I think that had I seen Mr. Downes' specimen I should have separated it under a distinct specific name instead of considering it merely a variety. It is singular that Dr. Fitton included *N. pectinata* in his list of Blackdown fossils; but as no specimen was known, I thought it likely that a specimen of *N. antiquata*, exhibiting pectinate structure, and which is still preserved in his original collection at Bristol, had been mistaken for it. I had previously noticed Blackdown species in the Grey Chalk, and think that when allowance is made for the different quality of sea-bottom, and the much greater probable depth of the Chalk sea, enough species will remain in common to prove that the two formations are practically of about the same age, or that at least the Blackdown Beds are much newer than the Gault.

J. Starkie Gardner.

"ELEVATION AND SUBSIDENCE."

Sir,—I either fail to comprehend Mr. Starkie Gardner's argument, or he seems strangely to misunderstand the value of the evidence afforded by the presence of stratified sand with marine shells at an elevation of 500 feet in Scotland. He seems to admit that it means the total disappearance of all ice below that level. Now this implies that the larger proportion of the ice-sheet, which he assumes was the cause of the depression of the land, had been entirely removed, and further that a very considerable part of it must have been floated off long before that degree of submergence was reached —assuming with Mr. Gardner that the land was depressed during glacial conditions, which is not the belief of the most competent authorities upon the glaciation of Scotland.

Mr. Gardner says that in the course of submergence "the Firth of Tay would in fact become a fiord." I do not wish to repeat Mr. Gardner's slighting phrase, but I really do not know what he means by that. I understand that fiord and firth are convertible terms, or perhaps that the latter is a fair attempt to spell out in English the Norse pronunciation of the former word. But what the Forth of Tay would actually become were the land depressed 500 feet would be part of a wide sea joining the North Sea to the Atlantic, and stretching from the flanks of the Grampians to the Southern Uplands, a sea certainly studded with innumerable islands, but few if any of them of sufficient area to bear an ice-cap, and not only would the great central valley of Scotland be turned into an archipelago, while vast tracts all round the coast as well as the Great Glen (through which the Caledonian Canal passes) would be deeply submerged, but even the mountainous regions that remained would be invaded in all directions by great firths occupying what are now the highland glens.

But apart from this sweeping removal of the ice, foot by foot, as the land sank down, the load of ice would be proportionately lightened, so that it would really be an instance of depression accompanied by unloading, not, as the new theory demands, depression by loading, and in proportion to the amount of the loading.

Mr. Gardiner writes somewhat contemptuously of the phrase

"ground moraine." I lay no claim to having invented it; I find, indeed, that it was used by Sir Andrew Ramsay at least as far back as the publication of his "Physical Geology of Great Britain." Perhaps I may be permitted to commend it to Mr. Gardner as a useful English equivalent for the French phrase so much in use.

JAS. DURHAM.

PACKING OF SAND GRAINS AS COMPARED WITH ROUND SHOT.

SIR,—I am indebted to your correspondent, Prof. A. Harker, for his suggestion and for recalling my attention to this subject (p. 192). No doubt, as he states, round shot could be so packed as to leave much less interstitial space than what would result from my hypothetical arrangement. But even if perfect spheres of absolutely the same size could be obtained and friction eliminated, they could not fall together naturally in perfect "pyramidal order," *i.e.* each shot having points of contact with twelve others; because their arrangement is conditioned by the packing which takes place against the sides of the vessel. If on the other hand they were unconfined as in a heap, their arrangement would be one of disorder.

To thoroughly test what practically happens, I filled a rain-gauge measurer up to the mark 30 with No. 4 shot carefully put in layers, and shaken to get them as close together as possible. A second rain-gauge measurer being filled also up to 30 with water, I poured sufficient from it among the shot to fill up the insterstices. I found that 18 remained in the gauge, leaving 12 among the shot, a relation of 4 to 6.[1] This shows somewhat less interstitial space than my hypothetical arrangement assumed, but considerably more than the "pyramidal order" arrangement. It is plain to see through the glass that the number of points of contact of the shots vary, and leave variable open spaces in places. This shows that minute differences in size, imperfection of spheroidal shape, and to a large extent the packing against the sides of the vessel and friction, are disturbing elements. Some time ago for the purposes of a paper on sandstones I repeated the experiment mentioned in "Miniature Domes in Sand" on a larger scale, and in a somewhat different way, taking great care to shake the sand well together in layers, as I afterwards did with the shot. Curiously enough, the result was within a third decimal place of that I now give for the shot. The grains are mostly well-rounded, but some of them are angular, and the sizes of the grains vary considerably. It is surprising how the sand will keep on packing closer and closer by shaking, whereas the shot is affected to the extent of a reduction of its bulk by only $\frac{1}{30}$. The question is one of considerable practical interest. I find if a trench for a sewer intersects another trench which may have been filled up for years, and all in apparently homogeneous siliceous sand, the filling in of the old trench discovers itself by falling into the new one, while the sides cut in the "growing" sand remain vertical. Thus it appears that percolation of rain assisted by gravity is slowly moving and packing the grains of sand until they reach the point of maximum consolidation. It is in fact a natural building operation which may be likened to the fitting together of rubble, shot from a cart, to form a wall. Pouring water on filled-up sand will consolidate it, and I am in the habit of having this done where a floor has to be made on filled-up sand. It is remarkable how solid sand becomes in time left only to natural influences. I have frequently built large houses on sandhills without failure of foundation.

PARK CORNER, BLUNDELLSANDS, *April 5th*, 1884. T. MELLARD READE.

[1] If this experiment were repeated with larger vessels, the proportions might differ more.