the author points out that there is a great deal of work still to be done, especially among the reptiles and the marine fishes. There are blanks, too, in the general record that it has been impossible to fill owing to the lack of resident observers. The records from Snowdonia and the central moorlands, for example, are derived almost entirely from the observations of naturalists who have visited those districts from time to time, and there are few or no winter records from these districts. The author proposes to publish additional records in the form of a supplement. We might suggest instead of this a new edition in two or more volumes, with more space and greater detail and the *authority* for the statements, which should always be given in a compilation.

Mr. Forrest has carried out a difficult and laborious task so well that we feel he might well undertake a work which would be monumental as a history of the vertebrate fauna of the most interesting (from that point of view) part of these islands. It was not to be expected that many of the rare stray avian visitors which straggle to our shores would penetrate so far as Wales. Nor are its shores patrolled day after day, in season and out, by men with guns on the look-out for a rarity, as are parts of our east and south coast. Two hundred and seventy-two species of birds are enumerated. But it is in its breeding species that the richness of the North Wales avifauna consists. The author states that 143 species have been known to breed in the district. They do not all do so now; but it has a list of 126 annual breeders, although its total area is not much more than half that of Yorkshire, which, despite great diversity of physical features, can only claim three less.

Treating of the Welsh names, which are dealt with very fully, the author states that his aim has been to include only those which are actually used by the people of the district; "'book' names are excluded." We cannot, however, regard some of the names given as other than book names. The honey buzzard, for instance, seems far too rare to have a genuine Welsh name: the same may perhaps be urged in the case of the black-tailed godwit, and there seems no reason why it should be called "black plover." Again, if the Welsh locally distinguished the Arctic from the common tern at all, there seems no reason why they should have pitched upon a word meaning Arctic or northern unless they had been influenced by books. Nor can we agree with the author (while giving full weight to his authorities) in rendering barcud as kite. Bergut or bearcoot is the name for an eagle among the Kirgiz Tartars, and the buzzard is really an eagle, while the kite is not. Moreover, we have, according to Eugene Rolland, barged and barguet for the buzzard in Breton and Breton Armoricaine, but no name like it for the kite in those branches of the Celtic language. The bird of which Giraldus Cambrensis and his companions heard the sweet notes between Carnarvon and Bangor was not in all probability a golden oriole. Giraldus says "of a bird, which some said was a woodpecker, and others, more correctly, an aureolus." He was not the last to mistake a green woodpecker for an oriole. The misprints are so few that there is no sheet of *errata et corrigenda*. Had there been, perhaps the unfortunate blunder about the buzzard would not have gone uncorrected. The statements that it rears two broods in the year, and will lay again if robbed of its first clutch of eggs, are, of course, the opposite of the facts. A map of so diversified a district is doubtless a serious and troublesome matter, but the one given in this volume is on so small a scale, and the names are printed in so small a type, that it is almost useless to eyes that read ordinary small print without difficulty.

THE WATER PROBLEM IN AGRICULTURE.[1]

THE increasing use of artificial manures and of improved tillage implements has rendered possible an increase in the amount of produce obtained from a given area of land, and attention has during the past few years been directed to another factor, the water supply, which at present limits crop production in a number of cases. The amount of water actually transpired through the crop depends on too many circumstances to be stated with precision, but it may be roughly estimated at 300 lb. or more for every pound of dry matter produced, so that if two tons of dry matter is produced per acre, at least 600 tons of water, equal to 6 inches of rain, will be used in transpiration, quite apart from what is lost by evaporation, percolation, &c. A crop of this size is by no means excessive; indeed, in some types of intense cultivation three times as much produce would be aimed at. Even in England the problem is often serious; it is far more so in countries where the rainfall is deficient during the whole or part of the growing season.

