THE RECENT REGIMEN OF THE ICE CAP MARGIN IN NORTH GREENLAND

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ABSTRACT

Field investigation and photographic interpretation indicate that during the last 50 years the ice cap margin extending from Kap York on the west coast north through Peary Land and south to Nioghalvfjerdsfjorden on the east coast has retreated generally 2 to 8 km or has diminished from 10 to 100 m in thickness at relatively stagnant ice fronts. Outlet glaciers at Independence Fjord and Hagen Fjord along the northeast margin of the ice cap have retreated farther than the outlet glaciers at Kap York, Inglefield Bredning, and Petermann Gletscher along the northwest margin. Several glaciers along the northwest coast of Greenland, such as Brother John Gletscher at Etah, have been advancing until recently, but are now stagnant. Their recent advances can be attributed to the fact that they are nourished by the independent caps or lobes of the Greenland Ice Cap which have received greater accumulation. The independent ice caps of northeast Greenland have diminished very little during recent time.

Recent studies of the ice cap in north Greenland suggest a slightly positive net balance of accumulation over ablation and calving. This is not neccessarily in conflict with the observed retreat of the ice cap margin if time lag and pulsation are considered.

RÉSUMÉ

Le travail sur le terrain et l'interprétation de photographies indiquent qu'au cours des 50 dernières années, le bord de l'Indlandsis du Groenland qui s'étend du Kap York sur la côte ouest, vers le nord à travers Peary Land et vers le sud jusqu'à Nioghalvfjerdsfjorden sur la côte est, a reculé d'une manière générale de 2 a 8 km, ou a diminué d'épaisseur de 10 à 100 m là où le front du glacier est relativement stationnaire. Les glaciers effluents d'Independence Fjord et de Hagen Fjord sur le bord nord-est de l'Indlandsis ont reculé davantage que ceux de Kap York, Ingelfield Bredning, et Petermann Gletscher sur le bord nord-ouest. Plusieurs glaciers de la côte nord-ouest du Groenland, tels que Brother John Gletscher à Etah étaient en crue jusqu'à une époque récente, mais sont maintenant stationnaires. Les avances récentes peuvent être attribuées au fait que ces glaciers sont alimentés par des calottes séparées ou par des lobes de l'Indlandsis du Groenland qui ont reçu une accumulation plus importante. Les calottes de glace séparées du Groenland du nord-est ont peu diminué pendant les temps récents.

Les études récentes de l'Indlandsis au Groenland du nord suggèrent qu'il y a un léger excès de l'accumulation par rapport à l'ablation et le vêlage. Ceci n'est pas nécessairement en contradiction avec le recul observé du bord de l'Indlandsis du Groenland si l'on tient compte du décalage dans le temps et des pulsations de la masse glaciaire.

1. INTRODUCTION

Recent studies indicate that the earth has passed through a period of net increase in temperature that culminated in 1940 (Mitchell 1961). Since 1940 the trend apparently has reversed and net lowering of temperature is now in progress. Observations on glaciers in southern Greenland show that the warming trend was reflected in the position of glacial fronts (Weidick 1959). In northern Greenland the effect of these trends is of interest especially in regard to the extreme aridity of the area.

As described in this paper northern Greenland covers the ice-free area from north of Kap York on the west around to the east coast as far south as Nioghalvfjerdsfjorden (fig. 1). It embraces an area of dissected plateaus along the west coast to Peary Land. In northern Peary Land alpine mountains occur; southern Peary Land is formed of

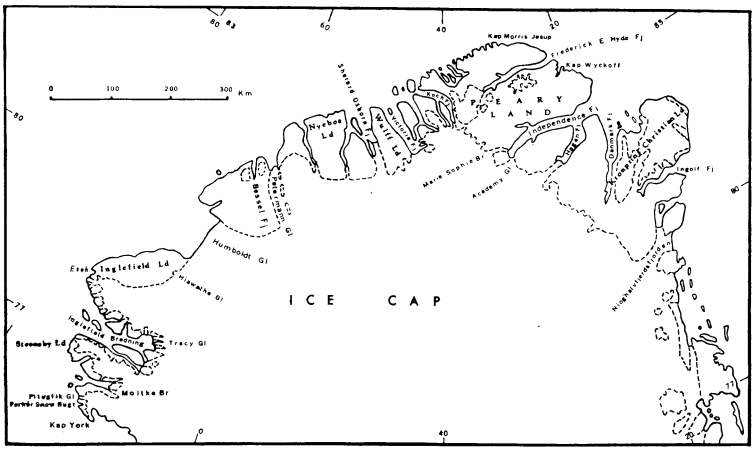

Fig. 1 — Map of North Greenland showing principal geographic features. Dashed lines indicate limits of major glaciers and ice caps.

