of Loch nan Gabhar, a little weedy hollow only 5 feet deep, which is evidently being rapidly silted up. An interesting account is also given of the Red Lochan at Tulloch, a small pond lying in an extensive morainic terrace near the north end of Loch Treig, called in Gaelic by a name signifying "brown eye." It is only about 30 yards in longest diameter and 5 feet deep in the centre, fed only by rains, and, though it has no outflow except by percolation through the gravel, its surface is maintained almost constantly at the same level. The water is always turbid, and varies in colour from dull green to brown or red. When examined in May, 1902, the water was brown, the collection with the coarse net was pale yellow, while that taken by the fine net was decidedly red; there were only two abundant organisms, the larva of an insect (Corethra) known as the "phantom larva," and a reddish-coloured rotifer, *Anuraea valga*, to which the colour of the water was evidently due, for none of the other organisms were abundant enough to be held responsible for the colour of the water. On placing the collections in formalin, a blood-red sediment was deposited, which was found to consist chiefly of *Anuraea valga* and myriads of its red eggs. Examined subsequently at different seasons, the changes of colour were doubtless correlated with the predominance of one or other organism. None of the other ponds in close proximity shared the turbidity and reddish-brown colour of the Red Lochan, the peculiarity being probably due to its being more closely shut in, the surrounding rim of gravel being 14 feet or more above the pond, and there is besides a fringe of birch trees. The water is stagnant, which favours the growth of certain organisms, particularly *Anuraea valga*. It is said that wildfowl never settle on the pond, and that the common frog cannot live in it. The following legend was related to Sir John Murray concerning this Red Lochan:—"Many centuries ago there lived in these parts a noted hunter named Donnuil. In return for some services rendered to the witch of Ben-a-Vreich, she offered to deprive the deer of the sense of sight or of smell, so far as he was personally concerned. He chose to have the deer deprived of the sense of smell, 'for,' said he, 'I can easily cheat their eye. The witch, however, told him that in the stomach of the last stag he would kill there would be found a ball of worsted thread. As time passed Donnuil became ill, and, while weak in bed, his daughter told him a fine stag was caught by the horns in some bushes near the house. He asked for his cross-bow, and, although in bed, he shot the stag through his bedroom window. Later on his daughter brought him a ball of worsted which had been found in the stomach of the stag. He knew his end was near; indeed, he died the same evening. On the following morning the Red Lochan had appeared at the place where the stag was killed."

The paper concludes with some interesting notes on the biology of the lochs by Mr. James Murray, who found that the plankton of Loch Lochy offered a remarkable contrast to that of Loch Ness, though the conditions seemed so similar, the quantity in Loch Lochy being many times greater and the species more numerous, but the special feature was the quantity and variety of the phytoplankton. In Lochan Lùnn dà-Bhrà the Diaptomus was so deep red that when the nets were drawn from the water they seemed to contain blood; the same peculiarity was observed in An Dubh Lochan, but in a lesser degree.

The paper is illustrated by coloured maps showing the bathymetry and orography, and there are several woodcuts in the text, some of which are reproduced in this notice.

THE STRUCTURE OF METALS.[1]

THE lecturer said that his purpose was to give some account of researches in which he had been engaged for a good many years, dealing with the manner in which metals were built up and the manner in which their structures allowed them to yield when they were compelled to change their shape by being overstrained. A piece of metal was not a homogeneous single thing; it was a collocation of grains or granules, which built it up just as granules of ice built up a glacier. The grains of metal were irregular in shape and unequal in size. Their existence was revealed by polishing and etching the surface of the metal and examining it under the microscope, when the grains could readily be distinguished by differences of texture, and the boundaries between them could be clearly traced. Investigation showed that each grain was, in fact, a separate crystal, and the irregular boundaries were due to casual inequalities in the rates at which the various crystals had grown during their formation, which might occur when the metal was solidifying from a fluid state, or when it passed in the solid state through certain temperatures at which re-crystallisation took place. Each grain might be regarded as composed of an immense number of molecular brickbats grouped in perfectly regular tactical formation, but the direction in which these brickbats were piled was different in different grains; hence on being etched the polished surface showed differences in texture and in behaviour as to reflecting light. Microscopic photographs illustrating these features in iron and other metals were exhibited.

