THURSDAY, AUGUST 7, 1873

GUSTAV ROSE

THE son-in-law of Gustav Rose, Professor G. vom Rath, has sent us the Nekrolog which affection and custom in the Fatherland unite in issuing in honour of those who are no more.

The first line of this tribute to the memory of the great mineralogist tells truly that Germany has lost one of her great ones in this learned and noble man: but it is for us to say that it is even a wider world than his fatherland that has lost in him one of its conspicuous citizens. For the two brothers Heinrich and Gustav Rose formed a double star in the constellation of illustrious men who have illuminated with a brilliancy all its own the first half of this great century; and, indeed, for now fifty years their twin lights have guided the course of their contemporary and of a younger generation of wayfarers on the track of Science.

Certainly the death of a man like Gustav Rose is calculated to call up some wonderment in our minds as we look back over the brief period that even his 76 years of life embrace, and think in what relation that little space of time stands to the long history of man in regard to the sciences that these two illustrious brothers cultivated so pertinaciously and so well. Berzelius spoke of looking back within his own memory to the dark age of phlogistic chemistry. Heinrich Rose first reduced to a scientific system the methods of inorganic chemical analysis, as J. von Liebig did afterwards for organic chemistry; it is but yesterday that the one, and but a few brief years since the other died. And now Gustav Rose, the first man in Germany who used the reflective goniometer, has followed them and Mitscherlich and Haussmann, and Haidinger. There still remain Breithaupt and Naumann, Wöhler, and a few other honoured men on whom the patriarch's mantle must successively devolve. Let us at least pay the tribute due to the memory of the last of these illustrious workers whose chair is empty by endeavouring to take a survey of the work he did, and by recognising the debt we owe him for the results that have accrued to our knowledge from the toil "Ohne Hast und ohne Rast," of fifty out of his seventy-six years, and no less for the example he has set of method and of energy in achieving them.

The sciences that Gustav Rose devoted himself to, crystallography and mineralogy, have been for many years so little or so superficially studied in England, that probably few of our countrymen are familiar with the continuous succession and admirable quality of the work turned out from the study of one of the soundest-minded, and, let us add, one of the soundest-hearted men that Germany ranked among her sons.

His country's troubles, though they ended as far as the great war was concerned in 1815, had called into the ranks even the youngest of the four brothers Rose. Their father, a not undistinguished pharmaceutical chemist in Berlin, had died in 1807, leaving his children to the care of his widow, who appears to have borne out the tradition of able men owing much to remarkable characteristics in their mothers. Young Gustav was not old enough in the days of the terrible conflicts to have borne his musket. But he was seventeen, in time to make the long march from Berlin to Orleans; and after the peace in 1815 he set himself to obtain a livelihood in the occupation of mining. Overtaken by an attack of inflammation of the lungs, his thoughts became directed into a new direction. For the contagious passion for the pursuit of truth in its most tangible form by the path of natural science seized him by contact with his elder brother Heinrich; and Gustav followed his example in going to Stockholm for a similar object to that which has drawn so many Englishmen and English-speaking men since to Germany. Berzelius was then in Sweden what afterwards were Heinrich Rose, Wöhler, Liebig, in the Fatherland; the great master in the science as in the practice of chemistry. Gustav Rose was twenty-six when he ceased to be a student, and of the fifty years that have run out their sands since 1823, there is scarce one that has not recorded some work or memoir by the great crystallographer; and in some of those years he produced several.

And Gustav Rose was a crystallographer and mineralogist in the completest sense. The first man in Germany, as we have said, who adopted the use of Dr. Wollaston's reflective goniometer, he aided Mitscherlich in his discovery of Isomorphism; and this must have been one of his earliest labours.

His first paper was an exercise in Latin on the Crystallography of Sphene; and in 1830 he brought out his treatise on Crystallography, in which recognising the simplicity introduced by the use of geometrical axes as employed by Weiss, he adopted that method of expression for the relations of the faces of a crystal, a method which has in fact been only carried out to its last logical form and simplest expression by the admirable system of our countryman Prof. W. H. Miller.

It is not easy now to transport ourselves back to the time when scientific men of high eminence deliberately closed, or rather refused to open, their eyes to the chemical composition of a mineral as the most fundamental point in its definition and description, and to its chemical relations as affording the only philosophical basis on which to form a classification of minerals. But this difficulty of placing ourselves in the position taken up by Mohs and his school, very much arises from our not appreciating the situation of chemical and crystallographic research in their mutual valuation twenty years before the death of Mohs. We may for instance take two garnets, one consisting of aluminium and magnesium silicate, another of iron and calcium silicate. The two minerals contain notably differing proportions of the only ingredient they have in common, namely silica; and yet their crystalline forms are the same, and the mineralogist could not fail to recognise so close a parallelism and similarity between the two minerals as to compel him to unite them under one general "natural-history" division.

The chemistry of that day, however, was not yet ripe for acknowledging such a classification. But when, on the other hand, the mineralogist assembled under one group minerals that differed in the way that, for instance, Linavite and blue copper carbonate (chessylite) differ in their chemical composition, or such widely different minerals as diamond and topaz, on the ground that they were hard and lustrous, and had the character of precious stones; then the remonstrance of the chemist was founded in truth and reason.

It was the discovery of isomorphism that explained the anomalies and enigmas which thus in many cases seemed to justify the mineralogist in standing apart from the chemist, and preferring to discriminate, define, and classify minerals by appealing to superficial characteristics, rather than to the most fundamental feature of such bodies, their chemical molecular structure.

It came now to be seen that in the language of the earlier chemistry alumina and sesquioxide of iron, on the one hand, were able to represent the same ingredient in the garnet, while on the other hand, also, the lime, the magnesia, and the protoxide of iron might equally represent one another in the silicate in question, provided that the chemical structure of the compound was not altered, that is to say, could be expressed by a general formula that was equally applicable to each variety of the mineral; the identity of the crystallographic features of all those garnets being the evidence that the unity of the mineral type had not been overstepped by the interchanges of the elements. The application of this great discovery left chemistry master of the situation, and relegated into the regions of darkness the systems of classification that were not built on chemical and crystallographic principles. It was Mitscherlich, aided as vom Rath tells us by the young Gustav Rose, who made this grand announcement to the world in the year 1823. The light which was thus shed on the dark and till then uncertain problems that might connect the crystalline form with chemical structure, gave, as it were, new life to the vigorous school that owed its chemical precision to the great Professor at Stockholm, the school to which the two Roses and Wöhler belonged. The purely chemical problems of mineralogy received their constant attention; and Gustave Rose, by publishing his crystallography, asserted the co-ordinate functions of the goniometer and the balance in the future discussions of all the larger questions of the mineralogist.

He, in fact, unconsciously perhaps, was now initiating the method to which, with a fine unity of purpose, he adhered through his life.

Thus, for instance, we find him in 1831-33 discussing the somewhat paradoxical resemblance in the crystallographic constants of the minerals augite and hornblende, as suggested by Uralite, a mineral uniting the outline form of the one with the internal structure of the other; in fact a pseudomorph of hornblende after the form of augite.

Then in 1836 came his masterly memoir on the forms of Aragonite, the distinction of which from calcite had been established by Haüy in the beginning of the century. Afterwards, among a mass of works, we find memoirs on the differences of crystallographic habit in Albite, and the nearly related variety of the same felspar pericline, a subject to which he returned in later times; on the dimorphism of iridium, of palladium, and again of zinc; several treating on the marvellous connection by which certain kinds of hemisymmetry in crystals are associated with the localisation on them of opposite electric conditions under changes of temperature (pyro-electricity), which he illustrated in the case of the tourmaline, and among his latest memoirs by a most masterly one on pyrites and cobalt-glance. Quartz he made an object of especial study, explaining the character of its twin forms; and no memoirs in the whole range of crystallographic research, not excepting the splendid work in which Des-Cloiseaux capped, as it were, the labour of Rose, can surpass, in originality and precision, that by this great master on the crystallography of quartz.

Meteorites and the minerals which they contain have challenged the attention and been a sort of exercising-ground for several of the great mineralogists of Germany. Berzelius, indeed, set the example, but it was Rose who, in 1825, measured the first olivine crystal from the Pallas meteorite, and he, Haidinger, Breithaupt, and Wöhler, have all contributed invaluable material for the scientific history of these very difficult and interesting objects of investigation. And to G. Rose we owe the most penetrating insight into their structure, and the best attempt thus far made at classifying them. So, too, the sum of his thought and labour on the classification of minerals was given in his "crystallo-chemische mineral-system," published twenty-one years ago, in which he, so to say, demolished, by leaving no further excuse for perpetuating, the system which was identified with the name of Mohs, or indeed any other system to which chemical law was not the master key.

But one great work that Gustave Rose might have done, and better done perhaps than any living man, was the writing a treatise on Petrography. Mineralogy, the science of minerals, stands to petrography, the science that describes rocks and investigates their history, somewhat as biography stands to history itself, or as histology to physiology. The reason why a geologist is hardly ever a master of petrography is that he is so seldom, in England, at least, a mineralogist. And it is precisely because Gustav Rose was, and Naumann is, a complete mineralogist and crystallographer, and that both have profoundly studied the characters of the minerals in association which form rocks, that either of these two veteran professors might have written—alas! a month ago we might have said may yet write—such a treatise on rocks as probably no other living man could write. Gustav Rose began an admirable training in the field for such a study when, in the company of A. von Humboldt and G. Ehrenberg, he traversed European Russia and found himself among the rocks of the Ourals in 1829. The results of this historical progress were given to the world in two volumes in 1837-1842. The memoirs which he published subsequently to this time and to his becoming full professor (he had been extraordinary professor since 1826) of mineralogy at Berlin, treat very frequently of rock minerals; and indeed deal, in the majority of instances, with those more ordinary minerals which perform an important function as constituents of rocks; quartz, felspar, mica, hornblende, augite, seem never to weary him in observation or exhaust his powers of telling some new fact regarding them. One of his latest papers on the very common mineral, mica, is one of the most admirable of his researches. It was published, like most of his memoirs, in Poggendorff's *Annalen*, and treated on the interpenetration by one another, of various kinds of mica, and of these, with hematite and pennine.

It would be unnecessary, for the purpose of this slight sketch of Gustav Rose's labours, to go further into details regarding his works. He is gone; but his work lives after him.

The two Roses were men of a distinguished presence. Heinrich was the taller, but each was a man of spare and somewhat stately figure, with an eye of peculiar force and truthfulness of glance; an eye that spoke out the character of the man, that beamed with kindliness and was ever staunch to truth. N. S. M.

CHALLIS'S "MATHEMATICAL PRINCIPLES OF PHYSICS"

An Essay on the Mathematical Principles of Physics, &c. By the Rev. James Challis, M.A., F.R.S., F.R.A.S., Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge, and Fellow of Trinity College. (Cambridge: Deighton, Bell, and Co., 1873.)

THIS essay is a sort of abstract or general account of the mathematical and physical researches on which the author has been so long engaged, portions of which have appeared from time to time in the *Philosophical Magazine*, and also in his larger work on the "Principles of Mathematics and Physics." It is always desirable that mathematical results should be expressed in intelligible language, as well as in the symbolic form in which they were at first obtained, and we have to thank Professor Challis for this essay, which though, or rather because, it hardly contains a single equation, sets forth his system more clearly than has been done in some of his previous mathematical papers.

The aim of this essay, and of the author's long-continued labours, is to advance the theoretical study of Physics. He regards the material universe as "a vast and wonderful *mechanism*, of which not the least wonderful quality is, its being so constructed that we can understand it." The Book of Nature, in fact, contains elementary chapters, and, to those who know where to look for them, the mastery of one chapter is a preparation for the study of the next. The discovery of the calculation necessary to determine the acceleration of a particle whose position is given in terms of the time led to the Newtonian epoch of Natural Philosophy. The study from the cultivation of which our author looks for the "inauguration of a new scientific epoch," is that of the motion of fluids, commonly called Hydrodynamics. The scientific method which he recommends is that described by Newton as the "foundation of all philosophy," namely, that the properties which we attribute to the least parts of matter must be consistent with those of which experiments on sensible bodies have made us cognizant.

The world, according to Professor Challis, is made up of atoms and æther. The atoms are spheres, unalterable in magnitude, and endowed with inertia, but with no other property whatever. The æther is a perfect fluid, endowed with inertia, and exerting a pressure proportional to its density. It is truly continuous (and therefore does not consist of atoms), and it fills up all the interstices of the atoms.]

Here, then, we have set before us with perfect clearness the two constituents of the universe: the atoms, which we can picture in our minds as so many marbles; and the æther, which behaves exactly as air would do if Boyle's law were strictly accurate, if its temperature were invariable, if it were destitute of viscosity, and if gravity did not act on it.

We have no difficulty, therefore, in forming an adequate conception of the properties of the elements from which we have to construct a world. The hypothesis is at least an honest one. It attributes to the elements of things no properties except those which we can clearly define. It stands, therefore, on a different scientific level from those waxen hypotheses in which the atoms are endowed with a new system of attractive or repulsive forces whenever a new phenomenon has to be explained.

But the task still before us is a herculean one. It is no less than to explain all actions between bodies or parts of bodies, whether in apparent contact or at stellar distances, by the motions of this all-embracing æther, and the pressure thence resulting.

One kind of motion of the æther is evidently a wave-motion, like that of sound-waves in air. How will such waves affect an atom? Will they propel it forward like the driftwood which is flung upon the shore, or will they draw it back like the shingle which is carried out by the returning wave? Or will they make it oscillate about a fixed position without any advance or recession on the whole?

We have no intention of going through the calculations necessary to solve this problem. They are not contained in this essay, and Professor Challis admits that he has been unable to determine the absolute amount of the constant term which indicates the permanent effect of the waves on an atom. This is unfortunate, as it gives us no immediate prospect of making those numerical comparisons with observed facts which are necessary for the verification of the theory. Let us, however, suppose this purely mathematical difficulty surmounted, and let us admit with Professor Challis that if the wave-length of the undulations is very small compared with the diameter of the atom, the atom will be urged in the direction of wave-propagation, or in other words *repelled* from the origin of the waves. If on the other hand the wave-length is very great compared with the diameter of the atom, the atom will be urged in the direction opposite to that in which the waves travel, that is, it will be *attracted* towards the source of the waves.

The amount of this attraction or repulsion will depend on the mean of the square of the velocity of the periodic motion of the particles of the æther, and since the amplitude of a diverging wave is inversely as the distance from the centre of divergence, the force will be inversely as the square of this distance, according to Newton's law.

We must remember, however, that the problem is only imperfectly solved, as we do not know the absolute value of this force, and we have not yet arrived at an explanation of the fact that the attraction of gravitation is in exact proportion to the mass of the attracted body, whatever be its chemical nature. (See p. 36.)

