THURSDAY, APRIL 28, 1887

PRACTICAL ELECTRICITY

Practical Electricity. By W. E. Ayrton, F.R.S. (London: Cassell and Co., 1887.)

PROF. AYRTON'S book on Practical Electricity fills a gap, and is well fitted for the purpose for which its author has designed it. The book comprises the substance of the first year's course for students of electrical technology in the City and Guilds Central Institution at South Kensington, with some additional matter, which is chiefly in small type. The subject of Current is treated first, then comes Electromotive Force or Potential Difference, and afterwards Resistance. This is undoubtedly the logical order, though, as Prof. Ayrton points out, this sequence appears complicated to the minds of learners, from the fact that in the definitions of the Paris Congress the volt is made to depend on the ohm and the ampere. The practical units, ampere, ohm, volt, &c., are used throughout, but a little more space might have been given with advantage to the definitions of these units. Take, for instance, the definition of an ampere,

6. After showing by means of a most instructive and well-arranged experiment (Fig. 1) that a current produces magnetic, chemical, and thermal effects, and further, that the chemical changes are the same in two or more voltameters of the same kind, Prof. Ayrton proceeds:—"We shall therefore *define the strength of a current as being directly proportional to the amount of chemical decomposition produced in a given time; and the current that deposits* 0·00111815 *gramme or* 0·017253 *grain of silver per second on one of the plates of a silver voltameter, the liquid employed being a solution of silver nitrate containing from* 15 *to* 30 *per cent. of the salt*, we shall call an *ampere*,' and take it as our unit current." But frequently a beginner will at once wish to know why these special numbers, which will seem to him unnecessarily complex, should have been taken. Why not select ·001 gramme of silver rather than ·00111815? will be an obvious question, to which no answer is given. Surely, too, four significant figures would be sufficient. Besides, this is not the definition of ampere adopted by the Paris Congress, and it involves the experiments of someone on the electro-chemical deposition of silver. The experiments given in the early part of Chapter II. do not need the previous definition of the *unit current*, and from them the fact that a current exerts on a magnet a definite force depending on its strength and (§ 22) on the dimensions and position of its circuit is established. Thence the idea of the current which exerts on a definite magnet a unit force is easily reached, and from this we get the ampere of the Congress definition, which is found, by careful experiment, to deposit so many grammes of silver per second.

So, too, the definition of the "volt" would have been clearer if the excellent illustration of difference of potential given in § 40, Fig. 28, had been carried a little further, and it had been pointed out that, just as the water loses potential energy in falling from one level to another, and that loss is measured by the quantity of water multiplied by the difference in pressure, so the electric current loses energy in passing from one point to another, and that loss is measured by the quantity of electricity multiplied by the difference of electrical potential. But these, perhaps, are points which can be better brought out by a teacher in explaining difficulties to his class.

The book is, we believe, the first in England which accepts distinctly the resolutions of the Paris Congress as a basis. Another novelty to be found in it is the use of the letters P.D. (potential difference) for the old abbreviation E.M.F. This is a change for which, if it can be satisfactorily introduced and accepted, all teachers will be thankful, for it will get rid of the confusion existing between the resultant electrical force at a point, and the electromotive force between two points, which is not a force at all.

The plan of the book has been already indicated. Starting from the definition of an ampere, the various means of measuring currents are described, and full

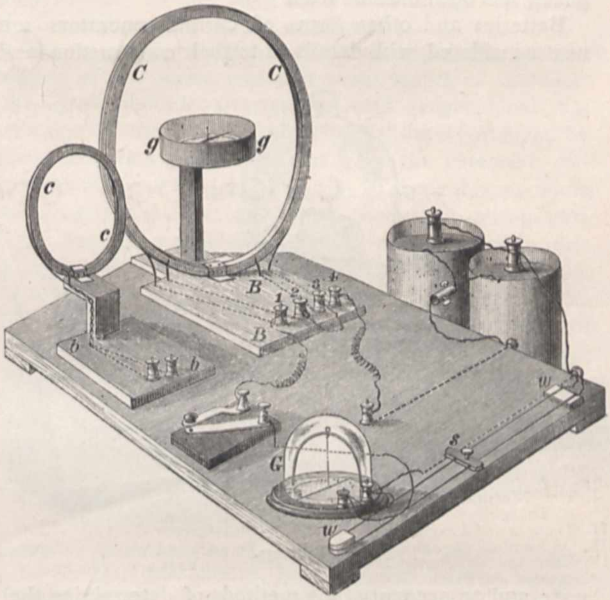

Fig. 15.[1]

details are given of the methods for carrying out the experiments, for recording results graphically and otherwise, and for drawing conclusions from the experiments. The illustrations show clearly the arrangement of apparatus in each case. In Prof. Ayrton's laboratory the apparatus required for any one series of observations is mounted permanently on the same board; the student finds everything ready, and the necessary connexions made when he begins. As to the desirability of this, there will no doubt be some difference of opinion; but with large classes of beginners some such plan is necessary. Thus, Fig. 15 shows the apparatus for investigating the action of a current on a magnet. The large coil C C is so arranged that the current can be made to traverse it eight, twelve, or sixteen times, and its effect on the magnet *g g* observed; or the coil C C can be replaced by *c c* of half the radius, which has four turns on it; or, again, C C can be used simultaneously with *c c*, the current being

[1] We are indebted to Messrs. Cassell for the blocks used to illustrate this article.

sent in opposite directions through the two. *w w* is a resistance by means of which the current may be varied at will, and G a galvanometer.

Chapter III. introduces us to difference of potential, and here the writer describes in a practical form the experiments for the verification of some of the ordinary laws of statical electricity.

Ohm's law and its proof follow in Chapter IV., and it is shown that the resistance of a conductor remains unchanged so long as its other physical conditions are the same. § 80 gives the definition of the "legal ohm." It is not quite accurate to speak of its having been legalised, at any rate in this country; though, as the letter from the B.A. Committee on Electrical Standards, which is printed at the end of the preface, shows, the question of its adoption as a legal standard is now before the Government. Various methods of comparing resistances follow, with full practical details, but the important one due to Prof. G. C. Foster, for comparing two nearly equal resistances, has been omitted from § 97.

Batteries and other forms of current-generators are next considered, with details as to their construction and

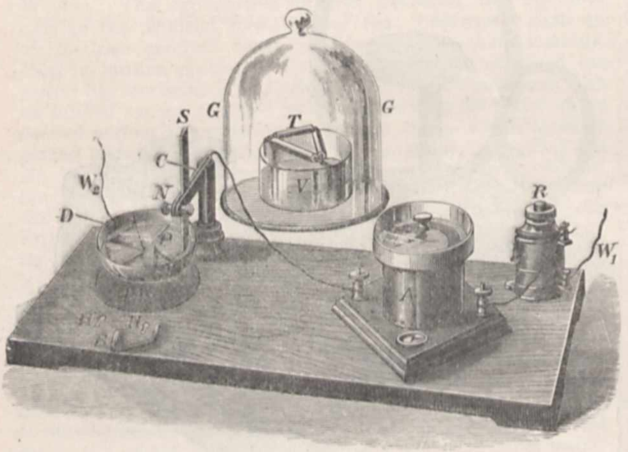

FIG. 157.

use; and an account of the methods of determining thei E.M.F. and resistance is given.

"Insulation" is the title of Chapter VI., and many o the practical hints given under this head are of grea value.

In the next chapter, condensers, and the methods of constructing them and of measuring their capacities, are treated of. We find also a chapter devoted to commercial ammeters and voltmeters, which gives in an easily accessible form particulars as to some of the best known of these instruments, with practical methods of testing and calibrating. In Fig. 157 we have the arrangement of apparatus for comparing an ammeter with a silver voltameter. R is an adjustable resistance of a useful character, made of a number of washers of carbonised cloth which can be pressed into close contact by a screw. Latimer Clark's cell is described in § 214, in the H form. A simpler pattern consists of a test-tube with a platinum wire sealed through the bottom. The end of this is covered with pure mercury, and above this is a layer of mercurous sulphate, with a saturated solution of sulphate of zinc above all. A rod of clean zinc dips into the zinc sulphate passing through the cork which closes the test-tube, and the whole is kept tight with marine glue.

In an appendix Kirchhoff's laws of divided circuits are considered. The method of treating such problems introduced by Maxwell, and which has recently been illustrated at some length by Prof. Fleming, is also referred to.

Another point of importance which calls for notice is the number of examples introduced by way of illustration; some of these are completely worked out, others left as exercises for the student.

The book concludes with some specimens of the instructions for experiments which are given to students at the City and Guilds Institution, with the apparatus with which each experiment is performed. Of these instructions there are four; and many who use the book will wish their number was larger. We will close this notice by quoting the last of them.

To calibrate an ammeter by means of a silver voltameter (the apparatus required has been figured above):—

"PRELIMINARY.—The voltameter consists of a platinum dish containing a 25 per cent. solution of silver nitrate, and in which a silver plate is immersed. An adjustable carbon resistance is provided, by means of which the current passing through the voltameter can be maintained constant during each experiment, and can be varied in the different experiments.

"EXPERIMENTS.—(1) Carefully clean, dry, and weigh the platinum dish, the *approximate* weight of which is 78 grammes.

"(2) Pour the solution of silver nitrate into the dish, and place it on the three brass pins provided for its reception, and which are electrically connected with the left-hand binding-screw on the board. Immerse the silver plate in the solution, and clamp it in such a position that its edges are equally distant from the sides and bottom of the dish.

"(3) Turn the small milled head at the top of the ammeter so that the pointer of the ammeter comes opposite the zero on the scale, if not there already. Place the copper connecting-wire in the mercury cups marked A and C (which cuts out the voltameter), and adjust the carbon resistance until a convenient current flows round the ammeter. Remove the connecting-wire.

"(4) Quickly insert the connecting-wire in the mercury cups marked A and B, carefully noting the instant at which the circuit was completed. Allow the current to pass for a convenient time (ten to thirty minutes, according to the strength of the current used), and keep the current constant by the adjustable resistance. Note the temperature of the room during the experiment, and, at the end of the interval decided on, quickly break the circuit.

"(5) Empty the solution from the dish into its bottle, and carefully wash the deposited silver with distilled water. Then fill the dish with distilled water, and allow it to stand ten to fifteen minutes Again wash with water, alcohol, and ether, dry over the spirit-lamp, and cool in the desiccator.

"(6) Carefully determine the increase of weight due to the silver deposited on the dish.

"(7) Calculate the strength of current used in the experiment, assuming that one ampere deposits 1·11815 milligrammes of silver per second.

"(8) Repeat the experiment with several different strengths of current.

"(9) Tabulate your results in some convenient form, and write them with your name on the card, on which you will find recorded the results of previous experiments."

SPOLIA ATLANTICA

Spolia Atlantica. (1) Contributions to the Knowledge of the Salpidæ, by M. P. A. Traustedt; (2) Remarks on some of the Oceanic Annulata, by G. M. R. Levinsen; (3) Contributions towards the Morphology and Systematic Arrangement of the Pteropoda, by J. E. V. Boas. (Copenhagen, 1885-86.)

THE three monographs which at the instance, and under the supervision, of the Directors of the Zoological Museum of Copenhagen, have been included in one quarto volume under the title of "Spolia Atlantica," originally appeared in the Transactions of the Danish Royal Society of Natural Sciences. But although bound together, each monograph in this *édition de luxe* is complete in itself, with separate title-page, table of contents, descriptive plates, and all other necessary means of separate reference, while the convenience of readers not acquainted with Danish has been amply considered by the addition of Latin and French translations of the descriptions of the animals, and of many other important parts of the text.

The first of this triplet of monographs, which deals with the so-called "aggregate" and "solitary" forms of the several species of Salpæ, is based on a study of the exceptionally complete collections preserved in the Zoological Museum of Copenhagen, for which that institution is mainly indebted to Prof. Steenstrup, at whose suggestion and under whose direction Herr Traustedt compiled his memoir. The monograph presents a clear and comprehensive description of all the well-established species of Salpæ with their distinctive dual forms, and unqualified praise may be given to the care with which the figures have been drawn, and the admirable manner in which, by means of pale blue outlines, the delicacy and transparency of the bodies of the animals have been represented.

In treating of the Salpidæ, it is impossible to forget how much of our knowledge of these curious animals is due to the observations of Chamisso, the clever author of "Peter Schlemihl," who, while serving as naturalist in the exploring expedition of the Russian commander Kotzebue, first discovered that the "aggregate" or chain Salpa and the "solitary" Salpa were not distinct species, as had been supposed, but only parts of the perfect organism of one species. By the discovery of this fact, which Chamisso ingeniously, but, as subsequent investigations have shown, too fancifully, explained on the hypothesis that these animals were subject to a law of "alternation of generations," new and highly important paths of morphological inquiry were opened. Yet, singularly enough, nearly thirty years passed after the publication, in 1819, of Chamisso's treatise "De Animalibus quibusdam e Classe Vermium Linneana (de Salpis)" before his observations were tested by further scientific investigation. About the middle of the century Meyen and Vogt turned their attention to the curious and interesting phenomena connected with the embryonic development of the Salpæ. These inquiries were soon followed by the still more important researches of Profs. Krohn and Huxley, the latter of whom in a paper entitled "Observations upon the Anatomy and Physiology of Salpa and Pyrosoma," which appeared in the Phil. Trans. 1851, has shown that Chamisso erred in his explanation of the nature of a "chain Salpa," which, to use Mr. Huxley's words, "is nothing more homologically than a highly individualised generative organ."

Herr Traustedt does not enter into the question of the embryonic development of the Salpidæ, and hence his work gives no information regarding the physiology of these animals, nor does he in any way refer to the various hypotheses that have been advanced in explanation of the character of the "aggregate" and "solitary" forms. For such information the student must go elsewhere. As a guide to the anatomical structure of both forms in the eleven species described and drawn by the author, the memoir will, however, be found of great service, while it contains much useful information as to the geographical distribution of these animals not to be found elsewhere.

In the treatise on "Some Oceanic Annulata" Herr Levinsen supplies many interesting details regarding various members of the families Alciopidæ and Typhloscolecidæ, together with descriptions of several species of Sagitta, to which are added lists of their geographical distribution. In this, as in the memoir on the Pteropoda, the illustrations are worthy of all praise.

The memoir by Dr. Boas, which constitutes the last and longest of the series, treats at great length of the morphology, systematic arrangement, and geographical distribution of the Pteropoda. The materials employed by the author were derived in part from the extensive collections in the Zoological Museum of Copenhagen made by, or under the direction of, Prof. Steenstrup, and in part from numerous specimens placed at the writer's disposition by Profs. Dohrn, Möbius, Leche, and Spengel. It is worthy of note that a very large proportion of the specimens referred to as belonging to the Museum of Copenhagen were obtained from amateur collectors; Danish naval officers, captains of merchant ships, and travellers having responded with alacrity to Prof. Steenstrup's appeal for help in obtaining samples of these and other animals from remote regions.

OUR BOOK SHELF

Complete Hand-book on the Management of Accumulators. By Sir David Salomons, Bart. Second Edition, revised and enlarged. (London: Whittaker and Co., 1887.)

THE author has for some years past had an installation at his country residence for the purpose of lighting it and for working motors which drive the machinery in his large and well-equipped workshop. He has used accumulators, as he informs us, ever since they may be said to have been produced in commercial form in 1882. No expense nor trouble have been spared in making this installation a model one, and experiments have been made on many points in connexion with the subject. As the whole installation has been made and worked under his immediate personal superintendence, he has acquired a considerable amount of experience, the result of which, as far as it regards the management of accumulators, he places before the public in this work.

After a general description of cells of the E.P.S. and Elwell-Parker type, he proceeds to give directions for setting up and charging them. The causes of, and remedies for, "buckling" and "scaling" are discussed. The harm caused by too rapid a discharge is pointed out, and methods for preventing it are explained, as well as various devices for regulating the E.M.F. of the charging current and that on the line. The method of cleaning and "re-pasting" the plates is explained, and various hints are given for the management of the battery. In an appendix is a description of the arrangement of his accumulator house, a photograph of the interior of which forms the frontispiece to his book. He also gives a brief account of the history of the installation, from which we learn that the total cost of buildings and installation has been about 6000*l.*, that the number of lamps is about 500 of 20-candle power, but that the greatest number used at any one time has rarely exceeded 200, and that an arc lamp taking 40 or 50 amperes and one or two motors have been used together with them. The expenses—including wages, coal, oil, waste, washers, repairs, lamp renewals, &c.—were, in 1886, 210*l.*, or at the rate of ¼*d.* per 20-candle lamp per hour. He does not, however, say anything as to the cost of the accumulators; and as to the length of time which they may be expected to last he only says vaguely that "the cells may last for years in perfect order if all the instructions here given are properly attended to." His present accumulators were only put up in August 1885, those previously erected having proved to be unsatisfactory.

It is a pity that the useful information in this work is not conveyed in better language. In what is intended as a workshop hand-book we do not look for the elegance of an Addison; but we do want plain English. As an example of the language we may quote the following sentence from the preface: "Only cells of the Electrical Power Storage Company, of Messrs. Elwell-Parker, and their type, are dealt with, because at this moment there is probably no other better kind, or largely in use." The meaning of this is clear, though even that is more than may be said of other sentences in the book.

Among minor faults we protest against the coinage of such a hideous word as "acidometer," by which, apparently, is meant the instrument commonly known as a hydrometer; we do not think "s.g." is an improvement on the ordinarily accepted abbreviation for specific gravity; and we object to the plural "dynamos" as against the ordinary rule of our language which gives us "potatoes" and "echoes."

A more serious error is found in the "Index of Terms" on the back of the title-page—

"Watt = volt × ampere = measure of force or energy."

We should recommend the author to get the work revised by some onewho understands the rudiments of science as well as those of the English language.

School Hygiene: The Laws of Health in Relation to School Life. By Arthur Newsholme, M.D. (London: Swan Sonnenschein, Lowrey, & Co., 1887.)

ABOUT the importance of the matters dealt with in this little book there can, of course, be no dispute; and, as Dr. Newsholme points out in his preface, they have engaged the serious attention of many School Boards and Committees, and been made the subject of a good deal of useful legislation. Most school-managers still have something to learn about the principles of school hygiene, and many of them will, no doubt, find in Dr. Newsholme's volume exactly the kind of information they want. He discusses the subject under two heads, "Schools" and "Scholars." Under the first head he presents his ideas on questions connected with the choice of sites for schools, the construction of school buildings, school furniture, lighting of school-rooms, general principles of ventilation, natural ventilation, ventilation and warming, and draining arrangements. In the part relating to "Scholars" he has chapters on mental exercise, excessive mental exercise, age and sex in relation to school work, muscular exercise and recreation, rest and sleep, children's diet, children's dress, baths and bathing, eyesight in relation to school life, communicable diseases in schools, and school accidents. Dr. Newsholme has studied his subject thoroughly, and his conclusions are all the more valuable because they have been to a large extent suggested by his experience as a medical officer of health, and as a medical referee for various schools and training colleges.

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Mass, Weight, and Dynamical Units

IF the laws of dynamics were made solely for the use of engineers, as a celebrated engineer declared of rivers that they were intended to feed canals, it might be conceded to Prof. Greenhill that it would not be *necessary* that the more abstract notion of mass should be distinguished from that of weight, and that the fundamental equation of dynamics might conveniently be taken as $P = W\frac{f}{g}$, where W is the weight (or mass) of the body moved expressed in pounds or tons, &c., and P the force producing in it the acceleration f, and reckoned in the same units. But a pound weight as a force is a variable unit, unless it is taken at some particular place (as Greenwich), and then the corresponding value of g must be employed (though the variation of g on the surface of the earth is not so great as often to need to be taken account of by the engineer); and so the astronomer and physicist, as well as the student of abstract dynamics, are right in demanding a less arbitrary measure of force than one founded on the force acting vertically downwards on a body at the earth's surface, as well as an absolute constant belonging to each body (its *mass*) independent of time and place. I conceive, therefore, in spite of Prof. Greenhill's arguments, that, in the interest of clearness of thought, as well as to avoid the practical inconvenience of a variable unit of force, the notions of mass and weight must be kept distinct, and the equation $W = Mg$, as a special case of the general equation $P = Mf$, still insisted on by all teachers of dynamics, at any rate to non-engineering students; while it would be well for engineers also (*me judice*) to have their dynamics cast in the same mould as the rest of the scientific world.

