In order to confirm my last illustration I would suggest to anyone who may be interested in pond life that he pay a visit to a stagnant pool of water, say early in spring. The pool should have an airy situation. Let the investigator pick up gently a few strands of the confervae which generally abound on the margin of the water in tangled masses of hair-like filaments and very often matted together. Put the green stuff into a bottle with a little water from its native haunt, and cork it tightly and take it home. In the quietness of the home transfer a few threads on to a glass slide and spread out the fine fibres with a needle. Then examine the material with a high-power microscope, and the marvels of pond life will be revealed to the gaze of the observer. A veritable drama of colours and elegant forms will be staged on the area of vision. The dripping plants will be found not only to be objects of ineffable beauty far surpassing human production, but to be teeming with myriads of organisms of various shapes and sizes.

In this way then the secrets of pond life are linked up with the romantic life of the elusive eel.

In order to refresh your memory, let me now briefly summarise the story of the common eel.

(1) the hatching of the larva in mid-ocean;
(2) the passage of the flat-shaped creatures to our shores where they arrive as elvers at the end of $2\frac{1}{2}$ years;
(3) the upstream journey;
(4) hibernation during the cold season;
(5) the silvery eel leaving loch and pond and travelling up river to the sea;
(6) the meeting of the male and female in the estuary;
(7) the long passage of the pair across the lonely waste of waters;
(8) the depositing of the ova in a suitable locality, and finally the death of the parents.

A fascinating drama from real life, to be eternally repeated.

SURFACE FEATURES OF WESTERN SCOTLAND,

WITH A NOTE ON A PRE-GLACIAL VALLEY IN NORTH BUTE.

By Archie Lamont, M.A., B.Sc., Ph.D.

[Read 19th March, 1935.]

The boundary between ancient and modern in the interpretation of scenery may be drawn in the year 1795, when James Hutton, of Edinburgh, published his "Theory of the Earth." In earlier times surface features were attributed to uplift by convulsive agencies. In Hutton, while the factor of the uplift of land-masses was recognised (vol. ii., pp. 445-446), actual valleys and mountains were explained as being due to erosion of the earth's crust by atmospheric agencies, change of temperature, rivers, frost, and wind. These forces, which operate very slowly over immense periods of time, combine to etch out a landscape. Their final product can be seen in a mature river valley all parts of which have been smoothed down so as to be "in grade." But it is also the case that during prolonged intervals harder rocks like granites and basalts will stand up as eminences, while softer shales and sandstones are worn away. These facts were appreciated by Hutton, who even reached the point of speculating on the results of a formerly extended glaciation in Switzerland. But research had not gone far enough for him to realise that the same influence had played an important part in the surface history of Scotland. Indeed, more than most countries, Scotland offered features unexplained by Hutton's generalisations.

After the evidence of ice-action in Britain had been verified in 1841 by Agassiz and Buckland, a tendency arose to account for certain unusual features on glacial lines. In Western Scotland, deep glens and fiords—the latter of which in many instances become shallower towards the sea and cannot have been eroded by rivers—were attributed to excavation by glaciers. This explanation, while it may be accepted

in cases where ice has cut out rock basins in softer strata and left harder rocks little eroded, raises more difficulties than it answers. Some of these have been enumerated by J. W. Gregory, who pointed out that fiords in Scotland do not necessarily coincide with directions of ice-movement, and that while the East of Scotland, was as intensely glaciated as the West, it shows no comparable fiords (1913, pp. 7-24). Gregory, as a result, was thrown back on the alternative view that fiords are produced initially, no matter how much they may later be moulded by ice lying in them, as great tension clefts and cracks due to structural disturbances such as are involved in the uplift of a plateau of hard rocks. Thus we are led to admit tectonic forces, as well as slow processes of erosion, in the evolution of western Scottish scenery—and almost without doubt this is the true account.