dissected, rolling plateaus. Along the northeast coast of Greenland are alpine mountains behind which lie dissected plateaus. On the inner border of this ice-free area is the Greenland Ice Cap, prongs of which discharge outlet glaciers into the major fjords and valleys that intersect the ice cap. Numerous small ice caps occur on the broad plateaus, and mountain glaciers and local ice caps occur in the mountainous districts of Peary Land and Northeast Greenland.

Along the margin of the Greenland Ice Cap the plateaus range from 800 to 1000 meters in altitude. Away from the ice cap the elevations drop slightly toward the sea. The alpine peaks of Peary Land and East Greenland range from 1000 to more than 1900 meters in height.

Average annual air temperature at Thule Air Base, 95 kilometers north-west of Kap York, is −12.0°C and at Nord in Northeast Greenland at the mouth of Independence Fjord it is −16.5°C. Summer mean maximum is about 8°C throughout the area. Winter mean minimum is −30° to −35°C.

Precipitation throughout North Greenland is low ranging from an annual mean of 65 mm. at Thule Air Base to about 50 mm. in Peary Land. The annual mean at Nord is about 154 mm. Precipitation is controlled by southeast winds that have lost most of their moisture by the time they reach northern Greenland.

Data for this paper were collected during summer field observations made in 1953 and 1956 to 1960 as a part of scientific studies of North Greenland supported by the U.S. Air Force Cambridge Research Laboratories. Historical data for purposes of comparison are based on photographs, maps, and descriptions contained in explorers' narratives and the Meddelelser om Grønland. Supplementary data from unpublished photographs are also used. Previous studies of the edge of the ice cap and outlet glaciers were made around Inglefield Bredning in 1894 by Chamberlin (1894-1897). Koch's studies from 1917 to 1922 of existing glaciers (Koch 1928) are the only comprehensive résumé available on the glaciology of North Greenland.

2. Glacial regimen

(*a*) *Kap York — Humboldt Gletscher*

In the Kap York — Humboldt Gletscher section of North Greenland excellent data are available with which to compare the extent of glaciers and the ice cap during

the past 60 years. The coast from Kap York to Pitugfik (Petowik) Gletscher is cut by 22 glaciers, all of which show distinct signs of recent retreat. In 1923 Koch (1928, p. 216-218) described many of these glaciers in detail. Comparison with present conditions shows that 9 of these glaciers have retreated 30 to 250 meters, one has disappeared, and the others have retreated only slightly. One of the latter, however, in comparison with a photo made by Peary in 1894 (Peary 1898, Vol. 2, p. 38) shows a retreat of 180 meters.

In this area only Cluett Gletscher and Neptune Gletscher at the head of Parker Snow Bugt have remained stable in recent time. These glaciers terminate on land, 2 kilometers short of the bay, and are bounded by large end and lateral moraines. Field observations in 1958 (fig. 2) compared with photographs of 1896 (Peary 1898, Vol. 2, p. 336), and 1903 (Low 1906) show no change.