I should not have troubled you with the above very obvious remarks had I not wished to observe, *à propos* of Mr. Geoghegan's suggestion of names for units of velocity and acceleration in NATURE of April 7 (p. 534), that it is highly desirable that a convenient and consistent *notation*, as well as *nomenclature*, should be adopted for the several dynamical units.

With respect to the particular suggestion that *vel* and *cel* (or *velo* and *celo*, as used by Mr. Lock in his forthcoming book, "Dynamics for Beginners") should be employed for the units of speed and acceleration in the foot-second system, I regard it as an almost fatal objection that the accepted C.G.S. system having appropriated the words *dyne* and *erg* for its units of force and work has a prior right to *vel* and *cel* for its units of speed and acceleration; namely, the centimetre per second, and the centimetre per second per second. If so, the units of the foot-second system might be called the *footvel* and the *footcel*.

Names for the dynamical units are, however, I think, of less importance than a convenient and suggestive notation for them. I have endeavoured to devise such a notation (or, rather, to fill up and complete notations which have more or less come into use) in a table, which is now under the consideration of a Committee of the Association for the Improvement of Geometrical Teaching, and which is substantially as follows.

In a perfectly general system, let **L, M, T** stand respectively for the fundamental units of length, mass, and time, and let **V, A, U, Δ, E** stand for the units thence derived of speed, quickening (acceleration), momentum or impulse, force, and energy or work respectively: then the statement that the unit of speed is the speed of the unit of length *per* unit of time is naturally expressed thus, $\mathsf{V} = \mathsf{L/T}$. On the same principle we should have—

$$\mathsf{A}=\mathsf{V/T}=\mathsf{L/TT},\ \mathsf{U}=\mathsf{MV}=\mathsf{ML/T},\ \Delta=\mathsf{MA}=\mathsf{ML/TT},$$
$$\mathsf{E} = \mathsf{L}\Delta = \mathsf{LML/TT}.$$

This may be simplified, using the analogy of the fluxional notation, by writing $\dot{\mathsf{L}}$ for $\mathsf{L/T}$ and L for $\ddot{\mathsf{L}}\mathsf{/TT}$. Then $\dot{\mathsf{L}}$, $\ddot{\mathsf{L}}$ may take the place of V and A, and we have—

$$\mathsf{U} = \mathsf{M}\dot{\mathsf{L}},\ \Delta=\mathsf{M}\ddot{\mathsf{L}},\ \mathsf{E} = \mathsf{L}\Delta = \mathsf{LM}\ddot{\mathsf{L}}.$$

Names for the several units are hardly needed in the general system.

In the C.G.S. system the units of length, mass, and time are respectively the centimetre, gramme, and second, denoted by C, G, S. Then if U_G, Δ_G, E_G denote the units of momentum or impulse, force, and energy or work, we have, on the same principle as before, $\dot{\mathsf{C}}$, $\ddot{\mathsf{C}}$ to denote the speed of a centimetre per second and the acceleration of a centimetre per second per second respectively, and the equations—

$$\mathsf{U}_G = \mathsf{G}\dot{\mathsf{C}},\ \Delta_G = \mathsf{G}\ddot{\mathsf{C}},\ \mathsf{E}_G = \mathsf{C}\Delta_G = \mathsf{CG}\ddot{\mathsf{C}}.$$

If *names* for all these units are required, we may use these: *vel, cel, mom, dyne, erg;* and we may say, a *mom* is a *gramme-vel*, a *dyne* is a *gramme-cel*, and an *erg* a *centimetre-dyne*.

In the F.P.S., or British system, the units of length, mass, and time are respectively the foot, pound, and second, denoted by F, P, S. Then, if U_P, Δ_P, E_P denote the units of momentum or impulse, force, and energy respectively, we have, on the same principles, $\dot{\mathsf{F}}$, $\ddot{\mathsf{F}}$ to denote the speed of a foot per second and the acceleration of a foot per second per second respectively, and the equations—

$$\mathsf{U}_P = \mathsf{P}\dot{\mathsf{F}},\ \Delta_P = \mathsf{P}\ddot{\mathsf{F}},\ \mathsf{E}_P = \mathsf{F}\Delta_P = \mathsf{FP}\ddot{\mathsf{F}}.$$

I propose as names for these units: *footvel, footcel, poundem, poundal, pounderg.* I should have called the unit of force a *pound-dyne* or *poundyn*, but that *poundal* has already obtained general acceptance.

The foregoing are all absolute units. The corresponding (Greenwich) gravitation-units are the *pound-weight* = 32·19 *poundals*, the *foot-pound* = 32·19 *poundergs*, and the *second-pound* (as it has been proposed by Prof. Unwin to name the gravitation-unit of momentum, or time-integral of a pound-weight through one second) = 32·19 *poundems;* so that to convert absolute F.P.S. units into gravitation-units, or *vice versâ*, it is only necessary to divide or multiply by 32·19, since the acceleration due to gravity at Greenwich = 32·19 $\ddot{\mathsf{F}}$.

It is, I think, comparatively unimportant whether the *names* above suggested are, all of them, accepted or not; but the *notation* will, I believe, be found a great aid to the beginner in fixing in his mind the dimensions of the different magnitudes, and an effective safeguard against the too common confusion of units of force, impulse, and work. I doubt whether in speaking much would be gained by saying "*footvel*" instead of "foot per second," or "*footcel*" instead of "foot per second per second," while in *writing*, the symbols $\dot{\mathsf{F}}$ and $\ddot{\mathsf{F}}$ might be always used and read either way. ROBT. B. HAYWARD

Harrow, April 12

Units of Weight, Mass, and Force

FAR be it from me to interfere between Mr. Alfred Lodge and Prof. Greenhill; but, whilst leaving Mr. Lodge to his fate and Prof. Greenhill, perhaps, as an engineer, I may be permitted to offer a few remarks on the general question. First, then, it appears to me that Prof. Tait's thoroughgoing condemnation of certain phrases of the engineering vernacular, and of the grave errors of certain writers, has been strained in some quarters to mean a general charge against engineers of inability to think or write clearly on the physical laws which lie at the root of their every-day practice. Such an unqualified charge is on the face of it absurd; for otherwise we must confess that the lives' work of Thomson and Tait has been a total failure as regards its influence on the truly practical men of their generation. Can this be so?

Prof. Greenhill's remarks on the abominable semi-numerical equation $W = Mg$, or $\frac{W}{g} = M$, I most heartily welcome [where W is a mass and g a numeric; the moment writers on dynamics, who use the gravitation system, pass from merely proportional equations to their physical interpretation, then must we face with them this most wretched equation]. But perhaps it will be at once a surprise and a gratification to Prof. Greenhill to know that a whole (academic) generation of Scottish University engineering students has been taught to eschew this same equation as an unclean thing, and to adopt the mode of thought clearly set forth in the last two paragraphs of his letter of February 28. Some five or six years ago I was myself so taught by one who is now, alas! no more. The possibility of thus clearing of cant not only the engineering but the purely mathematical mind seems to me, as indeed Prof. Greenhill indicates, to be a direct consequence of the acceptance by Thomson and Tait of the British Imperial pound as the unit of mass or quantity of matter.

Having fixed, then, for good and all, the unit of mass, and taking the British foot and the second as the units of time and length respectively, the unit of force defines itself in virtue of Newton's Second Law. To this unit—the British unit of force—Prof. James Thomson has given, as nearly everyone knows, the name "poundal." Now the most convenient practical unit of force, for physicists as well as engineers, is not the poundal, but the gravitation at the earth's surface of the unit of mass, a quantity which is not absolutely constant, the inconvenience so arising being, however, practically unimportant, or at most involving a reduction to an arbitrary standard. To pass, then, from a force expressed in poundals to a force expressed in units of gravitation of the Imperial pound at the standard place, one simply wants to know how many poundals go to the gravitation of the Imperial pound at that place—in other words, the change ratio. The answer is simple: the numeric g for the standard place; for a force equal to the gravitation of the Imperial pound at the standard place acting upon a mass of one Imperial pound would generate a momentum per second of g (numeric) pounds mass × feet per sec. per sec.; and the poundal a momentum per second of one pound mass × feet per sec. per sec.; and by Newton's Second Law the ratio of the forces is, therefore, the numeric g. What more does the physicist or engineer want to know? How many poundals go to the gravitation of a ton mass at the standard place? Answer, the numeric 2240 g. Could anything be simpler? The difficulty is to find the difficulty, or to assign the *raison d'être* of the so-called gravitation unit of mass.

When the old unnatural gravitation unit of mass is abandoned, and the transition from the natural unit to the gravitation unit of force made by means of the change ratio, the vicious use of the word mass to denote the result of dividing by the numeric g the mass of a body in standard pounds (viciously on the same system called the weight and denoted by W) ceases; and the dire confusion between weight and mass becomes a thing of the past. The emancipation of the term weight from its bondage to mass would appear to have afforded opportunity for its use wherever it might be of service in suggesting or denoting gravitation. For example, there are three units, each called a pound, viz. the Imperial British unit of mass, the gravitation of the same mass at any the same place on the earth's surface, and the pound sterling. Physicists, like Sir Wm. Thomson and Prof. Tait, use terms such as "pound weight," "gramme weight"; similarly we have "pound mass" coming into use; and probably we shall soon hear of "pound money." Prof. Greenhill, with his strong engineering sympathies, objects to the time-honoured "pounds per square inch" being rendered "pounds weight per square inch"; and if I may presume to offer an opinion, the old phrase is already cumbrous enough. Still, if Prof. Tait and Prof. Greenhill ultimately agree that there is anything to be gained in perspicuity, for the sake of the weaker members perhaps it might be well for us to put in practice, on some occasions, the injunction to sacrifice all rather than cause our brother to offend.

Some one might possibly step in to draw attention to the fact that the pages of even our own great high priest of exact applied science are disfigured by $\frac{W}{g}$; but sure I am that were Rankine now with us he would lead the way with Prof. Greenhill in a crusade against the apologists for the obscurity of which W/g is the symbol. Take, for example, Rankine's bold introduction of the dynamical unit of quantity of heat. Take the opinion of

Clausius, than whom none could be a more unprejudiced witness. "At the same time in the theoretical development of the mechanical theory of heat, in which the relation between heat and work often occurs, the method of expressing heat in mechanical units effects such important simplifications that the author has felt himself bound to drop his former objections to the method on the occasion of the present more connected exposition of that theory." ARCHD. C. ELLIOTT

Edinburgh, April 18

Seismometers

I HAVE long ago learnt not to look for any fair recognition of my work in seismometry on the part of Prof. John Milne, and when he accuses me of appropriating without acknowledgment the work of others it is time to decline further controversy with him. The points raised in his last communication (NATURE, April 14, p. 559) are sufficiently answered in mine of December 11 (p. 172). I there quoted part of a letter written by Prof. Chaplin, now of Harvard University, then of Tokio, and Secretary of the Seismological Society of Japan, under whose eyes the events occurred to which Prof. Milne refers. I did not quote the whole of Prof. Chaplin's letter, because it contained sentences I was unwilling to give except under the strongest provocation. After referring to my seismograph in the words already quoted (p. 172), Prof. Chaplin continues:—

"I do not remember that in the discussions on your machine Mr. Gray ever claimed to have invented a similar machine, and I am surprised to know that he makes that claim now. On this and other points it appears to me that Messrs. Gray and Milne have not treated your inventions and investigations with fairness, and that you have just grounds for complaint. I am willing you should make such use of this note as you see fit."

As to the question of priority, this judgment, from a man at once unprejudiced, most competent to form an opinion, and fully informed of the matter in dispute, must (so far as I am concerned) close a discussion of which your readers cannot but be weary. With your permission I shall give, in a later number of NATURE, an example of the excellent work which Prof. Sekiya is now doing with my instruments in Japan.

J. A. EWING

University College, Dundee, April 16

April Meteors

THE Lyrids have, this year, offered a somewhat scanty display, though a few brilliant meteors have been seen shooting from the usual radiant-point.

In 1884 April 19, this shower was very rich, the horary number of its meteors for one observer being about 22, but in the following year, 1885, it exhibited a considerable decline, the hourly rate being only 3. In 1886 I obtained no observations, owing to the bright moonlight and in the present year, on April 20, the horary number was slightly more than 2, so that the numerical character of the recent display has fallen far short of some of its apparitions in preceding years.

On the night of April 17, this year, the shower had not visibly opened, for none of its meteors were recorded in a 2½ hours' watch. On each of the nights of the 18th and 19th the sky was closely observed for 4½ hours, but the Lyrid shower was very feeble, and only furnished 1 meteor per hour. On the 20th, in 3 hours I noted 7 Lyrids, and these were brilliant.

The average radiant-point from the three nights was at 269° + 32°, and there is confirmation that this point advances in R.A. with the time, though not to the marked degree ascribed in NATURE for May 7, 1885, p. 5. But the meteors from this stream have been so scarce at their late recurrence that it has been very difficult to ascertain the exact radiant for each night. Moreover, these Lyrids move with great apparent velocity, flashing out with extreme suddenness and they are gone, together with the faint streaks sometimes accompanying them, before the eye is enabled to catch the directions with satisfactory precision.

On the four nights April 17 to 20 inclusive, I noticed 70 shooting-stars belonging to the minor systems of the Lyrid meteoric epoch, and amongst these the best was that of a radiant of very swift, short meteors at 231° + 17°, a few degrees west of β Serpentis. This stream is not new, for I saw a well-defined shower of Serpentids from the same point during my observations of the Lyrids in 1885, on April 19–20 (NATURE, May 7, 1885, p. 6).

In this and in previous years I have also recorded some meteors ascending in very long flights from a radiant centre close to θ Libræ, at 235° − 15°. This is the only observation of this shower at the April period, though Lieut.-Colonel Tupman found a pair of radiants near the position assigned in the first week of March 1869–70.

I subjoin a short list of bright meteors seen here while watching the progress of the Lyrids, and I should be glad to hear that any of these had been observed elsewhere.

Date	Hour	Mag.	Apparent Path From	Apparent Path To	Notes	Radiant
1887	h. m.		° °	° °		
April 19	13 13	♀	269 + 11	269 + 1	Swift, streak	Lyrid
19	13 46	♃	308 + 61½	56 + 65½	Swift, streak	279° + 13°
20	9 48	1	211 + 7	194 − 4	Very swift	Lyrid
20	10 29½	>1	243 + 14	234 + 5	Swift, streak	Lyrid
20	10 47	1	239 + 53	269 + 62¼	Slow, train	206° + 18°
20	12 28	>1	308 + 40	316 + 40¼	Very swift	Lyrid

Bristol, April 22 W. F. DENNING

Vertical Decrement of Temperature and Pressure

IN NATURE of March 10 (p. 437), Mr. Maxwell Hall gives an interesting table of the vertical distribution of temperature and pressure in Jamaica, and, apparently in happy ignorance of the dangers of the process known as extrapolation, goes on to apply the results of observations extending to a maximum height of only 7400 feet to the determination of the probable temperature of meteorites in extra-terrestrial space. As he expresses a desire to know whether any similar results have been found in India, and as I have on several occasions during the past ten years discussed the vertical distribution of temperature and pressure in this country, I gladly take this opportunity of referring him to my papers on the meteorology of the North-West Himalaya, and on the temperature of North-Western India, published in the "Indian Meteorological Memoirs," vols. i. and ii. From the latter I extract the following table on the mean decrement of temperature up to a height of 12,000 feet, computed from the observations of twenty-five stations combined in various ways. For each month an interpolation formula of the form

$$T = T_0 + ah + bh^2 + ch^3,$$

was computed, and by its means the decrements from sea-level to 1000 feet, 1000 to 2000 feet, &c., were calculated. Finally, the average decrement for the twelve months was computed, and is here given in an abridged form. The curves for the several months differ very widely from one another, those for the summer giving the most rapid decrement at sea-level, and the decrement increasing with altitude in winter:—

Height Feet	Mean temperature decrement ° F.
0 to 2000	6·16
2000 to 4000	5·87
4000 to 6000	5·61
6000 to 8000	5·37
8000 to 10000	5·16
10000 to 12000	4·98

The mean height of the barometer at sea-level in the region in question, the centre of which lies a little north of Simla, is about 29·8 inches; the mean at 6000 feet is 24·1 inches, and the mean at 12,000 feet about 19·4 inches. With these data, and adopting Mr. Hall's formula

$$\delta T = \lambda.\delta P + \mu.(\delta P)^2,$$

we find $\lambda = 2^{\circ}{\cdot}979$ and $\mu = 0^{\circ}{\cdot}02$. These coefficients do not differ widely from Mr. Hall's values, which are $2^{\circ}{\cdot}92$ and $0^{\circ}{\cdot}08$ respectively. At the limit of the atmosphere, where $\delta P = 29''{\cdot}8$, δT would be $-106^{\circ}{\cdot}5$, which would give, as the mean temperature of external space, about −30° F., the mean temperature at sea-level being 77° F.

Taking the simplest formula, $\delta T = \lambda.\delta P$, we find $\lambda = 3^{\circ}{\cdot}19$, which is almost identical with the value quoted by Mr. Hall from an early volume of NATURE, but which, if it held good to the limit of the atmosphere, would make the temperature of external space about −18° F., since the mean temperature at sea-level is 77° F.

The only conclusion to be drawn from such observations is that the vertical decrement of temperature on mountains varies greatly with locality as well as season, and the results obtained for one locality cannot be fully applied to another, much less extended to determine the temperature at the superior limit of the atmosphere.

An interesting point of resemblance between Mr. Hall's observations and those made on the Himalaya is that the diurnal range of temperature diminishes to a minimum at about 5000 feet, and then increases with increasing elevation.

Allahabad, March 30 S. A. HILL

Royal Society's *Soirée*

MAY I be permitted, through the columns of NATURE, to ask, on behalf of the Sub-Committee appointed to make arrangements for the forthcoming *soirée* of the Royal Society, that Fellows and others who have apparatus or objects of scientific interest suitable for exhibition on that occasion will communicate at once with the Secretaries or myself. HERBERT RIX,

Royal Society, Burlington House Asst. Sec. R.S.

HOMERIC ASTRONOMY[1]

II.

TURNING to the second great constellation mentioned in both Homeric epics, we again meet traces of remote and unconscious tradition. Yet less remote, probably, than that concerned with the Bear. Certainly less inscrutable. For recent inquiries into the lore and language of ancient Babylon have thrown much light on the relationships of the Orion fable.

There seems no reason to question the validity of Mr. Robert Brown's interpretation of the word by the Accadian *Ur-ana*, "light of heaven" ("Myth of Kirke," p. 146). But a proper name is significant only where it originates. Moreover, it is considered certain that the same brilliant star-group known to Homer no less than to us as Orion, was termed by Chaldeo-Assyrian peoples "Tammuz" (Lenormant, *Origines de l'Histoire*, t. i. p. 247), a synonym of Adonis. Nor is it difficult to divine how the association came to be established. For about 2000 B.C., when the Euphratean constellations assumed their definitive forms, the belt of Orion began to be visible before dawn in the month of June, called "Tammuz," because the death of Adonis was then celebrated. It is even conceivable that the heliacal rising of the asterism may originally have given the signal for that celebration. We can at any rate scarcely doubt that it received the name of "Tammuz" because its annual emergence from the solar beams coincided with the period of mystical mourning for the vernal sun.

