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HISTORICAL EXPOSITION OF MECHANICS.

The Science of Mechanics: a Critical and Historical Exposition of its Principles. By Dr. Ernst Mach, Professor of Physics in the University of Prague. Translated from the second German edition by Thomas J. McCormack. (Chicago: The Open Court Publishing Co. London: Watts and Co., 1893.)

THE appearance of a translation into English of this remarkable book should serve to revivify in this country the somewhat stagnating treatment of its subject, and should call up the thoughts which puzzle us when we think of them, and that is not sufficiently often.

Prof. Mach isa striking instance of the combination of great mathematical knowledge with experimental skill, as exemplified not only by the elegant illustrations of mechanical principles which abound in this treatise, but also from his brilliant experiments on the photography of bullets, which have been recently elaborated and simplified by Mr. C. V. Boys.

The appearance of the first edition, in 1883, is stated in the preface of the second edition, to have stimulated the production of treatises by Wohlwill, Streintz, Lang e, Epstein, Müller, Popper, Helm, Planck, Poske, and others, discussing theories of cognition in connection with Mechanics; but it is curious that Maxwell's little tract on "Matter and Motion," of 1879, a veritable master-piece on this subject, should appear to be unknown to the author, although mentioned in the translator's foot-notes.

The present volume is not a treatise upon the application of the principles of mechanics, to quote from the preface. Its aim is to clear up ideas, expose the real significance of the matter, and get rid of metaphysical obscurities. Mechanics is treated not as a branch of mathematics, but as one of the physical sciences; and the reader's interest is invited to know how the principles of mechanics have been ascertained, from what sources they take their origin, and to what extent they may be regarded as permanent acquisitions. All this, the positive and physical essence of mechanics, which makes its chief and high interest for a student of nature, is in existing treatises completely buried and concealed beneath a mass of technical considerations.

The gist and kernel of mechanical ideas has in almost every case grown up in the investigation of very simple and special cases of mechanical processes; and the analysis of the history of the discussions concerning these cases must ever remain the method at once the most effective and the most natural for laying this gist and kernel bare. Indeed, it is not too much to say that it is the only way in which a real comprehension of the general upshot of mechanics is to be attained.

Acting upon the plan laid down in the citations above, the author treats his subject from the historical order of development, and begins with an Introduction of general remarks, illustrated by an Egyptian representation of the mechanical arts, and by a quotation from Vitruvius.

Chapter i., on the Development of the Principles of Statics and Hydrostatics, follows closely the historical subject-matter given by Lagrange in the first section of his "Mécanique analytique"; but Prof. Mach's treatment has the very great superiority of being profusely illustrated by elegant diagrams, while Lagrange made a point of banishing figures entirely from the "Mécanique analytique."

Lagrange thus appears as a supporter of the ancient tradition that Rational and Practical Mechanics were to be considered as in a measure opposed to each other, as Newton observes in his preface of the "Principia"; the latter being an inferior branch of study, to be cultivated only for the sake of gain or some other material advantage.

To quote from Rankine's Preliminary Dissertation, prefixed to his "Applied Mechanics":—

"Archytas of Tarentum might illustrate the truths of Geometry by mechanical contrivances; his methods were regarded by his pupil Plato as a lowering of the dignity of science. Archimedes, to the character of the first geometer and arithmetician of his day, might add that of the first mechanician and physicist—he might, by his unaided strength acting through suitable machinery, move a loaded ship on dry land—he might contrive and execute deadly engines of war, of which even the Roman soldiers stood in dread—he might, with an art afterwards regarded as fabulous till it was revived by Buffon, burn fleets with the concentrated sunbeams; but that mechanical knowledge and that practical skill, which in our eyes render that great man so illustrious, were by men of learning, his contemporaries and successors, regarded as accomplishments of an inferior order, to which the philosopher, from the height of geometrical abstraction, condescended with a view to the service of the State."

We have only to study the progress of the essentially modern science of Electricity to recognise the eloquent truth of Rankine's words, in inveighing against the mediæval and ancient fallacy that there is a *double system of natural laws*, one theoretical, geometrical, rational, discoverable by contemplation, applicable to celestial, ætherial, indestructible bodies, and being an object of the noble and liberal arts; the other practical, mechanical, empirical, discoverable by experience, applicable to terrestrial, gross, destructible bodies, and being an object of what were once called the vulgar and sordid arts.

Possessed with these prejudices, the scholar of ancient and mediæval times, and even of the present day, was occupied in developing and magnifying the numerous errors, and in perverting and obscuring the much more numerous truths which are to be found in the writings of Aristotle; so that it is not surprising that the notion arose of scientific men being unfit for the business of life, and that various facetious anecdotes were contrived illustrative of this notion, anecdotes which have been handed down from age to age, and applied with little variation to the eminent philosophers of every time.

Returning to chapter i. of Prof. Mach's treatise, we find that the Principle of the Lever, employed in the writings of Archimedes, is the real foundation of the Science of Statics, and not the Parallelogram of Forces, as is generally taught; this theorem, although sketched out by Stevinus of Bruges, was first fully enunciated by Varignon and Newton, about 1687. In fact, the modern treatment of Statics is almost entirely due to Varignon.

Prof. Mach examines with the acumen of a metaphysician the weak points of a demonstration; it is a pity then that he seems unacquainted with Duchayla's proof of the Parallelogram of Forces, which is unfortunately so popular with writers on mechanics in this country, as he would have revelled in pointing out the weakness of a logic which prides itself above all things on its rigour.

The Principle of Virtual Velocities, employed as fundamental by Lagrange in his "Mécanique analytique" in preference to the principle of the Parallelogram of Forces, was enunciated very clearly by Stevinus in its application to systems of pulleys; and here we are compelled to call attention to a flaw in Fig. 39, *c*, the only one that we have met in the course of the work; the system cannot possibly be in equilibrium with the central portion of the thread askew, as drawn in the diagram.

The Principle of Virtual Velocities is important in the historical development of Mechanics as the first sketch and shadowing forth of the modern Principle of the Conservation of Energy; but it is unfortunate that the name should still survive, as it is confusing and meaningless. Prof. Mittag Leffler was eloquent at the meeting of the British Association at Oxford in his denunciation of the habit of attaching to theorems certain names of individuals, real or quasi discoverers; and he might have quoted the Principle of Virtual Velocities as an instance of the disadvantage of inventing a descriptive title of too great generality to a newly discovered theorem.

Lagrange has attempted an experimental verification of the Principle of Virtual Velocities, and it is a tradition that an apparatus was constructed on these indications by a former professor of mathematics at Cambridge. It is probable that the description of this demonstration and of the apparatus to be found in Todhunter's *Analytical Statics* was purposely ironical; and that, in popular language, Todhunter wrote this with his tongue in his cheek, knowing the story of the sceptical student who had tried the experiment himself.

The demonstration amounts to proving that a certain weight is no more likely to rise than to fall, and therefore (here Todhunter says he follows Lagrange's words very closely) the weight should remain stationary. The student, however, found that the weight did not remain stationary, and wanted to know why; the professor told him in confidence that it was prudent to make use of an invisible pin to keep the weight in order.

This is not the only case in which it is desirable for the professor to keep a card up his sleeve, as the saying is; in the Foucault experiment of the pendulum which shows the rotation of the Earth, the slightest current of air will destroy and reverse the desired motion; so that it is advisable in showing the experiment to have an elastic ball concealed in the palm of the hand, which can send a slight current of air on the bob of the pendulum, and thus accelerate the initial precession of the plane of the vibration so as to gratify the eyes of the audience and diminish their impatience at the slowness of the motion; afterwards the motion can be checked so that the total advance is made to agree with the theoretical result. Very undignified and dishonest, some will say; but the experiment is otherwise bound to fail from its delicacy when shown to a large audience, except under the most favourable conditions.

While Statics, both as a Science and an Art, can be traced back through Archimedes and the existing monuments of the Egyptians, Greeks, Romans, and of mediæval architects, the Principles of Dynamics, discussed in chapter ii., were first laid down clearly by Galileo; and the great fallacy to be destroyed before any real advance could be made was that of the Aristotelians, who maintained that heavy bodies fall faster than light ones, because the upper parts weigh down on the under parts and accelerate their descent. But in that case, retorted Galileo, a small body tied to a larger body, must, if it possesses *in se* the property of less rapid descent, retard the larger; *ergo* a larger body falls more slowly than a smaller body.

The entire fundamental assumption is wrong, as Galileo says, because one portion of a falling body cannot by its weight under any circumstances press another portion; although, according to Wohlwill (Appendix I.), even Galileo himself only very gradually abandoned the Aristotelian conceptions.

But discarding all metaphysical argument, the Aristotelian fallacy was demolished once for all by the *experimentum crucis* carried out by Galileo, of letting bodies of different weight fall from the Leaning Tower of Pisa, when all were found to take the same time of descent; any slight discrepancies were afterwards accounted for by the resistance of the air.

A still more delicate experimental verification is to be found in the pendulum, as pointed out by Galileo; a plummet at the end of a thread has the same period of oscillation whatever be the weight or the material of the plummet.

The theory of the pendulum, when composed of a body of finite size, as required in a clock, was completed by Huygens in his *Horologium oscillatorium*, 1673, in which the mutual controlling influence of a number of separate plummets is investigated when the plummets are rigidly attached together; and thus for the first time the idea of a moment of inertia and of a centre of oscillation was introduced into Mechanics. In his further researches into the theory of the clock, Huygens was led to the discovery that isochronism for all amplitudes can be secured by making the plummet oscillate in a cycloid; and to do this practically he found that the thread must wrap and unwrap on an equal cycloid, and thereby he made the first step in the doctrine of evolutes and the theory of the circle of curvature.

Having demolished the Aristotelian fallacies on falling bodies, Galileo had still to determine the true laws; his first conjecture that the velocity grew uniformly with the distance, or that $v = gs$, having proved untenable, Galileo stumbled upon the true law that the velocity grows at a constant rate, or that $v = gt$.

The next step in the theory, to prove that in consequence $s = \frac{1}{2}gt^2$, was not an easy matter for Galileo, who sought in general an experimental proof of his theorems (as, for instance, his attempted quadrature of the cycloid by weighing it made in sheet lead); once this was established, however, it was comparatively an easy matter to demonstrate that the path of an unresisted projectile is a parabola, and to prove it experimentally by rolling a ball obliquely on an inclined table.

Galileo's difficulty was to measure lapse of time with exactitude, accurate clocks and watches not being in existence in his day; but he overcame this difficulty by a modification of his own invention of the ancient Clepsydra.

The laws of circular motion were next investigated by Huygens; and a combination of these laws with Kepler's Third Law, on the assumption that the planetary orbits round the Sun are circles, leads at once to the Law of Attraction varying inversely as the square of the distance.

This law, generalised into the Law of Universal Gravitation, became in Newton's powerful hands the foundation of his system of Natural Philosophy, in explaining not only the elliptic orbits of the planets in accordance with Kepler's first two Laws, but also the perturbations of these orbits as exemplified in the Lunar Theory, and the Theory of the Tides.

Prof. Mach suggests in Fig. 139 a very ingenious experimental illustration of the tides on a body in free space, like the Earth, as distinguished from the tides which would be produced if the Earth was fixed, by means of a small iron sphere covered with a solution of magnetic sulphate of iron; this can either revolve as the bob of a conical pendulum in true planetary style round the pole of a fixed magnet, representing the disturbing Sun or Moon; or it can hang suspended at rest at a small distance from the pole, and thus illustrate high water under the disturbing Sun or Moon, and low water at the antipodes when the Earth is supposed fixed. The discrimination of the two cases must be considered one of the most brilliant parts of the "Principia."

