

GREENLAND

General description.

A large continental island, the greater portion of which lies within the Arctic Circle, while the whole is Arctic in character. It is not connected with any portion of Europe or America except by suboceanic ridges; but in the extreme north it is separated only by a narrow strait from Ellesmere Land in the archipelago of the American continent. It is bounded on the east by the North Atlantic, the Norwegian and Greenland Seas with Jan Mayen, Iceland, the Faeroe Islands and the Shetlands being the only lands between it and Norway.

Danmark Strait is the sea between it and Iceland, and the northern Norwegian Sea or Greenland Sea separates it from Spitsbergen. On the west coast Davis Strait and Baffin Bay separate it from Baffin Land. The so-called bay narrows northward into the strait successively known as Smith Sound, Kane Basin, Kennedy Channel and Robeson Channel. A submarine ridge, about 300 fathoms deep at its deepest, unites Greenland with Iceland (across Danmark Strait), the Faeroes and Scotland. A similar submarine ridge unites it with the Cumberland Peninsula of Baffin Land, across Davis Strait. Two large islands (with others smaller) lie probably off the north coast, being apparently divided from it by very narrow channels which are not yet explored. If they be reckoned as integral parts of Greenland, then the north coast, fronting the polar sea, culminates about 83° 40' N. Cape Farewell, the most southerly point (also on a small island), is in 59° 45' N.

The extreme length of Greenland may therefore be set down at about 1650 miles, while its extreme breadth, which occurs about 77° 30' N., is approximately 800 miles. The area is estimated at 827,275 sq. miles.

Greenland is a Danish colony, inasmuch as the west coast and also the southern east coast belong to the Danish crown. The scattered settlements of Europeans on the southern parts of the coasts are Danish, and the trade is a monopoly of the Danish government.

The southern and south-western coasts have been known, as will be mentioned later, since the 10th century, when Norse settlers appeared there, and the names of many famous Arctic explorers have been associated with the exploration of Greenland. The communication between the Norse settlements in Greenland and the motherland Norway was broken off at the end of the 14th and the beginning of the 15th century, and the Norsemen's knowledge about their distant colony was gradually more or less forgotten. The south and west coast of Greenland was then re-discovered by John Davis in July 1585, though previous explorers, such as Cortereal, Frobisher and others, had seen it, and at the end of the 16th and the beginning of the 17th century the work of Davis (1586-1588), Hudson (1610) and Baffin (1616) of the western seas afforded some knowledge of the west coast. This was added to by later explorers and by whalers and sealers. Among explorers who in the 19th century were specially connected with the north-west coast may be mentioned E. A. Inglefield (1852) who sailed into Smiths Sound, Elisha Kent Kane (1853-1855)² who worked northward through Smith Sound into Kane Basin, and Charles Francis Hall (1871) who explored the strait (Kennedy Channel and Robeson Channel) to the north of this.

The northern east coast was sighted by Hudson (1607) in about 73° 30' N. (Cape Hold with Hope), and during the 17th century and Inglefield,

Later this north eastern coast was probably visited by many Dutch whalers. The first known visitor who gave more accurate information was the Scottish whaler, Captain William Scoresby, jun. (1822), who, with his father, explored the coast between 69° and 75° N., and gave the first fairly trustworthy map of it. Captains Edward Sabine and Clavering (1823) visited the coast between 72° 5' and 75° 12' N. and met the only Eskimos ever seen in this part of Greenland. The second German polar expedition in 1870, under Carl Christian Koldewey (1837-1908), reached 77° N. (Cape Bismarck); and the Duke of Orleans, in 1905, ascertained that this point was on an island (the Dove Bay of the German expedition being in reality a strait) and penetrated farther north, to about 78° 16'.

From this point the north-east coast remained unexplored, though a sight was reported in 1670 by a whaler named Lambert, and again in 1775 as far north as 79° by Dames Barrington, until a Danish expedition under Mylius Erichsen in 1906-2908 explored it, discovering North-East Foreland, the easternmost point (see POLAR REGIONS and map). The southern part of the east coast was first explored by the Dane Wilhelm August Graah (1829-1830) between Cape Farewell and 65° 16' N. In 1883-1885 the Danes Gustav Holm and T. V. Garde carefully explored and mapped the coast from Cape Farewell to Angmagssalik, at 66° N. Dr Fritjhof Nansen and his companions also travelled along a part of this coast in 1888. A. E. Nordenskjold, in the *Sophia*, landed near Angmagssalik, in 65° 36' N. In 1883. Captain C. Ryder, in 1891-1892, explored and mapped the large Scoresby Sound, or, more correctly, Scoresby Fjord. Lieutenant Carl Amdrup, in 1899, explored the coast from Angmagssalik north to 67° 22' N. A part of this coast, about 67° N., had also been seen by Nansen in 1882. In 1899 Professor A. G. Nathorst explored the land between Franz Josef Fjord and Scoresby Fjord, where the large King Oscar Fjord, connecting Davis Sound with Franz Joseph Fjord, was discovered. In 1900 Lieutenant Amdrup explored the still unknown east coast from 69° 10' N. south to 67°N.

From the work of explorers in the north-west it had been possible to infer the approximate latitude of the northward termination of Greenland long before it was definitely known. Towards the close of the 19th century several explorers gave attention to this question. Lieutenant (afterwards Admiral) L. A. Beaumont (1876), of the Nares Expedition, explored the coast north-east of Robeson Channel to 82° 20' N. In 1882 Lieut. J. B. Lockwood and Sergeant (afterwards Captain) D. L. Brainard, of the U.S. expedition to Lady Franklin Bay, explored the north-west coast beyond Beaumont's farthest to a promontory at 83° 24' N. and 40° 46' E. and they saw to the north-east Cape Washington, in about 83° 38' N. and 39° 30' E., the most northerly point of land till then observed. In July 1892 R. E. Peary and E. Astrup, crossing by land from Inglefield Gulf, Smith Sound, discovered Independence Bay on the north-east coast in 81° ~7' N. and 34° 5' W.¹¹ In May 1895 it Journal of a Voyage to the...