The work of Cadell (1886, 1913), Mackinder (1902, 1907), and Gregory (1913, pp. 160-162; 1915) has shown that before the formation of the fiords the South-West Highlands formed part of a continuous plain sloping gently towards the south-east. The fiords of Loch Fyne, Loch Long, and Loch Lomond are intersected by a series of "hanging valleys" (Fig. 1). The latter lie at up to a 1000 feet above modern sea-level, and their more gradual slopes contrast with the nearly vertical walls of the fiords. They are often found to correspond with each other on opposite sides of a fiord, and, when relative heights are taken, may still, in spite of recent denudation, be "in grade." The existence of an ancient plain drained by these valleys is also indicated by the remarkably uniform average level of South-West Highland mountains like those of Cowal.

The drainage from this area is supposed to have flowed out in a south-easterly direction, across the Glasgow basin, to join the headwaters of the Tweed through the Biggar gap, though part may have found its way into the Rivers Nith and Tyne (Mackinder, 1907, pp. 132). In later times, as the Carboniferous rocks of the Central Valley were eroded, the Forth cut back its channel and captured much of the West Highland drainage (Cadell, 1886; 1913, pp. 56-80). It was

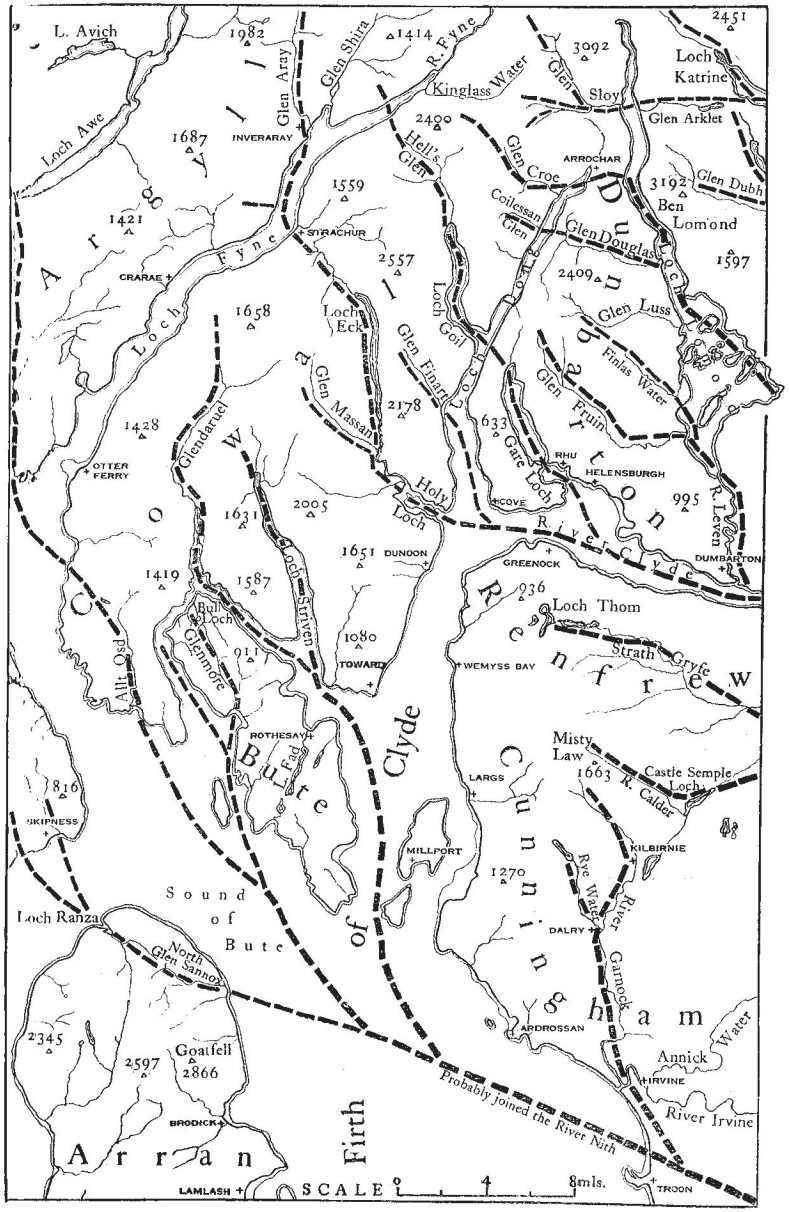

Fig. 1.—Map of Primitive River System of Cowal, etc.

only much more recently, after partial erosion of the Arran igneous centre, that the Clyde as we know it to-day came into existence.

