concluded on the basis of this small sample that the caribou of Northwest Greenland were intergrades between *pearyi* and *groenlandicus*; but the primary influence was from *pearyi*. The sample mean of basal length for Northwest Greenland caribou was significantly less ($t = 2.28$, $P = 0.025$) than the mean for *R. t. groenlandicus*. There was no significant difference between Banfield's sample means for Northwest Greenland caribou and *R. t. pearyi* (Table 1). Consequently, Banfield (1961) included Inglefield Land and the entire Thule District within the range of *R. t. pearyi* and he described the range of *R. t. groenlandicus* as "Upernavik (south of the Thule District) to Cape Farewell (southern tip of Greenland)..." (Fig. 1).

Vibe (1967) was in agreement with Banfield's conclusions when he reported that Inglefield Land is inhabited by a small population of Peary caribou which emigrated from nearby Ellesmere Island, N.W.T., Canada, across ice-covered Smith Sound (Fig. 1). The survival of this small, high arctic race in Northwest Greenland was attributed to the "precipitation shadow" produced by the Inland Ice south of Inglefield Land. This "shadow" prevents large accumulations of snow which Vibe felt were responsible for the demise of caribou elsewhere in the Thule District.

However, besides the four skulls used by Banfield (1961) in his comparisons, Degerbøl (1957) located the skulls of two other adult males collected in the Thule District. Degerbøl did not measure the basal lengths of these skulls, only the condylobasal lengths, so we obtained these measurements from the museums where the two skulls reside. When these two basal lengths are included in the sample for Northwest Greenland then the sample mean is no longer significantly different from the *R. t. groenlandicus* series ($t = 1.234$, $P > 0.1$) but is significantly different from the *R. t. pearyi* series ($t = 2.105$, $P < 0.05$) (Table 1).

Degerbøl (1957) also measured the skulls of four adult females collected in the Thule District. A comparison of this

small sample with the series of *R. t. groenlandicus* and *R. t. pearyi* adult females used by Banfield reveals that the sample mean for basal length from Northwest Greenland females is significantly different from both the *pearyi* mean ($t = 2.43$, $P < 0.025$) and the *groenlandicus* mean ($t = 4.64$, $P < 0.001$) (Table 1). A comparison of orbital width (another skull measurement useful in discriminating between *pearyi* and *groenlandicus*) reveals no significant difference between adult female *groenlandicus* and those from Northwest Greenland. However, the sample mean of orbital width from Northwest Greenland females was significantly different from the comparable sample mean from *pearyi* ($t = 2.04$, $P < 0.025$) (Table 1).

Degerbøl (1957) measured the condylobasal lengths of a small series of *R. t. pearyi* skulls ($n = 14$) as well as a series of *R. t. groenlandicus* skulls from Southwest Greenland ($n = 19$), but no statistical comparison of these samples was published. Despite the small samples, the mean condylobasal lengths for male and female Northwest Greenland caribou are significantly different from both *R. t. groenlandicus* and *R. t. pearyi* (Table 1). However, the differences between Northwest Greenland caribou and *R. t. pearyi* are greater than the differences between *R. t. groenlandicus* and Northwest Greenland caribou.

In summary, the available skull measurements from Thule District caribou do not indicate a statistically significant unique taxon. Neither do they indicate a dominant influence from *R. t. pearyi*, as Banfield (1961) concluded, but instead suggest a closer affinity with *R. t. groenlandicus*. The small size of the caribou in the Thule District relative to *R. t. groenlandicus* from Southwest Greenland was assumed by Banfield (1961) to be a heritable character indicative of considerable interbreeding with *R. t. pearyi*. Alternatively, such phenotypic differences may be predominantly the result of nutritional differences. Thule District caribou occupy high arctic ranges where they experience short growing seasons, long, severe winters, and low standing crops of forage species, relative to caribou of Southwest Greenland.

To our knowledge only one caribou skin has been collected in Inglefield Land and that skin is at the University of Copenhagen Museum. This skin of an adult male collected in early winter closely resembles skins of adult males from Southwest Greenland with which the authors have had considerable experience. Winter skins of *R. t. pearyi* from Axel Heiberg Land were available for direct comparison. The difference in size and coloration was striking. The only body measurements of caribou from Inglefield Land which could be found in the literature were those of an adult male shot near Rensselaer Bay in February 1855 (Kane, 1856). Kane measured the total length at 188 cm which is greater than the maximum for male Peary caribou (186 cm, $n = 23$) but close to the mean for *R. t. groenlandicus* (180 cm, $n = 58$) in the series used by Banfield (1961).

In August 1973 a geologist succeeded in photographing a young male caribou in Inglefield Land east of Dallas Bay (J. Gray, pers. comm. 1979). The appearance of this animal, including presence of a flank strip and contrasting markings on

head and legs (Fig. 4), is similar to that of the skin residing at the University of Copenhagen and to young males from the Southwest Greenland population.