...was revisited by Peary, who supposed this bay to be a sound communicating with Victoria Inlet on the north-west coast. To the north Heilprin Land and Melville Land were seen stretching northwards, but the probability seemed to be that the coast soon trended north-west. In 1901 Peary rounded the north point, and penetrated as far north as 83° 50' N.

Exploration of the great ice-cap, or inland ice, which may be asserted to cover the whole of the interior of Greenland, has been prosecuted chiefly from the west coast. In 1751 Lars Dalager, a Danish trader, took some steps in this direction from Frederikshaab. In 1870 Nordenskjold and Berggren walked 35 miles inland from the head of Aulatsivik Fjord (near Disco Bay) to an elevation of 2200 ft. The Danish captain Jens Arnold Dietrich Jensen reached, in 1878, the Jensen Nunataks (5400 ft. above the sea), about 45 miles in.

From the western margin, at 62° 50' Nordenskjold penetrated in 1883 about 70 miles inland to 68° 20' N, and two Lapps of his expedition went still farther on skis, to a point nearly under ~5

W. at an elevation of 6600 ft. Peary and Maigaard reached in 1886 about 100 m. inland, a height of 7500 ft. in 69° 30' N. Nansen with five companions in 1888 made the first complete crossing of the inland ice, working from the east coast to the west, about 64° 25' N., and reached a height of 8922 ft. Peary and Astrup, as part of the inland ice between 78° and 82° N., reaching a height of about 8000 ft., and detouring already indicated, crossed in 1892 the northern termination of the ice- journey again in 1895. Captain T. V. Garde between 61° and 62° N. near its southern termination, and he reached a height of 7080 ft.

The coasts of Greenland are for the most part deeply indented with fjords, being about 60 miles from the margin (the northern part of the west coast) is to some extent intensely glaciated. The coast-line of Melville Bay ~ ~ degree an exception, though the fjords may here be somewhat filled with glaciers, and, for another example it may be noted that Peary observed a marked contrast on the north coast. Eastward ~ as far as Cape Morris Jesup there are precipitous headlands and islands, as elsewhere, with deep water close inshore. East of the same cape there is an abrupt change the coast is unbroken, the mountains recede inland, and there is shoal-water for a considerable distance from the coast.

Numerous islands lie off the coasts where they are indented; but these are in no case large, excepting those off the north coast and that of Disco off the west, which is crossed the parallel of 70 N. This island, which is separated by Vaigat Strait from the Nussuaq peninsula, is lofty, and has an area of 3005 sq. m. Steenstrup in 1898 discovered in it the warmest spring known in Greenland, having a temperature of 66° F.

The unusual glaciation of the east coast is evidently owing to the north polar current carrying the ice masses from the north polar basin 1/4 south-westward along the land, and giving it an entirely arctic climate down to Cape Farewell. In some parts the interior ice-covering extends down to the outer coast, while in other parts coast-land is deeply intersected by fjords extend its margin is situated more inland, and the ice-bare ing far into the interior, where they are blocked by enormous glaciers or ice-currents from the interior ice-covering which discharge masses of icebergs into them. The east coast of Greenland is in this respect highly interesting. All coasts in the world which are much intersected by deep fjords have, with very few exceptions a western exposure, e.g. Norway, Scotland, British Columbia ~ and Alaska, Patagonia and Chile, and even Spitsbergen and Novaya Zemlya whose west coasts are far more indented than their east ones.

Greenland forms the most prominent exception, its eastern coast being quite as much indented as its western. The reason is to be found in its geographical position, a cold ice-covered polar current 5 Miles running south along the land, while not far outside there is an open warmer sea, a circumstance which, while producing a cold climate, must also give rise to much precipitation, the land being thus exposed to the alternate erosion of a rough atmosphere and large glaciers. On the east coast of Baffin Land and Labrador there are similar conditions. The result is that the east coast of Greenland has the largest system of typical fjords known on the earth's surface. Scoresby Fjord has a length of about 180 m. from the outer coast to the point where it is blocked by the glaciers, and with its numerous branches covers an enormous area. Franz Josef Fjord, with its branch King Oscar Fjord, communicating with Davis Sound, forms a system of fjords on a similar scale. These fjords are very deep; the greatest depth found by Ryder in Scoresby Sound was 300 fathoms, but there are certainly still greater depths; like the Norwegian fjords they have, however, probably all of them, a threshold or sill, with shallow water, near their mouths. A few soundings made outside this coast seem to indicate that the fjords continue as deep submarine valleys far out into the sea. On the west coast there are also many great fjords. One of the best known from earlier days is the great Godthaab Fjord (or Baals Revier) north of 64° N. Along the east coast there are many high mountains, exceeding 6000 and 7000 ft. in height. One of the highest peaks hitherto measured is at Tiningnertok, on the Lindenow Fjord, in 60° 35' N., which is 7340 ft. high. At the bottom of Mogens Heinesen Fjord, 62° 30' N., the peaks are 6300 ft., and in the region of Umanak, 63° N., they even exceed 6600 ft. At Umivik, where Nansen began his journey across the inland ice, the highest peak projecting through the ice-covering was Gamels Nunatak, 6440 ft., in 64° 34' N. In the region of Angmagssalik, which is very mountainous, the mountains rise to 6500 ft., the most prominent peak being Ingolfs Fjeld, at 66° 20' N., about 6000 ft., which is seen from far out at sea, and forms an excellent landmark. This is probably the Blaaserk (i.e. Blue Sark or blue shirt) of the old Norsemen, their first landmark on their way from Iceland to the Oster Bygd, the present Julianehaab district, on the south-west coast of Greenland. A little farther north the coast is much lower, rising only to heights of 2000 ft., and just north of 67° 10' N. only to 500 ft. or less. The highest mountains near the inner branches of Scoresby Fjord are about 7000 ft. The Petermann Spitze, near the shore of Franz Josef Fjord, measured by Payer and found to be 11,000 ft., has hitherto been considered to be the highest mountain in Greenland, but according to Nathorst it is probably only two-thirds as high as Payer supposed, perhaps between 8000 and 9000 ft.

