There is abundant evidence to prove that the ice-lobe filling the Irish Sea was thicker towards its axis than at its edges, and at the north than at its southern terminus, and that it was reinforced by smaller tributary ice-streams from both England and Ireland. It may be compared with the glacier of the Hudson River Valley in New York, each having a maximum thickness of something more than 3000 feet. The erosive power of the ice-sheet was found to be extremely slight at its edge, but more powerful farther north, where its action was continued for a longer period. Towards its edge its function was to fill up inequalities rather than to level them down. It was held that most glacial lakes are due to an irregular dumping of drift, rather than to any scooping action, observations in England and in Switzerland coinciding with those in America to confirm this conclusion. Numerous facts on both sides of the Atlantic indicate that the upper portion of the ice-sheet may move in a different direction from its lower portion. It was also shown that a glacier in its advance had the power of raising stones from the bottom to the top of the ice, a fact due to retardation by friction of its lower layers. The author had observed the gradual upward passage of sand and stones in the Grindelwald glacier, and applied the same explanation to the broken shells and flints raised from the bed of the Irish Sea to the top of Moel Tryfan, to Macclesfield, and to the Dublin mountains.

The occurrence of stratified deposits connected with undoubted moraines, was shown to be a common phenomenon, and instances of stratified moraines in Switzerland, Italy, America, and Wales, were given. The stratification is due to waters derived from the melting ice, and is not proof of submergence.

It was held that, notwithstanding a general opinion to the contrary, there is no evidence in Great Britain of any marine submergence greater than about 450 feet. It was to be expected that an ice-sheet advancing across a sea-bottom should deposit shell-fragments in its terminal moraine. The broad principle was enunciated that wherever in Great Britain marine shells occur in glacial deposits at high levels, it can be proved both by striæ and the transport of erratics that the ice advanced on to the land from out of the sea. The shells on Three Rock Mountain near Dublin, and in North Wales and Macclesfield, all from the Irish Sea; the shells in Cumberland transported from Solway Firth; those on the coast of Northumberland brought out of the North Sea; those at Airdrie in Scotland, carried eastward from the bottom of the Clyde; and those in Caithness from Moray Firth, were among examples adduced in proof of this principle. The improbability of a great submergence not leaving corresponding deposits in other parts of England was dwelt upon.

It was also held that there was insufficient evidence of more than one advance in the ice-sheet, although halts occurred in its retreat. The idea of successive elevations and submergences with advances and retreats of the ice was disputed, and the author held that much of the supposed inter-glacial drift was due to sub-glacial waters from the melting ice.

The last portion of the paper discussed the distribution of boulders, gravels, and clays south of the glacial area. Much the greater part of England was believed to have been uncovered by land ice. The drift deposits in this area were shown to be the result in part of great fresh-water streams issuing from the melting ice-sheet and in part of marine currents bearing icebergs during a submergence of some 450 feet. The supposed glacial drift about Birmingham and the concentration of boulders at Wolverhampton were regarded as due to the former agent, while the deposits at Cromer and the distribution of Lincolnshire chalk across Southern England were due to the latter. The supposed esker at Hunstanton was held to be simply a sea-beach, and the London drift deposits to be of aqueous origin. Thus the rival theories of floating icebergs and of land glaciers were both true, the one for Middle and Southern England, the other for Scotland, Wales, and the North of England; and the line of demarkation was fixed by great terminal moraines. The paper closed with an acknowledgment of indebtedness to the many geologists in England and Ireland who had uniformly rendered generous assistance during the above investigation.

THE CLIMATE OF NORTHERN EUROPE AND THE GULF STREAM

IN view of the reference made by Sir William Dawson, in his inaugural address at the meeting of the British Association, to the effect of the Gulf Stream on the climate of Northern Europe, particularly that of Norway, and the consequences of a diversion of the stream from its present course, the following contribution to the subject by the well-known Norwegian *savant*, Dr. Karl Hesselberg, which appeared in a recent number of the scientific journal *Naturen*, may be of interest and tend to its further elucidation.

According to the situation of Norway on the globe, the northern part of the country should have a distinct Polar climate, with eternal ice and snow, a home only for the Eskimo and Polar bears. Several circumstances contribute, however, to make it otherwise. The country forms a western promontory of the great Asiatic-European continent, and receives its full share of the advantages of such a situation. Mild south-west winds blow throughout the year, while warm sea-currents wash its extensive shores summer as well as winter. The winter cold is so reduced that only a small portion of the heat of the summer sun is consumed in melting the snow. The length of the summer days, too, which north of the Polar Circle last twenty-four hours, contribute to raise the mean temperature, and accelerate the growth of the flora. Certain other circumstances, as, for instance, the formation of the country and the physico-geographical conditions of the North Atlantic Ocean, contribute equally to make the Norwegian climate one of the most favourable in the world. A brief *résumé* of the circumstances will be of interest.