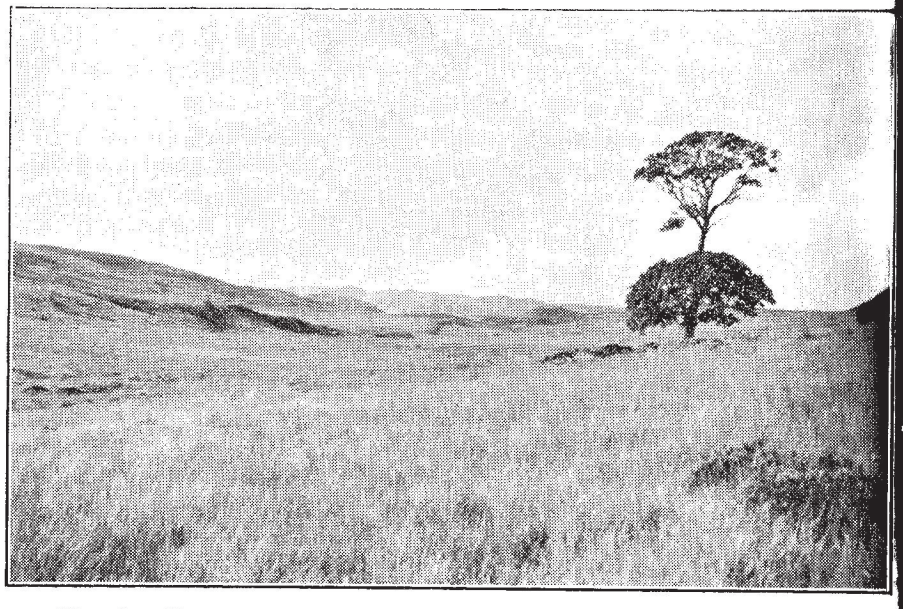

Fig. 2.—**Glenmore looking North.** The mountains in the distance belong to the Cowal plateau, with which summit levels in North Bute are "in grade." The dark ridge on the left is a tholeite dyke which extends almost the entire length of the valley.

It is in the light of these theories that the writer wishes to consider the valley of Glenmore, in North Bute (Figs. 2 and 3). This is a broad, mature valley, over four miles long, lying in its highest part at nearly 500 feet above sea-level. At the present source of the Glenmore Burn the valley is a mile wide. The stream is unable to carry away all the material brought in by tributaries, as can be seen from an alluvial fan on the west side of the burn, north of Glenmore Farm. It is impossible to credit the Glenmore Burn with having accomplished the denudation necessary to account for the valley. We must, therefore, assign to the original Glenmore stream at least all drainage from as far as the extreme

north end of Bute, if not from a continuation on the mainland of Cowal. Such an extension, however, is not easily to be made out, and this may have contributed to deterring previous observers from including Glenmore in the primitive river system of this part of Scotland.

The Bull Loch at the head of Glenmore at present drains by way of the Lagganbeg Burn into the Kyles of Bute. From the contour of the country, as well as from the necessity of a more powerful stream to account for the excavation of Glenmore, it is nevertheless evident that the Bull Loch was once an integral part of Glenmore. With an increase in level of twenty feet or so the loch would drain south into the broad valley. As it is, its drainage has been captured by the Lagganbeg, a steep little stream dating from the formation of the fiord-cleft of the Mid Kyle, which has cut back its channel to reach the loch.