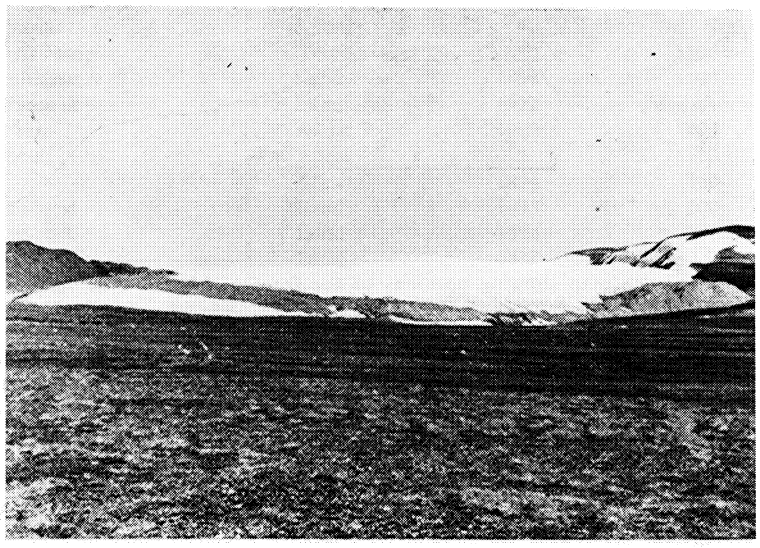

Fig. 2 — Cluett Gletscher, at Parker Snow Bugt, 1958. Glacier front, including moraine, is 45 m high and 1000 m wide. Photograph taken from a position 1000 m west of glacier.

Pitugfik (Petowik) Gletscher is one of the most impressive glaciers along the coast of northwestern Greenland. It projects into the sea as a broad fan about 2500 meters in diameter. In 1923 Koch (1928, p. 225) estimated that the tongue projected 3000meters beyond the coast. By 1946 this had been reduced to 2110 meters and in 1953 it was 1493 meters. In spite of these changes the fan-shaped front suffered few alterations, and little or no calving of icebergs occurred. The diminution apparently results from wastage through surface and subsurface melting. The surface of the glacier is free of large crevasses and contains many large melt-streams.

The front of the Greenland Ice Cap between Pitugfik Gletscher and Moltke Brae is stationary and consists of ice-cored morainal slopes. Since 1916 the fluctuations of the front of Moltke Brae has been well recorded (Wright 1939). Between 1916 and 1926 the glacier retreated 1600 to 3500 meters; from 1926 to 1932 it advanced until it was near the 1916 position (fig. 3). Since 1932 retreat has been dominant but in the last decade the rate of retreat has diminished. In 1959 the front had retreated 5 to 5.5 kilometers from 1932 position.

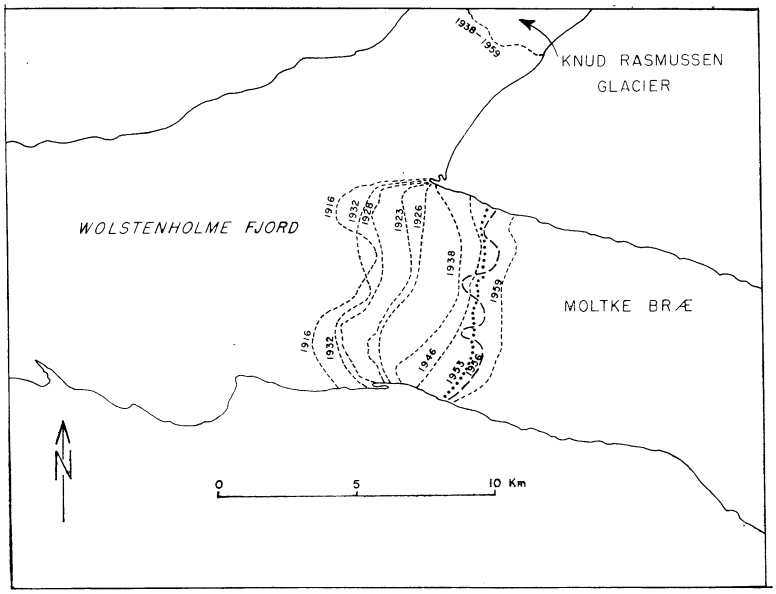

Fig. 3 — Sketch map showing positions of the front of Moltke Brae 1916-1959. Data for 1916-1938 modified from Wright (1939).

Knud Rasmussen Gletscher, about 5 kilometers north of Moltke Brae, by contrast shows no change since 1938. West of Rasmussen Gletscher, Chamberlin Gletscher shows a retreat of 380 to 680 meters between 1923, when it was sketched by Koch (1928, pl. III), and 1959.