It is curious that Prof. Mach does not accept Newton's distinction between the relativity of motion of translation and the absoluteness of motion of rotation, illustrated experimentally by Newton by means of a revolving bucket of water suspended by a twisted rope ("Principia," Definition VIII. *Scholium*); and here we think he would have been interested in Maxwell's arguments on Rotation in § 104, *Matter and Motion.*

Maxwell proceeds to explain that it is possible, by means of observation and experiment on or inside the Earth alone (by Foucault's pendulum, for instance), to disprove Milton's assumption, that it is evidently all the same

"Whether the sun, predominant in heaven,
Rise on the earth, or earth rise on the sun;
He from the east his flaming road begin,
Or she from west her silent course advance;"

&c., although the geometrical configuration of the earth and the heavenly bodies, so far as is discoverable by astronomical observation, is the same on either assumption.

In the Translator's Preface we are told that "Mr. C. S. Pierce has rewritten § 8 in the chapter on Units and Measures, where the original was inapplicable in this country (America) and slightly out of date."

As might be anticipated, this means that we are now to change the name of the quantity formerly designated by the word *weight*, *poids*, *gewicht*, *pondus*, and to use the word *mass* instead.

But if a continental mathematician, Prof. Mach included, is asked to give a numerical definition of the mass of a body, he replies, if in French, "poids divisé par g"; so that if a body weighs p kilogrammes, its mass is $\frac{p}{g}$, and the unit of mass is thus g kilogrammes.

When the gravitation unit of force was in universal use, it was considered an abbreviation to write m for $\frac{p}{g}$, and to replace the gravitation measures of momentum and energy, $\frac{pv}{g}$ and $\frac{pv^2}{2g}$, by mv and $\frac{1}{2}mv^2$.

But when Gauss's absolute unit of force is employed, the absolute measures of momentum and energy are pv and $\frac{1}{2}pv^2$, and the abbreviation of m for $\frac{p}{g}$ is no longer required; or if the letter m is employed, then $p=m$ and not mg, as Mr. Pierce asserts; if the mass of a body is 10 kilogrammes, its weight in kg cannot be anything except 10 kilogrammes.

But if with absolute measures we retain the equation $p=mg$, and measure m in kilogrammes, then p, the *weight* or *poids*, is measured in one-gth parts of a kilogramme; this is contrary to all practice, and is absolutely forbidden by the laws on *Weights and Measures.*

With gravitation units the *weight* of a body is at once the numerical measure of the quantity of matter in the body (Newton's *quantitas materiæ*) and of its gravitation, or the force with which it tends to the Earth; if a body weighs p kilogrammes, it is attracted by the Earth with a force of p kilogrammes. The loose definition usually given that "the weight of a body is the force with which it is attracted by the Earth," is really no definition at all, but a mere description; it should at least be amended to "the weight of a body is the *number of units of force* with which the body is attracted by the Earth"; and it will be found that this definition is never employed except with the gravitation unit of force; so that this definition merely asserts in a roundabout way that the weight of a body is a measure of the quantity of matter, as measured out by weighing against pound or kilogramme weights.

It is incorrect to say that there are two systems of *measurement*, the *absolute* and the *gravitational* (p. 284). There is no practical method for the measurement of forces in absolute measure with any pretence to accuracy; the absolute system is merely a system for recording numerically the results of experiment; the measurements themselves are always made in gravitation measure, and afterwards converted into absolute measure by multiplying by the local value of g. There is thus no need for absolute units with our insular British F.P.S. (foot-pound-second) system; and Prof. James Thomson's *poundal*, although a convenient name, is of no practical or theoretical use.

In experiments at Washington, the Paris gravitation unit would not be employed, so that the statements on p. 286 do not tend to clear up the subject. What appears to be meant is that if a perfect spring balance could be constructed such that a kilogramme deflected it at Paris through 981 divisions, then when carried to Washington the deflection would fall to 980·1 divisions, and if carried to the Moon to about 164 divisions, but if carried to the surface of the Sun the deflection would rise to about 30,000 divisions, provided Newton's "Law of Universal

Gravitation" is correct; but the kilogramme weight remains the same throughout the universe.

But if a balance could be constructed with its fulcrum somewhere in the Azores, and the scale pans hanging over Paris and Washington, then 1 kilogramme at Paris would equilibrate 1·00092 kilogramme at Washington (p. 286).

It is sometimes asserted in our school-books on Mechanics that a pound weight, if carried to the surface of the Sun, would weigh about 30 pounds; but if a balance could be made to stretch between the surfaces of the Earth and of the Sun, then a pound weight at the Sun's end would be equilibrated by 30 pounds at our end; so that it is equally true to say that a pound weight on the Sun will weigh 30 pounds on the Earth.

Prof. Mach would perform a great service if he would extend his criticisms on the usage of the word *pondus* by Huygens, Leibnitz, Wallis, &c., to modern times, as great mystifications exist at the present day.

The C.G.S. system of units is explained by Mr. Pierce on p. 285. These units are much too minute except for recording delicate physical measurement. If Prof. Johnstone Stoney's amendment of the M.K.S. (metre-kilogramme-second) system had been adopted, we should have a system incorporating the joule, watt, volt, ohm, and ampère as units; it is not too late to make the change; the disadvantage that the density of water is 1000 in this system is more apparent than real.

Although the double system of natural laws mentioned by Rankine is now exploded, we still have a double system of instruction in mechanical text-books, one theoretical, geometrical, rational; the other practical, mechanical, empirical, discoverable by experience. It should be the object of modern science to break down the barriers between these two systems, and to treat the subject of mechanics from one point of view. Instead of this, the gap between the two systems seems to be an increasing one, insomuch that Prof. A. B. W. Kennedy, in his inaugural address to Section G of the British Association at Oxford, demanded for young engineers a course of instruction in mathematics entirely different to that imparted at present in our schools and colleges.

Some remarks at the end of Prof. Klein's Sixth "Evanston Colloquium" may be consulted as bearing on this question.

A careful study of Prof. Mach's work, and a treatment with more experimental illustration, on the lines laid down in the interesting diagrams of his Science of Mechanics, will do much to revivify theoretical Mechanical Science, as developed from the elements by rigorous logical treatment.

A. G. GREENHILL.

NEWTH'S INORGANIC CHEMISTRY.

A Text-book of Inorganic Chemistry. By G. S. Newth, F.I.C., F.C.S. Pp. xiii. 667. (London: Longmans, Green, and Co., 1894.)

THE author states in the preface, that the arrangement of the course of elementary instruction in chemistry, which is given in this book, is based on the periodic classification of the elements. The properties of four elements, *hydrogen*, *oxygen*, *nitrogen*, and *carbon*, and the properties of many compounds of these elements, are considered before the systematic study is entered on, of the groups into which the elements are divided by the application of the periodic law. Then follow chapters wherein the members of the various groups of elements, and the chief compounds of these elements, are described. To this descriptive part of the book are prefixed fifteen chapters of "introductory outlines," constituting "a brief sketch of the fundamental principles and theories upon which the science of modern chemistry is built." In his directions to students using the book, the author says that a start should be made by reading carefully the chapters dealing with chemical change, elements and compounds, nomenclature, and symbols; that the four typical elements—hydrogen, oxygen, nitrogen, and carbon—should thenbe studied; and that, as this study is proceeding, the remaining chapters of the "introductory outlines" should be mastered.

It seems to me that the method of the author is radically wrong. Descriptive statements of facts ought, surely, neither to precede, nor to follow, but to accompany, the reasoning on these facts whereby general principles are gained.

The author's treatment of chemistry implies that "the science of modern chemistry is built" on the foundation of such generalisations as those stated in his "introductory outlines," and that detailed descriptions of the properties of certain kinds of matter called elements and compounds constitute the science that is raised on this foundation. Would it not be more advisable so to treat the subject as to show that chemistry rests on certain definite natural facts, but that only when these facts are compared, contrasted, and classified, does a scientific knowledge of them begin?

The descriptions in this book of the members of each group of elements seem to me to be exceedingly well done; many portions of the chapters treating of principles and theories, notably the pages which deal with the laws of chemical combination, are admirable; nevertheless the book, as a whole, gives the impression of being unscientific. The method of the book tends, in my opinion, to perpetuate the vicious and unreal distinction between chemistry and chemical philosophy, a distinction that has probably been as potent as any other cause in stopping the progress of the science.

The purely descriptive portions of this work are often extremely good, as far as they go. The facts, or rather half-facts, are stated in a clear and orderly way; care is taken to notice recent work of importance; the woodcuts are well executed: but, all this is only the material out of which chemistry is constructed.

About 130 pages are devoted to statements of the properties of four typical elements—hydrogen, oxygen, nitrogen, and carbon—and of the properties of many compounds of these elements. But hydrogen, oxygen, nitrogen, and carbon are not treated as typical elements they are not compared and contrasted with other elements. After reading the descriptions of these elements and their compounds, and studying the properties of the elements in each of the eight groups of the periodic classification, one still feels unsatisfied. Something is lacking. Surely some fair and fitly fashioned building ought to rise on this broad superstructure. If chemistry is to be treated as a recitation of disconnected, or artificially connected, facts, it ceases to be a subject worthy the serious attention of educated men. One turns to a new book on elementary chemistry, hoping to find at least an attempt to rescue chemistry from the overwhelming burden of so-called facts, beneath which the science is in danger of being buried. In this case I confess to disappointment. It may be replied that the chemistry which is not clearly apparent in the purely descriptive parts of the book is to be found in the "introductory outlines" wherein the "fundamental principles and theories" of the science are stated. I admit at once that there is much excellent matter in these earlier chapters; but I do not find there a connected setting forth of elementary principles, as arising from facts, and binding facts into some kind of harmonious whole. There is not much either exact or imaginative treatment; and these two I take to be the notes of genuine science.

The perusal of this book produces in one's mind a strange feeling of inversion; many things seem to be standing on their heads. The reader feels that a rapid mental rotation, to right or left, is demanded. Change is very properly said to be the feature of all chemical occurrences; but at a very early stage (p. 5), after two pages have been occupied in lightly touching the subject of the constitution of matter, the student is told that "Any change which arises from an alteration in the structure of the molecule is a chemical change." This is an example of the topsy-turviness of parts of the book. The statement quoted has a meaning when the meaning of such a very symbolical expression as "structure of the molecule" has been adequately grasped. At this stage of progress the student cannot have any clear image called up in his mind by the words I have quoted; they must be merely words to him. But he might have grasped the prominent and characteristic features of chemical change had these been put before him by well-chosen experiments. Another instance, to my thinking a glaring instance, of putting theory where facts should come, and facts where theory, is found in chapter ii., which deals with elements and compounds. The distinction between these classes of substances is stated at once, and is stated only, in the language of atoms and molecules.

"In the substance sulphur, all the atoms composing the molecules are alike; while in water . . . there are two distinct kinds of atoms in the molecule. Matter, therefore, is divided into two classes, according as to whether its molecules are composed of similar or of dissimilar atoms. Molecules consisting of atoms of the same kind are termed *elementary molecules*, and substances whose molecules are so constituted are known as elements."

The chapter which deals, and deals in a clear and most praiseworthy style, with the laws of chemical combination, is headed "The Atomic Theory." I think the author must have taken his own words too literally (p. 29):

"Dalton embraced the ancient doctrine of atoms, and extended it into the scientific theory which is to-day known as Dalton's atomic theory, and is accepted as a *fundamental creed* by modern chemists." (The italics are mine.)

A "scientific theory" and a "fundamental creed" are very different things.

For his descriptive treatment of the materials from which chemistry is built up, I think the author is to be praised; but I do not think he has succeeded in setting forth the principles of the science of chemistry clearly, adequately, or in fitting order.

M. M. PATTISON MUIR.

OUR BOOK SHELF.

Astronomia Sferica. An Elementary Treatise. By Francesco Porro. (Roma: Società Editrice Dante Alighieri, 1894.)

IN these 160 pages, the author has endeavoured with success to bring before his readers, in as simple a way as is consistent with the subject, the elements of spherical astronomy. With the exception of a small knowledge of the rudiments of the differential calculus, the mathematical ability is by no means taxed. The order in which the subject-matter has been arranged, and the field which is covered, can be gathered from the following short summary. After dealing first with the sphere generally, and the form and daily motion of the earth, the annual motion round the sun, and the methods of the transformation of coordinates, the measurement of time is next explained, in which Kepler's equation, the equation of time, and the transformation of mean into sidereal time, and *vice versâ*, are discussed. Then follows a chapter in which the movements of the moon are clearly expounded.

