

TRACES OF OLD GLACIERS IN THE HIGHLANDS.

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IT seems to me almost a pity that the fine pedestrian powers of the Cairngorm Club couldn't be turned to more account in the service of Geology. The mountain region of Braemar forms a fine field for exploration, especially in regard to the evidence it affords of the former presence of glaciers in this country.

During the last fifty years geologists have ascertained that Scotland, and indeed a large part of Northern Europe, was heavily covered with snow and ice, just as Greenland is at the present day. All North Britain was at one time so deeply buried that even the mountains were hidden out of sight, or only some of the highest rocky peaks protruded through the mantle of snow. In Greenland these protruding masses are called *Nunataks*, and stick up like little islands in the sea of ice which surrounds them. This state of matters was of long duration, and the covering of ice was subject to much variation in both depth and extent, before it finally melted away. It waxed and waned during many ages, stretching out at one time over the whole land, and extending even far beyond the present coast-line, at another time shrinking back into the higher valleys, and filling the deeper glens with tongues of ice. It was a long time ere geologists could be brought to believe that such a state of matters ever existed in this country, and every other conceivable method of explanation was tried to account for the facts. But facts are stubborn things, and refuse to be finally explained except on the true method. In order to understand the features presented by the surface of the ground in our Highland glens and mountains, we require to study the action of ice as it is exhibited at the present day in Greenland, Spitzbergen, and the Alps, or even in the more extensive

development it attains in the Antarctic region. Nansen's book on the crossing of Greenland has made us familiar with the aspect of that land, and any good manual of Geology will furnish information on the subject generally.

Now, the Cairngorm Mountains constituted a fine theatre of display during the glacial period, and hunting up the evidence to be met with in their corries, glens, and hill-tops would give an additional zest to the pleasure of rambling among these grand hills. When once we understand the meaning of the features they present, we experience a fresh delight in surveying their mighty forms; we scan their outlines with a more intelligent eye; we

"Hail in each crag a friend's familiar face,
And clasp the mountains in the mind's embrace".

It is long long ago, however, since the ice vanished from our land, and the freshness of the marks it left behind it has been much impaired by the lapse of time. This is more especially the case in regard to that smoothing and polishing of the rocks which the ice produces as it slides over them. The action of the weather, the rain and frost of countless winters, has wiped out this evidence in most cases. The granite of Aberdeenshire soon yields to this action, and the geologist will generally look in vain for any trace of it on the surface of that rock, although the rounding-off and abrasion of the faces that were most exposed to the pressure of the ice can still be detected by an educated eye. In the North-West Highlands these finer markings are better preserved, and are still to be met with in many localities, especially on the harder and flintier sort of rocks; but on the Deeside hills it is rare to meet with this evidence. I remember beating all over the long Hill of Fare in search of them, and hunted over it in vain until at last I came upon a shoulder of the ridge which was of a fine tough-grained quality, and there I found them quite distinct. A shower of rain had wetted the rock, and then the sun, shining out upon the smooth glancing surface,

made the fine needle-like scratches and heavier scores plainly visible; showing that the movement of ice had been from south-west to north-east, parallel to the general strike of the valley of the Dee. But there is plenty of evidence still remaining, and likely to remain for a long time to come, in the moraines or heaps of gravel and boulders which the glaciers left along their margin in the glens and valleys and on the sides of the hills. The large transported blocks of granite and other rocks, perched on the top of many an eminence, constitute another line of evidence, and afford the means of tracking the movement of the ice by the direction in which they have been carried from the parent mass. The corries themselves, those rocky amphitheatres so common in many parts of the Highlands, are merely the nests in which the last remnants of the ice lingered, after the main body of the stream had disappeared. The mountain tarns and lakes are also believed to lie in rocky basins which the ice hollowed out; for it is only in regions formerly occupied by glaciers that they seem to be found. The moraines generally present the aspect of heaps of rough gravel and stones, forming mounds 30 to 100 feet in height, grouped sometimes in clusters, or stretching out like a long curving embankment.