Admitting these results, and supposing the great ocean of æther to be traversed by waves, these waves impinge on the atoms, and are reflected in the form of diverging waves. These, in their turn, beat other atoms, and cause attraction or repulsion, according as their wave-length is great or small. Thus the waves of shortest period perform the office of repelling atom from atom, and rendering their collision for ever impossible. Other waves, somewhat longer, bind the atoms together in molecular groups. Others contribute to the elasticity of bodies of sensible size, while the long waves are the cause of universal gravitation, holding the planets in their courses, and preserving the most ancient heavens in all their freshness and strength. Then besides the waves of æther, our author contemplates its streams, spiral and otherwise, by which he accounts for electric, magnetic, and galvanic phenomena.

Without pretending to have verified all or any of the calculations on which this theory is based, or to have compared the electric, magnetic, and galvanic phenomena, as described in the Essay, with those actually observed, we may venture to make a few remarks upon the theory of action at a distance here put forth.

The explanation of any action between distant bodies by means of a clearly conceivable process going on in the intervening medium is an achievement of the highest scientific value. Of all such actions, that of gravitation is the most universal and the most mysterious. Whatever theory of the constitution of bodies holds out a prospect of the ultimate explanation of the process by which gravitation is effected, men of science will be found ready to devote the whole remainder of their lives to the development of that theory.

The only theory hitherto put forth as a dynamical theory of gravitation is that of Lesage, who adopts the Lucretian theory of atoms and void.

Gravitation on this theory is accounted for by the impact of atoms of incalculable minuteness, which are flying through the heavens with inconceivable velocity and in every possible direction. These "ultramundane corpuscules" falling on a solitary heavenly body would strike it on every side with equal impetus, and would have no effect upon it in the way of resultant force. If, however, another heavenly body were in existence, each would screen the other from a portion of the corpuscular bombardment, and the two bodies would be attracted to each other. The merits and the defects of this theory have been recently pointed out by Sir W. Thomson. If the corpuscules are perfectly elastic one body cannot protect the other from the storm, for it will reflect exactly as many corpuscules as it intercepts. If they are inelastic, as Lesage supposes, what becomes of them after collision? Why are not bodies always growing by the perpetual accumulation of them? How do they get swept away? and what becomes of their energy? Why do they not volatilise the earth in a few minutes? I shall not enter on Sir W. Thomson's improvement of this theory, as it involves a different kind of hydro-dynamics from that cultivated in the Essay, but in whatever way we regard Lesage's theory, the cause of gravitation in the universe can be represented only as depending on an ever fresh supply of something *from without*.

Though Prof. Challis has not, as far as we can see, stated in what manner his æthereal waves are originally produced, it would seem that on his theory also the primary waves, by whose action the waves diverging from the atoms are generated, must themselves be propagated from somewhere *outside* the world of stars.

On either theory, therefore, the universe is not even temporarily automatic, but must be fed from moment to moment by an agency external to itself.

If the corpuscules of the one theory, or the æthereal waves of the other, were from any cause to be supplied at a different rate, the value of every force in the universe would suffer change.

On both theories, too, the preservation of the universe is effected only by the unceasing expenditure of enormous quantities of work, so that the conservation of energy in physical operations, which has been the subject of so many measurements, and the study of which has led to so many discoveries, is apparent only, and is merely a kind of "moveable equilibrium" between supply and destruction.

It may seem a sort of anticlimax to descend from these highest heavens of invention down to the "equations of condition" of fluid motion. But it would not be right to pass by the fact that the fluids treated of in this Essay are not in all respects similar to those met with elsewhere. In all their motions they obey a law, which our author was the first to lay down, in addition—or perhaps in some cases in opposition—to those prescribed for them by Lagrange, Poisson, &c.

It is true that a perfect fluid, originally at rest, and afterwards acted on only by such forces as occur in nature, will freely obey this law, and that not only in the form laid down by Prof. Challis, in which its rigour is partially relaxed by the introduction of an arbitrary factor, but in its original severe simplicity, as the condition of the existence of a velocity-potential.

But, on the one hand, problems in which the motion is assumed to violate this condition have been solved by Helmholtz and Sir W. Thomson, who tell us what the fluid will then do; and, on the other hand, Professor Challis's fluid is able, in virtue of the new equation, to transmit plane waves consisting of transverse displacements. As this is what takes place in the luminiferous æther, other physicists refuse to regard that æther as a fluid, because, according to their definition, the action between any contiguous portions of a fluid is entirely normal to the surface which separates them.

It is not necessary, however, for us to say any more on this subject, as the Essay before us does not contain, in an explicit form, the equation referred to, but is devoted rather to the exposition of those wider theories of the constitution of matter and the phenomena of nature, some of which we have endeavoured to describe.

HENSLEY'S "SCHOLAR'S ARITHMETIC"

The Scholar's Arithmetic. By Lewis Hensley, M.A. (Clarendon Press Series, 1873.)

THERE is scarcely any subject more carelessly taught than arithmetic; and, if one would wish to ascertain the reason of this, he has merely to glance at the text-books which have been hitherto most commonly employed. Lately, however, several books of some worth have been presented to the public, and for these we are indebted in a great measure to the late Prof. De Morgan, whose "Elements of Arithmetic," published so far back as 1830, is still regarded as the very best handbook for advanced students. It has, nevertheless, some peculiarities—we cannot call them defects—which have prevented schools from adopting it up to the present time as a text-book; it presupposes too much special talent on the part of the teacher, and contains but few of the modern methods of calculation.

Two main points should ever be kept in view in teaching a subject like arithmetic: first, its principles; secondly, the application of these principles to the affairs of life. In our opinion, the former is undoubtedly the more important if the subject be regarded as an instrument of education. For arithmetical principles are, if properly explained, so very readily comprehended, that a beginner is not likely to find a more delightful path along which he may proceed to the extensive domains of mathematics; but, being generally regarded as a mere catalogue of empirical rules and as a means for exercising the memory, arithmetic becomes, not educational, but instructive, an act of drudgery, and of no more real assistance as a branch of education than needlework or spelling. Explain the ordinary system of numeration to a pupil, let him thoroughly understand the meaning of digit-value and of grade-value, and he will then require but little deep thought, though it will be excellent mental training, to find out for himself the reasons of the four simple rules with respect both to integers *and decimals*. Or, in some cases, let him construct a rule for himself. We do not remember to have ever seen what could fairly be called an arithmetical rider; ordinary problems are not riders, for they are scarcely more difficult than a geometrical theorem with the position and letters of the figure altered. The teacher would occasionally be called in to assist at these exercises; but assistance sought for is far more valuable than that which is spontaneously proffered, and its effect more lasting. Mr. Hensley's "Scholar's Arithmetic" is one of the very few books in which we find decimals discussed in their proper place; indeed it is difficult to understand how this branch of the subject can be logically postponed till a later period if our system of numeration is rationally explained, as of course it should be, at the very commencement of the course.

Pursuing the subject systematically, the pupil should be introduced next to other systems of numeration; and should have at least a little practice in such complex contrivances as long measure and troy weight. Certainly the contrast would be abundantly sufficient to mould any young rational being into a most ardent advocate of the metric system. But we cannot say that Mr. Hensley brings out so strongly as perhaps he might the vast difference between the two methods; his chapter on decimals, treating as it does of conceptions and quantities almost unknown to the great majority of British pupils, is somewhat too abstract. Yet we are glad to recognise in him an outspoken adherent of a universal decimal system, and he seems to look with becoming contempt upon our insular stupidity in fondly cherishing our marvellous weights and measures.

Fractions and proportion are the only other important branches of elementary arithmetic; and, when these are mastered, not only is the attainment of a first-rate knowledge of mental and commercial arithmetic a matter that requires merely time and practice, but algebra becomes thereby most highly attractive as a now comprehensible generalisation, and geometry more alluring even to the unmathematical pupil.

The above-mentioned fundamental divisions and their applications to business, the reader will find fully and ably discussed in the "Scholar's Arithmetic"; and Mr. Hensley has wisely interspersed these all-essential chapters with a few on short methods of calculation, processes of verification, engaging problems, and other similar topics which usually attract the attention and excite the interest of a thoughtful student. There is a short though very lucid chapter on involution and evolution; but, as Mr. Hensley remarks in his preface, he has intentionally passed over subjects which are most easily explained algebraically. There are also more than thirty pages of examination papers from various sources, over and above the numerous examples scattered through the book, as well as a short though sufficient index and glossary. The book is perhaps rather too bulky, and in parts very unequal as regards the difficulty of adjacent sections; but these are trivial failings which will not interfere with its use in schools, and we feel no hesitation in pronouncing it to be one of the most attractive educational works that have appeared on this subject, and it will doubtless be of very great assistance to every earnest teacher.

TEMPLE ORME

OUR BOOK SHELF

The Human Mind; A System of Mental Philosophy for the General Reader. By James G. Murphy, LL.D., Author of Commentaries on Genesis, Exodus, and Leviticus. (Belfast: William Mullan.)

THIS book shows that its author possesses at least one common characteristic of mental philosophers, namely, an inordinately good opinion of his own ability. And, lest the reader should not discover for himself what Prof. Murphy has actually done in psychology (which might happen), he is explicitly told in the preface that, while building on the foundations laid by Reid and Hamilton, Prof. Murphy has, in his own opinion, produced a work which he can venture to submit to "the mental philosopher, as a somewhat nearer approach to the real character of the mind than that of Reid, the founder, or even Hamilton, the lucid and eloquent expositor and defender, of the true system of mental philosophy." Another recommendation put forward in the preface is that this treatise is "among the briefest of those that have gone over the whole field of the mind. Perhaps, we cannot tell. But to us the marvel is that the book should have ever come to an end. We have made several honest attempts to read portions of the respectable looking volume, but have never been able to get beyond a few sentences; for we felt as if launched on a shoreless ocean where we might sail on and on, or round and round for ever, and we could not keep our eyes open on the prospectless outlook. We fear some of the mental philosophers, to whom the book is submitted, will not give it very earnest consideration. What seems to be a main object with Prof. Murphy, and which is, as it appears to us, rather inconsistent with a scientific treatment of the phenomena of mind, is to establish the existence and discover the attributes of Deity. But there are few readers, we should think, who will find much interest or pleasure in his mode of handling this part of his theme. There is not a little of the irreverent jargon with which metaphysical theologians have so often shocked all truly religious people. Here, for example, is a reflection that ought perhaps to leave no doubt as to the honesty of the Almighty, whatever other effect it may have on a religious mind: "He is the Creator of all actual things, which are therefore already His own by an absolute and indefeasible right. He has therefore no temptation to take that which does not belong to Him." S.

Second Report of the Winchester College Natural History Society. Second and Third Years. (Winchester: J. Wells, 1873.)

THIS Report contains a record of the doings of the Society from May 1871 to February 1873, and is thoroughly encouraging, and certainly a great contrast to the Reports of the two other public schools recently noticed in these pages. The Winchester Report proves that, by judicious management, a School Natural History Society may be made to yield most gratifying results.

The present Report for the two last years, although its record of the earlier papers is incomplete, shows that the Society has been fully alive, and has been growing quietly and steadily, and doing real and satisfactory work. The numbers of the Society are not at this time actually full. But it appears that the elder half of the members are nearly all of them real workers, and it is hoped that the younger half are learning to be the same. It is of more consequence, as the Preface rightly says, that those who belong to the Society should be working members, than that its numbers should be swelled by names. The meetings of the Society have been well attended, and there has been apparent an increasing appreciation of the opportunities afforded by the meetings for showing and seeing objects of interest, as well as for reading and hearing papers.

It is satisfactory to see that old members take an interest in the society after leaving school, several of them contributing valuable papers.

In general, however, we are extremely glad to see, the papers have been those of actual members, and the Society may well feel satisfaction at the increasing readiness, ability, and completeness shown by the leading members in supplying papers at its meetings. The papers which have been read by the Secretaries, Hall, Goddard, and Forbes, may, perhaps, the Preface says, and we think justly, be specially remarked, as combining ability with knowledge based upon personal observation. It is in these papers that the growth of the Society's work has been chiefly seen, and in which its main value consists.

The collections belonging to the School have been considerably increased. The cabinets attached to the Moberly Library now contain about 4,000 specimens, and more are waiting to be mounted and added.

Among the "desiderata" the Preface mentions the following, in case old Wykehamists, or other friends of the School, may be able and willing to supply them:—In Entomology, specimens of Notodontidæ and Pyralides, amongst Lepidoptera; and of any other orders than Lepidoptera. In Conchology, recent Brachiopoda, and Pteropoda. In Geology, Fossils from any of the Primary Formations, Wealden Beds, Red Crag, and Coralline Crag.

The Report contains a number of very interesting papers, mostly by Messrs. E. H. Goddard, W. A. Forbes, and C. S. Rayner, evidently three of the most industrious members of the Society; all the papers are evidence of original observation and independent thought on the part of the writers. The first-mentioned contributes the following papers:—"Hymenoptera," "Botany and Entomology" (in which the localities in the district are indicated in which the collector will reap the best harvest of flowers and butterflies), and one on "Gall Insects." Mr. W. A. Forbes contributes papers on "Coleoptera," "British Reptiles," and "Mimicry and Protective Resemblance." Mr. Raynor contributes a useful paper "On the Different Methods of obtaining Lepidoptera," and a very careful and interesting one "On the Different Modes of Concealment and Defence practised by Insects." The Report also contains a paper on "The Diamond Fields of South Africa," sent by Mr. E. A. Hall. Appended are very full and carefully compiled Botanical, Entomological, and Geological Lists. We hope the next Report will contain a list of the local Fauna, which it is proposed to form.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Perception and Instinct in the Lower Animals

I HAVE waited some time in the expectation that some of your readers would have asked Mr. Wallace a very obvious question with regard to the incident he adduces of a dog finding his master five months after having been lost, and in a house which the latter "had not contemplated going to or even seen before the loss of the dog." (NATURE, vol. viii. p. 66.) In seeking to account for this thoroughly authentic and highly remarkable case, Mr. Wallace observes: "Could it have obtained information from other dogs . . . . ? Could the odour of persons and furniture linger two months in the streets? These are almost the only conceivable sources of information; for the most thorough-going advocates for a "sense of direction" will hardly maintain that it could enable a dog to go straight to his master, wherever he might happen to be." Now, there is yet a third supposition open to us, and it is one which, in the absence of information, is certainly the most probable. Can Mr. Wallace's friend remember whether he had been walking in the vicinity of his new house during the day upon which the dog returned? *i.e.* can he be sure the dog did not trace his footsteps? That a keen-scented terrier is able to distinguish and to follow his master's track in a public thoroughfare, however densely it may be crowded, I know from the success of searching experiments.

With regard to dogs communicating information to one another, I may mention that I have often observed them doing so. According to my experience, the dogs must be much above the average in intelligence, and the gesture they invariably employ is a contact of heads with a motion between a rub and a butt. It is quite different from anything that occurs in play, and is always followed by some definite course of action. I must add, however, that although the information thus conveyed is always definite, I have never known a case in which it was complex—anything like asking or telling the way being, I believe, quite out of the question; so far, at least, as this action is concerned. One example will suffice. A Skye terrier (not quite pure) was asleep in the room where I was, while his son lay upon a wall which separates the lawn from the high road. The young dog, when alone, would never attack a strange one, but was a keen fighter when in company with his father. Upon the present occasion a large mongrel passed along the road, and, shortly afterwards, the old dog awoke and went sleepily down stairs. When he arrived upon the door-step his son ran up to him and made the sign just described. His whole manner immediately altered to that of high animation, and, clearing the wall together, the two animals ran down the road as terriers only can when pursuing an enemy. I watched them for a mile and a half, within which distance their speed never abated, although the object of their pursuit had not, from the first, been in sight.