Diurnal parallax and refraction, the variations of the fundamental planes, aberration and annual parallax, form the subjects for the next three chapters; while the remaining ones are devoted to the determination of the positions of stars and their proper motion, and to the solar system in general. In the last-named, the apparent movements of the planets, the theories of Copernicus and Kepler, the necessary data for the determination of planets' orbits, &c., are touched upon.

From the above it will be seen that the most necessary points for the student have been dealt with, but they have not been treated at too great a length. As an introduction to higher works, this book will be found most useful; but its use in this country will be to a great extent restricted, owing to it being printed in Italian.

The New Technical Educator. Vol. iv. (London, Paris, and Melbourne: Cassell and Co., 1894.)

THE previous volumes of this work have been duly noted in our pages. Volume iv. is in every way up to their standard of excellence.

The subject of the manufacture of iron and steel occupies the first part of the volume. The author of this seems to be well acquainted with the practical details. We note that he appears to consider that the presence of but 0·05 per cent. of sulphur in steel is more or less harmful, producing a metal sensibly red-short. This may be the case; but it is generally considered that the percentages of phosphorus, sulphur, or silicon must not each exceed 0·06 per cent., and then their effects may be overlooked in axles, tyres, plates, &c. Engine-tyres are said to give a tensile test of 46 tons per square inch, with a minimum elongation of 20 per cent. in a 3-inch length. These results are rather extreme, with a sectional area of ½ square inch of test-piece. If the extension exceeds 16 per cent. the result may be considered good with this tonnage.

As in previous volumes, we find much interesting information on cutting tools, from the pen of Prof. R. H. Smith, dealing principally with lathes, drills, and punching and shearing machinery. Different metal shavings are illustrated from photographs, and clearly show the nature of the different metals. The steel shavings shown, however, are not sufficiently described. Cases are known where shavings from a $2\frac{1}{2}$-inch drill working on cast steel have been obtained many feet in length, the material, of course, being of very excellent quality.

The illustrations of drilling machines are good, but all appear to have the ordinary power feed; in many cases it is found advantageous to have, besides the power feed, a quick hand feed in addition, in conjunction with a power attachment, the quick hand gear being used to withdraw the tool in all cases. These motions are very handy in boiler shops, where the same machine may have to drill rivet-holes out of the solid, rhymer or enlarge punched holes, and finally countersink holes, all requiring different feeds.

The continuation of the steam engine in this volume includes boiler fittings and details, efficiency of the engine and engine and boiler trials, concluding with a chapter on compound engines. The latter parts of these chapters are well written and interesting. The classical work of the late Mr. Willans is largely drawn upon, as well as the trials carried out by the Institution of Mechanical Engineers, besides careful descriptions of other steam-engine trials. The combination of indicator diagrams of compound or triple expansion engines is wel explained.

A series of articles on engineering workshop practice is commenced, and they are very good so far as they go, but it may be suggested that engineers' shop appliances as generally used should be described, and not the "elegant amateur tools," such as are illustrated in Figs. 29 and 77.

N. J. L.

Index Kewensis Plantarum Phanerogamarum. Sumptibus Beati Caroli Roberti Darwin ductu et consilio Josephi D. Hooker, confecit B. Daydon Jackson. Fasciculus iii. (Oxoni: E prelo Clarendoniano, 1894.)

THE third fasciculus of the Kew Index, which the Clarendon Press has just issued, brings us within sight of the completion of this monumental work. This part brings the Index down to near the end of the letter P, and we may look forward then to seeing in course of the coming year the concluding fasciculus. Since we noticed the earlier fasciculi there has been no new development in the nomenclature controversy, upon which, we believe, the Kew Index will exercise an important influence; the effect of this will likely be only apparent after the whole is published. Meanwhile the sterling value of the Index is increasingly evident, and every botanist will congratulate the preparers and the publishers upon the appearance of this third fasiculus, in which the same careful and conscientious workmanship is noticeable as characterised the portions of the work previously issued.

Alpine Climates for Consumption. By H. J. Hardwicke, M.D. Pp. 65. (London: J. and A. Churchill, 1894.)

THE high-altitude cure for acquired and hereditary consumption has gained ground in the medical world during recent years, with the result that numerous winter health stations have sprung into existence in Switzerland. Dr. Hardwicke's little brochure has been written for the purpose of providing trustworthy and unbiassed information with regard to some of these resorts. It is pointed out that the principal requirements of an Alpine winter climate in the treatment of phthisis are (1) high altitude, (2) low temperature, (3) dry atmosphere, (4) large amount of sunshine and ozone, (5) low atmospheric pressure, (6) freedom from wind, (7) freedom from organic and inorganic particles in the air, (8) absence of fogs, (9) good water-supply, (10) good drainage. The author believes that stations possessing all these properties are extremely beneficial to consumptive patients. His book will help sufferers from lung disease to the selection of a suitable winter residence.

LETTERS TO THE EDITOR.

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

"Acquired Characters."

IT may be at once conceded that persons who discuss whether "acquired characters" are inherited or not, ought to know and to be able to state clearly what is meant by the term "acquired characters."

I am surprised that Sir Edward Fry should find any difficulty in ascertaining what should be meant by this term when used in the case to which he refers, viz. the theories of Lamarck and of Darwin with regard to the origin of the species of plants and animals. Sir Edward Fry seems to assume that the matter under discussion is contained in certain writings by Prof. Weismann as though those writings were a sort of "affidavit," binding and limiting the discussion. The fact is that Prof. Weismann is a witness—and an advocate too—in a case which is of more ancient date than his connection with it.

Sir Edward Fry has found some satisfaction, as have many other writers, in pointing out inconsistencies and ambiguities in Prof. Weismann's statements; but it is to me somewhat astonishing that one should be invited to a textual criticism of Weismann's words in order to ascertain the significance of the term "acquired characters." The term and the discussion about the inheritance or non-inheritance of acquired characters were not invented by Weismann! They have been familiar ever since the discussion of Mr. Darwin's book on the "Origin of Species," commenced thirty-five years ago. The term has been explained and amplified over and over again. It really dates back to Lamarck; and I should propose, when anxious to know the meaning of a term associated with Lamarck's doctrine, to investigate Lamarck's writings rather than Weismann's.

Lamarck's "Philosophie Zoologique" was published in 1809. On p. 235 of vol. i. of the reprint of this work, issued in 1873 under the direction of Prof. Charles Martin, Lamarck states his two "laws" of organic development. They run:—

Première Loi.—"Dans tout animal qui n'a point depassé le terme de ses développements, l'emploi plus fréquent et soutenu d'un organe quelconque fortifie peu à peu cet organe, le développe, l'agrandit, et lui donne une puissance proportionné à la durée de cet emploi; tandis que le défaut constant d'usage de tel organe l'affaiblit insensiblement, le détériore, diminue progressivement ses facultés, et finit par le faire disparaître."

Deuxième Loi.—"Tout ce que la nature a fait *acquérir* ou perdre aux individus par l'influence des circonstances où leur race se trouve depuis longtemps exposée, et par conséquent, par l'influence de l'emploi prédominant de tel organe, ou par celle d'un défaut constant d'usage de telle partie: elle le conserve par la génération aux nouveaux individus qui en proviennent, pourvu que les changements *acquis* soient communs aux deux sexes, ou a ceux qui ont produit ces nouveaux individus."

I have italicised two words in this quotation. It is to this doctrine of Lamarck that the short term "doctrine of acquired characters" has been and is applied.

In the report of a lecture given by me, at the London Institution, in February 1889 (published in NATURE of that date), on "Darwin *versus* Lamarck," the two laws of Lamarck were quoted in full. In lectures given some three years earlier I had pointed out that there is no satisfactory evidence that animals or plants transmit by generation the characters acquired by the individual in the way supposed by Lamarck.

It is, I admit, a very difficult matter to determine whether a particular character which makes its appearance in the course of the life of an organism has been "inherited" (*i.e.* is congenital) or "acquired." But that has nothing to do with the question as to what we should mean when we say "acquired characters." The answer to that seems to be certain and simple. It is given by Lamarck, and the term directly refers to Lamarck's doctrine.

On the other hand, it is the fact, as Sir Edward Fry points out, that Weismann and others have employed the term "acquired characters" in an extended and modified sense. To this extension I will refer in another letter.

E. RAY LANKESTER.

WE must all agree with Sir Edward Fry's desire to obtain a clear and exact definition of an "acquired character," as this term has been used in the discussions upon hereditary transmissibility. I do not think, however, that those who have taken part in the various controversies and discussions which have raged intermittently during the last seven years, have been misled by the lack of a sufficiently exact definition or the multiplicity of inexact ones. I believe that both sides have known well enough the kind of character which was called acquired, even though no sufficiently clear definition was forthcoming. And it may be that this mutual understanding has tended to obscure the demand for a definition.

An acquired character has generally been briefly defined as "the result of the operation of some external force upon an organism," and I still think that this is as satisfactory as any definition of equal brevity can be. But some want of clearness follows from the elasticity of the word "result." Everything that follows the operation of some external force may be called its "result"; but the definition interpreted in this way would include much that is not within the meaning of the word "acquired." Some increased precision may be added by using the words "direct result"; but a perfectly satisfactory definition should, I think, imply the admission that the result (in its wide sense) of an external force on an organism must always contain elements which are not due to the force—which are not acquired—as well as those which are due to the force and which are acquired. I think that the following definition will meet the case: "Whenever an organism reacts under an external force, that part of the reaction which is directly due to the force is an acquired character."

In many cases the external force acts only as a shock, with the *starting* of reaction as its only direct result. In such a case the occurrence of the reaction, as contrasted with the sequence of events which make up the reaction itself, is the acquired character. In examples such as these, those who maintain the transmission of acquired characters would be required to prove that the reaction which could only be started by an external force in the parent, started without this stimulus in the offspring.

I believe the definition suggested above meets all Sir Edward Fry's conditions—viz., that it includes all "acquired" characters, and excludes all that are not acquired; that it is physical and not metaphysical; that it is not "stated in terms derived from hereditability or the contrary, or in terms of any hypothesis or theory"; and that it admits of ascertainment and verification.

That a reaction under an external force is compounded of two parts, due respectively to the body which reacts, and to the force which causes the reaction, is a fact and not a theory or hypothesis. It may be urged, however, that the separation of the two constituents does not admit of "ascertainment and verification." This may be true, in the present state of our knowledge, for certain cases; and if so, these cases would be unsuitable for the purposes of an inquiry into the transmissibility of acquired characters. But I do not admit that it is proved that the two constituents of the reaction cannot be separated in every case by a sufficiently careful investigation. For the purposes of this inquiry it is sufficient, however, if we can prove beyond doubt that some part of a reaction is the direct result of an external force, even if we have not thereby exhausted the whole of the direct results contained in the reaction. For if this can be done in a vast number of cases, an immense body of evidence will be provided, and we may expect that, if acquired characters are transmissible, some proof will be forthcoming.

I propose to test the efficiency of the definition given above, by showing how it can be applied to some of the examples given in Sir Edward Fry's letter.

In the case of the "exercierknochen" it is clear that the *occurrence* of the reaction—the existence of the bony growth—is the direct result of the external force. Here then is an acquired character which will be admitted by everyone, which can be witnessed in a vast number of examples, and which can be conveniently applied to test the transmissibility of such characters. There may, or may not, be other direct results contained in the reaction: some of the processes of osseous growth may have followed directly from continuous or intermittent pressure. But in the first place the verification is much more difficult, although not, I believe, beyond the reach of scientific inquiry, and, in the second place, such proof, if obtained, would yield evidence which would be far more difficult to obtain in very large quantity.