West of Chamberlin Gletscher there are four large glaciers that terminate on land and one that reaches the sea. In Steensby Land seven large glaciers terminate on land. All are bordered by fresh, recent end and lateral moraines which are 60 to 300 meters beyond the present ice margin. Descriptions of glacial conditions in 1923 around Booth Sund, on the south side of Steensby Land, made by Koch (1928, p. 251) show that since then Ingnimut Gletscher has retreated 90 meters, the glacier on the north arm of the sound 300 meters, and the west glacier 60 to 90 meters.

As a result of studies made by Chamberlin and Salisbury while on the Peary Auxiliary Expeditions of 1894 and 1895 (Chamberlin 1894-97; Salisbury 1895, 1896) and by Lauge Koch (1928), the glaciers along Inglefield Bredning are the best known in northern Greenland. All but a few of the 42 glaciers in this area show large retreats in the last 40 to 68 years (Table 1). Glaciers whose fronts are afloat show the greatest retreat, Tracy Gletscher retreated the most. In 1892 it extended along the north side of Josephine Peary Ø beyond Melville Gletscher. By 1947 it had retreated east of Melville Gletscher and extended to the east end of Josephine Peary Ø. In 1959 the front was clear of the island and was midway between Melville and Farquhar Gletschers. The retreat from 1892 to 1959 is about 7 kilometers representing about 50 square kilometers of glacier surface.

The glaciers on Northumberland Ø and Herbert Ø, at the entrance to Inglefield Bredning, all show recent retreat. Of 23 glaciers, there are comparative data for only 5 on Northumberland Ø, which were photographed by Peary (1898, Vol. 1, p. 118, 119, 211, Vol. 2, p. 59, 388) in 1895, and by Koch (1928, p. 337) in 1922. These show retreats of a few meters to more than 3000 meters. Koch's photograph of Western Gletscher

TABLE 1

Glaciers — Inglefield Bredning and Vicinity

1960

Glacier	Terminus	Comparison Date	Retreat - meters
Dodge	Afloat	*	slight
Storm	Afloat	*	slight
Chield	Land	1922	300
Bu	Land	1922	200
Bamse	Land	1922	60-180
Clements Markham	Afloat	*	450
Diebitsch	Afloat	*	750-1000
Morris Jesup	Afloat	*	1500
Igdluluarssuit	Land	1894	45
Sijorarsuak	Land	1922	slight
Meehan	Afloat ?	1922	900
Verhoeff	Afloat	*	750
Sun	Afloat	1894	750
Tugto-west	Land	1893	500
Tugto-east	Land	1894	200
Bowdoin	Land	1893	0-150
Kankolah	Land	1892	60
Scarlet Heart	Land	1892	300
Fan	Land	1894	60-90
Bryant	Land	1894	300
Kanaq	Land	1894	120
Gnome	Land	1892	240
South Fjord	Land	1893	150
Mirror	Land	1893	slight
East	Land	1893	60
Hubbard	Afloat	1922	750
Hart	Afloat	1893	1200
Sharp	Afloat	1893	1200
Melville	Afloat	1922	3000
Tracy	Afloat	1892	7000
Heilprin	Afloat	1892	0
Leidy	Afloat	1895	0
Marie	Land	1923	0
Falcon	Land	*	slight
Salmon River	Land	1894	slight
Savage	Afloat ?	1894	150
Hurlbut	Land	1894	150
Ittibloo	Land	1894	90-120
W. of Ittibloo	Land	1894	150
E. of Misumassaq	Afloat	1947-1956	90-120
Misumassaq	Land	1894	425
Barden Bugt	Land	1861	1000
Tyndall	Afloat	1861	600

(*) No comparative data available. Degree of retreat based on position of ice margin shown on aerial photos 1946 and 1956 with respect to fresh lateral and end moraines, and trim lines.

indicates no difference between 1895 and 1922, so the retreat of 150 meters and the thinning of this glacier probably occurred after 1922.

The long front of the ice cap in Inglefield Land is broken by glaciers at only a few points. In general the front is a steep slope which appears to be very stable. Brother John Gletscher at Etah is the southernmost glacier draining the ice cap in Inglefield Land. Its record goes back to 1861 when Hayes (1867) mapped its position. At that time it was about 740 meters east of Lake Alida. In 1873 Bessels (1879) measured the distance from the lake to the glacier as 730 meters. A sketch made by Moss (1878) in 1875 indicates that the front was still about 700 meters from the lake. In 1906 the front was slightly east of the lake (Senn 1907) and a small beach existed between the glacier and the lake. By 1914 the front extended about 1200 meters into the lake (MacMillan 1918) and the advance had halted. Koch's picture made in 1922 (Koch 1928, p. 269) shows no change since 1914. Recent aerial photographs show that wastage is taking place on the surface of the glacier but that the front remains the same as it was in 1914.