As the instinct question seems to have come to a close it is desirable to observe that the only outcome of its discussion has been to intensify the previous belief in the existence of some unexplained faculty, which may be provisionally termed a sense of direction. Mr. Wallace, in his general reply, avowedly ignores all those cases adduced by your correspondents in which his theory cannot possibly apply; *e.g.* dogs describing the third side of a triangle, or returning by land whence they had been taken by sea. He says: "Several of the writers argue as if I had maintained that in all cases dogs, &c. find their way, wholly or mainly, by smell; whereas I strictly limited it to the case in which their other senses could not be used" (vol. viii. p. 65). Now, whether or not Mr. Wallace originally intended his letter to raise the general issue as to the presence in dogs of a sense of direction, this has certainly been its effect, so that the instances he here refers to are not in any way beside the question which immediately arose. I have much too high an esteem for Mr. Wallace to say anything that might lead to a discussion with him, but it is evident that these remarks have no such tendency; for, if he admits, as he candidly does in the sentence just quoted, that his theory cannot apply to all cases, it necessarily follows that, even could he prove it to be true in some, the fact, although of considerable psychological interest, would leave the question as to a sense of direction just where it was before.

It should be borne in mind that dogs are not the only animals in which this sense appears to be present. It is popularly believed to occur in members of at least two orders of Insects, viz. white ants and bees, but I am not aware that any authentic cases have been recorded. Horses and cats seem to possess it in a high degree, and sheep must either have wonderful memories, or owe their return, in numerous cases, to the faculty in question. Still more wonderful, if we deny them this faculty, must be the memory of migratory birds, some of which return, after months of absence and over thousands of miles, to the same nests in successive seasons. If we allow them this faculty it is not, from analogy, improbable that migratory mammals and even fishes are likewise endowed with it. The most conspicuous example, however, is perhaps that afforded by carrier pigeons. To take one case: two or three years ago some of these birds were flown from the Crystal Palace to Brussels, and it stands, if I remember correctly, upon the authority of Mr. Tegetmeier, that they arrived within a few minutes of a telegram despatched from the Palace at the moment they were liberated. Now, in this case, even the extravagant supposition sometimes made that carrier pigeons are guided by the sight of their destination is excluded, for, as these birds are not high-flyers, the curvature of the earth between London and Brussels would prevent them from seeing the latter. And, even if we imagine that these particular pigeons occasionally towered to obviate this difficulty, yet the curvature of the intervening clouds would have imposed another quite as effectual.

There is still one important point which has not been noticed during the discussion of this subject. We possess indications that this sense of direction, like other mental capacities, admits of cultivation by exercise, and, indeed, that it may remain altogether latent and useless until thus developed. If these indications represent generalities we have at once an adequate explanation of the apparently capricious manner in which this faculty occurs.* As this communication is already too long, I shall here be brief.

It is, I believe, a recognised doctrine among fanciers that carrier pigeons, however purely bred, must be educated by flying short distances before they can be depended upon for long ones. I remember having myself lost a valuable bird by flying him, for the first time, at a distance of 500 yards from his nest. Although in full view of it he became utterly confused, taking long flights in various directions, and ultimately went straight out to sea.

Here is an analogous case in a mammal:—I kept a terrier, of highly intelligent parentage, enclosed in a yard with high walls from the time of its birth until it was eighteen months old, and then took it out for the first time, along the sea-shore. The experiment elicited several facts of psychological interest, and one of them has bearing upon the present subject. Part of the coast over which we went and returned was rough with large shingle, and the terrier's locomotive power being very limited, it was unable, on the homeward journey, to keep up with my pace. Desiring to see what it would do if left alone, I continued for half a mile, and waited to see it come up. As it did not do so, I returned, and found that the animal had actually reversed its direction and gone fully a quarter of a mile from the place where I had left it. After having been taken out short distances seven or eight times, it was inadvertently lost in a neighbouring wood. Now, it had only been in the wood once before, yet its appreciation of direction had made so great an advance that it returned an hour afterwards. As this terrier never evinced any disposition to track footsteps, I do not think its return was due to scent. Anyhow, in a few weeks it became an inveterate wanderer, roaming over the country far and wide. GEORGE J. ROMANES

Dunskaith, Ross-shire, July 7

* In connection with these points compare the suggestive remarks of Mr. Darwin, contained in the two concluding paragraphs of his article on Instinct (NATURE, vol. vii. p. 418).

Comte on the Survival of the Fittest

MR. JEVONS called attention some time ago to the desirability of preparing a list of past thinkers and writers who have held, in strength or weakness, the doctrines of Darwin and Spencer. Mr. Darwin has himself named a few of those authors, and Prof. Haeckel has extended the number. Recent communications in NATURE show that the list is as yet incomplete. In reading Comte's "Cours de Philosophie Positive" a few years ago, I was impressed with the general similarity of certain doctrines therein stated with some of Darwin's theories. Referring recently to the 42nd lesson of that course (t. iii.)—"Considerations générales sur la philosophie biotaxique," I find that Comte, in reviewing the Lamarck-Cuvier controversy, says:—

"Toute la célèbre argumentation de Lamarck reposait finalement sur la combinaison générale de ces deux principes incontestable, mais jusqu'ici trop mal circonscrits: 1°, l'aptitude essentielle d'un organisme quelconque, et surtout d'un organisme animal, à se modifier conformément aux circonstances extérieures où il est placé, et qui sollicitent l'exercise predominant de tel organe spécial, correspondant à telle faculte devenue plus nécessaire; 2°, la tendance, non moins certaine, á fixer dans les races, par la seule transmission héréditaire, les modifications d'abord directes et individuelles, de manière à les augmenter graduellement á chaque génération nouvelle, si l'action du milieu ambiant persévère identiquement. On conçoit sans peine, en effet, que, si cette double propriété pouvait être admise d'une manière rigoureusement indéfinie, tous les organismes pourraient être envisagés comme ayant être, à la longue, successivement produits les uns par les autres, du moins en disposant de la nature, de l'intensité, et de la durée des influences extérieures avec cette prodigalite illimitée qui en coûtant aucun effort à la naïve imagination de Lamarck." (1st ed. "Cours de Philosophie Positive," t. iii. pp. 560 and 561.)

Modification and heredity are here strongly asserted, and the conditions of unlimited transformation as strongly sketched. In continuance of the same argument, Comte, on p. 563, objects to Lamarck's hypothesis, of which he thought very highly as a logical effort:—

"Qu'il repose, ce me semble, sur une notion profondément erronée de la nature générale de l'organisme vivant. Sans doute, chaque organisme determiné est en relation nécessaire avec une système egalement déterminé de circonstances extérieures, comme je l'ai établi dans la quarantième leçon. Mais il n'en résulte nullement que la première de ces deux forces co-relatives ait dû être produite par la seconde, pas plus qu'elle n'a pu la produire: il s'agit seulement d'un équilibre mutuel entre deux puissances hétérogènes et indépendantes. Si l'on conçoit que tous les organismes possibles soient successivement placés, pendant un temps convenable, dans tous les milieux imaginables, la plupart de ces organismes finiront, de toute nécessité, par disparaître, pour ne laisser subsister, que ceux qui pouvaient satisfaire aux lois générales de cet équilibre fondemental: *c'est probablement d'après une suite d'éliminations analogues que l'harmonie biologique a dû s'établir peu à peu sur notre planète, où nous la voyons encore, en effet, se modifier sans cesse d'une manière semblable.* Or, la notion d'un tel équilibre général deviendrait inintelligible et même contradictoire, si l'organisme était supposé modifiable à l'infini sous l'influence suprême du milieu ambiant, sans avoir aucune impulsion propre et indestructible."

The struggle for existence and the survival of the fittest or natural selection are here acknowledged. What is more, the fact that the eliminations due to unfitness for the environment or medium have produced and is producing biological harmony, is pointed out. I have not met with any passages outside of the writings of the new school, which are more explicit than these, though it must not be understood that their author was a transformationist. The preface to the volume in which this occurs is dated "Paris, le 24 Février, 1838." In his general table appended to the sixth volume of his work, Comte says that the Leçon from which these extracts are taken was written between the 9th and 15th of August, 1836. J. D. BELL

New York

The Glacial Period

CAN you inform me if anyone has suggested the following explanation of the existence of the glacial period? And is the explanation I am about to offer a possible one? I put the question in all diffidence, for I have not carefully studied the theory of heat: you must therefore regard any utterance of mine on the subject as merely "a random arrow from the brain." Well, then, it seems to me that the quantity of heat given out in a unit of time from a unit of surface of an intensely heated globe, such as the sun, does not follow the law of radiation of bodies moderately heated. What I mean is this:—It is quite possible that at a time when the sun's mean temperature was higher than it is now, his rate of radiation might have been less; the quantity of heat emitted by him in a unit of time less than it is now. For since his chromosphere must have been thicker, and his solid or fluid nucleus somewhat less in diameter, I suppose that the radiation of the nucleus must have been more retarded by the chromosphere than is at present the case. It is true, that owing to the increased pressure at the surface of the nucleus due to a thicker chromosphere, the temperature there may have been a little higher; but I do not think that difference would make up for the increase in absorption of the chromosphere.

Assuming then that the sun gives out more heat now in a given time than he did during the glacial period, and that the earth had already so far cooled down that her surface was not sensibly more warmed by internal heat than it is in our own epoch, the mean temperature of the earth's climate would have been lower, and the sea-level line of perpetual snow nearer the Equator in both hemispheres; and glaciers would have covered vast tracks of country which are now denuded of them.

Again, let us go back some millions of years in the world's history, till we arrive at the carboniferous period. The sun then would probably be emitting less heat than even during the glacial period; but the earth would not have cooled down to such an extent, and her internal heat would be sensible at the surface. The mean climate of the globe would have probably been warmer then than it is now, and the temperature more equally distributed, depending not so much on solar as on terrestrial radiation. This being supposed, the vegetation of England and India in those days must have presented less difference than what we find at present. Does the flora of our English and Indian coal-beds support or upset this conclusion? Can any of your correspondents answer this query, or set me right if I am wrong in my hypothesis of solar radiation?

Hampstead, July 22 J. H. RÖHRS

P.S.—Is there any good mathematical treatise on heat, English or French, up to the latest information on the subject? Can you or any of your correspondents recommend me such a treatise?

Telescope Tube for Celestial Photography

I HAVE not yet seen any satisfactory plan suggested of getting over the difficulty experienced in celestial photography by the expansion and contraction of telescope tubes, by changes of temperature in metal tubes.

I therefore venture to suggest the following plan, which may be so arranged as to keep the object-glass and camera-slide *exactly* the same distance apart, and so keep the true focus when once found. The arrangement would have to be modified according to the metal of which the tube is made, but taking a brass one (the most common), with the camera attached to the eyepiece-slide, the correction will be effected by attaching to the main tube, near the eyepiece, two zinc rods the length of the main tube, upon which they must rest loosely; to the free ends of these, near the object-glass, attach a rod of iron extending to the eye-tube; let this iron rod be attached to the eye-tube when the sensitive-plate is exactly in focus; any change in temperature will then have no effect on the focus, for the expansion and contraction of the three metals will keep the distance from object-glass to sensitive-plate constant. All who have worked with a telescope giving sharp definition, will know that this is not an unnecessary precaution, as it may seem to some.

Sydney Observatory, June 14 H. C. RUSSELL

Colour of the Emerald, etc.

I HAVE to beg "A. H." to refer again to NATURE (July 24) p. 254, col. 1, line 23, where he will find it stated that "the emeralds employed were canutillos from Santa Fé de Bogotá. Their specific gravity was 2·69." It is evident, therefore, that they could only be the green silicate of alumina and glucina.

The green sapphire, known also as the "oriental emerald," is the rarest of all gems; and Mr. Harry Emanuel, in his work, "Diamonds and Precious Stones," speaking of it says, "In the whole course of my experience I have only met with one specimen." Its specific gravity would at once distinguish it from the true emerald.

The Beryl A. was colourless, opaque, and had a specific gravity of 2·65. GREVILLE WILLIAMS

INSTINCT, PERCEPTION, AND REASONING POWER OF ANIMALS

THE correctness of the following facts, bearing on the above question, I can warrant:—

A beautiful greyhound bitch in my possession had puppies, and I gave one of them, about a month old, to a friend of mine who was also living in Montpellier at that time. Some few days subsequently, on going to call at my friend's house, I took the greyhound with me. She appeared delighted at finding her puppy again, and expressed her strong feeling by lavishing on it, in her own way, the most tender marks of affection. After a few days I paid a second visit to my friend (unaccompanied by the greyhound), when he informed me that, in consequence of the earnest request of one of his friends, he had been induced to give him the puppy, which had thus been removed to a considerable distance. I returned home, and on my arrival was struck with the peculiar manner in which the animal met me. There was nothing of her usual expression of delight—no barking, no jumping to and fro—but she met me with a serious and thoughtful look, and began slowly to smell my clothes in different places, with the most earnest perseverance. Nor was she content with a mere cursory effort to discover the particular object, whatever it was, which, no doubt, she had in view; but she continued the same course of proceeding for at least a quarter of an hour, in fact, till I found it quite necessary to bring it to a close.

From the above statement of the conduct of the animal, the impression on my own mind was that I must have carried away from my friend's house some subtle effluvia, which tended to bring back to the mother the recollection of her puppy. And this caused me some additional surprise, inasmuch as greyhounds are possessed of great keenness of sight, but are generally considered as rather deficient in their power of smelling. The conclusion is still more remarkable. During the space of about two years I usually paid my friend a visit twice a week, and on every occasion, on my return home, the greyhound would invariably go through the same ceremony. At length the proceeding became altogether so striking that it was quite unnecessary for my wife and family (perhaps from a little innocent curiosity) to ask, "Where have you been?" They could save themselves the trouble of a question and say "I see that you have been calling on your friend."

My cousins were residing in a small village about thirty kilom. from Montpellier, and on one occasion, when I was going to spend some days with them, I took, for the first time, my greyhound with me. It so happened that not far off there was a hound bitch that belonged to one of my cousins' neighbours, and between these two animals (from the beginning of my short stay) there arose the deepest hatred and animosity, and conflicts of the most ferocious kind were matters of daily, almost hourly, occurrence. Time altogether failed in producing any better feeling between them, and to the end of my visit each was ever ready and anxious to try their strength whenever the opportunity offered. In the course of the following year I paid a second visit to the same place, accompanied by my greyhound, and about three-quarters of an hour before I reached the village the animal, as if struck with a sudden idea, rushed forward at her full speed, and all attempts to call her back proved quite ineffectual. On reaching the village I found that a terrible encounter had already taken place between the two heroines, who were on the point of renewing the attack after a temporary cessation of hostilities.