It is clear that when Prof. Weismann admits that "the periodical change of leaf in temperate climates has been produced *in relation to* the recurring alternation of summer and winter," he is referring to the selection of inherent characters, and not the production of acquired characters. The sentences which follow the one quoted (p. 406), leave no doubt upon this point. Sir Edward Fry may feel assured that when any direct results of heat, cold, air, food, moisture, gravity, or light upon the organism are proved to be heritable, the controversy is at an end.

The case of geotropism logically resembles that of the "exercierknochen." The *occurrence* of the reaction is certainly a direct result of the external force—an acquired character; and here too we have an immense body of evidence to which to appeal, and which points only in one direction. In spite of the innumerable generations during which plants have assumed certain relative proportions under the influence of gravity, this influence is just as necessary to-day as it has ever been, and the youngest generation starts unbiassed by the direct result of external forces upon its ancestors.

As regards the "extra fingers or toes, patches of grey hair, moles, &c.," the question is raised as to whether external forces are not involved as direct causes. If this can be proved the question at issue is settled, for such characters are known to be transmissible. If not, the observation merely shows us that certain characters, not proved to be acquired, are transmissible. But if the non-transmissibility of those proved to be acquired has been established on a sufficiently large scale, then the observation in question, accompanied by the continued absence of proof that the characters in question are acquired, may be fairly held to indicate the existence of two contrasted classes of characters, which we may call spontaneous or inherent, and acquired.

We are asked if we have any scientific knowledge of the organic world independently of any external influence. This method of eliciting an answer must not be allowed to disguise, as it appears to do, the very positive knowledge we possess of the separate effects of the several external influences. This is a legitimate province of scientific investigation, and a large amount of research at the present day is devoted to such questions.

In handwriting the two constituents of the reaction are somewhat difficult, but by no means impossible, to distinguish. The external influence of training operates upon the most complex part of the organism, the nervous system, which again directs the muscular system. Is the style of handwriting due to the external force, or the organism which reacts? We can eliminate pen, ink, and paper as influences by only considering the cases in which these have been identical. There remains the influence of the teacher, and in order to prove that this has been the direct cause of style, it must be shown that the teacher had produced the same style in many pupils. If a style so produced became hereditary, evidence of transmissibility of an acquired character would be provided. Conversely, variety of style under the same conditions of teaching, &c., would favour the view that we are not dealing with an acquired character in this part of the reaction.

It is unnecessary to consider further the cases of mutilation and wounds, for I imagine that Prof. Weismann, and all who agree with him on this subject, will be willing to accept the clear statements of Sir Edward Fry's letter. "What the organism transmits is the capacity or predisposition, and not the actual result of the reaction." The latter in these cases is an acquired character, while no one has ever shown that there is any probability that the former is acquired.

I have, in this letter, avoided reference to many points raised by Sir Edward Fry, not from want of interest or inclination, but in order to keep to the main issue—the attempt to furnish a clear definition of the class of characters in question.

If acquired characters are transmissible, we must expect that sooner or later among the vast body of characters which are or will be admitted on all hands to be acquired, some valid instances of hereditary transmission will be forthcoming.

Such cases as that mentioned by Dr. Hill in NATURE of October 25, when on a sufficient scale and adequately sifted, would supply the requisite evidence. But up to the present such satisfactory evidence has not been forthcoming, although it has been sought for by many observers. EDWARD B. POULTON.

Oxford, November 4.

THE following seems a passable definition, such as Sir Edward Fry asks for in his letter of November 1. But, in offering it, I only speak of the sense in which I myself use the expression.

Characters are said to be acquired, when they are regularly found in those individuals only, who have been subjected to certain special and abnormal conditions.

FRANCIS GALTON.

Science Teaching in Schools.

TWO articles have recently appeared in NATURE which call for some comment, if the columns of your journal are to be opened once more to a discussion of this question. Educational reformers will agree heartily with the general position taken up by Mr. H. G Wells, in "Science, in School and after School" (vol. l. p. 525), and by Prof. Armstrong in "Scientific Method in Board Schools" (p. 631). But they either ignore or give very little credit for the honest science teaching that is actually being done at the present time. I realise, only too personally, the great difference between training in scientific method and mere instruction in science; and how few are the attempts to make use of the former in all grades of schools. But I hold that the old-fashioned instruction in science has, under favourable conditions, a considerable *educational* value. To have enabled a boy to realise the composition of the air and water is to have introduced him to the world of nature, and has widened his ideas and conceptions to an extent which justifies the means. Was not this one of the original pleas for the introduction of science into the school course? But having entered my protest, I will pass on.

Mr. Wells admirably distinguishes between the two styles of science teaching, and points out the original function of the Science and Art Department in encouraging and examining only the one of them. But he admits that the field of operation of the Department has been very much widened in recent years, and that its examinations "seriously affect the teaching of middle-class, and even of the higher standards of elementary schools." Yet his only suggestion is that the Department should withdraw from this work; for that would be the effect of an age limit, and is intended to be the effect of the recent alteration in the regulations in the elementary stage.

But circumstances are such that the Department cannot and ought not to withdraw from its present control of science teaching in *day-schools*, for its influence is greater than that of any other examining body; not simply financially, but from the magnitude of its operations. It is a historical quibble to say that the Department is concerned primarily with continuation and adult classes, when it specially encourages the formation of organised science day-schools, and yet rigidly confines the teaching in them to the schedules devised for adult instruction.

Last session there were 94 organised science day-schools, containing about 10,000 pupils taught on the lines laid down by the Department. As is well known, the majority of these are what are otherwise known as Higher Grade Board Schools, which are absolutely dependent for their existence on the grants obtained from the Department. I take it as indisputable that this is the very class of schools where the science ought to have an educational basis; where its function is "to develop and train the hand, eye and mind together, enlarge the scope of the observation, and stimulate the development of the reasoning power." I also believe that many of the teachers are anxious to make it so, judging from their liberal denunciations of the present "pernicious system." Equally axiomatic is it that, under the Science and Art Department, it is impossible to indulge in such teaching. Time will not permit. The pressure is so great that oxygen and water are almost always written and spoken of as O and H_2O.

Mr. Wells considers other examining bodies, whose work is exclusively directed to school needs, are far more blameworthy. This I absolutely deny. In the first place, the South Kensington examinations are the only ones which are entirely controlled by scientific men. The sole cause for the existence of the Department is the encouragement of science and art, whereas the other bodies referred to provide for the examination of secondary education generally; and the examining board may not have a single representative of science upon it. But further, assuming that the South Kensington examinations are neither better nor worse than others, there are two causes which make them an educational abomination.

(1) In one year the pupils have to be rushed through such an excessive amount of work that the teaching degenerates into the merest cram. The Department distinctly states that students in the first year are to be prepared for the first stage, and in the second year for the second stage. Putting aside entirely the consideration as to whether the scheme is any particular subject, as chemistry, will any practical teacher deny that the requirements for either the first or second stage are far beyond what it is possible to accomplish with satisfaction within the given time? It must be kept in mind that the time-table has to provide not only for the seven or eight subjects of which the Department takes cognisance, but "for instruction in those literary subjects which are essential for a good general education." Do not these latter often suffer in favour of the former, especially at the approach of May?

(2) The consequence of this restriction is that boys scarcely in their teens enter by thousands for an examination beyond their normal capacities. It is in this that the South Kensington examinations differ so entirely from those of the Universities. The difference in standard between the Department's examination in chemistry and the Cambridge Junior Locals or London Matriculation is not great; but in practice, the average age of candidates in the latter is higher by two or three years. Time is allowed for the awakening and development of the powers of observation and reasoning. A boy is then able to describe intelligently what he has become thoroughly familiar with, instead of reproducing mechanically his notes or text-book.

In still another particular have the University Boards a decided advantage. Either they dispense altogether with an examination in practical chemistry, or they make something more of it than an analytical drill. Not much, it is true, but it must be remembered that practical chemistry is the most perverted subject in the whole range of knowledge at the hands of both teachers and examiners. But the greatest mockery is that which passes under the name at South Kensington. Of the written part of the examination it is needless to say anything; no boy would regard it as a test of what he has done in the laboratory, but what he has seen in the lecture-room. As to the analysis of salts, what bearing has it on the chemistry he is being taught elsewhere? Though at a certain stage it has a considerable educational value, the amount of time wasted upon it is appalling. It is useless to reiterate how easily it lends itself to being converted into a mechanical grind.

Mr. Wells is of the opinion that the recent abolition of the second class pass in the May examinations has had a beneficial effect. So it may, in extinguishing what might be termed "bogus" classes. But it has only intensified the evils in organised science schools, and put a higher premium on the cleverest cramming. The change did not deter such schools from sending in their pupils as before, but now they had to obtain 60 per cent. of the possible marks, or fail—and most of them failed. This year there were fewer failures, because the teaching has answered to the whip. Financially the result is satisfactory to them, but educationally it is disastrous. At that age the average boy is not capable of obtaining more than forty or forty-five per cent. of the marks in such a subject as chemistry. Very often he does not understand the full meaning of the question; and when he does, he is unable to write down more than a moiety of what he knows, or what could be drawn from him by a series of oral questions. There is no consideration shown for the immaturity of the candidates, but the standard is pitched higher than that of any other public examination in the country.

So far from agreeing with Prof. Armstrong that science must be admitted to equal rights with the *three R's*, I hold that it is taught too extensively as long as the present system of examination prevails, and that the first battle to be fought ought to be against the South Kensington examinations, until they truly perform their double function.

W. B. CRUMP.

Heath Grammar School, Halifax.

WILL you allow me to take the opportunity afforded by the publication, in NATURE, vol. l. p. 631, of Prof. Armstrong's address at the Berners Street Board School, to offer my testimony to the value of teaching, based on the principles which he advocates so eloquently? The *practical* difficulty of teaching what Prof. Armstrong has called scientific method in an ordinary school, is often the ground of the objection made to it, so that it may interest your readers to hear of any experiments in this direction.

My work has been amongst girls, and the attempts made thus far in teaching scientific method in girls' schools show that such a method will inevitably lead to the development desired by Prof. Armstrong.

Doubtless one of the drawbacks is the difficulty of giving to each member of a large class the opportunity of individual work. I am not sorry, however, to have sometimes laboured under this difficulty myself, as it has brought about the discovery of how much could still be done on the right lines. When necessary I have replaced individual work by a demonstration class, in which the pupils, three or four at a time, have taken it in turns to work in front of the others, the work consisting in the solution of problems such as those suggested in the British Association's report on chemical teaching. The principal results are these: the children take a growing interest in the work, and those who are doubtful how far girls may desire to work with their hands, instead of always sitting still, may be glad to hear that no greater incentive to invention can be given in a demonstration class than the reward of becoming the experimenter for the time being. There is never any lack of suggestion for the next step in the work, and the rapidity with which such work trains the girls to consider the value or defects of any new proposal for the solution of their problem, is sometimes astonishing. In these classes the teacher plays a very small part—at least, apparently—only from time to time directing the suggestions, and giving permission for new work to be started; invention, experiment, meaning of results, and criticism are all undertaken by the children, and the final "discovery" is their own triumph.

I have often been asked by teachers about the discipline of such a class, since experimental work goes so slowly that they think it would be impossible to keep those who are not actually at work attentive. I can only say that the class consists of a group of people genuinely interested in a common object, and it behaves in the way such groups generally do. If at times a girl's enthusiasm so far carries her away that she rushes from her seat to the experimenting table, the class, with a laugh, excuses her, sympathises with her feelings, and is not disturbed thereby.

It seems unquestionable that the result of such work should have a wider-reaching effect than the mere knowledge of certain facts in nature, though such knowledge is also obtained. Where children, through their own work, have been led to observe and then to think, the result may fairly claim to be truly educative, and one is often at a loss to understand what support can be found for the still largely-existing method of teaching not science but "useful information."