Orion, too, has solar connexions. In the Fifth "Odyssey" (121-24), Calypso relates to Hermes how the love for him of Aurora excited the jealousy of the gods, extinguished only when he fell a victim to it, slain by the shafts of Artemis in Ortygia. Obviously, a sun-and-dawn myth slightly modified from the common type. The post-Homeric stories, too, of his relations with Œnopion of Chios, and of his death by the bite of a scorpion (emblematical of darkness, like the boar's tusk in the Adonis legend), confirm his position as a luminous hero (R. Brown, *Archæologia*, vol. xlvii. p. 352; "Great Dionysiak Myth," chap. x. § v.). Altogether, the evidence is strongly in favour of considering Orion as a variant of Adonis, imported into Greece from the East at an early date, and there associated with the identical group of stars which commemorated to the Accads of old the fate of Dumuzi (*i.e.* Tammuz), the "Only Son of Heaven."

It is remarkable that Homer knows nothing of stellar mythology. He nowhere attempts to account for the names of the stars. He has no stories at his fingers' ends of translations to the sky as a ready means of exit from terrestrial difficulties. The Orion of his acquaintance—the beloved of the Dawn, the mighty hunter, surpassing in beauty of person even the divinely-born Aloidæ —died and descended to Hades like other mortals, and was there seen by Ulysses, a gigantic shadow "driving the wild beasts together over the mead of asphodel, the very beasts which he himself had slain on the lonely hills, with a strong mace all of bronze in his hand, that is ever unbroken ("Odyssey," xi. 572-75). His stellar connexion is treated as a fact apart. The poet does not appear to feel any need of bringing it into harmony with the Odyssean vision.

The brightest star in the heavens is termed by Homer the "dog of Orion." The name *Seirios* (significant of sparkling), makes its *début* in the verses of Hesiod. To the singer of the "Iliad" the dog-star is a sign of fear, its rising giving presage to "wretched mortals" of the intolerable, feverish blaze of late summer (*opora*). The deadly gleam of its rays hence served the more appropriately to exemplify the lustre of havoc-dealing weapons. Diomed, Hector, Achilles, "all furnish'd, all in arms," are compared in turn, by way of prelude to an "*aristeia*," or culminating epoch of distinction in battle, to the same brilliant but baleful object. Glimmering fitfully across clouds, it not inaptly typifies the evanescent light of the Trojan hero's fortunes, no less than the flashing of his armour, as he moves restlessly to and fro ("Iliad," xi. 62-6). Of Achilles it is said :—

"Him the old man Priam first beheld, as he sped across the plain, blazing as the star that cometh forth at harvest-time, and plain seen his rays shine forth amid the host of stars in the darkness of night, the star whose name men call Orion's Dog. Brightest of all is he, yet for an evil sign is he set, and bringeth much fever upon hapless men. Even so on Achilles' breast the bronze gleamed as he ran" (xxii. 25-32).

In the corresponding passage relating to Diomed (v. 4-7), the *naïve* literalness with which the "baths of Ocean" are thought of is conveyed by the hint that the star shone at rising with increased brilliancy through having newly washed in them.

Abnormal celestial appearances are scarcely noticed in the Homeric poems. There are neither eclipses[1] of sun or moon, nor comets, nor star-showers. The rain of blood, by which Zeus presaged and celebrated the death of Sarpedon ("Iliad," xvi. 459, also xi. 54) might be thought to embody a reminiscence of a crimson aurora, frequently, in early times, chronicled under that form; but the portent indicated is more probably an actual shower of rain tinged red by a microscopic alga. An unmistakable meteor, however, furnishes one of the glowing similes of the "Iliad." By its help the irresistible swiftness and unexpectedness of Athene's descent from Olympus to the Scamandrian plain are illustrated.

"Even as the son of Kronos the crooked counsellor sendeth a star, a portent for mariners or a wide host of men, bright shining, and therefrom are scattered sparks in multitude; even in such guise sped Pallas Athene to earth, and leapt into their midst" ("Iliad," iv. 75-9).

In the Homeric verses the Milky Way—the "path of souls" of prairie-roving Indians, the mediæval "way of pilgrimage"[2]—finds no place. Yet its conspicuousness, as seen across our misty air, gives an imperfect idea of the lustre with which it spans the translucent vault which drew the wondering gaze of the Ionian bard.

The point of most significance about Homer's scanty astronomical notions is that they were of home growth. They are precisely such as would arise among a people in an incipient stage of civilisation, simple, direct, and childlike in their mode of regarding natural phenomena, yet incapable of founding upon them any close or connected reasoning. Of Oriental mysticism there is not a vestige. No occult influences rain from the sky. Not so

[1] Continued from p. 588.

[1] Görlitz finds a prediction of a solar eclipse at "Odyssey," xx 357; but the expression appears quite indefinite and figurative.

[2] To Compostella. The popular German name for the Milky Way is still *Jakobsstrasse*, while the three stars of Orion's belt are designated, in the same connexion, *Jakobsstab*, staff of St. James.

much as a square inch of foundation is laid for the astrological superstructure. It is true that Sirius is a "baleful star"; but it is in the sense of being a harbinger of hot weather. Possibly, or probably, it is regarded as a concomitant cause, no less than as a sign of the August droughts; indeed the *post hoc* and the *propter hoc* were, in those ages, not easily separable; the effect, however, in any case, was purely physical, and so unfit to become the starting-point of a superstition.

The Homeric names of the stars, too, betray common reminiscences rather than foreign intercourse. They are all either native, or naturalised on Greek soil. The transplanted fable of Orion has taken root and flourished there. The cosmopolitan Bear is known by her familiar Greek name. Boötes is a Greek husbandman, variously identified with Arkas, son of Callisto, or with Ikaros, the luckless mandatory of Dionysos. The Pleiades and the Hyades are intelligibly designated in Greek. The former word is usually derived from *plein*, to sail; the heliacal rising of the "tangled" stars in the middle of May having served, from the time of Hesiod, to mark the opening of the season safe for navigation, and their cosmical setting, at the end of October, its close. But this etymology was most likely an after-thought. Long before rules for navigating the Ægean came to be formulated, the "sailing-stars" must have been designated by name amongst the Achaian tribes. Besides, Homer is ignorant of any such association. Now in Arabic the Pleiades are called *Eth Thuraiyâ*, from *therwa*, copious, abundant. The meaning conveyed is that of many gathered into a small space; and it is quite similar to that of the Biblical *kîmah*, a near connexion of the Assyrian *kimtu*, family (R. Brown, "Phainomena of Aratus," p. 9; Delitzsch, "The Hebrew Language," p. 69). Analogy, then, almost irresistibly points to the interpretation of Pleiades by the Greek *pleiones*, many, or *pleios*, full; giving to the term, in either case, the obvious signification of a "cluster."

Of the Hyades, similarly, the "rainy" association seems somewhat far-fetched. They rise and set respectively about four days later than the Pleiades; so that, as prognostics of the seasons, it would be difficult to draw a permanent distinction between the two groups; yet one was traditionally held to bring fair, the other foul weather. There can be little doubt that an etymological confusion lay at the bottom of this inconsistency. "To rain," in Greek is *huein;* but *hus* (cognate with "sow") means a "pig." Moreover, in old Latin, the Hyades were called *Suculæ* ("little pigs"); although the misapprehension which he supposed to be betrayed by the term was rebuked by Cicero (*De Nat. Deorum*, lib. ii. cap. 43). Possibly the misapprehension was the other way. It is quite likely that "Suculæ" preserved the original meaning of "Hyades," and that the pluvious derivation was invented at a later time, when the conception of the seven stars in the head of the Bull as a "litter of pigs" had come to appear incongruous and inelegant. It has, nevertheless, just that character of *naïveté* which stamps it as authentic. Witness the popular names of the sister-group—the widely-diffused "hen and chickens," Sancho Panza's "las siete cabrillas," met and discoursed with during his famous aërial voyage on the back of Clavileño, the Sicilian "seven dovelets,"—all designating the Pleiades. Still more to the purpose is the Anglo-Saxon "boar-throng," which, by a haphazard identification, has been translated as Orion, but which Grimm, on better grounds, suggests may really apply to the Hyades (*Teutonic Mythology*, trans. by J. S. Stallybrass, vol. ii. p. 729). It is scarcely credible that any other constellation can be indicated by a term so manifestly reproducing the "Suculæ" of Latin and Sabine husbandmen.

The Homeric scheme of the heavens, then, (such as it is), was produced at home. No stellar lore had as yet been imported from abroad. An original community of ideas is just traceable in the names of some of the stars; that is all. The epoch of instruction by more learned neighbours was still to come. The Signs of the Zodiac were certainly unknown to Homer, yet their shining array had been marshalled from the banks of the Euphrates at least 2000 years before the commencement of the Christian era. Their introduction into Greece is attributed to Cleostratus of Tenedos, near, or shortly after, the end of the sixth century B.C. By that time, too, acquaintance had been made with the "Phœnician" constellation of the Lesser Bear, and with the wanderings of the planets. Astronomical communications, in fact, began to pour into Hellas from Egypt, Babylonia, and Phœnicia about the seventh century B.C. Now, if there were any reasonable doubt that "blind Melesigenes" lived at a period anterior to this, it would be removed by the consideration of what he lets fall about the heavenly bodies. For, though he might have ignored formal astronomy, he could not have remained unconscious of such striking and popular facts as the identity of Hesperus and Phosphorus, the Sidonian pilots' direction of their course by the "Cynosure," or the mapping-out of the sun's path among the stars by a series of luminous figures of beasts and men.

Thus the hypothesis of a late origin for the "Iliad" and "Odyssey" is negatived by the astronomical ignorance betrayed in them. It has, however, gradations; whence some hints as to the relative age of the two epics may be derived. The differences between them in this respect are, it is true, small, and they both stand approximately on the same astronomical level with the poems of Hesiod. Yet an attentive study of what they have to tell us about the stars affords some grounds for placing the "Iliad" the "Odyssey," and the "Works and Days" in a descending series as to time.

In the first place, the division of the month into three periods of ten days each is unknown in the "Iliad," is barely hinted at in the "Odyssey," but is brought into detailed notice in the Hesiodic calendar. Further, the "turning-points of the sun" are unmentioned in the "Iliad," but serve in the "Odyssey," by their position on the horizon, to indicate direction; while the winter solstice figures as a well-marked epoch in the "Works and Days." Hesiod, moreover, designates the dog-star (not expressly mentioned in the "Odyssey") by a name of which the author of the "Iliad" was certainly ignorant. Besides which an additional constellation (Boötes) to those named in the "Iliad" appears in the "Odyssey" and the "Works and Days"; while the title "Hyperion," applied substantively to the sun in the "Odyssey," is used only adjectivally in the "Iliad." Finally, stellar mythology begins with Hesiod; Homer (whether the Ionian or the Ithacan) takes the names of the stars as he finds them, without seeking to connect them with any sublunary occurrences.

To be sure, differences of place and purpose might account for some of these discrepancies, yet their cumulative effect in fixing relative epochs is considerable; and, even apart from chronology, it is something to look towards the skies with the "most high poet," and to retrace, with the aid of our own better knowledge, the simple meanings their glorious aspect held for him.

A. M. CLERKE

ON ICE AND BRINES[1]

I.

THE composition of the ice produced in saline solutions, and more particularly in sea-water, has frequently been the object of investigation and of dispute. It might be thought that to a question of whether ice so formed does or does not contain salt, experiment would at once give a decisive answer. Yet, relying on experiment alone, competent authorities have given contradictory answers. All

[1] Paper read before the Royal Society of Edinburgh, by J. Y. Buchanan on March 27 last.

agree that ice, whether formed artificially in the laboratory by freezing sea-water, or found in nature as one of the various species of sea-water ice, retains, in one form or another, and with great tenacity, the salt existing in solution in the water. The question at issue is whether this salt is to be attributed to the solid matter of the ice or to the liquor mechanically adhering to it, from which it is impossible to free it. Most bodies, and especially those which take a crystalline form, are easily purified and freed from all suspected foreign matter, with a view to analysis, by the simple operation of washing and drying. It is impossible to wash the crystals, formed by freezing a saline solution, with distilled water, because they melt at a temperature below that at which distilled water freezes. The effect of the addition of a small quantity of distilled water to a quantity of saline ice is at first the anomalous one, that what was a wet sludge is transformed into a dry crystalline powder. It is of course impossible to dry the ice by heat, and to do so by more intense freezing would be begging the question. The experimental difficulties therefore account for some of the divergence of opinion on the subject. The mixed character of the substances examined has also much to do with it. As a rule it may be said that those investigators who have confined their observations to the laboratory have concluded that the ice forming when saline solutions of moderate concentration, including sea-water, are frozen, is pure ice, and the salt from which it is impossible to free it entirely belongs to the mother-liquor, while those who have collected and examined sea-water ice in high latitudes have come to the opposite conclusion.

During the Antarctic cruise of the *Challenger* I made a number of observations on the sea-water ice found in those regions, and relying principally on the fact that the melting temperature of the ice was markedly lower than that of fresh-water ice, and that it was impossible by any of the ordinary means familiar to chemists for freeing crystals from adhering mother-liquor to materially reduce its salinity, I came to the conclusion that the ice forming in freezing sea-water is not a mixture of pure ice and brine, but that it contains the salt found in it in the solid state either as a crystalline hydrate or as the anhydrous salt, but most probably as a hydrate. In dealing with this subject, Dr. Otto Pettersson ("Water and Ice," p. 302) quotes my observations, and also rejects the view that "sea-ice is in itself wholly destitute of salts, and only mechanically incloses a certain quantity of unfrozen and concentrated sea-water." He founds his belief on the fact that numerous analyses of specimens of sea-water ice have shown that the constitution of the saline contents of different specimens of ice differs for each specimen, and is always different from that of the saline contents of sea-water. Were the salinity due to inclosed unfrozen and concentrated sea-water, we "ought to find by chemical analysis exactly the same proportion between Cl, MgO, CaO, SO_3, &c., in the ice and in the brine as in the sea-water itself." He adduces numerous examples of analyses of specimens of sea-water ice from the Baltic and from the Arctic Seas to show that this is not the case. Calling the percentage of chlorine in each case 100, he found in various sea-waters the percentage of SO_3 vary from 11·49 to 11·89. In specimens of sea-water ice it varied from 12·8 to 76·6, and in brines separating from the ice and remaining liquid at −30° C. it varied from 1·14 to 1·16.

This argument appears conclusive. In order to explain all the phenomena observed in connexion with sea-water ice he cites Guthrie's investigations, which went to show that, in freezing saline solutions, under a certain concentration, pure ice is formed at a temperature which falls from 0° C., when the amount of salt dissolved is infinitely small, to a certain definite temperature when the solution contains a certain definite percentage of salt. Further abstraction of heat then produces solidification of the solution as a whole, in the form of a crystalline hydrate, of constant freezing- and melting-point. To such hydrates, Guthrie gave the name of cryohydrates. Pettersson quotes the following as being particularly applicable to the case of sea-water:—

The cryohydrate of		Contains per cent. of water		Solidifies at ° C.
NaCl	...	76·39	...	−22
KCl	...	80·00	...	−11·4
$CaCl_2$	...	72·00	...	−37·0
$MgSO_4$	...	78·14	...	−5·0
Na_2SO_4	...	95·45	...	−0·7

And he refers more particularly to the cryohydrate of Na_2SO_4 forming and melting at −0°·7.

Now the bearing of Guthrie's experiments is to show that, while at sufficiently low temperatures, and with suitable concentration, the water will solidify along with one or other of the salts in solution, until this low temperature and high concentration are attained, pure ice must be the result of freezing.

The abnormal phenomena attending the formation and the melting of ice in saline solutions and sea-water, find a natural explanation in an observation which I have frequently quoted, and which Dr. Pettersson mentions in a footnote at p. 318, namely, that "a thermometer immersed in a mixture of snow and sea-water which is constantly stirred indicates −1°·8 C." If this is true, it is clear that my melting-point observations proved nothing. On repeating the experiment I found it confirmed, and took the opportunity this winter of investigating the matter more closely. The paper read before the Royal Society of Edinburgh contains the first portion of the results. It deals with the subject under two heads, namely, (*a*) the temperature at which sea-water and some other saline solutions freeze, and the chemical constitution of the solid and the liquid into which they are split by freezing; and (*b*) the temperature at which pure ice melts in sea-water and in a number of saline solutions of different strengths.

(*a*) The freezing experiments were limited to sea-water and solutions of NaCl comparable with sea-water.

Chloride of Sodium.—Four solutions were used, and they were intended to contain 3, 2·5, 2, and 1·5 per cent. NaCl respectively. Forty grammes of this solution, in a suitable beaker, were immersed in a freezing mixture of such composition as to give a temperature from 2° to 2°·5 C. below the freezing temperature expected. The temperature at which ice began to form (if necessary after adding a minute splinter of ice) was noted, and the freezing was allowed to continue with constant stirring till the temperature had fallen 0°·2 C. A specimen of the mother-liquor was removed, and the chlorine in it determined; the chlorine in the original solution had been determined before. The beaker was then removed from the freezing bath and allowed to melt. The temperature in all cases rose during melting exactly as it had fallen during freezing. In the following table are given the means of the temperature at which ice began to form in the original solution, and that of the liquid when the sample of brine was taken, and the means of the chlorine found in the original solution and in the brine sample

Mean Freezing Temp.	−1°·875 C.	−1°·63	−1°·30	−0°·975
Mean per cent. Cl.	1·87	1·60	1·30	0·98

It will be seen that, in the dilute solutions experimented with, the percentage of chlorine expresses, in terms of the Centigrade scale, the lowering of the freezing-point of the solution.

Sea-Water.—Similar experiments were made with sea-water of different degrees of concentration. In sea-water from the Firth of Clyde containing 1·84 per cent. of chlorine, ice forms at $-1^{\circ}\cdot 9$ C. The following results are from means of closely-agreeing results:—

Freezing temperature	$-2^{\circ}\cdot 0$	$-1^{\circ}\cdot 5$	$-1^{\circ}\cdot 0$	$-0^{\circ}\cdot 5$
Per cent. chlorine	1·94	1·445	0·963	0·475
Difference	0·06	0·055	0·037	0·025

Sea-water resembles a chloride of sodium solution, containing the same percentage of chlorine, and the resemblance is closer the greater the dilution. When the beaker was removed from the freezing-bath, the temperature rose during melting as it had fallen during freezing. In these experiments, which had for their object the determination of the temperature at which the crystals melted, as well as that at which they began to form in the water, it was impossible to remove a sample for analysis large enough to enable the sulphuric acid to be determined in it.

For this purpose a series of observations were made, using quantities of 300 grammes of sea-water. Freezing was continued usually until the temperature had fallen $0^{\circ}\cdot 3$ C. below that at which crystals began to form. The mother-liquor was then separated from the crystals by means of a large pipette with fine orifice, before removing the beaker from the freezing bath. The magma of crystals was then brought rapidly on a filter and drained by means of the jet pump. The ice, thus drained, was then melted, and the three fractions were analysed. In the following table (I.) the results of four experiments are given. In the one column (W) will be found the weight of the original water taken and of the fractions into which it was split in freezing; in the other (R) will be found the ratio of SO_3 to Cl found by analysis, the chlorine being set down as 100; thus, in I, the percentage of chlorine found in the crystals, melting at the lowest temperature, was 1·497, and that of the SO_3, 0·174; the ratio (R) is therefore 11·62.

TABLE I.—*Freezing sea-water—Analyses of fractions.*

No. of Experiment.	I.		II.		III.		IV.	
Nature of Water...	Forth 100 °/₀		Mother liquor		Clyde 100 °/₀.		Clyde 50 °/₀.	
	W.	R.	W.	R.	W.	R.	W.	R.
Original water	300	11·83	90	11·67	300	11·58	300	11·21
Mother-liquor	} 170·6	11·67 {	—	11·83	102	11·57	78	11·67
Drainings			—	—	94	11·56	109	—
Crystals	106	11·62	23	11·22	97	11·67	106	11·44
,, ...	22·5	11·11	—	—	—	—	—	—

It will be seen that the ratios (R) found for mother-liquor, drainings, and ice agree with one another quite as closely as those found in samples of pure sea-water from different localities. It is to be remembered that in these experiments the water was frozen *gently*, that is, the rate of abstraction of heat was low, the temperature of the freezing bath being regulated so as to be about 2° C. below the freezing temperature of the solution. Much of the error and uncertainty about the freezing of saline solutions arises from the violence of the methods employed. Judging then by the constancy of the relation of the percentage of Cl to SO_3 we see that in sea-water, frozen at moderate temperatures, the composition of the saline contents of the original water, the mother-liquor and the ice is identical; and we are justified in concluding that it is probable that the saltness of the ice is due to unfrozen and concentrated sea-water adhering to it. Ice forming in even very weak saline solutions closely resembles snow (which is ice forming in air), and has the same remarkable power of retaining mechanically several times its weight of water or brine.