Along the west coast of Greenland the mountains are generally not quite so high, but even here peaks of 5000 and 6000 ft. are not uncommon. As a whole the coasts are unusually mountainous, and Greenland forms in this respect an interesting exception, as there is no other known land of such a size so filled along its coasts on all sides with high mountains and deep fjords and valleys.

The Inland Ice.

The whole interior of Greenland is completely covered by the so-called inland ice, an enormous glacier forming a regular shield-shaped expanse of snow and glacier ice, and burying all valleys and mountains far below its surface. Its area is about 715,400 sq. m., and it is by far the greatest glacier of the northern hemisphere. Only occasionally there emerge lofty rocks, isolated but not completely covered by the ice-cap; such rocks are known as nunataks (an Eskimo word). The inland ice rises in the interior to a level of

9000 ft, and in places perhaps 10,000 ft. or more, and descends gradually by extremely gentle slopes towards the coasts or the bottom of the fjords on all sides, discharging a great part of its yearly drainage or surplus of precipitation in the form of icebergs in the fjords, the so-called ice-fjords, which are numerous both on the west and on the east coast. These icebergs float away, and are gradually melted in the sea, the temperature of which is thus lowered by cold stored up in the interior of Greenland. The last remains of these icebergs are met with in the Atlantic south of Newfoundland. The surface of the inland ice forms in a transverse section from the west to the east coast an extremely regular curve, almost approaching an arc of a wide circle, which along Nansen's route has its highest ridge somewhat nearer the east than the west coast. The same also seems to be the case farther south. The curve shows, however, slight irregularities in the shape of undulations. The angle of the slope decreases gradually from the margin of the inland ice, where it may be 1 or more, towards the interior, where it is 0. In the interior the surface of the inland ice is composed of dry snow which never melts, and is constantly packed and worked smooth by the winds. It extends as a completely even plain of snow, with long, almost imperceptible, undulations or waves, at a height of 7000 to 10,000 ft., obliterating the features of the underlying land, the mountains and valleys of which are completely interred. Over the deepest valleys of the land in the interior this ice-cap must be at least 6000 or 7000 ft. thick or more. Approaching the coasts from the interior, the snow of the surface gradually changes its structure. At first it becomes more coarse-grained, like the Firn Schnee of the Alps, and is moist by melting during the summer. Nearer the coast, where the melting on the surface is more considerable, the wet snow freezes hard during the winter and is more or less transformed into ice, on the surface of which rivers and lakes are formed, the water of which, however, soon finds its way through crevasses and holes in the ice down to its under surface, and reaches the sea as a sub-glacial river. Near its margin the surface of the inland ice is broken up by numerous large crevasses, formed by the outward motion, of the glacier covering the underlying land. The steep icewalls at the margin of the inland ice show, especially where the motion of the ice is slow, a distinct striation, which indicates the strata of annual precipitation with the intervening thin seams of dust (Nordenskiöld's kryokonite). This is partly dust blown on to the surface of the ice from the ice-bare coast-land and partly the dust of the atmosphere brought down by the falling snow and accumulated on the surface of the glaciers covering by the melting during the summer. In the rapidly moving glaciers of the icefjords this striation is not distinctly visible, being evidently obliterated by the strong motion of the ice masses. -

The ice-cap of Greenland must to some extent be considered as a viscous mass, which, by the vertical pressure in its interior, is pressed outwards and slowly flows towards the coasts, just as a mass of pitch placed on a table and left to itself will in the course of time flow outwards towards all sides. The motion of the outwards creeping inland ice will naturally be more independent of the configurations of the underlying land in the interior, where its thickness is so enormous, than near the margin where it is thinner. Here the ice converges into the valleys and moves with increasing velocity in the form of glaciers, into the fjords, where they break off as icebergs. The drainage of the interior of Greenland is thus partly given off in the solid form of icebergs, partly by the melting of the snow and ice on the surface of the ice-cap, especially near its western margin, and to some slight extent also by the melting produced on its under side by the interior heat of the earth. After Professor Amund Helland had, in July 1875, discovered the amazingly great velocity, up to 643/4 ft. in twenty-four hours, with which the glaciers of Greenland move into the sea, the margin of the inland ice and its glaciers was studied by several

expeditions. K. J. V. Steenstrup during several years, Captain Hammer in 1879-1880, Captain Ryder in 1886-1887, Dr Drygalski in 1891-1893, and several American expeditions in later years, all examined the question closely. The highest known velocities of glaciers were measured by Ryder in the Upernivik glacier (73° N.), where, between the 13th and 14th of August of 1886, he found a velocity of 125 ft. in twenty-four hours, and an average velocity during several days of 101 ft. (Danish). It was, however, ascertained that there is a great difference between the velocities of the glaciers in winter and in summer. For instance, Ryder found that the Upernivik glacier had an average velocity of only 33 ft. in April 1887. There seem to be periodical oscillations in the extension of the glaciers and the inland ice similar to those that have been observed on the glaciers of the Alps and elsewhere. But these interesting phenomena have not hitherto been subject to systematic observation, and our knowledge of them is therefore uncertain. Numerous glacial marks, however, such as polished striated rocks, moraines, erratic blocks, &c., prove that the whole of Greenland, even the small islands and skerries outside the coast, has once been covered by the inland ice.