Another objection often made to teaching scientific method instead of facts, that it takes too much time, I have already answered in this journal. I may perhaps be permitted to repeat that experiment shows the result of elementary training, of the kind described, to have a lasting influence on the rapidity and comprehension with which new subjects are grasped later on. Books, too, which are never put into the hands of beginners, are used with more than ordinary sense at this later stage. I may say that, even from the examination test (which, however, is not always going to be our standard), the results are very favourable. One thing, however, cannot be done by the teaching of scientific method, and that is to prepare for the London Matriculation examination in chemistry in three months—but then, is that altogether to be regretted?

GRACE HEATH.

North London Collegiate School for Girls, November 5.

Italian Scientific Expedition to Monte Rosa.

IN the summer of this year, my assistant Dr. L. Scofone and I stayed a month at the Alp of Lavez in the valley of Gressoney, near the foot of the Indren glacier, at an altitude of 2450 m., not far from the place where the brothers Schlagintweit spent some days in 1851 while engaged in their well-known scientific observations on Monte Rosa.

We purposed to examine, both chemically and bacteriologically, the composition of the waters of that region (inclusive of snow and ice); some of the analyses (ammonia, nitrites, nitrates and organic matter) were made directly on the spot, where we had a small laboratory. To be able to carry the waters to Turin, for further analysis, we had only to evaporate them, and seal the residues in little glass bottles by means of a blowpipe. The detection of germs was made by using agar and gelatine plates enclosed in the well-known Petri's glass-boxes; gelatine, agar, pipettes, and other instruments being duly sterilised first in Turin, and then at Lavez, with a good hot air oven. The development of germs was secured by putting the plates in an incubating oven.

We also collected the water of the Indren torrents issuing from the glacier, and measured the amount of suspended matter in the water, which can give an idea of the process of erosion that takes place in the bed of the ice stream.

The results of the various observations will be published in the scientific papers of Turin as soon as the study of the collected material has been completed. It will perhaps interest your readers to know that while the water of the springs, streams and lakes was constantly free from ammonia, there was found a tolerable quantity of it in the snow collected on the summit of the Punta Guifetti or Signal Kuppe, one of the loftiest peaks in the Monte Rosa range, measuring 4539 m. The ice of the Lys Glacier, dug out from the depths of a huge crevasse, also contained ammonia; nitrites and nitrates being absent in every case. Accordingly we found that the water of the Indren stream, during a very hot day, when the melting of the ice was considerable, contained traces of ammonia.

We also found that the ice and snow collected on the various peaks, passes, and snow-fields of the Monte Rosa range, contained a few germs. The number of the species whose germs can thrive at those heights is certainly not large; the usual forms, living in decayed matter and in the intestines, cannot probably endure the condition of temperature, pressure and light of the place.

Turin, October 28. PIERO GIACOSA.

Chinese Beliefs about Caves.

MR. HERBERT SPENCER, in his "Principles of Sociology" (3rd edition, New York, vol. i. p. 207), relates the beliefs in the creation of mankind under the ground or in caverns, current among the Todas in Asia, the Basutos in Africa, and at least one-half of the American tribes. A similar belief I have lately found in a Chinese record. In Li Shih's *Süh Pöh-wuh-chì* (written in the 13th cent. A.D., Japanese edition, 1683, tom. ii. p. 3) a quotation from the *Ning-kwöh-lun* runs as follows:—"Primitively there was no Liáu-Kién in Shuh (now Sze Chuen); this tribe emanated from red clay in a cave of Teh-yáng mountain, whence bits of the soil had began to roll out, each roll enlarging them, so that at last thereby was created a couple, who gave birth to many."

In another paragraph Mr. Spencer remarks:—"Stationary descendants of troglodytes think that they return into a subterranean other-world whence they emerged (*ibid.* p. 213). According to this, I would suggest that the same belief, entertained by some aborigines in China, has revived itself among the Taôists, who used to call their paradise the "Cave-Heaven" (Tung-Tièn)—*e.g.* Twan Chìng-Shih describes the "Cave-Heaven" 10,000 *lis* in circumference and 2600 *lis* in height (his "Miscellanies," Japanese edition, 1697, tom. ii. p. 1), and Li Shih enumerates thirty-six caves in the empire, all entitled "Heavens" (*ibid.* tom. i, p. 8).

KUMAGUSU MINAKATA.

15 Blithfield Street, Kensington, W., November 2.

Spots over Dogs' Eyes.

I WOULD have written a note on this subject long ago, had I not failed to see similar spots general amongst wild animals allied to the dog. The spots may, however, be more general than I am aware. The spots are by no means always tan; a black dog will sometimes have them white, and a white dog black. I have a white-and-tan fox-terrier, in which the spots are very eye-like and jet black; in a brown bull-pug of mine, the spots are also black. These spots are so eye-like, that when the dogs are asleep they seem at first sight to be wide awake.

Has not the human eyebrow, highly developed in some crude races, as in Australians and Ainos, a similar meaning? The eyebrow gives many sleeping persons the appearance of being awake. WORTHINGTON G. SMITH.

Dunstable.

Gravitation.

IN his interesting paper upon the "Mechanical Stretching of Liquids" (*Phil. Trans.* 1892, A, p. 370), Prof. Worthington describes a phenomenon of attraction between bodies immersed in a stretched liquid. His explanation is ingenious: that the close contact of the bodies liberates from a denser surface layer, liquid which will go to supply the prevailing demand, and so lower the energy of the stretched liquid.

Whether this be a quite correct explanation or not, does not the experiment suggest the possibility of an analogous phenomenon occurring in a tensile ether in which matter is immersed; giving rise to the effects which we appreciate as gravitational attraction? J. JOLY.

Trinity College, Dublin, November 6.

Homogeneity of Structure the Source of Crystal Symmetry.

To the lucid notice of my paper, "Ueber die geometrischen Eigenschaften homogener starrer Strukturen und ihre Anwendung auf Krystalle," contained in your issue of October 18, it is perhaps desirable to add a remark.

The paper referred to is purely geometrical; it starts with a definition, and not with a supposition. Consequently the various new theories advanced by the writers referred to in the notice receive no support from it.

Homogeneity of structure pure and simple, unaided by any theory as to the nature of matter, leads inevitably to all the varieties of symmetry presented by crystals. It is useless, therefore, to look to the facts as to this symmetry for any light upon the vexed question whether the seat of the symmetry is in the arrangement or in the configuration of the molecules, or, indeed, for any proof of the existence of molecules or separable units. WM. BARLOW.

Muswell Hill.

THE PRESENT STATE OF PHYSIOLOGICAL RESEARCH.

THE following extracts from an article by Prof. Max Verworn, of Jena, on "Modern Physiology," published in the *Monist* for April 1894, seem to be well worth the attention of English biologists. It would be interesting to obtain in the pages of NATURE an expression of opinion from our physiologists as to how far the reproach is true, that "in treading the beaten paths we are making no progress in physiology, and have stood still for years on the same spot." How far is it true that physiologists must revert to the point of view of comparative physiology, or the physiology of the endless variety of lower and simpler forms of life which was that which formerly so fruitfully shaped the research of the great master Johannes Müller? Is it, or is it not, time that the methods of horological physiology were less dominant and gave place to a determined and persistent study of living structure in its varied manifestations other than the frog and the rabbit?

"Psychologically, it is a highly interesting phenomenon, and one of moment in the history of science, that now, almost immediately after the final suppression of the old vitalism by the new development of the natural sciences, we have again arrived at a point which corresponds in the minutest details to the reversion to mystical vitalism which took place after the clear and successful research of the preceding century. As a fact, the parallel between the conditions of the eighteenth century and those of to-day is unmistakable. Now, as then, the physico-chemical method of explaining phenomena of life looks back on a brilliant, almost dazzling sequence of successes; now, as then, the tracing of vital processes to physical and chemical laws has reached a point at which, for many years, with the methods now at our command, no essential progress has been made, where, on the paths hitherto trodden, a boundary line is everywhere distinctly marked; and now, as then, on the horizon of science the ghost of a vital force looms up. It has already taken possession of the minds of serious thinkers in Germany, with the dire prospect of more extensive conquests; and in France, too, it would seem, science is slowly opening its door to this invasion of genuine mysticism.

"To understand this phenomenon psychologically, and to acquaint ourselves with the means of staving off a general reaction into vitalism, it is desirable to examine more carefully the present state of physiology. A review of the productions which appear in our different physiological journals, which will best exhibit the present state and tendency of the science, furnishes an extremely remarkable spectacle. Leaving aside the science of physiological chemistry, which is independently developing with great success, we find, with the exception of a few good contributions to the physiology of the central nervous system, as a rule, only extremely special performances of very limited scope and import, wholly without significance for the greater problems of physiology, whether practical or theoretical, and exhibiting no connection whatever with any well-defined general problem of physiology. In fact, what is called physiology is beginning here and there to degenerate into mere technical child's play. With every new number of our physiological magazines, the unprejudiced observer is gradually gaining the conviction that general problems of physiology no longer exist, but that inquirers, driven to desperation in the struggle for material, have no choice but to hunt up the old dry bones of science, on which they fall with the nervous rapacity of hungry dogs. And in the case of most of the productions, this impression is strengthened by the fact that the results, when once found, are wholly disproportionate to the tremendous expenditure of labour and time which it might be seen beforehand they would require. And yet all the time the great problems of physiology everywhere stare us in the face and seek solution. For, if we regard the problem of physiology as the investigation of the phenomena of life, we are certainly yet very far from the solution of even its most important and most general problems. We need not go to the extreme that Bunge does in his excellent text-book of physiological chemistry, of maintaining that the phenomena of our organism which we have explained mechanically are not genuine vital processes at all, no more than is 'the motion of the leaves and branches of a tree shaken by a storm, or the motion of the pollen which the wind wafts from the male to the female poplar.' But it is certainly no exaggeration to say that what the splendidly-conceived methods of the great masters of physiology since Johannes Müller have explained, are not elementary processes of life, but almost exclusively the crude physical and chemical actions of the human body.

"For what have we attained? We have measured and registered the motions of respiration, the mechanics of the gaseous exchange in the lungs in their minutest details. We know the motions of the heart, the circulation of the blood in the vascular system, nay, even the slightest variations of the pressure of the blood, as produced by the most diverse causes, as accurately as we do the phenomena of hydrodynamics in physics. We know that respiration and the motion of the heart are conditioned by the automatic activity of nervous centres in the brain. But no spirometer, no kymograph, no measuring or registering apparatus can give us the slightest idea of what takes place in the nerve-cells of the brain that condition the beating of the heart and respiration.

"Further, we have investigated the motions of the muscles, their dependence on the most diverse factors, their mechanical powers, their production of heat and electricity, as exhaustively as only the phenomena of the special departments of mechanical physics have hitherto been treated. But of what goes forward in the minute muscle-cells during simple muscular contraction, no myograph, no galvanometer has as yet given us the slightest hint.

"We know also the laws of the excitability of the nervous fibres, of the propagation of irritations, of the direction and velocity of nervous transmission, thanks to the ingenious methods of recent physiology, in all their details. But of what is enacted during these processes in the nerve-fibres and in the ganglion-cell from which it ramifies, no induction-apparatus or multiplicator can give us the least information.

"We know besides, that the heat and electricity produced by the body, and the mechanical energy of muscular work, are the consequence of the transformation of the chemical energy which we have taken into our bodies with our food. But by means of what chemical processes the cells of the individual structures take part in these achievements, the most sensitive thermometer or calorimeter will not disclose, and no thermal pile or graphical apparatus will indicate.

"We might give any number of examples of this kind, but those adduced exhibit distinctly enough the point to be signalised. What we have hitherto attained is this: we have measured, weighed, described, and registered the gross mechanical actions of the human body, for the most part with a degree of precision that would excite the astonishment of the uninitiated; we have also acquired a considerable knowledge of the rough mechanical interactions of the individual organs of the body, the mode of operation, so to speak, of the machinery of organisms. But all that has been done, has been done only up to a certain point; and this point, at which we are brought to a halt, is the *cell*. We have traced all phenomena of change in matter, form, and force back to the point where they disappear in the cell. But of what takes place in the muscle-cell, the ganglion-cell, the lymph-cell, the gland-cell, the egg-cell, the sense-cell, and so forth, we have not the slightest conception. Moreover, we discover here, that even the minutest cell exhibits all the elementary phenomena of life; that it breathes and takes nourishment; that it grows and propagates itself; that it moves and reacts against stimuli. The *elementary* riddles of life, accordingly, have so far defied all research.