Glaciers are streams of ice which flow along so slowly and steadily, that, like the hour-hand of a clock, they seem to be motionless to a person looking at them, or standing on their surface. Just as the rivers convey the surplus water off the land, so do the glaciers serve to carry off the surplus snow and ice. In its laws of motion ice does not differ materially from other semi-fluid bodies, such as pitch or lava. We have to picture to ourselves majestic streams, filling the valleys to the depth of hundreds of feet (and during the height of the glacial period to thousands of feet), and flowing onward with a continual but extremely slow motion. What are called moraines are the stones, gravel, and mineral debris which the glacier bore on its surface, and cast off along its sides and termination. Just as a river bears along sticks and trees and leafy branches, and strands them at its margin,

so does the glacier bear along the stones and blocks that roll down upon its surface from the rocks alongside of it, and casts them off either at its terminal escarpment, or on its flanks, forming what are called terminal or lateral moraines. Some fine examples of these will be found in the glens which pierce the north slope of the Cairngorm Mountains; as, for example, in Glen Eunach. It has a small loch at the upper end. From Lynwilg to the lower extremity of the loch is eight or nine miles. After crossing the Spey at Rothiemurchus, you find a road leading past Loch an Eilein, from which a road has been made for sportsmen up to Loch Eunach. Loch an Eilein itself is encompassed by moraine hillocks, full of large boulders of granite and gneiss. These mounds lie chiefly on the east side of the loch, and are covered with heather and fir trees. Moraines extend all the way up Glen Eunach, but are more developed at some places than at others. About three miles below the loch the glen is narrow, and has been completely choked up by a huge mound of gravel and stones, probably 200 feet in height. Above this for some distance the glen is filled with accumulations of gravel and boulders, some of which are disposed in high flat-topped banks. Along the base of the granite hill, about a mile or a mile and a-half below the loch, there are some fine lateral moraines of a very typical character, forming long irregularly-curved mounds, with steep sides which bristle with great blocks of granite, some of them 20 feet in length. These lateral moraines are best seen on the west side of the glen, and have been formed along the left flank of the glacier which occupied the basin of Loch Eunach, and stretched down the glen to here, or to the big mound above-mentioned. This wild little glen, with its loch at the top, is one of the best localities in the Highlands for studying the traces left by the old glaciers.

At Aviemore the glaciers of the Cairngorm Mountains had crossed the Spey in great force, and lodged their moraines high up on the hills on the west side of the river. In doing so they seem to have barred the valley above, damming the water so as to form a considerable lake above

Craigellachie, in the neighbourhood of Kingussie. In making the Highland Railway, deep beds of fine silty sand, which had accumulated in the bottom of this lake, were cut into during my visit to the locality in 1863. This old lake extended up the valley towards Laggan, and undoubtedly must have been caused in the way I have mentioned. Similar occurrences are found in the Alps and other mountain regions where glaciers still exist.

In going up to Ben Muich Dhui from Braemar, there is a fine group of moraines at the head of Glen Derry, just at the turn where you ascend to Loch Etchachan. Further on there is a steep brae rising up to this little loch. This steep bank is strewn with large granite stones, many of which probably tumbled off the front of the glacier, when it filled all the basin of Loch Etchachan, and presented a cliff of ice overhanging this slope.