Of the 9 small glaciers extending west from the front of the ice cap in Inglefield Land only one shows signs of recent changes. When Hiawatha Gletscher was mapped in 1922 by Koch (1928, p. 279) it consisted primarily of a glacier tongue extending into, but not filling, the lake. Recent aerial photographs indicate that this glacier advanced after 1922. At present the front is at approximately the same point as it was in 1922, but the glacier now is higher and wider, and fills the valley.

At the north end of Inglefield Land is Humboldt Gletscher, the largest in Greenland. Because of its great size (about 100 kilometers along its front) it is difficult to obtain comparative data. Based on Koch's (1932) map it appears that changes have occurred along the face of the glacier but that its general position has not changed since 1922.

(b) Humboldt Gletscher to J.P. Koch Fjord

This part of Greenland consists of large areas of ice-free land intersected by long fjords which extend to the main Greenland Ice Cap. Of 54 glaciers in this area, 32 appear to be stable and 21 show definite indications of recent retreat. In addition there are 145 small, isolated ice caps which appear to be stable. Twenty small ice caps have outlet glaciers that have recently retreated.

The glaciers in Bessels Fjord are probably the best indicators of the glacial régime in the area. Three glaciers descend steep valleys from a large, local ice cap to the east and 10 similar glaciers occur on the west. All these glaciers show evidence of retreat in the form of fresh lateral and end moraines no longer in contact with the ice. In 1922 Koch (1928, pl. V, p. 334, 335) photographed 5 of these glaciers. These photographs compared with aerial photographs taken in 1947 indicate no perceptible change. It is probable that the glaciers are stable at present and that retreat occurred earlier in the present century.

Data for Petermann Gletscher go back to 1876 when its front was mapped by Coppinger of the British Arctic Expedition 1875-76 (Coppinger 1877). In 1922 Koch (1928, p. 293) found the glacier front to be in about the same position as in 1876. The present front is within 6 kilometers of the previously mapped positions.

Sherard Osborn Fjord is blocked by a mass of tabular icebergs which extend within 25 kilometers of the mouth of the fjord. In 1917 an ice tongue from Ryder Gletscher (Koch 1928, p 298) occupied much of the fjord which is now choked with icebergs. After the break up of the ice tongue Ryder Gletscher has continued to calve more rapidly than it moves forward. Between 1947 and 1956 the front withdrew 5 kilometers. At present many of the fragments of the broken tongue are dispersing westward into Hartz Sound which is open during the summer. The clearing of icebergs from Sherard Osborn Fjord in this manner may accelerate calving.

Four major glaciers descend into the head of Victoria Fjord. All of them are bordered by large, fresh lateral moraines which extend as much as 2000 meters beyond the present front of the glaciers. Victoria Fjord is choked with large tabular icebergs that apparently broke from the glacier tongues. It is estimated that the icebergs have a total surface of 600 square kilometers, which is equivalent in size to an ice tongue extending 60 kilometers beyond the present head of the fjord. In 1917, near Isvolden, Koch (1928, p. 300-301) encountered a blockage formed by fragments of the ice tongue. Its position is about the same today.

(*c*) *Peary Land*

Very few reliable and comparative data are available for the area north of Independence Fjord and east of J.P. Koch Fjord. Peary's crude sketch made in 1892 of Academy Gletscher (Peary 1898, Vol. 1, p. 353) shows the ice front extending to Lyngeholmene in the middle part of the head of the fjord (fig. 4). Whether the ice sketched was an integral part of Academy Gletscher or whether it was made up in part of closely-packed icebergs cannot be told from Peary's descriptions, and photographs do not give any clues.