"A balance thus cast of the results of past physiological research does not, it must be admitted, exhibit a very encouraging outlook.

"But the resignation of physiology has been strengthened by another prominent factor. This is the attitude of physiological research to psychical phenomena. This attitude is at the present moment a varying one. On the one hand, we still find secretly cherished the vain hope of a chemical and physical explanation of psychical processes, that is to say, of a reduction of them to the motions of atoms, even though Du Bois-Reymond, in his famous address on 'The Limits of Our Knowledge of Nature,'[1] characterised such an understanding as utterly futile; while on the other hand we meet with an absolute resignation in the face of this question—an attitude which is simply a frank acceptation of the conclusion of Du Bois-Reymond's, address. Owing to the authority of its author, the 'Ignorabimus' of Du Bois-Reymond has influenced great numbers of inquirers, and produced in physiology a real paralysis of research, so that the abandonment thus effected of the solution of the old problem of explaining psychical phenomena mechanically has caused physiology for the most part anxiously and reverently to avoid any intrusion whatever of psychological questions. On the one side, then, is the idle hope of solving a problem which, despite its being as old as human thought itself, research has not yet even touched; and on the other, an absolute renunciation of any treatment of the problem whatsoever.

CELLULAR PHYSIOLOGY.

"If on the one hand we can justly cherish the hope that the increasing extension of the monistic world-view in natural science will ward off the dangers of a reaction to the old vitalism, the fact nevertheless remains that in treading the beaten paths we are making no progress whatever in physiology, and that we have stood still for years on the same spot, and not approached a single step nearer our goal of explaining the elementary phenomena of life.

"We have reached a turning-point in physiological research which could scarcely be made more prominent. The reappearance of vital force is a token of it. As before all great crises of history portentous spirits appear to clairvoyant people, so in our days the ghost of the old vital force has loomed up in the minds of some of our natural inquirers.

"But striking and obvious as the fact is that we can no longer approach by the old paths of research an explanation of the elementary phenomena of life, still, it is exactly as obvious and striking in what direction there is the only chance or hope of our approaching our goal.

"We have traced the vital processes of man in physiology back to the point where they are lost in the cell. Now, what is more reasonable than that we should seek them out in the cell? In the muscle-cell is hidden the riddle of muscle-movement, in the lymph-cell is hidden the causes of secretion, in the epithelial cell is buried the problem of resorption, and so on. The theory of the cell has long since disclosed that the cell is the elementary foundation-stone of the living body, the 'elementary organism' itself, that in which the processes of life have their seat; anatomy and evolution, zoology and botany, have long since realised the significance of this fact, and the wonderful development of these sciences has furnished a brilliant proof of the fruitfulness of this branch of inquiry. Only in physiology was the simple, obvious, and logical consequence overlooked, and until very recently not practically applied, that if physiology regards it at all as her task to inquire into the phenomena of life, she must seek these phenomena at the spot where they have their origin, at the focus of life-processes, in the *cell*. If physiology, therefore, is not simply content with confirming the knowledge which is already gained of the crude mechanical actions of the human body, but makes it its object to explain clearly elementary and general phenomena of life, it can accomplish this object only as cellular physiology.

"It may appear paradoxical, that although nearly half a century has elapsed since Rudolf Virchow first enunciated in several classical works the cellular principle as a basis of all organic inquiry, a basis on which to-day, indeed, all our ideas in pathology are constructed, physiology still is only just beginning to develop out of a physiology of organs into a physiology of cells. Yet this is the true and normal course of development of science which always advances from the crude to the delicate. And it would therefore be impardonable ingratitude, and a mistaking of the mode of development of human knowledge, if we should seek in the least to underrate the high importance of the physiological research of the past epoch, on whose shoulders in fact we stand, and with whose results we more or less consciously continue our work. Further, in our judgment of the course of development of physiological research, a factor must not be overlooked which controls the development of every science, namely the psychological factor of fashion. The development of every science depends on the stupendous influence of great discoveries. Wherever we cast our eye in the history of inquiry, we find that great discoveries such as, to take the case of physiology, are represented in the works of Ludwig, Claude Bernard, Du Bois-Reymond, and Liebig, deflect interest from other fields and induce a great multitude of inquirers to pursue research in the same direction, with the same methods, especially when these methods have proved themselves so wonderfully fruitful as in the cases adduced. Thus, certain departments of inquiry become, in connection with epoch-making performances, fashionable, and the interest of thinkers in others subsides. But an equalisation in the course of time is always re-effected, for every field of inquiry, every method of inquiry is finite and exhausts itself in time. We have now reached just such a point in physiology: the physiology of organs is in its period of exhaustion. Also the method of cellular physiology will exhaust itself in the course of time, and its place will be taken by other methods which the present state of the problem do not yet require.

But for the present the future belongs to cellular physiology. There are, it is true, inquirers who, although they are convinced of the present necessity of a cellulur physiology, and see perfectly well that the cell as the focus of the processes of life must now constitute the real object of research, yet doubt for technical reasons whether it is possible to get at the riddles of life as they exist in the cell. It may, therefore, be justly demanded that some way, some methods be shown with which a cellular physiology can be founded. The doubt of the feasibility of this undertaking is in great part the outcome of a phenomenon, which, unfortunately we must say, has characterised physiology ever since the death of Johannes Müller, namely, the total lack of a comparative physiology. Physiology has not yet entered on this rich inheritance of the great master. How many among the physiologists of the day are acquainted with other objects of experiment than the dog, the rabbit, the guinea-pig, the frog, and a few other higher animals! To how many are the numerous and beautiful objects of experiment known which the wonderful luxuriance of the lower animal world offers! And yet, just among these objects are to be found the forms which are best adapted to a cellular-physiological solution of physiological problems.

"Naturally, if we believe we are limited, in our cellular-physiological treatment of the riddles of motion, digestion, and resorption, solely to man and the higher animals, we shall encounter in our investigation of the living muscle-cell, lymph-cell, epithelial cell, and so forth, more or less insuperable technical difficulties. And yet the splendid researches of Heidenhain on secretion, digestion, lymph-formation, and so forth, have shown what good results the cellular-physiological method can achieve even here. Well-planned histological experiments, such as those which put the living cell in its intact connection with the remaining woof of the body under given conditions, and then investigate the results

[1] *Ueber die Grenzen des Naturerkennens. Reden. Erste Folge.* Leipsic, 1886.

in the suddenly slaughtered animal, to get from such experiments light on the processes peculiar to the condition of life, undoubtedly furnish the germ of much valuable knowledge. But it is of the very nature of these experiments that they must always remain difficult and restricted, for the *living* object, the tissue-cell, is accessible to microscopic investigation only with the greatest difficulty. Comparatively small difficulties in this respect are offered only by the free-living cells of the organism, as, for example, by the leucocytes or blood-corpuscles. And as a fact, by the researches of Metschnikoff, Massart, Buchner, Gabritchevsky, and many others, we have recently acquired some important and wide-reaching experimental knowledge concerning the vital phenomena of these very objects.

"But if we place ourselves at the point of view of comparative physiology which Johannes Müller represented throughout his whole life with such success and energy, an infinitely broad perspective opens itself up for cellular investigations. A comparative view shows one fact of fundamental importance, namely, that elementary life-phenomena are inherent in every cell, whether it be a cell from the tissues of higher animals or from the tissues of lower animals, whether it be a cell of a plant, or, lastly, a free cell, an independent unicellular organism. Every one of these cells shows the general phenomena of life, as they lie at the basis of all life, in their individual form. With this knowledge, all that it is necessary for the inquirer to do is to select for every special object of experiment the fittest objects from the wealth of forms presented, and with a little knowledge of the animal and plant world, such forms really obtrude themselves on the attention of the experimenter. Accordingly, it is no longer necessary to cleave so timorously to the tissue-cells of the higher vertebrate animals, which, while alive and in normal environment, we can only use for microscopic experiments in the rarest and most exceptional cases; which further, the moment they are isolated from their tissues, are no longer in normal conditions, and quickly die or give reactions that may easily lead to wrong conclusions and to errors. Much more favourable are the tissue-cells of many invertebrate, cold-blooded animals or plants which can be more easily investigated in approximately normal conditions of life; yet even these, as a rule, will not outlast protracted experiments. But here appear as the fittest imaginable objects, for cellular-physiological purposes, free-living unicellular organisms—namely, protists. They seem to be created by nature expressly for the physiologist, for they possess, besides great powers of resistance, the incalculable advantage of existing in a limitless variety of form, and of exhibiting, as the lowest organisms that exist, all phenomena of life in their simplest conditions, such as are not to be found among cells which are united to form tissues, on account of their one-sided adaptation to the common life of the cellular colony.

"Concerning the application of experimental physiological methods to the cell, we need be in no perplexity as to which we shall choose. In the luxuriant multiplicity of form which this world presents, there can always be found for every purpose a great number of suitable objects to which the most different special methods can be capitally applied.

"We can, to begin with the simplest method, apply in the easiest manner imaginable to the free-living cell the method of simple microscopic observation of vital processes. In this manner mere observation has furnished us knowledge of the individual life-phenomena of cells in many details, and also of their mutual connection. Among the most recent achievements of this simple method may be mentioned only the extremely valuable knowledge concerning the more delicate and extremely minute circumstances of fecundation and propagation which Flemming, Van Beneden, the Hertwigs, Strasburger, Boveri, and many others have gained in recent years, partly from living cells and partly from cells fixed in definite conditions of life.

"Moreover, we can also conduct under the microscope vivisectional operations on unicellular organisms in exactly the same scope and with greater methodical precision than can be done on the higher animals. Several inquirers, as Gruber, Balbiani, and Hofer, have already trodden this path with great success, and a considerable group of researches has shown distinctly enough the fruitfulness which this cellular vivisectional method of operation promises for the treatment of general physiological problems. With this vivisectional method also Roux, the Hertwigs, and others conducted their splendid investigations on the 'mechanics of animal evolution,' by showing what functions in the development of animals fall to the lot of the different parts of the egg-cell, or to the first filial cells that proceed from their division.

"We can also apply here, in its whole extent, that powerful physiological method known as the method of irritation, and investigate the effects of different kinds of irritation on the life-phenomena of the cell or of different cell-forms. The vegetable physiologists have already collected a great mass of material in this field. But also in the department of animal physiology a great number of recent works have endeavoured to prove that the phenomenon of irritation which takes place on the application of chemical, mechanical, thermal, galvanic, and luminous stimuli to unicellular organisms are of the greatest importance for the phenomena of life generally.

"Finally, we can approach the life-phenomena of the cell chemically, although in this direction only the very first beginnings have been made, seeing that the microchemical methods have been hitherto little developed. Nevertheless, the labours of Miescher, Kossel, Altmann, Zacharias, Löwitt, and others have already shown that the microchemical investigation of the cell has a future of great promise."

INK-CRYSTALS.