A strict account was kept of the heat removed from the sea-water while the freezing was going on. In Table II. will be found the number of heat-units (gramme ° C.) removed during the freezing in the case of Nos. III. and IV.; and this number, divided by 79·25, gives the weight of pure ice, which could have been formed at 0° C. by the removal of heat.

TABLE II.—*Calculation of ice formed.*

		III.	IV.
Weight of original water (grammes)	W	300	300
Per cent. Cl in ditto	c	1·836	0·923
Per cent. Cl in mother-liquor	K	2·212	1·153
Weight of mother-liquor $W\frac{c}{K}=$	L	249·0	239·3
Weight of ice $W-L=$	I	51·0	60·7
Mean freezing temperature (° C).....................	...	$-2^{\circ}.05$	$-1^{\circ}\cdot 05$
Heat abstracted (grammes ° C)	...	4230	5193
Equivalent ice formed (grammes)	...	53·4	65·5

Sea-water, like other saline solutions, is easily cooled several degrees below its freezing-point before crystals begin to form. While cooling down to and below what was known to be its freezing-point, simultaneous observations of the temperature of the sea-water and the freezing bath were made from half-minute to half-minute. From these observations, the rate of abstraction of heat for different differences of temperature of sea-water and bath was found. At a given moment a minute splinter of ice (weighing much less than a drop of water) was introduced. Crystals immediately began to form, and the temperature rose in from ten to fifteen seconds to the freezing-point. During the freezing the temperatures of bath and sea-water were observed at regular intervals. The heat removed is thus made up of that eliminated during the few seconds when freezing began and the temperature rose to the freezing-point, which is found by multiplying the rise of temperature by the weight of liquid, and that removed during the subsequent cooling, which is deduced from the duration of the operation and the rate of loss of heat observed before freezing commenced. The specific heat of the solution is taken as unity. In the table are further given the weight of the sea-water used, the percentage of chlorine in the original water and in the mother-liquor, the weight of the mother-liquor on the assumption that it contains all the salt of the original water, and, by difference, the weight of the ice formed. The agreement between the two quantities of ice formed as calculated by the different methods is as close as could be expected.

It has thus been shown that the composition of the saline contents of the ice formed as above described is the same as that of the original water, and this of itself is almost conclusive that the salt is contained in adhering brine and not as a solid constituent of the ice. Assuming that this is so the amount of ice formed as deduced from the composition of the mother-liquor agrees well with the amount deduced from the thermal exchange taking place during the freezing.

It has, moreover, been proved by Guthrie, Rüdorff, and others, that, in solutions of the salts occurring in sea-water, ice does separate out at first, and continues to separate out until the concentration has become many times greater than that of sea-water. Assuming that in sea-water all the chlorine is united to sodium, 87 per cent. of the water would have to be removed as ice before a cryohydrate would form, and if it contained nothing but sulphate of soda in the proportion corresponding to the sulphuric acid formed in it, over 90 per cent. of the water would have to go as ice, before the cryohydrate would be formed.

In my experiments, about 15 per cent. of the weight of the water was frozen out as ice, causing a lowering of freezing-point by $0^{\circ}\cdot 3$ C. In nature it is probable that the ice forming at the actual freezing surface does so at an almost uniform temperature, the local concentration produced by the formation of a crystal of ice being immediately eliminated by the mass of water below. In the interstices of the crystals there will be retained a weight of slightly concentrated sea-water at least as great as that of the ice crystals. These retain the brine in a meshwork of cells, and, as the thickness of the ice covering increases, and the freezing surface becomes more remote, the ice and the brine become more and more exposed to the atmospheric rigours of the Arctic winter. The brine will continue to deposit ice until its concentration is such that, for example, the cryohydrate of NaCl is ready to separate out. It probably will separate out until it comes in conflict with, for instance, the chloride of calcium or the chloride of magnesium, which will retain some of the water, without solidifying, even at the lowest temperatures. At the winter quarters of the *Vega* brine was observed oozing out of sea-water ice and liquid at a temperature of − 30° C. It was very rich in calcium and especially magnesium chlorides. In fact, *it is probably quite impossible by any cold occurring in nature to solidify sea-water*.

The residual and unfreezable brine which remains in considerable quantity liquid when sea-water is frozen, must also remain in greater or less quantity when fresh water is frozen. All natural waters, including rain-water, contain some foreign and usually saline ingredients. If we take chloride of sodium as the type of such ingredients, and suppose a water to contain a quantity of this salt equivalent to one part by weight of chlorine in a million parts of water, then we should have a solution containing 0·0001 per cent. of chlorine, and it would begin to freeze and to deposit pure ice at a temperature of − 0°·0001 C.; and it would continue to do so until, say, 999,000 parts of water had been deposited as ice. There would then remain 1000 parts of residual water, which would retain the salt, and would contain, therefore, 0·1 per cent. of chlorine, and would not freeze until the temperature had fallen to − 0°·1 C. This water would then deposit ice at temperatures becoming progressively lower, until, when 900 more parts of ice had been deposited, we should have 100 parts residual water, or brine as it might now be called, containing 1 per cent. of chlorine, and remaining liquid at temperatures above − 1°·0 C. When 90 more parts of ice had been deposited, we should have 10 parts of concentrated brine containing 10 per cent. of chlorine and remaining liquid at − 10° C. In the case imagined, we assume the saline contents to consist of NaCl only, and with further concentration the cryohydrate would no doubt separate out and the mass become really solid. On reversing the operations, that is, warming the ice just formed, we should, when the temperature had risen to − 10° C., have 999,990 parts ice and 10 brine containing 10 per cent. chlorine. Now, owing to the remarkable fact (which is dealt with at length in the second part of the paper) that pure ice, in contact with a saline solution, melts at a temperature which depends on the nature and the amount of the salt in the solution, and is identical with the temperature at which ice separates from a solution of the same composition on cooling, the brine liquefies more and more ice at progressively rising temperatures, until, as before, when the temperature of the mass has risen to − 0°·1 C., it consists of 999,000 parts of ice and 1000 parts of liquid water, containing 1 part of chlorine. The remainder of the ice will melt at a temperature gradually rising from − 0°·1 C. to 0° C.

The consideration of this example furnishes an easy explanation of the anomalous behaviour of ice, formed from anything but the very purest distilled water, in the neighbourhood of its melting-point. This subject has been studied with great care and thoroughness by Pettersson. The apparent expansion of all but the very purest ice, when cooled below 0° C., is ascribed by him in part to solid saline contents of the ice which exercise a disturbing and unexplained influence on its physical properties. Viewed in the light of the fact that the presence of even the smallest quantity of saline matter in solution prevents the formation of ice at 0° C. and promotes its liquefaction at temperatures below 0° C., we see that this apparent expansion of the ice on cooling is probably due to the fact that we are dealing not with homogeneous solid ice but with a mixture of ice and saline solution. As the temperature falls this solution deposits more and more ice and its volume increases. But the increase of volume is due to the formation of ice out of water and not to the expansion of a crystalline solid already formed.

In Table III. are given the volumes occupied by the ice (with inclosed brine) formed by freezing 100,000 c.c. (at 0° C.) of a water containing chloride of sodium equivalent to 7 grammes chlorine in 1,000,000 cubic centimetres (at 0° C.).

TABLE III.—*Water containing 7 parts Cl in* 1,000,000.

Temp. °C.	Water frozen. c.c.	Ice formed. c.c.	Brine remaining. c.c.	Ice and Brine. c.c.	Pettersson III. Vol. of ice at T. c.c.	Diff.
T	V_1	v_1	V_2	v_2	P	$P - v_2$
− 0·07	99000	107979	1000	108979	108980	1
− 0·10	99300	108306	700	109006	109007	1
− 0·15	99533	108561	467	109028	109038	10
− 0·20	99650	108687	350	109037	109048	11
− 0·40	99825	108879	175	109054	109057	3

The volume of the ice formed on freezing this water is compared with that observed by Pettersson in freezing a sample of the distilled water in ordinary use in the laboratory.

It will be seen that the volumes observed by Pettersson agree very closely with those calculated for a water containing 7 parts of chlorine in a million.

The irregularities in the melting-points of bodies like acetic acid, to which Pettersson refers, are without doubt due to a perfectly similar cause.

Also the very low latent heat observed by Pettersson for sea-water is to be explained by the fact that the salt retains a considerable proportion of the water in the liquid state even at temperatures many degrees below the freezing-point of distilled water.

The *plasticity* of ice and the motion of glaciers receive a simple and natural explanation when we see, as in Table III., that, if the water from which this ice is produced contains no more than 7 parts of chlorine per million, it will, in the process of thawing, when the temperature has risen to − 0°·07 C., consist to the extent of 1 per cent of its mass of liquid brine or water. The water considered in Table III. is certainly not less free from foreign ingredients than rain or snow. It follows, therefore, that a glacier, in a climate where the temperature is for the greater part of the year above 0° C., must have a tendency to *flow*, owing to the power of saline solutions to deposit ice and to dissolve it at temperatures below 0° C.

(*To be continued.*)

NOTES

THE Endowed Schools Committee, of which Sir Lyon Playfair is Chairman, after sitting for a year and a half, have agreed to their Report. This is not yet issued, but it is known that the Committee have reported in favour of endowed schools being in future largely used for the promotion of scientific and technical education. The Report also recommends that local authorities should be authorised to employ local rates for founding or contributing to laboratories and workshops in such schools in order to promote practical scientific education.

LAST week an important Conference was held at Oxford for the consideration of questions connected with the University Extension Scheme. The meetings were attended by many members of the University, local delegates, and others interested in this method of University development. There can be no doubt whatever as to the good work done by University Extension lecturers. Unfortunately, however, it is hard to obtain the funds which are necessary for the complete success of the experiment. One speaker urged that "the University should lead the way by the creation of a Jubilee Fund, and so stimulate local efforts." To this Prof. Rogers replied that the University was "positively poor." Prof. Rogers added that the result of an appeal to London Companies "had not been favourable," but that the Charity Commissioners might perhaps be willing to do something for the movement.

THE American Exhibition to be opened in the Earl's Court neighbourhood on May 9 will contain much that ought to be of scientific interest. The large encampment of American Indians will be found to contain a great variety of types, and ought to prove attractive to ethnologists. The machinery department will contain many illustrations of the successful applications of science, especially in the section directed to machines for the production and application of electricity. Under mining and metallurgy there will be a large collection of minerals, ores, and stones, besides specimens of metallurgical products. In the department of education and science will be found illustrations of the varied educational appliances and apparatus used in the United States, exhibits from the many institutions and organisations which exist in the States, and a very varied collection of scientific and philosophical instruments.

A NEW scientific journal—*Centralblatt für Physiologie*—has made its appearance this month in Germany. It is edited by Dr. S. Exner, of Vienna, and Dr. J. Gad, of Berlin, who have the advantage of the co-operation of the Berlin Physiological Society. The journal will be issued once a fortnight.

A MONUMENT to Galileo has been erected in Rome, on the Via Pincio, fronting the old Medici Palace, now occupied by the French Embassy, where he was kept a prisoner, in 1637, during his prosecution by the Inquisition. The monument consists of a column with a pedestal, on which is the following inscription in the Italian language:—"Erected in memory of Galileo Galilei, who was kept a prisoner in this Palace, for having seen that the earth moves round the sun."

DR. R. MÜLLER publishes, in the April number of *Mittheilungen aus dem Gebiete des Seewesens*, the results of an investigation as to whether or not the popular idea of equinoctial gales, the existence of which was contested some time ago as regards this country by Mr. Scott (NATURE, vol. xxx. p. 353), holds good for the Adriatic Sea. For this purpose the hourly records of the anemometer at Pola, from 1876–86, were used. During this period strong winds or gales were registered on 607 days, 63 per cent. of which occurred in the winter season (October to March). The months with least wind were naturally June and July; then a tolerably regular increase in the number of days with stormy winds took place till the end of January. A considerable decrease occurred in Febuary, while March had the greatest number of stormy days. The result arrived at is that, for the Adriatic, no important influence can be attributed to the equinoctial seasons, especially during the autumnal equinox. Dr. Müller also quotes a similar investigation made by the *Deutsche Seewarte*, for the years 1878–83, for the German coasts, with nearly similar results; the percentage of storms for the winter season being 80 per cent., and for the summer season only 20 per cent. The greatest number of storms occurred in November and December, March having 14 per cent., and September 3 per cent. only.

AT a recent meeting of the Italian Meteorological Society, reported in its *Bollettino mensuale* for February last, the Committee enumerated the meteorological stations lately established by it abroad, viz. one in Tripoli, two in the Argentine Republic, three in Uruguay, one in Colombia (South America), and one in Mexico, and notified their intention of shortly establishing others on the Patagonian coasts of the Pacific, and in some of the islands near Cape Horn. Among other matters discussed was the proposed suppression of the *Bollettino decadico*—which has reached its fourteenth yearly volume, and which contains the observations made at ordinary stations, and at stations in the Alps and Apennines, for decades—as the increasing work of the Society renders its publication difficult. The monthly means of these observations appear in the *Bollettino mensuale*, but the last published are for March 1886.

ON the night of April 12, at about 11.30, a brilliant meteor was seen in Værdalen, in Norway. It appeared in the east, and went in a southerly direction. At first the colour was a pure white, but during the progress of the meteor it changed into green and yellow. The lustre of the body was very bright, and its greatest apparent size was about that of an ordinary plate. On the meteor disappearing from view behind a mountain ridge, a sudden brilliancy seemed to indicate that it had burst into fragments, but no detonation was heard. It left a faint trail of smoke behind, about a few yards in length, which remained for a few seconds in the sky, then disappeared.

ON April 13 a shock of earthquake was felt at Lisbon, and in Malta and Sicily. Considerable alarm was caused in Jersey at a few minutes past 3 o'clock on the morning of April 21 by a slight shock of earthquake, the direction of which was from south-west to north-west. There was so loud a noise that at first some persons fancied guns were being fired. About the same time a smart shock of earthquake was experienced in Guernsey. A decided tremor of the earth, lasting about three seconds, and accompanied by a rumbling noise, was felt in all parts of the island.

THE death is announced of Dr. Nathaniel Lieberkühn, Professor of Anatomy at the University of Marburg, on April 14, at the age of sixty-five; and of Herr J. B. Obernetter, well known by his researches in photographic chemistry, on April 13, at the age of forty-seven.

A NEW GUINEA Exhibition will shortly be opened at Bremen.

MESSRS. R. FRIEDLÄNDER AND SON, of Berlin, send us the first quarterly list for 1887 of their new publications. It includes many valuable works in natural history and the exact sciences.

THE scheme for the formation of a North Sea Fisheries Institute is still under the consideration of the National Fish-Culture Association and of various local authorities, by whom efforts are being made to secure the necessary funds. It is proposed to form a Fish-Culture Station at Cleethorpes, and schools at Grimsby, and to carry out scientific observations wherever the conditions seem to be most favourable. Particular attention is to be given to the culture of the oyster and cod. A meeting has lately been held in London to advance the undertaking, and another is to take place shortly at Grimsby for the same purpose.

THE list of elements whose atomic weights have been determined with great accuracy has just received two valuable additions, for although one of them, silicon, is by no means rare in its occurrence in nature, and the other, gold, is neither among the most recently discovered of metals nor rare from the chemist's point of view, yet past determinations of the atomic weights of these important elements have resulted in leaving the subject enshrouded with considerable ambiguity. Prof. Thorpe and Mr. J. W. Young, who have recently determined the atomic weight of silicon, used for this purpose the tetrabromide $SiBr_4$, and, instead of the small quantities of material used by other experimenters, prepared upwards of half a kilogramme of this substance by passing bromine vapour over a heated mixture of pure silicon dioxide and charcoal. The product was rectified in an atmosphere of nitrogen, and portions for analysis were collected in bulbs without exposure to air; these bulbs were then broken in bottles containing pure water, and in each case the resulting turbid liquid was very slowly evaporated to complete dryness, the relation of the weight of silicon dioxide obtained to that of the tetrabromide used forming the basis of the calculations. The result of this long and difficult series of analyses fixes the atomic weight of silicon as 28·332. The instability of the salts of gold has long been a stumbling-block in the way of obtaining accurate determinations of its atomic weight, but Prof. Thorpe and Mr. A. P. Laurie have overcome this difficulty by utilising the double bromide of gold and potassium, which they prepared by digesting together pure gold, bromine, potassium bromide, and water, the salt being afterwards subjected to several recrystallisations. An unknown quantity of the pure salt was then carefully ignited, and the mixture thus obtained, of potassium bromide and gold, weighed; after removal of the potassium bromide by washing, the weight of residual gold obtained in each analysis furnished data from which one set of values averaging 196·876 was obtained. The bromine in the potassium bromide as determined by titration with silver nitrate gave a second averaging 196·837, and the weight of silver bromide formed yielded a third series of numbers, averaging 196·842. Taking Stas's value for oxygen at 15·96 the atomic weight of gold is fixed by these analyses at 196·85; but if, along with Mendelejeff, we consider oxygen 16, then gold becomes 197·28, and it is interesting to note that Mendelejeff considered the old value, 196·2, to be too low, there being no place in the periodic system for an element of this atomic weight having the properties of gold. Hence the result of the present determination has been to place gold in its proper position in the periodic classification. Prof. Krüss has just published (*Ber. Deut. Chem. Ges.* No. 2, 1887) the results of a determination of the atomic weight of gold recently made by him, according to which the probable value is 196·64. The method employed, however, was slightly different from the above, a weighed quantity of the double bromide itself being used as the basis of a portion of the analyses.

In a paper on Electric Locomotion, read before the Society of Arts on the 20th inst., Mr. Reckenzaun pointed out that in the United States and on the European continent there are dozens of electric tramways at work to the satisfaction of everybody, while we have few opportunities of testing their advantages in England. Yet England is "the home of the dynamo-machine, the country where the electromotor has found its highest development." We have been outstripped in this matter chiefly because an Act of Parliament must be obtained before electric cars can be run, and every company has to apply for it separately.

The other day M. Émile Rivière discovered a prehistoric station in the wood of Chaville, to the right of the Versailles road, in a part where there are comparatively few trees. Some flint implements and weapons were found, and a fragment of coarse pottery without ornament.

At the February meeting of the Pekin Oriental Society, Mr. Owen read a paper on animal worship amongst the Chinese. He referred at considerable length to the worship paid to the fox, weasel, hedgehog, and snake, to which at Tientsin is added the rat. The first four are called the immortals. These deified animals seem to usurp the entire attention of the people, even to the exclusion of the Buddhist and Taoist gods. Dr. Edkins quoted from the Chinese to prove that animal worship was unknown in ancient times, while Dr. Dudgeon pointed out that it was a mistake to suppose that animal worship was confined to the four animals mentioned. The horse, cow, dog, insects, dragon, lion, &c., are worshipped. In the fifth month the centipede, lizard, scorpion, frog, and snake—the five poisonous animals, as they are called—are also objects of worship. Dr. Martin disputed Dr. Edkin's theory that animal worship was unknown in ancient times because it was not mentioned by Confucius; he (Dr. Martin) believed that it existed to a much greater extent in ancient than in modern times. From the observations of other speakers it is clear that animal worship occupies a very large place in Chinese superstitious observances.

