has not done or thought of doing—*prove* the proportionality of cause and effect. Neither he, nor any other of Mr. Spencer's opponents, has made the smallest attempt to deal with this main issue. Mr. Spencer alleges that this cognition of proportionality is *à priori:* not in the old sense, but in the sense that it grows out of experiences that precede reasoning. His opponents, following Prof. Tait in the assertion that Physics is a purely experimental science, containing, therefore, no *à priori* truths, affirm that this cognition is *à posteriori*—a product of conscious induction. Let us hear what are the experiments. It is required to establish the truth that there is proportionality between causes and effects, *by a process which nowhere assumes* that if one unit of force produces a certain unit of effect, two units of such force will produce two units of such effect. Until the "Senior Wrangler" has done this he has left Mr. Spencer's position untouched.

Bayswater, May 20 JAMES COLLIER

The Great Ice-Age

IN reply to Mr. Belt's letter (p. 62), I did little more than express an adverse opinion to his theory, because to discuss it would have required an essay. I expressed this because I notice that unless something like a demurrer is entered against a new theory it is apt to be taken for granted in subsequent text-books and papers written by those who have had no opportunities of obtaining a practical knowledge of the subject. For the above reason I must answer his strictures very briefly.

(1) I fail to see why the Scandinavian sea-beaches are irrelevant. (2) I have more than once read Mr. Tiddeman's paper, and without committing myself to all its conclusions, think I may quote it as assuming that the Lake district (as distinguished from North Lancashire) was the centre of a great ice-sheet; not that it was over-ridden by ice coming from somewhere further north. The same might be expected to be the case with the Welsh mountains; and Mr. W. Kingsley has brought forward good evidence of the existence of an ice-sheet there also. (3) Mr. Belt appears to forget that shells have been found not only at Moel Tryfaen, but also near Llyn Ffynnon-y-gwas, about two miles west of the peaks of Snowdon. Does Mr. Belt mean to say that Snowdon could not protect itself in the heart of its own domain better than this? If the Lake mountains had an ice-sheet, surely Snowdonia? Mr. Belt asks for evidence of the shore of the glacial sea. I reply that to me these and the Moel Tryfaen beds, not to mention others, appear to be far more probably littoral deposits than transported. For example, I think it in the highest degree improbable that the Vale Royal shells (Lyell, "Antiquity of Man," p. 317) could be brought to their present position (more than 1,100 feet above the sea) by any ice-sheet without the cold being enough to cover *all* the higher ground in Britain with ice, and so protect it. I did not deny a glacier might push a stone before it up-hill; my contention was that the enormous force which would be exerted on beds scooped out as described, and shoved some 1,500 feet up-hill for miles over broken ground, would crush the shells to a far more comminuted state than they are now in. With regard to Holderness, Mr. Croll's view of the shells there appears to me to be at present only a *theory* of which Mr. Searles V. Wood, jun., has effectually disposed (Geol. Mag. 1872). I grant there are some difficulties in the submergence theory; my position is that those in Mr. Belt's are very much greater.

A recent perusal of Mr. J. Geikie's suggestive book, the "Great Ice Age," has brought before my mind more strongly than ever a dilemma, which, as it appears to me, the modern school of Glacialists cannot escape.