Numerous raised beaches and terraces, containing shells of marine mollusca, &c., occur along the whole coast of Greenland, and indicate that the whole of this large island has been raised, or the sea has sunk, in post-glacial times, after the inland ice covered its now icebare outskirts. In the north along the shores of Smith Sound these traces of the gradual upheaval of the land, or sinking of the sea, are very marked; but they are also very distinct in the south, although not found so high above sea-level, which seems to show that the upheaval has been greater in the north. In Uvkusigsat Fjord (72° 20' N.) the highest terrace is 480 ft. above the sea.⁴ On Manitsok (65° 30' N.) the highest raised beach was 360 ft. above the sea. In the Isortok Fjord (67° 11' N.) the highest raised beach is 380 ft. above sea-level.⁰ In the Ameralik Fjord (64° 14' N.) the highest marine terrace is about 340 ft. above sea-level, and at Ilivertalik (63° 14' N.), north of Fiskernaes, the highest terrace is about 325 ft. above the sea. At Kakarsuak, near the Bjornesund (62° 50' N.), a terrace is found at 615 ft. above the sea, but it is doubtful whether this is of marine origin.¹ In the Julianehaab district, between 60° and 61° N., the highest marine terraces are found at about 160 ft. above the sea. The highest marine terrace observed in Scoresby Fjord, on the east coast, was 240 ft. above sea-level. There is a common belief that during quite recent times the west and southwest coast, within the Danish possessions, has been sinking. Although there are many indications which may make this probable, none of them can be said to be quite decisive.

The structure of explored Greenland is as follows:

I. Laurentian.

Gneiss forms the greatest mass of the exposed rocks of the country bare of ice. They are found on both sides of Smith Sound, rising to heights of 2000 ft., and underlie the Miocene and Cretaceous rocks of Disco Island, Noursoak Peninsula and the ~ E. v. Drygalski, Gronland-Expedition der Gesellschaft fur Erdkunde zu Berlin, 1891-1893 (2 vols., Berlin, 1897).

Oolites of Pendulum Island in East Greenland. Ancient schists occur on the east coast south of Angmagssalik, and basalts and schists are found in Scoresby Fjord. It is possible that some of these rocks are also of Huronian age, but it is doubtful whether the rocks so designated by the geologists of the Alert and Discovery expedition are really the rocks so

known in Canada, or are a continuous portion of the fundamental or oldest gneiss of the north-west of Scotland and the western isles.

2. Silurian.

Upper Silurian, having a strong relation to the Wenlock group of Britain, but with an American facies, and Lower Silurian, with a succession much the same as in British North America, are found on the shores of Smith Sound, and Nathorst has discovered them in King Oscar Fjord, but not as yet so far south as the Danish possessions.

3. Devonian.

Rocks are believed to occur in Igaliko and Tunnudiorkbik Fjords, in S.W. Greenland, but as they are unfossiliferous sandstone, rapidly disintegrating, this cannot be known. It is, however, likely that this formation occurs in Greenland, for in Dana Bay, Captain Feilden found a species of Spirifera and Productus mesolobus or costatus, though it is possible that these fossils represent the Ursa stage (Heer) of the Lower Carboniferous. A few Devonian forms have also been recorded from the Parry Archipelago, and Nathorst has shown the existence of Old Red Sandstone facies of Devonian in Traill Island, Geographical Society Island, Ymer Island and Gauss Peninsula.

4. Carboniferous.

In erratic blocks of sandstone, found on the Disco shore of the Vaigat have been detected a Sigillaria and a species of either Pecopleris or Gleichenia, perhaps of this age; and probably much of the extreme northern coast of Ellesmere Land, and therefore, in all likelihood, the opposite Greenland shore, contains a clearly developed Carboniferous Limestone fauna, identical with that so widely distributed over the North American continent, and referable also to British and Spitsbergen species. Of the Coal Measures above these, if they occur, we know nothing at present. Capt. Feilden notes as suggestive that, though the explorers have not met with this formation on the northern shores of Greenland, yet it was observed that a continuation of the direction of the known strike of the limestones of Feilden peninsula, carried over the polar area, passes through the neighborhood of Spitsbergen, where the formation occurs, and contains certain species identical with those of the Grinnell Land rocks of this horizon. The facies of the fossils is, according to Mr Etheridge, North American and Canadian, though many of the species are British. The corals are few in number, but the Molluscoida (Polyzoa) are more numerous in species and individuals. No Secondary rocks have been discovered in the extreme northern parts of West Greenland, but they are present on the east and west coasts in more southerly latitudes than Smith Sound.

5. Jurassic.

These do not occur on the west coast, but on the east coast the German expedition discovered marls and sandstones on Kuhn Island, resembling those of the Russian Jurassic, characterized by the presence of the genus, Ucella, Olcostephanus Payeri, O. striolaris, Belemnites Panderianus, B. volgensis, B. absolutus, and a Cyprina near to C. syssolae. On the south coast of the same island are coarse-grained, brownish micaceous and light-colored calcareous sandstone and marls, containing fossils, which render it

probable that they are of the same age as the coal-bearing Jurassic rocks of Brora (Scotland) and the Middle Dogger of Yorkshire. There is also coal on Kuhn Island.

The Danish expeditions of 1899-1900 have added considerably to our knowledge of the Jurassic rocks of East Greenland. Rhaetic Lias plants have been described by Dr Hartz from Cape Stewart and Vardeklift. Dr Madsen has recognized fossils that correspond with those from the Inferior oolite, Cornbrash and Callovian of England. Upper Kimmeridge and Portlandian beds also occur.

6. Cretaceous.

Beds of this age, consisting of sandstones and coal, are found on the northern coast of Disco Island and the southern side of the Nussuaq Peninsula, the beds in the former locality, the Kome strata of Nordenskild, being the oldest. They reach 1000 ft. in thickness, occupying undulating hollows in the underlying gneiss, and dip towards the Nussuaq Peninsula at 20°, when the overlying Atanakerdluk strata come in. Both these series contain numerous plant remains, evergreen oaks, magnolias, aralias, &c., and seams of lignite (coal), which is burnt; but in neither occur the marine beds of the United States. Still, the presence of dicotyledonous leaves, such as *Magnolia alternans*, in the Atanakerdluk strata, proves their close alliance with the Dakota series of the United States. The underlying Kome beds are not present in the American series. They are characterized by fine cycads (*Zamites arcticus* and *Gtossozaniites Hoheneggeri*), which also occur in the Urgonian strata of Wernsdorff.

