THURSDAY, OCTOBER 28, 1897.

THE LOGIC OF DARWIN.

The Method of Darwin: a Study in Scientific Method. By Frank Cramer. (Chicago: A. C. McClurg and Co., 1896.)

THIS excellent and most useful little work arose, as its author states in the preface, "from the belief that the direct study of scientific method, as it is illustrated by the works of the accepted masters, is worthy of far more careful attention than is usually accorded to it." The method of Darwin was chosen for the author's purpose (pp. 23, 24) because of the importance of scientific method as a study, because "logicians and scientific philosophers draw their illustrations of scientific method almost exclusively from the physical sciences" which, although "fascinating on account of their brilliancy and their approach towards mathematical certainty," are less adapted than the biological sciences "to furnish models for the average student, because in the nature of their logical difficulties they approach more nearly to the experiences of common life," lastly because

"Darwin's custom of presenting all sides of a case very frequently led him to expose the original course of his thought and the order of his discoveries [rightly regarded by the author as a rare thing in a discoverer] so clearly as to make the reader almost feel that he and Darwin are making the discovery together. Darwin consciously recognised or unconsciously felt that there was considerable power to produce conviction in an understanding of the particular mode in which the truth was reached. He so habitually took the reader into his confidence that he will probably always remain the clearest model in the biological world for the study of applied logic."

Having made his choice for the weighty and cogent reasons which have been quoted above, the author proceeds to analyse Darwin's method, and the manner in which he applied it, continually illustrating his argument by reference to various discoveries and hypotheses—well selected and briefly but sufficiently described in language of great clearness and precision. The attitude of the writer towards his great subject is peculiarly pleasing. Although feeling the deepest respect for the "master-mind" of Darwin, and proclaiming "that Darwin's investigations, and the reasoning based upon them, have furnished the biological sciences with their dominant principles," the author frankly criticises and employs as illustrations any mistakes which he can find in the vast researches of the great thinker of our century, and having found them, attempts to explain the causes to which they were due.

The scope and object of the work may be inferred from the subjects of its chapters. The first deals with "Education and the Art of Reasoning"; the second, "Darwin's Views of Method"; the third, "The Starting Point of Investigations"; the fourth, "Exhaustiveness—Time given to Investigations . . ."; the succeeding four chapters are devoted to "Negative Evidence," "Classification," "Analogy," and "Induction" respectively; the succeeding five to "Deduction"; while the fourteenth contains "General Discussions"; the fifteenth, "Logical History of the Principle of Natural Selection"; the sixteenth, "Conclusion."

The whole volume is full of suggestive thoughts worthy of the deepest attention. The exigencies of space prevent more than a very brief selection to be made use of in this place. The distinction between the reasoning which follows the order of discovery, and that which follows the order of proof, is very clearly expressed, together with a plea, on behalf of the student, for the more frequent employment of the former. "Books and lectures are invariably built up on the plan of proof—the question how a conclusion was reached is rarely presented . . ." Hence

"the student is made a recipient. He is struck by the lucid arrangement of facts, the majestic sweep of the argument, and wonders why the world did not sooner get hold of the truth that seems so conclusive to him. In the laboratory the hand-books tell him what to look for and where to find it, and in the lecture-room the facts are arranged and the theoretical explanations are made for him. Thus in neither of the two practical divisions of the art of reasoning is he allowed to follow even the untrained impulses of his intellect" (pp. 19, 20).

Even when the importance of the reasoning employed in discovery is recognised, models of it will be found to be rare because a man of science,

"after establishing a conclusion to his own satisfaction, is not concerned with telling other people how he reached it, but with convincing them of its truth. For this purpose he throws his conclusions and facts into the order best suited to form a compact argument."

This statement seems to us to be not only true, but one of those truths which merely require to be pointed out in order to produce an important effect. This reasoning, stated in the author's clear language, is likely to lead observers to reconsider their methods of exposition, and determine occasionally to attempt the not uninteresting task of unravelling the tangled and devious lines by which they have been led to discovery.

The hard work, especially upon geological problems, performed in all the isolation and difficulties of the voyage of the *Beagle*, is regarded as the great educational influence of Darwin's life, and the author attaches importance to the fact that he was "unhampered by laboratory handbooks with directions for finding the facts, or by professors to do the reasoning for him, either before or after the facts were found" (p. 30).

The writer truly maintains that "the very grain of his scientific character was conscientiousness" (p. 31), a view which was eloquently put before the members of the Junior Scientific Club at Oxford by Prof. Michael Foster in one of the earliest lectures—I think the earliest—delivered before that Society.

One of the greatest of the many debts due to the author is the clear statement of the meanings of the terms induction, deduction, and the inductive method (pp. 35-39). Darwin, as we know, was not convinced by writers of a "deductive" cast; on the other hand, Darwin's friend and teacher Sedgwick accused him of forsaking the "inductive method." Deduction has come to be a term of reproach, induction a term of commendation, when applied to a scientific worker. Now the work before us puts all this in its true light, to the great help and comfort of those who have not the time to make a special study of formal logic. Deduction, or "reasoning from the general to the particular, from a law, principle, or general fact to a particular fact," is as much a part of the scientific or so-called inductive method as induction itself, or "reasoning from particular to general, from facts to laws or principles." The scientific method

"includes all the logical processes, induction, deduction, analogy, verification—every way in which the intellect passes from fact to fact. This is widely different from what Bacon originally meant by inductive method; but practically no scientific man has ever followed Bacon's method. The inductive method, as illustrated by Darwin's own work, and as understood by all who think clearly on the subject, consists in the formation of an hypothesis from the facts by induction at the earliest possible moment in an investigation, deductive application of the hypothesis to known facts, and in the search for others that ought to exist if it is true, until it proves itself imperfect. By the help of the new facts the hypothesis is improved (by induction) and again applied, until by successive approximations it reaches the truth. So that in the so-called inductive or scientific method deduction is far more extensively used than induction."

In fact, as the author states, John Stuart Mill has "described the combination 'hypothesis, deduction, and verification' as the deductive method." Inasmuch as induction and deduction are both absolutely essential to the process above described, neither of them ought to be selected for the purpose of giving it a name; the process should always be called "the scientific method." When "induction" is used as a term of commendation, it is employed to mean the whole process, in which deduction, although not more necessary than induction, is "far more extensively used." When "deduction" is used as a term of reproach, it means "reasoning from postulates the truth of which is accepted *beyond dispute*"; it "starts from principles whose truth is not questioned," whereas

"in the scientific method the object is not merely to deduce consequences from laws or principles, but to establish the truth or falsity of those laws or principles themselves. Hence there is an incessant interplay of induction and deduction."

In considering "starting-points," it is well shown that Darwin's material lay all round him—the first facts already known, and sometimes the explanation hit upon, but the whole significance as yet unappreciated. This is shown to be the case with the local variation of the Galapagos fauna, the action of earth-worms, the reversion caused by the crossing of pigeons, and the facts upon which the investigation of insectivorous plants was begun. This is not only true, but most encouraging; such material is still thickly spread around every scientific worker, ready to lead to important researches, and yield the most valuable conclusions when its significance is understood. And the effect of practice and learning from example is well seen in the increasing power which this kind of understanding gains. The beginner who has not yet commenced his first research has much difficulty in finding a subject, and here it is that an inspiring teacher or friend may turn the whole current of his life by a few suggestive words. When he has had experience, the difficulty is to find time to undertake the innumerable researches which now seem to crowd around him.

In the chapter on "exhaustiveness" is shown the immense gain which we owe to the patience and thoroughness with which Darwin conducted his researches, even though

"he could have secured for himself the priceless gem of '*priority* of discovery' without the tedious years of work."

"One of the most notable legacies that he left to the ambitious student is his example of great energy and great patience; his incarnation of the truth that time, as well as reason, is the handmaid of science."

In giving a brief account of Weismann's theory of heredity (pp. 119-120), the erroneous impression might be gathered that the theory in question was framed in order to support natural selection and the contention that acquired characters are not transmitted. This is the wrong order; Weismann's study of the early history of the germ-cells, especially in Hydrozoa, suggested the theory, and this again opened up the question of the transmission of acquired characters and the scope of natural selection.

The "importance of theory" is well illustrated by the remarks upon Darwin's and Sedgwick's failure to see the traces of glacial action during their careful examination of the rocks at Cwm Idwal. "The secret of their failure is that they were not looking for it. It is usually the things that men look for that they see; and to look for things as yet unseen requires a theory as a head light" (p. 129).

Wallace's brilliant suggestion of the warning significance of the bright colours of caterpillars is described; but the great development which this and kindred subjects have undergone in recent years is undervalued by the writer who only sees "the enormous amount of wild deduction and half-digested observation." In a subject of wide general interest attracting an immense number of observers of all degrees of competence and experience, these strictures are likely enough to have force as regards a large number of the suggestions made; but, in spite of all errors of interpretation and observation, the whole subject has advanced immensely and greatly gained in extent and solidity since Bates' fruitful suggestion was brought before the Linnean Society in 1861, and Wallace's, before the Entomological Society in 1867. Some of the most important conclusions reached since then have not only been confirmed by an immense body of evidence brought together by their supporters, but have also been verified by the researches of those whose attitude was severely critical. The author's conclusion that "what is most needed is more light on the physiological causes at work within the animal, and producing and determining the distribution of colours," is, it is maintained, erroneous. Such researches, some of which have been and are being undertaken, are of the deepest interest and importance, but they are likely to shed but little light upon the significance of colour and pattern in the struggle for existence.

The very common mistake made by Darwin's critics in supposing that the inability to supply a cause of variation undermines the logical foundation of the theory of natural selection is well exposed (p. 166). In dealing with "unverified deductions," the interesting case of the electrical organ of certain fish is considered in some detail, and the treatment should have been enriched by some account of Prof. Gotch's researches on the subject continued through so many years.

We regret to see the reference to Garner (on p. 191) in a work of such high merit; although the author wisely hesitates to accept any conclusions as yet made public.

We cannot do better than conclude this notice of Mr. Cramer's admirable and well-written little book, in his own well-chosen words :—

"Whatever may be the future of the particular conclusions which Charles Darwin reached, the general method which he employed and the general drift of his conclusions will have a permanent value. All his efforts tended towards the unification of knowledge. All his inductions became corollaries of one great theory; all his deductions had to do with efforts to test and prove the truth of that theory. The subordination of all the devices of the intellect to one great comprehensive purpose has given a unity of aim to all the great works of his life, and has made his general method conspicuously lucid, and has knit the products of his intellect into one great logical whole." E. B. P.

A THEORY OF PHYSICS.

Theory of Physics. By Joseph S. Ames, Ph.D. Pp. xviii + 513. (New York: Harper, 1897.)

MR. AMES has written a very interesting book, and one which to many students will be of great value. At the same time it is extremely condensed. To cover the whole range of physics, beginning with mechanics and properties of matter, including also sound, heat, light, electricity and magnetism in about 500 pages, is no easy task. Nor is it made less easy by the fact that Mr. Ames is not content with dealing only with the elementary parts of each subject, but carries his readers far into the region of modern theories. Thus Book ii., on heat, contains a chapter on the kinetic theory of matter; while the introduction to Book iv., electricity and magnetism, deals with the properties of the ether, and in the section on light we have chapters on double refraction and polarisation. The book is intended to be studied in an academic year of nine months by "students who have had no previous training in physics, or at the most only an elementary course." A large majority of these, we fear, will find beyond them the task of assimilating in so short a time all the nourishment it contains; the minority who succeed in the attempt will have a very good knowledge of physics, and all who read the book intelligently will benefit by its study.

There is a freshness about the style and about the manner in which the laws and facts of physics are presented, which is very invigorating, and which adds greatly to the interest of the book.

The book opens with a chapter on kinematics; this, on the whole, is clear and precise, but the proof given in § 18 of the formula connecting the space passed over by a body moving with uniform acceleration with its central velocity and the time of motion is incomplete.

The chapter on dynamics, dealing with motion and force, might usefully be amplified. The author starts from the law of the conservation of linear momentum for a series of bodies "entirely free from all external inflences" as an experimental fact, which, so far as it has been tested, seems absolutely true and without exception.

Inertia is defined as a property of matter which becomes evident to our muscular senses when we try to change the motion of matter, and two bodies are said to have the same mass when they have the same inertia; the masses of two bodies are supposed to be compared by observing the velocities which a given spiral spring can confer on them when compressed to a definite extent and allowed to act on each in turn.

Knowing the masses, the momenta of a series of bodies having motions of translation only can be calculated, and the law of the conservation of momentum tested.

The rate of change of the linear momentum of a body with respect to the time is then defined as the "force acting on it," and Newton's laws of motion are explained. Such an explanation of dynamics has many claims to our attention, and is certainly more logical than that adopted in many modern books; at the same time, it is more difficult for the ordinary student to grasp; he knows force as muscular exertion. The schoolboy who illustrated his reply to his teacher's question, What is force? by doubling his fist and striking his classmate is typical, and the difficulties of introducing him in his first study of dynamics, to "force" as a name for rate of change of momentum are considerable. The book is, the author implies, intended for students working in a class, seeing demonstrations and doing experiments for themselves; thus opportunities for explanation and amplification will naturally arise; still we wish the author had found space to develop this part of his book more fully.

Matter in rotation is dealt with in § 41, and the elements of rigid dynamics are based on the law of the conservation of angular momentum. This law is stated as independent of the law of the conservation of linear momentum; it is usually deduced from the latter. The treatment of the section on liquids introduces fewer novelties than that dealing with solids; the important idea of pressure at a point, however, deserves, we think, a fuller explanation than is accorded to it; the sections on capillarity are clear, and the principal phenomena of osmosis are described. The parts of the book on sound and heat do not call for any very detailed notice; the main criticism, to which the book is open throughout, applies here also: advanced portions of the subject are somewhat frequently referred to in so brief a manner that the student cannot, without further assistance, obtain really clear ideas on the subjects dealt with.

Book iv., electricity and magnetism, commences with a reference to the ether, with which, we are told, electric and magnetic effects are intimately connected. But the earlier sections of the book describe the production of electric charges and the ordinary phenomena of electrostatics in the usual manner. It is stated, § 215, that the property of attraction possessed by an electrified body "will be shown in Article 221 to be due to changes in the strain of the medium round the charged body"; but the demonstration given in § 221 can hardly be called a proof.

The difficult questions involved in the theory of primary cells are treated of in § 242, but not, we think, quite successfully. It is stated, among other things, "that there is a *slight* difference [of potential] at the junction of the copper and the zinc," and it is implied that the charge in potential in passing from the liquid to the zinc is considerable. "These facts, it is said, may be proved by direct experiment." While in all probability these statements would be found true if we could measure the actual potential of the zinc, the copper and the acid, direct experiments, measuring as they do the potential in the air near the zinc and copper, seem to show us that these differ in potential considerably.

Book v. deals with light, and bases the explanations entirely on the wave theory.

There is much to be said for such a treatment; still some of the proofs given necessarily want in rigidity—*e.g.* that in § 306, on the law of reflection—and the clearness of conception acquired by the student who makes a careful study by graphical methods of the phenomena afforded by lenses and mirrors is a great gain to him.

The book is clearly printed and admirably got up; the diagrams are good; the plate of spectra in black and white, facing p. 264, is a marked improvement on many of the chromolithographed plates we have seen.

OUR BOOK SHELF.

A Detailed Course of Qualitative Chemical Analysis of Inorganic Substances, with Explanatory Notes. By Arthur A. Noyes, Ph.D. Pp. 89. Third edition. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THE present work arose out of the difficulty experienced by the author in attempting to give a thorough course of qualitative analysis in limited time to large classes of students. Of course in a work dealing with so hackneyed a subject anything new must be looked for in the arrangement of the material. It is a common practice to preface the actual analytical separations by a course of test-tube reactions with each metal and acid, with the object of combining a course of systematic inorganic chemistry with the study of analysis. The author prefers to keep the two separate, thinking that the former is better taught by a course of inorganic preparations than by the test-tube reactions, which mostly involve mere questions of solubility. The present course accordingly plunges at once into the separations of the metals, passing on to the wet tests for acids, and concluding with dry tests and an excellent chapter on the preliminary preparation of substances for analysis. The book is intended to be used in the laboratory, and to be accompanied by lectures on, and demonstrations of, the analytical processes. When employed in this way it is thoroughly to be commended. Minute directions are given for carrying out each operation, followed by notes explaining the reason of everything which is done, and the apparently anomalous results which may arise from the neglect of the precautions specified, or from other causes. These notes form a peculiarly excellent feature of the book, and reveal the hand of the experienced teacher. The section on the tests for acids is, perhaps, the least satisfactory, the tests selected being, in the writer's opinion, not invariably the best available.

The printing, paper, and binding are uncommonly good, and a useful index is provided.

Physikalische Chemie für Anfänger. By Dr. C. M. van Deventer; with a preface by Prof. J. H. van 't Hoff. Pp. 167. (Amsterdam: S. L. van Looy. Leipzig: W. Engelmann, 1897.)

PROF. VAN 'T HOFF says, in his preface, that he had experienced, in his lectures to medical students, the want of a text-book dealing with the general laws of chemistry in an elementary way, a want which was supplied by Dr. van Deventer's book. The book begins with definitions of terms, and then goes on to the laws of chemical combination, the laws regulating the behaviour of gases, Avogadro's hypothesis, atomic and molecular weights. The fourth chapter deals with the specific heats of elements and compounds, and contains an excellent *résumé* of the more important results of thermo-chemistry, concluding with the laws of mass action and some pages on distillation. The last three chapters deal briefly with the theory of solutions, spectroscopy and photo-chemical action, and the periodic law. Although it might be objected that the discussion of the asymmetric carbon atom on p. 40 is somewhat beyond first-year students, that too much space is devoted to the erroneous principle of maximum work, and too little to the hypothesis of electrolytic dissociation, which is of such great interest in connection with the qualitative analytical work which forms a considerable portion of the laboratory practice of elementary students, yet these are matters on which different teachers would entertain different opinions, and on the whole it must be said that the work is thoroughly well done and suited to the purpose for which it is intended.

Bromide Enlargements, and How to Make them. The Popular Photographic Series, No. 13. By J. Pike. Pp. 64. (London: Percy Lund, Humphries, and Co., 1897.)

THERE are many of us who delight in the use of hand cameras, but who find those of larger size too cumbersome and unwieldly to carry about. With the former pictures may be obtained without those numerous preliminaries which must be gone through every time a picture is required, such as putting up the tripod, setting up the camera, &c., but their size necessitates that the pictures must be rather small. These latter can, however, be enlarged when required, and it is with this special subject that the present little book deals. The process is quite simple, as will be gathered from the sixty-four pages in which the author brings together all information that the operator can require. Not only is the actual method of making bromide enlargements described, but useful hints will be found on constructing one's own apparatus, the different sources of light available, screens, skies and sky printing, &c. The book forms an interesting addition to the popular photographic series, and it should be widely read.

The Machinery of the Universe: Mechanical Conceptions of Physical Phenomena. By Prof. A. E. Dolbear, A.B., Ph.D. Pp. vi + 122. (London: Society for Promoting Christian Knowledge, 1897.)

