ginous grit-stone; probably from the Karoo Beds. 15. Sandstone; from the Karoo Beds. Nos. 13 to 15 have been drifted from the Stormberg and neighbourhood higher up the country. 16. Pebble of brown quartzite; possibly from the Karoo Beds.

17. Mundic in slate. 18. Siliceous schist, or brown banded lydite. 19. Jasper. 20. Vein-quartz. Nos. 17—20 have been derived from the old rocks; probably having been brought up from below, but possibly drifted on the surface.

The mineral contents of the diamond-matrix or "Blue Ground" of Kimberley (De Beer's, etc.) were described by the late Professor H. Carvill Lewis in the *GEOL. MAG.* 1887, pp. 22–24.

The diamond-yielding gravel of the Vaal River, partly drifted from the igneous and the old rocks of the higher country on the East, and partly derived from diamantiferous necks and patches, has much analogy to that of the refuse-heaps or washed stuff of the diamond-mines. The constituents of the Vaal gravel, and of that of Dutoit's Pan, are enumerated in the *GEOL. MAG.* 1871, pp. 55, 56; and *Quart. Journ. Geol. Soc.* vol. xxviii. 1871, pp. 17–21.

VII.—ON A GLACIAL MOUND IN GLEN FRUIN, DUMBARTONSHIRE.

By DUGALD BELL,
Geological Society of Glasgow.

GLEN FRUIN¹ is a quiet secluded glen, about six miles in length, extending in a north-westerly direction between Lochlomond and the Gareloch, and opening off the neck of land which divides those lochs at between 200 and 300 feet above the sea. To the south-east, it slopes towards Lochlomond, of which the Fruin water is one of the principal affluents. On the west it is divided from the Gareloch by a range of hills 1000 or 1200 feet in height, which at its upper extremity subside into a col or pass of 600 or 700 feet. This upper part of the glen is composed of the mica and clay slates common to the Western Highlands. The lower part is formed of beds of the Calciferosus Sandstone series, which have here been faulted down against the older formations.

The upper part of the glen bears every indication of having been at one time occupied by a lake.

A huge boulder of mica-schist, resting on the sandstone, occurs near the foot of the glen, and there are many smaller ones in the same neighbourhood. The respected Convener of the Edinburgh Boulder Committee, the late Dr. Milne-Home, thought this large boulder had been brought by an iceberg (which was his favourite means of transport) either coming down Lochlomond and drifting aside into Glen Fruin, or more probably finding its way over the head of the glen during a period of "great submergence."

The iceberg hypothesis seems to be attended with insuperable difficulties, when we consider (1) where such large icebergs could be formed in the event of so great a submergence as the theory

¹ The "Glen of Sorrow," scene of a sanguinary conflict between the Colquhouns and Macgregors in 1603. (See Introduction to "Rob Roy.")

requires; and (2) by what possible main currents of the ocean, which alone could move them, they could be brought to these localities and positions. For these and other reasons, it seems more probable that such boulders owe their transport to a great sheet of land-ice which once filled the glen from side to side, proceeding from the Argyleshire mountains on the north-west, and overflowing the neck or col at the bend of the glen as also that at the head of the Gareloch, between it and Lochlong.¹

This view is strongly corroborated by the phenomenon we have now to describe, viz. a remarkable mound of detritus which occurs about half a mile farther up the glen than the large boulder referred to, and extends for a considerable distance in a winding line across the hill-side in a direction from S.W. to N.E., i.e. *transverse* to the glen. It is most conspicuous on the eastern side of the glen, where it runs from 300 to about 500 feet above the sea, "tailing out" on the hill-side towards Lochlomond at a still greater elevation; but it can be traced on the western side also, in the same general direction, though there the ground is lower, and not so favourable for its preservation. It is composed of typical moraine matter—large and small stones, sand and gravel, confusedly mixed together; many of the stones being distinctly striated. Some are sandstones from the immediate neighbourhood; others, schists and quartzes, from greater distances.

The mound varies from 10 to 20 or 25 feet in height, and from 20 to 30 feet in breadth. In some parts it resembles a row of hummocks of varying height; in others it rises from the surrounding moor, distinct and continuous as a railway embankment. A number of boulders, some of considerable size, are perched on its sides or summit, and strewn along its base.

There can be little doubt this is a "terminal moraine" of the great ice-sheet which once occupied the glen; and we may add it is one of the most notable and characteristic which we have seen in the West of Scotland.

A number of detached mounds of considerable size occur at lower levels, beyond the opening of the glen towards Lochlomond, and may be relics of still older moraines.

