while there are also indications in the relative sizes of the leaves of others that the climate was milder. Perhaps the Alps were less elevated and the sea nearer at the time, but interest is given to the problem by the undoubted presence of *Rhododendron ponticum*, which at present only flourishes in a much warmer climate far to the east, but, from its discovery in other localities, was evidently thoroughly indigenous in the Alps. The author regards the flora as a relic of the "steppe-flora" which then spread over the greater part of Europe, and of which numerous traces still exist, especially in Switzerland and Lower Austria, where plants of Oriental facies, such as the yew, box, holly, Ephedra, Sumach, hornbeam, feather-grass, maidenhair, &c., are its lingering remains.

The work is carefully prepared, doubtful determinations, except in the case of the Arbutus and a new buckthorn allied to *Rhamnus latifolia* of the Canaries, are eschewed, and the photographic illustrations, pencilled over by the artist, are extremely satisfactory. J. S. G.

Observational Astronomy. By Arthur Mee, F.R.A.S. (Cardiff: Daniel Owen and Co., 1893.)

THIS small book should serve the purpose for which it is issued; the object being to provide the beginner with an inexpensive treatise to enable him to become familiar with and interested in the practice of observational astronomy. For this reason the author limits himself to the purely descriptive side of astronomy, dealing with the sun, planets, comets, and meteors, giving numerous references where necessary. Short chapters are given on eclipses, transits, occultations, and "the sidereal firmament," the latter treating of double and coloured stars, &c. The chapter on the telescope contains many practical hints, besides numerous woodcuts, while that devoted to the moon is very pleasant reading, and gives a good account of the more general features. The illustrations, as will be gathered from the above, are very numerous, many of them being from the pen of the author himself. With respect to these, we must add that the one given on p. 72 of the Orion nebula does not remind us of the most beautiful object in the heavens, while on p. 66 Donati's comet is depicted minus the two long streamers which made this object so striking. The book concludes with a short obituary of the Rev. T. W. Webb and an appendix containing brief contributions from Denning on comets and meteors, Gore on variable and temporary stars, Seabroke on double star measurement, and a few others.

W. J. L.

Mechanics and Hydrostatics for Beginners. By S. L. Loney, M.A. (Cambridge University Press, 1893.)

THIS is the latest addition to the series of elementary text-books recently launched by Mr. Loney. The same high standard of excellence is maintained, and the author must again be congratulated on his efforts to place in the hands of a beginner a book which will give him correct ideas of the laws and principles which are included in a study of mechanics.

It consists of three parts, statics, dynamics, and hydrostatics, each part containing the usual chapters. If the reader should fail to understand the chapter on the laws of motion, he must attribute it either to his want of ability or the nature of the subject, for we fail to see how the author could improve his remarks on this part of the subject. We are glad to observe that the words "rate of change" find their way into the statement of the second law, for its definiteness is increased thereby. More than the usual care appears to have been devoted to the selection of suitable examples; some of them are exceptionally good, and thus add to the usefulness of the book. Occasionally the trigonometrical ratios are used, but their definitions will be found in the appendix; we are afraid, however, that the suggestion that their values for certain angles should be committed to memory is not a wise one. G. A. B.

LETTERS TO THE EDITOR.

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The Glacier Theory of Alpine Lakes.

THE letter of the Duke of Argyll against the theory of the formation of alpine lakes by glacial action shows such an amount of misconception of the theory itself, and so completely ignores the great weight of evidence in its favour, that a few words on the other side seem desirable.

The Duke says that glaciers "do not dig out," do not "act like a ploughshare," but, when moving down a slight incline do "scoop," as well as rub down and abrade. No observer of glaciers has ever stated, so far as I know, that they do "dig out," and it is equally erroneous to say that they "scoop," for that implies that it is the end of the glacier that acts. But the end is its weakest point, where it is melting above and below, and where consequently it can do practically nothing. The whole action of a glacier is a grinding action, and its grinding power is greatest where it is thickest, and where, consequently, it presses on the rocks with the greatest weight. The result of this grinding is seen in the muddy stream issuing from all existing glaciers; while the well-known "till" is the product of the rock grinding mill of ancient glaciers and ice-sheets.