IN December 1895, Prof. Dolbear delivered before the Franklin Institute of Philadelphia a lecture on mechanical conceptions of electrical phenomena, and the substance of it was published in NATURE a year ago (vol. lv. p. 65). The lecture has been enlarged by the addition of a section in which the properties of matter and the ether are compared, and it now forms one of the "Romance of Science" series of the Society for Promoting Christian Knowledge. The aim of Prof. Dolbear is to show that the mechanical antecedents of physical phenomena are sufficient to explain the phenomena without assuming the existence of other factors.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

On the Meaning of Symbols in Applied Algebra.

REFERRING as briefly as possible to Prof. McAulay's letter on page 588, I contend (1) that no complex reasoning is necessary to show that the commutative and associative laws hold for the symbols of units or (better term) standards; a simple method was indicated in vol. xxxviii. p. 281; and (2) that meaningless things like the square root of a foot do not appear in any correct final result. It is true that the square of an hour is meaningless too, but the *apparent* occurrence of such a thing, in acceleration for instance, is otherwise explicable; for velocity is a real and simple physical quantity.

Magnetic intensity is not really the time rate of the square root of a linear density, as Prof. McAulay imagines that physicists suppose it to be; he has omitted an essential factor; and when we discover the real nature of μ, we shall find it such as to satisfactorily rationalise the gibberish he properly "abhors." If, for instance, μ turns out to be an etherial density, the specification of H would be length divided by time.

University College, Liverpool, OLIVER J. LODGE.
October 22.

Strange Instinct of Fear in the Orang.

THE following circumstance which occurred at the Zoo on Sunday last, and was witnessed by Mr. W. E. de Winton and myself, is perhaps worth putting on record.

We were watching and making friends with the baby orang, and my wife was standing by, holding on her hand a muff manufactured out of the skin of the Indian flying-squirrel, with the unstuffed skin of the head to the front, and the bushy tail hanging loosely over it. Suddenly, but quite gently, she stretched out the muff towards the orang, but at the sight of the advancing fur a light of unmistakable terror sprang into the creature's eyes. Upon repeating the experiment, the ape promptly rolled over backwards as the quickest way of removing himself from the immediate vicinity of the terrifying object; then gathering himself together, climbed up the branches of his tree, and retreated to the back of the cage, keeping all the while a wary and frightened eye upon the muff, as if in fear of an attack from behind. It is interesting that the whole performance was carried through without the utterance of a sound on the part of the orang; but that he was acting under the influence of fear, there is, I am persuaded, no doubt. His behaviour, in fact, reminded me irresistibly of the behaviour of a friend's little child of ten months old, who evinced similar signs of fright upon being shown a toy fur monkey for the first time. R. I. POCOCK.

Natural History Museum, October 25.

Hereditary Colour in Horses.

MR. FRANCIS GALTON'S very characteristic article in the current number of NATURE, page 598, upon hereditary colour in horses, appealed to me with more than usual interest, as for some months I have been planning a somewhat extensive investigation into the hereditary transmission of various characteristics amongst the higher members of the animal kingdom, including that of colour in horses.

It may be of interest to your readers if I summarise a recent quite preliminary investigation upon the same matter, which I shall hope at some future time to work out more thoroughly. I may add that, contrary to what Mr. Galton experienced with the data he used, all the grey foals in my data did *not* come from grey dams.

An examination of the offspring, numbering in all 1566, of one special class of mares shows that there were 686 offspring which resembled the general colour of the dam, and 880 which differed; or a preponderance of 28 per cent. dissimilar. Of these:—

313 colts were the same in general colour as the dam.
394 ,, ,, *not* ,, ,, ,, ,, ,,
373 fillies ,, the same ,, ,, ,, ,,
486 ,, ,, *not* ,, ,, ,, ,, ,,

Hence we have two broad results: (1) the excessive preponderance of fillies over colts; and (2) that the colts more frequently resemble the colour of the dam than do the fillies. For every hundred fillies there would be 102 colts resembling the dam.

Truly this is not a large difference, but, based as it is upon over 1500 cases accurately described and exactly tabulated, it seems worth calling attention to, as it carries Mr. Galton's analysis a step further, and points to the possibility of a further development in an exceedingly interesting branch of heredity.

Churchfield, Edgbaston. F. HOWARD COLLINS.

Dog Running on Two Legs.

IT is not necessary that a dog should be compelled by accident to resort to this mode of progression (p. 588). Some years ago I had a clever little Scotch terrier which would occasionally run in this way. It would balance itself on two legs, sometimes on one side and sometimes on the other, holding the other pair up, and run with perfect ease for a considerable distance. As this is the only instance I ever met with, or heard of, I do not suppose that the accomplishment is a common one with dogs.

Highfield, Gainsborough. F. M. BURTON.

THE OBSERVATION OF METEORS, WITH ESPECIAL REFERENCE TO THE LEONIDS.

DURING the next few years a large amount of attention will be given to meteoric astronomy in general and to the great shower of Leonids in particular. The present may, therefore, be an appropriate time to refer to a few points connected with this interesting branch. It has often occurred to the writer that it would greatly facilitate the comparison of different materials if observers adopted one uniform method of recording meteor-flights. Some merely give estimated compass bearings, and a rough guess at the altitude and inclination of path, others give the place and direction according to conspicuous stars near, others simply mark the courses on a map without reading off the individual positions, while others give the R.A. and Decl. of both beginning and ending of every object observed. It would be a great advantage if every one tabulated results according to the latter method. It can easily be done if the tracks, as observed, are pencilled upon a celestial globe or star chart, and the positions read off; and this is a much more exact method than describing the flights by stars near which they happen to pass.

Another point is that the accurate observation of meteors demands a considerable amount of practice. It would, therefore, be a most useful preparation for intending observers of the Leonids if they carefully watched the Perseids of August, Orionids of October, and some other prominent displays, and gained a little practical experience of the work. They would find it of material assistance to them, and would enable the Leonids to be observed more expeditiously and correctly than must otherwise be the case. Accounts are sometimes published of meteoric showers by persons who are reporting a perfectly novel experience, and it is not too much to say that such descriptions are useless as regards many essential details. A perfect novice may of course stand and count the number of meteors visible, and may be capable of describing a star-shower in a general way, but he is heavily handicapped when it comes to recording the more difficult features with precision.

What photography may achieve in meteoric work we cannot definitely foresee, but it is quite certain that the proper observation of meteors, as at present conducted, demands the work of a lifetime. A man must watch for meteors all night, and suitably record them, and by day he must analyse the observations and determine the radiant points. The observer need not, perhaps, absolutely isolate himself from all other work; but the meteoric branch is such an extremely difficult one, embracing, as it does, some thousands of streams which exhibit many different peculiarities, that in order to grapple with the subject successfully he must make it his constant care and the object of his earnest efforts and thoughts during many years.

Fortunately the Leonids are to be classed amongst that description of meteors comparatively easy to observe and record. They leave streaks for a second or two, and from these the directions are to be determined with great facility and precision. It is also a fortunate circumstance that the radiant point is surrounded by the well-known stars in the Sickle of Leo. The lines of flight may therefore be readily carried back in the correct directions by projecting a straight wand upon the streaks, and noting their points of convergence relatively to the stars named.

The writer has usually found the radiant very definitely and sharply defined, and it can be readily fixed to within 2° of probable error. But naked-eye observation is capable of much more accurate results than this, if, during a pretty active return of the shower, the observer will independently fix the radiant during, say, successive half-hours of the night; he will in this way get eight, ten, or twelve positions, from which he may derive the mean place of the radiant to within about ½° of error.

The Leonid radiant is sometimes described as very diffuse; but this is a false effect brought about by two circumstances which, if properly allowed for, would leave a very definite and satisfactory position. One cause of its apparent diffusion is that meteors are attributed to it which really belong to the minor showers in Leo and the surrounding region, of which quite a large number exist. They display similar visible characteristics to the Leonids, and can only be dissociated from them by the exercise of extreme care in noting their directions of flight. In *Popular Astronomy*, vol. i. p. 298, I gave a list of sixty-eight meteoric radiants situated in various parts of the heavens, and active during the period November 10–15; and in *The Observatory*, vol. xx. p. 306, a table of seventy-two circum-Leonid showers was published. Those which chiefly affect the determination of the Leonid radiant are placed near δ and ι Cancri, μ and ξ Ursæ Majoris, λ Hydræ and π, λ, τ and β Leonis. The meteors are swift, and usually leave streaks. Another contributing feature to dispersed radiation is found in the unavoidable errors of observation. Great care and habitual practice can, however, reduce these to small limits, and it will be found that the radiants derived from accurate materials will be pretty sharply defined.

The probable error in the case of different observers must, however, vary to a considerable degree, for practice cannot equally eliminate inaccuracy from amongst them all. In catching and retaining correct impressions of meteor flights, natural aptitude exercises an important influence. It is like a game of skill depending upon the eye, judgment and quickness in execution. Really few will excel, while many will only attain mediocrity, and some must altogether fail to acquire the desirable proficiency, even after years of experience.

The horary rate of appearance of Leonids cannot be exactly determined unless the contemporary showers are considered, and their meteors separated from the true Leonids. Many observers count every meteor proceeding from the general direction of Leo as necessarily a Leonid, and thus the horary number is exaggerated. If an inexperienced observer gives 20 as the number of Leonids seen in an hour, the fair inference is that not more than 14 or 15 of them were true members of that system. During very strong returns of the shower this point may, however, be disregarded, for the minor streams can then exercise very little relative influence on the results, and are virtually obliterated by the superabundance of Leonids.

One new feature to be attempted during the ensuing return of the Leonids is to photograph the meteor group of November 1866 in space, and an excellent ephemeris of its nearly stationary position in Libra and south-eastern limits of Virgo, during the first four months of 1897, was given in *Monthly Notices*, lvii. p. 70–2. Some people will regard the idea as little more feasible than opening a correspondence with the inhabitants of Mars, and certainly there appears very slender prospect of its successful realisation. The experiment ought, however, to be tried. Let us support every project which has a possible side to it, for it is quite clear that many things deemed beyond our reach are capable of attainment by persevering efforts and proper means. Novel attempts of this kind, if seemingly chimerical, should not be hastily condemned or necessarily considered as vain labour. Mr. Roberts's photographic search for a trans-Neptunian planet was a novelty, and it proved vain labour; but who will say that it ought not to have been undertaken? The same may be said of Mr. Barnard's similar search for a satellite to the moon. To look for a fifth satellite of Jupiter was decidedly a novelty in these modern times, and yet it proved productive. Let, then, new researches like these have our encouragement; for if they do not always succeed, they stimulate our interest and enthusiasm, and make the science more attractive by imparting to it a welcome freshness and, perhaps, a touch of romance.

As to the practical aspect of the question, it is fair to conclude that the Leonid group of 1866 is too faint an object to be ever impressed on a photographic plate, especially when its distance is so great as during the past spring, for on March 1 this was equivalent to 800,000,000 miles, and not far short of the mean distance of Saturn! In the great meteor storm of November 27, 1885, when the meteors were more thickly congregated than in the Leonid shower of November 13, 1866, Prof. Newton computed that "the space in the meteroid group corresponding to each single visible meteor was in the densest portion of the group, a cube whose edge is 32·8 kilometres or 20·4 miles." This means one small pebble in twenty miles of space! The degree of illuminating power exhibited by a group of these bodies, separated by such distances, must be infinitesimally small. If any one were to attempt to photograph Tempel's comet (1866 I.), on its return journey, the chances of success would be far greater, for though the comet has still to run eighteen months before reaching perihelion, it is nearer to us than the meteor group of 1866, and must be infinitely brighter, as it doubtless represents the richest part of the stream. We must remember that Tempel's comet passed its perihelion on January 11, 1866, while the meteor-group reached it ten months afterwards; and it is quite fair to suppose that the meteoric train of the comet, at a distance of some hundreds of millions of miles from the nucleus, must be relatively tenuous as compared with that part in the immediate wake of the comet. The meteors may not, however, show a regular decrease in numbers according to distance from their derivative comet, but may probably consist of a series of groups. There is every reason to believe that disruptions of a violent character affect the physical character of comets, and this was well exemplified in Brooks's comet (1889 V.), visible, in 1896, at its second observed return, which was seen separated into five portions on August 1, 1889. There is, however, every probability that the meteor cluster of 1866 is some hundreds of times fainter than Tempel's comet; yet even the latter was not visible to the naked eye in December 1865, or January 1866, and indeed the object was only followed for a month in telescopes. It might be a good plan to endeavour to photograph the comet first, and then fish for its associated meteor-stream; for the easier objects are sometimes capable of leading us up to the discovery of the more difficult ones.

W. F. DENNING.

THE KLONDIKE PLACERS.

WHEN the attention of the world was called to the new Canadian gold-fields during the past summer, few people had ever heard of the Yukon placers. Nevertheless, prospecting has been carried on for over fifteen years throughout the whole length of the river, both in the North-western Territory of Canada, and across the border in Alaska. The number of gold diggers at work tended to increase from year to year, but the severity of the climate, and the difficulty of getting supplies into the country checked its progress, especially before 1892, when the first steamers were placed on the river by a trading company. In 1896 the total production of gold amounted to little more than 100,000*l.* with about 2000 miners at work, and although some of this was produced on the Canadian side of the boundary, little attention was paid to it by the Geological Survey of the Dominion, and it was reported as if it were a part of the Alaska output.

On September 6, 1896, however, Mr. W. Ogilvie, the surveyor of the Yukon district, reported to the Canadian Government that rich discoveries of gold had been made on Bonanza Creek, a tributary of the Klondike, which flows into the Yukon some fifty miles south-east of Fort Cudahy, where he was stationed, and about the same distance from the U.S. boundary. Mr. Ogilvie continued to make reports during the winter, and from his book on the subject, lately published by the Dominion Government, most of the following information is obtained. The discovery was made by G. W. Cormack, who had been in the country since 1887, and a rush from Cudahy at once took place, 200 claims extending 20 miles along the creek being staked out within a fortnight of the time when the strike became known. Later on, when the neighbouring creeks El Dorado, Hunker, Dry Fork and West Fork were found to promise well, the other diggings on the Yukon were almost entirely deserted. Miners travelled with sleds over the snow from Circle City and other places still further off in United States territory, and by January 1897, 2000 men were encamped on and around the Klondike, with scanty supplies and little protection against the cold, although a temperature of 50° below zero Fahrenheit was not unusual. Many men bought a share in the claims even as early as this for thousands of dollars, and the few labourers who preferred to work for hire received one and a half dollars per hour, working as long as they liked.

Little gold was actually recovered in the winter, the "pay dirt" being dug out and piled up to wait until the spring, when the frost had gone and water was plentiful. Some extraordinary yields were announced, however, as the result of prospecting washings, 250 dollars in a pan (containing about a quarter of a cubic foot of gravel) being reported, but not generally believed. There is little doubt, however, that from one to ten dollars per pan was usually recovered in El Dorado and Bonanza creeks, although the diggers, as is their wont, were very reticent.

In spite of this reticence and the lack of communication with the outside world, news of important discoveries leaked out, and in the early spring the rush into the Yukon basin from British Columbia and California was unprecedented. By May over 2000 people had entered the country by one route or another, and were pushing on to the Klondike, where the town lots of Dawson City had been staked out, and building was in progress. At the beginning of July the population of Dawson City had risen to 5000, and more people kept coming in; but the supplies brought by them were far from being adequate, so that the scarcity of provisions continued almost unabated, and as the summer wore on became more and more pronounced, until it was evident that the 7000 people who will be shut up there in the ensuing winter must suffer serious privations, if not absolute starvation, before the Yukon River becomes navigable again next spring.

Meanwhile, about July 15, the first miners from Klondike reached San Francisco, bringing with them about 400,000*l.* in gold, and the excitement, which had been growing on the Pacific sea-board, became intense, and spread over the whole of the United States and Canada, and even reached England. Thousands of people started for the Yukon without sufficient supplies, and regardless of the fact that it was already too late in the season. Fortunately the means of transport failed. The steamers on the Yukon were delayed, owing to the lowness of the water in the river; and the difficulty of transporting large quantities of stores over the passes leading from the sea-board to the interior prevented the southern route from being used by the majority of the immigrants, so that not one in ten of those who started late in the summer succeeded in reaching the Klondike, and starvation, if it comes, will not be largely due to the newspaper boom of July and August.

Turning from the history of the district to the description of the gold-fields themselves, it may be remarked at once that the placers, which have caused so much excitement, do not present any very unusual features. The gravels are in general about 20 feet thick, and, as usual, the parts immediately overlying the bed-rock are the richest. The pay dirt is, however, said to be frequently 5 or 6 feet thick, and about 30 feet wide, the whole width of the creek-beds varying from 100 feet to 600 feet or more. The gold is very coarse, and is therefore easy to save with crude washing appliances. It is of lower standard than most placer gold, containing only about 800 per 1000 of gold, whilst the average fineness of Californian gold is about 880, and of Australian about 950. No very large nuggets have been found yet, the largest recorded being worth about 2*l.* 10*s.*, and in this particular the placers resemble those of the Pacific coast generally, where large nuggets are very scarce.

Mr. Ogilvie considers that the auriferous gravels have been derived from the crystalline rocks lying to the south of the Klondike, between it and the Stewart River, which also contains gold, but no evidence has been brought forward as to their age. An interesting point in connection with the question of age is that the ground remains perennially frozen, only the surface being thawed in summer to the depth of two or three feet. It would appear therefore that, like the placers of Siberia, these deposits have remained undisturbed and unaltered ever since the Glacial period, and perhaps some such evidence of this will in course of time be discovered, as was afforded by the remains of mammoths and other animals in the Siberian frozen mud.

It is worthy of note that the comparative lowness of standard of the gold is, under the existing conditions, in favour of the view that the placer gold is derived from the erosion of auriferous quartz lodes formerly existing at a higher level, and has not been formed *in situ* by being deposited from solution. For, according to those who support the former view, placer gold becomes of higher standard than reef gold after it has found its way into the drifts, the base metals being gradually removed by the solvent action of running water, in which gold is not readily soluble. Since, however, the Klondike gold has been frozen up during a large part of the time since it was deposited in the gravel, it is obvious that it cannot have altered in composition so much as the gold in river sands further south, and might be expected to resemble the gold in the parent lodes, which is not usually more than 800 fine. The low standard of the gold is not so readily accounted for by the accretion theory of formation of placer gold. Some auriferous veins have already been discovered both in the creek valleys and on the mountains round them, although no direct evidence has yet been adduced to connect these lodes with the sources of the placer gold. Moreover, many nuggets have been found adhering to quartz, so that the weight of evidence appears to be in favour of the view that the gold in these placers, at any rate, has been laid down there by mechanical rather than chemical processes.

The method of working the placers resembles that followed in the frozen placers in the Trans-Baikal in Eastern Siberia. Prospecting is done chiefly in the short summer when the snows are gone and water is plentiful, but the excavation of the gravel is best carried on in winter when nothing else can be done. The shafts are sunk to the pay dirt, and tunnels are then run through the gravel, following the rich material wherever it may be. To soften the ground a pile of wood is placed against the end of the drift and set on fire, the gravel, to the depth of about a foot, being brought down by pick and shovel after the fire has gone out. As M. Levat points out in speaking of the Siberian placers (*Eng. and Mng. Jour.*, June 12, 1897), the method is not an ideal one, but the circumstances are difficult. The frozen soil cannot be easily worked with the pick, as it does not break but simply mats together under a blow. For the same reason powder and dynamite have little effect; moreover, the drilling of the alluvium through which quartz boulders are scattered is a slow and costly work. The gravel is piled up to await the arrival of spring, when it is washed in the cradle or in short sluices, which are expensive owing to the high cost of timber.