When the metal was strained beyond the elastic limit, and thereby compelled to change its form, the change of form took place by slips occurring between the layers of molecular brickbats in the individual granules. The discovery of these slips had been made by the lecturer in conjunction with Mr. Walter Rosenhain, by noticing certain lines to appear on the polished surface of a piece when subjected to severe strain. These lines, which they called slip lines, looked like minute crevasses, but were really steps caused by the slipping of one layer on its neighbours, just as cards might slip in a pack. In any one crystal grain there were at least three sets of independent parallel planes in which such slips could take place, and these allowed the grain to undergo complete alteration of form as a result of the straining. Microscopic photographs were exhibited showing three systems of slip lines on the surface, corresponding to slips in three directions throughout the substance of the grain. The true nature of these slip lines was made apparent by means of obliquely incident light, which showed them as little steps in the surface. An interesting direct confirmation of this had been afforded by recent experiments of Mr. Rosenhain in which cross-sections of the stepped surface had been obtained.

Dr. Ewing next explained, by aid of models, a theory which he had recently advanced as to the structure of the crystal granule itself. This theory might be regarded as an extension of the views he put forward fifteen years ago to explain the phenomena of magnetic induction by the mutual actions of polarised magnetic molecules. Cohesion in the crystalline structure might similarly be regarded as due to the mutual forces between polarised molecules, the polar quality of which determined the regular tactical formation in which they grouped themselves to form the crystal. For this purpose he conceived of each molecule as possessing polarity along each of three rectangular axes; in other words, as having six poles exercising forces of attraction on the opposed poles of neighbouring molecules.

The lecturer proceeded, by aid of the model, to demonstrate the process of crystal-building with these polarised molecules for brickbats. He showed how, under certain conditions, a group of dissenting molecules might be formed within the crystal grain, possessing a certain degree of stability, though not in complete harmony with the molecules around them. Evidence for the existence of such groups was furnished by the microscope in the examination of iron and other metals. The process of straining was next considered, and it was shown that the conception of polarised molecules was in agreement with what was known of the actual behaviour of metals during, first, the elastic stage of straining, and, second, the stage where much greater yielding took place and permanent set was produced. The molecular theory explained how energy was dissipated in the process of straining, and also how elastic "fatigue" resulted. After any severe strain the piece was a long time in recovering its full amount of elastic quality, but the recovery could be accelerated by heating it. These phenomena were accounted for by

[1] Abstract of "Wilde" Lecture, delivered by Dr. J. A. Ewing, F.R.S., before the Manchester Literary and Philosophical Society on February 18.

the setting up of dissenting groups, as a result of straining, which resolved themselves after a time into the normal configuration. It further explained the fatigue of strength which was found to occur when a metal was subjected to repeated reversals of stress, a matter of great practical importance in the design of machines and engineering structures. The manner in which a piece broke, for example, after repeated bendings to and fro was discussed by aid of the molecular model. It was shown that the effects of slip are felt for some distance on either side of the plane of slip, a fatigued condition of the metal being established. This is especially the case when slip is many times repeated, backwards and forwards, and a condition is ultimately arrived at in which the cohesive bonds are broken and a crack results.