A chart of the distribution of the atmospheric depression in the North Atlantic Ocean—the Norwegian Sea—shows that all the year round a strong barometric minimum prevails in the middle of the sea between Norway, Iceland, Jan Mayen, and Spitzbergen, the consequence of which is that south-west winds always blow in the eastern part of this area, viz. along the coast of Norway. Warm water is thereby forced up towards Norway and Spitzbergen, even into the East Arctic Ocean. The bottom formation of the sea, too, contributes to preserve the high temperature. If a chart be examined of the depths of the North Atlantic Ocean, such a one, for instance, as is the result of Prof. Mohn's labours after the measurements of the Norwegian North Atlantic Expedition, it will be found that the sea-bottom between Norway, the Faroe Islands, Iceland, and Jan Mayen, forms a basin with a depth of a little over 2000 English fathoms. It will also be seen that the Norwegian coast does not fall abruptly into this abyss, but that the bottom along the whole coast slopes gradually down from the shore seawards to a certain point where it terminates perpendicularly. In other words, Norway is surrounded with a continuous "bank," which in a great measure contributes to preserve the high temperature along the coast. In the great basin, however, the water is icy cold at the bottom, but against this the bank forms a natural barrier, whilst above the bank the warm water is without any bottom layer of cold. It is the warm water which fills the fjords and there preserves a temperature so high that it is sometimes higher than the mean temperature of the air, and under which the fjords do not freeze, a circumstance of great importance. If the temperature of the sea-water in the winter contributes to raise the temperature of the air, it will in the summer have the opposite effect, and cause the climate to be very much tempered along the coast. It is only in the fjords and adjacent valleys that the temperature in the summer rises to a height unusual for the latitude.

In order to show the relatively favourable climate which Norway enjoys, Dr. Hesselberg supplies two diagrams. The first of these shows the mean temperature of the air over Europe and the North Atlantic Ocean in January, when it is lowest. Isotherms are shown for every fifth degree. If now, for instance, the isotherm 0°—the temperature of the air—be followed, it will at once be seen how far it shoots up northwards between Iceland and Norway, in fact, right above lat. 70° N. Instead of running east and west, it goes nearly straight north and south, particularly along the west coast of Norway, which it follows throughout its entire length, from the latitude of Tromsö to that of Christiansand. Hence it deviates towards Denmark, then runs into the Baltic, returns to Hamburg, and thence runs in a south-easterly direction across Europe, nearly down to the Adriatic Sea. Here it first trends eastwards, across Turkey and the Black Sea. Off the Norwegian coast, therefore, in lat. 70° N., the same mean temperature prevails in January as in Southern Europe in lat. 45°, and even there the mean temperature is probably 3° higher than might be expected according to the latitude. The other isotherms have a similar course, as well as the temperature at the surface of the sea. A great wave of warm water rolls up along the coast of Norway, and may be traced even to Spitzbergen.

Another equally interesting illustration of the mildness of the winter in Norway is shown by two diagrams of the "thermal anomaly" in January. By way of comparison the month of July is included. It may be added that by thermal anomaly is meant the difference which exists between the *true* mean temperature of a place and the mean temperature *actually registered* in that latitude.

In January the thermal anomaly is very remarkable. Thus, along the coast of Norway, between the northernmost and westernmost promontories, the North Cape and Stat, it reaches + 20° C., and in the sea outside most probably + 25° C. These figures are certainly very remarkable. Eastwards, it decreases inland, but even here—where the cold is very great in the winter—it never falls below + 7°. In the Baltic, on the other hand, it again rises, as might be expected.

In the summer, however, the conditions are far from being so favourable. There is, indeed, then a narrow strip of land, on the very verge of the coast, where the thermal anomaly is slightly *negative*. The line for the 0° C. anomaly then follows the west coast, decreasing gradually seawards, whilst eastwards, across Southern Norway, it rises to + 4° C., and in Finmarken to + 70° C.