The following anecdote relating to the same greyhound seems to prove that these animals may sometimes exhibit a higher standard of reasoning power than according to general opinion they possess.

I was passing some days in the country with my aunt, who had a middle-sized spaniel bitch, of a somewhat sullen and treacherous temper. This spaniel observed, with an evident feeling of jealousy, that my greyhound was making herself quite at home in my aunt's kitchen, and whenever she had a favourable opportunity, without exposing herself to too much danger, she never failed to give an angry bite to her unsuspecting rival, and immediately to rush for shelter under a kneading-trough, from which position my greyhound was unable to dislodge her.

After a short time the spaniel had puppies, and she was placed with two of them in a corn-loft, over the kitchen, from which there was a door which led to it by a flight of stairs; the door was usually kept closed in consequence of the known animosity between the two rivals. For some days the new mother, entirely occupied with the care of her little ones, did not descend to the kitchen, and my greyhound occasionally showed a strong desire to go up to the loft and see what was going on there. When the puppies were about seven or eight days old, their mother began to re-appear in the kitchen, and to observe towards the greyhound the same line of conduct, with the exception only of an appearance of increased hatred. At length, on one occasion, when the spaniel was eating her dinner, and the corn-loft door happened to be partly open, my greyhound, taking advantage of the opportunity, sprang up the stairs of the loft. I observed the circumstance, and on calling her down she immediately obeyed, and made her appearance before me with a look of perfect satisfaction. About an hour afterwards my aunt's husband, on going to the loft, found both the puppies dead, without the least mark of external violence, and he was at a loss to imagine what could have caused their death. For myself I had an impression on my own mind as to the cause of death, but I did not consider it necessary at the time to mention it to others. I opened the bodies of the puppies, and found my opinion confirmed. The skin was externally sound through its elasticity, but the fangs of the greyhound had done their work, and the liver had been bruised into a kind of marmalade—exactly in the same manner as the greyhound usually crushes the liver of the hare or the rabbit, which, literally speaking, are no sooner seized than dead.

In November last, when I was staying with my cousin, I was much interested in observing the proceedings of various kinds of poultry in a field almost contiguous to the house. There were six or seven young guinea fowls, ducks, hens, &c., and also a pair of old guinea fowls, which kept always by themselves, and continued running to and fro with that perpetual restlessness which is natural to them. In the midst, however, of their wildest proceedings they always appeared to keep an eye on the young guinea fowls, and whenever any of the other poultry happened to approach the spot where they were, the old guinea fowls invariably ran with all speed and drove them away. Two large hens alone seemed to be exempt from this rough treatment, and to have full permission to come near the young guinea fowls or not, just as they liked. One of the hens, in particular, seemed to enjoy some special privileges, and in case of any apparent danger, there was some immediate proof of care and protection on the part of the old guinea fowls.

The above circumstances excited my curiosity, and I obtained the following explanation:—

One of these hens had hatched some guinea fowls' eggs, but after three days had neglected to perform the new functions incumbent on her, and had left the young brood to themselves. Fortunately, the other hen, which had previously exhibited the well-known symptoms of the fever of incubation, adopted the deserted young ones, and had nursed them with the greatest affection till they were able to take care of themselves. The old guinea fowls, it appears, had observed all these circumstances, and had retained a grateful recollection of them.

Under the roof of a small tower at my father's house in the country, a large number of sparrows (consulting their own convenience, rather than that of others), had established their nests; but in consequence of the extensive injury caused to the corn-fields by their depredations at harvest-time, my father, with a view to lessen their number, gave direction that all the nests should be removed, and thus, by this wholesale order of destruction, about 80 nests with 366 eggs suddenly disappeared. Their fondest hopes being thus blighted, and the expected fruit of all their labour nipped, as it were, in the bud, the sparrows betook themselves to noisy meetings, and, in their own way, to expressions of anger and resentment. This proceeding continued for at least a week, after which they dispersed, and went in search of some other less dangerous shelter for their future progeny. In the following year some sparrows, which had built their nests under other buildings of our country house, and which had been left unmolested, returned to them; but from that time to the present day (forty-eight years) I can safely affirm that no sparrow has ever rebuilt her nest under the roof of the tower. The singular facts of the case are these: the sparrows decidedly object and decline to build any more nests under the roof of the tower, but they are quite willing to avail themselves of the shelter of the position during the severe nights of the winter season.

Montpellier DR. PALADILHE

THE GROWTH OF SALMON

SINCE the time of Magna Charta it has been an object, directly or indirectly, on the part of the Legislature, to protect the supplies of salmon with which our rivers used to be so abundantly stocked: but notwithstanding the laws which have at various times been enacted, this fish gradually became scarcer till, in 1861, all the old laws were repealed, and fresh and more stringent regulations made for protecting and increasing our salmon supplies. In addition to the fostering care which is bestowed, under the Salmon Fishery Acts of 1861 and 1865, on the fish in the rivers, means have been adopted to artificially rear salmon, so as to increase their numbers more rapidly than could be done in the ordinary course of nature. Mr. Frank Buckland has been the pioneer of this system of artificial breeding of salmon and trout, and the experiments and operations which have been carried on during the last few years have thrown great light on the hitherto unknown habits of this "king of fish."

Anyone who looks into the fishmongers' shops just now can see what a clean, fresh-run salmon, ready for cooking, is like—a silvery, plump creature, whose "lines" are made for speed in water, and whose graceful curves give the completest idea of vigour and strength in stemming a rapid current of water.

But very few people, probably, know what sort of an appearance this beautiful fish presents in its infancy. Hidden away during that period in the upper waters of our salmon rivers, and ultimately in the depths of the sea, it is lost to sight till it grows large enough to be taken by the salmon nets; and until lately very little was known of its natural history, or of its habits, though the experience of the last few years has revealed many interesting facts concerning the development of this fish, through the egg, fry, smolt, and grilse stages, till it becomes a full-grown salmon.

Fig. 1 represents the egg—natural size—of a salmon just laid. Each female salmon carries, on an average, 800 to 900 of such eggs to every pound of her weight. They are generally of a pinky opal colour, elastic to the touch, covered with a soft horny membrane, with a minute opening through which a particle of the spawn—the soft roe—of the male fish enters, and the egg is fertilised. From this moment the young fish gradually develops, under the influence of the cold running water. At the end of about 35 days—more or less according to the temperature, which should be about 40°—two little black specks can be seen, as at Fig. 2, which are the eyes of the embryo fish; the vertebræ may be discerned in the form of a faint red line, and a small red globule which shortly afterwards appears, represents the vital organs of the embryo fish.

At the end of about 80 to 100 days from the deposition of the egg the fish has so increased in size that it bursts the "shell" and makes its *début* in the form represented at Fig. 3. The sac or umbilical vesicle attached to the under part of the fish contains a secretion resembling albumen, which affords nourishment to the infant fish for the first six weeks or so of its existence. By that time it is quite absorbed, and for the first time we see a perfect

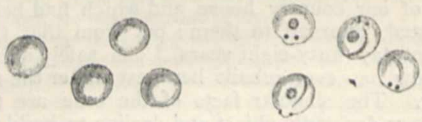

FIG. 1. FIG. 2.

Fig. 1.—New-laid Salmon Egg. Fig. 2.—Egg after about 35 days.

fish, Fig. 4, with its fins, gills, and scales, which have hitherto been present, but imperceptible except under the microscope, fully formed: and now the young salmon begins to feed. His growth is not very rapid for some months, the lines *a b c* representing the average length of a salmon at 2, 3, and 4 months old. At 2 years old the fish is about 9 to 12 inches long.

As soon as they are large enough and strong enough, the "smolts," as they are now called, descend to the sea; here they are lost sight of until they return up the river as "grilse." The actual duration of their stay in the sea is not yet known, from one to three years being variously estimated as the probable length of time. The object of this migration to the sea is to find the food which is necessary for the secretion of the fat of the fish, who lives on the *Infusoria*, smaller fish and crustaceans, and the spawn of sea-fish which abound in our seas. The length of their stay in salt-water is regulated, no doubt, by various circumstances, and is not the same in every case. When the salmon has laid up a sufficient supply of fat in its body and on its pyloric appendages, which are a wonderful provision of Nature for the secretion of an amount of fat sufficient to supply it during its sojourn in fresh waters, it ascends the river, its roe or spawn developing as it ascends; till, about Christmas-time, or sometimes earlier, it reaches the shallow headstreams of the river, in the gravelly beds of which it deposits its eggs, returning immediately afterwards to the sea, no

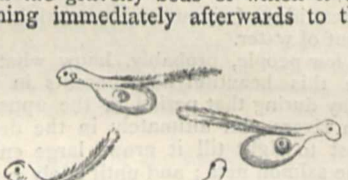

FIG 3.—Fish coming out of egg.

longer in the bright, plump, muscular condition in which it ascended, but a lean, lank, ugly, wounded beast, which one would hardly recognise as *Salmo salar*. Fig. 5 represents the head of a "kelt," as those salmon are called which have newly spawned. The curved projection, or hook, on the lower jaw, is a cartilaginous membrane, the use of which nobody knows. The fish is in a very weakly condition, as his fat is gone, and he perhaps assumes this appearance to frighten other animals, which might otherwise be tempted to attack him. The drawing is taken from the photograph of a salmon, weighing 20lb., which was found dead on the banks of one of our Welsh rivers.

This fish, had it survived, would have returned to sea, recovered its fat, and presently come back worth 2*l*. or 3*l*., whereas, by dying in this condition, it was worth nothing. It had, however, done its duty by depositing perhaps 16,000 eggs. Only a very small percentage, however, of the eggs laid ever become adult fish. Floods wash them out of their gravel nests; ducks, and other birds, eat them; beetles and various insects attack them; they are smothered with mud, or left high and dry on the shore; the young fish are poisoned by pollu-

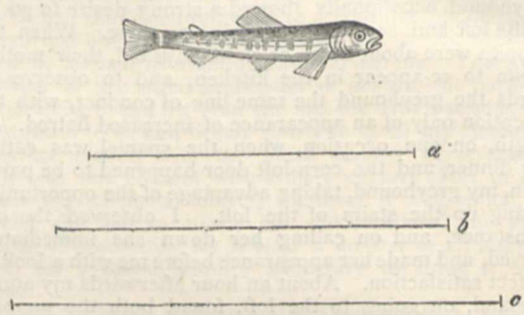

FIG. 4.—Young Salmon six weeks old. *a*, *b*, *c*, size of salmon at two, three, and four months respectively.

tions, or diverted into mill leats and canals, and so lost; trout eat them wholesale; in fact the whole of their earliest existence is a very living death, and it is a wonder, with all the ordeals they have to pass through, that we have any salmon left. To kill them legitimately for food for ourselves is bad enough, and we ought to do all we can to protect them when young.

In the artificial system of breeding salmon the adult fish are caught just as they are on the spawning beds, and the eggs taken from them; the ova and milt are properly mixed together, and the eggs placed in troughs of water so arranged as to imitate as closely as possible the natural conditions necessary for the development and growth of the fish. Properly managed, 90 per cent. of the eggs will hatch out: the young fish are turned into the river when they are about a year old; if they can be kept two years in tanks large enough, with plenty of running water, so

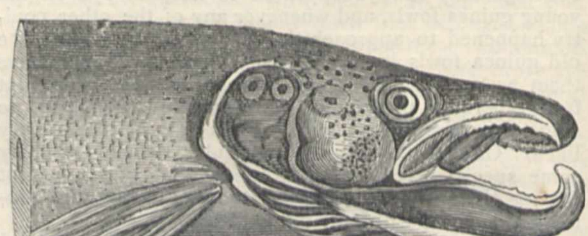

FIG. 5.—Head of a Kelt.

much the better for the prospect of their reaching the sea in safety.

When we can make up our minds to keep all our pollutions out of our rivers, and build "salmon ladders" over all the weirs, so as to give the fish a fair field, and enable them to run up stream unimpeded, then, and then only, shall we see salmon as plentiful throughout the country as it is said to have been in the North a century ago, when apprentices are reputed to have stipulated in their indentures that they should be fed on salmon not more than three days a week. Without this all our efforts to stock our barren rivers with artificially bred fry will prove comparatively unavailing. C. E. FRYER

THE GLACIAL DRIFTS OF NORTH LONDON

THE landscape memorials of the great glacial period in Britain have hitherto been chiefly looked for by the tourist in the northern and mountainous districts of our island. The vast and wide-spreading products of the same epoch which lie in the lower and more southerly districts of England, as far as the Valley of the Thames, have had to wait longer for their due recognition. In the interval, the Londoner addicted to geologising has been fain to go to Snowdonia, Borrodaile, and the Highlands of Scotland—to the region of perched blocks and terminal moraines—for memorials of the Ice Age within our own coasts. Nor is it to be wondered at that the districts in which glacial action on a grand and cosmical scale was first detected in Britain, and which still afford the more obvious monuments of the glacial period, should so long have monopolised attention. But the time seems now to have come for the drifts of the southern regions to take their proper place in the gallery of glacial phenomena.

So recently have these drifts changed their character in the eyes of geologists that it may be worth while to summarise their history, and indicate the conclusions which have now been arrived at with regard to them as well as one or two important moot points which will perhaps remain doubtful for some time to come.