In conclusion, Dr. Ewing briefly referred to the relation between the molecular structure of the crystal grain, to which strength and elasticity were to be ascribed, and the finer structure which accounted in magnetic metals for the phenomena of magnetism. He had formerly shown that in the process of magnetisation in iron there was a turning round of a molecular axis possessing magnetic polarity. It was when the magnetically polar axes of all the molecules were turned round so as to face one way that the iron became "saturated." The polarity he was now concerned with was different in kind. It was not magnetic, and it existed in three directions, whereas the magnetic polarity with which the process of magnetisation was concerned was uniaxial. Moreover, the three-directional polarity concerned in crystal building did not suffer rotation when a magnetising force was applied. We had accordingly to think of the molecule as possessing polar axes which were non-magnetic and remained fixed under the control of forces of the same kind exerted by the poles of neighbouring molecules, and at the same time as possessing an inner structure characterised by uniaxial magnetic polarity, which was capable of rotation under the influence of an applied magnetising force while the non-magnetic polar axes remained fixed.

FORTHCOMING BOOKS OF SCIENCE.

MESSRS. BAILLIERE, TINDALL AND COX direct attention to:—"Practical Agricultural Chemistry," by F. Robertson; "Meat Inspection," by Dr. W. Robertson; "Blood Stains (a Medico-legal Book)," by Major Sutherland; "Trypanosomata and the Trypanosomiases," by A. Laveran and F. Mesnil, translated and edited by Dr. D. Nabarro; and a new edition of "The Röntgen Rays in Medical Work," by Dr. D. Walsh, with section on apparatus and methods by Dr. L. Jones.

Messrs. A. and C. Black announce:—"Notes upon the Island of Dominica (British West Indies)," by S. Grieve, illustrated; "Rudolf Eucken's Philosophy of Life," by W. R. B. Gibson; "The Sense of Touch in Mammals and Birds, with Special Reference to the Papillary Ridges," by Dr. W. Kidd; "How to Fish," by W. E. Hodgson; "Man, his Manners and Customs," by L. W. Lyde; and "Descriptive Geography of the British Isles," by F. D. Herbertson.

Messrs. William Blackwood and Sons promise:—"In the Footsteps of Marco Polo, being the Account of a Journey Overland from Simla to Pekin," by Major C. D. Bruce; "The Sovereignty of the Sea, an Historical Account of the Claims to the Exclusive Dominion of the British Seas and of the Evolution of the Territorial Waters, with Special Reference to the Rights of Fishing," by Dr. T. W. Fulton; "In Malay Forests," by G. Maxwell; and "Forest Entomology," by A. T. Gillanders.

In Messrs. Cassell and Co.'s list we find:—"Greenhouses and Conservatories, Constructing and Heating"; "Steel, its Varieties, Properties, and Manufacture"; "Domestic Hot Water Supply"; "Iron, its Sources, Properties, and Manufacture"; "Photographic Studios and Dark Rooms"; "Window Blinds"; "Tinplate Work"; "Rustic Carpentry"; "Pumps and Rams, their Action and Construction"; "Domestic Jobbing"; and "Zinc Working."

Messrs. Chatto and Windus give notice of:—"A History of Sumer and Akkad, being an Account of the Primitive Inhabitants of Babylonia, with Maps and Illustrations after all the Principal Monuments of the Period in the British Museum and Elsewhere, and a Special Binding Design after a Monument of the Period," by L. W. King; and "The Paradise or Garden of the Holy Fathers, being Histories of the Anchorites, Recluses, Cœnobites, Monks, and Ascetic Fathers of the Deserts of Egypt between A.D. CCL and A.D. CCCC circiter, compiled by Athanasius, Archbishop of Alexandria, Palladius, Bishop of Helenopolis, Saint Jerome, and others, now translated out of the Syriac, with Notes and Introduction," by Dr. E. A. W. Budge.