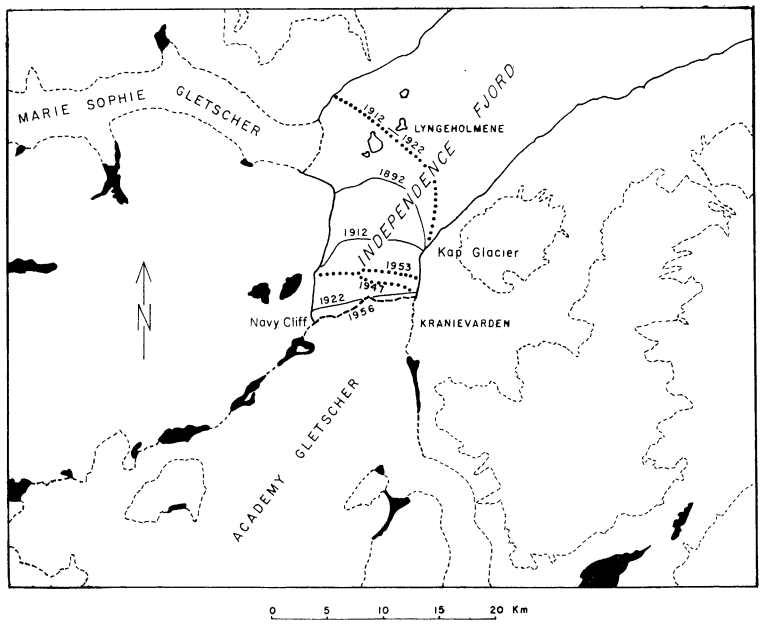

Fig. 4 — Sketch map showing positions of the front of Academy Gletscher 1892-1956. Solid black areas are lakes. Dashed lines are glacier and ice cap boundaries. Dots are limits of closely packed icebergs. Solid lines are glacier fronts.

Rasmussen's (1915) and Freuchen's (1915) descriptions of the glacier in 1912 indicate that the head of Independence Fjord was choked with closely-packed icebergs; their maps show the front of the glacier extending from base of Navy Cliff to Kap Glacier, 8 kilometers south of Lyngeholmene (fig. 4).

Lauge Koch (1928, pl. V) encountered extensive areas of hummocked sea ice and closely-packed icebergs in front of Academy Gletscher in 1921. He indicated that the

front of the glacier (Koch 1927, pl. VI) extended from 3 kilometers north of Kranievarden on the east to the base of Navy Cliff. This is approximately the front of the glacier in 1956. At present the concentration of icebergs covers only a small area extending about a kilometer in front of the glacier. The glacier moves and calves regularly.

Two interpretations are possible concerning changes in Academy Gletscher since 1892. The first is that its front has changed little, being close to the base of Navy Cliff, and that closely-packed icebergs, extending originally to Lyngeholmene, have been progressively dispersed to the lower parts of Independence Fjord.

A second possibility is that by extensive break-up and calving the glacier front has retreated. If Peary's sketch of 1892 represents the front of the glacier, a retreat of 12 kilometers has occurred between then and 1956. Freuchen's sketch shows the 1912 position of the glacier front 6 kilometers seaward of its present position. Regardless of which postulation is accepted, it is apparent that loss exceeds replenishment of the glacier. The icebergs are now dispersed as rapidly as they are produced. Large areas of the upper part of the glacier as well as the sides are stagnant and numerous streams and melt pools occur on the ice. Fresh lateral moraines stand higher above the ice at present than in 1921.

Compared with present conditions, Koch's picture of a small north-flowing valley glacier leading from Marie Sophia Brae near its head (Koch 1927, p. 122) shows a retreat of 60 to 90 meters between 1921 and 1956. During this period the tapering snout has changed to an irregular, serrated, moraine-chocked terminus. Its rounded surface is now intersected by ridges and troughs developed by thawing along shear lines.