7. Miocene.

This formation, one of the most widely spread in polar lands, though the most local in Greenland, is also the best known feature in its geology. It is limited to Disco Island, and perhaps to a small part of the Nussuaq Peninsula, and the neighbouring country, and consists of numerous thin beds of sandstone, shale and coal, the sideritic shale containing immense quantities of leaves, stems, fruit, &c., as well as some insects, and the coal pieces of retinite. The study of these plant and insect remains shows that forests containing a vegetation very similar to that of California and the southern United States, in some instances even the species of trees being all but identical, flourished in 700 N. during geological periods comparatively recent. These beds, as well as the Cretaceous series, from which they are as yet only imperfectly distinguished, are associated with sheets of basalt, which penetrate them in great dikes, and in some places, owing to the wearing away of the softer sedimentary rocks, stand out in long walls running across the beds. These Miocene strata have not been found farther north on the Greenland shore than the region mentioned; but in Lady Franklin Bay, on the Grinnell Land side of Smith Sound, they again appear, so that the chances are they will be found on the opposite coast, though doubtless the great disintegration Greenland has undergone and is undergoing has destroyed many of the softer beds of fossiliferous rocks. On the east coast, more particularly in Hochstetter Foreland, the Miocene beds again appear, and we may add that there are traces of them even on the west coast, between Sonntag Bay and Foulke Fjord, at the entrance to Smith Sound. It thus appears that since early Tertiary times there has been a great change in the climate of Greenland.

Nathorst has suggested that the whole of Greenland is a horst, in the subordinate folds of which, as well as in the deeper graben, the younger rocks are preserved, often with a covering of Tertiary or later lava flows. [J. A. H.]

Minerals.

Native iron was found by Nordenskiöld at Ovifak, on Disco Island, in 1870, and brought to Sweden (1871) as meteorites. The heaviest nodule weighed over 20 tons. Similar native iron has later been found by K. J. V. Steenstrup in several places on the west coast enclosed as smaller or larger nodules in the basalt. This iron has very often beautiful Widmannstätten figures like those of iron meteorites, but it is obviously of telluric origin.² In 1895 Peary found native iron at Cape York; since John Ross voyage in 1818 it has been known to exist there, and from it the Eskimo got iron for their weapons. In 1897 Peary brought the largest nodule to New York; it was estimated to weigh nearly 100 tons. This iron is considered by several of the first authorities on the subject to be of meteoric origin, but no evidence hitherto given seems to prove decisively that it cannot be telluric. That the nodules found were lying on gneissic rock, with no basaltic rocks in the neighbourhood, does not prove that the iron may not originate from basalt, for the nodules may have been transported by the glaciers, like other erratic blocks, and will stand erosion much longer than the basalt, which may long ago have disappeared. This iron seems, however, in several respects to be unlike the celebrated large nodules of iron found by Nordenskiöld at Ovifak, but appears to resemble much more closely the softer kind of iron nodules found by Steenstrup in the basalt; it stands exposure to the air equally well, and has similar Widmannstätten figures very sharp, as is to be expected in such a large mass. It contains, however, more nickel and also phosphorus. A few other minerals may be noticed, and some have been worked to a small extent graphite is abundant, particularly near Upernavik; cryolite is found almost exclusively at Ivigtut; copper has been observed at several places, but only in nodules and laminae of limited extent; and coal of poor quality is found in the districts about Disco Bay and Umanak Fjord. Steatite or soapstone has long been used by the natives for the manufacture of lamps and vessels.

Climate.

The climate is very uncertain, the weather changing suddenly from bright sunshine (when mosquitos often swarm) to dense fog or heavy falls of snow and icy winds. At Julianehaab in the extreme south-west the winter is not much colder than that of Norway and Sweden in the same locality; but its mean temperature for the whole year probably approximates to that on the Norwegian coast 600 m. farther north. The climate of the interior has been found to be of a continental character, with large ranges of temperature, and with an almost permanent anti-cyclonic region over the interior of the inland ice, from which the prevailing winds radiate towards the coasts. On the 64th parallel the mean annual temperature at an elevation of 6560 ft. is supposed to be 13°F., or reduced to sea-level 50°F. The mean annual temperature in the interior farther north is supposed to be 0°F. reduced to sea-level. The mean temperature of the warmest month, July, in the interior should be, reduced to sea-level, on the 64th parallel 32°F., and that of the coldest month, January, about 22°F., while in North Greenland it is probably 0°F. reduced to sea-level. Here we may probably find the lowest temperatures of the northern hemisphere. The interior of Greenland contains both summer and winter a pole of cold, situated in the opposite longitude to that of Siberia, with which it is well able to compete in extreme

severity. On Nansen's expedition temperatures of about 49°F. were experienced during the nights in the beginning of September, and the minimum during the winter may probably sink to -90°F. in the interior of the inland ice. These low temperatures are evidently caused by the radiation of heat from the snow-surface in the rarefied air in the interior. The daily range of temperature is therefore very considerable, sometimes amounting to 40°F. Such a range is elsewhere found only in deserts, but the surface of the inland ice may be considered to be an elevated desert of snow. The climate of the east coast is on the whole considerably more Arctic than that of the west coast on corresponding latitudes; the land is much more completely snow covered, and the snow-hoe goes considerably lower. The probability also is that there is more precipitation, and that the mean temperatures are lower. The well-known strangely warm and dry fohnwinds of Greenland occur both on the west and the east coast; they are more local than was formerly believed, and are formed by cyclonic winds passing either over mountains or down the outer slope of the inland ice. Mirage and similar phenomena and the aurora are common.