In order that a large proportion of the rain-water should remain near the surface of the soil within reach of the plant roots, it is obviously necessary to reduce loss by percolation and evaporation. The practical man in dry districts has succeeded in evolving methods which go some way to doing this. The methods and implements used by the Madras cultivators are described by Mr. H. C. Sampson in the Agricultural Journal of India. In some districts recourse is had to deep ploughing with a heavy plough, followed by a lighter plough, and then when the crop is up the land is hoed. In other districts the plough is the only tillage implement. But in practically all cases the plan is to stir the surface of the soil after a rain, and to keep the top soil loose during the growth of the crop. The methods adopted in the arid regions of the United States are described in the Transvaal Agricultural Journal (April, 1908) by Mr. Macdonald, and in the Journal of Agriculture of South Australia (March, 1908) by Mr. Strawbridge, who was sent with the express purpose of reporting thereon. They include deep ploughing, followed by harrowing, so as to get the soil into a fine state; the harrowing is, as a rule, repeated after each rain. When the crop is up the surface soil is frequently stirred. It seems definitely established that when the top layer of soil is in a loose condition it retains water better than if it is compact, but the loose condition must be maintained by constant stirring.

The gain in water content may probably be ascribed to decreased evaporation, for water evaporates less freely from loose than from compact soil. The explanation usually given is that the movement of water in soils (apart from the gravitational flow) is a surface-tension effect akin to the rise of water in capillary tubes, and is therefore facilitated when the spaces between the particles are diminished, and impeded when the spaces are kept large. Frequent stirring of the soil, which prevents it becoming compact, reduces the capillary movement of water to the surface, and consequently lessens the evaporation. This hypothesis explains a good deal, but unfortunately it has not been very fully developed; there is little doubt that if some physicist would take the matter up he could obtain results of great importance to agricultural science and practice.

[1] (1) The Agricultural Journal of India, vol. iii., part 1. (1908.)
(2) Memoirs of the Department of Agriculture in India, vol. i., No. 6, "The Loss of Water from Soil during Dry Weather," by J. W. Leather.
(3) The Transvaal Agricultural Journal, April, 1908.
(4) The Journal of the Department of Agriculture of South Australia, March and May, 1908.

A number of measurements showing the amount of evaporation from the soil, or the amount of water left behind in different circumstances, have already been made, and Dr. Leather adds a further interesting series. Water determinations were made in samples taken to a depth of 7 feet from a plot of soil at Pusa during the dry season. The results are as follows:—

Lbs. of water per Cubic Foot of Soil.

Depth	Sept. 19	Oct. 20	Nov. 30	Jan. 8	Feb. 15	March 27	May 6	June 5	June 15
0–1 foot	18·97	15·78	14·21	12·15	12·10	14·18	10·83	13·87	10·41
1–2 feet	20·96	19·27	17·95	18·17	18·79	19·62	16·39	15·40	15·38
2–3 ,,	24·75	18·84	10·68	11·95	12·00	10·51	10·35	9·67	9·03
3–4 ,,	25·95	17·51	18·35	13·54	11·27	9·27	6·55	6·63	6·36
4–5 ,,	25·65	23·69	21·91	21·07	20·18	19·56	18·10	16·20	16·64
5–6 ,,	26·42	25·60	24·50	24·00	23·54	22·45	20·82	19·45	18·99
6–7 ,,	26·42	26·00	25·00	25·00	25·30	25·26	24·5	23·10	24·00
Total	169·12	146·69	133·00	125·88	123·18	120·85	107·57	104·32	100·81
Rainfall in inches since last determination.....		0·82	nil	nil	1·14	1·85	0·89	2·08	

The showers only seem to have affected the surface layer. It will be observed that there is a considerable break below the fourth foot; this is due to a change in the soil, which unfortunately was not uniform throughout the entire depth. Taken as a whole, the figures show that the rate of loss decreases as the depth increases, but the want of uniformity of the soil makes it impossible to get out any expression showing the rate of loss. Dr. Leather argues that water moves upwards from a limited depth only, and considers that none has come from the seventh foot, but he offers no evidence on this point. The results are equally well explained on the supposition that the upward movement takes place at all depths, since the amount of water present in a particular layer depends on the respective rates at which water is gained from below and lost to the upper layers. If these measurements could be repeated on a fairly uniform piece of soil the results would furnish very valuable data for a study of the movements of water in soil.