Messrs. Archibald Constable and Co., Ltd., announce:—"European Animals, their Geological History and Geographical Distribution," by Dr. R. S. Scharff; "Natives of Northern India," by W. Crooke; "Universal Dictionary of Mechanical Drawing," by G. H. Follows; "Railroad Curve Tables for the Field Engineer," by R. S. Henderson; "Cranes," by A. Bottcher, translated from the German, enlarged, and edited with a complete description of English and American practice by A. Tolhausen; "Searchlights," by F. Nerz, translated from the German by C. Rodgers; "Agglutinants and Adhesives," by H. C. Standage; "Irrigation, its Principles and Practice as a Branch of Engineering," by Sir H. Brown; "Design of Irrigation Works," by W. Bligh; "Experimental and Theoretical Applications of Thermodynamics to Chemistry," by Prof. W. Nernst; "The Elastic Arch, with Reference to the Reinforced Concrete Arch," by B. R. Leffler; "Machine Design," by C. H. Benjamin; "A Text-book of Hydraulics, including an Outline of the Theory of Turbines," by L. M. Hoskins; "Fuel, Water, and Gas Analysis," by J. B. Kershaw; "Gas, Oil, and Solid Fuel," by Prof. V. B. Lewes; "Gold and Precious Metals," by Dr. T. K. Rose; "Electrometallurgy," by J. B. C. Kershaw; "Electrical Distribution of Power," by J. H. Davis; "Gas Light and Heating," by W. H. Y. Webber; "Coal," by J. Tonge; "Iron and Steel," by J. H. Stansbie; "The Manufacture of Paper," by R. W. Sindall; "India-rubber and Guttapercha," by H. L. Terry; "Wood Pulp and its Applications," by C. F. Cross, E. J. Bevan, and R. W. Sindall; "Steam Engines," by J. T. Rossiter; "Glass," by W. Rosenhain; "Electric Lamps," by M. Solomon; "Steam Locomotives," by V. Pendred; "Patents, Trade Marks, and Designs," by K. R. Swan; and "Photography," by A. Watkins.

Messrs. J. M. Dent and Co.'s list includes:—"Nature-study," by Prof. J. R. A. Davis; "Trigonometry," by C. Hawkins; "Fly-fishing," by Sir E. Grey, illustrated; "Our Gardens," by the late Dean Hole and G. S. Elgood; and "Farming," by W. M. Tod, illustrated.

Messrs. Duckworth and Co. announce:—"The Interpretation of Nature in Earlier Greek Art," by E. Löwy, translated and illustrated; and a new edition of "A Text-book of Plant Diseases," by G. Massee.

In Messrs. Everett and Co.'s list appears:—"Charts of the Diseases of the Horse, with Explanatory Notes and Prescriptions," by C. Gresswell.

Mr. Gustav Fischer (Jena) will publish:—"Die Bakteriologie des Auges," by Prof. Axenfeld, illustrated; "Das Dysenterietoxin," by Dr. R. Doerr, illustrated; "Geologische und Palaeontologische Abhandlungen," edited by E. Koken, Band viii., Heft iii., illustrated; "Die Grosshirnrinde des Menschen in ihren Massen und in ihrem Fasergehalt," by Dr. T. Kaes, 1 Teil, text, 2 Teil, illustrations; "Praktikum der Bakteriologie und Protozoologie," by Drs. K. Kisskalt and M. Hartmann; "Jahresbericht der Literatur über physische Anthropologie im Jahre 1905," by Dr. E. Fischer, edited by Dr. G. Schwalbe; "Normentafeln zur Entwickelungsgeschichte der Wirbeltiere," edited by Prof. F. Keibel, Siebentes Heft, "Normentafel zur Entwickelungsgeschichte des Koboldmaki (Tarsius Spectrum) und des Plumplori (Nycticebus Tardigradus)," by Prof. A. A. W. Hubrecht and F. Keibel, illustrated; "Progressus rei Botanicae, Fortschritte der Botanik, Progrès de la Botanique, Progress of Botany," edited for the International Association of Botanists by Dr. J. P. Lotsy, Erster Band, Zweites Heft; "Verhandlungen der deutschen pathologischen Gesellschaft," Zehnte Tagung gehalten in Stuttgart vom September 17–21, 1906,