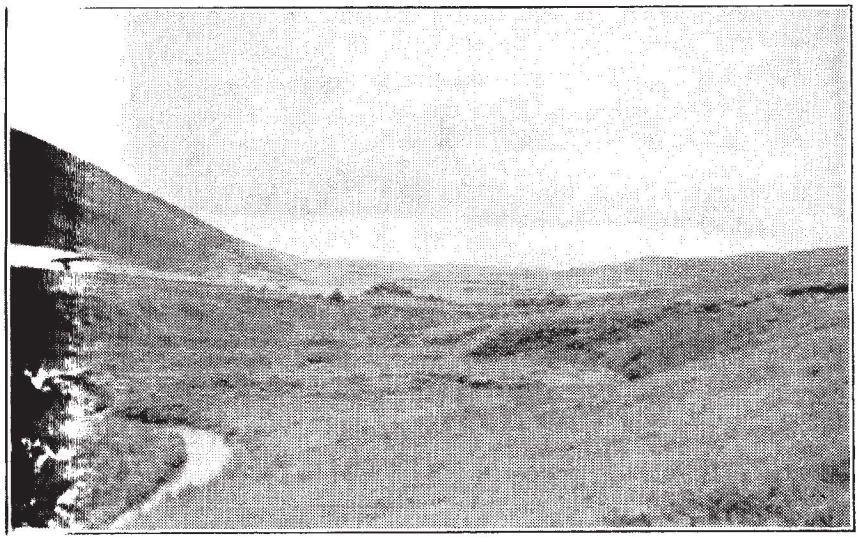

Fig. 3.—**Glenmore looking South.** The Glenmore Burn is cutting small meanders in boulder clay which covers the slopes and floor of the pre-glacial valley.

The fact that there are no moraines in Glenmore points to the small amount of denudation done by valley-glaciation. But certain small cliffs, near its head on the north-east side, which is that most exposed to the sun, may have been formed on the margin of ice lying in the valley. Glenmore, especially in the more southerly half, shows a considerable covering of boulder-clay, but even the continental glaciation by which the boulder-clay was deposited can have had little effect on a valley with no outstanding spurs and about 500 feet high at the point of entry of the ice. We may here note the elongate hillock, in the fields between Glenmore farmhouse and the burn, as quite a good example of a drumlin, or boulder-clay hill moulded by ice. Apart from such a feature, Glenmore probably presents much the same form to-day as it did in pre-glacial times.

Between Glenmore farmhouse and Achavoulig, the burn flows in a series of complicated meanders and cuts terraces in the boulder-clay to a depth of about six feet. South of Achavoulig the meanders continue, but are deeply incised so that a "v" shaped glen reaching a depth of seventy feet is formed below the level of the mature valley. This gully is the result of rejuvenation of the stream, owing to uplift of the land, between the immediately post-glacial time when the hundred-foot beach—on which the farms of Drumachloy, Kilbride, and Nether and Upper Ettrick stand—lay at sea-level, and the present day.

SELECTED WORKS OF REFERENCE.

BAILEY, E. B.—"The Interpretation of Scottish Scenery,"* Scot. Geog. Mag., vol. L., 1934 pp. 308-330, figs. 1-3.

CADELL, H. M.—"The Dumbartonshire Highlands," Scot. Geog. Mag., vol. II., 1886, pp. 337-347, with map.

—— ——"The Story of the Forth," 1913, pp. i.-xvii., 1-299, pls. 75, etc. Maclehose & Sons, Glasgow.

*This work contains an extensive bibliography.

GREGORY, J. W.—"The Nature and Origin of Fiords,"* 1913, pp. i.-xvi., 1-542, pls. 8, etc. Murray, London.

—— "The Age of Loch Long, and its Relation to the Valley System of Southern Scotland," Trans. Geol. Soc. Glasgow, vol. XV., 1915, pp. 297-312, pls. XXXI.-XXXII.

—— "The Relative Influence of Denudation and Earth-Movements in Moulding the Surface of the Earth," Scientia, vol XL, 1926, pp. 217-230.

HUTTON, J.—"Theory of the Earth," vols. I-II., 1795, pp. i.-viii., 1-620, pls. 4; and pp. i.-viii., 1-567, pls. 2. Cadell, Junior and Davies, Edinburgh.

MACKINDER, H. J.—"Britain and the British Seas" (Second Edition), 1907†, pp. i.-xii., 1-377, pls. 6, etc. Clarendon Press, Oxford.

*This work contains an extensive bibliography.
†First Edition, 1902.