For the further elucidation of this, the following comparison of the January mean temperature in various places on the globe in about the same latitude may serve :—

About 60° *N. lat.*

	°
Hellisö Lighthouse...	2
Bergen	0
Christiania ...	− 5
Stockholm ...	− 3
St. Petersburg	− 10
Jakutsk	− 42
North Kamchatka ...	− 20
South Alaska	− 20
Great Slave Lake ...	− 25
North Coast of Labrador ...	− 25
Cape Farewell	− 7
Shetland Islands	4

About 71° *N. lat.*

	°
North Cape...	− 4
South Novaya Zemlya	− 20
Mouth of the Yenisei	− 34
Mouth of the Lena	− 40
Point Barrow	− 30
Boothia	− 32
Upernivik ...	− 20
Jan Mayen ...	− 10

The coldest place on the globe where the mean temperature has been *exactly* ascertained, viz. Werchojansk, in the interior of Siberia, with − 48° C. in January, lies in the same latitude as Bodö, where it is − 2° C., and Röst, with 0°·5 C.

In order to obtain correct normal values of the temperature in a place, long and continuous series of observations are necessary ; and when we consider that the longest we possess for any place only extends over 100 years, and that meteorology is but a science of yesterday, the Norwegian meteorological records can make a fair show. With regard, however, to the changes which take place in the climate in a certain spot during ages—which occurrence is beyond dispute—we have no reliable data. I will only mention here Prof. Blytt's theory,[1] which has attracted many supporters, viz. that the periodical changes in the climate are due to the precession of the equinoxes (with a mean period of about 21,000 years), and to changes in the eccentricity of the earth's orbit.

It is, however, possible to accept a shorter periodical change in the climate than this, and theories on this point have not been wanting ; but the only one which has found any support is the eleven-year period, corresponding to that of the sunspots, which again coincides with that of the terrestrial magnetic phenomena. It has even been attempted to bring the fall of rain and snow within a certain law, and, as some maintain, with success ; but in my opinion the proofs advanced in support of such a theory are far from being conclusive.

[1] Cf. Prof. Darwin's Address to the British Association, Section A ; also NATURE, vol. xxxiv. pp. 220 and 239.

TO PROVE THAT ONLY ONE PARALLEL CAN BE DRAWN FROM A GIVEN POINT TO A GIVEN STRAIGHT LINE

(1) LET OP and OQ be two lines at right angles, and let PQ move along them from O, so that OP always = OQ. Then PQ always > OQ or OP.

Hence if OQ increase without limit, PQ must also do so.

Let ON bisect the angle POQ. Then N bisects PQ.

Then if OQ increase without limit, QN does so (QN = ½ QP).

If OQ′ be taken along ON = OQ, QQ′ > QN.

Hence if OQ increase without limit, QQ′ does so.

Similarly by bisecting Q′OQ by OM, we can show that QM increases without limit with OQ, and so on by continual bisection. Hence—

If two straight lines meet at any angle, the perpendicular from a point of one on the other becomes infinite when that point is at infinity.

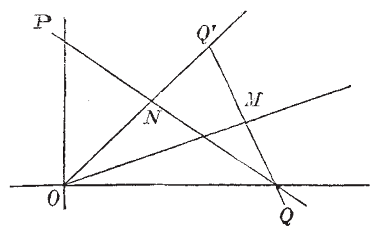

FIG. 1.

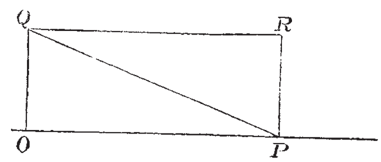

FIG. 2.

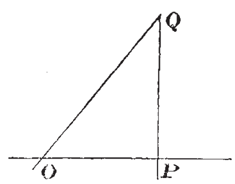

FIG. 3.

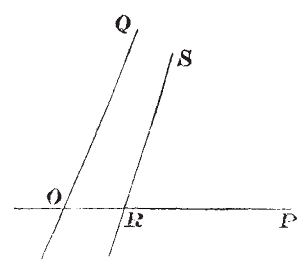

FIG. 4.

(2) Let OQ be some given length taken at right angles to a line OP ;

Let PR move along OP at right angles to OP, so that PR always = OQ.

Join QR, QP.

Let OP increase without limit.

Then the angle PQR tends to become zero.

For the lines QR, PQ never become infinitely separated.

Thus there is evidently some definite position for the line QP when OP becomes ∞.

(3) Let a line PQ move at right angles to OP, so that PQ = OP.

Then if OP increase without limit, OQ increases without limit.

Hence, there is some finite angle, QOP, such that the perpendicular QP from Q at ∞ on OP falls at an infinite distance from O.

The same thing is evidently true for all angles less than QOP.

Then either it is true of all angles less than a right angle, in which case it can be easily shown that only one parallel can be drawn from a given point to a given line ;

Or, there is some limiting angle, QOP, for which QP falls at ∞, and for any greater angle (< right angle) QP falls at some finite distance from O.