The future of the country can hardly be foreseen as yet. It is certain that next year hundreds of miles of unworked creek beds will be vigorously prospected by the thousands who will enter and find that all the ground on the tributaries of the Klondike is already occupied. If, as seems likely, other fairly rich placers are found, many of the men will remain in the country, and with the development of the auriferous quartz lodes and the beds of lignite, some of which have already been discovered, the Yukon district of Canada will probably become one of the steady producers of gold like California or Colorado. The output this year will probably not greatly exceed 800,000*l*., partly owing to the scarcity of water in the creeks this summer, which has interfered with the washing in the creeks. Nevertheless, the Canadian production of gold for 1897 will with this addition be raised to over 1,000,000*l*., or considerably above that of 1863, which amounted to 860,000*l*., and is still the highest on record. There is little doubt that this will be largely augmented in the next few years, and that the Yukon district will be the richest Canadian gold-field yet discovered.

T. K. ROSE.

NOTES.

THE International Congress of Zoology is to meet in Cambridge on August 23, 1898, and a general committee has been formed to make arrangements for its reception. The President-elect (Sir William Flower) has summoned a meeting of the committee, to be held at the rooms of the Zoological Society, 3 Hanover Square, W., at 2.30 p.m. on Thursday, November 4; and special notices have been addressed to those who have expressed their willingness to act as members of the committee. Zoologists who have not been asked to join the committee are requested to communicate with the Local Secretaries (International Congress of Zoology), The Museums, Cambridge.

H.M. THE KING OF BELGIUM has conferred upon Prof. D. E. Hughes, F.R.S., the decoration of Officier de l'Ordre Leopold. This mark of appreciation is due to Prof. Hughes' work in connection with his printing telegraph instrument, which the Belgian Government have largely used during the last twenty-seven years. The Belgian Minister of Railways, Posts and Telegraphs has telegraphed to Prof. Hughes the congratulations of the telegraphic service upon the distinction conferred upon him.

AT a meeting of the Royal College of Physicians of London last week, the Moxon medal was awarded to the President, Sir Samuel Wilks, Bart.; and the Weber-Parkes prize of 150 guineas and a silver medal to Dr. Arthur Ransome for the best essay on consumption and its treatment. A similar medal, called the second medal, was awarded to Dr. Peter Paterson, of Glasgow. The Baly medal was awarded to Prof. Schäfer, of University College. This medal is given every third year to the person who has distinguished himself the most in physiology during that interval.

THE Reale Accademia dei Lincei has recently elected the following associates and correspondents:—National associate, in the section of zoology and morphology, Prof. G. B. Grassi; correspondent, in the same section, Prof. G. Fano; foreign associates in mathematics, Profs. H. Weber and T. Reye; in mechanics, Prof. G. H. Darwin; in mathematical and physical geography, Prof. F. R. Helmert; in geology and palæontology, Prof. A. Gaudry; in physiology, Profs. H. Kronecker and O. Schmiedeberg.

WE print in another part of this number an abridgment of a report drawn up by a deputation appointed by the Manchester Technical Instruction Committee to visit technical schools, institutions, and museums in Germany and Austria last July and August. This is the second time Manchester has delegated some of its educational advisers to see what foreign countries have done and are doing to establish an efficient system of scientific and technical education. The recent visit showed the deputation that since 1891 there has been a considerable development throughout Germany of educational means and resources. The technical education movement in England during the past five or six years has not gone unnoticed in Germany, and the effect has been the extension and improvement of facilities for imparting instruction of a scientific and technical character, the evident determination of Germany being to maintain the lead in higher scientific education. It is satisfactory to know that the educational authorities of some of our cities are also alive to the importance of scientific instruction as an aid to the development of our commerce and industries. When a deputation from an industrial city like Manchester speaks of continental schools and methods in the glowing terms of the report abridged this week, and urges the extension of higher scientific instruction as the force which will enable us to keep our place among the nations, it is time to give thanks that the eyes of leaders of industry have been opened, so that the intimate connection between science and commerce can be clearly seen. The discussion which took place at the Manchester City Council upon the report of the deputation, fully bears out the views expressed by Dr. Armstrong in his recent articles in NATURE on the need of organising scientific opinion (vol. lv. pp. 409, 433). Moreover, it shows that a large number of manufacturers are well able to understand that the reason for the prominence of some of the continental Powers lies in the educational system. It is evident that the report has given Manchester people a clear view of the direction in which advance should be made, and doubtless they will profit by it. Other municipal authorities would do well to send their wise men into the Fatherland for the lessons to be learned if they wish to make industrial progress.

PROF. G. H. DARWIN has gone to the United States to give a course of ten lectures on "Tides" at the Lowell Institute.

A SEA-FISHERIES exhibition, arranged to illustrate the fishing industries and the application of science to agriculture, will be opened in the Museum of Zoology, University College, Liverpool, to-morrow, by Mr. John Fell, chairman of the Lancashire Sea-Fisheries Committee.

PROF. F. OMORI, of the Seismological Institute, Tōkiō, is now in India, for the purpose of investigating the recent Calcutta earthquake, and reporting on the same to the Japanese Government.

THE Departmental Committee recently appointed to consider and report upon the desirability of establishing a National Physical Laboratory, and the functions which such an institution would perform, has just commenced its sittings.

WITH the last issue of our contemporary *The Electrician*, Mr. Bond's nine and a half years' connection with that journal ceased. Mr. W. G. Bond joined the editorial staff in April 1888, and was appointed editor in April 1895, upon the retirement of Mr. Alex. P. Trotter.

THE United States Board of Geographical Nomenclature have lately come to the following decisions about the orthography of some names brought into prominence through the Klondike gold discoveries :—Klondike will be spelt this way and not Clondyke or Klondyke, Lake Lebarge is adopted instead of Lake Labarge, Lake Lindeman instead of Lake Lindemann or Linderman, the Lewes river and not the Lewis river, and Taiya instead of Dyea, to denote the inlet, river, and village at the head of the Lynn Canal.

WE regret to receive confirmation of the report, already referred to, that Dr. J. Hann, Director of the Austrian Meteorological Service, has resigned that arduous position, from considerations of health, and has been appointed by the Minister of Instruction, &c., to the Professorship of Meteorology at the University of Graz. We have very frequently had occasion to notice Dr. Hann's valuable labours in our columns, and we may hope that now he is relieved from the onerous routine duties of such a large organisation he may be able to continue his studies for the benefit of meteorological science. His place in Vienna will be worthily filled by Dr. J. M. Pernter, late Professor of Meteorology at Innsbrück University, and the author of several meteorological publications.

THE Paris correspondent of the *Times* states that the value of the collections bequeathed by the late Duc d'Aumale to the Institute of France is officially reported to be 15,000,000 francs. Of this sum, 1,500,000 francs represents the additions made by the Duke subsequent to his deed of gift. The library alone, with its 28,000 volumes and 1400 manuscripts, is worth 5,000,000 francs. The receipts from lands, fisheries, timber, &c., are estimated at 400,000 francs per annum, which will leave a surplus of 40,000 francs over the outgoings. Annuities, moreover, to the Crédit-Foncier, now amounting to 86,000 francs, will expire in 1934. The Institute will enter next spring into possession of this princely bequest.

THE Duchess of Portland, president of the Society for the Protection of Birds, has written a special letter of appeal for increased funds to enable the Society to establish a small permanent office in London. More annual subscribers are wanted, and as an inducement it is proposed to designate as Fellows all who subscribe not less than one guinea per annum.

A GREAT physiologist, Dr. Rudolf Heidenhain, professor of physiology in the University of Breslau, has just passed away. From a notice of his life and work in the *British Medical Journal*, we derive the following particulars of his career :—Heidenhain was born in Marienwerder on January 29, 1834, and was thus just over sixty-three years of age at his death. He studied medicine at Berlin, Königsberg, and Halle. In Berlin he attended the lectures of Du Bois-Reymond, and in Halle those of F. W. Volkmann. He graduated at Berlin in 1854, and in 1859 he was called to the chair of Physiology and Histology in Breslau, a post which he held throughout his life. The early fruits of his labours and that of his pupils in Breslau appeared in his "Studien des physiologischen Institutes zu Breslau," in four volumes, from 1861 to 1868. Before that time, however, he had published his "Physiologische Studien" (1856). The first volume of "Pflüger's Archiv für d. gesammte Physiologie" appeared in 1868. In this "Archiv," from the second volume onwards, we have numerous papers from his laboratory, by himself, by his pupils, and by his assistants, including such diverse topics as the influence of the nervous system on temperature, metabolism in muscle, arhythmical activity of the heart, action of drugs on the nerves of the submaxillary gland, for example, atropine, calabar bean, nicotin, digitalin; his histological observations on the structure of the pancreas, wherein he showed the changes in gland cells that accompany secretion; the action of stimulation of sensory nerves on blood pressure, both by himself and in conjunction with his pupil Grützner, now professor of physiology in Tübingen; spinal reflexes; the innervation of blood vessels, a continuation of Ostroumoff's work on the same subject. In 1883 appeared his essay, "Physiologie der Absonderungsvorgänge," in vol. v. of Hermann's "Handbuch d. Physiologie." This is still a standard essay on this subject, and it contains an account of his researches on the salivary, pancreatic, gastric, and other glands. The whole series extends to over four hundred pages. His results are incorporated in every text-book on physiology. These essays record a masterly array of work dealing both with the physiological and the histological aspects of the question, and there stands out the pre-eminent fact that in all glands secretion is accompanied by characteristic structural changes. In later years came his now well-known researches on lymph formation, in which he attributed such great importance to the activity of the capillary wall as secretory organs. From his laboratory have appeared that long and important series of studies on hæmodynamics, by his assistant, K. Hürthle, while from the chemical department under Prof. Rohmann has come a whole series of important memoirs, many of them dealing with ferment action, which at present is attracting so much attention. Throughout the whole of Heidenhain's researches we have exemplified the value of conjoint histological, chemical, and more purely physiological work, the one serving to elucidate the other. Heidenhain was an admirable example of an "all-round" physiologist who did not work in a limited groove, but had a wide and comprehensive grasp of his subject, and, directly by his own work and indirectly by that of his pupils, added innumerable stones to the stately building of physiological science.

MANY of the scientific societies commence the new session next week. On November 2, a short address will be given at the Institution of Civil Engineers by Sir J. Wolfe Barry, K.C.B., F.R.S., and the medals and prizes awarded by the Council will be presented.—A meeting of the Institution of Mechanical Engineers will be held on November 3 and 4. The chair will be taken by the President, Mr. E. Windsor Richards, at 7.30 p.m. on each evening. The following papers will be read and discussed, as far as time permits: Experiments upon propeller ventilating fans, and upon the electric motor driving them, by Mr. W. G. Walker; diagram accounts for engineering work, by Mr. John Jameson; mechanical features of electric traction, by Mr. Philip Dawson.—The Chemical Society meets on November 4, when papers by Profs. Moissan and Dewar will be read (see p. 596).—The Society of Chemical Industry will meet on November 1, and papers will be read on (1) the adulteration of Portland cement, by Messrs. W. H. Stanger and Bertram Blount; (2) an improved adjustable drip proof Bunsen, by Dr.

W. P. Evans.—The first meeting of the Linnean Society for the new session will take place on November 4. Papers will be read by the Right Hon. Sir John Lubbock, Bart, F.R.S., on the attraction of flowers for insects; and by Mr. W. C. Worsdell, on transfusion-tissue, its origin and function in the leaves of gymnospermous plants; Mr. F. G. Jackson will show some zoological and botanical exhibits collected by the Jackson-Harmsworth Polar Expedition; and Mr. Reginald Lodge will exhibit lantern-slides of marsh-birds and their nests, from photographs recently taken in Spain and Holland.—The Geologists' Association will hold a conversazione at University College on Friday, November 5, when a number of interesting objects will be exhibited by some of the members.—The opening meeting of the new session of the Röntgen Society will be held at St. Martin's Town Hall on November 5. Prof. Sylvanus Thompson will deliver the presidential address.

THE new session of the Royal Geographical Society will open on November 8 with a brief introductory address by the President, and a paper on the Jackson-Harmsworth Arctic Expedition, by Mr. Frederick J. Jackson. On November 22 Dr. Sven Hedin will give an account of four years' exploration in Central Asia. Other papers which may be expected during the session are the following:—Exploration in Spitsbergen, 1897, by Sir W. Martin Conway; exploration in the Chilian Andes, by Mr. E. A. FitzGerald; explorations in Greenland, by Lieut. Peary; researches in the Scottish Lakes, by Dr. John Murray, F.R.S.; the Eastern Malay Provinces of Siam, by Mr. H. Warrington Smyth; a trip in Northern Somaliland, by Mr. F. B. Parkinson and Lieut. Brander-Dunbar. During the session it is probable that a special meeting will be held in connection with the 400th anniversary of the discovery of the Cape route to India by Vasco da Gama. Under the joint auspices of the Society and the London University Extension Committee, Mr. H. J. Mackinder is giving a course of twenty-five lectures on the geography of Britain and the British Seas, at Gresham College, Basinghall Street, E.C. It is probable that arrangements will be made for two Christmas lectures to young people, by Dr. H. R. Mill.

ON the 17th, 18th and 19th inst., the Liége Association of Engineers, a society composed exclusively of graduates of the Liége School of Mines, celebrated its fiftieth anniversary. Six hundred members took part in the celebration, as well as delegates bearing addresses of congratulation from the Iron and Steel Institute, the French Society of Engineers, the German Ironmasters' Association, and numerous other continental technical societies. The guests were received by Mr. R. Paquot, the President, who was one of the founders of the Association. After a brief presidential address, Prof. A. Habets, the indefatigable secretary, read a paper summarising the history of the first fifty years of the Association. The meeting was then divided into two sections, one dealing with mining and the other with metallurgy. In the former the following papers were read: (1) The development of the mining industry of Belgium since 1831, by Mr. E. Harzé; (2) a contribution to the geology of the Charleroi district, by Mr. J. Smeysters; (3) winding from great depths at the Harpen Collieries, by Mr. E. Tomson; (4) the economy due to steam compression, by Mr. V. Dwelshauvers-Dery and Mr. E. Hubert; and (5) continuous breaks, by Mr. A. Kapteyn. In the metallurgical section the papers dealt with were: (1) a study of the blast-furnace, by Mr. G. Rocour; (2) the progress accomplished in the knowledge of steel, by Mr. A. Greiner, of the Cockerill Company; (3) the direct utilisation of the gas of blast-furnace for the production of motive power; and (4) notes on steel, by Mr. J. Magery, of Aix-la-Chapelle. In the evening a banquet was held at the Royal Conservatoire, at which the Belgian Minister of Public Works and the Minister of Foreign Affairs were present. October 18 was devoted to excursions to Cockerill's Works, to the Small Arms Factory at Herstal, and to the University laboratories, a concert being held in the evening. October 19 was devoted to a visit to the Brussels Exhibition, where a farewell luncheon was held.

IN view of assertions which have been published, with some appearance of authority, as to the efficacy of sanitation as a substitute for vaccination in dealing with small-pox, the following opinions, from a declaration, signed by upwards of 850 medical officers of health in Great Britain, India, and the Colonies, and issued by the Jenner Society, are worth putting on record: (1) As responsible sanitary officials, to whom the care of the health and lives of the community is especially entrusted, we have every inducement to give due weight to the value of "sanitation" in the widest sense of the term for the prevention of small-pox as of other forms of infectious disease. We include in that term good drainage, the removal of refuse, the supply of pure air and water, and all other conditions which are calculated to fortify the body against disease in general. (2) We are no less alive to the importance of those special precautionary measures which experience has shown to be so valuable, when effectively used, to arrest the spread of infectious disease, such as the immediate notification of illness, the efficient isolation of the sick and of those who have been exposed to infection, and thorough disinfection of persons and things. (3) While thus fully appreciating the value of these agencies for such purposes, we unhesitatingly declare our belief that they cannot alone be relied on either to prevent or to stamp out epidemics of small-pox. (4) We believe that the only trustworthy protection at present known against small-pox, alike for the individual and the community, is efficient vaccination in infancy and subsequent re-vaccination, and that the only effective way of stamping out epidemics of this disease lies in the free use of these agencies.

WHETHER X-rays exist in the kathodic pencil which produces them is a question that forms the subject of some interesting experiments at the hands of Prof. A. Ròiti (*Atti dei Lincei*, vi. 5). To put the matter briefly, a discharge-tube was closed at one end by a plate of aluminium covered by a diaphragm of lead with a central aperture, in such a way that when kathodic rays fell on the central portion, the X-rays given off illuminated an actinometer. On placing the tube in the field of a powerful magnet, so as to deflect the kathodic rays to one side, the actinometer appeared almost dark. By inserting a tube of lead *inside* the discharge tube, so as to prevent any reflected rays from the side of the tube from reaching the central portion of the aluminium, complete extinction of the X-rays was obtained. The author concludes that indeflectable kathodic rays either are non-existent, or else, if they exist, are not transformable into Röntgen rays. Prof. Ròiti also describes experiments establishing the law that metals of greatest atomic weight emit rays of greatest intensity.

THE Commission appointed to inquire into the practicability of effecting electrical communication between light-houses and light-vessels and the shore, have issued their fifth and final report. They state that the system which has been in use for connecting the *Sunk* light-vessel with the shore is the best system of continuous connection which has been brought to their notice, but they do not consider it as affording an entirely satisfactory solution of the difficulty of maintaining in an efficient manner, and at a reasonable cost, electrical communication with light-vessels anchored in deep water and in exposed positions. Attention has been directed to the method of signalling without wires on the system used by Signor Marconi, but the Commissioners have not thought it desirable to make any definite recommendations as to this until further light has been thrown on the matter by the investigations now being conducted by the Post Office. Experiments which have been made at the instigation of the Commissioners proved satisfactory, communication having been obtained without the aid of intermediate wires between two points on either side of the Bristol Channel, distant about nine miles from one another, and it has further been arranged for a practical trial of the system at a light-vessel.

IN the *Journal de Physique* for October, M. Henri Becquerel's explanation of the experiments of M. Le Bon on the so-called black light (*lumière noire*) is given. M. Becquerel finds that all the observed phenomena can be attributed to the action of ordinary red and infra-red rays. Not only is ebonite transparent to such rays, but they possess the property of extinguishing the phosphorescence of sulphide of zinc, and of acting on a slightly "fogged" photographic film in exactly the manner observed by Le Bon. Moreover, when the ebonite is replaced by a sheet of red glass the same phenomena are observed.

WE have received the first number of a new series of the "Publications of the University of Pennsylvania" devoted to mathematics. It contains "Contributions to the Geometry of the Triangle," by Robert Judson Aley, and "Properties of the Locus r = constant in Space of n Dimensions" by Paul Renno Heyl. In the latter, the author finds expressions for the measure of the content of the locus of the extremity of unit radius vector, and arrives at the result that this content is a maximum in the case of five-dimension space. A corresponding maximum is also shown to exist for the measure of boundary of the same locus.