There was an interesting Geographical Exhibition in connexion with the meeting of the Deutsche Geographentag at Carlsruhe on the 13th inst. An historical department showed the development of cartography, all the exhibits being from Baden and Würtemberg. Water-colour sketches by the well-known African traveller Paul Reichard, and some fine oil sketches by the painter Hellgreve, who was sent to East Africa by the Artists' Club at Berlin, were exhibited. In the plant department were shown cotton plants found growing wild in Togoland, wild coffee and sugar-cane from Cameroons, and tobacco and various seeds from the gardens of the German East African Society.

An interesting case of "colour-hearing" was recently reported to a meeting of the Société de Psychologie Physiologique. In this case, colour-hearing was an hereditary peculiarity, transmitted from father to daughter.

The third volume of the "Grande Encyclopédie" has just been published It is expected that thirty volumes will probably be required to complete this great work. Each volume consists of 1200 quarto pages in two columns, printed in small type.

Everyone who takes an interest in zoology is probably acquainted with the "Zoological Record," which consists of an annual volume containing a summary of the work done in the various branches of zoology. It was begun in 1865, and for the first six years was published by Mr. Van Voorst. For the last sixteen years it has been carried on by an Association of zoologists called the "Zoological Record" Association, who have received assistance in the shape of grants from the Government Fund of the Royal Society, the British Association, and the Zoological Society of London. The "Zoological Record" Association, having been lately unsuccessful in obtaining the continuance of some of these grants, and being unwilling to carry on the publication of the "Record" any longer, have agreed, upon certain conditions, to transfer their whole stock to the Zoological Society of London, who, for the future, have determined to carry on this most useful publication. The "Zoological Record" will, therefore, beginning with the volume for the present year (which will contain the record of the zoological literature of 1886), be published by the Zoological Society of London, under the management of a Committee of the Council of that Society, and will be edited by Mr. F. E. Beddard, the Society's Prosector. The "Record" will be published for the Society by Messrs. Gurney and Jackson at the former price of 30*s.* per volume. But all members of the Society will have the privilege of receiving it, including the cost of delivery, at a subscription price of 20*s.* per annum. This subscription will be due on July 1 in every year, and the privilege of subscription will be forfeited unless the amount be paid before December 1 following. The Zoological Society, having purchased the entire stock of the "Zoological Record," are now able to supply complete sets of the first twenty-two volumes at the price of 5*l.* 10*s.*, that is 5*s.* per volume. Volumes of any single year can likewise be supplied at 10*s.* per volume. Learned Societies and Institutions and members of the former "Zoological Record" Association will be permitted to subscribe to the "Record" on the same conditions as are accorded to members of the Zoological Society.

It is intended to form a class, including beginners and advanced students, this summer, in the same way as last year, for the study of geology near London, to be conducted on Saturday afternoons, by Prof. H. G. Seeley, F.R.S., King's College. Applications for tickets should be made at once to the Hon. Secretary, W. W. R. May, 16 Bethune Road, Manor Road, Stoke Newington, N.

The additions to the Zoological Society's Gardens during the past week include two Rhesus Monkeys (*Macacus rhesus* ♂ ♀) from India, presented by Mr. W. F. Lock; a Common Fox (*Canis vulpes* ♂) British, presented by Mr. Isaac Bell, Jun.; a Bosch-bok (*Tragelaphus sylvaticus* ♂) from South Africa, presented by Capt. Travers; a Vulpine Phalanger (*Phalangista vulpina* ♂) from Australia, presented; two Turkey Vultures (*Cathartes aura*) from the Falkland Islands, presented by Mr. James H. Moore; a Common Viper (*Vipera berus*), British, presented by Mr. S. E. Gunn; a Chinese Lark (*Melanocorypha mongolica*) from China; two Common Rheas (*Rhea americana* ♂ ♀) from the Argentine Republic, received in exchange; a Burrhel Wild Sheep (*Ovis burrhel*); two White-backed Pigeons (*Columba leuconota*) from the Himalayas; a Hodgson's Partridge (*Perdix hodgsoniæ*) from Bootan, purchased; four Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Barnard's First and Second Comets 1887.—Comet *c* 1887, discovered by Mr. Barnard on January 23, has now attained a high declination, and, though faint, may possibly be observed within the next few days. Dr. H. Kreutz gives the following ephemeris for it for Berlin midnight, derived from Dr. H. Oppenheim's elements:—

1887	R.A. h. m. s.	Decl. ° ′	log Δ	log *r*
April 27	1 12 46	65 40·4	0·4742	0·3989
29	1 21 49	65 52·7		
May 1	1 30 47	66 3·8	0·4827	0·4057
3	1 39 38	66 13·7		
5	1 48 22	66 22·5	0·4910	0·4125

Correction of ephemeris for April 15, in R.A. + 3m. 46s.; in Decl. *nil*.

The second comet discovered by Mr. Barnard, viz. Comet *d* 1887, discovered February 16, is scarcely likely to be seen further. Its present brightness is but one-seventh of that which it had on March 11, and having almost exactly the same R.A. as the sun it scarcely frees itself from the twilight. An ephemeris for its course throughout the month of April, based on Dr. Palisa's elements, was given by Dr. Kreutz in the *Astronomische Nachrichten*, No. 2777, and in the *Observatory* for April; but the probability of its being observed after the April full moon had passed away, except with very powerful instruments, was very slight.

Probable Re-discovery of Hesperia.—Dr. R. Luther detected a minor planet on April 11 which it appears probable is no other than the lost Hesperia, No. 69, as the magnitude and motion resembled those of the missing asteroid. Dr. Luther had previously looked for the planet in vain in 1882, 1885, and in March of the present year.

The Ellipticity of Uranus.—Prof. W. Valentiner, of the Karlsruhe Observatory, writing in the *Astronomische Nachrichten*, No. 2781, states that Herr von Rebeur, observing Uranus with the 6-inch refractor of the Observatory on the evening of April 3, noticed that the disk appeared distinctly elliptical. On the following evening Prof. Valentiner himself observed the planet, and found that the direction as estimated of the major axis of the disk, the ellipticity of which was unmistakable, agreed closely with that of the assumed equatorial diameter as read off from the position-circle of the micrometer. Prof. Valentiner brings the subject forward now in the hope that those astronomers who have the command of powerful telescopes may be induced to give some attention to it.

The Washington Observatory.—It appears from *Science*, vol. ix. No. 218, that the statement (reported in last week's Nature, p. 595) that the sum of 400,000 dollars had been appropriated by Congress for the erection of a new Naval Observatory near Washington is erroneous. The amount actually available is but 100,000 dollars, with the understanding that the entire cost of the work shall not exceed 400,000 dollars.

The Paris Conference.—The same number of *Science* states that Ensign Winterhalter, of the United States Naval Observatory, had sailed for Paris, to represent the Observatory at the Photographic Conference. It is understood that Dr. Peters, of Clinton, and Mr. Rutherfurd, of New York, will also attend the Conference.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *MAY* 1-7

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 1

Sun rises, 4h. 34m.; souths, 11h. 57m. 0·2s.; sets, 19h. 20m.; decl. on meridian, 15° 4′ N.: Sidereal Time at Sunset, 9h. 58m.

Moon (Full on May 7) rises, 11h. 27m.; souths, 18h. 59m.; sets, 2h. 19m.*; decl. on meridian, 14° 0′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 6	10 30	16 54	3 59 N.
Venus	5 58	14 21	22 44	24 16 N.
Mars	4 32	11 51	19 10	14 24 N.
Jupiter	18 1	23 14	4 27*	9 59 S.
Saturn	8 30	16 38	0 46*	22 21 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
1	*o*′ Cancri	6	0 25	0 53	172 236
5	γ Virginis	2½	0 25	1 8	141 230
5	B.A.C. 4277	6	1 40	1 46	186 199
5	*l*² Virginis	5	21 30	near approach	323 —

May	h.	
1	15	Venus at least distance from the Sun.
6	8	Jupiter in conjunction with and 3° 14′ south of the Moon.

Saturn, May 1.—Outer major axis of outer ring = 39″·9; outer minor axis of outer ring = 16″·4; southern surface visible.

Variable Stars

Star	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·3	81 16 N.	May	4,	3 40	*m*
S Aurigæ	5 19·7	34 3 N.	,,	3,		*M*
R Canis Minoris	7 2·5	10 12 N.	,,	6,		*m*
R Camelopardalis	14 26·2	84 21 N.	,,	4,		*M*
δ Libræ	14 54·9	8 4 S.	,,	4,	20 11	*m*
U Coronæ	15 13·6	32 4 N.	,,	7,	22 7	*m*
S Herculis	16 46·8	15 8 N.	,,	3,		*m*
R Ophiuchi	17 1·3	15 57 S.	,,	2,		*M*
U Ophiuchi	17 10·8	1 20 N.	,,	4,	2 37	*m*
		and at intervals of			20 8	
W Sagittarii	17 57·8	29 35 S.	May	2,	22 0	*m*
			,,	6,	2 0	*M*
T Herculis	18 4·8	31 0 N.	,,	7,		*m*
U Sagittarii	18 25·2	19 12 S.	,,	2,	2 0	*m*
			,,	5,	1 0	*M*
β Lyræ	18 45·9	33 14 N.	,,	2,	22 0	*M*
			,,	6,	4 0	m_2
R Aquilæ	19 0·9	8 4 N.	,,	2,		*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor-Showers

	R.A.	Decl.
Near υ Herculis	236°	47° N.
η Ophiuchi	254	21 S.
ζ Draconis	262	64 N.
α Aquilæ	298	5 N.

GEOGRAPHICAL NOTES

WE are glad to know that General R. Strachey, R.E., F.R.S., has agreed to accept the presidency of the Royal Geographical Society, in succession to Lord Aberdare. The Society's honours for the present year will be conferred as follows:—The Founder's Medal to Lieut.-Colonel T. H. Holdich, R.E., for the eminent services he has rendered to geography in Afghanistan; the Patron's Medal to the Rev. George Grenfell, for the extensive explorations he has carried out during his thirteen years' residence in Africa, partly in the Cameroons country and more recently in the Congo region; the Murchison Grant to Mr. George Bourne, second in command and sole survivor of the Landsborough Expedition, which crossed the continent of Australia in 1861; the Back Premium to Sarat Chandra Das, for his researches in Tibet; the Gill Memorial to Mr. J. F. Needham, for his explorations in the Lohit Valley of the Brahmaputra. The following have been made Honorary Corresponding Members:—H.R.H. Krom Mun Damrong Rajah Nubharp, Director-General of Surveys and Minister of Public Instruction, Siam; Dr. Alfred Kirchhoff, Professor of Geography at Hallé University, and President of the Hallé Geographical Society; and Dr. E. Naumann, late Director of the Geographical and Topographical Survey of Japan.

THE paper read at the Royal Geographical Society on Monday was by General J. T. Walker, F.R.S., on the Lu River of Tibet, the Lu-Kiang, or Lu-tse-Kiang of the Chinese. This river is generally held to be the source of the Salwin, but General Walker adduced many reasons for maintaining that it is more probably that of the Irrawadi. In the course of an able paper, the result of much research, General Walker gave a most useful summary of exploration in this highly interesting hydrographical region; more particularly insisting on the value of the work of the late Abbé Krick, who ascended the Lohit in 1852, but of whom little is known in this country. General Walker made out a strong case for his position, but the leading conclusion of his valuable paper is that further exploration in this remarkable region is urgently demanded. Probably no region of the earth would yield more valuable results to scientific geography.

ACCORDING to the latest news, Mr. Stanley is well up to time in his ascent of the Congo with the Emin Pasha Expedition. He is at present on his march across country from Matadi, at the lower end of the Livingstone Falls, to Leopoldville, on Stanley Pool. It is hoped that when he reaches the Pool he will find sufficient vessels in readiness to convey his large following up the river without delay. So far the Expedition has been exceedingly fortunate.

THE statement that Baron Nordenskjöld will undertake an Antarctic expedition at the expense of the King of Sweden and Mr. Oscar Dickson is, to say the least, premature. We are informed by Mr. Dickson that Baron Nordenskjöld is "willing" to undertake such an expedition, but that if he does so neither the King of Sweden nor Mr. Dickson will find the money. No doubt Baron Nordenskjöld would be an excellent leader for such an expedition, and as Committees have been formed both in this country and in Australia to promote Antarctic exploration, would it not be wise in them to unite their forces, and place themselves in communication with the Baron? Those who are competent to give an opinion on the subject maintain that an Antarctic expedition is much less risky than one to the other Pole. There would be no difficulty in a party wintering on some part of the Antarctic continent; a vessel could cruise round the verge of the ice during the winter and watch a favourable opening, of which immediate notice could be given to the exploring party, while a third vessel could leave New Zealand at a suitable time with additional supplies. No doubt the subject will again be brought up at the next meeting of the British Association, when it is hoped a strong and active Committee will be appointed. Baron Nordenskjöld will be among the distinguished foreigners invited to the meeting, and we hope he will accept the invitation.

THE Germans continue to show great activity in the exploration of their portion of New Guinea. Freiherr von Schleinitz has recently accomplished a running survey of Huon Gulf, and besides establishing the direction of the coast-line and the positions of reefs, has laid down eight hitherto unknown harbours and discovered nine new rivers. Some of them, especially the Markham River, would form excellent routes for the exploration of the interior; the broad valley of the latter extends for miles between high ranges of mountains. The south coast of Huon Gulf consists exclusively of primitive and metamorphic rocks, with older sedimentary rocks and volcanic formations. At a later date a further survey was made of the coast from Astrolabe Bay to the mouth of the Empress Augusta River, and led to the discovery of a series of bays, harbours, islands, and rivers.

M. GRIMAILO, in company with his brother, an engineer, and six Cossacks, has set out for a further exploration of the Pamir.

DR. LABONNE left Cherbourg a few days ago for a further exploration of the geysers and glaciers of Iceland.

PRELIMINARY NOTE ON THE FOSSIL REMAINS OF A CHELONIAN REPTILE, CERATOCHELYS STHENURUS, *FROM LORD HOWE'S ISLAND, AUSTRALIA*[1]

THE interesting remains of which I propose to give a brief notice in the present communication are contained in a friable sandstone (apparently formed of concreted blown sand), and they have a very recent appearance. The age of the deposit in which they are found is unknown, but it is probably Quaternary. The specimens have been for some years in the palæontological collection of the British Museum, and, for the most part, they have not yet been submitted to careful examination. But I learn that the greater number of them were long since rightly determined to be Chelonian by Mr. Davis, and set aside as such.

Several of the most important of these numerous and, in general, very fragmentary bones were originally found imbedded close together in the same block of sandstone. They consist of a great part of a pelvis, a caudal vertebra, and an imperfect skull. Of the pelvis, a right ischium and a pubis are imbedded in the rock, while an imperfect right ilium, which fits well on to the ischium, is separate; all these bones are unmistakably Chelonian. The caudal vertebra has remarkable peculiarities. It resembles an ordinary Chelonian caudal vertebra from the anterior half of the tail, in its general characters; but it is strongly opisthocœlous, the centrum having a deep cup behind and a correspondingly curved articular head in front. From the posterior part of the ventral face two stout processes diverge, and present terminal rounded facets for the rami of the large chevron bone which must have articulated with them. As a general rule, the caudal vertebræ of Chelonia are procœlous—but *Chelydra* and *Gypochelys* (perhaps also *Staurotypus* and *Platysternum*) form well-known exceptions,[2] in so far as the vertebræ behin the third and fourth are strongly opisthocœlous. In fact, the vertebra in question closely resembles the sixth or seventh of *Chelydra* or of *Gypochelys* (see Figs. 1 and 2). In the first, however, the transverse processes are very much stronger, and the pentagonal platform into which the upper surface of the neural arch expands, in place of a neural spine, is as long as the vertebra, instead of being only about half as long. The stout pre-zygapophysis of the right side is broken off, leaving only the base visible in the fossil.

[1] Paper read at the Royal Society, by Prof. Thomas H. Huxley, F.R.S., on March 31.

[2] The opisthocœlous character of most of the caudal vertebræ of *Chelydra* was first pointed out by Von Meyer in his description of the Œningen *Chelydræ*. Baur ("Osteologische Notizen," *Zool. Anzeiger*, No. 238, 1886) has gone fully into the question, and has pointed out the exceptional nature of their structure among the Chelonia. Since the above paragraph was written, Dr. Günther has kindly enabled me to examine a spirit specimen and a skeleton of *Platysternum*. The caudral vertebræ resemble those of *Chelydra*, except that the last nine are procœlous, while that between these and the more anterior opisthocœlous vertebræ is nearly flat at the ends. In this, as in other respects, *Platysternum* presents characters intermediate between *Chelydra* and the ordinary *Emydæ*. Prof. Cope ("Vertebrata of the Tertiary Formations of the West," 1883, p. 111) ascribes opisthocœlous caudal verebræ to the *Bænidæ*, but no figures or descriptions of such vertebræ are given. Of the opisthocœlous Chelonian vertebræ figured in Plate XXIV. of the "Report of Extinct Vertebrata obtained in New Mexico" (1887), it is expressly stated that their "correct reference cannot now be made" (p. 43).

Two other caudal vertebræ, having the same structural features, occur among the detached remains, and belong, like the first, to the second fourth of the tail. Another tolerably complete vertebra, with a considerably longer centrum, corresponds very closely with a caudal vertebra of *Gypochelys* from the third fourth of the tail. In this, as in one of the foregoing vertebræ, the chevron bones are anchylosed with the centrum. I conceive, then, that there can be no doubt that the pelvic bones and these caudal vertebræ belonged to a Chelydroid Chelonian, of about the size of the largest "snapping turtles" which are met with in North America at the present day.

Primâ facie, the skull found in the same block might also be expected to be that of a Chelydroid; and, in fact, it is so. I do not base this interpretation on the Chelonian character of the upper jaw, as there are various extinct Saurian reptiles which closely approximate to Chelonia in this part of their structure. The diagnostic characters lie in the back part of the skull; and especially in the auditory region, which is altogether Chelonian. Not only so, but when this fragmentary skull is compared with that of *Chelydra*, the correspondence between the two is singularly exact (Figs. 3 and 4). In two respects, however, the fossil differs from *Chelydra* and *Gypochelys*.

(1) The roof over the temporal fossa formed by the parietal, post-frontal, and other bones, which leaves the auditory region uncovered in the recent genera,[1] extends back, beyond the occiput, in the fossil, and sends down a broad vertical rim from its margin.

(2) The upper surface of the cranial shield is, at most, rugose

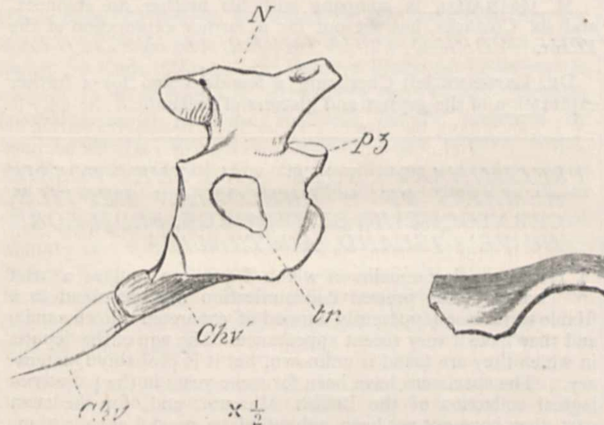

FIG. 1.—Caudal vertebra of *Ceratochelys*. *N*, platform on the neural arch; *pz*, pre-zygapophysis mutilated; *tr*. broken transverse process; *Chv'*, processes for the chevron bone; *Chv*, chevron bone.

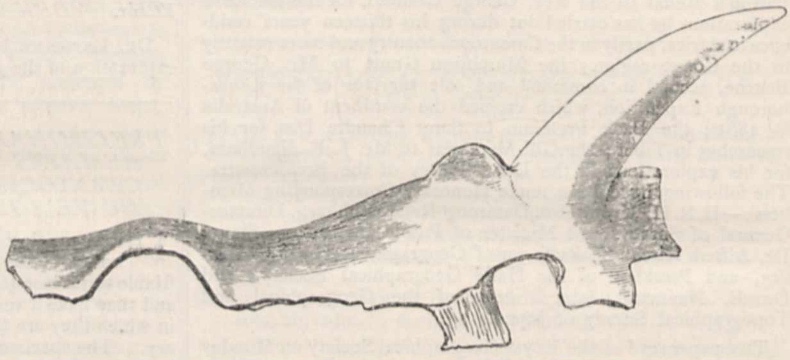

FIG. 3.