THE pictorial representations of the forms taken by ice-crystals are familiar to everyone; and many young observers have been grievously disappointed with the difference between nature's handiwork and artistic fancy, as exemplified by the ice-crystals really seen and those which embellish scientific works. These "ice-flowers," as Tyndall called them, cannot always be conveniently produced, so a substitute for them, in the form of "ink-flowers," should be interesting to students of crystallography. Dr. E. Trouessart describes in *La Nature* how "fleurs de l'encre" can be procured, and the accompanying illustration reproduces some of the forms observed by him. The method employed is very simple. A drop of ink is allowed to dry on a slip of glass, and observed under a microscope with powers of

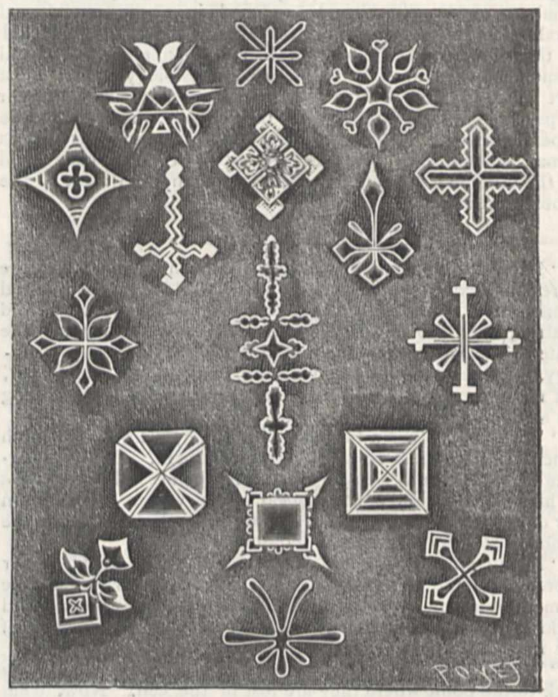

FIG. 1.—Crystals formed by the Evaporation of Ink.

50, 100, or 200 diameters. The inks of commerce vary somewhat in composition, hence the facility with which certain crystalline forms are obtained differs. All inks, however, having a base of solution of gall-nuts and sulphate of iron, give analogous results.

Dr. Trouessart hesitates to express an opinion as to the nature of the salt which crystallises in the forms illustrated. The crystals chiefly belong to the cubical system, and this suggests that they are magnetic oxide of iron. On the other hand, their white colour, and the peculiar shapes of some of the groups of crystals, indicate that iron disulphide or marcasite is the substance in question. Perhaps some worker in chemical crystallography will determine the point.

NOTES.

WE learn from the *Lancet* that the late Prof. Pouchet, of the Muséum d'Histoire Naturelle, has bequeathed his entire fortune to the Paris Society of Biology. The bequest is made in the following terms: "N'ayant pas de famille, je lègue tout ce que je possède à la Société de Biologie, où j'ai toujours trouvé bon accueil et sympathie depuis le jour où j'en ai été membre. Je crois fermement que c'est le meilleur usage social à faire du peu de bien que je laisse environ 2000 francs de rente." (£80 a year).

DR. WALTER DICKSON, R.N., the author of "The Antarctic Voyage of H.M.S. *Pagoda*," and several works on naval hygiene, died on the 9th inst. at the age of seventy-three.

BY the recent death of Lieut.-Colonel Garrick Mallery, in his sixty-fourth year, the U. S. Bureau of Ethnology has lost one of its chief ornaments. The results of his important researches into the sign and gesture language of American aborigines occur in the current annual report of the Bureau.

THE *Times* reports a severe earthquake and volcanic eruption at Ambrym, an island in the New Hebrides group. The disturbance is said to have occurred on October 15, when several severe shocks were felt throughout the whole island. Immediately afterwards the volcano, which is 2500 feet high, was observed to be in active eruption. The lava destroyed the native villages on one side of the island, and a large number of natives sought refuge on board H.M.S. *Dart*, which was cruising off the coast. Considerable damage appears to have been done in a large portion of the island.

THE Christmas course of lectures, adapted to children, at the Royal Institution, will be delivered by Prof. J. A. Fleming, F.R.S. The subject will be "The Work of an Electric Current," and the first lecture will be delivered on Thursday, December 27, at three o'clock.

FOR several weeks the weather over the British Isles has been very unsettled, but no gales of serious importance had been generally experienced until Sunday night, when a deep barometric depression reached our south-west coasts from the Atlantic, accompanied with very heavy rainfall in the south and west; the amount measured at Scilly during twenty-four hours ending 8 a.m. on the 12th instant amounted to over three inches, or nearly the average fall for the month, while at Hurst Castle, on the Hampshire coast, the fall exceeded two inches. The central area of the storm passed the whole length of the English Channel, and crossed the North Sea during Monday night, strong northerly gales being experienced in the rear of the disturbance, accompanied with thunderstorms, hail, and more heavy rain, the amount measured in London on the 13th instant being about 0·75 inch. A very rough sea was experienced in the English Channel and in the Irish Sea. This disturbance was followed by another which approached our extreme north-west coasts on Tuesday night, causing strong gales over all parts of the country, and very heavy rain in the west. The temperature has been from 4° to 6° above the mean; during the week ended the 11th instant the highest maxima recorded were 61° in the Channel Islands, and 60° in the south of England, and the lowest minima fell to 29° in the south-west of England, and to 32° in the Midland Counties.

PROF. GUIDO CORA, of Turin, will, on his approaching birthday, December 20, be presented by his former students with "a special mark of esteem and affection" in the form of a memorial in recognition of the twenty-fifth anniversary of his first published paper. It is well known that he founded and has maintained the geographical journal, *Cosmos*, at his own expense. In order to give his many scientific friends an opportunity of sharing in the general recognition of Prof. Cora's labours, Prof. Paul Revelli, 12 Via Galliari, Turin, is prepared to receive any written "sentiment," portrait, drawing, or signature for the memorial volume. The date up to which such tokens of respect may be sent is extended to March 31, 1895.

DR. DONALDSON SMITH, who left London early this summer to attempt to reach Lake Rudolf from the north-east, has been able to send letters home from a position in 7° 11′ N., and 42° 11′ E., dated early in September. He had formed a caravan at Berbera, started with more than a hundred camels, and travelled south-westward through an unmapped country, of which he has made a running survey. At Turfa he reached a great river, which he believes to be the Erer, and to be continuous with the Webi Shebeli. Being unable to cross, he spent a week in following the course of this river, thirty miles of which he has mapped; and on his return he succeeded in finding a ford, where the caravan crossed with much difficulty. The country was very thinly peopled, on account of wars between the Gallas and Ogadams, but some natives were found to carry letters to the coast, a task which they must have performed very expeditiously. Dr. Smith has made large collections of the fauna and flora of the region traversed, and has had some thrilling adventures with big game. His men were doing well, and he was confident of success in his journey, although the time necessary to complete it appeared likely to be rather longer than was originally expected.

THE death is announced of Colonel R. Y. Armstrong, C.B., F.R.S., late of the Royal Engineers. He was born in 1839, and was the son of the late Rev. W. Armstrong, of Cairy, County Sligo.

IN the last number of the *Scottish Geographical Magazine* Mr. W. S. Anderson, of the Scottish Marine Station, discusses the relative merits of the methods for determining the density of sea-water by means of hydrometers and by direct weighing. He shows that if the temperatures of water, instrument, and air are in equilibrium, and the observations made on land, the *Challenger*-type hydrometer yields results of equal value with those of Sprengel tubes, provided the mean of a large number of observations is taken. At sea the hydrometer is less satisfactory. Mr. Anderson throws discredit on previous work in this direction, and assumes that the work of some earlier observers showed large discrepancies on account of the scale of the hydrometer being read from the wrong end. Unfortunately, he does not make any reference to the place where this work is published. By the use of a very large hydrometer admitting of the detection of extremely delicate differences in density, Mr. Anderson satisfied himself that capillarity has no perceptible effect upon the accuracy of the readings. By a series of observations at different temperatures he has been able to construct new tables for the reduction of observed densities to standard temperature, and for the calculation of the function D, which is the difference of density between the sample and pure water divided by the number of grammes of chlorine per litre, a function to which considerable importance is now attached in the discussion of the relative differences between samples of sea-water.

OUR excellent contemporary, *The Engineering Magazine*, commenced a "Review of the Industrial Press" in the October number, and an index of current technical literature. The object of this review and index is to give concisely-written notices of the most important articles of the month ; and to supply a carefully classified index to all the articles published currently in the scientific and industrial press of the United States and Great Britain. An entirely new feature is the establishment of a department to supply all or any portion of any article reviewed or indexed. That technical journalism has grown to proportions and importance which warrant such a development, is a fact at which we can all rejoice.

OBSERVATIONS on the variations in level of well-water have been made for the last three years at the Observatory of Catania in Sicily, and the first results are described in a paper by A. Riccò and S. Arcidiacono (*Boll. mens. dell' Acc. Cioenia di Sci. Nat. in Catania*, fasc. 37, June 10, 1894.) They classify the movements into progressive, annual and accidental, subdividing the latter into meteoric and geodynamic. The accidental variations of geodynamic origin consist of small abrupt changes of level, generally downwards, which frequently correspond to movements of the ground. Shortly before the eruption of Etna in 1892, and for several months after, the changes in level of the water-surface were extremely irregular. From June 1, to December 31, 1892, corresponding to thirty-nine groups of earthquakes, there were abrupt changes of level within twenty-four hours in twenty-one cases ; there were also fifty small but marked changes coinciding with strong oscillations of the tromometer. Somewhat similar observations have been made in Wisconsin, by Prof. F. H. King (U. S. Dep. of Agri. Weather Bureau, *Bull.* No. 5). Here the shock was imparted by heavily-laden trains passing less than fifty yards from the well ; but the surface of the water invariably rose, sometimes as much as one-tenth of an inch, returning to its former level after a few seconds.

AT a recent meeting of the Academy of Science of Amsterdam, Herr C. H. Wind read a note on the Kerr phenomenon. The author breaks up the electric current into two parts—a current of conduction and a displacement current—and to these attributes, as Lorentz has done, the Hall effect. He supposes, however, that the electromotive force which constitutes the Hall effect is different for the two constituents, while Lorentz supposes them to be equal. The introduction of this hypothesis into the calculations of Van Loghem does not alter the general form of the results, but has the effect of giving expressions for the phase and the amplitude of the magneto-optic component which differ by a constant quantity and a constant angle from the old values. In this way the difference of phase discovered by Sissingh is explained ; and from the observed value of this difference of phase the ratio between the intensity of the Hall effect for the displacement and conduction currents can be calculated, and then from observations of the amplitude the value of each of these can be found. From the calculations made by the author, it appears that the values thus obtained are of the same order as those got by direct observation of the Hall effect, if we suppose that the specific resistance of metals for periodic currents of extreme rapidity is greater than for continuous currents. This view is further supported by other calculations which have been made by the author. The paper concludes with a comparison between the above theory and the theories propounded by Thomson, Goldhammer, and Drude.

IN No. 38 of the *Sitzungsberichte* of the Berlin Academy, Prof. Goldstein gives an account of a curious effect which the cathode rays exert on the colour of certain salts. If potassium chloride be made to phosphoresce in a radiation-tube, it quickly assumes a strong heliotrope shade, and eventually becomes bright violet. On heating, the colour changes to blue, and at high temperatures the salt becomes white. The same series of colour-changes may be obtained with this decolourised salt, and also with naturally occurring potassium chloride or sylvine. Several haloid salts of the alkali metals were examined, and with the exception of cæsium and rubidium chlorides all gave after-colours. The chlorides of barium and strontium gave no after-colours. In ordinary air the colour disappears the more quickly the more soluble the salt. The colour of lithium chloride fades almost immediately ; the blue colour of sodium chloride lasts about a day. In contact with water the salts at once lose their colour. In a vacuum or in dry air the deep blue colour of lithium chloride has now lasted for two months without apparent change. The colour of potassium chloride gradually fades and completely disappears in about a week ; the behaviour of most of the salts is like that of potassium chloride. The cause of these phenomena is unknown. The salts were as pure as could be obtained. Electrodes of different materials gave the same results. The radiation-tubes contained, of course, a little mercury vapour, but none of the known compounds of mercury with the constituents of the salts have the colours above described. Chemical decomposition is unlikely, since the coloured salt gradually changes into its original condition. The author inclines to the view that during phosphorescence the particles of the salt have been made to take up positions and motions differing from those of the unaltered substance, and that a physical modification of the salt has thus been brought about.