FIG. 4. A young male caribou near Dallas Bay, Inglefield Land, Northwest Greenland, in August 1973. (Photo: James Gray)

Concerning the origin of caribou in Greenland Degerbøl (1957) hypothesized that, "The possibility exists that a primitive *R. t. pearyi* — or probably, *R. t. arcticus*, before the distinct insular subspecies *R. t. pearyi* was finally formed — may have reached the N.W. corner of Greenland. Some of these animals emigrated from there to the south giving rise to *R. t. groenlandicus*, whereas others immigrated to the north — and east coast of Greenland and there evolved *R. t. eogroenlandicus*". *R. t. eogroenlandicus* was a small, pale subspecies, quite similar to *R. t. pearyi*, which formerly inhabited the east coast of Greenland from Germania Land (c. 77°C) to Ammassalik (c. 66°N) but was extinct by 1900 (Degerbøl, 1957). This insular subspecies may have survived the Wisconsin glaciation in the Pearyland refugia, much as Peary caribou presumably survived in the western Queen Elizabeth Islands refugia. No skeletal material from *R. t. eogroenlandicus* has been found in northern Greenland (Degerbøl, 1957), so it is very unlikely that any exchange occurred with the Northwest Greenland population in historic times.

Degerbøl (1957) considered Davis Strait, between Baffin Island and Southwest Greenland, too formidable a barrier for caribou to cross. Banfield (1963) disagreed and concluded that barren-ground caribou had colonized Southwest Greenland from Baffin Island. That conclusion was strongly supported by the close similarity between Baffin Island and Southwest Greenland caribou, particularly with regard to skull measurements (Banfield, 1961). Vibe (1967) agreed with Banfield's hypothesis that caribou had reached Southwest Greenland, probably repeatedly, by crossing the 330-km-wide Davis Strait in winter (Fig. 1).

Consequently, the most likely origin of the barren-ground caribou which immigrated to the Thule District is the Southwest Greenland Herd to the south, not caribou of the Canadian High Arctic to the west (Fig. 1). There is little evidence to sup-

port the other possibility, that *R. t. groenlandicus* emigrated from Baffin Island to Devon Island and continued to Ellesmere Island, finally crossing Smith Sound to Northwest Greenland.

A small herd of caribou lived at Cape Seddon in southern Melville Bay (Fig. 1) around the turn of the century (Freuchen, 1912). Also, caribou antlers have been found at Savigsivik in northern Melville Bay (Rasmussen, 1921; Degerbøl, 1957). This supports the hypothesis of an immigration route from the south since Melville Bay separates the Thule District from Southwest Greenland and is a formidable barrier to animal dispersal. However, Melville Bay is a relatively minor barrier when compared with Davis Strait. From Cape Seddon to Savigsivik is 195 km and there are small, unglaciated islands and nunataqs between. During a caribou population high in Southwest Greenland, animals from Upernavik District may have wandered north along the coast in search of unexploited winter range and thus reached the Thule District.

The Thule District population predominantly originated from *R. t. groenlandicus* stock despite the short distance separating Ellesmere Island and Northwest Greenland. This may be a result of the scarcity of Peary caribou on the east coast of Ellesmere Island south of Lady Franklin Bay. However, Peary caribou have been reported from Bache Peninsula (A.W.F. Banfield, pers. comm. 1983). Also, there is a broad unglaciated valley connecting Bache Peninsula with the Fosheim Peninsula on the west coast of Ellesmere Island (Fig. 1) where Peary caribou regularly occur. Peary caribou could easily reach Inglefield Land by this route, but the available evidence indicates no large numbers have crossed Smith Sound to Inglefield Land in the last century.

CONCLUSIONS

The virtual extirpation of caribou throughout the Thule District cannot be blamed on adverse snow conditions alone; nor can it be blamed solely on over-hunting. These two factors in combination effected the decline. Hunting pressure was sustained despite catastrophic winters which caused starvation locally. The potential for population recovery had hunting been curtailed is speculative, but the survival of introduced reindeer at Olrik Fjord even in the presence of hunting suggests that at least a small herd of several hundred caribou could have survived in the Thule District given adequate protection from hunting.

A few caribou may still survive in Inglefield Land. The last reliable report was of two caribou shot by Inuit at Cape Inglefield in extreme western Inglefield Land in April 1978. However, these two animals may have been *R. t. pearyi* which crossed the ice from Ellesmere Island, only 45 km away, since most recent sightings of caribou in Inglefield Land are from further east. This is supported by our discovery of a presumed *R. t. pearyi* mandible at Rensselaer Bay in western Inglefield Land.

There is virtually no chance of reimmigration of *R. t. groenlandicus* to the Thule District within the foreseeable

future. The northern limit of the range of *R. t. groenlandicus* in Southwest Greenland is presently over 700 km south of Melville Bay (Fig. 1). Consequently, indigenous caribou may eventually become reestablished in Inglefield Land only by slow emigration of Peary caribou from Ellesmere Island.

The presumably extant population of feral reindeer from the Olrik Fjord region is unlikely to reach Inglefield Land since 150 km of ice cap separate the two areas. Immigration by reindeer to Inglefield Land via a coastal route would necessitate crossing several major glaciers and passing at least two Inuit settlements where detection by hunters would be nearly certain.

