

strokes would be unaccompanied by the phenomena of slicing or pulling or rising above the natural gravitational path. The dynamical condition for the production of underspin is clearly pointed out by Tait in his various articles. The resultant blow must be delivered so as to act in a line which passes beneath the centre of mass. For this purpose the blow need not be horizontal; but a horizontal stroke with a lofted club will produce underspin if the club-face hits the ball below the height of the centre. In this sense loft is an important factor in the production of underspin. In all cases, whether the ball is hit with a downward or a practically horizontal stroke, the production of underspin depends on the existence of a pronounced tangential component of impulse, and this requires that the direction of the blow must be inclined to the face of the club.

Mr. Vaile expresses the same idea when he speaks of the ball being hit with a glancing blow. In his explanation of the manner in which the wind-cheater is produced he is indeed quite sound; and it is a matter of regret that a book so admirable in many respects should be marred, not only by faulty dynamics, but by an inability to follow the dynamical reasoning of a master like Tait. Mr. Vaile sneers at the mathematician and physicist as having gone on utterly fallacious lines. He misquotes, and when he quotes aright he not unfrequently misunderstands. Nevertheless, on the more practical aspects of the game, when he is speaking for himself, and not piling up adjectives of denunciation against the mathematician, Mr. Vaile has done no small service in removing some of the clouds of mystery with which popular writers have obscured the soul of golf.

C. G. KNOTT.

THE AGE OF THE EARTH.

The Age of the Earth. By A. Holmes. Pp. xii + 196. (London and New York: Harper and Brothers, 1913.) Price 2s. 6d. net.

THE question "For how long has it been possible for organic beings to have lived on the earth?" must always be one of supreme interest; and it is good to find a book which states shortly but quite clearly how far we have proceeded towards an answer.

No great weight ought ever to have been given to the argument from the lengthening of the day, because it assumes that the ratio of the polar and equatorial diameters of the earth now is the same as when the earth ceased to be liquid; in spite of the fact that great forces are acting tending to change this ratio. Kelvin's argument from the temperature gradient downwards in the earth's

crust ceased to be of value when it was shown that greater conductivity in the interior led to an enormously larger answer; for whether such greater conductivity is or is not probable, it could not be said to be impossible. We are sorry that Mr. Holmes should refer to the work of Mr. Clarence King as if it affected the question. He, following Kelvin, assumed that there could be no greater conductivity inside the earth than in the crust. But all earth-cooling arguments have been set aside by Mr. Strutt's measurement of radium in rocks, and they are now of historical interest only.

Three of the old arguments still hold the field—one from the sun's energy, a second from the amount of salt in the oceans, and the third from observations of rates of erosion and deposit of sediment. To these a fourth is now being added which is likely to have great weight in settling the matter—the increase in the proportion of lead to uranium in rocks as time goes on. Mr. Holmes has himself devoted much time to the laboratory study of radio-active minerals, and of the creation of lead and helium from uranium; in the present state of our knowledge we can suggest no modification of his figures. He ought, however, we think, to be prepared to accept a less age for the earliest sedimentary rocks than 1300 million years.

Consideration of the amount of sodium in the ocean gives less than a quarter of this age, as does also the consideration of the accumulation of carbonate of lime. These two methods of study are on a much less certain basis than the calculation from the rate of accumulation of sediment, which, however, gives about the same age. With this last method Mr. Holmes, as a geologist, is very familiar. The suggestion that erosion used to take place more slowly because all continents were smaller and lower in level than now, would lead to a better agreement between the two methods which he favours. If the average slopes were 60 per cent. of what they are now, we are led to multiply the age by four. On the whole, we feel with Mr. Holmes that the question is in a fair way towards settlement, but, unlike him, we still see a difficulty due to the age of the sun. A person who has not made the calculation will scarcely believe in the liberality with which Kelvin treated his opponents in regard to the argument based on the sun's heat. Assuming that the whole mass of the sun was once scattered through space, and by mere gravitation the stuff came together as we now have it, and considering that it is denser in its central part, the total amount of energy given out as heat cannot be much greater than 25 million

times the amount of heat now given out in one year. Kelvin, after making this kind of calculation, said: "It seems, therefore, on the whole, most probable that the sun has not illuminated the earth for 100 million years, and almost certain that he has not done so for 500 million years."