Fauna and Flora.

It was long a common belief that the fauna and flora of Greenland were essentially European, a circumstance which would make it probable that Greenland has been separated by sea from America during a longer period of time than from Europe. The correctness of this hypothesis may, however, be doubted. The land mammals of Greenland are decidedly more American than European; the musk-ox, the banded lemming (*Cuniculus torquatus*), the white polar wolf, of which there seems to have been a new invasion recently round the northern part of the country to the east coast, the Eskimo and the dog probably also the reindeer have all come from America, while the other land mammals, the polar bear, the polar fox, the Arctic hare, the stoat (*Mustela erminea*), are perfectly circumpolar forms. The species of seals and whales are, if anything, more American than European, and so to some extent are the fishes. The bladder-nose seal (*Cystophora cristata*), for instance, may be said to be a Greenland-American species, while a Scandinavian species, such as the grey seal (*Halichoerus grypus*), appears to be very rare both in Greenland and America.

Of the sixty-one species of birds breeding in Greenland, eight are European-Asiatic, four are American, and the rest circumpolar or North Atlantic and North Pacific in their distribution. About 310 species of vascular plants are found, of which about forty species are American, forty-four European-Asiatic, fifteen endemic, and the rest common both to America and Europe or Asia. We thus see that the American and the European-Asiatic elements of the flora are nearly equivalent; and if the flora of Arctic North America were better known, the number of plants common to America might be still more enlarged. In the south, a few goats, sheep, oxen and pigs have been introduced. The whaling industry was formerly prolific off the west coast but decayed when the right whale nearly disappeared. The white whale fishery of the Eskimo, however, continued, and sealing is important; walrus are also caught and sometimes narwhal. There are also important fisheries for cod, capelin, halibut, red fish (*Sebastes*) and nepisak (*Cyclopterus lumpus*); a shark (*Somniosus microcephalus*) is taken for the oil from its liver; and sea-trout are found in the streams and small lakes of the south. On land reindeer were formerly hunted, to their practical extinction in the south, but in the districts of Godthaab, Sukkertoppen and Holsteinsborg there are still many reindeer. The eider-duck, guillemot and other sea-birds are in some parts valuable for food in winter, and so is the ptarmigan. Eggs of sea-

birds are collected and eider-down. Valuable fur is obtained from the white and blue fox, the skin of the eider-duck and the polar bear.

At Tasiusak (73° 22' N.), the most northern civilized settlement in the world, gardening has been attempted without success, but several plants do well in forcing frames, At Umanak (70° 40 N.) is the most northern garden in the world. Broccoli and radishes grow well, turnips (but not every year), lettuce and chervil succeed sometimes, but parsley cannot be reared. At Jacobshavn (69° 12 N.), only some 15 miles from the inland ice, gardening succeeds very well; broccoli and lettuce grow willingly; the spinach produces large leaves; chervil, pepper-grass, leeks, parsley and turnips grow very well; the radishes are sown and gathered twice during the summer (June to August). In the south, in the Julianehaab district, even flowering plants, such as aster, nemophilia and mignonette, are cultivated, and broccoli, spinach, sorrel, chervil, parsley, rhubarb, turnips, lettuce, radishes grow well. Potatoes give fair results when they are taken good care of, carrots grow to a thickness of 1 1/2 inches, while cabbage does poorly. Strawberries and cucumbers have been ripened in a forcing frame. In the Kongespeil (Kings mirror) of the 13th century it is stated that the old Norsemen tried in vain to raise barley.

The wild vegetation in the height of summer is, in favourable situations, profuse in individual plants, though scanty in species. The plants are of the usual arctic type, and identical with or allied to those found in Lapland or on the summits of the highest British hills. Forest there is none in all the country. In the north, where the lichen-covered or ice-shaven rocks do not protrude, the ground is covered with a carpet of mosses, creeping dwarf willows, crowberries and similar plants, while the flowers most common are the andromeda, the yellow poppy, pedicularis, pyrola, &c. besides the flowering mosses; but in South Greenland there is something in the shape of bush, the dwarf birches even rising a few feet in very sheltered places, the willows may grow higher than a man, and the vegetation is less Arctic and more abundant.

Government and Trade.

The trade of Greenland is a monopoly of the Danish crown, dating from 1774, and is administered in Copenhagen by a government board (Kongetige Gronlandske Handel) and in the country by various government officials. In order to meet the double purposes of government and trade the west coast, up to nearly 74 N., is divided into two inspectorates, the southern extending to 67 40 N., the northern comprising the rest of the country; the respective seats of government being at Godthaab and Godhavn. These inspectorates are ruled by two superior officials or governors responsible to the director of the board in Copenhagen. Each of the inspectorates is divided into districts, each district having, in addition to the chief settlement or coloni, several outlying posts and Eskimo hunting stations, each presided over by an udligger, who is responsible to the coloni best yrer, or superintendent of the district. These trading settlements, which dot the coast for a distance of 1000 m., are about sixty in number. From the Eskimo hunting and fishing stations blubber is the chief article received, and is forwarded in casks to the coloni, where it is boiled into oil, and prepared for being despatched to Copenhagen by means of the government ships which arrive and leave between May and November. For the rest of the year navigation is stopped, though the winter months form the busy seal-killing season. The principle upon which the government acts is to give the natives low prices for their produce, but to sell them European articles of necessity at prime cost, and other stores, such as bread, at prices which will scarcely pay for the purchase and freight,