Another still more interesting display occurs a little way below Ballater. The streams of ice which came down Glen Muick, Glen Gairn, and the valley of the Dee, united at Ballater, and filled all the wide expanse of plain around and below that village, throwing down their moraines along the flanks of the inclosing hills on either side of the river. These moraine hillocks commence at the base of the hill, just outside the Pass of Ballater, and extend eastward past Tullich on to Culblean, forming a great cluster of hillocks and mounds of various forms. To the eastward of Tullich they attain a height of about 400 feet above the level of the Dee, their upper surface forming a nearly horizontal line which slopes downward a little to the eastward. These moraine hillocks fill all the curve of the hills between Tullich and Cambus o' May, and are composed in a great measure of debris of red granite. The uppermost hillocks consist of little else than a collection of granite stones of various sizes; but nearer the river there is more water-worn gravel and gritty mud mixed with stones. The altitude of the top of the moraine near the Burn of the Vat is about 900 feet. A mile further west it is about 1018 feet, or rather more than 100 feet higher, indicating a slope of the glacier of, say, 100 feet in

the mile, or $1^{\circ} 30'$. On the opposite side of the river, at Pannanich, the base of the hill is plastered over with moraine matter, which does not take the form of hillocks and mounds as it does on the north side, but forms a great bank leaning against the hill, and constituting in some places a rude platform or terrace, strewn with large granite boulders, and corresponding closely in height to the top of the moraine on the opposite side of the river. The granite of the shoulder of the hill to the east of Pannanich Wells is much bared, like that of Culblean, and is rounded off into pillowy masses, especially on the west front, being more rugged on the east, which was the lee side, or that which was most sheltered from the abrading action of the stream of ice. There are some fine examples of large perched boulders here just as on Culblean.

Scott, in his "Lord of the Isles", describes with great felicity a splendid scene of extinct glacial action at Loch Coruisk, in the Isle of Skye:—

"Huge terraces of granite black
 Afforded rude and cumber'd track ;
 For from the mountain hoar,
 Hur'd headlong in some night of fear,
 When yelled the wolf and fled the deer,
 Loose crags had toppled o'er ;
 And some, chance-poised and balanced, lay,
 So that a stripling's arm might sway
 A mass no host could raise,
 In nature's rage at random thrown,
 Yet trembling like the Druid's stone
 On its precarious base".

Sir Walter, however, was no geologist; otherwise he might have known that these huge blocks were not hurled in Nature's rage, but were set down by the melting ice as gently as a nurse sets down a baby in its cradle. They are merely fine examples of the "perched blocks", familiar to travellers among the Swiss Alps. These, and the "bare crags and banks of stone" he mentions, are very characteristic of places where glaciers have been, and Coruisk is a grand spot for studying their effects. No doubt it requires a special acquaintance with the action of

ice to appreciate the evidence of its former presence in our Scottish glens, and I daresay it is only those who have this subject for a hobby that really take any interest at all in the matter; but the aspect of the scenery has been so moulded by the influence of the glaciers which formerly dwelt here that its features can be understood rightly by those only who can read the record, and can call up in the mind's eye the Arctic scenery that formerly prevailed in our islands. There are few places easier of access and better adapted for studying the subject in the field than the locality I have mentioned near *Cambus o' May*. The rocky slopes of *Culblean* and *Pannanich*, the great group of moraines filling the bosom of the hills up to *Tullich*, and the gravel-covered *Muir of Dinnet* stretching away to the east, are all splendid places for the purpose. The granite rock of *Culblean* has been scoured bare by the ice, and left in large, smooth, rounded masses, with here and there a great block perched upon the surface. Sir Walter, no doubt, would have looked upon these as

“Hurl'd headlong in some night of fear,
When yelled the wolf and fled the deer”;

but we know better. A good view will be got at the summit level of the hill road which leads from *Tullich* to *Tarland*, near the *Burn of the Vat*. On either side of the *Culblean* ridge numerous mounds of debris are to be seen, but the ridge itself has been swept bare all the way down to the river. The *Muir of Dinnet* is a great expanse of gravel spread out by the floods of water issuing from the front of the retreating glacier. Beneath this sheet of gravel will be found the grey boulder clay, or bed of gritty mud, on which the glacier rested. Good sections for studying its character and composition are, or were, to be seen along the side of the *Dee* in this neighbourhood. As you approach the rock at *Cambus o' May* from the east, great blocks of granite will be seen which have been torn up and carried eastward some distance by the ice.