FIG. 2.—Caudal vertebra of *Chelydra*. Letters as in Fig. 1.

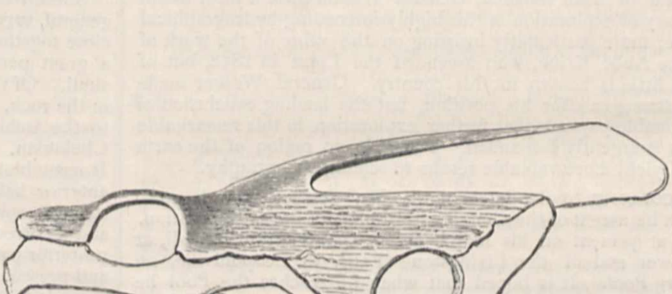

FIG. 4.

FIGS. 3, 4.—Skulls of *Ceratochelys* (Fig. 3) and *Chelydra* (Fig. 4); the latter of the natural size, the former much reduced. The portion of the skull of *Chelydra* which corresponds with the fossil is shaded.

in the recent *Chelydridæ*; in the fossil, three strong conical processes, like horn-cores, of which the middle is the longest, are developed from its posterior and lateral region.[1]

This skull is described and figured in the Philosophical Transactions for 1886 (Plate 30, Fig. 1) by Sir R. Owen, under the generic or sub-generic name of *Meiolania*, and is said to belong to a Saurian reptile closely allied to the "*Megalania prisca*" described in earlier communications. But the skull is assuredly that of the Chelydroid Chelonian to which the pelvis and caudal vertebra belong. What *Megalania prisca* may be I do not pretend to say; but the remains which I have described can have nothing to do with any Saurian reptiles; and I propose to confer on the genus of Chelonia to which they belong the name of *Ceratochelys*.

The singular osseous caudal sheaths described by Sir R. Owen, in the same memoir, also appertain to *Ceratochelys*. They formed part of the series of remains sent to the British Museum along with the foregoing, in which none but Chelonian bones have yet been discovered; and the remains of vertebræ left in these sheaths are similar to the caudal vertebræ of the terminal fourth of the tail in the *Chelydridæ*. The snapping turtles are noted for the length and strength of the tail and for the strong, laterally-compressed, acuminated "scales" which form a crest along the median dorsal line, while others, less strongly keeled, lie at the sides of the tail. In many Chelonia, the extremity of

[1] It is possible that these may be dermal bones coherent with the proper cranial shield.

[1] The "roof" extends much further back in *Platysternum*.

the tail is enveloped in a continuous sheath. These and other scale-like structures in the Chelonia are usually spoken of as if they were entirely epidermal. But, a day or two ago, Dr. Günther informed me that in the Australian tortoise, *Manouria*, the great imbricated scales of the limbs contain bony scutes; and that similar scutes are to be found in *Testudo græca*. This, of course, suggested the examination of the caudal scales of *Chelydra* and *Gypochelys*; and, having been enabled by Dr. Günther's kindness to examine the caudal scales of a good-sized specimen of the latter, I have found that those of the crest contain bony scutes.[1] The bony scute corresponds very closely in form with the whole "scale," but the recurved apex of the latter is formed only by epidermal substance (Figs. 5 and 6).

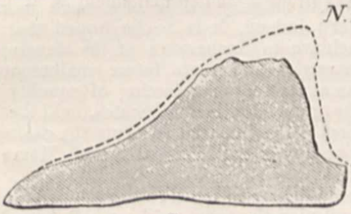

FIG. 5.

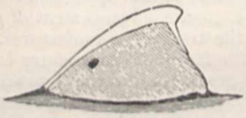

FIG. 6.

FIGS. 5, 6.—Sectional views of a scute of the tail-armour of *Ceratochelys* (Fig. 5), and of one of the crest plates of *Gypochelys*, both of the natural size.

The living *Chelydra*, therefore, has a caudal armature which, in principle, is similar to that of *Ceratochelys*, but the osseous elements are relatively atrophied. There is exactly the same relation between the armour of species of living *Crocodiles* and *Alligators*, on the one hand, and those of *Jacare* and *Caiman* and the extinct *Teleosauria*, on the other. In the former, the epidermal scales remain well developed on the ventral side of the body, while the corresponding osseous scutes, fully developed in *Jacare*, *Caiman*, and *Teleosauria*, have vanished.

Among the detached fragments to which I have referred, there are remains of ribs, with their costal plates; marginal and other plates of the carapace; parts of the plastron; part of a scapula; sundry limb bones; and several of the cranial processes called "horn-cores." They all agree, so far as they can be compared, with the determination already arrived at; which, to sum it up in a few words, is that the remains of crania and caudal sheaths from Australia, hitherto referred to Saurian reptiles, under the names of *Megalania* and *Meiolania*, appertain to a hitherto unknown species of Chelonian, *Ceratochelys sthenurus*, closely allied to the living *Chelydra*, *Gypochelys*, and *Platysternum*.

The evidence of this fact offered in the present note appears to me to be conclusive, but it may be desirable hereafter to figure the parts mentioned and to describe them at length.

The interest which attaches to the discovery of this singular Chelonian arises partly from the fact that the group of Chelonia to which it belongs is wholly unrepresented in the fauna of Australia, as at present known. *Platysternum* is usually said to be found in China. Dr. Günther, however, informs me that Upper Burmah is its proper habitat; otherwise, North America, east of the Rocky Mountains, is the nearest region in which the *Chelydridæ* are to be found. But *Chelydridæ*, and, indeed, species of the genus *Chelydra*, occur in Upper Miocene (Œningen) and in Eocene formations in Europe. Moreover, *Platychelys*, of the Upper Jurassic series of Bavaria and Switzerland, is regarded by Rütimeyer as an early form of the group.

Lord Howe's Island is about 200 miles from the nearest Australian mainland, and something like 400 miles, as the crow flies, from the Darling Downs, in which the caudal armour, which has been ascribed to *Megalania*, was found. The discovery of *Ceretochelys*, therefore, has an interesting bearing on the question of the former extension of Australia to the eastward, on the one hand; and of the possible derivation of such forms as *Ceratochelys* from Asia, on the other hand. An elevation of the sea-bottom of 6000 feet would place Norfolk Island and Lord Howe's Island on a peninsula extending from the region of the present Barrier Reef to New Zealand; and the floræ and faunæ of those islands are known to have special affinities with those of New Zealand, and none with those of Australia.

Speculations respecting the origin of the Chelonian carapace are suggested by the discovery of osseous scutes in the vertebral region of the tail, and their coalescence in *Ceratochelys* to form a sort of caudal carapace, ridged in a manner resembling that of *Chelydra* and *Platychelys*. But the consideration of these points would take me beyond the limits of the present note.

[1] The fact is noted by Rütimeyer (Lang and Rütimeyer, "Die Fossilen Schildkröten von Solothurn," *Denkschriften der Allg. Schweiz. Gesellschaft*, vol. xxii.). The armature of the tail in *Platysternum* is for the most part arranged in zones, of four plates in each zone; but I have not yet been able to find any bone in them.

THE WORK OF THE IMPERIAL INSTITUTE[1]

I.

THE Colonial and Indian Exhibition, which owes not only its conception, but also its brilliantly successful realisation to your Royal Highness, will be pre-eminently remarkable in times to come, for having achieved many results of vital importance and highest benefit to Her Majesty's subjects in all parts of her vast realms.

The collection of all that is commercially valuable and scientifically interesting of the natural products of the great Indian Empire and of the Colonies in one Exhibition, embracing as it also did very comprehensive illustrations of the development of commerce, of the arts, and of certain industries, in the many countries beyond the seas which combine with the United Kingdom to constitute our vast Empire, afforded those at home an opportunity, surpassing all previous conception, of studying and comparing the natural history and resources of those distant lands, of which, attached though we might be individually to one or more of them by ties of friendship or of interest, the knowledge of many of us was of a very vague or partial character.

To the Colonists who visited us last year, the Exhibition has been of inestimable value, in affording them a most favourable and appropriate opportunity of becoming acquainted or renewing their old friendship with the mother country, and of examining the progress there made in industrial, educational, and commercial development; in leading to the cultivation of intimacy between Colonists from different sections of the Queen's Dominions; and in affording them invaluable opportunities of comparing the resources and state of development of their respective countries with those of other parts of Europe. No more convincing illustrations than were provided by this great Exhibition could have been conceived of the importance to the home country, to each Colony, and to India, of fostering intimate relationship and unity of action. No more encouraging proof could have been afforded of the desire of all classes of Her Majesty's subjects at home to cultivate a knowledge of those far-off countries which the enterprise and perseverance of the British, and men of British offspring, have converted into prosperous and important dominions, chiefly during the period of the Queen's reign, than was furnished by the interest which the thousands upon thousands, who came from all parts, displayed in the study of the instructive collections in the galleries at South Kensington.

It was the success of the Exhibition which led to the definite formulation of the suggestion first made by your Royal Highness in a letter addressed by you in the autumn of 1884 to the Agents-General of the Colonial Governments, that a permanent representation of the resources of the Colonies and India, and of their continually progressing development, might, with great benefit to the Empire at large, be established in this country. That the realisation of this idea upon a sufficiently comprehensive basis might constitute a worthy memorial of the accomplishment of fifty years of a wise and prosperous reign; a memorial not personal in its character excepting so far as it constituted an emblem of the love and loyalty of Her Majesty's subjects, but tending, as she would most desire, to serve the interests of the entire Empire; this had only to be pointed out by your Royal Highness to be heartily concurred in by the official representatives of the Colonies and India, who

[1] Lecture (abridged) delivered at the Royal Institution, on Friday, April 22, by Sir Frederick Abel, C.B., F.R.S.; H.R.H. the Prince of Wales, K.G., F.R.S., Vice-Patron, in the Chair.

were so intimately identified with the triumphs of the recent Exhibition.

The Committee to whom you, Sir, intrusted the elaboration of a scheme for carrying this conception into effect, became persuaded by a careful consideration of the subject that such an Institution as your Royal Highness desired to see spring into life, to be a memorial really worthy of the Jubilee of Her Majesty's reign, and to fulfil the great purposes which you had in view, must not be confined in its objects to particular portions of Her Majesty's Dominions, but must be made thoroughly representative of the interests and of the unity of the whole Empire.

The outline of the scheme for the establishment of an Imperial Institute for the United Kingdom, the Colonies, and India, which met with the cordial approval of your Royal Highness, was necessarily concise in dealing with the very wide extent of ground which the operations of the Institute are intended to cover; but those who have carefully considered it, and rightly interpreted its proposals, have not failed to realise that it aims at very much more than the creation and maintenance of collections illustrative of the natural resources of our Colonies and of India, and of the development and present condition of the chief industries of different parts of the Empire.

One of the primary objects of the Institute will certainly be the establishment of thoroughly well selected, carefully arranged, and efficiently maintained representations of the natural products which constitute the treasures, and are emblematic of the important positions in the Empire, of those great colonial possessions which, during the fifty years of Her Majesty's reign, have, in many instances, experienced a marvellous development in extent, in commercial, social, and even in political importance.[1] The recent Exhibition not only afforded conclusive demonstration of the great interest and value to the United Kingdom which must attach to such collections if properly organised; it also served, by such illustrations as the magnificent collections of valuable woods, from nearly every colony, many quite unknown in England, and the great variety of valuable economic products from India, of the existence of which we at home had little idea, to convince us that our knowledge of the great countries which constitute the chief portion of the Empire is very limited and imperfect, and that their resources are in many directions still in the infancy of development. Our Colonial brethren cannot, on their part, fail to be greatly benefited by being thoroughly represented in a well-selected and carefully organised assemblage of illustrations of the sources of prosperity which constitute the sinews of their commerce, and upon a continued exploration and cultivation of which must depend the maintenance of their influence upon industrial and social progress. Neither can they fail to reap substantial advantages by pursuing a friendly rivalry with each other in demonstrating the advances made from time to time in the development of the resources of the respective portions of the Empire in which their lot is cast.

The hearty co-operation and important material support to which the great Colonies, through their representatives in London, pledged themselves when the scheme for the proposed Imperial Institute was in the first instance limited to this branch of the great work which it is now contemplated to accomplish, afforded conclusive evidence of their earnest desire to be in all respects thoroughly represented in the mother country, and to take their places permanently in our midst as fellow-labourers in the advancement of the prosperity of the Empire. In furtherance of this important end, a notable feature of that building which, in its character, will, it is hoped, be worthy of the momentous epoch which it is to commemorate, will be the attractions and conveniences presented by it, as a place of resort and a *rendezvous* for Colonists visiting England, and, it is also anticipated, for the important Societies which represent the Colonies and Asiatic possessions in this country, and the facilities which it will afford for reference to literature concerning the Colonies and India, for conferences on matters of common interest and value to the Colonists and those at home, for the interchange of information between the British manufacturer and those in the Colonies who are directly interested in meeting his requirements, and generally for the cultivation of intimate relations and good fellowship between ourselves and our brethren from all parts of the Empire.

The Institute will, however, not only operate actively under its own roof in promoting the cultivation of a better knowledge of the geography, natural history, and resources of our Colonies, and for the advancement of the interests of the Colonists in this country; it is also contemplated that representative collections of the natural products of the Colonies and India, carefully identified with the more elaborate collections of the head establishment, shall be distributed to provincial centres, and that the provinces shall be kept thoroughly conversant with the current information from the Colonies and India, bearing upon the interests of the commercial man, the manufacturer, and the intending emigrant.

Although the formation and maintenance up to date of collections illustrative of the development and present condition of the important industries of the Empire also forms, as I have stated, a part of the programme of the Institute, the scope of its activity in relation to industry will be of a much more comprehensive character; indeed, it is to be hoped that the work which it will achieve in furtherance of the development and progress of industries and their future maintenance in the United Kingdom at least upon a footing of equality with their conditions in the great Continental States, will be most prominent in securing to the Imperial Institute the exalted position which it should occupy as the National Jubilee Memorial of Her Majesty's reign.

There is no need for me to recall to the minds of an audience in the Royal Institution the great strides which have been made during the last fifty years in the applications of science to the purposes of daily life, to the advancement of commerce, and to the development of the arts and manufactures. Nor is it necessary to dwell upon the fact that this country is the birth-place of the majority of the great scientific and practical achievements which have revolutionised means of intercommunication, and have in other ways transformed the conditions under which manufactures, the arts, and commerce are pursued. These very achievements, of which we as a nation are so justly proud, have led, however, by many of their results, to our becoming reduced to an equality of position with other prominent nations in regard to important advantages we so long derived from the possession in this country of great material resources easy of access and application, and from the consequent pre-eminence in certain branches of the trade and industry which we so long enjoyed.

In 1852, Sir Lyon Playfair was impelled by the teaching of the preceding year's Great Exhibition to point out that "the raw material, formerly our capital advantage, was gradually being equalised in price and made available to all by the improvements in locomotion," and "that industry must in future be supported, not by a competition of local advantages, but by a competition of intellect." If this was already felt to be the state of the case six-and-thirty years ago, how much more must we be convinced of the full truth of this at the present day, by the conditions under which the British merchant and the manufacturer have to compete with their rivals on the Continent and in the United States.

It is still within the recollection of many that almost the whole world was in very great measure dependent upon Great Britain for its supplies of ordinary cast iron. Even as lately as 1871, the United States of America received from Great Britain nearly one-fifth of its total produce of pig iron; but from 1875 all importation of British iron ceased for over three years, and it was only in consequence of requirements in the States exceeding the capabilities of production, that some small demands arose in 1879, which were for some time maintained.

Within three years, however, the make of iron in the United States increased by 70 per cent., and although, since 1882, the actual make has not increased, the *capacity of production* has risen enormously, it being at present estimated at nearly 300 per cent. greater than it was in 1879. Looking nearer home, we find that the iron of France, Belgium, and Germany not only competes with ours in the open market, but that Belgian and German iron is actually imported into this country to a moderate extent.

From time to time the ground which we have lost through the development of the resources of other countries has been more than retrieved temporarily by improvements effected through the more thorough comprehension and consequent better application of the scientific principles underlying processes of manufacture, but the ultimate effect of advances of importance has not unfrequently been to improve the position, in relation to the manufactures concerned, of other nations less favourably circumstanced than Great Britain.

The history of the development of steel manufacture during the last twenty-five years affords a most instructive illustration of the

[1] Statistical statements illustrating the development of the colonies during the Queen's reign are appended.

fluctuations which may ensue in the value of our natural resources, and the consequent condition of one or other of our important industries, arising out of continued advances made in the application of science to the perfection or transformation of manufacturing processes, and of the stimulating effects of such fluctuations upon the exertions of those who are able to bring scientific knowledge to bear upon the solution of problems in industrial operations which entirely baffle the ordinary manufacturer. Within that period the inventions of Bessemer and of Siemens have led to the replacement of iron by steel in some of its most extensive applications. This important change in our national industry was, ere long, productive of a serious crisis therein, and for the reason that the pig iron produced from a large proportion of those ores which, from their abundance and the cheapness of their treatment, have been greatly instrumental in placing Great Britain in her high position as an iron-producing nation, could not be applied to the production of marketable steel by means of the Bessemer converter. Hence the application of this rapid steel-making process had to be chiefly restricted to particular kinds of ores, free from the impurity, phosphorus, which it was powerless to eliminate; the supplies of such ores being limited to a few districts in this country. These had to be largely supplemented by importations from other countries; nevertheless the cheapness of production and superiority in point of strength, durability, and lightness of the steel rails thus sent into the market from the Bessemer converter combined to maintain a supremacy of them over iron rails, &c., manufactured by the old puddling process from the staple ores of the country.

The advantages presented by steel over the wrought iron of the puddling furnace for constructive purposes speedily became evident, and the effect of the rapid displacement of malleable iron by steel produced from ores of a particular class has been that at least 85 to 90 per cent. of the iron ores of Great Britain could no longer be applied to the production of material for rails, for ships, and for other important structures. Great has been the apprehension among the owners of those ores that the demand for iron which they can furnish could not revive, but the scientific metallurgist has successfully grappled, from more than one direction, with the great problem of restoring their commercial importance; and a simple alteration of the method of carrying out the Bessemer process has within the last few years led to really triumphant results, with the employment of those ores which before could only be dealt with by the searching operation of the old puddling furnace. A new era has thus been established in steel manufacture, there being now but very few restrictions to the application of the quick processes to iron produced from all varieties of ores. Indeed, the treatment is actually being applied profitably to the recovery of iron from the rich slag forming the refuse-product of the puddling furnace in the production of malleable iron, which before had been condemned to limited usefulness as a material for road-making. Yet another most interesting and valuable result has been achieved by this simple application of scientific knowledge. The slag or refuse-product of the so-called *basic treatment* of iron contains, in the form of phosphates of lime and magnesia, the whole of the phosphorus which it is the main function of that treatment to separate from the metal; it was soon found that the phosphoric acid was there presented in a condition as readily susceptible of assimilation by plants as it is in the valuable artificial manure known as superphosphate; this refuse-slag, simply ground up, constitutes therefore a valuable manure which already commands a ready sale at very profitable prices.

The origination of this latest advance in the development of steel manufacture dates back only nine years, and already the year's product of the basic process amounts to over 1,300,000 tons of steel. But although it is to Englishmen that the owner of iron property and the steel-maker are again indebted for these important results, and to English manufacturers that the first practical demonstration of the success of this process is due, its application has been far more rapidly elaborated upon the Continent than here; in Germany the importance of the subject was at once realised, and it is there that considerably the largest proportion of steel is produced by the basic treatment; it is in Germany also that the value of the slag for agricultural purposes has been developed, the first steps in its utilisation here being but just now taken, in Staffordshire.