The prospects for recovery of the caribou population in Northwest Greenland are poor. Reestablishment will only be possible with strict closure of caribou hunting in Inglefield Land. Such a closure would rely heavily on the cooperation of the Thule (Polar) Inuit.

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REFERENCES

- ALLEN, J.A. 1902. A new caribou from Ellesmere Land. *Bulletin of the American Museum of Natural History*, New Series 1:101-226.
- BANFIELD, A.W.F. 1961. A revision of the reindeer and caribou genus *Rangifer*. *Bulletin of the National Museum of Canada* 177:1-137.
- . 1963. The post-glacial dispersal of American caribou. *Proceedings of the XVI International Congress of Zoologists* 1:206. Washington, D.C.
- BERGERUD, A.T. 1978. Caribou. In: Schmidt, J.L. and Gilbert, D.L. (eds.). *Big Game of North America*. Harrisburg: Stackpole. 83-101.
- BURT, W.H. and GROSSENHEIDER, R.P. 1964. *A Field Guide to the Mammals*. Boston: Houghton Mifflin Co. 284 p.
- CLAUSEN, B., DAM, A., ELVESTAD, K., KROGH, H.V. and THING, H. 1980. Summer mortality among caribou calves in West Greenland. *Nordisk Veterinaer-Medicin* 32:291-300.
- DAWES, P. 1978. Ulve i Nordgrønland. *Tidsskriftet "Grønland"* 10:289-303.
- DEGERBØL, M. 1957. The Extinct Reindeer of East-Greenland. *Acta Arctica*, Fasc. X. Copenhagen: Munksgaard. 57 p.
- FREUCHEN, P. 1912. Om rener og moskusokser i Kap York Distriktet. *Geografisk Tidsskriftet* 21:144-146.
- and SALOMONSEN, F. 1958. *The Arctic Year*. London: G.P. Putnam's Sons. 440 p.
- GREELY, A.W. 1888. Report on the Proceedings of the U.S. Expedition to Lady Franklin Bay, Grinnell Land. Washington: Government Printing Office. 2 vols. 545 p. and 738 p.

- HALL, E.R. 1981. *The Mammals of North America*. 2nd edition. New York: J. Wiley and Sons. Vol. 2:1102-1106.
- HAYES, I.I. 1867. *The Open Polar Sea; A Narrative of a Voyage of Discovery towards the North Pole in the Schooner United States*. New York: Hurd and Houghton. 454 p.
- JENSEN, A.S. 1928. *Grønlands Fauna: Et Forsøg pa en Oversigt*. Copenhagen: University of Copenhagen Press. 316 p.
- KANE, E.K. 1856. *Arctic Explorations: The Second Grinnell Expedition in Search of Sir John Franklin, 1853-1855*. Philadelphia: Childs and Peterson. 2 vols. 464 p. and 465 p.
- MacMILLAN, D.B. 1925. *Four Years in the White North*. Boston: Medical Society. 428 p.
- . 1927. *Etah and Beyond*. Boston: Houghton Mifflin. 287 p.
- MILLER, F.L. 1974. *Biology of the Kaminuriak Population of Barren-Ground Caribou*. Part 2. Ottawa: Canadian Wildlife Service Report Series Number 31. 88 p.
- MILLER, D.R. 1976. *Biology of the Kaminuriak Population of Barren-Ground Caribou*. Part 3. Ottawa: Canadian Wildlife Service Report Series Number 36. 42 p.
- NARES, G.S. 1878. *Narrative of a Voyage to the Polar Sea during 1875-1876 in H.M. Ships Alert and Discovery*. London: Low, Marston, Searler, and Rivington. 2 vols. 947 p.
- PEARY, R.E. 1898. *Northward over the Great Ice*. London: Methuen. 2 vols.
- . 1907. *Nearest the Pole*. New York: Doubleday. 411 p.
- RASMUSSEN, K. 1921. Thule District. *Meddelelser om Grønland* 60: 517-567.
- . 1928. Report of the Second Thule Expedition, 1916-1918. *Meddelelser om Grønland* 65:1-180.
- REMMERT, H. 1980. *Arctic Animal Ecology*. New York: Springer-Verlag. 250 p.
- THING, H. 1980. Preliminary studies of habitat use and food selectivity of West Greenland caribou. In: Reimers, E., Gaare, E., and Skjenneberg, S. (eds.). *Proceedings of the Second International Reindeer/Caribou Symposium, Røros, Norway*. Trondheim: Direktoratet for vilt og ferskvannsfisk. 151-158.
- . 1981. Feeding ecology of the West Greenland caribou (*Rangifer tarandus groenlandicus* Gmlin) with special reference to the Holsteinsborg-Sdr. Strømfjord region. Unpublished Ph.D. thesis, University of Aarhus, Denmark. 111 p.
- VIBE, C. 1948. *Langthen og Nordpa*. Copenhagen: H. Hagerup. 199 p.
- . 1967. Arctic Animals in Relation to Climatic Fluctuations. *Meddelelser om Grønland* 170:1-227.
- WINGE, H. 1902. Grønlands pattedyr. *Meddelelser om Grønland* 21:317-521.