It seems only yesterday that the glacial drifts of the

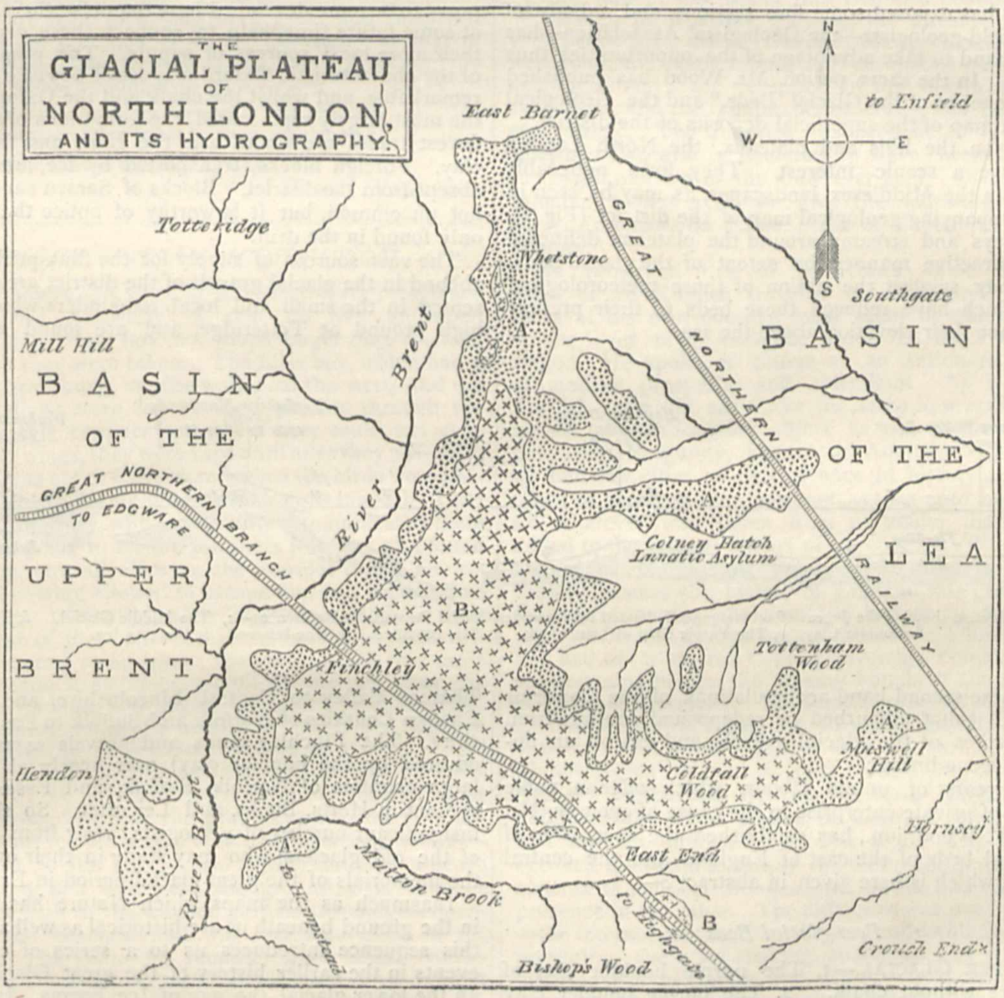

FIG. 1.—A, Glacial Sands and Gravels. B, Glacial Clay. Unshaded Parts—London Clay.

lower and southern districts of England were looked upon as a mere congeries of rubbish heaps and "diluvium"—chaotic and unintelligible relics of some mysterious and partly hypothetical period. Now, however, these deposits are no longer slighted by geologists. In the hands of one or two earnest workers—notably Mr. Searles V. Wood, jun.—the glacial clays, and sands, and gravels of England are rising into the dignity of a system. The North London glacial drifts may be taken as typical in most respects of the great and wide-spreading deposits which are found in the inland counties most remote from the homes of the old British glaciers.

The Finchley and Muswell Hill drift lying on the northern heights of London overlooking the Thames Valley occupies a position of great geological interest and significance. Muswell Hill figures in the very early annals of the beds which are known to be of glacial origin. In the year 1835, Mr. N. T. Wetherell, of Highgate, made the discovery which has given such repute to the spot. In Coldfall Wood, just beneath the vegetable soil, Mr. Wetherell found one of those strange medleys which geologists were then wont to dismiss as "diluvium." Here, as far south as the Thames Valley, were water-worn fragments of granite, mountain limestone, coal, red chalk—indeed rock-specimens from all the northern formations, with a similarly heterogeneous collection of fossil remains. Agassiz had not as yet broached the great conception of the glacial period; the diluvium reigned supreme. Year by year more extensive patches of fossiliferous clays and gravels were found adjacent to Muswell Hill. From Finchley and Whetstone an abundance of fossils proper to the chalk and oolite formations was obtained, and whole hampers of belemnites were sent off to Prof. Phillips at Oxford for the purpose of his monograph on that genus. But the drift itself remained an isolated phenomenon. It was left to men of the younger generation to attack a problem as worthy of solution as the problems of Cambria and Siluria.

During the last five or six years, the Finchley and Muswell Hill drift has excited fresh attention. The Great Northern Branch Railway from East End to Finchley has exposed some fine sections, and a body of earnest field-geologists—the Geologists' Association—has been at hand to take advantage of the opportunities thus afforded. In the same period Mr. Wood has published his "Sequence of the Glacial Beds," and the Geological Survey a map of the superficial deposits of the district.

Lying on the hills and plateaux, the North London drifts have a scenic interest. They form noticeable features in the Middlesex landscapes, as may be seen in the accompanying geological map of the district (Fig. 1). The valleys and streams around the plateaux delineate in an instructive manner the extent of the glacial beds, whilst they suggest the action of those meteorological forces which have reduced these beds to their present limits since their elevation above the sea.

But unlike the moraines of Snowdonia and other mountain districts, these much older lower ground accumulations are not, in the view of most English glacialists, the immediate deposits of land ice. Contrary to the beliefs of the Scotch geologists, who would regard them as the equivalents of the Till, they are referred to the era of the great submergence of England beneath the glacial sea. They are the transported material of the submarine terminal moraine. As the ice-foot retired before the submerging sea, it left behind it the *débris* of the rocks it had degraded to be transported by bergs and rafts over the Middlesex of the future.

The glacial deposits at Finchley station, although they conform to the general character of such beds in the south-western counties, have certain features which may prove to be more developed here than elsewhere, and may, at some future time, help to connect these deposits with their more local sources of supply. The preponderance of the characteristic Oxford clay fossil *Gryptea dilatata* is remarkable, and whilst the chalk and the Oxford clay are the most largely represented, the formations of which the fewest traces are found are the gault and the London clay. Foreign blocks, transported by ice, are generally absent from the district. Blocks of Sarsen sandstone are not uncommon, but it is worthy of notice that they are only found in the drift.

The vast sources of supply for the flint pebbles which abound in the glacial gravels of the district are still represented in the small and local remainders which cap the high ground at Totteridge, and are found at Barnet,

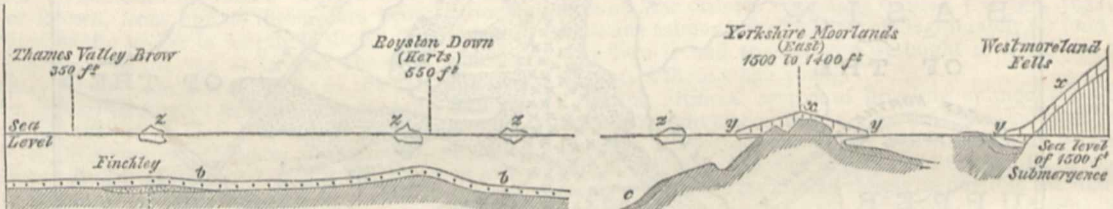

FIG. 2.—Section showing the degree of submergence indicated by the upper Glacial Deposits. References—*a*, The Middle Glacial. *b*, The Chalky Boulder Clay. *c*, The Purple Clay without Chalk. *x*, The Ice Sheet. *y*, The Ice-foot. *z*, Floating Ice.

where these second-hand accumulations of the Lower or Middle Bagshot, disturbed or redeposited, are free from the quartzites of the glacial gravels, and exhibit an unmixed Eocene lineage.

After years of untold labour, which offer a noble example of private enterprise in the cause of geology, Mr. Searles V. Wood, jun., has established the succession of the glacial beds of the east of England and the central counties, which is here given in abstract :—

Post-glacial Beds

I. UPPER GLACIAL.—1. The purple boulder clay of Yorkshire without chalk. 2. The purple boulder clay with chalk. 3. *The Great Chalky Boulder Clay of the South of England* (*e.g.* at Finchley and Muswell Hill).

II. MIDDLE GLACIAL.—*The Middle Glacial Sands and Pebbly Gravels of the South-East of England and the Central Counties* (*e.g.*, the Finchley and Muswell Hill sands and pebbly gravels).

III. LOWER GLACIAL.—The Contorted Drift of Norfolk, the Cromer Till, and the Pebbly Sands of Norfolk and Suffolk (Upper Crag).

A few words further in explication of this sequence will show how wide an area of England is concerned in the deposits with which the Finchley drifts are thus correlated.

The deposit to which the Finchley chalk boulder clay belongs stretches in an intermittent way from the lower Thames Valley to Central Lincolnshire, and from the Eastern Counties of Norfolk and Suffolk to East Staffordshire. The Finchley sands and gravels extend (mostly covered by the boulder clay) over nearly all the three large counties of Norfolk, Suffolk, and Essex, and are present in Herts, Bucks, and Leicester. So there is no insignificant number of geologists, away from the region of the old glaciers, who may study in their own locality the memorials of the great glacial period in England.

Inasmuch as the maps which Nature has laid down in the ground beneath us are historical as well as physical, this sequence introduces us to a series of consecutive events in the earlier history of the great Glacial Period. In the lower glacial the age of Ice begins. In the next deposit we notice a pause in the Arctic conditions which had prevailed. The formation of that characteristically glacial deposit, the boulder clay, was arrested, and the sands and gravels (middle glacial), of milder waters, took its place. Then the Arctic conditions returned, and brought in the chalky boulder clay. At length the higher rocks were brought within the reach of the sea, until the Yorkshire Wolds were submerged, and eventually the Westmoreland fells yielded their *débris* to be spread over the sea-bottom (Fig 2). That the glacial period should have left its memorials so far south in our island as the valley of the Thames, was a matter of incredulity among many geologists, even so recently as ten years since, when Sir Charles Lyell had compelled attention to the Muswell Hill drift in the "Antiquity of Man." That the drift of the glacial period did not once extend over the counties south of the Thames has yet to be demonstrated, and those geologists who hold that we have already discovered the original southern limits of the glacial clays and gravels in England, have yet to explain the condition of these deposits of the north brow of the Thames Valley, where they are as pelagic in character as they are a hundred miles farther north.

The dwellers in the south of England have thus been compensated for their distance from the bolder region of the old British glaciers, of perched blocks, and terminal moraines. The glacial period has now been brought home, as it were, to their own doors. By the classification of the glacial beds which we now possess, patches of clay and gravel which seemed to have a sporadic and insignificant character are seen to belong to a great and historical series. In the presence of such "diluvium" as that of Muswell Hill, with its astonishing medley of organic remains, it needs no longer to be asked,—

> "What seas receding from what former world
> Consigned these tribes to stony sepulchres?"

We know now that it was an icy sea.

HENRY WALKER

FLIGHT NOT AN ACQUISITION

A FEW weeks ago, when at Ravenscroft (the residence of Lord Amberley), I shut up five unfledged swallows in a small box not much larger than the nest from which they were taken. The little box, which had a wire front, was hung on the wall near the nest, and the young swallows were fed by their parents through the wires. In this confinement, where they could not even extend their wings, they were kept until after they were fully fledged. I was not at Ravenscroft when the birds were liberated, but the following observations were made by Lord and Lady Amberley, who have kindly communicated them to me. On going to set the prisoners free, one was found dead—they were all alive on the previous day. The remaining four were allowed to escape one at a time. Two of these were perceptibly wavering and unsteady in their flight. One of them after a flight of about 90 yards disappeared among some trees; the other, which flew more steadily, made a sweeping circuit in the air after the manner of its kind, and alighted, or attempted to alight, on a branchless stump of a beech; at least it was no more seen. I give the unabridged account of No. 3 and of No. 4 as it stands in the notes made at the time by Lady Amberley. "No. 3 (which was seen on the wing for about half-a-minute), flew near the ground first round Wellingtonia, over to the other side of kitchen garden, past beehouse, back to the lawn, round again, and into a beech tree. No. 4 flew well near the ground, over a hedge twelve feet high to the kitchen garden, through an opening into the beeches, and was last seen close to the ground." The following remarks were added subsequently: "The swallows never flew against anything, nor was there in their avoiding objects any appreciable difference between them and old birds. No. 3 swept round the Wellingtonia, and No. 4 rose over the hedge just as we see the old swallows doing every hour of the day." It remains to add that each of these birds was weighted with a small collar of coloured cloth, put on for the purpose of marking them; and that an old swallow on being set free encumbered by a similar adornment, exhibited the same unsteadiness in its flight.

There is little need to make any remark on the above facts. In proving the flight of birds, and their power of guiding their course through the air in accordance with their sensations of sight, not to be an acquisition, they support the general doctrine that all of what may be called the professional knowledge and skill of the various species of animals come to them by intuition, and not as the results of their individual experiences. With wings there comes to the bird the power to use them. Why, then, should we believe that because the human infant is born without teeth, it should, when they do make their appearance, have to discover their use? The swallow, the first time it is in the air takes care, or rather does not need to take care, not to dash its brains out against a stone wall. Why, then, should we believe man to have no instinctive faculty of interpreting his visual sensations?

DOUGLAS A. SPALDING

BRITISH ARCHÆOLOGICAL INSTITUTE

THE annual meeting of this Institute commenced at Exeter on Tuesday, July 29, the President for the year being the arl of Devon. Many valuable papers were read, and many interesting excursions made in the neighbourhood; the reception by the Mayor, the local authorities, and the inhabitants generally, has been most enthusiastic. The Congress was brought to a close on Tuesday last, and is declared to have been the most successful meeting of the kind ever held. Of the many valuable papers read we give the following by Dr. E. A. Freeman, on "The Place of Exeter in English History."

He remarked that it sometimes came into the mind of an English traveller in other lands that the cities of his own country must seem of small account in the eyes of a traveller from the land which he visited. He spoke of course as an antiquary and not of modern prosperity and splendour. As a rule an English town did not make the same impression as an artistic and antiquarian object as did towns of Italy, Germany, Burgundy, France, or Aquitaine But whilst we had few cities as rich at once in history and art as many of those on the Continent, yet we need not grieve; for whatever was taken from particular districts was added to the general history of our country. Why was the history of Nuremburg greater than that of Exeter? Simply because the history of England was greater than that of Germany, The domestic history of an English town which had always been content to be a municipality, and had never aspired to be a sovereign commonwealth, seemed tame beside the stirring annals of the free cities of Italy and Germany. But for that especial reason it had a value of its own, it had not struggled for the greatness of its own, but it had done its work as part of a greater whole—it had played its part in building up a nation. And the comparison beween the lowly English municipality and the proud Italian or German commonwealth had also an interest of another kind. The difference between the two was simply the difference implied in the absence of political independence in the one case and its presence in the other. The difference was purely external—the internal constitution—history and revolutions—often presenting the most striking analogies. In both might often be seen the change from democracy to oligarchy, and from oligarchy to democracy. In both they might see men who, in old Greece, would have taken their places as demagogues, perhaps tyrants. Exeter had something to tell of Earl and Countess of Devon; Bristol of its half-citizens, half tyrants, the Lords of Berkeley. In the free cities of the Continent we saw what English cities might have been if the royal power in England had been no stronger than that of the Emperors, and if England had therefore split up into separate states like Germany, Italy, and Gaul. In England the constant tendency had been to unity and to make every local power subordinate to that of the king, and it was this that had made the difference between a municipality like Exeter and a commonwealth like Florence. In Exeter reflections of this kind had a special fitness. No city in England had a history which came so near to that of the great continental cities; none could boast of a longer unbroken existence nor was so direct a link between the earliest and the latest days of the history of our island. None had in all ages more steadily kept the character of a local capital, the undisputed head and centre of a great district. And none had come so near to being something more than a local capital, none had had so fair a chance as Exeter of once becoming an independent commonwealth, the head of a confederation of smaller boroughs, perhaps the mistress of dependent towns and subject districts. It was not then with mere words of form that he might congratulate the Institute on finding themselves at last within the walls of the great city of Western England. They had been to many other places, to York, Lincoln, and Chester, and if Exeter must yield to these in the wealth of actually surviving monuments, it assuredly did not yield to any of them in the historic interest of its long annals. It had, in truth, peculiar interest of its own in which it stood alone amongst the cities of England; she was among cities what Glastonbury was among churches, it was one of the few ties which directly bound the Englishman to the Roman and the Briton. It was the great trophy of that stage of English conquest when our forefathers, weaned from the fierce creed of Woden and Thunder, deemed it enough to conquer and no longer sought to destroy.