THE Corporation of Bristol, as owners of the port and docks built at Bristol and at Avonmouth and Portishead, are making great efforts to draw to the port some of the enormous trade which is now carried on between this country and the United States and Canada. At one time the port of Bristol stood first as the great centre for all the trade with the countries on the other side of the Atlantic, but gradually as the size of vessels increased, and as other ports improved their shipping facilities while Bristol practically stood still, the trade was directed principally to Liverpool, and more recently also largely to Southampton. However, owing to improvements which have been carried out at Avonmouth, a large firm of shippers have now commenced to run a regular line of steamers between Canada and Bristol, and cargoes of 8000 tons of miscellaneous merchandise have been quickly and efficiently discharged at the Avonmouth Dock. To further foster and secure this growing trade, the Corporation have recently decided to apply to Parliament for power to expend a million and a half of money in building a new and enlarged dock of 40 acres, which is to have an entrance lock 850 feet long, capable of receiving the largest steamers at present likely to be built.

AMONG various important articles in the *Annalen der Hydrographie und maritimen Meteorologie* for September, there is one of special interest, by Dr. G. Schott, on the fogs of the Newfoundland Banks. Fogs are prevalent in various parts of the world, but there is no district in which navigation is endangered in a similar way by the combination of icebergs and fog. The author has shown the distribution of fog upon twelve monthly charts, compiled from all the materials collected by the Deutsche Seewarte, for the routes of steam vessels between New York and 40° west longitude. The charts show that the period of most copious fog is from April to August inclusive; in September there is a sudden and considerable decrease, while February has the least amount. There are two regions in the district under consideration which have the greatest frequency of fog, viz. south of Nova Scotia and the eastern part of the Great Newfoundland Bank. On the Bank itself, especially on the western side, the frequency of fog is much less, owing to the water being considerably warmer there than on the eastern side, and because the sudden changes of the sea temperature do not occur there to the same extent as on the eastern side, where the two currents come into contact.

A SUGGESTIVE paper by Prof. W. P. Mason, entitled "Sanitary Problems connected with Municipal Water Supply," has been published in the *Journal* of the Franklin Institute. Some interesting facts are recorded concerning the health of some American cities in relation to typhoid fever and water supply. The writer tells us that the average annual typhoid death rates for thirteen Massachusetts cities before the introduction of a public water supply was 7·94 per 10,000, whilst since the improvements have been carried out the deaths from typhoid fever have fallen to 3·83 per 10,000. In the whole State of Connecticut the percentage of typhoid deaths to total deaths has fallen from about 5·8 in 1870 to 1·84 in 1893. But although much advance has been made in the improvement and protection of American public water supplies, a great deal remains yet to be done. A source of pollution too often overlooked is the contamination of water in the pastures through which it passes. Mason cites an instance which came under his notice of twenty-six cows in a pasture through which ran the open watercourse connecting the storage and distributing reservoirs of a city. The animals had perfect freedom to wade in the stream to within a few yards of the point where the water entered the city mains. A very remarkable example of how typhoid fever may be spread is given in the case of a serious outbreak of this disease which took place at Plymouth, Pa. The origin of this disastrous epidemic was traced to a single typhoid patient whose dejecta were thrown out upon the snow of a frozen hillside, at the base of which ran a small stream, whence the town water supply was ultimately drawn. Several weeks elapsed, during which the dejecta were hard frozen before the March thaws permitted the melting snows to wash them into the stream below; but during this interval the typhoid germs had retained their vitality and full complement of virulence, as demonstrated by the otherwise quite unaccountable outbreak of typhoid fever in the said town. Various investigators have shown that typhoid bacteria can stand being frozen; indeed, it has been found that three months' continuous freezing does not destroy these germs.

A LOUISIANA Society of Naturalists has been established, with about forty-five members. The Secretary is Mr. E. Foster, of New Orleans.

A. VIERKANDT gives in *Globus* (Band lxxii. p. 133) a long and illustrated account of Ehrenreich's "Anthropologische Studien über die Urbewohner Brasiliens." The evidence seems to these authors to show that the American Indians are a distinct race of mankind, and not a branch of the Mongolian race.

THE primitive inhabitants of India in their ethnological, religious and linguistic aspects, is the subject of two illustrated articles in *Globus* (Band lxxii. p. 53, 77), by Prof. Gustav Oppert. This is a preliminary sketch of a memoir that the author is preparing, and which promises to be of considerable importance.

IN a collection of fifteen skulls from the Papuan Gulf, Dr. G. A. Dorsey (*Dental Review*, Chicago, vol. xi.) finds three examples of suppressed third molars and two examples of supernumerary pre-molars. The occurrence of the latter looks like an atavism, while the absence of the wisdom-tooth is generally regarded as due to a reduction of the jaw, and therefore, to a certain extent, is a result of civilised or cultural habits.

THE affinities of the Hovas of Madagascar have often been discussed. A recent paper by Mr. Duckworth (*Journ. Anth. Inst.*, 1897, p. 285) gives occasion to Zaborowski (*Bull. Soc. Anthrop.*, viii. p. 84) to review this problem; he points out various difficulties in deriving the Hovas from a pure Malay stock, and draws attention to numerous resemblances with the Nias. The latter are by no means pure Battaks, and Modigliani believes in an Indian influence. Zaborowski endeavours to show that this is largely Dravidian (rather than Aryan), and hints that this is also indirectly felt among the Hovas.

DURING next month the following science lectures will be delivered at the Royal Victoria Hall, Waterloo Bridge Road, on Tuesday evenings:—November 2, "Across Spitsbergen," Dr. J. W. Gregory; November 9, "Impressions of Canada," Prof. Beare; November 16, "Indian Meal and English Yeast," Mr. J. A. Baines; November 23, "The Gas Helium, and how it was discovered," Prof. Ramsay, F.R.S.; November 30, "Speech," Dr. B. L. Abrahams.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Miss A. E. Ard; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Miss Shone; two Weka Rails (*Ocydromus australis*) from New Zealand, presented by Mr. Forbes White; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mr. Aitchinson; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Crowned Lemur (*Lemur coronatus*), a Grey Lemur (*Hapalemur griseus*) from Madagascar, a Diademed Amazon (*Chrysotis diademata*) from South America, deposited; two Trumpeter Swans (*Cygnus buccinator*) from North America, a Crested Grebe (*Podiceps cristatus*), European, purchased; a Wapiti Deer (*Cervus canadensis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

STARS IN THE LARGE MAGELLANIC CLOUD.—The Henry Draper Memorial has been the means by which it has been ascertained that the spectra of those stars belonging to Pickering's fifth type, and consisting mainly of bright lines, have hitherto been found only near the central line of the Milky Way. Out of the sixty-seven stars which come under this category, their mean deviation from this line amounts to the remarkably small angle of 2° 39′, while only one object deviates more than 9°. Prof. Pickering now points out that the two Magellanic clouds closely resemble the Milky Way in appearance, although both are detached from it and distant from the central line above mentioned by about 30° and 45°. A recent examination, by Mrs. Fleming, of the spectra of the stars in the large cloud (*Harvard College Circular*, No. 19), obtained by means of the Bruce photographic telescope, has shown that six stars have been discovered whose spectra are of the fifth type; further, that in seven stars of Pickering's first type, bright hydrogen lines are present, while the spectra of six known nebulæ are gaseous and not continuous. The *Circular* gives a list of the positions of these objects, but their declinations are too far south to be worth repeating here. It is interesting to note that Dr. Stewart in Peru independently observed the presence of bright lines in twelve of these objects, and communicated his results to Prof. Pickering while the *Circular* was in preparation.

THE PHOTOGRAPHY OF DELICATE CELESTIAL PHENOMENA.—Will one ever be able to satisfactorily record the details on planetary discs by the aid of photography? Dr. T. J. J. See says an emphatic No, while Prof. F. L. O. Wadsworth says very probably Yes. The former, writing in the *Astr. Nachr.* (No. 3449), bases his answer on the effect of the motion of the air, which shifts at insensible intervals the positions of the images by measurable quantities. By uninterrupted observation the eye becomes capable of detecting very delicate phenomena at the occasional moments of good seeing, and the mind, without any special effort, "readily determines what is permanent and what is transient." The photographic plate has a cumulative power, and the partial images are superposed with the result that the developed plate is impressed with an enlarged and blurred image, which gives nothing but the average result for the whole time of exposure. Further, Dr. See points out that small details cannot be photographically recorded because, even if there were no spreading of the light on the plate, no bodily motion of the whole image, and the motion of the telescope were perfect, phenomena smaller than 0″·5 could not be recorded. Thus, he says, "it does not seem possible that anything requiring even a moderate exposure could be detected in a luminous field (where the contrast is very great) when the diameter of the image is less than 1″."

Prof. Wadsworth (*Astronomical Journal*, No. 414) thinks, on the other hand, that photography up to the present time has failed only because the particular ways in which it has been applied have not been perhaps the best to secure the most satisfactory results. "There seems to be no good reason why we should not, under proper conditions, photograph all or even more (on account of greater resolving power and greater light action) than we can ever be sure we really see (up to a certain size of aperture not greater than 12 to 15 inches) on a planetary surface." The unsteadiness of the image during exposure, which is the main difficulty, he proposes to practically eliminate by mounting the photographic and the observing telescope on the same stand, and exposing the plate only for those intervals when the seeing is the best and the image steady. As Prof. Wadsworth is engaged in experiments in this direction, it would be perhaps more satisfactory to await his results. The problem is, however, of great interest and well worth solving.

COMET PERRINE, OCTOBER 16.—From Kiel we have received a *Centralstelle Circular* (No. 1), in which we are informed that Prof. Schaeberle has telegraphed the elements and ephemeris computed by Messrs. Hussey and Aitken from observations made on October 16, 17 and 18. A later *Circular* (No. 2) gives us the elements and ephemeris as calculated by Prof. H. Kreutz and Herr Möller from the observations made on October 16, 18 and 20. Below we give the two sets of elements mentioned above, together with the ephemeris printed in the second *Circular*:—

Elements.

T = 1897 Dec. 9·23 G.M.T.	T = 1897 Dec. 7·799 Berlin M.T.
$\varpi = 66°\ 28'$ } 1897·0	$\varpi = 65°\ 4'{\cdot}2$ } 1897·0
$\Omega = 32\ \ 5$ } 1897·0	$\Omega = 31\ \ 57{\cdot}9$ } 1897·0
$i = 69\ \ 38$ } 1897·0	$i = 69\ \ 26{\cdot}5$ } 1897·0
$\log q = \bar{1}{\cdot}3525$	$\log q = 0{\cdot}13440$

Ephemeris for 12h. Berlin M.T.

1897.	R.A. h. m. s.	Decl. ° ′	log r.	log Δ.	Br
Oct. 28	0 5 20	+81 24·7	0·1716	9·9072	1·1
29	23 23 35	81 41·0	1700	9093	1·1
30	22 41 27	81 40·1	1683	9116	1·1
31	22 1 40	81 22·7	1667	9141	1·1
Nov. 1	21 26 4	80 51·6	1652	9170	1·1
2	20 55 44	80 9·5	1636	9201	1·1
3	20 30 21	79 19·7	1621	9234	1·1
4	20 9 25	78 24·3	1606	9270	1·1
5	19 52 8	77 25·3	1592	9307	1·0
6	19 37 51	+76 24·2	0·1577	9·9346	1·0

The comet's position is now very favourable for observation, lying to the north of the constellation of Cepheus, passing on October 29 between γ Cephei and the Pole Star; its distance from the former of these being equal to about a quarter of the distance between the two stars.

DR. B. ENGELHARDT'S OBSERVATORY.—We notice in the current number of the *Astronomische Nachrichten* (No. 3450) that, through age and ill-health, Dr. Engelhardt is compelled to discontinue his astronomical labours, and has given up his observatory at Dresden. He has presented all the instruments and the library to the Russian Royal University Observatory at Kasan.

SCIENCE AND MODERN CIVILISATION.[1]

WHEN Harvey was entering on his career as an investigator, in the early years of the seventeenth century, the great movement of the Renaissance had produced its full effects. Starting in Italy in the fourteenth century, it spread during the fifteenth and sixteenth centuries and permeated the rising nationalities of Western Europe. It was through the zeal engendered by this movement that the priceless literary and artistic treasures of Greece and Rome were rescued from oblivion and made the secure heritage of all time. The study of these monuments of ancient genius, and the inspiration communicated by them, saved mediæval Europe from barbarism, and created a new civilisation not inferior in polish to that of the classical ages. Upon literature and the fine arts the spirit of the Renaissance reacted with the happiest possible effects. It inspired the masterpieces of poetry, painting, architecture, and sculpture, which constitute the glory of the fifteenth and sixteenth centuries, and compel the admiration and challenge the rivalry of the nineteenth century. But, as regards natural knowledge, the influence of the Renaissance was at the first, and even for a long time, distinctly unfavourable. The writings of Hippocrates, Aristotle, Ptolemy, Galen and other masters were studied and searched, not for inspiration to new inquiry and higher development—but these great names were erected into sacrosanct authorities, beyond whose teaching it was vain, and even impious, to seek to penetrate. The result of this perversion was that the pursuit of natural knowledge degenerated into sterile disputations over the words of the masters. This numbing despotism of authority comatosed the intellect of Europe during many generations. It received the first rude shocks from the discoveries of the great anatomists of the sixteenth century; and it was finally overthrown by the force of the demonstrations of Galileo and Harvey—powerfully aided, no doubt, by the philosophical writings of Bacon and Descartes.

These four men—Galileo, Harvey, Bacon, and Descartes—were the dominating spirits of their epoch in the sphere of natural knowledge; they were contemporaries; and three of them must have had more or less personal acquaintance with each other. Harvey was Bacon's friend and physician; and we can easily believe that much talk went on between the investigator and philosopher concerning the studies in which they were mutually interested—and that Bacon imbibed his enlightened notions respecting the importance of experiments in the pursuit of knowledge from the precepts and practice of Harvey. It does not appear that Descartes was personally known to Harvey, but he was one of the earliest to accept the doctrine of the circulation, and to write in its defence. When Harvey was a student at Padua, Galileo occupied the chair of mathematics in that university. These two men take rank as the twin founders of modern science—the one in the domain of biology and the other in the domain of physics. Their lives largely overlapped; they were contemporaries for sixty-four years, and both nearly reached the patriarchal age of fourscore. Roughly speaking, their period of activity covered the first half of the seventeenth century. They were, each in his respective department, pioneers in the method of searching out the secrets of nature by observation and experiment, and in proclaiming the paramount necessity of relying on the evidence of the senses as against the dicta of authority.

The present year is the 300th anniversary of Harvey's graduation at Cambridge, and of the commencement of his career as a student and investigator of nature. That date, 1597, corresponds roughly with the birth-time of modern science. The occasion is, therefore, not inappropriate for a survey of the changes impressed upon civilised society by science—after three centuries of expansion and growth. The lapse of time is sufficiently long, and the advance made is sufficiently great, to enable us to estimate approximately the scope and strength of this new factor in our environment; and perhaps even to appreciate the influence which the cultivation of science is likely to have on the future of modern civilisation.

All the older civilisations have issued either in extinction, or in permanent stagnation. The civilisations of Egypt and Chaldæa and of Greece and Rome, after a phase of progressive decline, eventually perished by military conquest. The ancient civilisations of the Far East—those of India and China—still persist, and have a semblance of life; but it is a life of helpless torpor and immobility. Is our modern civilisation doomed to share a kindred fate? There are, I think, good reasons for believing that in this respect history will *not* repeat itself. Special features are observable, and special forces are at work, in contemporary civilisation which differentiate it profoundly from all its predecessors.

It may be said, broadly, that the older civilisations rested essentially upon art and literature (including philosophy)—and that modern civilisation rests, in addition, upon science and all that science brings in its train. This distinction is, I think, fundamental—and connotes a radical difference as regards stability and continuance between ancient and modern society. A comparison of the mode of growth of the fine arts and literature on the one hand, with the mode of growth of science and its dependent useful and industrial arts on the other, brings out this point very clearly.

The evolution of literature and art displays the following well-marked characteristics. Starting from some rude beginnings, each branch of literature and each branch of the fine arts grows by a succession of improved ideals until a certain culminating level of excellence (or phase of maturity) is attained. When this level is reached no further growth takes place, nor even seems possible. The level of excellence attainable by any nation depends presumably upon the measure of the original endowment of the race with artistic and literary faculty. When and after this summit level of excellence is achieved, all subsequent expansion, if any, is quantitative rather than qualitative—and consists in modifications, variations, repetitions and imitations—but without any real advance in artistic and literary excellence. It may be further noted that there is observable in the past annals of literature and the fine arts a fatal tendency to a downward movement. The variations are apt to show meretricious qualities—which indicate, in the judgment of critics, a degradation from the high standard of the earlier masters. The life of each of the fine arts seems, as Prof. Courthope has expressed it, to resemble the life of an individual in having periods of infancy, maturity and decline. The witness of history bears out this view.

It is almost startling to consider how long ago it is since most branches of art and literature had already reached their highest known pitch of excellence. The Homeric poems are supposed to have been composed a thousand years before the Christian Era—and no one doubts that as examples of epic poetry they still stand in the front rank. In the fourth and fifth centuries B.C. there occurred in Greece an extraordinary outburst of artistic and literary genius—such perhaps as the world has never seen before nor since. During this epoch sculpture was represented by Phidias and Praxiteles—architecture by the builders of the Parthenon—painting by Apelles and Zeuxis—dramatic poetry by Sophocles, Euripides, and Aristophanes—and speculative philosophy by Plato and Aristotle. Greece maintained her political independence for two centuries after this period; but she did not produce anything superior, nor apparently even equal, to the masterpieces of this golden age.

A parallel sequence is observable in the history of Ancient Rome. Art, literature, and philosophy—and all studies that may be grouped under these headings—attained their culmination in the Augustan age; and no advance thereupon took place, but rather a falling off, during the subsequent centuries of imperial Rome's political existence.

If we turn our eyes to the Far East we see that the masterpieces of architecture and ornamental metal work, and of poetic and philosophical literature are all old—many of them very old. Neither in India nor China nor in any other Far Eastern country are there any indications of advance for many centuries in the domain of artistic and literary culture.

The history of Western Europe tells a similar tale. The finest examples of Gothic and Norman architecture date from the twelfth and thirteenth centuries. Painting culminated in Italy during the fifteenth and sixteenth centuries with Raphael, Da Vinci, Correggio, Titian, and Paul Veronese. The same art reached its highest level in the Low Countries with Rembrandt and Rubens—in Spain with Velasquez and Murillo—in France with Claude Lorraine and Poussin—all artists who flourished in the seventeenth century. In England nothing greater than the works of Reynolds, Gainsborough, and Turner has been produced by later artists. Similarly with literature: most of the masterpieces belong to a past age. Italy can show no higher examples of poetry than the creations of Dante,

[1] Extract from the Harveian Oration, delivered before the Royal College of Physicians, October 18, by Sir William Roberts, M.D., F.R.S., Fellow of the College.

Petrarch, Tasso, and Ariosto. The most ardent admirers of the Victorian poets would scarcely contend that any of them stand on a higher pedestal than Shakespeare and Milton; nor would any German critic claim equality for any recent poet of the Fatherland with Goethe and Schiller. In the delightful art of music, the masterpieces of Haydn, Handel, and Mozart, judging by their popularity at the present day, are not surpassed by the works of any of the later musical composers.