Notwithstanding the Duke's disbelief in ice-sheets I venture to think that their former existence has been demonstrated both in Scotland and Ireland; but leaving this point, I wish to make a few remarks on the extreme inadequacy of the earth-movement theory to account for the facts. In the first place it is certain that no alpine lake can possibly have a long life, geologically speaking. In the course of a few thousands of years, certainly in less than a hundred thousand, all alpine lakes would be filled up by the sediment brought into them. It follows that all the existing lakes must have been formed about the same period, and that, geologically, a very recent one, and corresponding approximately with that of the well-known glacial epoch. But if these lakes were all formed by earth movements, either just before the glacial epoch came on, or during its continuance, or afterwards we have to explain the remarkable fact that such movements only occurred within the limits of glaciation, never beyond those limits. In Wales, Cumberland, and Scotland, in the Alps, in Scandinavia, in Finland, in the northern United States and Canada, in Mongolia and Thibet, in Tasmania and New Zealand, we have thousands of rock-basin lakes, amid palpable signs of glaciation. But the moment we pass beyond the glaciated districts, mountain lakes abruptly cease. There are hardly any in Spain, none in the Great Atlas, none in Sardinia or southern Italy, except in the volcanic areas and away from the mountains, none in any of the West Indian islands with their fine mountain-ranges, none in the peninsula of India or in Brazil. And there is exactly the same distribution of fiords. We have them in Norway, in West Scotland, in Alaska, in South-West America, and in New Zealand, all characterised by deeper water within than at their outlets, and all in glaciated countries, but nowhere else in the world.

Now it is simply impossible to believe that at a very recent period there should have been earth-movements of such a character as to produce lakes, but always in glaciated districts and never beyond them, unless the movements were a result of the glaciation. This has not, I believe, been yet suggested; but, in view of the modern theory that any considerable loading of the surface produces subsidence, it is at least a possible explanation. But there are some important facts that seem more in favour of the grinding out of the lake-basins by the enormous weight of ice accumulated over their sites during the height of the ice-age. Looking at a geological map of the Alps it will be seen that most of the lakes are more or less bordered by tertiary or secondary rocks. Lakes Annecy and Bourget are in miocene and eocene; the lake of Geneva on the north side is miocene or jurassic; the lake of Neuchatel, miocene; lakes Thun and Brienz, eocene or jurassic; lake Lucerne, eocene and miocene; lakes Zug and Zurich in miocene; lake Constance miocene; lake Maggiore is mostly in gneiss, but it is very suggestive that it is here comparatively shallow, but becomes suddenly deeper and reaches its maximum depth in its lower portion where it is bordered on the east by the jurassic beds; lake Como also has its greatest depth in triassic rocks, the upper portion, where gneiss prevails, deepening gradually southward as in a submerged valley. Equally suggestive is the fact that in the eastern Alps of Tyrol and Carinthia, where gneiss, porphyry, and the older stratified rocks prevail, and where glaciers are not now so extensive, there are hardly any lakes, except on the northern borders, where a considerable number occur in eocene, cretaceous, jurassic, or triassic formations.

These various facts as to the distribution of alpine lakes—their almost total absence in all parts of the world outside of glaciated districts, and within glaciated districts their prevalence in the newer and more easily denuded rocks—are what have to be explained by the advocates of the theory of earth-movements, and this, so far as I am aware, they have never attempted to do. Equally important, and equally difficult to explain on the earth-movement theory, is the fact that alpine lakes are almost always situated just at those spots where, by means of converging valleys, the glaciers would become heaped up and attain their maximum thickness, or where there is good evidence that they have been very thick; and it is the grinding power of this enormous weight of ice, acting differentially as regards the softer and harder rocks, that has worn out hollows in pre-existing valleys now occupied by lakes. In almost every case, too, it will be seen that there is a constriction or narrowing of the valley towards or beyond the lower end of the lake, which, by preventing the free escape of the ice, has increased its thickness and grinding power.

In the presence of such important series of facts as those here referred to, mere opinions, or even small and detailed cases of difficulty, can have no weight; but there is yet another consideration, which most geologists will admit is antagonistic to the earth-movement theory. The whole tendency of geological observation is in favour of the usually very slow rate of earth-movements, while it is equally in favour of the comparatively rapid action of denudation by running water. But in order that earth-movement could form a lake, it would be necessary that the rate of elevation or depression should be so great that the river could not keep pace with it by cutting down its channel; and, considering that all the rivers in question are rapid mountain streams carrying great quantities of sediment, this will be admitted to be a very improbable supposition. But when we add to this the still greater improbability that such rapid earth movements have occurred in scores and hundreds of cases, all at about the same time, geologically speaking, and all just in those spots where it can be shown that during the glacial period ice must have accumulated, and where the rocks were of such a character as to admit of being ground away; and yet further, that no similar earth movements producing similar results have recently occurred in any part of the globe beyond the limits of glaciation, the whole assumption becomes so hugely improbable as to render the theory of lake-formation by ice-grinding easy in comparison.