while no merchandise is charged, on an average, more than 20% over the cost price in Denmark. In addition the Greenlanders are allowed to order goods from private dealers on paying freight for them at the rate of 21/2d. per 10 lb. or 6d. per cub. ft. The prices to be paid for European and native articles are fixed every year, the prices current in Danish and Eskimo being printed and distributed by the government~ Out of the payment five-sixths are given to the sellers, and one sixth devoted to the Greenlanders public fund, spent in public works, in charity, and on other unforeseen contingencies. The object of the monopoly is solely for the good of the Greenlanders to prevent spirits being sold to them, and the vice, disease and misery which usually attend the collision between natives and civilization of the traders type being introduced into the primitive arctic community. The inspectors, in addition to being trade superintendents, are magistrates, but serious crime is very rare. Though the officials are all-powerful, local councils or *parssissæter* were organized in 1857 in every district. To these parish parliaments delegates are sent from every station. These *parssissøks*, elected at the rate of about one representative to 120 voters, wear a cap with a badge (a bear rampant), and aid the European members of the council in distributing the surplus profit apportioned to each district, and generally in advising as to the welfare of that part of Greenland under their partial control. The municipal council has the disposal of the annual profits made on produce purchased within the confines of each district. It holds two sessions every year, and the discussions are entirely in the Eskimo language. In addition to their functions as guardians of the poor, the parish members have to investigate crimes and punish misdemeanours, settle litigations and divide inheritances. They can impose fines for small offences not worth sending before the inspector, and, in cases of high misdemeanour, have the power of inflicting corporal punishment.

A Danish colony in Greenland might seem to many not to be a cheerful place at best; though in the long summer days they would certainly find some of those on the southern fjords comparatively pleasant. The fact is, however, that most people who ever lived some time in Greenland always long to go back. There are generally in a colony three or four Danish houses, built of wood and pitched over, in addition to storehouses and a blubber-boiling establishment. The Danish residents may include, besides a colony-bestyrer and his assistant, a missionair or clergyman, at a few places also a doctor, and perhaps a carpenter and a schoolmaster. In addition there are generally from twenty to several hundred Eskimo, who live in huts built of stone and turf, each entered by a short tunnel. Lately their houses in the colonies have also to some extent been built of imported wood. Following the west coast northward, the trading centres are these: in the south inspectorate, Julianehaab, near which are remains of the early Norse settlements of Eric the Red and his companions (the *Oster-Bygd*); Frederikshaab, in which district are the cryolite mines of Ivigtut; Godthaab, the principal settlement of all, in the neighbourhood of which are also early Norse remains (the *Vesler-Bygd*); Sukkertoppen, a most picturesque locality; and Holstenborg. In the north inspectorate the centres are: Egedesminde, on an islet at the mouth of Disco Bay; Christianshaab, one of the pleasantest settlements in the north, and Jacobshavn, on the inner shores of the same bay; Godhavn (or Lively) on the south coast of Disco Island, formerly an important seat of the whaling industry; Ritenbenk, Umanak, and, most northerly of all, Upernivik. On the east coast there is but one colony, Angmagssalik, in 65 30 N., only established in 1894. For ecclesiastical purposes Danish Greenland is reckoned in the province of the bishop of Zealand. The Danish mission in Greenland has a yearly grant of 2000 from the trading revenue of the colony, besides a contribution of 880 from the state. The Moravian mission, which had worked in Greenland for a century and a half, retired from the

country in 1900. The trade of Greenland has on the whole much decreased in modern times, and trading and missions cost the Danish state a comparatively large sum (about 11,000 every year), although this is partly covered by the income from the royalty of the cryolite mines at Ivigtut. There is, however, a yearly deficiency of more than 6000. The decline in the value of the trade, which was formerly very profitable, has to a great extent been brought about by the fall in the price of seal-oil. It might be expected that there should be a decrease in the Greenland seal fisheries caused by the European and American sealers catching large quantities every year, especially along the coasts of Newfoundland and Labrador, and so actually diminishing the number of the animals in the Greenland seas. The statistics of South Greenland however, do not seem to demonstrate any such decrease. The average number of seals killed annually is about 33,000. Owing to representations of the Swedish government in 1875 as to the killing of seals at breeding time on the east coast of Greenland, and the consequent loss of young seals left to die of starvation the Seal Fisheries Act 1875 was passed in England to provide for the establishment of a close time for seal fishery in the seas in question. This act empowered the crown, by order in council, put its provisions in force, when any foreign state, whose ship or subjects were engaged in the seal fishery in the area mentioned in the schedule thereto, had made, or was about to make, similar provisions with respect to its ships and subjects. An order in council under the Act, declaring the season to begin on the 3rd of April each year, was issued February 8, 1876. Rescinded February 1st, 1876, it was re-enacted on November 2nd, 1876, and is still operating. The annual value of imports, consisting of manufactured goods, foodstuffs, etc., may be taken somewhat to exceed 40,000. The chief articles of export (together with those that have lapsed) have been already indicated; but they may be summarized as including seal-oil, seal, fox, bird and bear skins, fish products and eiderdown, with some quantity of worked skins. Walrus tusks and walrus hides, which in the days of the old Norse settlements were the chief articles of export, are now of little importance.

Population.

The area of the entire Danish colony is estimated at 45,000 sq. m., and its population in 1901 was 11,893. The Europeans number about 300. The Eskimo population of Danish Greenland (west coast) seems to have decreased since the middle of the 18th century. Hans Egede estimated the population then at 30,000, but this is probably a large overestimate. The decrease may chiefly have been due to infectious diseases, especially a very severe epidemic of smallpox. During the last half of the 19th century there was on the whole a slight increase of the native population. The population fluctuates a good deal, owing, to some extent, to an immigration of natives from the east to the west coast. The population of the east coast seems on the whole to be decreasing in number, several hundreds chiefly living at Angmagssalik. In the north part of the east coast, in the region of Scoresby Fjord and Franz Josef Fjord, numerous ruins of Eskimo settlements are found, and in 1823 Clavering met Eskimo there, but now they have either completely died out or have wandered south. A little tribe of Eskimo living in the region of Cape York near Smith Sound the so-called Arctic Highlanders or Smith Sound Eskimo number about 240.