I have already referred to the remarkable strides which have been made in the extension of iron manufacture in the United States; the development there of steel production has been no less marvellous, and the causes of this are evident; the resources of the country in ore and fuel are gigantic, and the systematic technical training of the people has made its influence felt upon the development of this as of every other branch of industry which our friendly rivals pursue. But it is not only in the United States that the development in the production of iron and steel has greatly increased of late years; thus, in Germany the increase in the production of pig iron alone, during the last twenty-one years, has been 237 per cent., while with us it has been 75 per cent.

Although, however, the increase in actual production of iron and steel in Great Britain has not kept pace with that of some other countries, it is satisfactory to know that our *productive power* has very greatly increased in late years, and there is probably no one branch of our industries in which we have maintained our position so satisfactorily in regard to quality of product as that of iron and steel manufacture, even though, every now and then, we have indications that in the struggle with other nations for superiority of product and for pre-eminence in continuity of progress, we have to look to our laurels.

There are, however, other important branches of industry, for a time essentially our own, the present condition of which, in this country, we cannot contemplate with equal satisfaction. Several instructive illustrations might be quoted, but I will content myself with a brief examination of one of the most interesting.

In illustrating the advances which were being made, thirty-five years ago, as demonstrated by the Exhibition of 1851, Playfair referred to the great development of the value of the evil-smelling coal-tar, which was then made to furnish the solvent liquids benzene and naphtha, and the antiseptic creosote, the residual material being utilised for pavements and for artificial fuel. The chemist little dreamt then that between 1851 and the year of the next great Exhibition, 1862, coal-tar would have become a mine of wealth equally to science, the manufactures, and to the arts, in which fresh workings have ever since continued to be opened up, and still present themselves for exploration. Hofmann, in his valuable report on the chemical products and processes elucidated by that Exhibition, dwells with the enthusiasm of the ardent worker in science upon the brilliant products obtained from coal-tar which had resulted from the labours of the scientific chemist, and had already acquired an almost national importance, although this great industry was then still in its infancy. From the year 1856, when the first colouring-matter, known as *mauve*, was discovered and manufactured by one of Hofmann's most promising young pupils, Mr. Perkin, down to the present time, the production of new coal-tar colours, or of new processes for preparing the known colours in greater purity, has progressed uninterruptedly, this industry having long since become one of the most important, and also one of the most remarkable, as illustrating by each stage of its development the direct application of scientific research to the attainment of momentous practical results.

The difficulties to be overcome before mauve could be produced upon a manufacturing scale were very great, and were only solved by a steady pursuit of scientific research, side by side with practical experiments suggested by its results. Aniline—the parent of the first coal-tar colour, a liquid organic alkali—a most fertile source of interesting and important discoveries in organic chemistry, was produced with difficulty by various methods in very small quantities, so as to be almost a chemical curiosity at the time of the discovery of mauve. Among the substances from which it had been prepared was the volatile liquid known as *benzene*, first discovered in the laboratory of this Institution in 1825 by Faraday, in the liquid products condensed from oil gas, but afterwards obtained by Mansfield, in the College of Chemistry, from coal-tar naphtha. The conversion of benzene into aniline was accomplished as a manufacturing process after many difficulties by Perkin; and within a year after the discovery of mauve by him, it was in the hands of the silk dyer. Perkin's success led other chemists at once to pursue researches in the same direction, especially in France, where the next important coal-tar colour, *magenta* or fuchsine, was obtained, by M. Verguin, the successful manufacture of which in a pure state was, however, first accomplished by English chemists. In 1861 beautiful violet and blue colours were produced, again by French chemists, but were manufactured shortly afterwards in a pure state in England.

The six years succeeding those which formed the first period (1854-62) of existence of this industry were fruitful, not only of many beautiful new dyes, first produced in England, but also of important progress made here, as well as on the Continent, in the development of the manufacture, and of our knowledge of the constitution, of the parent colours.

In the next period of six years (1868–74) another great stride was made in the coal-tar colour industry, due to important scientific researches carried out by two German chemists, Graebe and Liebermann, which led them, in the first place, to obtain an insight into the true nature of the colouring-matter of one of the most important staple dye-stuffs, namely the madder-root. They found that this colouring-matter which chemists call *alizarine* was related to *anthracene*, one of the most important solid hydrocarbons formed in the distillation of coal, a discovery which was speedily followed by the artificial formation of the madder-dye, alizarine, from that constituent of coal-tar. At first, this achievement of Graebe and Liebermann was simply of high scientific interest; but Perkin, and Graebe, and Liebermann, were not long in discovering methods by which the conversion of anthracene into the madder-dye could be accomplished on a large scale, and the manufacture of alizarine was soon most actively pursued in this country, with very momentous results, as regards the market value of the madder root. The latter has long been most extensively cultivated in Holland, South Germany, France, Italy, Turkey, and India, the consumption of madder in Great Britain having attained to an annual value of as much as 1,000,000*l.* sterling. Playfair pointed out in 1852 that important improvements had lately been attained in the extraction of the red colour or alizarine from the madder-root, but those results, most valuable at the time of the first Great Exhibition, became insignificant when once the dye was artificially manufactured from anthracene; the price paid for madder in 1869 was from 5*d.* to 8*d.* per pound, but now the equivalent in artificial madder-dye, or alizarine, of one pound of the root, can be obtained for one-halfpenny.

With the discovery of artificial alizarine the truly scientific era of the coal-tar industry may be said to have commenced, most of the commercially valuable dye-products, obtained since that time, being the result of truly theoretical research by the logical pursuit of definite well-understood reactions. The wealth of discovery in this direction made during the last thirteen years is a most tempting subject to pursue; but I must content myself with mentioning that one of the results was the production of very permanent and brilliant scarlet and red dyes, the manufacture of which has greatly reduced the market value of cochineal; that the careful study of the original coal-tar colours led to their production in a state of great purity by new and beautifully simple scientific methods; and that even the well-known vegetable colouring-matter, *indigo*, one of the staple products of India, now ranks among the colours synthetically obtained by the systematic pursuit of scientific research, from compounds which trace their origin to coal-tar.

The rapid development of the industry has also not failed to exercise a very important beneficial influence upon other chemical manufactures; thus, the distillation of tar, which was a comparatively very crude process, when, at the period of the first Exhibition, benzene, naphtha, dead-oil, and pitch were the only products furnished by it, has become a really scientific operation, involving the employment of comparatively complicated but beautiful distilling apparatus for the separation of the numerous products which serve as raw materials for the many distinct families of dyes. Very strong sulphuric acid became an essential chemical agent to the alizarine manufacturer, and, as a consequence, the so-called anhydrous sulphuric acid, the remarkable crystalline body which was for many years prepared only in small quantities from green vitriol, is now made at a low price upon a very large scale by a beautifully simple process worked out in England. The alkali- and kindred chemical trades have been very greatly benefited by the large consumption of caustic soda, of chlorate of potash, and other materials used in the dye manufactures, and the application of constructive talent, combined with chemical knowledge, to the production of efficient apparatus for carrying out on a stupendous scale the scientific operations developed in the investigator's laboratory, has greatly contributed to the creation of a distinct profession, that of the chemical engineer.

One of the most beneficial results of the rapid development of the coal-tar colour industry has been its influence upon the ancient art of dyeing, which made but very slow advance until the provision of the host of brilliant, readily-applicable colours completely revolutionised both it and the art of calico-printing.

I venture to think that it will be interesting at this point to quote some words of prophecy included in Prof. Hofmann's important "Report on the Chemical Section of the Exhibition of 1862," and to inquire to what extent they have been verified. In commenting upon one of the features of greatest novelty in that world's show, the exhibition of the first dye-products derived from coal-tar, he says:—

"If coal be destined sooner or later to supersede, as the primary source of colour, all the costly dye woods hitherto consumed in the ornamentation of textile fabrics; if this singular chemical revolution, so far from being at all remote, is at this moment in the very act and process of gradual accomplishment; are we not on the eve of profound modifications in the commercial relations between the great colour-consuming and colour-producing regions of the globe? There is fair reason to believe it probable that, before the period of another decennial Exhibition shall arrive, England will have learnt to depend, for the materials of the colours she so largely employs, mainly, if not wholly, on her own fossil stores. Indeed, to the chemical mind it cannot be doubtful that in the coal beneath her feet lie waiting to be drawn forth, even as the statue lies waiting in the quarry, the fossil equivalents of the long series of costly dye-materials for which she has hitherto remained the tributary of foreign climes. Instead of disbursing her annual millions for these substances, England will, beyond question, at no distant day become herself the greatest colour-producing country in the world; nay, by the strangest of revolutions, she may ere long send her coal-derived blues to indigo-growing India, her tar-distilled crimson to cochineal-producing Mexico, and her fossil substitutes for quercitron and safflower to China, Japan, and the other countries whence these articles are now derived."

So far as concerns the displacement of madder, cochineal, quercitron, safflower, and other natural dye-materials from their positions of command in the markets of England and the world, Hofmann's predictions have been amply fulfilled, and it appeared in the earlier days of the coal-tar colour industry as though he would be an equally true prophet in regard to England becoming herself the greatest colour-producing country in the world. But, although Germany did little in the very early days of this industry, beyond producing a few of the known colours in a somewhat impure condition, many years did not elapse ere she not only was our equal in regard to quality of the dyes produced, but, moreover, had outstripped us in the quantities manufactured and in the additions made to the varieties of valuable dyes sent into the market. So far back as 1878 the value of the make of colours in England was less than one-fourth that of Germany, and even Switzerland, which, in competing with other countries industrially, is at great natural disadvantages, was not far behind us, ranking equal to France as producers. The superior position of Germany in reference to this industry may be in a measure ascribable to some defects in the operation of our Patent Laws and to questions of wages and conditions of labour; but the chief cause is to be found in the thorough realisation, by the German manufacturer, of his dependence for success and continual progress upon the active prosecution of scientific research, in the high training received by the chemists attached to the manufactories, and in the intimate association, in every direction, of systematic scientific investigation with technical work.

The young chemists whom the German manufacturer attracts to his works rank much higher than ours in the general scientific training which is essential to the successful cultivation of the habit of theoretical and experimental research, and in the consequent power of pursuing original investigations of a high order. Moreover, the research laboratory constitutes an integral part of the German factory, and the results of the work carried on by and under the eminent professors at the universities and technical colleges are closely followed and studied in their possible bearings upon the further development of the industry.

The importance attached to high and well-organised technical education in Germany is demonstrated not only by the munificent way in which the scientific branches of the universities and the technical colleges are established and maintained, but also by the continuity which exists between the different grades of education; a continuity, the lack of which in England was recently indicated by Prof. Huxley with great force.

The important part taken by the German universities in the training of young men for technical pursuits has often been dwelt upon as constituting a striking feature of contrast to our university systems. The national appreciation of the opportunities there presented for scientific training is demonstrated by the large number of students which are always working in the university laboratories, while the expenditure of 30,000*l.* upon the physical laboratory, and 35,000*l.* upon the chemical department, of the New University of Strasburg, serves to illustrate the unsparing hand with which the resources of the country are devoted to the provision of those educational facilities which are the very life-spring of the industrial progress whence those resources are derived.

In France, higher education had been allowed to sink to a low ebb after the provincial universities had been destroyed in the great Revolution, and the University of Paris had been constituted by the first Napoleon the sole seat of high education in the country. Before the late war, matters educational were in a condition very detrimental to the position of the country among nations. There was no lack of educational establishments, but the systems and sequence of instruction lacked organisation, but since the war, France has made great efforts to replace her educational resources upon a proper footing. The provincial colleges have been re-established at a cost of 3,280,000*l.*, and the organisation of industrial education has now been greatly developed, though still not on a footing of equality with that of Germany. Every large manufacturing centre has its educational establishment where technical instruction is provided, with special reference to local requirements; and, in order to render these colleges accessible to the best talent of France, more than 500 scholarships have been founded, at an annual cost of 30,000*l.* The Ecole Centrale des Arts et Manufactures, of Paris, still maintains the reputation as the great technical university of the country which it earned many years ago, and receives students from the provincial colleges, where they have passed through the essential training preliminary to the high technical education which that great institution provides.

Switzerland has often been quoted as a remarkable illustration of the benefits secured to a nation by the thoroughly organised education of its people. Far removed from the ocean, girt by mountains, poor in the mineral resources of industry, she yet has taken one of the highest positions among essentially industrial nations, and has gained victories over countries rich in the possession of the greatest natural advantages. Importing cotton from the United States, she has sent it back in manufactured forms, so as to undersell the products of the American mills. The trade of watch-making, once most important in this metropolis, passed almost entirely to Switzerland years ago; the old-established ribbon trade of Coventry has had practically to succumb before the skilled competition of Switzerland; and although she has no coal of her own, Switzerland is at least as successful as France in her appropriation of the coal-tar colour industry and her rivalry in rate of production with England, the place of its birth and development. Comparative cheapness of labour will not go very far to account for these great successes; they undoubtedly spring mainly from the thoroughly organised combination of scientific with practical education of which the entire people enjoys the inestimable benefit.

Holland furnishes another brilliant example of the success with which a nation brings the power of systematic technical education to bear in securing and maintaining industrial victories in the face of most formidable disadvantages, while the United States of America, so rich in natural resources, have long since realised the immensity of additional advantages to be gained over European nations in the war of industry by a wide diffusion and thorough organisation of technical education. So long as forty years ago the States already possessed several excellent educational institutions established upon the basis of the Continental polytechnic schools, but it was not until about fifteen years later that the country became thoroughly impressed with the great advances achieved by Germany in technical education, and that the subject was made a thoroughly national one. It is now just upon a quarter of a century ago since Congress ordained that each State should provide at least one college, having for its leading objects the diffusion of scientific instruction in its relations to the industry of the country, and decreed that public lands should be granted to the States and Territories providing such colleges. The combined effect of this State action, and of great private munificence, was a remarkably rapid development of scientific and technical education throughout the country; besides some fifty colleges, with eight or nine thousand students, which sprang out of the Land Grant Act for Industrial Education, there are now in the States about 400 other universities and colleges, in a large proportion of which efficient instruction in applied science is provided. To the useful work accomplished within a few years by these and many other highly important educational institutions, which have placed the acquisition of scientific knowledge within the reach of the very humblest, the enormous strides made by the United States in the development of home industries must unquestionably be in the main ascribed.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—There are only a few alterations and additions to the usual scientific lecture-list to report, as most of the courses are in continuation of those given last term. Prof. Sylvester is to lecture on the theory of numbers; in the Chemical Department, Mr. Wyndham Dunstan lectures on organic chemistry in relation to medicine and physiology; Prof. Prestwich is to have his usual summer geological excursions; Dr. Tylor continues his exposition of the development of arts, as illustrated in the Pitt-Rivers Museum.

The Sibthorpian Professorship of Rural Economy has been filled up by the re-election of Dr. Gilbert. The Radcliffe Travelling Fellowship has been awarded to Mr. W. Overend, B.A., of Balliol. The statutes of the University Commissioners, which limited the competition for most college scholarships to candidates under nineteen, seem to be having an unfortunate, though not unexpected, effect, as several colleges have lately found it impossible to award scientific scholarships, owing to the want of sufficiently qualified candidates.

There is a good deal of strong feeling in the University with regard to the approaching appointment of a Reader in Geography, and the action of the Delegates of the University Fund in transferring a Readership from History to Geography, just after the offer of the Royal Geographical Society for a similar purpose had been refused, is the subject of much unfavourable comment. There is no thought of opposition to the study of geography, even of scientific geography, but history lecturers not unnaturally complain that the only University appointment open to them should be abolished to make a post for a lecturer in another subject.

CAMBRIDGE.—Among the seven courses on chemistry being delivered this term are lectures on gas analysis and on aromatic bodies, by Dr. S. Ruhemann. Prof. Dewar and Dr. Ruhemann also superintend laboratory practice specially directed to research.

The course given by Mr. Lyon, the Superintendent of the Mechanical Workshops, this term is on machine construction.

Mr. Langley is giving a special course on the central nervous system, with demonstrations and practical work.

Prof. Macalister's lectures this term are on the history of human anatomy. It is to be hoped that he will publish them.

Mr. M. A. Fenton is lecturing on elementary comparative osteology: Dr. Gadow on the morphology of Mammalia, recent and extinct, and on the palæontology of the Vertebrata.

Dr. Vines has a course of advanced embryology of plants, and Mr. F. Darwin is giving advanced demonstrations in the physiology of plants.

In geology, Prof. Hughes is taking the geology of the neighbourhood of Cambridge, by lectures and field excursions; Mr. Marr, foreign stratigraphy; and Mr. Roberts, the Trilobites.

Prof. Roy has classes for general pathology, morbid anatomy, and practical morbid histology, bacteriology, &c.

The lectures mentioned above are only a selection of the more interesting courses. The lists from which the above are selected announce about seventy-five courses of lectures and practical work.

Candidates for the John Lucas Walker Studentship, the holder of which must devote himself or herself to original research in pathology, should send their applications to Prof. Roy, Trinity College, Cambridge, not later than May 31 next. The Studentship is of the annual value of 250*l.*, and is tenable under certain conditions for three years.

SCIENTIFIC SERIALS

The American Journal of Science, April.—Contributions to meteorology, twenty-second paper, by Elias Loomis. In this communication the author treats of areas of high pressure, their magnitude and direction of movement, and their relation to areas of low pressure. The latter subject is illustrated with a plate giving the isobars for December 15, 1882, in the northern hemisphere, and it is shown generally that the movement of areas of high pressure depends upon very different causes from that of areas of low pressure, which seem to be endowed with a power of locomotion residing within themselves. Areas of high pressure exhibit no such power, their movement seeming to depend entirely on external forces.—The faults of South-West Virginia, by John J. Stevenson. Here is given a summary of the information communicated by the author in several memoirs read before the American Philosophical Society (1880-84) on a reconnaissance made by him of the faulted region in Virginia from the Tennessee line to nearly twenty miles beyond New River, a total distance of 150 miles.—On Taconic rocks and stratigraphy, with a geological map of the Taconic regions, part 2, by James D. Dana. The general facts are here detailed which bear on the geographical distribution of the limestone and other rocks. A description is given of Williamstown, regarded as the birthplace of the Taconic system, and it is shown generally that the great quartzite formation, forming the foundation of the Palæozoic of the region, derived its material from Archæan formations of the vicinity and not from the fabled "Atlantis" as some geologists have supposed.—Irish esker drift, by G. H. Kinahan. It is pointed out that, in common with some other observers, Prof. Carvill Lewis confounds true esker drift and ridges of esker-like drift. His statement in the December number of the *American Journal of Science* that the Irish eskers appear to be adjuncts of the melting of the ice-sheets is shown to be impossible.—Physical characteristics of the northern and north-western lakes, by L. Y. Schermerhorn. The results are given of the lately completed surveys made by the United States of all the great lakes draining through the St. Lawrence to the Atlantic. The total water-area is 95,275, and the total area of the lacustrine basin over 270,000, square miles. The length of shore-line with connecting rivers is about 5400 miles, the extreme depth of Superior 1008 feet, or over 406 below sea-level, the mean annual rainfall of the whole basin 31 inches, the volume of water in the lakes about 6000 cubic miles, and the discharge of Ontario at St. Lawrence River 300,000 cubic feet per second.—Mineralogical notes from the laboratory of Hamilton College, by Albert H. Chester. Specimens are described and analysed of fuchsite, pink celestite, zinkenite, brochantite, pectolite, crystals of barite, scorodite, and bismuthite.—The topography and geology of the Cross Timbers and surrounding regions in Northern Texas, by Robert T. Hill. This wooded zone penetrating in two belts from Indian territory through the surrounding prairie southwards to 32° N. lat., is explained by the detritus of arenaceous strata which occupy well-defined horizons in the geological series, and which have been exposed by the denudation of the overlying strata.—American Jurassic mammals, by Prof. O. C. Marsh. In this paper are described the remains of several hundred individuals which have come to light since the appearance of the author's previous papers on the subject. Although fragmentary, the remains are usually well preserved, comprising the lower jaws, teeth *in situ*, various portions of the skull, vertebræ, and other parts of the skeleton. Placental as well as marsupial mammals occur in the oldest formations, whence the inference that the former do not derive from the latter evolutionally, as is supposed, but that both of these orders descend in independent lines from a common ancestor.