Along the north coast of Peary Land historical comparison is possible at Clarence Wyckoff Fjeld, 13 kilometers southeast of Kap Wyckoff. In 1907 Bertelsen (Koch 1917

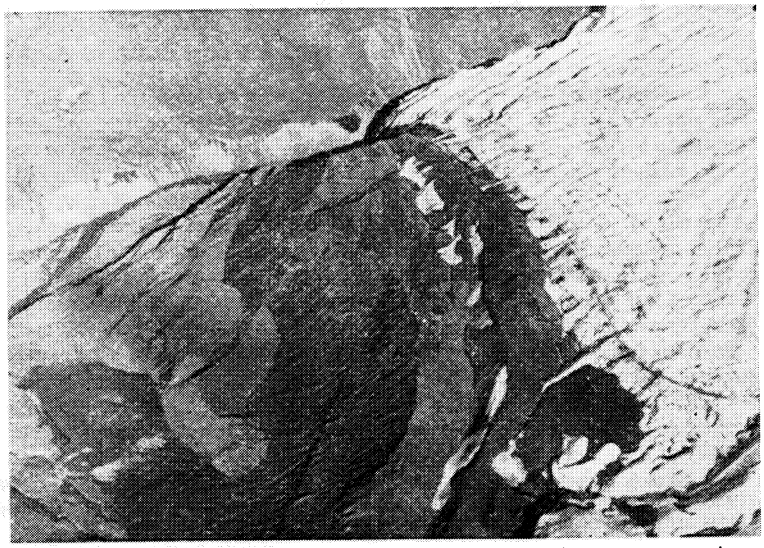

Fig. 5 — Front of Sifs Gletscher, Dobbeltsøen, 1960. Marine terraces cut into old moraine are covered in part by more recent moraines. Distance between crests of recent moraines is 120 m.

fig. 46) sketched a small glacier on the northeast face of the mountain. When examined in the field in 1960 this glacier showed no distinct change from the position sketched in 1907.

Sifs Gletscher, which ends in a large lake (tentatively called Dobbeltsøen) 30 kilometers southeast of Kap Morris Jesup, in the north part of Peary Land, is indicative of the present glacial régime in this part of northern Greenland. The glacier flows eastward into the lake and is diverted northward for 5000 meters by the east wall of the valley in which the lake lies. At its northern edge is a large accumulation of morainal material, the north side of which has been reworked into 5 raised marine terraces. The terraces have changed little and only the top terrace has been altered by changes in the glacier front (fig. 5). Two low ridges, apparently resulting from minor fluctuations of the glacier front, cut across the terrace. The top terrace corresponds to the upper terrace of Kaffeklubben Ø (30 kilometers east of Kap Morris Jesup) which has been dated by radiocarbon methods as 7730 ± 400 b.p.* Apparently this glacier has maintained a relatively uniform position for about the last 7500 years and variations, possibly recent, are only of the order of 120 meters.

Examination of aerial photographs supplemented by field observations in 1956 and 1960 indicates that the majority of glacial fronts in Peary Land have neither advanced or retreated recently. Of the 309 glacier fronts in the area, 208 are apparently stable, 99 show definite indications of recent retreat, and 2 show evidence of recent advance. Of 11 small, isolated ice caps, 9 are apparently stable and 2 show signs of recent retreat.

(*d*) *Northeast Greenland*

For the ice-free area south of Independence Fjord almost no historical data are available for comparison with present day glacial conditions. Hoeg Hagen's sketch of the large glacier in Hagen Fjord made in 1907 (Amdrup 1913, pl. IV) shows that the glacier front was to the east of a group of nunataks. Although this sketch was made from a point 10 kilometers east of the glacier it is apparently correct, for the area covered by large tabular icebergs now in the lower part of Hagen Fjord is sufficient to restore the former front. The present glacier front is 8 kilometers west of the 1907 position and the nunataks are now islands. Practically the entire glacier is now stagnant, and a surface of interlacing streams and large interconnecting ponds lie in parallel troughs. Hagen Gletscher is afloat in its lower part, but 20 kilometers from the front a ridge cuts across the bottom of the fjord and the glacier is aground at this point.

Aerial photographs supplemented by field observations show that of 203 glaciers in Northeast Greenland 120 are stationary and 83 have recently retreated. Three major glaciers flowing from the main Greenland Ice Cap show a recent retreat of 60 to 300 meters from fresh end and lateral moraines; 5 similar glaciers show evidence of stationary positions.

Almost all the steeply sloping, short glaciers in the mountainous area adjacent to Ingolf Fjord have retreated 30 to 120 meters from fresh, end and lateral moraines. Several of the glaciers that extend into the water have retreated further. The large tongue of Spaerregletscher that extended more than half way across Ingolf Fjord in 1939 (Nielsen 1941) has broken up and the glacier front is now in line with the coast. Many large icebergs are scattered in the vicinity of the former tongues.