Meantime the one we have described suggests the following inferences:

1. There has been no submergence to this point *since* the mound was deposited. Its rough, undressed, unstratified condition—its very existence as a distinct mound—proves this. Had there been a submergence of as much as 500 feet since it was deposited, such a loose earthwork would soon have been demolished and effaced by the currents sweeping across this low neck of land between Lochlomond and the Clyde.

2. For the same reason, there could be no submergence to that extent *while* the mound was being deposited. Some geologists hold that the ice-sheet reached the sea as the land rose (assuming a submergence) and laid down such mounds along the sea-margin. In

¹ As noticed many years ago by C. Maclaren; *Edin. New Phil. Journ.* vol. xi.

that case they would surely have borne distinct marks of assortment and stratification, especially in localities where strong currents must have been in operation.

3. Nor, finally, is there any proof of a "great submergence" prior to these latest works of the ice. This is where the advocates of such a submergence join issue. They maintain that there was a first or general glaciation, then a deep submergence, then a partial or local glaciation, by which all distinct traces of the submergence were removed. But a little reflection will show (a) that it is very improbable any subsequent local glaciation could remove all traces of the sea's presence at high levels, supposing it had been there. The sea marks a *horizontal* line and goes into every nook and cranny of the land along the line; whereas the glacier marks a *descending* line, and keeps to one main channel, not branching off in every direction as the waters do. The *area* of the glacier, therefore, could not coincide with that of the submergence so as to remove all traces of the latter.¹ Then (b) if such traces *had* been entirely removed

FIG. 1.—Sketch Map showing position of Mound (M.)

FIG. 2.—General Aspect of the Mound.

from every glen like this Glen Fruin, they should at least be discernible in the heaps of *débris* which the ice has left near the mouths of such glens. All over the country there are innumerable glacial mounds and heaps—the "sweepings" of glens which, in the case of the alleged submergence, must have been sheltered inlets of the sea, favourable to almost every form of marine life. These heaps, as well as the Boulder-clay of the country generally, should abound in fragments of marine fossils, if there had been such a

¹ See Trans. Geol. Soc. of Glasgow, vol. ix. p. 109.

submergence, instead of being, as they are on the whole, quite destitute of organic remains.

This argument is not founded on a supposition, but on a fact. Wherever the ice can be shown (by the striæ on the rocks, the stones in the "drift," etc.) to have passed over what is still a sea-bed, or what there is no doubt was formerly such, during a very moderate submergence, there also numerous fragments of sea-shells are found in the drift or Boulder-clay; as in the instances of Caithness, Arran, Drymen, South Ayrshire, Holderness, Cromer, Lancashire, etc.

The advocates of the "great submergence" have therefore these two facts to account for: (1) the absence of all proofs of such submergence *in situ* at the high levels to which it is supposed the sea attained; and (2) the absence of all evidence of it in the *débris* derived from these high levels.

REVIEWS.

I.—AN INTRODUCTION TO THE STUDY OF MAMMALS LIVING AND EXTINCT. By WILLIAM HENRY FLOWER, C.B., F.R.S., D.C.L., etc., etc., and RICHARD LYDEKKER, B.A., F.G.S., etc., etc. 8vo. pp. xvi. and 763, Illustrated with 357 Woodcuts. (London, Adam and Charles Black, 1891.)

THE authors of this important Manual have rendered a most valuable service to Biological Science by furnishing us with a book, long wanted, but heretofore not to be met with in any country or language, and one which will be eagerly sought after by zoologists and palæontologists engaged in the study of the higher Vertebrates all over the world.

The few manuals approaching somewhat to this in size, in other countries, are of too popular a character to be compared with the present work. We have some bulky recent works, and smaller manuals too, on systematic zoology, on palæontology, on comparative anatomy, and on the habits of mammals. In the present volume these different details are so happily amalgamated together that we are enabled to gain a good general knowledge of our subject, which a laborious journey through many volumes by various authors would have failed to procure for us.

Originally initiated as a series of articles running through the twenty-four volumes of the ninth edition of the "Encyclopædia Britannica," from 1875 to 1888, by one of the authors (Prof. Flower), the present work has the additional advantage not only of bringing all this information on the Mammalia together, but by the coöperation of Mr. Lydekker, as joint author with Prof. Flower, much new matter relative to fossil forms has been added, and the whole brought up to date, both as to the living and extinct forms.

After a brief introduction of six pages, chapter ii. (pp. 7 to 81) is devoted to the general anatomical characters of the Mammalia; these are written in terse yet clear language, and by the aid of some