I need not pursue the subject in greater detail. Wherever we look—in all ages, among all peoples—we encounter the same story with regard to that large and varied and most precious outcome of the human mind which may be grouped under the categories of the fine arts and literature. There is a history of improvement and growth up to a certain culmination, or phase of maturity. Beyond that point no further growth seems possible—but rather, instead, a tendency to decline and decadence.[1]

The evolution of science differs fundamentally from that of literature and the fine arts. Science advances by a succession of discoveries. Each discovery constitutes a permanent addition to natural knowledge—and furnishes a post of vantage for, and a suggestion to, further discoveries. This mode of advance has no assignable limits; for the phenomena of nature—the material upon which science works—are practically infinite in extent and complexity. Moreover, science creates while it investigates; it creates new chemical compounds, new combinations of forces, new conditions of substances, and strange new environments—such as do not exist at all on the earth's surface in primitive nature. These "new natures," as Bacon would have called them, open out endless vistas of lines of future research. The prospects of the scientific inquirer are therefore bounded by no horizon—and no man can tell, nor even in the least conjecture, what ultimate issues he may reach.

The difference here indicated between the growth of art and literature and the growth of science is, of course, inherent in the subjects; and is not difficult to explain. The creation of an artist, whether in art or literature, is the expression and embodiment of the artist's own mind—and remains always, in some mystic fashion, part and parcel of his personality. But a scientific discovery stands detached; and has only an historical relation to the investigator. The work of an artist is mainly subjective—the work of a scientific inquirer is mainly objective. When and after a branch of art has reached its period of maturity, the pupil of a master in that art cannot start where his master ended, and make advances upon his work; he is fortunate if at the end of his career he can reach his level. But the pupil of a scientific discoverer starts where his master left off; and, even though of inferior capacity, can build upon his foundations and pass beyond him. It would seem as if no real advance in art and literature were possible except on the assumption that there shall occur an enlargement of the artistic and literary faculty of the human mind. No such assumption is required to explain and render possible the continuous advance of science. The discoverer of to-day need not be more highly endowed than the discoverer of a hundred years ago; but he is able to reach further and higher because he stands on a more advanced and elevated platform built up by his predecessors.

The fatal weakness of previous civilisations lay in the absence of any element which had inherent in it the potentiality of continuous growth and unlimited expansion—and this is precisely what exact science supplies to modern civilisation. A sharp distinction must be drawn between the so-called science of antiquity and the science of to-day. The ancients had a large acquaintance with the phenomena of nature, and were the masters of many inventions. They knew how to extract the common metals from their ores; they made glass; they were skilled agriculturists; they could bake, brew, and make wine, manufacture butter and cheese, spin, weave, and dye cloth; they had marked the motions of the heavenly bodies, and kept accurate record of time and seasons; they used the wheel, pulley and lever; and knew a good deal of the natural history of plants and animals, and of anatomy and practical medicine. This store of information had been slowly acquired in the course of ages—mostly through haphazard discovery and chance observation—and formed a body of knowledge of inestimable value for the necessities, conveniences, and embellishments of life. But it was not science in the modern sense of the word.[1] None of this knowledge was systematised and interpreted by coordinating principles; nor illuminated by generalisations which might serve as incentives and guides to further acquisitions. Such knowledge had no innate spring of growth; it could only increase, if at all, by casual additions—as a loose heap of stones might increase—and much of it was liable at any time to be swept away into oblivion by the flood of barbaric conquest.

It is quite obvious, from the subsequent course of events, that there came into the world of natural knowledge about three centuries ago, in the time of Galileo and Harvey, a something—a movement, an impulse, a spirit—which was distinctly new—which Bacon, with prophetic insight, termed a "new birth of time."

This remarkable movement did not originate with any startling revelation; it consisted rather in an altered mental attitude, and a method. There arose a distrust in the dicta of authority, and an increasing reliance on ascertained facts. These latter came to be regarded as the true and only data upon which natural knowledge could be securely founded and built up. Doubt and question took the place of false certainty. The hidden meaning of phenomena was sought out by observing them under artificially varied conditions—or, to use the words of Harvey, "the secrets of nature were searched out and studied by way of experiment." *À priori* reasoning from mere assumptions, or from a few loosely observed facts, fell into discredit. Observations were repeated and made more numerous and more exact. These were linked together with more rigid reasoning to stringent inductions. Hypotheses (or generalisations) were subjected to verification by experiment; and their validity was further tested by their efficacy in interpreting cognate problems, and by their power to serve as guides to the acquisition of fresh knowledge. Instruments of precision were devised for more accurate observation of facts and phenomena—for weighing and measuring, for estimating degrees of temperature, the pressure of gases, the weight of the atmosphere, and for recording time. The sense of sight was aided by means of the telescope and microscope. The invention of instruments and appliances for assisting research was an essential and invaluable feature of the "new philosophy." It is singular that so little progress in this direction was made by the quick-witted Greeks of the classical period; and their neglect or incapacity in this respect largely accounts for their conspicuous failure in science as contrasted with their brilliant success in art and literature.[2]

The new method soon began to yield fruit—at first slowly, then more and more rapidly as the workers increased in number, and the method was more fully understood. Discoveries were no longer solely stumbled on accidentally, but were gathered in as the fruit of systematic observation and purposive research. It is not necessary for me, even if I had the time and ability, to trace the history of scientific discovery from the time of Harvey onward. I will only mention a few particulars by way of illustration. You all know how, as time passed on and knowledge

[1] If we take a wider view of the constituent elements of organised society—and embrace in our consideration the religious systems, the political and civil institutions, the military organisations, the commerce and the miscellaneous disconnected mass of natural knowledge existing in the older civilisations—we look in vain for any constituent which had more than a limited scope of expansion, and was not subject to decay.

[1] "It is not a collection of miscellaneous, unconnected, unarranged knowledge that can be considered as constituting science."—*Whewell.*

[2] Whewell observes ("History of the Inductive Sciences," vol. i. book 1, chap. iii.): "The Aristotelian physics cannot be considered as otherwise than a complete failure. It collected no general laws from facts; and consequently, when it tried to explain facts, it had no principles which were of any avail." Whewell argues that this failure was not due to the neglect of facts. He goes on to say: "It may excite surprise to find that Aristotle, and other ancient philosophers, not only asserted in the most pointed manner that all our knowledge must begin from experience, but also stated in language much resembling the habitual phraseology of the most modern schools of philosophising, that particular facts must be *collected*; that from these general principles must be obtained by *induction*; and that these principles, when of the most general kind, are *axioms*." Then he quotes passages in proof from Aristotle's writings. It is, however, pretty evident that Aristotle's reverence for facts was no more than a pious opinion, which he habitually ignored in the actual handling of questions of natural knowledge. His treatise "On the Parts of Animals" bristles with errors of observation which a very moderate amount of painstaking would have rectified. Had the ancient Greeks, and their successors in the middle ages, been more accurate observers of facts, and had they sought for and invented instruments for the more exact observation of facts, they would not have so conspicuously failed to establish at least the foundations of exact science. The historian of the inductive sciences, however, will have it otherwise. He sums up his argument thus: "The defect was that, although they had in their possession *Facts and Ideas, the Ideas were not distinct and appropriate to the Facts.*" Is it not rather the case that the "Ideas were not distinct and appropriate to the Facts," precisely because the "Facts" were indistinctly seen and imperfectly apprehended?

expanded, the primary sciences became divided into separate departments for more minute study—how new sciences have arisen, some of which have now grown to vast proportions—how improved instruments and appliances of infinite delicacy have been invented to aid research—and how, in the present age, the gains of pure science have been turned to innumerable channels of practical utility.

The advances made in physics and mechanics during the seventeenth and eighteenth cenuturies prepared the way for the invention and perfection of the steam-engine in the nineteenth century. The introduction of the steam-engine increased at a bound the power of the human arm many-fold.[1] Through its instrumentality the land has been covered with railways, and the sea with ocean steamers. Electrical science has given us the telegraph and telephone, a new illuminant, and a new motor. The steam printing press, the telegraph, and the railway together, have made it possible to produce that perhaps most wonderful of all the indirect outcomes of the growth of science—the modern newspaper. The great science of chemistry has revealed the composition of the material world; has originated vast industries, which give work and wages to millions of the population; and has placed all kinds of manufacturing processes upon a basis of scientific precision. Under cover of chemistry have sprung up the sub-sciences of photography and spectroscopy, which have given a new and unexpected development to our knowledge of the heavenly bodies. The revelations of palæontology and embryology have led to the establishment on a firm basis of the theory of organic evolution. This theory—by far the most penetrating generalisation of our time—has not only thrown a flood of light upon the deepest problems of natural history, but has also revolutionised the whole domain of speculative thought. Physiology and practical medicine have profited immensely by the general advance of the sister sciences, and by the adoption of scientific methods in the prosecution of research. Optical science gave birth to the achromatic microscope. The microscope has laid bare the minute structure of plants and animals, and introduced zoologists and botanists to a vast sub-kingdom of minute forms of life, previously undreamt of. The microscope also, in conjunction with chemistry, founded the new science of bacteriology. Bacteriology has inspired the beneficent practice of antiseptic surgery; it has also discovered to us the parasitic nature of zymotic diseases—and opened out a fair prospect of ultimate deliverance from their ravages.

Thus have the several sciences advanced, and are still advancing, in concert, step on step, by mutual help, at an ever-increasing speed—pushed on by that irrepressible forward impulse which has characterised the scientific movement from its inception. This movement has now become the dominant factor in civilisation.

There is no doubt that, under the reign of science, a striking amelioration in the state of society has taken place. The mass of the people are better housed and fed—and, above all, better educated. Their sanitary surroundings are improved, and the death-rate has fallen. Crime and pauperism have diminished, and there is greater security for person and property. The amenities and enjoyments of life are on the increase, and the average scale of comfort is markedly raised. Moreover, this amendment is not confined to the material and physical well-being of the population. There is some evidence that the complex of conditions we term "modern civilisation" is acting favourably in the direction of making people more reasonable and better conducted. Peace is now the normal condition between civilised states; and there is a growing trend of opinion in favour of settling international differences by the more rational method of arbitration, rather than by war. Political morality approximates more nearly to that recognised as proper in private life. The duel has almost been laughed out of court. Industrial quarrels are conducted with more order; there is an appeal to facts and reason on both sides, and more readiness to adjustment by compromise.

The whole environment of modern life seems in several ways calculated to foster habits of correct thinking and acting. The inclusion of science in the scope of general education is a very important innovation. This extends the range of subjects in regard to which precise reasoning is possible; and tends to promote the application of scientific modes of thinking and reasoning to all the problems of life. We may be quite sure that exact thinking leads in the main to correct conduct; an evil deed is not only a crime, but also a blunder. The periodical press must, one would think, be a good training-school for thinking and reasoning. The discussion of all sorts of questions in its columns can scarcely fail to have an educating effect. The disputants must perforce read one another's arguments, and be, consciously or unconsciously, influenced thereby. It may be assumed, or at least hoped, that there is in arguments, as in organic forms, a tendency to the survival of the fittest—and that in the long run the better argument carries the day. The blaze of publicity amid which we live, through the ubiquitous newspaper, lends an additional motive to right-doing. The "fierce light which beats upon a throne" beats nowadays also upon the citizens, and doubtless helps to keep them in the straight path.

But, say the prophets of evil: "This will not endure; modern civilisation, based on science, will in time go the way of all its predecessors, and end in extinction or in decay and stagnation." It is proverbially unsafe to dogmatise about the future; and in all human affairs, even those termed scientific, there is nothing so certain as the unexpected. This, however, may be affirmed: that if modern civilisation is to come to an end, it will not perish in the same way, nor from the same causes, as previous civilisations.

One of the standing perils of civilised communities in ancient times was the risk of being subjugated by less civilised neighbours, or of being overwhelmed by hordes of barbarian invaders. This danger no longer threatens us. Power has passed for ever into the hands of the nations which cultivate science, and invent. The appliances of war are now placed on a scientific basis; and the issue of battle is decided in the laboratories of the engineer and the chemist. The late C. H. Pearson argued that the dark and yellow races, in virtue of their greater number and fecundity, might in time come to dispute the supremacy of the white races—that they would learn the drill and copy the armaments of European armies, and thus equipped would be able, by their superior mass, to hem in and curb, if not to subjugate, the Western nations. But the march of science and invention never stops; and it is inconceivable that the scientific nations shall not always be many stages in advance of the unscientific nations in the destructiveness of their weapons and the perfection of their military equipments—and this would give them an advantage which scarcely any disparity of numbers could neutralise. The "yellow terror" can never be more than a phantom until these races begin to show capacity for scientific discovery, and the further (and somewhat different) capacity for turning their discoveries to practical uses.

Against the more insidious peril of decay and stagnation the scientific movement seems also to offer effective safeguards. We sometimes hear complaints of the hurry and bustle—the stress and strain—of modern life; this unrest may incommode individuals—but it is the antiseptic of society. Probably the deadliest predisposing factor in the decline of former civilisations was the mental inanition arising from deficiency of fresh and varied intellectual pabulum. Physiological analogies lead us to the inference that an idle brain, like an idle muscle or an idle gland or nerve, would deteriorate in function; and, conversely, that a well-exercised brain would tend to reach its possible best. I conceive that our forefathers and the ancients, for the most part, led somewhat monotonous lives. They had but little fresh and varied food for thought. The generality could not, for lack of "news," take a sustained interest in the course of public events. The world of science was an unopened book. Intercommunication was slow and difficult; and the whole current of existence flowed sluggishly. Contrast this with the vivid abounding life of the present day. Veins of interest are greatly multiplied—to meet and satisfy the infinitely varied individual aptitudes of men and women. A considerable number of persons of both sexes now busy themselves, either as amateurs or something more, with the study of some branch of science or natural history. Those whose bent is to politics, art, letters, sport, or fashion, find in the daily newspaper and the periodical press an unfailing fresh supply of the mental food they love. Business and pleasure are carried on with a briskness formerly unknown, and the pulse of national life is quickened through every part. It seems impossible that decay should invade the body politic while such conditions of all-pervading activity prevail—and there is no valid reason why these conditions should not continue to prevail. It has often been remarked that

[1] Mr. Mulhall calculates that "our steam-power in the United Kingdom is equal to the force of 169,000,000 able-bodied men, a number greater than the whole population of Europe could supply."—*National Progress during the Queen's Reign*, p. 22.

periods of national upheaval, when men's minds are deeply stirred—like the rise of Islam, the Protestant Reformation, and the French Revolution—were exceptionally prolific of able men. It does not appear altogether unreasonable to suppose that the stir and movement of modern life may be similarly favourable to the production of "men of light and leading" for the service of the community. The proximate cause of the downfall of states seems always to have been a defective supply of strong and capable men at the head of affairs, and in positions of trust. The *dolce far niente* is not conducive to the formation of strong characters; and those who sigh and yearn for social quietism may find comfort in the reflection that the hum and buzz which disturbs them is a sure token of the health and strength of the common hive.

THE BEHAVIOUR OF ARGON IN X-RAY TUBES.[1]

In continuation of some experiments made by Prof. Callendar in the early part of 1896, the authors have studied the behaviour of argon in X-ray tubes of various types. The phenomena presented by a tube filled with carefully dried and purified argon, are in many respects peculiar, as compared with those presented by other gases under similar conditions.

In the early experiments above mentioned it had been our custom to keep the X-ray tube connected with the pump, which was used as a reservoir of dry air during long exposures. The gas, which was absorbed by the working of the tube at a high vacuum and a long equivalent spark-gap, was restored from time to time, as the vacuum became too high, by letting a little air in from the pump by means of a convenient tap. In this manner it was possible to operate the tube at a very high rate of efficiency for two hours or more at a time. These long exposures were required for some experiments on the velocity of the X-rays, which have been described in a communication to the Canadian Royal Society, May 1896.

It was noticed on several occasions, after one of these long exposures, that there was considerable blackening and sputtering of the electrodes, and also that the pressure of the air in the tube had increased considerably above the degree of vacuum required for the production of X-rays when the tube was first exhausted. After allowing the tube to rest for a few hours, although there was very little increase in the pressure, it was also observed that no kathode rays were produced until the discharge had been passed for some time. It appeared probable that some of these effects, which are recorded in the paper above mentioned, were due to the accumulation of argon in the tube. The spectral lines of that gas were on some occasions faintly discernible in parts of the tube, but no systematic spectroscopic observations were taken.

In making further investigations on the behaviour of argon, we hoped to find that, owing to its natural inertness, the vacuum would be of a very permanent type as compared with other gases. We also hoped that its monatomic character would afford features of interest.

For the preparation and purification of the argon used in these experiments, the Cavendish spark method was adopted, as described by Rayleigh and Ramsay. For this purpose a special transformer was constructed, the primary and secondary of which were wound on different parts of the core. The primary was connected to the 100-volt lighting circuit. The secondary gave 10,000 volts on open circuit, available for starting the arc, but the voltage on the arc when running was only 2,000. The secondary could be short-circuited, owing to the arrangement of the winding, without materially increasing the current, or running any risk of burning up the coil. The apparatus could thus be left running safely by itself day and night without wasting any power on resistances. After concentrating the argon to about 60 or 70 per cent. in the flask, it was further purified in a test-tube apparatus, constructed so as to contain the minimum of liquid. The excess of oxygen was sparked off with hydrogen, and the residue removed by absorption with alkaline pyrogallate. The argon thus purified was kept in a bulb containing P_2O_5.

In the first set of trials of this argon in X-ray tubes, a Fleuss mechanical pump was used, which permitted very rapid exhaustion of the tubes, but had no arrangement for measuring the high vacua. The vacuum was estimated in these cases by the appearance of the tube and the width of the dark space.

The first tube tried had two aluminium electrodes, and had been lying open to the air for some time previously. It was exhausted and washed out two or three times with dry argon, and then sealed off at a good X-ray vacuum. Each operation occupied only two or three minutes, and the vacuum has since that date deteriorated slightly, probably owing to insufficient removal of residual gas from the electrodes, but it still gives sufficient light to see the bones of the hand. The tube during exhaustion presented exactly the same appearances, except in colour and spectrum, as if it had been filled with air.

The second tube had been worked up to a sparkless vacuum some weeks previously, and had been frequently renovated by heating. It had an aluminium kathode and a platinum anode. It was connected to the pump and exhausted as soon as possible after opening. It was then filled with dry argon up to a pressure of one-fifth millimetre, and exhausted to an X-ray vacuum five times in succession. The glow on the kathode inside the dark space showed the F line of hydrogen, and also the C line more faintly. These lines probably indicated the elimination of hydrogen from the electrodes, especially the kathode, as they became fainter with each repetition of the process of washing out.

At the sixth filling of the tube, the pump was worked for ten strokes only. The kathode then began to sputter and blacken the tube, and the argon was apparently absorbed, as the discharge refused to pass in three minutes. Fresh argon was again admitted, the coil was left running, but *the pump was not worked at all*. The spectroscope this time showed only blue argon without any trace of hydrogen. The concave aluminium kathode sputtered violently and partly melted down. In less than two minutes the discharge refused to pass through the tube, which was then sealed off.

The coil used in these experiments was a very small one, which gave a two-inch spark with difficulty when running on a large 8-volt battery.