Exeter, Isca, Caer Wisc was a city of the same class as Bourges and Chartres. Here was what was found commonly in Gaul but rarely in Britain—the Celtic hill-fort which had grown into the Roman city, which had lived on through Teutonic conquest, and which still, after all changes, kept its place as the undoubted head of its own district. In Wessex such a history was unique; in all Southern England London was the only—and that but an imperfect —parallel. The name carried on the same lesson which was taught by the site. Caer Wisc had never lost its name. It had been Latinised into Isca, Teutonised into Exancester, and cut short into modern Exeter, but through all conquests, through all changes of language, it had proclaimed itself as the city by the Exe. In this respect the continuity of its being had been more perfect than that of most of the cities of Northern Gaul. The name and the site of Exeter at once distinguished it from most of the ordinary classes of English towns. . . .

The first question which now suggests itself was one which he could not answer—when did the city first become a West Saxon possession? When did the British Caer-Wisca, the Roman Isca, pass into the English Exancaster? Of that he could find no date—no trustworthy mention. The first distinct and undoubted mention of the city he could find was in the days of Alfred, where it figured as an English fortress of great importance, more than once taken and retaken by the great king and his Danish enemies. He was as little able to fix the date of the English conquest of Isca as he was to fix that of its original foundation by the Britons. John Shillingford said that Exeter was a walled city before the incarnation of Christ, and though it was not likely to have been a walled city in any sense that would satisfy either a modern or Roman engineer, yet it was likely enough to have been already a fortified port before Cæsar landed in Britain. At all events the first definite mention of it was in the time of the wars of Alfred. But though it was English by allegiance, it was not until two centuries later that it became wholly English in blood and speech. In Athelstan's day the city was still partly Welsh, partly English, each forming a city within a city. To this state of things Athelstan deemed it right to put a stop and to put the supremacy in the chief city of the western peninsula beyond a doubt. Exeter was a port which needed to be strongly fortified, and to be in the hands of none but what were thoroughly trustworthy. The British inhabitants were driven out, and to the confusion of those who say Englishmen could not put stones and mortar together until a hundred and forty years later, the city was encircled by a wall of square stones and strengthened by towers, marking a fourth stage in the history of English fortification. If anyone asked him where the wall of Ethelstan was now he could only say that a later visitor to Exeter took care that there should not be much of it left for them to see. Still there were some small fragments, but suppose not a stone was left, yet as he understood evidence, the fact that a thing was recorded to have been destroyed was one of the best proofs that it once existed. The distinguishing point in this stage of the history of Exeter was this, that it alone of the great cities of Britain did not fall into the hands of the English invaders till after the horrors of conquest had been softened by the influence of Christianity. When Caer Wisc became an English possession there was no fear that any West Saxon prince should deal with it as Ethelfrith had dealt by Deva. When Isca was taken the West Saxons had ceased to be destroyers, and deemed it enough to be conquerors. Thus it was that Exeter stood alone as the one great English city which had lived an unbroken life from pre-English and even from pre-Roman days.

Whatever was the exact date when it became an English possession, it was with the driving out of the Welsh inhabitants under Ethelstan that it became purely English. As such it filled during the whole of the tenth and eleventh centuries a prominent place among the cities of England and a place altogether without a rival among the cities of its own part of the country. Later in the century the fortress by the Exe was the chief bulwark of Western England during the renewed Danish invasions of the reign of Ethelred. It was a spirit-stirring tale to read how the second millennium of the Christian era was ushered in by the record which told how the heathen host sailed up the Exe and strove to break down the wall which guarded the city, how the burghers bore up against every onslaught, and how they withstood the invaders. Exeter was saved, but the unready King had no help or reward for the men who saved it, and the local force of Devon and Somerset had to strive how they could against the full might of the invader, and the devastation of the land around followed at once upon the successful defence of the city. In the next year Exeter became part of the "Morning gift" of the Norman Lady, and Hugh, "The French Churl," as our chroniclers call him, was sent by his foreign mistress to command in an English city, and through his cowardice or treason Sweyn was able to break down and spoil the city. It was not clear whether all the walls were broken down then, but it was quite certain that sixty years afterwards, Exeter was strongly fortified according to the best military art.

After the city's capture by Sweyn nothing more was heard of it during the Danish wars, and the only further knowledge of it between the Danish and Norman invasions consisted of the foundation of the bishopric, and this was accompanied by several circumstances which marked it as an event belonging to an age of transition. It was among the last instances of one set of tendencies, among the earliest instances of another. The reign of Edward the Confessor was the last time (excepting the reign of Edward the Sixth) when two English bishoprics were joined together without a new one being formed to keep up the number. It had happened more than once in earlier times; it happened twice under Edward when the bishoprics of Devonshire and Cornwall were united, and those of Dorset and Wiltshire. But this also was the first instance of a movement for bringing into England the continental rule that the bishopric should be placed in the greatest city of the diocese.

The great ecclesiastical change of the eleventh century had carried him on beyond the great time which stood out above all others in the history of Exeter, when they might say that for eighteen days Exeter was England The tale of the great siege he had told elsewhere in full detail, and he would not tell it again now, but the story of the resistance of the western lands and their capital to the full power of the Conqueror, was one that never ought to pass away from the memories of Englishmen. The bravery of the inhabitants formed a tale which, even in that stirring time, spoke more than any other—save the tale of the great battle itself—to the hearts of all who loved to bear in mind how long and hard a work it was to make England yield to her foreign master. But whilst our hearts beat with those of the defenders of Exeter, yet we saw none the less now that it was for the good of England that Exeter fell. A question was here decided, greater than that whether Harold, Edgar, or William should reign—the question whether England should be one. When Exeter stood forward for one moment to claim the rank of a free, imperial city, and her rulers expressed themselves willing to receive William as an external lord, but refused to admit him within her walls as her immediate sovereign, they saw that the tendency was at work in England by which the kingdom of the continent was split up into loose collections of independent cities and principalities, and the path was opening by which Exeter might have come to be another Lubeck, the head of a Damonian house, another Bern, the mistress of the subject lands of the Western Peninsula. Such a dream might sound wild in our ears, and we might be sure that no such ideas were present in any such definite shape to the minds of the defenders of Exeter. But any such designs were probably just as little known to the minds of those who in any German or Italian city took the first steps in the course by which from a municipality, or less, the city grew into a sovereign commonwealth. Historically, the separate defence of Exeter was simply an instance of the way in which, after Harold was gone, England was conquered bit by bit. York never dreamed of helping Exeter, and Exeter, if it had the wish, had not the power to help York. But it was none the less true when we saw a confederation of western towns, with the great city of the district at their head, suddenly starting into life to check the progress of the Conqueror—we saw that a spirit had been kindled which, had it not been checked at once, might have grown into something, of which those who manned the walls of Exeter assuredly never thought. We could hardly mourn that such a tendency was stopped even by the arm of a foreign conqueror. We could hardly mourn that the greatness of Exeter was not purchased at the cost of the greatness of England. But it was worth while to stop and think how near England once was to running the same course as other lands. From the sacrifice of the general welfare of the whole to the greater brilliance of particular members of the whole, we had been saved by a variety of causes, and not the least of them by the personal character of a series of great kings working in the cause of national unity, from West Saxon Egbert to Norman William. The tendency of the patriotic movements in William's reign was to division; the tendency of William's own rule was to union. The aims of the Exeter patricians could not have been long reconciled with the aims of the sons of Harold, nor could the aims of either have been reconciled for a moment with those of the partisans of the Etheling Edgar, or of the Danish Sweyn. We sympathised with the defenders of Exeter, York, Ely, and Durham, but from the moment England lost the one man of her own sons who was fit to guide her, her best fate in the long run was to pass as an individual kingdom into the hands of the victorious rival.

With the subjection of Exeter by William might fairly be ended the tale of the place of Exeter in English history. It was then settled for Exeter that she was to be an English city—no separate commonwealth—a member of the individual English kingdom, but still a city that was to remain the undisputed head of its own district. Its history from this time was less the history of Exeter than the history of those events in English history that took place at Exeter. It still had its municipal, ecclesiastical, its commercial history, but no longer a separate political being of its own. It was no longer an object to be striven for by men of contending nations, nor something that might be cut off from the English realm either by the success of a foreign conqueror or the independence of its own citizens.

In the other sense of the word, as pointing out those events of English history of which Exeter was the scene, the place of Exeter in English history was one which yielded to that of no other city in the land save London itself. It was with a true instinct that the two men who open the two great eras in local history—English Ethelstan and Norman William—both gave such special heed to the military defences of the city. No city in England had stood more sieges. It stood one, and perhaps two more, before William's own reign was ended—indeed before William had brought the conquest of the whole land to an end by the taking of Chester. The men of Exeter had withstood William as long as he came before them as a foreign invader; when his power was once fully established, when the Castle on the Red Mount held down the city in fetters, they seemed to have had no inclination to join in hopeless insurrections against him. When, a year and a half after the great siege, the Castle was again besieged by West Saxon insurgents, the citizens seemed to have joined the Norman garrison in resisting the attack. According to one account they had already done the like to the sons of Harold and their Irish auxiliaries. The wars of Stephen did not pass without a siege of Exeter, in which king and citizens joined to besiege the rebellious lord of Rougemont, and at last to starve him within the towers of which legend was already beginning to speak as the work of the Cæsars.

To pass to later times, the Tudor era saw two sieges of the city, one at the hands of a pretender to the crown, and another at the hands of the religious insurgents of the further West. Twice again in the wars of the next century Exeter passed from the one side to the other by dint of siege, and at the last she received an invader at whose coming no siege was needed. The entry of William the Deliverer through the Western Gate formed the balance—the contrast—to the entry of William the Conqueror through the Eastern Gate. The city had resisted to the utmost when a foreign invader, under the guise of an English king, came to demand her obedience. But no eighteen days' siege, no blinded hostages, no undermined ramparts were needed when a kinsman and a deliverer came under the guise of a foreign invader. In the army of William of Normandy Englishmen were pressed to complete the conquest of England, but in the army of William of Orange, strangers came to awake her sons to begin the work of her deliverance. In the person of the earlier William the Crown of England passed away for the first time to a king wholly alien in speech and feeling; in the later William it in truth came back to one who was even in mere descent, and yet more fully in his native land and native speech, nearer than all that came between them to the old stock of Hengist and Cedric. The one was the first king who reigned over England purely by the edge of the sword, the other the last king who reigned over England purely, by the choice of the nation. The coming of each of the men who entered Exeter in such opposite characters marked an era in our history. The unwilling greeting which Exeter gave to the one William and the willing greeting which she gave to the other, marked the wide difference in the external aspect of the two revolutions. And yet both revolutions had worked for the same end; the great actors in both were, however unwittingly fellow workers in the same cause. It was no small place in English history which belonged to the city whose name stood out in so marked a way in the tale alike of the revolution of the eleventh and the seventeenth centuries. It was no small matter, as we drew near by the western bridge or the eastern isthmus, as we passed where once stood the eastern and the western gates, as we trod the line of the old Roman streets, to think that we were following the march of the Conqueror and the Deliverer; it was no small matter, as we entered the minster of Leofric, Warlewast, and Grandison, to think that the *Te Deum* was there sung alike for the overthrow of English freedom and for its recovery. It was no mean lesson if we had to connect with the remembrances of this ancient city—among so many associations of British, Roman, and English days—the thought that rose above all the rest, the thought that there was no city in the land whose name marked a greater stage in the history of the Conquest of England, that there was none whose name marked a greater stage in the history of her deliverances.

NOTES

FOREIGN honours have been recently falling in showers on the heads of English scientific men. Not long ago the Emperor of Brazil nominated as Knights of the Imperial Order of the Rose, the following gentlemen:—Sir G. B. Airy, Dr. Warren De La Rue, Dr. Birch, Prof. Abel, Major Moncrieff, Capt. Andrew Noble, and Mr. J. Norman Lockyer. The other day, King Oscar II. of Sweden, at his coronation at Stockholm, marked his appreciation of the services rendered by science by conferring distinctions on several men of learning, both Swedes and foreigners. Among the latter were the following eminent scientific men of this country:—Sir Charles Lyell and Sir George B. Airy, named Commanders of the First Class of the Order of the Polar Star; and Professor John Tyndal, Professor Thomas Henry Huxley, and the Director of the Botanical Gardens at Kew (Dr. Joseph Dalton Hooker), named Knights of the same Order.

WE understand that one of the evening discourses at the meeting of the British Association next month will be delivered by Prof. W. C. Williamson, of Manchester, on "Coal and Coal Plants." It is also hoped that Prof. Clerk-Maxwell will deliver a discourse on "Molecules." Several papers on subjects of local interest have also been promised. The following is a list of the vice-presidents and other officers of the Association, the president-elect, as we have already announced, being Prof. A. W. Williamson, F.R.S.:—Vice-Presidents elect: the Earl of Rosse, F.R.S.; Lord Houghton, F.R.S.; W. E. Forster, M.P.; the Mayor of Bradford; J. P. Gassiot, F.R.S.; Prof. Phillips, F.R.S.; John Hawkshaw, F.R.S. Local Secretaries for the meeting at Bradford: the Rev. J. R. Campbell, D.D.; Mr. R. Goddard; Mr. Piele Thompson. Local Treasurer for the meeting at Bradford: Mr. Alfred Harris, jun. General Secretaries: Capt. Douglas Galton, C.B. R.E. F.R.S., Dr. Michael Foster, F.R.S., Trinity College, Cambridge. Assistant General Secretary: George Griffiths, M.A. General Treasurer: William Spottiswoode, F.R.S. Auditors: John Ball, F.R.S.; J. Gwyn Jeffreys, F.R.S.; Colonel Lane Fox, F.G.S. The sections are the ollowing:—A, Mathematical and Physical Science.—President: Prof. Henry J. Stephen Smith, F.R.S. Vice-Presidents: Prof. Balfour Stewart, F.R.S., and Prof. Henrici. Secretaries: Prof. W. K. Clifford, M.A.; J. W. L. Glaisher, Prof. A. S. Herschel, and Prof. Forbes. B, Chemical Science.—President: Dr. W. J. Russell, F.R.S. Vice-Presidents: Prof. Roscoe and I. Lowthian Bell. Secretaries: W. Chandler Roberts, F.C.S.; Dr. Armstrong; and Prof. Thorpe. C, Geology.—President: Prof. Phillips, D.C.L. Vice-President: W. Pengelly Secretaries: Louis C. Miall; William Topley, F.G.S.; R. Tiddeman. D, Biology.—Vice-Presidents: Dr. Beddoe and Prof. Rutherford, M.D. Department of Zoology and Botany.—Secretaries: Prof. Thiselton-Dyer and Prof. Lawson. Department of Anatomy and Physiology.—Secretaries: E. Ray Lankester and Dr. Pye-Smith. Department of Anthropology.—Secretaries: F. W. Rudler, F.G.S., and J. H. Lamprey. E, Geography.—President: Sir Rutherford Alcock. Vice-Presidents: Major-Gen. Sir Henry Rawlinson and John Ball. Secretaries: H. W. Bates, F.R.G.S.; Keith Johnston, F.R.G.S.; and Clements R. Markham, C.B., F.R.S. F, Economic Science and Statistics.—President: Mr. W. E. Forster, M.P. Vice-Presidents: Dr. Farr; Lord Houghton, F.R.S.; E. Baines, M.P. Secretary: J. G. Fitch, M.A. G, Mechanical Science.—President: W. Froude, LL.D. Vice-President: A. Bessemer. Secretaries: H. M. Brunel; J. N. Shoolbred; H. Bauerman.