E. J. RUSSELL.

LORD KELVIN.[1]

THESE notices of the life and work of Sir William Thomson, Lord Kelvin, are all true, and they are all quite different from one another. Prof. Larmor dwells upon the important mathematical theorems with which Lord Kelvin enriched natural philosophy, and he is almost indignant that mere inventions for the service of man should have occupied the best time in the life of the greatest of naturalists. It is a masterly essay, and will be of the greatest value to some future biographer or historian of science. As Stokes and Fitzgerald are dead, there is nobody now living who could have done the work so well as Larmor. Nobody ever could have done it better.

Prof. Gray's book gives a very straightforward and interesting account of Kelvin's work; he does not dwell so much upon that part which had the higher mathematical aspects; he writes as an old pupil, as one who was Kelvin's secretary, and as the present occupant of his professorial chair. Probably this book will give most satisfaction to the general reader, but the reader must be one who already knows something of what Kelvin did in electricity and magnetism, and elasticity and light and thermodynamics. It gives an interesting account of college life and Kelvin's relations with his assistants and students.

Prof. Ayrton's article, in spite of an obvious restraint, is intense with affection and enthusiasm for the memory of his master. He dwells on none of the great theorems which are of fundamental importance in all applications of mathematics, which indeed created many parts of natural philosophy; he only casually mentions the discoveries and inventions of his chief, for he assumes that they are all well known; he merely recalls his own experiences of forty years ago, and his story is alive with interest, with reminiscences of a thousand acts of kindness and words of sympathy from a man who never seemed to remember his greatness when he was talking to a student, for indeed he was always a fellow-student.

Prof. Thompson's lecture, delivered to the members of the Institution of Electrical Engineers, was perfect for its purpose. He touched on most of Kelvin's work, but in particular he recalled to the leaders in electrical engineering the history of their profession. That history may be said to begin with Faraday and with Thomson's papers when he was not yet twenty years of age, papers in which he recognised the inner meaning of Faraday's work. Until he died he never ceased to make electrical history, but the most wonderful time was the time of his youth, when he was developing the theories which were to educate Maxwell. The lecturer recalled the practical electrical engineering work of the man who, when he died, was president of the institution for the third time. This is not the place to speak of the many other tributes which have lately been written to Thomson's genius and ability. The real life of Lord Kelvin has yet to be written, and the biographer will take account of the notices now before us, as well as many others, and he will especially use that masterly essay by Fitzgerald which was prepared for the Kelvin jubilee.

To us, Prof. Larmor's notice is the most wonderful of these productions. Was there ever so long an obituary notice of a Fellow in the Proceedings of the Royal Society? And this notice is filled not only with an enumeration of the contributions of Kelvin to applied mathematics, with sufficient detail to keep the reader intensely interested, but also with ungrudging praise. To anyone who knows the severity of Prof. Larmor's criticism, the almost impossibly high standards which the modern Cato is in the habit of applying to all scientific work involving mathematics, this obituary notice will count as the greatest praise ever given to any scientific man! It is from another point of view that we would ask students to read particularly what Prof. Larmor says about the memoirs of Clausius of 1850 and Thomson's papers on thermodynamics until 1851 and on to 1855. It is just possible that the men who think they know the thermodynamic events of that most interesting time may find that Thomson's habits of self-effacement have made it necessary now to re-write the history. We know that it was all one to him; he never made a claim for priority except on behalf of somebody else than himself. We are sorry to say that we can make no more comments on these essays; when we try to write, memory throngs too much with reminiscences and power of expression fails us. He is still too close to us; affection and emotion are overpowering. We have

[1] Proceedings of the Royal Society; Obituary Notice of William Thomson, Baron Kelvin. By J. L. Pp. i+lxxvi.

"Lord Kelvin, an Account of his Scientific Life and Work." By Dr. Andrew Gray, F.R.S. (English Men of Science Series.) Pp. ix+318. (London: J. M. Dent and Co., 1908.) Price 2*s.* 6*d.* net.

"Kelvin in the Sixties." By Prof. W. E. Ayrton, F.R.S. An article in the *Times* Engineering Supplement, January 8, 1908.

"The Kelvin Lecture." By Prof. Silvanus P. Thompson, F.R.S. Proceedings of the Institution of Electrical Engineers.