The next tube upon which we experimented was a double focus tube, containing two aluminium kathodes and a platinum antikathode. This was washed out with argon and exhausted eight times with the two-inch spark coil running all the time. The direction of the discharge was frequently reversed, but no trace of absorption could be observed. The argon lines always disappeared, and the hydrogen lines, especially F, became faintly visible inside the kathode, as the tube approached an X-ray vacuum. The tube at each exhaustion gave fairly bright X-rays, and showed no blackening or sputtering. The hydrogen lines showed more brightly close to the kathode than in the body of the tube, where the argon lines were most conspicuous. The hydrogen appeared in fact to be coming out of the metal. The glass walls of the tube were in a very dry state, as it had been previously heated and exhausted.

Finding that we could not get rid of the residual hydrogen with the coil, we had resort to the alternating current, which we had previously found very effective in tubes with double electrodes. It appears that the elimination of hydrogen takes place chiefly, if not entirely, at the kathode. With the first application of the alternating current, the hydrogen lines showed extremely bright. The tube was then exhausted. In fifty strokes, the discharge refused to pass. On refilling with argon to a pressure of one-tenth of a millimetre, the blue glow inside the dark space showed only argon and no hydrogen. The pump on this occasion was not worked at all, but the gas apparently was absorbed, and the discharge refused to pass in about three minutes. There was some sputtering of the electrodes and blackening of the tube, but the aluminium, though blistered, was not melted. The experiment was repeated twice with the same results. On reconnecting the tube to the two-inch spark coil, the same absorption was observable but less rapid. The electrodes were larger, and were less heated than in the case of the first tube.

We concluded from these and similar observations, of which the above may be taken as a sample: (1) that the hydrogen occluded in the kathode played the part of carrier of the discharge from the metal to the gas. (2) That if there were sufficient occluded hydrogen, there would be little or no sputtering of the aluminium. (3) That when no hydrogen was present, the discharge was conveyed from the kathode by particles of the metal itself, which were capable of exciting fluorescence of the glass, and of gener-

[1] By Prof. H. L. Callendar, F.R.S., and Mr. N. N. Evans, Lecturer in Chemistry, McGill University, Montreal. (Read before Section A of the British Association, at Toronto.)

ating X-rays wherever they impinged, behaving in fact as kathode rays. (4) That in X-ray tubes, as usually exhausted, without excessive precautions for the drying of the gases, and the complete removal of residual hydrogen from the electrodes, the residual gas was in most cases hydrogen or water vapour.

In order to test the behaviour of other gases as compared with argon, similar experiments, in the same tubes, were made with dry air, with hydrogen, with oxygen, and with water vapour.

With dry oxygen and nitrogen, the absorption of the gas was very rapid at a pressure of one-tenth of a millimetre, if the electrodes were sufficiently heated. Although hydrogen was not observable and was presumably absent, the blackening of the tubes was very slight, and a much greater power could be applied than in the case of argon, without melting the electrodes.

With water vapour under the same conditions an X-ray vacuum could not be obtained (owing probably to the slowness of diffusion), unless the tube were considerably heated, either with a flame or by means of an excessive current. On allowing the tubes to cool under these circumstances, the vacuum improved very greatly, owing to absorption by the surface of the glass, and the discharge often refused to pass. Under steady conditions of running at a low temperature, there was no clear evidence of absorption of the water vapour, in spite of the drying tube on the pump.

With carefully dried hydrogen, under the same conditions, the process of exhausting the tubes with the mechanical pump was extremely rapid as compared with the other gases, owing to the greater velocity of diffusion of the lighter gas. With the smaller tubes, ten or twenty strokes were sufficient to give brilliant X-rays, starting in each case with a pressure of half a millimetre to a millimetre. There was no marked absorption at any stage of the vacuum, and no trace of sputtering of the electrodes. We expected to find some evidence of absorption by the electrodes or the platinum antikathode, but it is possible that these became saturated with gas very rapidly at an early stage, and ceased to absorb gas at an X-ray vacuum. We concluded that hydrogen was the most suitable gas to use in X-ray tubes, but it is possible that helium, being also a very light gas, might be equally good, if its inert or monatomic character does not lead to the disintegration of the electrodes in the same manner as in the case of argon.

If the great resistance to the passage of the discharge from the kathode to the gas in the case of argon, is dependent upon the monatomic nature of the gas, it might be expected that similar phenomena would be observed in the case of mercury. Some mercury vacuum tubes were therefore made in the form of inverted U tubes. The electrodes were liquid surfaces of mercury in each limb, to which connection was made by short pieces of platinum wire, which did not project above the surface of the mercury. These tubes were exhausted and boiled with an alternating discharge passing, until more than half the mercury had distilled over. They then presumably contained only mercury vapour. When cool, the two-inch spark discharge refused to pass at first, but if the tube were tilted for a moment, so as to expose the platinum wire, it appeared that sufficient gas was liberated to enable the discharge to pass without any difficulty. The tubes showed only the mercury spectrum. In the high resistance state, immediately after boiling, the kathode limb, with a larger spark coil, showed brilliant fluorescence and feeble X-rays. We concluded from these experiments that a very small trace of another gas was sufficient enormously to reduce the resistance of a mercury vapour tube, and that if the vapour could be obtained quite pure, it would possibly not conduct at all.

To verify more accurately the conditions of vacuum at which these phenomena occurred, the whole apparatus was subsequently connected to an automatic Sprengel mercury pump to which a McLeod gauge was attached. The pump and all its connections were carefully tested for leakage, and the drying tube was filled with fresh P_2O_5. We had found in previous experiments of a similar character made two or three years previously, that sulphuric acid, however carefully prepared, gave off appreciable quantities of water vapour, which would have been quite sufficient to vitiate these results.

Using a large coil and a slow mercury break, to avoid overheating the tubes, we found that fairly efficient X-rays were obtained in most of the tubes at an average vacuum of ·006 millimetre, if the tubes were exhausted in the ordinary way without taking special pains to remove the hydrogen. The H lines always showed faintly in the kathode light before this vacuum was reached. After using an alternating discharge to heat the electrodes, and carefully washing out the hydrogen as far as possible with argon, we found that the pressure corresponding to an X-ray vacuum gradually increased up to ·030 millimetre. Before letting the argon into the tube it was allowed to remain ten or fifteen minutes in contact with the fresh P_2O_5. On omitting this precaution and admitting the argon direct from a bulb containing an old sample of P_2O_5, which was beginning to deliquesce on the surface, it was necessary to raise the vacuum to ·015 millimetre before X-rays were produced. On the other hand, the sudden addition of dry argon at this stage up to a pressure of ·029, produced no change in the appearance of the tube. It is probable that we never succeeded *entirely* in eliminating the residual hydrogen, but we concluded from these and similar experiments that the presence of the argon by itself had little, if any, effect on the production of X-rays, since the amount present in the tube could be varied within wide limits.

We next endeavoured to ascertain at what degree of vacuum the apparent absorption of the argon previously observed could be reproduced. For this purpose we used two tubes of the double-focus pattern, and an alternating discharge. Taking the first tube slightly damp from the blowpipe, we exhausted it to one-fifth millimetre vacuum with the mechanical pump. The discharge was then turned on and adjusted to heat the tube and electrodes as much as possible with safety, *and the pump was not further worked.* Under these conditions the remaining water vapour was rapidly expelled and absorbed by the P_2O_5, the tube soon showed a brilliant hydrogen spectrum followed by green fluorescence, the antikathode became red hot, then cooled, and in fifteen minutes the discharge (20,000 volts) refused to pass. The tube was not appreciably blackened. On connecting to the direct current discharge, it gave brilliant X-rays. This case is interesting as showing that a very good vacuum may be obtained in these cases by simple absorption.

Dry argon was then admitted into the tube up to a pressure of 0·160 millimetre. At this pressure, in tubes three inches in diameter, with the direct or alternating current, the tube was filled with blue light, and gave a spectrum which was verified to be that of blue argon, without any visible trace of hydrogen or nitrogen. After running the direct and alternating current through the tube for half an hour, the tube became very black, but there was no change in the pressure as measured by the gauge. It should be remarked that in measuring these high vacua, the pump was usually stopped to allow time for the equalisation of the pressure throughout the apparatus. The alternating current in the primary of the coil was only 2·5 amperes with argon, whereas 4 amperes had been used with air. The latter current, if used with argon, would have melted up the kathodes. Finding no absorption at this pressure, the pump was started to run very slowly, and the same alternating discharge was continued. The sputtering of the electrodes rapidly increased, and at a vacuum of about one-tenth of a millimetre, the upper electrode suddenly melted off. Another tube was then tried, but met with a similar fate at the same degree of vacuum. The failure was so sudden that it was difficult to control the current in time. If the argon is actually absorbed, it is clear that the phenomenon depends upon very special conditions of temperature and discharge. It is possibly that the absorption is only apparent, and corresponds to a very sudden increase of resistance to the discharge at a particular degree of vacuum, such as occurs in an ordinary X-ray tube when the boundary of the dark space reaches the antikathode. With greater care, it may be possible to decide this point, but an unfortunate accident to our water mains prevented further investigations at the time. It is clear, however, that the behaviour of argon is peculiar, and it seems probable that most of the ordinary kathode ray phenomena are due to residual hydrogen.

THE ORIGIN OF THE EUROPEAN FAUNA.[1]

I HAVE endeavoured to show how the present fauna of Europe originated. For that purpose it was found advisable to commence the inquiry by the study of the past and present fauna of an island. The British Islands, and in particular Ireland, seemed to me most suitable for that object.

[1] Summary of a paper by Dr. R. F. Scharf, read before the Royal Irish Academy. (Reprinted from the *Proceedings* of the Academy, 3 ser. vol. iv. No. 3, 1897.)

The fauna of Ireland as well as the flora is found to consist mainly of two elements, one of which came from the north and the other from the south. In the fauna of Great Britain the same two elements occur, but there is, in addition, a third—an eastern one—chiefly confined to the eastern counties. The southern element contains animals which came originally from south-western, and others which migrated to the British Islands from the South and Central Europe. The former are confined to the south-western counties of England and Ireland, whilst the latter are chiefly found in the south-west of England, Wales, Ireland, and the west of Scotland. The northern element chiefly occurs in Scotland, the north of England, and the north and west of Ireland.

Though it may be admitted that a small percentage of the British fauna reached the British Islands by occasional means of dispersal, the bulk of it migrated on land. A land-connection must therefore have existed formerly between Great Britain and Ireland, and the continent of Europe.

The late Edward Forbes believed that the Lusitanian or south-western element in the Irish flora (it was not known at the time that there was also a similar fauna) came to Ireland in Miocene times and survived the Glacial Period on a now sunken land which lay to the south-west of that island. Almost all other authorities are convinced that both flora and fauna were entirely exterminated in Ireland during the Pleistocene Epoch, and that what exists there now, migrated to it after the Glacial Period.

A short statement of the general conclusions arrived at with regard to the geographical changes in Europe during later Tertiary times, and the chief migrations of animals now follows, so as to facilitate the comprehension of the principal arguments advanced in favour of the view that there were two distinct invasions of northern species, and that the Irish fauna is altogether pre-Glacial.

To judge from the range of the south-western European plants and animals in Ireland, it is evident, as Forbes suggested, that they came long before the other southern species or the northern ones. Last of all came the eastern or Siberian migrants. These never reached Ireland, but as we have such abundant evidence of the time of their arrival in Europe, the history of their migration is of great importance, since it furnishes us with a clue to the date of earlier migrations.

We have geological evidence that a vast migration proceeded from Siberia, and entered Europe between the Caspian and the Ural Mountains. A large number of mammals came with this Siberian invasion, and no fewer than twenty-nine species reached England, ten of which still inhabit Great Britain. There is no evidence that any of them ever lived in Ireland.

I have endeavoured to ascertain the causes of that migration and its geological date. Both Tcherski and Brandt, the two highest authorities, are of opinion that the present Siberian fauna lived in the country already in pre-Glacial times, and that, with the addition of some now extinct forms, such as the mammoth, it flourished as far north as the New Siberian Islands. Since the advent of the Glacial Period, the fauna is supposed to have very gradually retreated from these high northern latitudes, which are now almost uninhabitable.

Against these views it has been urged that, to some extent, the mammalian bones and carcases found in the New Siberian Islands, rest on a solid layer of ice, and that as this ice was probably formed during the Glacial Period, the migrations must have taken place in post-Glacial times. This presupposes an extraordinary amelioration of climate in Siberia, the effects of which certainly would have been felt in Europe, but of which we have no evidence.

There is geological evidence that a marine transgression took place in Northern Russia in early Pleistocene times, and that at the same time the united waters of the Caspian Sea and the Sea of Aral covered a large tract of the central parts of that country. It is supposed by some naturalists (and in favour of this view I have collected some additional facts) that the White Sea and this large inland sea were connected right across Russia, thus forming a barrier by means of which the Siberian fauna was prevented from migrating to Europe. It is also suggested that the whole of the continental boulder-clay is a marine deposit, and that its maximum southward extension approximately marks the shores of a north European ocean.

In support of this view are quoted a number of Caspian species which must have come from the Arctic Ocean, and the fact of the occurrence of *Dreyssensia polymorpha*, in the lower and not in the upper continental boulder-clay, thus proving that a migration took place in both directions.

As all the deposits in continental Europe, containing remains of Siberian mammals, are of a later age than the lower boulder-clay, it seemed to me that the connection between the Aralo-Caspian and the White Sea must have ceased to exist during and after the Interglacial phase of the Glacial Period, which would also explain the absence of Dreyssensia in the more recent beds. The Siberian fauna probably began to pour into Europe immediately after the deposition of the lower continental boulder-clay. But since the first Siberian mammals made their appearance in England, during the deposition of the Forest-bed, the British newer Pliocene beds must be contemporaneous with this boulder-clay. Further proof of this will be mentioned later on.

Some further evidence is now given in favour of the marine origin of the boulder-clay, and the causes of the absence of marine shells in the Russian deposits are explained.

We have geological proofs that the Siberian fauna migrated to Europe on a tract of country known as the "Tchernosjen" or black earth of Russia, and that this originated from the decay of grass which grew there during long ages This fauna then invaded Central Europe and Great Britain. In France its further progress was arrested by the river Garonne. England and France must therefore have been connected; whilst the absence of deposits containing Siberian mammals from Scandinavia proved that it was separated from the continent.

The Northern or Arctic element in the Irish fauna must have come directly from the north. It is more or less confined to the northern and western parts of Ireland, and forms a large proportion of the fauna of Scotland and Scandinavia. It suggests that a land-connection between the latter and the British Islands must have existed. The present and past range of the Arctic hare, the reindeer, and the stoat are discussed in detail to show that such a connection actually united the two countries. Reference is also made to the North American species occurring in Ireland which belong to the same migration.

The evidences in favour of a former land-connection between Scandinavia and Greenland *via* Spitsbergen are now reviewed.

It is suggested that the American marine mollusca which have been discovered in late Tertiary deposits of the east coast of England reached that coast, not from the Atlantic, but from the Arctic Ocean by means of the sea which extended from the White Sea to the German Ocean.

The migration of terrestrial animals and plants from this ancient northern land southward took place chiefly during the deposition of the newer English crags, and of the continental lower boulder-clay, that is to say, before the Siberian migrants set foot on British soil.

The southern migration to the British Islands commenced earlier than either the Arctic or the Siberian. Numerous instances are quoted to prove that the southern fauna is composed of species of south-western and of southern and Central European as well as of Asiatic origin.

In connection with the origin of the Red Deer, the nature of the geographical changes which the Mediterranean basin has undergone during later Tertiary times are now discussed.

I have endeavoured to show that Ireland was separated from England at the time while the migration from Southern and Central Europe was in progress. The contradictory evidence from fossil sources as to the climate prevailing at that time in the British Islands are there now discussed.

The orgin and nature of the Glacial Period is so intimately connected with these faunistic problems, that it has been thought advisable to devote a short chapter to this important era in the life of the direct ancestors of our animals. The prevailing opinions as to temperature and general atmospheric conditions during the period are reviewed in connection with the questions as to the possibility of a survival of the terrestrial fauna and flora chiefly in the British Islands. The British Pleistocene fauna does not indicate the prevalence of Arctic conditions—neither does the flora.

This fact certainly supports the view formerly held by geologists that the phenomena in Northern Europe, now attributed to land-ice, have been produced by sea with floating icebergs, under conditions somewhat comparable to those at present obtaining in Tierra del Fuego. A succinct statement of my views on the Glacial Period and the geographical features of Europe at the time—as derived from a study of the European fauna and of its origin—concludes this memoir.

MANCHESTER'S REPORT ON TECHNICAL EDUCATION IN GERMANY AND AUSTRIA.

IN pursuance of a resolution of the Technical Instruction Committee of Manchester, confirmed by the City Council, a deputation, comprising Alderman James Hoy, Alderman J. H. Crosfield, Councillor Nathaniel Bradley, Mr. Ivan Levinstein, Mr. John Craven, Mr. Charles Rowley, with Mr. J. H. Reynolds (Director), recently visited certain institutions and schools on the continent devoted mainly to scientific and artistic instruction as applied to industrial and commercial pursuits. The Report of the Committee has just been published, and the following extracts from it will do much to show the British public the extent to which provision is made in Germany and Austria for the supply of instruction of a scientific and technical character in aid of the commerce and of the industries of these countries.

Since 1891, when a deputation from the Technical Instruction Committee visited some of the continental countries, the Council has undertaken the task of maintaining the Technical and Art Schools of the city; and with the purpose of giving full effect to this responsibility, has already not only greatly developed these institutions, but has embarked upon the erection of the largest technical school in the country, the proper equipment of which is a matter of the most serious concern and importance. The erection of the new school was begun in August 1895, and its completion, ready for occupation, is confidently expected at an early date. The Committee, therefore, felt that it was high time the question of the equipment of the school was considered, especially in respect of the important departments concerned with the textile industries, with the industrial applications of chemistry, and of physics in relation to electrical engineering.

The extraordinary development which has taken place within quite recent years in electrical science as applied to electrical engineering industries, and the certainty of great extension in the near future, make the equipment of a large technical school a responsible matter.

Hardly less important than electricity is the great textile industry in its various departments of spinning, weaving, designing, dyeing, and finishing, in some of which we find ourselves at a serious disadvantage (especially those in which chemistry plays a part) as compared with our foreign competitors.

It has been found necessary in the dyeing and finishing schools abroad to discard mere laboratory methods, and to equip them on a scale approaching that of the works themselves, and analogous to the practice obtaining in the spinning and weaving schools, so as to give the students who are trained in them a real, practical, and effective knowledge of the processes employed.

THE CREFELD DYEING SCHOOL.

Hence at Crefeld, where the Textile School already enjoys a world-wide repute for the splendour of its equipment, and the effectiveness of its influence in promoting the special industry for which Crefeld is famous, and which finds in this country its best market, the Prussian Government have built and equipped a large three-story building in the near neighbourhood of the present Textile School and Museum as a Dyeing and Finishing School. This School contains extensive chemical laboratories for instruction in qualitative and quantitative analysis, physical laboratories, drawing-rooms, lecture and testing rooms, chemical museum, reading-room and library. In the library are to be found technical books of all nations bearing upon textiles, all of which are introductory to the special work of the school, namely, the dyeing and finishing of textile goods, particularly those of importance to the special industries of Crefeld and the district.