Control.

The municipal council has the disposal of 20% of the annual profits made on produce purchased within the confines of each district. It holds two sessions every year, and the discussions are entirely in the Eskimo language. In addition to their functions as guardians of the poor, the parish members have to investigate crimes and punish misdemeanours, settle litigations and divide inheritances. They can impose fines for small offences not worth sending before the inspector, and, in cases of high misdemeanour, have the power of inflicting corporal punishment.

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History.

In the beginning of the 10th century the Norwegian Gunnbjorn, son of Ulf Krflka, is reported to have found some islands to the west of Iceland, and he may have seen, without landing upon it, the southern part of the east coast of Greenland. In 982 the Norwegian Eric the Red sailed from Iceland to find the land that Gunnbjorn had seen, and he spent three years on its south-western coasts exploring the country. On his return to Iceland in 985 he called the land Greenland in order to make people more willing to go there, and reported so favourably on its possibilities that he had no difficulty in obtaining followers. In 986 he started again from Iceland with 25 ships, but only 14 of them reached Greenland, where a colony was founded on the south-west coast, in the present Julianehaah district. Eric built his house at Brattalid, near the inner end of the fjord Tunugdliarfik, just north of the present Julianehaab. Other settlers followed and in a few years two colonies had been formed, one called Osterbygd in the present district of Julianehaab comprising later about 190 farms, and another called Vesterbygd farther north on the west coast in the present district of Godthaab, comprising later about 90 farms. Numerous ruins in the various fjords of these two districts indicate now where these colonies were. Wooden coffins, with skeletons wrapped in coarse hairy cloth, and both pagan and Christian tombstones with runic inscriptions have been found. On a voyage from Norway to Greenland Leif Ericsson (son of Eric the Red) discovered America in the year 1000, and a few years later Torfinn Karlsefne sailed with three ships

and about 150 men, from Greenland to Nova Scotia to form a colony, but returned three years later (see VINLAN0).

When the Norsemen came to Greenland they found various remains indicating, as the old sagas say, that there had been people of a similar kind as those they met with in Vinland, in America, whom they called Skraeling (the meaning of the word is uncertain, it means possibly weak people); but the sagas do not report that they actually met the natives then. But somewhat later they have probably met with the Eskimos farther north on the west coast in the neighbourhood of Disc - The Norse colonists penetrated on these fishing expeditions a least to 73 N., where a small runic stone from the 14th century has been found. On a voyage in 1267 they penetrated even still farther north into the Melville Bay.

Christianity was introduced by Leif Ericsson at the instance of Olaf Trygvasson, king of Norway, in 1000 and following years. In the beginning of the 12th century Greenland got its own bishop, who resided at Gardar, near the present Eskimo station Igaliko, on an isthmus between two fjords, Igaliksfjord (the old Einarsfjord) and Tunugdliarfik (the old Eriksfjord), inside the present colony Julianehaab. The Norse colonies had twelve churches, one monastery and one nunnery in the Osterbygd, and four churches in the Vesterbygd. Greenland, like Iceland, had a republican organization up to the years 1247 to 1261~ when the Greenlanders were induced to swear allegiance to the king of Norway. Greenland belonged to the Norwegian crown till 1814, when, at the dissolution of the union between Denmark and Norway, neither it nor Iceland and the Faeroes were mentioned, and they, therefore, were kept by the Danish king and thus came to Denmark. The settlements were called respectively Oster Bygd (or eastern settlement) and Vester (western) Bygd, both being now known to be on the south and west coast (in the districts of Julianehaab and Godthaab respectively), though for long the view was persistently held that the first was on the east coast, and numerous expeditions have been sent in search of these lost colonies and their imaginary survivors. These settlements at the height of their prosperity are estimated to have had 10,000 inhabitants, which, however, is an over-estimate, the number having probably been nearer one-half or one-third of that number. The last bishop appointed to Greenland died in 1540, but long before that date those appointed had never reached their sees; the last bishop who resided in Greenland died there in 1377. After the middle of the 14th century very little is heard of the settlements, and their communication with the motherland, Norway, evidently gradually ceased. This may have been due in great part to the fact that the shipping and trade of Greenland became a monopoly of the king of Norway, who kept only one ship sailing at long intervals (of years) to Greenland; at the same time the shipping and trade of Norway came more and more in the hands of the Hanseatic League, which took no interest in Greenland. The last ship that is known to have visited the Norse colony in Greenland returned to Norway in 1410. With no support from home the settlements seem to have decayed rapidly. It has been supposed that they were destroyed by attacks of the Eskimo, who about this period seem to have become more numerous and to have extended southwards along the coast from the north. This seems a less feasible explanation; it is more probable that the Norse settlers intermarried with the Eskimo and were gradually absorbed. About the end of the 15th or the beginning of the 16th century it would appear that all Norse colonization had practically disappeared. When in 1585 John Davis visited it there was no sign of any people save the Eskimo, among whose traditions are a few directly relating to the old Norsemen, and several traces of Norse influence. For more than two hundred years Greenland seems to have been neglected, almost forgotten. It was visited by whalers, chiefly Dutch, but nothing in the form of permanent European

settlements was established until the year 1721, when the first missionary, the Norwegian clergyman Hans Egede, landed, and established a settlement near Godthaab. Amid many hardships and discouragements he persevered; and at the present day the native race is civilized and Christianized. Many of the colonists of the 18th century were convicts and other offenders; and in 1750 the trade became a monopoly in the hands of a private company. In 1733-1734 there was a dreadful epidemic of smallpox, which destroyed a great number of the people. In 1774 the trade ceased to be profitable as a private monopoly, and to prevent it being abandoned the government took it over. Julianehaab was founded in the following year. In 1807-1814, owing to the war, communication was cut off with Norway and Denmark; but subsequently the colony prospered in a languid fashion.