Sir Charles Lyell considered that the gravest objection to the glacial-erosion theory was the entire absence of lakes where they ought apparently to exist; and he instanced the valley of Aosta and the Dora Baltea, the glacier of which produced the enormous moraines of Ivrea. The valley of the Rhone above Martigny may be adduced as another example of the absence of lakes where they might be expected. But this kind of difficulty will apply to many other valleys, and can only be answered by general considerations. In both these cases the valleys are comparatively broad and open, and have a rather rapid descent. It is probable, therefore, that the ancient glacier in both was of a nearly uniform thickness, so that its wearing action on the floor of the valley would be tolerably uniform. To produce a lake we require essentially a differential action. There must be much more rapid degradation in one part than in another, due either to greater ice-accumulation or to softer rocks in one part than in another. In both the valleys referred to there is much uniformity in the rock-formations throughout, and even if some lakes or chains of lakes had been formed, the enormous amount of debris still brought down may well have filled up and altogether obliterated them. The absence of lakes in certain valleys cannot be considered an argument of any value until it is ascertained by borings that none have been formed and filled up again. It must also be shown that the whole conditions are such as to produce that amount of differential grinding down, without which no lake can be expected to have been formed.

It certainly seems to me that all the facts, all the probabilities, all the converging lines of evidence, are in favour of the glacial theory, to which the only serious objection is the assumption that glaciers cannot move uphill. But that they can do so, and have done so, is now admitted by most students of glacier-motion. Mr. Jamieson, and other Scotch geologists, have proved that glaciers, over 2000 feet thick, have travelled up lateral valleys, and up the slopes of many hills and mountains; and when we consider that the Rhone glacier was 5000 feet thick just above the lake of Geneva, and more than 2000 feet thick where it abutted against the Jura, we can have no difficulty in admitting that it might have travelled up the very gentle slope of the lake bottom, which appears to be less than 100 feet in a mile in its steepest parts. ALFRED R. WALLACE.

Waves as a Motive Power.

HAVING frequently observed the swimming motions of the fishes in our Aquarium—and occasionally of porpoises in the open sea—I have tried to make use for propelling boats of the same principle of locomotion, as exemplified particularly in the tail-fin.

I fixed a fin (blade) of elastic material like a helm to the end of a canoe; moving that fin laterally to and fro, the same went forwards. I have since learned that this "motor" was used already twenty-five to thirty years ago by Ciotti, a Sicilian; it is of course only an exact version of the method of sculling with one oar, familiar to all boatmen. Whilst trying my canoe and models of boats I soon became convinced that a boat ought to move forward if elastic fins are fixed to it, directed backwards, in such a manner that their flat sides are pressed against the surrounding water, when the boat rolls and pitches. The elastic fins, whilst overcoming the resistance of the water, curve like the fins of a fish, driving the water backwards and consequently pushing the boat forwards.

The canoe was provided with two horizontal fins at the stern and two vertical ones at the keel, total surface 0·2 square metres; speed against rather sharp wind and waves estimated at 25 metres per minute. I was unable to take exact measurements, as the canoe was accidentally sunk before the experiment was complete.

I then provided another boat, three metres long, at each of the two pointed ends with a horizontal fin (later on two), and at the keel with two vertical fins; these were all made of steel sheet, 1 – 0·8 mm. thick, subsequently replaced with aluminium bronze. The boat covered, against a gentle sea and wind, the distance of 900 metres in 25 minutes. Putting the fins obliquely the boat turned towards the right or left; directing one group of the fins forward, and another of equal surface backward, their action was paralysed, and in similar manner it was easy to make the boat turn round on the spot or to move backward.

The changing of the surface of the fins (0·3 to 0·6 square metres) caused very little difference in the speed produced. The same movements of the boat take place if the rocking is caused artificially.

I undertook a series of trials, in which I wish to acknowledge with thanks the kind assistance of Mr. Nelson Foley. The first result was that the *rolling* yields so little power, (very little energy being sufficient to prevent rolling,) that the vertical fins as a source of power may be nearly neglected in the calculations.

As to *pitching*, the power resulting from the action of the waves against gravity is proportioned to (weight of boat with crew) × (number of undulations) × (height of waves). But only a small portion of the energy developed in moving the boat up and down acts upon the fins (surface of boat in water-line three square metres, surface of fins 0·3 to 0·6 square metres), and of this remaining available force a considerable portion is lost by the low efficiency of the fins. Supposing, for the sake of argument, the efficiency to be 25 per cent., the propelling capacity in a moderate sea works out to the fraction of a man's power.

Considering these circumstances it seems doubtful, even with