Much attention is given to the examination of colouring matters, and to mordanting on all kinds of fibres and cloth; and constant experimenting, with a view to new materials and processes, is a special feature of the instruction. Experiments are undertaken in testing the colours employed, and in dyeing the yarns for exposure to light, adverse atmospheric influences, resistance to acids, alkalis and soaps; and investigations are made with a view to the production of colouring matters formerly employed in the dyeing of old tapestries. Every effort is made to assist the manufacturers and merchants; and on their behalf the school will undertake investigations as to the dyeing and finishing of materials submitted, which, when completed, are reported to the manufacturer or merchant, with information as to the methods used, and the chemicals employed on the fabric, together with the cost of production. These investigations are carried on by the students under the direction of the teachers, and are of inestimable value to them as a training in solving real industrial problems.

THE CREFELD SCHOOL AS AN EXAMPLE TO BE FOLLOWED.

Your deputation is convinced, as a result of the inspection of the Crefeld School, that the Manchester district would gain materially by the development of the Textile School in the new building on the same lines.

(1) By the increase in the number and variety of the looms and of the goods woven upon them.

(2) By the establishment of a school of tinctorial chemistry, and of practical dyeing and finishing, upon an adequate scale, alike in respect of the completeness and the real efficiency of the machinery employed.

(3) By the establishment, in actual touch with the other departments of the school, of a well-organised museum, replete with examples of ancient, mediæval, and modern productions of the best type of workmanship, colour, and design.

It is to variety and excellence in these respects that Lancashire must look to maintain and increase its supremacy and reputation as a manufacturing centre.

HOW PRUSSIA DISSEMINATES TECHNICAL INFORMATION.

As showing the thoroughness and the zeal with which the Government supplies the means of technical training in the various industries of the country, it was stated to the deputation that if any paper—dealing, for example, with some department or detail of the textile industry—is read before any foreign society, and is published, or appears in any journal, the communication is immediately translated and circulated throughout the textile schools of Prussia, with directions to have it dealt with as a lecture to the students; and if models, illustrations, or lantern slides are required by way of illustration, they are prepared and sent with the paper. Moreover, in Berlin there exists a department of the Bureau of Education not accessible to visitors or inquirers, where models, diagrams, and other means of illustration are prepared and circulated to the technical schools of the country.

THE EFFICIENCY AND HIGH STANDARD OF TECHNICAL INSTRUCTION IN GERMANY.

Your deputation are convinced that the textile schools of Germany, so far as they have observed them, are of singular value in training up a supply of exceedingly well-instructed men, capable, by reason of the methods employed, the examples studied, the variety of the appliances used, and the investigations and experiments made, to take the lead as foremen, managers and manufacturers in the industries concerned.

The present and potential importance of the electrical engineering industry led your deputation to visit Darmstadt, where, in 1895, the Technical High School was entirely rebuilt on a greatly enlarged site at a cost of 130,000*l*. The school includes, in addition to the main building, and opposite to it, two fine buildings—one for physics and technical electricity, and the other for pure chemistry, electro-chemistry, chemical technology, and pharmacy.

It is important to remember that these figures referring to the cost of building represent a much larger corresponding cost in England—for example, the cost of the Darmstadt building, which is of stone, was only 5*d*. per cubic foot, which is about half the cost of similar buildings in England. This remark applies also to statements of cost of administration and of teaching—salaries being on a lower scale than with us. It is, however, important to observe that the principal professors enjoy the status and the advantages of civil servants.

It is to be noted that Darmstadt has only 57,000 inhabitants, and that the entire State, of which it is the chief city, has a population of not more than one million. This Technical High School is an institution of university rank, and is built on a scale of great liberality. Considerable as it is, it was felt by the authorities that the growing demands and development connected with electrical science and its adaptation to industrial needs and the general service of the community necessitated the establishment of special provision in suitably equipped buildings of means of instruction in electro-chemistry and electrical engineering. This has been done, as already stated, in two new and separate buildings (which are even now being enlarged), on an exceptionally complete scale. The efficiency, extent, completeness, and fine organisation of the equipment in the electrical building especially impressed the deputation.

Darmstadt undoubtedly possesses the means of giving the highest possible theoretical and practical instruction to electrical engineering and electro-chemical students, and that this is highly appreciated is shown by the fact that out of the 1100 day students in attendance in this school (all of whom are over eighteen years of age), more than a third of them are enrolled in the physics and electrical engineering division. The reputation and efficiency of the school attract a large number of students from various European countries.

The equipment of this school has set before the deputation an excellent example of the methods to be followed in equipping the electrical engineering and physical department of the new Technical School of this city, though we may not hope that it can be approached either in extent or completeness, for want of space and want of means. The cost of this department alone has been 28,000*l.*; and the building, which is three stories in height, stands upon a space of ground 123 feet by 140 feet.

The comparatively advanced age of the day students in German technical schools is especially remarkable as showing (1) the relative position of technical schools with respect to general education on the continent and in England; (2) the standard of attainment reached before entering upon specialised studies; and, lastly, as indicating the advance which is possible under such circumstances.

ADVANTAGES OF SCIENTIFIC AND TECHNICAL TRAINING.

Without doubt the general industry of the country gains immensely by the extended time given to scientific technical training in the supply of a large number of adequately educated men. Nothing is more striking than the prevision of those responsible for the education of the German and Swiss people in providing the means for the best possible training in chemical science and its industrial applications.

The sense of the importance of chemistry as a predominant factor in future industrial developments, led to the establishment of large and costly laboratories, directed by the most eminent men of science of the day, where students were encouraged to devote five, six, or even seven years to study, with the result that it has unquestionably placed the German and Swiss manufacturers, especially the former, easily first as the greatest producers in the world of colours and fine chemicals.

The success of this policy may be realised from the fact that the great colour manufacturing works of the Badische Anilin and Soda Fabrik at Ludwigshafen, on the Rhine, alone employs nearly 5000 men and upwards of 100 scientifically trained chemists, its technical laboratories themselves being on the scale of the laboratories of a great university. In 1865 this firm employed only thirty workpeople. These works are but one of several on a similarly large scale.

The command of the world's market in colouring matters and pharmaceutical products derived from coal-tar, the value of which is estimated at about 10,000,000*l.* sterling, is in the hands of Germany to the extent of three-fourths, 75 per cent. of which is sent abroad.

The success in this great department of applied science has stimulated the educational and industrial leaders of Germany to further efforts, and the recent great advance in knowledge in the department of physical science has resulted in the erection and equipment of electrical laboratories on an imposing scale at Stuttgart at a cost of 100,000*l.* (including additional provision for the study of pure chemistry), at Hanover, where a new Electro-Technical School has been added to the Royal Technical High School, and again, as already stated, at Darmstadt.

It is clear that the educational advisers of the various German Governments are of opinion that the same success which has already attended the establishment of numerous and costly chemical laboratories in stimulating German industry, and placing the nation first in the manufacture of chemical colour products, will be repeated through the establishment of like laboratories for the study of technical electricity as applied to the field of chemistry and to engineering.

The real bearing of the importance of electricity in association with chemistry in the production of new organic and inorganic compounds, and by electrolytic action of the more economical production of chlorine and of such metals as zinc, nickel, sodium, potassium, and aluminium, is hardly fully grasped in this country, so far as means exist for its study; but there is abundant evidence of the activity af Germany in the establishment of special schools and laboratories, splendidly equipped, with a view to important industrial developments in the near future, which will win for Germany a similar pre-eminence to that she has attained in the domain of chemistry.

PROGRESS IN GERMANY.

That Germany is in a prosperous condition, due to her successful manufacturing and commercial enterprise, was plainly evident on every hand in the extension of her cities—the making of new streets, and the erection of fine, handsome buildings which is going on everywhere in her large towns.

It is not less clear that the schools are the root and base of this surprising industrial development, and are the main contributors to this great economic result; it is no less certain that if we are to maintain our position as a great industrial community, it must be by following and adopting the same methods.

It is not, however, only in the domain of science that Germany is making great progress. In almost every town visited by the deputation fine industrial art museums were found, arranged with the express purpose of cultivating a knowledge of what has already been accomplished in the production of fine examples of colour, design, and workmanship. Every technical school has its special museum of objects applicable to its purposes. Notably was this the case in Berlin, Vienna, Nuremberg, Crefeld, and at Düsseldorf, in which latter place the Industrial Art Museum is said to be the finest in the Rhine land. These museums help to preserve and hand down the traditions of past achievement and excellence, and stimulate the desire to reach to as high, or higher, levels to-day.

INFLUENCE OF TECHNICAL SCHOOLS ON INDUSTRY.

In submitting this report, your deputation are not insensible to the consideration that it may be thought that a too favourable view has been taken of the educational provision and the industrial advance observed by them in German States as compared with the position in England.

In deprecation of such possible criticism, they would observe that it is by no means a difficult matter to trace to the influence of the schools, and the system of education generally, the improvement which has marked the manufacturing progress of Germany and especially the unique position occupied by the chemical industries in that country.

Almost every industry has schools specially equipped and staffed—well described by the phrase Mono-technic Schools. Such schools are almost unknown here, or are to be found in connection with only one or two industries, as, for example, with weaving and dyeing, and one or two other industries, such as tanning; but even in these cases the number is very limited, and the day students are comparatively few, whilst the equipment is nowhere on the ample scale of Crefeld.

The German Mono-technic School is intended primarily for day students, and only incidentally for evening students. The knowledge, skill, and experience of the highly-qualified staffs are all directed to the advantage and cultivation of the day students, and your deputation are of the opinion that that policy must be followed here if any marked industrial advance is to be secured.

The attention of the deputation was frequently directed to the importance of another factor in the development of German commercial progress, namely, the careful attention given to the study of foreign languages, especially to English (which latter language is most successfully taught), with a view to their use in business transactions, and of enabling those engaged in commerce to come into the closest relations with customers in all parts of the world.

It is further desirable to draw attention to the advantages enjoyed by foreign nations by the adoption of the metric system. The ease with which the knowledge and use of it is acquired, and its universal adoption, in all scientific training and investigation, not to speak of its value in commercial transactions in foreign markets where, with rare exceptions, it is employed, make its universal adoption here much to be desired.

The excellent system of secondary education has greatly contributed to this, but, in addition, special commercial schools are found in all the largest towns.

LESSONS TAUGHT BY GERMANY.

Referring once more to Germany and especially to Prussia, your deputation cannot conceal their sense of the advantage, whatever may be the ultimate drawbacks, of a centralised bureaucratic administration which, taking a careful survey of the educational and industrial needs, places the schools here or there as circumstances require, brings them into mutual relation, supplies ample means, and effectively assists without loss of time the industrial advance. Something may be lost of "freedom, variety, and elasticity," and that loss may ultimately be serious in its effect upon individual initiative, upon which we as a nation so confidently rely. Which is the better policy the future can alone determine. It may, however, be safely asserted, that it is high time the effort was made in this country to give to our youth the educational advantages, general and special, which are enjoyed by their rivals abroad.

Exception has sometimes been taken to the size and cost of the new building now being erected by the Technical Instruction Committee for the Municipal Technical School, but your deputation have returned from their visit doubly confirmed in their conviction that every foot of space will be needed, and that even when fully utilised and equipped it will fail to rival in amplitude of resource the splendid industrial schools of Germany and Switzerland.

The report, of which the above is a summary, was presented to the Manchester City Council on Wednesday, October 20, when the following interesting discussion, abridged from the *Manchester Guardian*, took place upon it:—

Mr. Alderman Hoy, Chairman of the Technical Instruction Committee, moved the adoption of the report. The report, he said, contained the latest information as to the developments of technical instruction upon the continent, in the countries named, in respect of certain specific industries, more especially textile manufactures, dyeing and finishing, and electrical engineering, and, generally, what was being done in these countries under the name of technical education. It was to this point, and to this alone, that he wished to draw the Council's attention. The term "technical education," as generally used in this country, was much abused. It would appear to mean anything, as occasion might require, from an evening continuation school for teaching the elements of cookery or the practice of sewing and cutting-out, up to an institution designed to give the highest form of specialised scientific instruction. No doubt the grant of funds from the Exchequer, under the provisions of the Technical Instruction Act, and the vague and general definition of the objects of the Act, contributed to this loose interpretation of the phrase and to the application of the money in aid of almost every form of instruction. Let him give the definition of the phrase as understood in the Manchester Municipal Technical School:—"The chief object of the Technical School is to provide instruction in the principles of those sciences which bear directly or indirectly upon our trades and industries, and to show by experiment how these principles may be applied to their advancement." This object was carried out in two ways—first, by day instruction; second, by evening instruction. As with the country generally, evening teaching was at present by far the most important in point of the numbers taught and range of subjects, the numbers in the daytime being only the merest fraction of those in attendance at night. The object of the evening student was to supplement the practice of his daily occupation by an attempt to study and to understand the scientific principles which underlie it, in the hope of increasing his efficiency as a workman. Without doubt this was a most desirable object, and the schools which provided such instruction and those who took advantage of it, often under conditions requiring the greatest sacrifice of time and strength, deserved the highest praise. Nevertheless, important and valuable as was the provision made in this country for evening scientific and technical instruction, and useful as it undoubtedly was to the artisans who with scant educational equipment endeavoured to profit by it, it could not, when regarded from the wider view of the serious industrial and commercial competition among the leading nations of the world, be accepted as satisfactory or as sufficient to enable this country to maintain its position, especially in those industries where scientific knowledge and training were indispensable factors. Thus the efforts of the chief continental nations were directed to the highest scientific training of those who were ultimately to become the leaders and organisers of the great scientific industries. The main point of interest in the report now presented would be found, therefore, to lie in the emphasis (only faintly indicative of the real extent and wealth of equipment and teaching power which was observed) laid upon the abundance of the provision for scientific instruction to day students preparing to enter upon industrial pursuits, and its quite extraordinary development within the past few years. In every industrial centre new buildings were rising, old institutions were being enlarged, and their equipment increased in order to keep pace with the demand for better and more advanced training in science and art, with a view to industrial and commercial advancement. The advance in scientific knowledge of the past half-century had changed the conditions of the industrial problem, and had gone far to equalise the struggle for industrial supremacy, or at least was tending to make countries once dependent upon us for supplies of manufactured goods more self-contained and self-supporting, and even to enable them to meet us in open markets. It was a case of steam dependent upon abundant coal supplies *versus* electricity dependent upon abundant water power. Germany had already found her reward in her command of the market for products requiring the aid of the highest scientific skill in chemistry, due entirely to the existence of her schools, and what she had done in the domain of chemistry she hoped confidently she would do in that of electricity also. The future of the manufacturing industry depended entirely upon the application of the highest scientific skill and experience in developing natural resources and products, and those nations which realised the truth of this and provided for the training of the leaders and organisers of industry would surely win the day. Nothing struck the English visitor to Germany more than the extraordinarily large number of well-educated young men in the day departments of foreign technical schools, clearly pointing to the recognition of the value of scientific training as the chief element and necessity for industrial efficiency and success. The report now presented was not written with any idea of depreciating the value or skill and efficiency of the English workman, but with the aim of showing how much more efficient would be the result of his efforts if directed by leaders and managers who were themselves thoroughly trained in the principles of science and of art in their application to the industries in which they were engaged. Without doubt we had the finest race of workmen in the world. Their fine qualities would be improved by education, and their opportunities of advancing to the front rank of leaders and managers in our great and varied industries would be well served by the facilities now increasing on every hand in every industrial centre of the country through the operations of the Technical Instruction Act, and he, as one of their sincere well-wishers, trusted that they would take full advantage of the facilities thus freely offered.

Mr. Alderman Crosfield, deputy-chairman of the Technical Instruction Committee, in seconding the motion, mentioned that the deputation was accompanied by Mr. Charles Rowley and by Mr. Reynolds, director of technical education, both of whom showed great interest and enthusiasm in the subject. The deputation found that since the deputation from the Corporation, headed by Mr. Alderman Rawson, went to the continent some years ago very great progress had been made, particularly in Germany. The paternal Government of Germany and the good sound sense of the German people had put that country far ahead of us in educational matters. The difference between the German artisan and the Lancashire artisan was very great, and if we did not take care we should be not only as far behind that country as we were at present, but a great deal further. The idea that students should go to the technical schools unprepared, which was a thing we suffered from very much here, was apparently entirely unknown in Germany. It was much to be regretted that in this country parents, preferring a few shillings now to pounds a few years hence, should take their children away from the day schools at such an early age.

Mr. N. Bradley, who also accompanied the deputation, said he was struck with the complete way in which the work was done in the technical schools in Germany. Every penny that could be spent in Manchester for the purpose of technical instruction would be to the advantage of Manchester and of the people of this country. The impression that entered his mind was that in all industrial pursuits where there was competition it was a great advantage to see the other side. Consequent on the kindness of the professors and the officials connected with the continental institutions which they visited, everything was shown to them, and the benefits of experience were placed unreservedly at their disposal. They found that the schools were conducted under a system in which cleanliness and discipline showed themselves on every side. The result of the teaching the pupils received was exemplified in this country, for it was a fact that foreigners came to England to fill places which ought to be held by Englishmen. He believed it would be possible to save a very large sum of money to the ratepayers if the equipment of our technical schools were made far more efficient than they had been.

Sir Bosdin Leech supported the resolution. They had, he said, just heard what was being done on the continent. He had recently crossed the Atlantic and travelled in America and Canada, and he found that there the course of education was being greatly pushed forward. He saw what was being done there in the way of the introduction of labour-saving appliances, and in the efforts that were being made to oust us from the markets of the world, and unless we went forward much more quickly than we had done up to now, improving the minds of our children and increasing our scientific teaching, we should be distanced very materially. Already we were far behind the United States and Canada in the matter of electricity. In thirty or forty towns which he visited he did not see a single horse employed in traction. Electricity was used, and people were able to get about very rapidly. Electricity was also applied to the lighting of streets in a way that was most effective. He felt that we should strain every nerve to help forward the work of the Technical Instruction Committee.

Mr. Alderman Higginbottom said he had had an opportunity of seeing on the continent what Sir B. Leech had seen in America. The subject of electricity had occupied a great deal of the attention of the Technical Instruction Committee, and he wanted to emphasise very strongly that it was the duty of that committee to place every convenience before their students who were studying electricity. He regretted that he and those who accompanied him were forced to the conclusion that England was very much behind continental nations in regard to electrical work. Sir Bosdin Leech had said that electric traction was everywhere adopted in America. It was also almost universal on the continent. But besides electricity, we had something else to learn. We had been under the belief that we were the home of engineering, but we were nothing of the kind. He had travelled through the principal cities of France, Germany, Austria and Italy, and had visited fifty of the finest electric stations for traction and lighting purposes, and, with one exception, he found that all the machinery used in those stations was from the works of continental firms. The deputation had seen engines of 1000 and 1500 horse-power, vertical and triple-expansion engines—which we thought we could build in Lancashire better than anybody else—and he was bound to say that he had never seen finer. The whole secret of the success of the foreign engineer was that for many years the foreigner had been giving his students the best technical instruction possible. He said nothing about the capabilities of the German workman as compared with those of the English workman. The English workmen were superior to the German or Italian workmen in the matter of ordinary work, but as regarded technical training and in matters of detail they were far ahead of us. The workshops were kept in the cleanest and most systematic way, and they were able to turn out work cheaper than it could be done in England.