He speaks of the till as a *grund moräne* or *moraine profonde* formed between the glacier and the rock, while he attributes the majority of rock-basins to the action of the glaciers. Now it appears to me that if the glaciers could pass over considerable deposits of this *moraine profonde* without sweeping it clean away, then their action as erosive agents must have been comparatively feeble; or, if they could scoop out great rock basins like the Alpine and (buried) Highland lakes, then they would have peeled off almost all the till from the land. As it appears to me, the analogy with a river, by means of which Mr. J. Geikie (p. 88) seeks to escape from a portion of this difficulty, does not hold. When a river begins to deposit sand and gravel largely, its work as an erosive agent at that place is almost over. Besides we cannot conceive a nearly solid mass, like a huge glacier, changing its motion so rapidly as a stream of water. Difficult as it undoubtedly is to explain some of the lake-basins, it appears to me that the great bulk of his evidence, with regard to till and other deposits over which ice-streams have passed, shows how slight under ordinary circumstances is their erosive power; and this has been confirmed by every journey that I have made among the Alps. I may add also that from study of the same regions my faith in a *moraine profonde* is much shaken. I believe that, except possibly as a very local and exceptional phenomenon, it exists solely in the imagination of the eminent geologists of whom Mr. Geikie is a disciple. T. G. BONNEY

St. John's College, Cambridge, May 26

Photographic Irradiation

IN the paper referred to by Prof. Forbes (NATURE, vol. x. p. 29) what is ordinarily called Photographic Irradiation was attempted to be explained by us, not as being caused by reflections from the back of the plate, but as being due to the sum of all the optical imperfections of the instrument with which the photograph is taken.

If Mr. Stillman (p. 63) will refer to our original paper, published in the *Monthly Notices* for June 1872, he will find that only the cloudy indefinite haze which surrounds the image of a luminous object, and which has frequently been called halation, was referred by us to reflection from the back of the plate.

When an over-exposed photograph is taken upon an opaque plate a marked fringe of irradiation still remains, and experiments were instituted by us which appeared to show that this is not to be accounted for by any circulation taking place within the thickness of the collodion or by the chromatic dispersion of the lenses; but when the oblique pencils from the edges of the lenses were stopped out the irradiation fringe was found to be greatly decreased. We were led to conclude that irradiation is to be accounted for by the fact that each luminous point in the object is not accurately represented by a luminous point in the image, but rather by a luminous patch of sensible area, the central and more intense portion of which prints itself first in the photograph, giving comparatively sharp picture prints when the exposure is short; but as the picture is still further exposed, the outer portions of the luminous patches imprint themselves, and by their overlapping cause the blurred appearance to which has been given the name of irradiation. LINDSAY

A. COWPER RANYARD

Uncompensated Chronometers and Photographic Irradiation

WITH regard to the employment of uncompensated chronometers (NATURE, vol. x. p. 63), I have every reason to believe that the Russians alone have tested them. For some reason which is not easily discovered, the employment of a negatively compensated chronometer has not given any very remarkable results. The Russians have employed simply an uncompensated chronometer; and have obtained very remarkable results as mentioned in my article on the Transit of Venus to which Prof. Everett has alluded.

With regard to the prevention of photographic irradiation, of course various means have been employed for dry plates; but I believe that Lord Lindsay and Mr. Ranyard were the first to experiment on the matter exhaustively. I believe Mr. Stillman would be interested in reading their paper in the *Monthly Notices*. At the same time all honour is due to the photographers named by him for their experiments.

Birkenhead, June 1 GEORGE FORBES

The Seal Fishery

CAPT. DAVID GRAY, of the steamship *Eclipse*, has done good service to the cause of humanity in writing, and Mr. Buckland in publishing, the letter on the seal fishery which appears in *Land and Water* for May 9. The fearful cruelties perpetrated year after year, and the enormous waste of life entailed by the reckless manner in which the seal fishery is prosecuted, are well known, but no steps have hitherto been taken to regulate a trade which, if carried on within proper bounds, would continue to yield great profits, but if still pursued with such utter disregard to consequences must soon end in the extermination of the whole race. As an instance of the wastefulness of the mode of proceeding, Capt. Gray says that five ships attacking a pack of seals, in four days killed about 10,000 old seals; "add 20 per cent. for seals mortally wounded and lost, gives an aggregate of 12,000 old ones; add 12,000 young which died of starvation, gives 24,000; but this is not all. The men spread on the ice, so that the old ones that were left alive could not get on to suckle their young. The consequence was that the whole of the young