Spaltegletscher, a subordinate floating tongue on the north side of Nioghalvfjerdsfjorden and 17 kilometers from its front, has apparently retreated 18 kilometers from its position of 1907 (Koch and Wegener 1912) and 2 to 3 kilometers from its position of 1938 (Dastrup 1945). The area between the 1938 front and the present front is filled with large tabular icebergs that result from the break-up of the tongue.

All the 59 small isolated ice caps in the area south of Independence Fjord appear to be stationary. Small valley glaciers draining from them do not indicate recent retreat.

(*) Radiocarbon dating by Meyer Rubin, U.S. Geological Survey, W 1090.

3. Summary

Of the glaciers and small ice caps in northern Greenland a large majority exhibit stable conditions but a significant number show evidence of recent retreat (Table 2). In the case of ice caps located on smooth plateaus the figures are probably misleading, for most of these ice caps are wholly within the area where annual snow cover is removed in the melt season. The slow surface melting and thinning, with no appreciable movement of the ice, leaves little or no trace of retreat. The glacier data, however, are probably correct in indicating the order of magnitude of recent changes. It is interesting to note that the degree of stability increases northwards while conditions of retreat decrease. It is also significant that the greatest degree of retreat takes place in glaciers whose fronts are afloat in the sea or in small glaciers that descend steeply as small outlet glaciers from isolated ice caps.

The general retreat and stability of glaciers in northern Greenland is somewhat contrary to recent observations on the Greenland Ice Cap. These observations indicate a net accumulative balance of snow on the central part of the ice cap (Summer 1960; Benson 1961; Langway 1961; Lister 1961). For Greenland north of 78° the net mean annual accumulation is equivalent to 11 to 26 cm. of water. However, along much of the periphery of the ice cap and on glaciers draining from the ice cap more than the annual accumulation of snow is removed by thawing. The degree of this depletion probably offsets the accumulation in the central part of the ice cap and results in a retreat of glaciers along the edge of the ice cap.

Since the early 1920's precipitation trends in Greenland, based on snow stratigraphy (Diamond 1956), indicate a correlation between glacial retreat and precipitation. In northern Greenland since 1920 there has been apparently a gradual decrease in precipitation, and a decrease in net snow accumulation, with an accelerated decrease since 1932. The post-1922 retreat of many glaciers in associated with this decrease.

TABLE 2

Glacial Regime, Northern Greenland

(based on apparent net changes of ice margins with respect to end and lateral moraines, and trim lines, during the last 68 years)

	Glaciers			Local Ice Caps		
	Advance	Stationary	Retreat	Advance	Stationary	Retreat
Kap York - Humboldt Gl.	1(0.8)	36(31)	80(68)	0	7(20)	28(80)
Humboldt Gl. - Koch Fj.	1(2)	32(60)	21(38)	0	145(88)	20(12)
Peary Land	2(0.7)	208(67)	99(32)	0	9(82)	2(18)
NE Greenland	0(0)	120(59)	83(41)	0	59(100)	0(0)
Total	4(1)	396(58)	283(41)	0(0)	220(82)	50(18)

Number in brackets is percentage.

Conclusions

The recent regime of outlet glaciers in northern Greenland is one of excessive melting in relation to supply of snow and ice, resulting in retreat or apparently stationary conditions of glacier fronts.

The large percentage of glaciers in retreat in the area from Kap York to Humboldt Gletscher results from an adjustment of glaciers to a dry, coastal-type climate wherein recent changes in precipitation and temperature are directly reflected in the régime of the glacier.

The stable glacier fronts which are dominant in Peary Land and most of North-eastern Greenland reflect adjustment to an extremely arid, cold, inland type climate that has apparently existed throughout recent and Late Pleistocene time.

The net retreat in the periphery of the ice cap over a period of 65 years is in accord with precipitation trends (Diamond 1956). Present conditions of precipitation, with a net accumulation in the central part of the ice cap, are not directly reflected in the periphery. This is probably a result of extensive net ablation in the peripheral zone which offsets the positive balance elsewhere. It is also possible that the difference represents a lag in outward movement of material accumulated in the central part of the ice cap. If the latter is correct, the peripheral zone is a relic of former conditions.

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