ON Tuesday the forty-first annual meeting of the British Medical Association was opened in King's College, London, the large hall of which was crowded on the occasion of the general assembly, at 3 o'clock. The General Meeting was presided over by Mr. A. Baker, surgeon to the General Hospital, Birmingham, and president of the Association. After the retiring president had addressed the meeting, Sir W. Fergusson took the chair as president of the Association for the coming year, and read an address of considerable length. It was difficult in the present time, he said, for a president of an association like that to find a suitable subject for an address, as, whatever topic he started with he was immediately surrounded with so many specialists, who of course knew everything better than himself, that he did not know where to stand. The president then entered at much length on the subject of the valley of the Thames and the importance of pure water in a hygienic sense. He suggested that, without having recourse to the expensive process of going to the lakes of Cumberland and Westmoreland for a supply of pure water, there were many streams and rivulets and water sheds where the waters could be confined in lake above lake, and utilised for the supply of London and the large towns. In the evening the Lord and Lady Mayoress held a reception at the Mansion House, which was attended principally by medical gentlemen and their wives and daughters. More than 3,000 were received during the evening.

AMONG the distinguished foreigners now attending the meeting of the British Medical Association in London, may be mentioned—Professors Virchow, Oscar Liebreich, and Baron von Langenbeck, of Berlin; Prof. Busch, of Bonn; Prof. Marey, of Paris; Prof. Chauveau, of Lyons; Prof. Spiegelberg, of Breslau; Prof. Lazarewitch, of Charkow; and Dr. Fordyce Barker, of New York.

ON Monday, the annual meeting of the Cambrian Archæological Association was opened at Knighton, Radnorshire. This Association was established some thirty years ago for the purpose of investigating and preserving the objects of antiquity which abound in the Principality. The first Congress was held at Aberystwith, and the present is the 28th of the series. The President for the past year was Sir J. Russell Bailey, M.P., and the President-elect is the Hon. A. Walsh. The week's programme opened on Tuesday night with the annual meeting and reception of report, after which the President for the year, Sir J. R. Bailey, was to resign the chair to his successor, the Hon. A. Walsh, who was to deliver the inaugural address. The rest of the week will be occupied with excursions, and meetings for the reading of papers.

MR. G. KITCHENER has been elected to the headmastership of the High School, Newcastle-under-Lyne, Staffordshire, in the middle of the Potteries. It is to be the first "First Grade" established as a semi-classical school (*i.e.* without Greek in the ordinary school course). The time thus made available, will enable more attention to be given to Mathematics and Science. The scheme directs that Chemistry and Design should be specially taught, with a view to the Potter's art. The school is to be opened in the spring of 1875.

IT has long been familiar to geologists that the western and southern coast-line of Scotland is pierced with caves at different levels, indicating former successive levels at which the sea waves worked. Unfortunately, owing to the want of limestone or very calcareous rocks, these caves as a rule present none of that stalagmite deposit which has elsewhere served so abundantly to cover over and preserve the remains of the ancient denizens of our country with traces of the presence of man himself. The caves usually open directly upon the coast, with free exposure to the air, so that their floors show nothing but damp boulders and pools of water from the drip of the roof. Recently, however, a remarkable exception to these ordinary conditions has been observed on the wild cliff line to the south-west of the bay of Kirkcudbright; the Silurian greywacke is there traversed with strings and veins of calcite along lines of joint and fracture, and at one point where an old sea cave occurs, the walls and floor at the cave mouth, and for a few yards inwards, have a coating of solid calcareous matter. Beneath this coating in the substance of the breccia, which extends across the cave mouth, as well as throughout the cave earth behind the breccia, a great quantity of bones, with traces of human occupation, has been found. A systematic investigation of the cave, commenced last autumn, is being carried on under the direction of Mr. A. J. Corrie and Mr. W. Bruce-Clarke, the discoverers of the osseous layer. At the present time the following, among other remains, have been noted: bones of ox, red-deer, goat, horse, pig, pine-marten, rabbit, watermole, and other small rodents, together with numerous remains of birds, and a few frog and fish bones. Intermingled with these occur fragments of bronze, bone needles, and other bone implements, to the number of more than twenty. One piece of worked stone (a fragment of greywacke) has been found, but as yet not a single chip of flint. A full account of the cave will be published as soon as the investigations are completed.

A CONFERENCE of the City Companies, under the presidency of his Royal Highness the Prince of Wales, was held at Marlborough House, on Monday, July 21, with the view of discussing how technical education might be promoted by those companies acting in concert with the International Exhibition. It was unanimously agreed that the City Companies should give their best support to the object which the meeting had in view, and Mr. Cole, C.B., explained that the Commissioners had determined that, during the months of August, September, and October, schools should be admitted to the Exhibition by ticket, at three-pence each scholar, and that, during the month of August at least, frequent lectures each day would be given on the various subjects and processes exhibited. He suggested that the City Companies, in addition to sending their own schools to attend these lectures, might purchase tickets, and place them at the disposal of the London School Board, to enable them to award them as prizes. Such tickets might also be distributed among other public schools.

AT a meeting held at Grosvenor House on July 17, a Provisional and an Executive Committee were formed for the establishment of a National Training School for Cookery in connection with South Kensington. The Committee of Management of the Lectures on Cookery at the International Exhibition have been urged to take this step from the comparatively great success monetarily and otherwise, of these lectures. The meeting agreed that the Executive Committee of the present School for Cookery be an Executive Committee to prepare a scheme and issue the same. The meeting also agreed to the following resolutions:—1. That the establishment of a Training School for Cookery, to be in alliance with the School Boards and Training Schools throughout the country, is most desirable at the present time. 2. That the aim of the proposed school should be to teach the best methods of cooking articles of food in general consumption among all classes. 3. That an Association should be formed with the intention of making the School self-supporting. 4. That it would be prudent to secure a capital, say 5,000*l*., which might be raised by means of donations giving the privilege of nominating students in the School, as well as by means of a guarantee fund; it is estimated that an expenditure of about 1,000*l*. would be required to fit up a practical school or laboratory. The Provisional Committee, containing several Royal and noble names, were authorised to take the necessary measures to establish the school by means of shares, donations, and guarantees. Assuming the necessary capital to be provided—and we hope there will be no difficulty in doing so—the Executive Committee hope that they may be able, before the end of the year, to establish courses of practical instruction in the kitchen, as well as lectures. Arrangements will be made so that courses may be severally attended by pupil-teachers in training for public education, by domestic servants, and by ladies. The experiment of this school will be first tried in London, and if it succeeds, similar schools will be established in the large towns. We sincerely hope such a laudable scheme will meet with perfect success. All communications on the subject of the school should be addressed to the Secretary (*pro tem.*) of the school, Annual International Exhibitions, Kensington Gore, London, S.W.

ARRANGEMENTS have been made with Mr. P. Simmonds for the delivery each day of six short lectures on the industries illustrated in this year's International Exhibition. These lectures will be commenced on Saturday next.

ON Saturday a deputation from the Trades' Guild of Learning which was formed for the promotion of technical education in the various trades and industries of the United Kingdom, waited upon the Marquis of Ripon at the Privy Council Office, with a view of urging upon the Government the desirability of taking further steps to promote a higher technical education. The deputation included Sir A. Brady, Mr. H. Solly, and others. Sir A. Brady said what the working-men wanted was not money but a fair start. They felt that enough had not been done in utilising the resources of the South Kensington Museum. The Chancellor of the Exchequer had acted very penuriously in the matter. One way in which they could be assisted was by the establishment of a class of instructed teachers and the attaching art schools to the museums. The Rev. Mr. Solly said that the great body of the intelligent artisans, who were largely represented on the council, found that the benefit of the services they received from the Educational Department almost wholly failed to reach themselves. This failure arose principally from the following causes:—First, because the sources of information were not readily accessible as to what the Department really aimed at with a view to assist them. Secondly, the workmen in the East-end of London found the cost of the journey to the South Kensington Museum to be too great in time and money, and therefore they desired that two or three other well-furnished museums should be established in other parts of the metropolis. The next point was that the Department should not only assist classes which had made some progress, but classes in their incipient stages, and which required nursing. The last and most important point of all was, that however able the Government teachers were to instruct in Science and Art, they were not able to give that practical instruction in any trade which the workman might pre-eminently need and desire. The apprenticeship system had practically broken down. The Marquis of Ripon said that if Mr. Solly's paper were sent in it should receive careful consideration.

NOTWITHSTANDING the vast importance of St. Paul's Cathedral and the impossibility of making up for its loss were it destroyed, until recently it was in imminent danger of being shattered by every thunderstorm that passed over it. The lightning-rods that were supplied to it 120 years ago have long been utterly useless, and from its position, size, and certain peculiarities of structure, the noble building formed a tempting object of attraction to the destructive stroke of lightning. Happily, we learn from the *Telegraphic Journal*, this is no longer the case. The authorities, dissatisfied with the electrical state of the building, upon the report of Mr. John Faulkner, Associate of the Society of Telegraph Engineers, of Manchester, commissioned him to prepare a plan for the fitting of the cathedral with an efficient system of conductors. The plan submitted was approved, and the fitting is now completed. In metallic connection with cross and ball and scrolls are eight copper conductors, each being a ½-inch strand of copper wires. The octagonal strand has been adopted as giving most metal in the least space. These eight conductors then pass to the metallic railing of the Golden Gallery, with which they are in metallic connection. Thence they are carried down to the dome, to the metallic surface of which they are again connected at several portions of their length. Then down the rain-falls, over the leaden roofs of the aisles, in the angles formed by the aisles themselves, again down the rain-falls to the sewers. Further, the choir and nave roofs are connected together by a saddle or conductor stretching over them both, and joined to the conductors proceeding from the summit of the west towers. Even this did not satisfy the zealous care of Mr. Faulkner, who tested, sheet by sheet, the electrical condition of the leads, connecting the worse insulated sheets by copper bands to the better conducting surfaces. Thus the dome, aisle-roofs, and ball and cross, and the two west towers, form one immense metallic conductor, and the danger arising from interior gas-piping is removed; for Coulomb and Faraday have proved beyond doubt that electricity accumulates upon the surface only of bodies. In the sewers, which always afford a moist earth connection, the copper strands are riveted to copper plates, and these again are pegged into the earth. By this means as good an earth connection is obtained at the top of the cross, at the very summit of the Cathedral, as is found in the sewers at its base.

THE Examinations in the Crystal Palace School of Practical Engineering, for the Easter term, commenced last Saturday, and will close on Friday, August 9th. The Autumn Term will commence on Monday, September 8. The Principal will attend in the school from 10 till 4 each day, from Saturday, August 2nd, to Friday, the 8th, to pass Candidates for admission.

AN earthquake occurred at Jamaica at 0·30 A.M. on July 1, which created much alarm. It lasted nearly five seconds.

AMONG Mr. Murray's announcements of forthcoming works are—"Personal Recollections, from Early Life to Old Age," by Mary Somerville; "The Geography of India, Ancient and Modern," by Colonel Yule, C.B.; "The Naturalist in Nicaragua," by Thomas Belt, F.G.S.; and a popular edition of Mr. H. W. Bates's "The River Amazons."

A NEW and cheap edition of Mr. James B. Jordan's "Elementary Crystallography" has been published by Mr. Murby as one of his series of science manuals. To any one commencing the study of crystallography this manual will be very useful, especially as appended to the letterpress is a series of carefully drawn nets for the construction of models illustrative of the simple crystalline forms.

THE report of the annual meeting of the Perthshire Society of Natural Science shows that Society to be in a prosperous and good working condition. The number of members is large, and among them is a fair proportion of workers. We are glad to see that excursions have been started, and hope they will be continued; no richer field, we are sure, than the County of Perth, especially for Botany, exists in this country. The Society, under the energetic management of Dr. Buchanan White, of Dunkeld, is publishing a Fauna and Flora of Perthshire, and it is under its auspices the *Scottish Naturalist* is brought out. During the last summer Mr. J. Allen Harper turned out, for the purpose of acclimatisation, about 7,000 living specimens of the following molluscs: *Helix virgata*, *H. pisana*, and *Bulimus accutus*. The annual address of the president, Col. Drummond Hay, occupies the greater part of the report, and gives many interesting details concerning the birds of Perthshile. The Society has entered on the seventh year of its existence.

THE following are the chief additions to the Brighton Aquarium during the past week:—4 Corkwing Wrasse (*Crenilabrus melops*); 7 Pogge (*Agonus cataphractus*); 1,000 Prawns (*Palæmon serratus*); several groups of *Serpula contortuplicata* and *Alcyonium digitatum*. Four young rough-hounds (*Scyllium canicula*) have been hatched from eggs laid during the last week in January. The period of their development in *ovo* is therefore six months. A large number of young Squid (*Loligo vulgaris*) have also been hatched from spawn brought in by fishermen.

THE additions to the Zoological Society's Gardens during the last week include an Ocelot (*Felis pardalis*) from America, presented by Mr. A. B. Keymer and Mr. C. C. Lovesy; a Togue Monkey (*Macacus pileatus*) from Ceylon, presented by the Sergeants of the 1st Batt. Scots Fusiliers; a grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. G. S. Daintry; a starred Tortoise (*Testudo stellata*) from India, presented by Capt. C. S. Sturt; two lesser black-backed Gulls (*Larus fuscus*), presented by Mr. C. W. Wood; two crested Pigeons (*Ocyphaps lophotes*), hatched in the Gardens; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, and a black-eared Marmoset (*Hepale jacchus*) deposited.

METEOROLOGY IN HAVANNA *

TO judge from the pamphlets mentioned below, the practical study of Meteorology seems to be pursued at the Cuba Observatory with diligence and a harvest of good results. The care and skill with which they are compiled must lead to the conclusion that science will receive very valuable aid both in meteorological and magnetic research from this station of the West Indies.