Mr. Alderman Rawson said the matter under discussion was not merely of local, but of national importance, and attention to it was requisite if we were to maintain the position we had hitherto held. Since the establishment of the textile department of the Technical School in 1882, the Committee had been dependent upon the foreigner in every case but one for the teaching of dyeing, bleaching, and printing, and they had paid higher salaries in that department than in any other, with one exception. The foreigner had anticipated us not only in technical matters, but in the preparation of men who were competent to teach in those subjects. He hoped the report of the Committee would be widely circulated and read. With regard to our general system of education, he hoped the time was not far distant when the clever child of the poor man would be able to proceed from the elementary school to the Grammar School, the Technical School, Owens College, and the University.

Mr. Trevor said he hoped the effect of the speeches that had been made would be to induce public men to pay more attention to the subject under discussion; then they would perhaps not feel called upon to subscribe so much in the way of amusement, and give rather more to matters of real profit. At the Owens College he understood they had an important section for giving instruction in steam-engine testing. The subject of steam-engine testing and the taking of diagrams was a most important one; yet last week the number of students from this great centre of engineering, with its half-million of inhabitants, was only five, and the teacher told the students that unless they could make the number up to seven it would not be worth while to carry on the class. The fees, he understood, were only two guineas for a term of ten lessons. We possessed as much conceit as any country on the globe—he meant the thing that stood in the place of ability; it was very common—but we could only produce five young men interested in their work to the degree that they wished to perfect themselves in it. We were always talking about our being the best workmen in the world. Those who worked were the best, but men should do a little more for the honour of their work, and, apart from the question of wages, try to perfect themselves in it. It was time the British workman should try to improve himself individually, and not depend so much upon organisation. If he would take more advantage of the expensive arrangements that were provided for him, and study, we should get back our trade.

Mr. J. Phythian (Gorton) said that as a member of the Amalgamated Society of Engineers he went upon the deputation with a prejudiced mind. He believed the working men of England were capable of building engines and dynamos superior to any, but his opinion had been changed. He saw work done by continental artisans—and he thought he was a fair judge of good work—which would put to shame a great deal of the work done in this country. He was perfectly certain he never saw better engines built than those which he saw being constructed on the continent. He attributed this to the care with which the workmen were trained in details, which enabled them to excel in those niceties which were absolutely essential in the making of engines and boilers.

Mr. Mainwaring said as a member of the deputation he was glad some plain unvarnished truths had been uttered in that chamber. Twenty years ago he visited some of the towns visited by the deputation, and he was amazed at the great advances which had since been made. It was quite time the veil was torn from the eyes of the English workman, and that we abandoned the short-sighted belief that no one could touch us in our various industries. The deputation had not come in contact with a single foreman of works in Germany who could not speak to people in either French or English. He should like to know where they would find a foreman in works at home who would be able to speak to a visitor in German or French. They found that these foreign foremen could speak to them as easily in English or French as in their native language.

Mr. Wilson said he had seen engine work in America and Canada, and he had recently travelled on the continent, but he had seen nothing which, to his mind, was superior to English workmanship. He had heard it stated repeatedly that German workmen were not superior to English workmen when they came to work with the vice, and he believed that was an understood thing. He should strongly oppose the introduction of any foreign machinery into Manchester in connection with the extension of the use of electricity.

The resolution was adopted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Sir W. L. Buller, F.R.S., has presented to the University a valuable skeleton of the Elephant Seal for the Museum of Zoology.

Dr. Hobson, F.R.S., Dr. Bryan, F.R.S., Mr. A. N. Whitehead, and Mr. A. Berry have been appointed examiners for Part ii. of the Mathematical Tripos.

The examiners for the Natural Sciences Tripos 1898 are: in Physics, Mr. Shaw, F.R.S., and Mr J. T. Bottomley, F.R.S.; in Chemistry, Mr. A. Scott and Dr. W. H. Perkin, F.R S.; in Mineralogy, Mr. A. Hutchinson and Mr. L. Fletcher, F.R.S.; in Geology, Mr. Teall, F.R.S., and Mr. Marr, F.R.S.; in Botany, Dr. Marshall Ward, F.R.S., and Prof. R. W. Phillips; in Zoology, Mr. Shipley and Mr. Jeffrey Bell, F.R.S.; in Anatomy, Dr. Barclay Smith and Prof. A. M. Paterson; in Physiology, Dr. Shore and Dr. Waller, F.R.S.

The examiners for the Mechanical Sciences Tripos 1898 are Prof. Ewing, F.R.S., Prof. Perry, F.R.S., and Mr. Peace.

Mr. Marr and Prof. Judd have been appointed examiners for the Sedgwick Prize in Geology.

The Rev. Prof. Wiltshire has given his extensive and valuable collection of minerals to the Mineralogical Museum. It contains a large number of beautiful and costly specimens.

At the matriculation on October 21, 872 freshmen, including nine advanced students who had graduated in other Universities, were enrolled.

The Harkness Geological Scholarship for women has been awarded to Miss Hilda D. Sharpe, of Newnham College.

THE first Congregation of the *Prifysgol Cymru* (University of Wales) for conferring degrees was held in the Park Hall, Cardiff, on Friday, October 22. Ten students from Aberystwyth, Bangor, and Cardiff were admitted to the B.A. degree of the University, and five, including one lady, to the B.Sc. degree.

THE new physical laboratory and workshop at the Langton Schools, Canterbury, were formally opened on Tuesday under the presidency of the Ven. Archdeacon of Maidstone. Dean Farrar gave an address in which he traced the growth of scientific instruction in secondary schools, and emphasised the work done by the Committee of the British Association in developing the newer methods. The new rooms give the school full facilities for instruction in science, as it now comprises chemical and physical laboratories, store-room, manual workshop, and a well-equipped lecture theatre devised somewhat after the plan of the chemical lecture theatre at the Royal College of Science.

SCIENTIFIC SERIALS.

American Journal of Science, October.—Fractional crystallisation of rocks, by G. F. Becker. Among the phenomena most often appealed to in support of the theory of magmatic segregation or differentiation is the symmetrical arrangement of material in certain dikes and laccolites. But this separation is more readily accounted for by the theory of fractional crystallisation. Before solidification, the lava constituting a dike or laccolite is subject to convection currents. The colder masses flowing down the sides of the bed deposit first the less fusible rock, leaving the more easily fusible mass to solidify in the centre. The process only takes weeks where a molecular flow would take centuries.—On the conditions required for attaining maximum accuracy in the determination of specific heat by the method of mixtures, by F. L. O. Wadsworth. Errors in reading temperatures are the most serious. To avoid them, the calorimeter should be small, and the surface of the solid large. The initial temperature of the latter should be as high as possible. The calorimeter should be surrounded by a water jacket, maintained at a temperature higher than the initial temperature of the water by an amount given in an equation worked out by the author. He also describes an improved calorimeter in which the body is conveyed in a small car of sheet copper along a track laid along an inclined tube which serves as a heating chamber. This prevents loss of heat, and also enables the observer to experiment upon small fragments.—On a new species of the Palinurid genus Linuparus found in the Upper Cretaceous of Dakota, by A. E. Ortmann. Two unique specimens of a hitherto unknown fossil have been acquired by Princeton University. They are the first remains of the Palinuridæ found on the American continent. They not only show all the chief characteristics of the family, but are so well preserved that their generic position may be made out. The fossil is congeneric with a species living nowadays in the Japanese seas, namely with *Linuparus trigonus*, hitherto regarded as a monotypic genus. The author calls the new species *Linuparus atavus*, and gives a full description.—On an improved heliostat invented by Alfred M. Mayer, by A. G. Mayer. The author describes a form of heliostat invented by his father, which is of simple construction and possesses certain decided advantages. It consists of a kind of wide telescope containing a large object-glass and a bi-concave lens which concentrate a parallel beam upon a system of two total-reflection prisms, one of which is mounted on the axis of rotation. A very intense beam is thus obtained, which is at the same time so free from heat that the most delicate microscopic slides may be exposed to the rays. Magnifications of 3800 diameters may thus be obtained on a screen.

American Journal of Mathematics, vol. xix., No. 4 (October).—On three septic surfaces, by J. E. Hill. The surfaces here discussed at some length are thus introduced: If, in the general cubo-cubic transformation between two spaces, we cause the principal sextic of one space to degenerate into a twisted quintic of deficiency 2, and into a right line meeting the quintic twice, to the general cubic surface upon which the right line lies, there will correspond in the second space, a septic surface upon which the line is triple and the quintic is double. If, however, the principal sextic of the first space breaks up into a twisted quartic of the second kind, and into a conic, meeting the quartic four times, to the general cubic surface passed through the conic, there will correspond in the second space, a septic surface possessing the quartic doubly and the conic triply. If, however, finally, the principal sextic of the first space degenerates completely, to the general cubic, passed through two transversals, and one line, of the remaining ingredients (four lines), there will correspond, in the second space, a septic surface, possessing three lines (corresponding to the first three above) triply and three lines (corresponding to the last three) doubly.—On Sylvester's proof of the reality of the Roots of Lagrange's Determinantal Equation is an examination by Dr. Muir of the applicability of Sylvester's proof (*Phil. Mag.*, 1852) to an extension of the theorem which recently appeared in the *Phil. Mag* Dr. Muir gets some interesting results.—Dr. Kluyver, of Leyden, writes concerning the twisted biquadratic.—M. René de Saussure, in "Calcul Géométrique Réglé," gives an analytical treatment of a subject which he had previousl discussed, by a purely geometrical method (see his article " tude de Géométrie Cinématique réglée," vol. xviii. No. 4).—In a note on Mr. A. B. Basset's paper, "Theory of the Action of Magnetism on Light" (vol. xix. p. 60), Dr. Larmor offers a few remarks which he hopes may be worth recording.—M. Paul Appell gives a few examples d'inversion d'intégrales doubles "que j'ai énoncé dans une courte Note des *Comptes rendus*, Fév. 1, 1897." Two Notelets are: Bemerkungen zu C. S. Pierce Quincuncial Projection, by I. Frischauf, and on the Sign of a Determinant's Term, by Ellery W. Davis.

Bulletin of the American Mathematical Society, October, vol. iv. No. 1.—The number opens with an account of the fourth summer meeting of the Society, which was held at Toronto on August 16-17 of the present year. Owing to the meeting of the British Association, and from other causes, the success of the gathering exceeded all anticipation. Fifty-five persons attended, and twenty-one papers were read. An analysis of the papers is given, and two of them are printed *in extenso*—concerning regular triple systems, by Prof. E. H. Moore, and collineations in a plane with invariant quadric or cubic curves, by Prof. H. S. White.—"A generating function for the number of permutations with an assigned number of sequences" is the title of a paper read by Prof. F. Morley at the May meeting of the Society. In *Liouville's Journal* 1895, and in earlier memoirs, M. André proves the formula $P_{n,s} = s P_{n-1,s} + 2 P_{n-1,s-1} + (n - s) P_{n-1,s-2}$, where $P_{n,s}$ is the number of permutations of n things (say of the number 1, 2, . . . n) with s sequences; and shows that (taking the number of sequences as great as possible) the numbers $\frac{1}{2} P_{n+1,n}$ are the coefficients of $x^n/n!$ in $1/(1 - \sin x)$, when expressed as a Maclaurin series. Prof. Morley states his object to be to obtain a function of x and y which, when developed in positive integer powers of x and y, will have $P_{n,s}$ as the general coefficient.—Dr. V. Snyder reviews "La Géométrie réglée et ses Applications," by G. Kœnigs. The reviewer remarks: "One gathers that the author had intended to make the treatise much more extensive, especially as the second part of the title is entirely ignored. Roughly the book is a reproduction, with some extensions, and some omissions, of parts of three papers by Prof. Klein (*Math. Ann.*, ii. pp. 203-213; v. pp. 257-268 and pp. 278-293). Should one use the book, to enable him to better understand most of the memoirs on line-geometry, it would prove a valuable aid, but read alone, the reader would get but a narrow and one-sided idea of its usefulness."—The courses of lectures at the University of Berlin, and other fragments of mathematical news are given in the Notes.

Symons's Monthly Meteorological Magazine, October.—Weather maps and early synchronous meteorological observations. On June 5, 1850, the Secretary of the Smithsonian Institution wrote to Mr. Glaisher to learn what was being done in this country. Mr. Glaisher's reply is printed, and, as Mr. Symons points out, the letter is very remarkable, considering its date, and shows that the first reports made at fifty railway stations about the year 1849 were not telegraphed but were sent by train. These were collected each afternoon in London by the *Daily News*, and thirteen of them were printed in their next issue. The observations were also collated and charted day by day by Mr. Glaisher. The first daily report issued by Admiral FitzRoy was on September 6, 1860.—True time. This is a reprint of a circular by Mr. John Milne, stating that there is no publication which shows the corresponding value in Greenwich mean time of the local time employed throughout the world. Such a table is much wanted, and is indispensable in order to determine the instant of occurrence of earthquakes, magnetic phenomena, &c.—Sunless days and the day-distribution of sunshine in summer. This is a discussion of twenty years' observations at Greenwich (1877–96). About one-fourth of our days are sunless. Spring has an average of 12·1; summer, 6·4; autumn, 25·0; and winter, 48·5 sunless days. The most "bright sunshine" occurs in May. During the five months May to September, 20 per cent. of the days have less than one hour's sunshine, while 14 per cent. have ten hours, or more. There are only eight cases of fourteen to fifteen hours' sunshine, and only one (in 1887) over fifteen hours.—Other papers refer to "so-called sulphur rains," "trees damaged by lightning," &c.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 19.—Mr. J. Cosmo Melvill, President, in the chair.—The death of Mr. James Heywood, F.R.S., the father of the Society, was announced, and a vote of condolence with the family was moved.—Prof. H. B. Dixon described experiments made in photographing explosion-flames: first, attempts made abroad, and afterwards experiments of his own.—Prof. F. E. Weiss exhibited some flowering specimens of the Dog's Mercury, which usually flowers in spring; but the plant from which the shoots exhibited were collected has been observed by Mr. F. J. George, of Chorley, for thirteen successive seasons to flower in the autumn. Sir Joseph Hooker, to whom some of these shoots had been sent, was of the opinion that this plant might be regarded as a special form with this autumn flowering character.—A paper by Mr. P. Cameron, entitled "Notes on a collection of Hymenoptera from Greymouth, New Zealand, with descriptions of new species," was communicated by the President.—Mr. Melvill afterwards exhibited some specimens of *Sisymbrium strictissimum*, found by Mr. Henry Hyde on the banks of the Mersey at Stretford.

PARIS.

Academy of Sciences, October 18.—M. A. Chatin in the chair.—On the observation and kinematical interpretation of the phenomena discovered by Dr. Zeeman, by M. A. Cornu. The phenomenon in question, the formation of doublets and triplets in a spectrum by the action of external magnetic forces, is shown experimentally to be subject to the laws of Fresnel and Ampère. It differs essentially from the Faraday effect, in that the latter is produced upon luminous waves that have acquired a steady state, causing an alteration in the velocity of propagation, whilst in the Zeeman effect the magnetic action is exerted upon the source of the waves, and affects the period of vibration.—An account of the International Geological Congress at St. Petersburg, by M. Albert Gaudry.—On pencils and congruences, by M. Guichard.—Researches upon alcohol motors, by M. Max. Ringelmann. Two sets of trials were made, one upon a 3 h.p. horizontal, the other upon a 4 h.p. vertical oil engine. As the result of the trials it was found that the cost of alcohol, petroleum spirit, and ordinary burning oil were 5·625, 1·75 and 1·00 respectively.—On the form of the lines of electric force in the neighbourhood of a Hertz resonator, by M. Gutton. The field was explored by means of a modification of the receiver of Prof. J. C. Bose.—Densities of some easily liquefiable gases, by M. A Leduc. The gases examined were carbon dioxide (1·5287), nitrous oxide (1·5301), hydrogen sulphide (1·1895), chlorine (2·491) and ammonia (0·5971).—On the impurities of crude copper, by M. Schlagdenhauffen. Thin sheets of crude Chilian copper, left in contact with water for several days, gave up appreciable quantities of arsenious acid and oxide of antimony. From this experiment the conclusion is drawn that arsenic and antimony are present, at any rate in part, in the form of oxide in crude copper.—On the electric conductivity of trichloracetic acid, by M. Paul Rivals. Measurements of the conductivity and heat of solution of trichloracetic acid at different concentrations showed that the heat of dilution of this acid is a linear function of the fraction of dissociation. The heat of neutralisation by potash (N) calculated from Ostwald's formula, $N = 13·52 + (1 - m)d$, where 13·52 is a constant common to both strong acids and strong bases, m is the fraction of dissociation, and d the heat of dissociation, accorded very closely with the experimentally determined values.—On the mean molecular weight of the soluble material in germinating grains, by M. L. Maquenne.—General observations on oats, by M. Balland. An analytical table is given, showing the maximum and minimum values of the proximate constituents of oats.—New bile pigments, by MM. A. Dastre and N. Floresco.—Action of the X-rays on the heat radiated by the skin, by M. L Lecercle. Under the action of the X-rays there is an increase in the radiation of heat from the skin, an increase which frequently persists for some time after the exposure.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Founders of Geology: Sir A. Geikie (Macmillan).—Papers printed to commemorate the Incorporation of the University College of Sheffield: The Winter Meteorology of Egypt, and its Influence on Disease: Dr. H. E. L. Canney (Baillière).—Chemistry for Photographers: C. F. Townsend (Dawbarn).—Memorials of Wm. Cranch Bond and of his Son Geo. Phillips Bond: E. S. Holden (San Francisco, Murdock).—Life-Histories of American Insects: Prof. C. M. Weed (Macmillan).—Tracé d'un Chemin de Fer: A. Dufour (Paris Gauthier-Villars).—Theoretical Mechanics: A. E H. Love (Cambridge University Press).—A Practical Physiology: Dr. A. F. Blaisdell (Boston, Ginn).—Ostwald's Klassiker der Exakten Wissenschaften, Nrs. 88–91 (Leipzig, Engelmann).—Nights with an Old Gunner: C. J. Cornish (Seeley).—Report of the Commissioner of Education for the Year 1895–96, Vol. 1, Part 1 (Washington).—La Vie Mode de Mouvement: Prof. E. Préaubert (Paris, Alcan).—Wechselstrommessungen und Magnetische Messungen: Dr. C. Heinke (Leipzig. Hirzel).—Notes on Micro-Organisms Pathogenic to Man: Surgeon-Captain B. H. S. Leumann (Longmans).

PAMPHLETS.—Revision of the Tachinidæ of America North of Mexico: D. W. Coquillett (Washington).—Zur Psychologie des Erkennens: Dr. G. Wolff (Leipzig, Engelmann).

SERIALS.—Physical Review, August (Macmillan).—Bibliotheca Geographica herausgegeben von der Gesellschaft für Erdkunde zu Berlin, Band iii. Jahrg. 1894 (Berlin).—Revue de l'Université de Bruxelles, October (Bruxelles).—Bulletin of the American Mathematical Society, October (New York).—Traité Encyclopédique de Photographie: Prof. C. Fabre, deux supplément, B, 1, 2, 3 fasc. (Paris, Gauthier-Villars).—Journal of the Chemical Society, October (Gurney).—Quarterly Review, October (Murray).—Middlesex Hospital Journal, No. 4 (London).—Reliquary and Illustrated Archæologist, new series, Vol. 3 (Bemrose).—Longman's Magazine, November (Longmans).

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