SOCIETIES AND ACADEMIES

London

Royal Society, March 24.—"On the Magnetisation of Iron in Strong Fields." By Prof. J. A. Ewing, University College, Dundee, and William Low.

The behaviour of iron and steel when subjected to very strong magnetising forces is a matter of considerable practical and very great theoretical interest, especially from its bearing on the molecular theory of magnetisation, which assigns an upper limit to the intensity of magnetism that a piece of iron can acquire, and even suggests that the metal may become diamagnetic under the influence of a sufficiently great force. All experiments hitherto made, by magnetising iron in the field of an electric solenoid, have shown that the intensity of magnetism, $\mathfrak{J}$, as well as the induction, $\mathfrak{B}$, is increasing with the highest values actually given to the magnetising force, $\mathfrak{H}$. It is scarcely practicable, however, to produce by the direct action of a magnetising solenoid, a field whose force exceeds a few hundreds of C.G.S. units.

In the space between the pole-pieces of a strong electro-magnet we have a field of force of much greater intensity than it is practicable to produce by the direct action of the electric current. This field is not well adapted for experiments whose object is to determine with precision the relation of magnetisation to magnetising force, on account of the distortion which it undergoes when the piece of iron to be magnetised is introduced into it. It is, however, well suited for experiments whose object is to determine how much magnetism the metal can be forced to take up.

In the authors' experiments, bobbins of Lowmoor and Swedish wrought-iron and cast-iron were magnetised by placing them between the pole-pieces of a large electro-magnet. The bobbins consisted of a short narrow central neck with conical ends. The magnetic induction in the neck was measured ballistically by means of an induction coil, consisting of a single layer of fine wire, wound on the neck; and the magnetic field in the air-space immediately contiguous to the neck was also measured by means of a second induction coil wound over the first, and of slightly greater diameter. This enabled the non-ferrous space under the inner induction coil to be corrected for, and also gave an approximation to the value of $\mathfrak{H}$, the magnetic force acting on the metal. The magnetic force varied up to about 11,000 C.G.S. units, and the highest induction observed (in a sample of Lowmoor wrought-iron) was 32,880 C.G.S. units. In some instances the magnetic induction was observed by withdrawing the bobbin; in others the bobbin was turned round suddenly so that its magnetism was reversed. The following results refer to Lowmoor wrought-iron and to cast-iron.

Lowmoor wrought-iron

Field round iron neck per sq. cm.	Magnetic induction in the metal	Current in field magnets, amperes	$\frac{\mathfrak{B} - \text{outside field}}{4\pi}$	$\frac{\mathfrak{B}}{\text{outside field}}$
3,630	24,700	1·98	1680	6·80
6,680	27,610	4·04	1670	4·13
7,800	28,870	5·81	1680	3·70
8,810	29,350	7·60	1630	3·33
9,500	30,200	11·0	1650	3·18
9,780	30,680	13·5	1660	3·14
10,360	30,830	16·2	1630	2·98
10,840	31,370	21·6	1630	2·89
11,180	31,560	26·8	1620	2·82

Cast-iron

Field round iron neck per sq. cm.	Magnetic induction in the metal	Current in field magnets, amperes	$\frac{\mathfrak{B} - \text{outside field}}{4\pi}$	$\frac{\mathfrak{B}}{\text{outside field}}$
3,900	19,660	1·97	1250	5·04
6,400	21,930	3·75	1240	3·42
7,710	22,830	5·38	1200	2·96
8,080	23,520	7·08	1230	2·91
9,210	24,580	13·15	1220	2·67
9,700	24,900	16·9	1210	2·57
10,610	25,600	22·6	1190	2·46

The magnetic force within the metal ($\mathfrak{H}$) differs from the field in the surrounding space by an amount which cannot be estimated without a knowledge of the distribution of free magnetism on the pole-pieces and conical faces of the bobbin. It appears probable that, with the dimensions of the various parts used in these experiments, the magnetic force within the metal is less, but not very greatly less, than the outside and closely neighbouring field. In the absence of any exact knowledge of $\mathfrak{H}$, it is interesting to examine the relation of $\mathfrak{B}$ to the outside field. Thus, ($\mathfrak{B}$ − outside field)/4π gives a quantity which is probably not much less than the intensity of magnetism, $\mathfrak{J}$. The values of this quantity and also of the ratio $\mathfrak{B}$/outside field for Lowmoor wrought-iron and cast-iron are stated in the tables above.

Curves are given showing the relation of $\mathfrak{B}$ to $\mathfrak{B}$/outside field for Lowmoor iron and for cast-iron, in the manner introduced by Rowland for showing the relation of $\mathfrak{B}$ to μ (the permeability). The curves have the same kind of inflection that a curve of μ and $\mathfrak{B}$ begins to have when the magnetising force is raised sufficiently high. The range through which the permeability of iron may vary is well shown by comparing the values reached here (probably in the extreme case less than 3) with the value 20,000, which was found by one of the authors in the case of a soft wire exposed to a very small magnetising force and kept at the same time in a state of mechanical vibration.

The experiments give no support to the suggestion that there is a maximum of the induction, 𝔅. The value of 𝔅 capable of being reached by the method here employed depends mainly on the scale of the experiments. Larger field magnets with pole-pieces tapering to a narrow neck should yield values of 𝔅 greatly in excess even of those that were observed.

Linnean Society, April 7.—Mr. William Carruthers, F.R.S., President, in the chair.—Mr. Hunter J. Barron, Mr. Jas. H. Dugdale, and Mr. Edwd. B. Poulton were elected Fellows of the Society.—Fresh specimens were exhibited of a pure white variety of primrose, which had been gathered, growing wild, near Biarritz, France, by Mr. W. D. Godolphin Osborne.—A large series of instantaneous photographs of storks nesting, &c., were exhibited for Mr. E. Bidwell. These had been taken in Germany, and were specially interesting as showing the peculiar attitudes assumed in flight, &c.—Some malformed trout in an early stage of development were shown and commented on by Dr. F. Day.—A paper was read by Prof. Huxley on "The Gentians; Notes and Queries." Taking the flower as a basis, he divides the Gentianeæ into two great series, each of which is characterised by a peculiar disposition of the nectarial organs, and a gradation of forms of the corolla from the deeply cleft rotate or stellate condition, through the campanulate to the extreme infundibulate kind. In one series termed (I.) Perimelitæ, the nectarial cells are aggregated in a single or two patches; in the other series (II.) Mesomelitæ, the distinguishing characters are a zone of secreting cells encircling the ovary, or absence of such, with presence of a honey-secreting surface which may exist in the central parts of the flower. He assumes, on morphological grounds, a hypothetical ancestral flower or Ur-Gentian = Haplanthe. As a starting-point, this would lead, on the one hand, to the series of Perimelitaæ, with four subsidiary types; and on the other to the Mesomelitæ, also with four subsidiary types of floral structure. The Perimelitæ comprise the groups:—1. Actinanthe, 2. Keratanthe, 3. Lophanthe, and 4. Stephananthe; the Mesomelitæ comprise:—1. Asteranthe, 2. Limnanthe, 3. Lissanthe, and 4. Ptychanthe. The one series appears to bear a certain progressive relation in its evolution to the leading morphological modifications of the opposite series. In treating of the geographical distribution of the gentians, Prof. Huxley adopts the lines previously followed by him on animal distribution. Under (I.) Arctogea he includes Europe, Africa, Asia, and North America as far as Mexico; South Africa, Madagascar, Hindostan, and Indo-China forming a sub-province = South Arctogea; the remainder = North Arctogea. (II.) Austro-Columbia comprises South America, isthmus and islands as far north as Mexico. (III.) Australia is another province; and (IV.) New Zealand with adjoining islands. Species of the Gentianeæ are found in all these provinces, the head-quarters being North Arctogea and Austro-Columbia. The Ptychanthe are predominant in North Arctogea; the Lissanthe in South Arctogea; and Actinanthe, Lophanthe, and Lissanthe in Austro-Columbia. In Australia and New Zealand there is a paucity of species. He considers that the present distribution of the Gentianeæ is not to be accounted for by migration from any given centre, whence diffusion to their present localities. Borrowing analogy from zoological distribution, he likens the gentians to the tapirs, at present only represented in South America and the Indo-Malayan region. Yet the Tapiridæ in the Middle Tertiary epoch were distributed everywhere in the intermediate areas. Though fossil remains of gentians are not yet known, Prof. Huxley nevertheless suggests that in Pliocene and Miocene times their distribution may have been substantially similar to what is now extant. He further throws out the hint that, could the age of the first appearance of dipterous, hymenopterous, and lepidopterous insects provided with long haustra be indicated, we should then be in a position to guess approximately when specialisation of the types of the gentians and their ultimate distribution occurred.

Geological Society, April 6.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—On the rocks of the Malvern Hills, part 2, by Mr. Frank Rutley. The details of the microscopic examination of the rocks constituted the principal part of the present paper. The author concluded that the rocks of the Malvern Hills represent part of an old district consisting of plutonic and, possibly, of volcanic rocks associated with tuffs, sedimentary rocks composed mainly or wholly of eruptive materials, and grits and sandstones; that the structural planes in these rocks (sometimes certainly, at others possibly) indicate planes of stratification, and that the foliation, in many cases if not in all, denotes lamination due to deposition either in water or on land surfaces, probably more or less accentuated or altered by the movements which produced the upheavals, subsidences, and flexures prevalent in the range.—On the alleged conversion of crystalline schists into igneous rocks in County Galway, by Dr. C. Callaway.—A preliminary inquiry into the genesis of the crystalline schists of the Malvern Hills, by Dr. C. Callaway. The author's researches amongst the crystalline rocks of Connaught had suggested certain lines of investigation which had subsequently been followed out in the Malvern district. He had satisfied himself that many of the Malvern schists had been formed out of igneous rocks; but at present he limited himself to certain varieties. The materials from which these schists were produced were diorite (several varieties), granite, and felsite. The metamorphism had been brought about by lateral pressure. Evidence of this was seen in the intense contortion of granite-veins and in the effects of crushing as observed under the microscope. The products of the metamorphism were divided into two groups:—(1) Simple schists, or those formed from one kind of rock. (2) Injection schists, formed by the intrusion of veins, which had acquired parallelism by pressure. Veins of diorite in diorite produced *duplex diorite-gneiss*, and veins of granite in diorite originated *granite diorite-gneiss*. It was further noted that (1) generally the particular varieties of schist occurred in the vicinity of the igneous masses to which they were most nearly related in mineral composition; (2) the mineral banding of the rocks in the field was more like vein-structure than stratification. The author accepted the received view of the age of the schists. The parallel structure was clearly antecedent to the Cambrian epoch, and the occurrence of similar rocks as fragments in the Uriconian conglomerate of Shropshire seemed to indicate that the Malvernian schists were older Archæan. The reading of this paper was followed by a discussion in which the President, Mr. Teall, Dr. Hicks, Colonel McMahon, Dr. Callaway, and Mr. Rutley took part.

Entomological Society, April 6.—Dr. David Sharp, President, in the chair.—Mr. Francis Galton, F.R.S., Mr. J. H. Leech, B.A., F.L.S., and Mr. G. S. Parkinson, were elected Fellows.—Mr. S. Stevens exhibited specimens of *Arctia mendica*, collected in the county of Cork. The peculiarity of the Cork form of the species is that the majority of the males are as white as the female of the English form, and the typical black or English form appears to be unknown in Cork.—Mr. McLachlan exhibited a zinc box used by anglers for the purpose of keeping living flies in, which he thought might be adapted to practical use in the field by entomologists.—Mr. G. T. Porritt exhibited specimens of *Hybernia progemmaria*, from Huddersfield. All the females and a large proportion of the males were of the dark variety *fuscata*, which formerly was almost unknown in Yorkshire, but which now seemed likely to replace the original type. Mr. Jenner-Weir and Lord Walsingham both remarked that the number of melanic forms appeared to be on the increase in the north, and suggested explanations of the probable causes of such increase.—Mr. Gervase F. Mathew, R.N., exhibited several new species of Rhopalocera taken by him in the Solomon Islands during the visits to those islands of H.M.S. *Espiègle* in 1882 and 1883. Amongst them were species of *Euplœa*, *Mycalesis*, *Messarus*, *Rhinopalpa*, *Cyrestis*, *Diadema*, *Parthenos*, *Pieris*, *Papilio*, &c.—Mr. E. B. Poulton exhibited a large and hairy lepidopterous larva brought from Celebes by Dr. Hickson, and made remarks on the urticating properties of the hairs of the species, which were said by the natives to produce symptoms similar to those of erysipelas if the larva was handled. Lord Walsingham, Mr. McLachlan, Dr. F. A. Dixey, Mr. Jenner-Weir, Dr. Sharp, Mr. Slater, and Mr. Poulton, took part in a discussion as to whether urtication was due to the mechanical action of the hairs in the skin, or to the presence of formic acid, or some other irritant poison, in glands at the base of the hairs. There appeared to be no doubt that in some species the irritation caused by handling them was merely due to the mechanical action of the hairs.—Mr. P. Crowley exhibited a collection of Lepidoptera recently received from West Africa, including several new or undescribed species of *Mylothris*, *Diadema*, *Harma*, *Rhomaleo-*

soma, &c.—Mr. H. Goss announced the capture by Mr. G. D. Tait, at Oporto, of a specimen of *Anosia plexippus*, and remarked that, although some twenty specimens had been caught in the South of England, only two specimens had been previously recorded from the continent of Europe.—Lord Walsingham read a paper entitled "A Revision of the Genera *Acrolophus* (Poey) and *Anaphora* (Clem.)"; and exhibited about twenty new species of these and allied genera. Mr. Stainton made some remarks on the genera, and said he was glad Lord Walsingham was working at them and their allies.—Mr. Poulton read "Notes in 1886 on Lepidopterous Larvæ." In the discussion which ensued, Lord Walsingham referred at some length to instances of protective resemblance in larvæ, and alluded to the existence in certain species, especially of the genus *Melitæa*, of prothoracic glands.—Dr. F. A. Dixey remarked on the extraordinary powers of contraction which appeared to be possessed by the retractor muscle of the flagellum in *D. vinula*, and inquired whether any corresponding peculiarities of minute structure had been observed in it. The discussion was continued by Mr. G. F. Mathew, Mr. W. White, Dr. Sharp, Mr. Porritt, and others.

Paris

Academy of Sciences, April 18.—M. Janssen, President, in the chair.—On an absolute unity of time; electric standards of time and chronoscopes of their variations, by M. Lippmann. It is shown that from the study of certain electric phenomena an absolute invariable unity of time may be obtained. The electric apparatus here described yields more accurate results than the best constructed astronomical clock. It has the further advantage of indicating, recording, and, where needed, automatically correcting, its variations of velocity.—Solar observations made at Rome during the first quarter of the year 1887, by M. Tacchini. The period of minimum activity for the spots and faculæ, as recorded in November 1886, has continued throughout the first three months of 1887. The protuberances also continued to decline during the same period.—On antipyrine, an antidote against pain, by M. Germain Sée. Antipyrine, with the formula $C_{11}A_{12}N_2O$, discovered by Knorr in 1884, is shown to be not only a good febrifuge, but also a most efficacious remedy for gout, rheumatism, and similar affections.—On the earthquake of February 23, by M. J. L. Soret. Certain derangements of the telephonic apparatus in the central office at Cannes seem to show that the violent shock which occurred at 5.50 a.m. was accompanied by strong electric discharges.—On a special circumstance connected with the production of the bicarbonate of soda, by M. Paul de Mondésir. An experiment here described shows that the carbonate of soda, combined with a single equivalent of water, scarcely absorbs carbonic acid at the ordinary temperature at all. But when it is mixed with a slight portion of dry bicarbonate the reaction on the contrary begins at once, and with an energy in direct proportion to the quantity of the bicarbonate and the thoroughness of the mixture.—Method of determining the relative value of the four unities of chemical action of the atom of carbon, by M. Louis Henry. At the base of the doctrines of organic chemistry as now understood lie the two principles of the quadrivalence of the atom of carbon, and the identity in value of its four unities of chemical action. The former is an accepted fact proved by experiment, while the latter is far from possessing the same degree of objective certainty. The author here proposes a method by means of which its truth may be rigorously determined.—Artificial reproduction of rose-red spinel (balas ruby), by M. Stanislas Meunier. The author, who has been for several years incidentally occupied with the synthesis of spinel, has lately again attacked the problem in a way quite different from his first method. He now crystallises the aluminate of magnesia, tinted a rose colour by traces of chromium, the result being a stone absolutely identical with the balas ruby of nature. The experiment here described has already been varied in several ways, yielding a series of products, such as the aluminates of zinc, iron, &c., besides secondary compounds, whose study is still in progress.—On the functions of the semicircular ducts, by M. J. Steiner. From experiments made on Crustaceans at the Zoological Station at Naples, the author shows that these organs exercise little or no influence on the locomotion of the lower animals, as supposed by Delage, Viguer, and others.—On a station of the Stone Age discovered at Chaville, by M. E. Emile Rivière. This station of Chaville lies on the skirt of the wood of like name on the right side of the road between Paris and Versailles. Here the author has just discovered a large number of flint implements of the Neolithic epoch, scrapers, knives, arrow-heads, and the like. All lay on or near the surface, and were of a more or less deep gray colour, some showing clear traces of the action of fire. They closely resemble the objects found by the author at the Neolithic station of Trou-au-Loup, Clamart, in 1884-85. Amongst them was a small fragment of black, siliceous pottery without any ornamentation, and also perfectly analogous to the pottery of the Neolithic beds in the same neighbourhood.—The members of the International Conference on Celestial Photography were present at the sitting, and were welcomed by the President in an appropriate address dwelling especially on the importance for astronomy of the photographic labours of MM. Henry, of Paris.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Hyderabad, Kashmir, Sikkim, and Nepal: Sir R. Temple and Capt R. C. Temple (Allen).—Geology of England and Wales, 2nd edition: H. B Woodward (Philip).—An Elementary Treatise on the Mathematical Theory of Perfectly Elastic Solids: W. J. Ibbetson (Macmillan).—Dynamics for Beginners; Rev. J. B. Lock (Macmillan).—Catalogue of Lizards, 2nd edition, vol. iii.: G. A. Boulenger (British Museum).—Mineral Resources of the United States, 1885 (Washington).—Photography of Bacteria: E. M. Crookshank (Lewis).—Chemistry for Beginners: R. L. Taylor (Low).—Woodland Tales: J. Stinde (Unwin).—Geological and Natural History Survey of Minnesota, 13th and 14th Annual Reports: W. H. Winchell (St. Paul).—Longmans' New Geographical Readers, Standard VII. (Longmans).—The Prevention of Consumption: C. Candler (K. Paul).—Pictographs of the North American Indians: G. Mallery (Washington).—Der Bau des Menschen: Dr. R. Wiedersheim (Williams and Norgate).—Thomas Young: Prof. Tyndall.—Oberpliocän-Flora aus den Baugruben des Klärbeckens bei Niederrad und der Schleuse bei Höchst A. M.: Drs. Geyler and Kinkelin (Frankfort).—The Eruption of Krakatão: E. D. Archibald.—City Government of St. Louis: M. S. Snow (Baltimore).—Notes to Accompany a Geological Map of Northern Canada: G. M. Dawson (Montreal).—Étude Numérique des Concours de Compensation de Chronomètres: G. Cellérier (Genève).—Journal of the Royal Statistical Society, March (Stanford).—Zeitschrift für Wissenschaftliche Zoologie, xlv. Band, 2 Heft (Leipzig).—Bulletin de l'Académie Royale des Sciences de Belgique, No. 3 (Bruxelles).

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