The observatory is situated at a height of 19·297 metres above the sea level, in N. lat. 23° 8′ 14″·5, its longitude being 76° 9′ 42″·8 west of San Fernando, and therefore 82° 22′ 6·95 west of Greenwich. The first volume is a yearly meteorological and magnetic report, and consists entirely of monthly tables and curves of the daily mean results of the barometer, thermometer, tension, humidity, wind, evaporation, rain, and state of sky. For each month the daily maximum, minimum, and mean values are given, and then follows a table of the monthly means for every even-hour of the day and night. The direction and force of the wind are shown on a circular diagram, and the mean daily values of the barometer, thermometer, tension, and humidity are exhibited by broken lines. Rain curves are added from May.

Regular two-hourly observations of the Magnetic Declination were commenced on April 1, 1871, and the same details are given as for the barometer, &c. To these were added at the

* Observaciones Magneticas y Meteorologicas del real Colegio de Belen de la compania de Jesus en la Habana, de 30 Nov. 1870 a 30 Nov. 1871.
Memoria de la Marcha regular o periodica, et irregular, del Barometro en la Habana des de 1858 a 1871 inclusive, por el R. P. B. Vines, S.J.
Observaciones correspondientes al mes de Octubre de 1870, con la descripcion de los huracanes ocurridos en la Isla en dicho mes.

commencement of the following month similar observations of the horizontal magnetic force. For these elements of terrestrial magnetism two-hourly, as well as daily mean, curves are traced for each month.

In the general table that closes the report, we notice that the prevailing wind never deviates, in any season, more than 13° 31′ from the east, and in spring it is only 3° 36′ N. of E. The rainfall for the seasons given in millimetres was in winter, 71·1; in spring, 181·0; in summer, 480·0; and in autumn, 547·2; the number of rainy days being respectively 13, 15, 33, and 39.

The coincidence of magnetic disturbances with local storms, with hurricanes in Florida and St. Thomas, with Auroras visible in distant lands, and with similar magnetic perturbations in England, was remarked in August, September, and November. The frequent disturbances of the needle noted in October certainly do not agree with photograghic records in England, this month having been remarkably free from perturbations of this nature.

The second book contains the results of a continued series of barometric observations between the years 1858 and 1871. The reliance we may place on the accuracy of the work can be estimated from the fact, that the correction of 1·07mm. for sea level was the result of 2,000 comparisons.

A very regular double period is apparent in the daily range, which may be represented by the expression $h=k \sin (a+t) + k' \sin (b+2t)$; but the range for the day hours is somewhat in excess of that of the night. The minima occur at 2—4 A.M. and 3—4 P.M., and the maxima at 9—10 A.M. and 10 P.M., the times varying slightly with the seasons.

In December, January, and February, the amplitude of the daily range is greatest, and then gradually decreasing it attains its minimum in June and July. This confirms the law of Ramond, cited by Kaemtz, that the amplitude of the barometric range within the tropics is least in the rainy season. This annual variation of the daily range is, remarks our author, the more worthy of note, as it is directly opposed to what has been observed in Europe, where the range is greatest in summer. This remark appears to me to require some modification, for on turning to the monthly mean range observed, for instance, at Stonyhurst, during the last quarter of a century, I find a perfect agreement with the annual variation for Cuba. The mean values for the several months at Stonyhurst are 1·448, 1·415, 1·378, 1·167, 0·970, 0·896, 0·869, 0·927, 1·217, 1·323, 1·451, 1·449. These means are, it is true, obtained from the extreme monthly maxima and minima, but our author informs us that the amplitude of the extraordinary oscillations, if we eliminate the four greatest which were due to hurricanes, resembles the mean annual variation of the range, being greatest in January and least in July. The mean values of the extraordinary oscillations being almost identical in November, December, February, and March, give this annual daily range curve at Cuba a singular symmetry. The periodic recurrence of summer storms at fixed hours will account for the diminution of the range in that season.

The mean values of the Daily Range have been deduced by several methods: 1. From the absolute maxima and minima, by which the irregular oscillations are not sufficiently eliminated. 2. By Humboldt's method, from the maxima and minima at fixed hours. 3. By Kaemtz's method, from the arithmetical means of the maxima and minima. 4. From Bravais formula, $R = \frac{\sqrt{d^2 + d^2_2 + \ldots d^2_n}}{n}$; d, d_2 . . . being the differences between the monthly mean and those of certain fixed hours. There is a striking agreement in the results from all these methods, but the second shows in certain cases signs of a suspicious irregularity.

Besides the Daily Range, and an annual variation of this range, there exists a yearly variation of the mean value analogous to the diurnal, having its principal maximum and minimum in January and October, and secondary ones in July and May. This double inflexion of the mean annual curve is peculiar to Cuba, since there is generally in the same latitude only a single maximum in January, and a minimum in July.

The abnormal inflexion occurs during the month of June, July, August, and September. Kaemtz, in his "Météorologie," who is followed by Marie Davy, fixed the principal minimum in August, but this and other lesser differences arise probably from not eliminating extraordinary perturbations, and from the confessed imperfection of his series of observations.

The observations of fourteen years are insufficient to determine any certain law respecting the years of hurricanes; but an inspection of the yearly curves shows that 1865 and 1870 are distinguished from the rest by the almost identity of the means for February, March, and April, followed by a rapid rise from May to July, a fall from July to October, and a still more marked rise from October to January.

The third pamphlet gives a very interesting and detailed account of the terrible hurricanes that caused such wide-spread desolation in the October of 1870. The first storm occurred on the 7th and 8th, the second on the 19th and 20th.

The author adopts the theory of cyclones first enunciated by Redfield in 1831, and since accepted and modified by many eminent meteorologists. Situated N. of the Equator he considers the storm to be rotating in the directiou from E. to W. through N. and the centre to be at the same time moving N.W. within the tropics, and N.E. in higher latitudes. The resultant path he finds to be a spiral wrapped round a parabola, the folds of the spiral being closest at the apex of the curve. The position of the centre or vortex is given at any moment by the height of the barometer and the direction of the wind. The barometer being lowest at the centre, the reading of the mercurial column, corrected for daily range and for the particular wind, furnishes data for determining the distance of the centre, whilst the angular bearing of the latter is known from its being at right angles to the direction of the wind, and to the rigtht hand of an observer facing the wind. This follows necessarily from the circular motion of the cyclone, and falls, as a particular case, under the general law of Buys Ballot, since we know that the barometer is lowest at the vortex. The latter is thought to move in a cycloidal curve with loops at the cusps, which just fall on the parabolic trajectory. The vortex is thus almost always to the E. of the parabola. The double motion of translation and rotation causes the effects of the hurricane to be much more disastrous in the N. hemisphere to the E. of the parabolic path than on the W. side, and the velocity of the wind at a given distance from the vortex for any points of the compass may be found from the formula $V = \sqrt{t^2 + r^2 + 2tr \cos \theta}$, where t and r are the velocities of translation and rotation, and θ is measured from the E. point when the storm is moving N. The calm at the centre of the cyclone gives a ready means of estimating the velocity of translation. The storm of the 7th was felt from the 4th to the 13th, the maximum humidity lasting till the 12th. The rate at which the vortex crossed the island was only four miles an hour, and this remained almost constant throughout. The second storm was much more sudden and rapid, and the increasing rate, from 9½ to 20 miles an hour, at which the vortex was travelling, showed that the second branch of the parabola had been reached before passing Cuba.

Equal heights of the barometer combined with the directions of the wind enable the meteorologist to lay down the parabolic trajectory with considerable accuracy, either from observations at a single station, or at several. Thus on the 7th at 2 P.M. the corrected barometer read the same at Havannah and at Cienfuegos, the wind being S. by W. at the latter, and N.E. at the former station, the vortex was therefore at that time S.E. of Havannah, and a few degrees N. of W. from Cienfuegos, but equally distant from the two places. The more rapid changes and greater fall of the barometer, together with the increase in the velocity of the wind, show that the storm passed more centrally over Havannah than over Cienfuegos. The discharges of electric fluid were very intense, and at Cardenas an appearance similar to the aurora borealis was visible for ten minutes. The magnetic needles were much disturbed. The inundations from the rising of the sea were very destructive, and on the 7th the existing wind favoured the rise. This rise under the centre of the cyclone seems to follow from the removal of pressure, and the inrush of air of different temperatures fully accounts for the heavy rainfall. The diminution of atmospheric pressure is also offered as a probable explanation of the slight shocks of earthquake, due perhaps to the violent expansion of certain gases confined within the cavities that abound in the island.

A careful consideration of the accounts published in the local papers, and a personal inspection of the localities, tended strongly to confirm the results of theory.

Cuba, from its situation just within the Tropic of Cancer, and at the entrance to the Gulf of Mexico, is admirably placed for the study of these cyclonic storms, and eight of those which have been best observed are traced on a map appended to the pamphlet, showing that in most cases the apex of the parabolic curve is not far from the island. It is a subject of congratulation that an observatory so well conducted, and so situated, has, by the kind assistance of Sir E. Sabine, been provided with a set of magnetic instruments by which the connection of terrestrial magnetism with the most violent of our tropical storms may be thoroughly investigated.

SCIENTIFIC SERIALS

THE *Monthly Microscopical Journal* for this month commences with a paper by Mr. W. H. Dallinger and Dr. Drysdale, entitled "Researches on the Life History of a Cercomonad: a lesson in Biogenesis,"—in which they describe, as the result of a very thorough and long-continued series of observations, the life history of a new Cercomonad, which is thus summarised:—"When mature, it multiplies by fission for a period extending over from two to eight days. It then becomes peculiarly amæboid; two individuals coalesce, slowly increase in size, and become a tightly distended cyst. The cyst bursts, and incalculable hosts of immeasurably small sporules are poured out, as if in a viscid fluid, and densely packed; these are scattered, slowly enlarge, acquire flagella, become active, attain rapidly the parent form, and once more increase by fission." They show also that the granules can withstand a temperature much higher than can the mature forms.—Dr. Royston-Pigott makes remarks on the Confirmation given by Dr. Colonel Woodward to the "Colour test," which comes into play in proving that spherical aberration is reduced to a minimum in objectives.—Dr. Dawson remarks on Mr. Carruthers' views of Protataxites, the latter author having described it as a gigantic seaweed, called by him *Nematophycus*. Dr. Dawson gives further reasons for maintaining his original opinion that it is phænogamous.—Prof. Rupert Jones continues his excellent papers on Ancient Water-flees of the Ostracodous and Phyllopodous tribes (Bivalve Entomostraca). This is followed by an article on the pathological relations of the diphtheritic membrane and the croupous cast, by Mr. Jabez Hogg, which would have been more in place in a medical journal. The Wenham-Toller controversy is maintained by the latter and some others, and there are abstracts of several interesting papers, with notices of Vol. III. of Stricker's Histological Manual and Dr. Frey's work on the microscope.

Poggendorff's Annalen der Physik und Chemie: No. 4, 1873.—In this number appears the sixth of the series of papers on internal friction of gases, by O. E. Meyer and F. Springmühl. The authors, having formerly examined the transpiration of atmospheric air through capillary tubes, have further observed that of carbonic acid, of oxygen, and of hydrogen, and find the Poiseuille law to hold good for these gases also. In most of the experiments the gas streamed from one vessel into another containing the same gas at lower pressure; but the case of a gas streaming into a vessel containing another kind of gas was also examined. The velocity of transpiration proved the same, and there was no counter-current of the second gas through the capillary tube, as in the case of diffusion. In an appended note the authors criticise some experiments of von Lang.—Dr. Röntgen gives details of a careful determination of the relation of specific heat at constant pressure to that at constant volume, for the gases, air, carbonic acid, and hydrogen; the mean numbers obtained being 1·4053, 1·3052, and 1·3852 respectively. The writer discusses these results in their bearing on the mechanical equivalent of heat, and the velocity of sound, and compares the work of previous experimenters on the subject.—The concluding part of a paper by F. Rudorff on solubility of salt mixtures appears in this number; and A. Potier replies to certain strictures, by Quincke, on some recent observations of his, as to reflection from metals and glass. Among the remaining matter may be noted an important memoir by G. Rose (communicated to the Berlin Academy), on the behaviour of the diamond and graphite on being heated. The author describes and illustrates the regular forms produced in the diamond through combustion, treats of the general heating effects where air is excluded and where it is not, the natural blackening of diamonds, the so-called carbonate, and connected topics.—A note by F. Zöllner, detailing further experiments to show that electrical currents are produced by current water (a statement which was questioned by Beetz a short time since), also deserves attention.

Der Naturforscher, June 1873.—Among the more important papers in this issue we may note the account of Pettenkofer and Voit's recent researches on the value of fat as a nutritive substance. They find that fat is very largely absorbed from the alimentary canal, but after long feeding with great quantities of fat the absorption becomes less; also that (contrary to a common opinion), fat is much more readily decomposed into simpler products than albumen. The decomposition of food-fat depends on that of albumen, on the amount of albumen present, and on the proportion of it fixed in the organs, to what is in circulation. The results given in this memoir have an important practical bearing. Another physiological paper treats of the influence of food on the structure of digestive organs: the experimenter, H. Crampe, thinks that the nature of food, alone, affords no sufficient explanation of the differences found in these.—An article on the loss of free nitrogen in putrefaction describes some interesting experiments by Messrs. König and Kiesow. In physics and chemistry we find notes on the change of length and electricity produced by the galvanic battery, on the action of electricity on carbon compounds, on Dr. Gladstone's new air battery, on the action of electrical force on non-conductors, &c.—There are two French astronomical papers, one on an attempt to measure the diameter of Sirius; the other, on MM. Cornu and Baille's new determination of the mean density of the earth. Geology, meteorology, and other branches of science, are also represented.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 28.—M. de Quatrefages, president, in the chair.—The following papers were read:—On the exponential function, by M. Hermite.—An examination of the theory of the thrust of earthworks against their sustaining walls, by M. de Saint-Venant. This was a criticism on M. Curie's late papers on this subject.—On a proposed regular service of train transports between Dover and Calais, by M. Dupuy de Lôme. The author, in conjunction with Mr. Scott Russell, has devised a method of transporting entire trains by means of large steamers. Part of the paper was devoted to a project of a new port west of Calais, as that place is useless for the purpose; at Dover everything is ready for such a purpose, there being now 40 ft. of water at the end of the Admiralty pier at low tide. The proposed scheme would be able to carry 800,000 passengers, and 870,000 tons of goods annually.—On electric cauterisation applied to surgery, by M. Sédillot.—New researches on the solar diameter, by Father Secchi. The author had found the sun's diameter, observed spectroscopically in the lines C and B, to be less than that given by the Nautical Almanac; he hence advocated the use of monochromatic images for making such determinations, and replied to some objections of S. Respighi, who, on repeating these experiments, agreed with the almanac.—M. Ledieu's paper on thermo-dynamics was continued.—On a new method of condensing liquefiable bodies held in suspension in gases, by MM. Pelouze and Audouin.—On different forms of curves of the fourth order, by M. H. G. Zeuthen.—On the respiration of submerged aquatic vegetables, by MM. P. Schutzenberger and F. Quinquaud.—On the structure of the cerebral ganglia of *Zonites algirus*, by M. H. Sicard.—On the planet Mars, by M. C. Flammarion.—On a new system of pneumatic telegraphy, by MM. D. Tommasi and R. F. Michel.

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