The possibility that the existence of radium in the sun might increase the calculated age has been carefully considered, and it is found that it will not do so; it has no practical effect on the result if the proportion of radium to other substances is taken to be the same as it is on the earth.

It may have been the possibility of a much less radiation from the sun in the past that caused Kelvin to be so generous. But, making every allowance of this kind, it is difficult to imagine a greater age than 100 million years; indeed, it is difficult to imagine so great an age. It seems absolutely necessary to find more energy than mere gravitational energy, and we are very loth to assume that the matter which now forms the sun had once much greater atomic energy than it possesses now. It is curious that the mathematics of a spherical mass of gas, published in *NATURE*, July 13, 1899, pp. 250 and 252, should lead to a speculation of this very kind; that is, that the mass of gas could not exist unless there was originally some more atomic energy than we find it to possess in the laboratory. Lord Kelvin thought that this conclusion merely meant that such a body would collapse until its stuff ceased to behave as a perfect gas. In these days when the facts of radio-activity are unsettling our beliefs, and it is necessary to get the sun's heat argument into agreement with the others, there is a temptation to let our thoughts linger on the other speculation, although, indeed, it must be quite absurd. And yet we know that the second law of thermodynamics is being evaded somewhere in the universe.

Our thanks are due to Mr. Holmes for this very welcome and interesting little book. J. P.

POPULAR BOTANY AND GARDENING.

- (1) *Trees and How They Grow*. By G. Clarke Nuttall. With 15 Autochromes by H. Essenhig Corke. Pp. xi+184+plates. (London: Cassell and Co., Ltd., 1913.) Price 6s. net.
- (2) *Wild Flowers as They Grow*. Photographed in Colour Direct from Nature by H. Essenhig Corke. With Descriptive Text by G. Clarke Nuttall. Fifth Series. Pp. viii+200. (London: Cassell and Co., Ltd., 1913.) Price 5s. net.
- (3) *Garden Flowers as They Grow*. Photographed in Colour Direct from Nature by H. Essenhig Corke. With Descriptive Text by H. H.

Thomas. Pp. iii+197. (London: Cassell and Co., Ltd., 1913.) Price 5s. net.

- (4) *Garden Work: A Practical Manual of School Gardening*. By William Good. Pp. xvi+399+plates. (London: Blackie and Son, Ltd., 1913.) Price 3s. 6d. net.
- (5) *Dahlias*. By George Gordon. Pp. xi+115+8 coloured plates. (London and Edinburgh: T. C. and E. C. Jack.) Price 1s. 6d. net. (Present-Day Gardening.)

IT is somewhat difficult to know just what to say about the majority of the numerous popular works on botany and gardening that are turned out in such rapid succession in these days—in some cases the writers of such books rival even the most popular of popular novelists in their industry, turning out half-a-dozen or more sizeable books a year. If one is to judge them critically, one is bound to say that these books are, on the whole, rather poor; if inclined to cynicism, one would certainly say that most of them are totally unnecessary; but, after all, one cannot but rejoice at the increasing interest in plant-life and gardening of which this flood of good, bad, and indifferent books may be regarded as the outcome and reflection. One may at least admit that compilers of books of this kind are making fairly good use of improved methods of colour and other illustration processes; that the letterpress, though too often hasty and slipshod, is freer from actual inaccuracies than one might have expected; and that these books are likely to arouse the reader's interest. So much to the good; only, since the writing of such books appears to be fatally easy, let us hope that some few readers may resist the temptation to write books themselves.

(1) This is a readable and interesting account of a number of common trees, with fifteen coloured plates by Mr. Corke, in addition to which the author contributes a large number of remarkably good photographs, including stages in the germination of the seeds and the unfolding of the buds in the majority of the trees dealt with. So much has been done in the letterpress to make the story of these trees attractive that it seems a pity the author did not give, either as introduction or appendix, a general account of the growth of trees and the many interesting biological features (leaf-mosaics, for instance) which they present, and perhaps some account of the ecology of woodlands as developed in Britain—to mention only one or two of the aspects of tree-life not touched upon.

(2) Messrs. Nuttall and Corke are steadily working their way through the British flora; in this volume the former describes, and the latter depicts, a fifth batch of twenty-five native wild flowers. The coloured plates are unusually good, even for