SOME efforts have again been made in France to overcome the air resistance which a locomotive encounters when running at a high rate of speed. *La Nature*, for October 27, contains a very interesting article by M. Max de Nansouty, descriptive of the experiments of M. Ricour, originally made in 1887. In these, inclined planes were placed in front of the engine, and by adopting this means, making the slanting planes four in three, and filling up the spokes of the wheels, the resistance was diminished by one half. This resulted in a notable increase of useful work, and an economy of ten per cent. on the coal consumption. The results are so satisfactory that M. Ricour has fitted his apparatus on forty engines belonging to the Paris-Lyon-Mediterranée Railway, for general traffic. Similar experiments were carried out in 1890 by M. Dresdouit, chief engineer to the State railways, and they were of more prolonged character. The engines in this case were ran 300,000 kilometres, and by means of this apparatus they saved six to eight per cent. in coal consumption, and sometimes as high as twelve per cent. M. Max de Nansouty tells us, however, "il est vrai que le chauffeur et le mécanicien étaient excellents." A few other experiments were tried with seemingly the same satisfactory results. The main point, however, that, on an average, a benefit of four to five per cent. is obtained by the use of these inclined planes, and it is asserted that this is more than the saving obtained from locomotives with compound and other systems. If the statement be true, our locomotive superintendents had better take heed, as nothing has yet been done in this direction. We are not told, however, how the apparatus behaves with a side wind.

WE have received a catalogue of botanical works offered for sale by Messrs. Dulau and Co. The books refer to the anatomy, morphology, and physiology of plants.

THE *Journal* of the Sanitary Institute, vol. xv. part iii., contains the addresses delivered at the Congress held at Liverpool in September. Dr. J. F. J. Sykes contributes a report of the proceedings of the International Congress of Hygiene, Budapest.

MESSRS. BLACKIE AND SON have published the seventh part of Kerner and Oliver's "Natural History of Plants." The new part, which is just as admirable as the previous ones, concludes the section on climbing plants; and deals with erect foliage stems; the resistance of foliage stems to strain, pressure, and bending; the floral stem. It also contains the beginning of the section on the forms of roots.

"ELECTRIC Lighting and Power Distribution," by Mr. W. Perren Maycock, published by Messrs. Whittaker and Co., has reached a second edition. The book is described as "an elementary manual for students preparing for the preliminary and ordinary grade examinations of the City and Guilds of London Institute." It is profusely illustrated and clearly written, and is altogether a good introductory text-book of technical electricity.

DR. OSCAR GRULICH has prepared a history of the foundation and growth of the K. Leopoldinisch - Carolinischen Akademie der Naturforscher at Halle. The volume is dedicated to Halle University, which celebrated its bi-centenary this year. The first president of the Academy was J. J. Baier, who held the office from 1731 to 1735. Many eminent investigators have occupied the president's chair since then, and Prof. Dr. Knoblauch has held it since 1878. Dr. Grulich's book chiefly deals with the famous library and scientific collections of the Academy.

THE third volume of Sir David Salomons' "Electric Light Installations," dealing with the applications of electric energy, has been published by Messrs. Whittaker and Co. It will be remembered that the original work, "Electric Light Installations and the Management of Accumulators," was in one volume, and it was not until a seventh edition was demanded that the division into three volumes took place. The present volume is mainly concerned with the mechanical details which interest the electrical engineer, and the workmen engaged in electric installations, and to such we cordially recommend it.

Science Progress for November contains five articles of technical interest and importance. Dr. A. D. Waller, F.R.S., describes the state of knowledge of inhibitory phenomena; Mr. J. W. Rodger contributes the third of a series of articles on the new theory of solutions. Recent researches in thermal metamorphism are described by Mr. Alfred Harker. Mr. S. H. Burbury, F.R.S., discusses Dr. H. W. Watson's "Treatise on the Kinetic Theory of Gases" and a communication made by Prof. Tait to the Royal Society of Edinburgh, "On the Foundation of the Kinetic Theory of Gases." Finally, Prof. A. C. Haddon gives a bibliography of the ethnography of British New Guinea.

THE "Division of Microscopy" of the United States Department of Agriculture is publishing a very useful series of small manuals under the title "Food Products." The first three numbers deal almost entirely with edible and poisonous fungi, with directions for their identification, and for the culture and preparation for the table of the edible species. They are illustrated by excellent coloured and uncoloured plates. It is a significent illustration of the wide distribution of the lower as compared with the higher forms of vegetable life, that every one of the twenty-four edible and twelve poisonous species of fungus here described is a familiar European species. The letterpress is written by Dr. Thomas Taylor, chief of the Division of Microscopy.

THE Meteorological Council have just issued a volume containing the meteorological observations made at stations of the Second Order, for the year 1890. Such observations have been published in a more or less complete form since 1866, and the present volume contains returns from sixty-eight stations, part of the information being obtained from the English and Scottish Meteorological Societies. A map shows the distribution of the stations, which are well distributed over the United Kingdom, although in some districts, especially in the West of Ireland, there appears to be difficulty in obtaining good observers. In addition to daily observations at many stations, the work contains carefully prepared monthly and yearly summaries, and a table showing the number of hours of bright sunshine for each month at those stations which are provided with sunshine recorders.

IN 1815 there was published in Philadelphia the second edition of a "Geographical, Historical, and Commercial Grammar," by William Guthrie. This edition contained an account of North American Zoology, by George Ord, which was by far the most complete and accurate that had appeared. Prof. Baird, in his work on the mammals of North America, refers frequently to this contribution to Guthrie's Geography, and his citations have helped to establish its importance. The Academy of Natural Sciences, Philadelphia, being desirous of rescuing Ord's work from extinction, determined to reprint it. After considerable difficulty, a copy of Guthrie's Geography was found, containing marginal pencil notes by Ord, on the zoological portion. This section of the book has now been reprinted, with the notes, and to it Mr. S. N. Rhoads has added an appendix on the more important scientific and historic questions involved. The reprint will be heartily welcomed by students of the systematic zoology of America.

HELMHOLTZ remarked, in the autobiographical address delivered on the occasion of his jubilee: "Many a time when the class was reading Cicero or Virgil, both of which I found very tedious, I was calculating under the desk the path of rays in a telescope, and I discovered, even at that time, some optical theorems, not ordinarily met with in text-books, but which I afterwards found useful in the construction of the ophthalmoscope." The enquiring student of the present time has no difficulty in finding optical theorems not referred to in the text-books in common use, for in most elementary manuals on optics, the sections appertaining to lenses and mirrors are treated inadequately. It ought to be recognised, however, that a thorough knowledge of lenses and mirrors is the all-important point of optics. To supply the deficiency of text-books in this respect, Prof. R. C. Bodkin has prepared a little pamphlet—"On Lenses and Mirrors, and the Automatic Image-Finder" (John J. Griffin and Sons)—in which he simplifies the study of lenses and mirrors, and deduces the construction of microscopes, telescopes, &c., from first principles. The image-finder referred to in the title is an ingenious piece of apparatus for illustrating the directions of the rays forming the image of an object.

WE do not often receive a catalogue of educational books, scientific and technical treatises, and works of general knowledge prepared for use in Chinese schools. Therefore we have looked with unusual interest through such a catalogue received from "the well-known Chinese Scientific Book Depôt, 407 Hankow Road, Shanghai." According to the title-page of the catalogue, the works described have been translated or written by Dr. John Fryer; and as there are nearly two hundred of them, covering the whole fields of natural and physical sciences, we confess to a reverential feeling for Dr. Fryer's marvellous industry and encyclopædic knowledge. The translations are mostly based upon standard English or American educational books, and are arranged into five series. There is the "outline" series, for general reading and elementary instruction; the "handbook" series, for more advanced students; the "temperance physiology" series, the "magazine" series, adapted for school reading books; and the "Imperial Government" series, consisting of treatises, which together form a valuable encyclopædia. As the avowed object in publishing the works is the higher education and intellectual enlightenment of the Chinese nation, we echo the hope that the use of the translations will continue to extend wherever instruction in scientific subjects is given in the Chinese language.

THE additions to the Zoological Society's Gardens during the past week include two White-shafted Francolins (*Francolinus leucoscepus*) from North-east Africa, presented by Lord Lilford; two Nilotic Crocodiles (*Crocodilus niloticus*) from West Africa, presented by Mr. J. A. McDiarmid; four Hispid Lizards (*Agama hispida*) from South Africa, presented by Mr. J. E. Matcham; an Australian Fruit Bat (*Pteropus poliocephalus* from Australia; a White-fronted Amazon (*Chrysotis leucocephala*) from Cuba, purchased.

OUR ASTRONOMICAL COLUMN.

A NEW VARIABLE STAR OF THE ALGOL TYPE.—Dr. E. Hartwig announced in the middle of September that the star B.D. + 15°·3311 (R.A. 17h. 53m. 36s., Decl. + 15° 8′ 47″·2, 1900) was a variable of the Algol type. He afterwards determined the period to be 3d. 23h. 49m. 32s.·7. (*Astro. Nach.* 3260). It appears, however, that Dr. S. C. Chandler discovered the character of the star's variability at the end of July, and communicated his discovery to several other observers, who confirmed it. The star was assigned the notation 6442 Z. Hercules about the middle of August, the period having previously been determined as 3d. 23h. 50m. Prof. Dunér has found that the minima follow each other at unequal intervals of forty-seven and forty-nine hours. There appears to be a secondary minimum which occurs a few hours previous to the time midway between two successive primary minima.

THE POLAR CAPS OF MARS.—Several sketches of Mars, made at the Juvisy Observatory, by M. Antoniadi, accompany a paper by M. Flammarion in the current *Comptes-rendus*. The figures show clearly the slow diminution of the snow-caps of Mars during the summer of the planet's southern hemisphere. The summer solstice occurred on August 31, and the planet was kept under observation from June 1 to November 1. The following are the results of the measures of the diameters of the cap at the south pole of Mars, on different dates:—

Dates.	Areocentric arc. (°)	Diameter in kilometres.
June 1	65	3900
,, 15	50	3000
July 1	42	2520
,, 15	35	2100
August 1	30	1800
,, 23	15	900
September 27	11	660
November 1	5	300

ENCKE'S COMET.—Prof. M. Wolf has found Encke's comet upon a photograph taken on October 31, that is, a day before Dr. Cerulli's observation, noted last week (*Astr. Nach.* 3262). The comet has been observed by M. Perrotin, and is said to be at the extreme limit of visibility of the twenty-eight-inch refractor of the Nice Observatory.

STATISTICAL ACCOUNT OF FRENCH FORESTS.[1]

M. DAUBRÉE, the Director of the French Forest Department, has recently published a statistical account, up to the end of 1892, of the French forests which are managed by that department; and as these forests, especially in the northern and central parts of France, greatly resemble those which might be grown in the United Kingdom, and of which some badly-managed examples are still to be found, a short notice of this work will be interesting to those who wish to know what are the possibilities of economic forestry at home.

The areas of the forests in question are as follows:—

	Acres.
Belonging to the State	2,691,165
,, communes and public establishments (hospitals, colleges, &c.) ...	4,738,637
Total	7,429,802

Or 11,609 square miles, one-eighteenth of the total area of France, which is about 207,100 square miles.

No account is here taken of the private forests in France, which contain about 20,813 square miles, so that the area of all the forests in France is 32,422 square miles, or 15½ per cent. of the area of the country.

Of the 7½ million acres of forest managed by the State, 18 per cent. of the State forests and 3·6 per cent. of the communal forests are classed as unproductive or not stocked with trees.

A larger proportion of the State forests is unproductive because the State is constantly acquiring waste lands in order to prevent denudation of mountains by torrents, or the encroachment of sandy dunes; whilst land belonging to the communes, &c., which is not fit for reafforesting, is not generally handed over to be managed by the State Forest Department.

Twenty excellent maps are attached to the report, and are differently shaded so as to show the distribution of the forest area among the different *départements*, according to ownership; mode of management (coppice, coppice-with-standards, high-forest); annual degrees of productiveness—in material (cubic metres per hectare); in money (francs per hectare)—and also in oak and coniferous timber.

From these maps and the statement which precedes them, it may be readily seen that the State forests are most extensive north of Lyons, and especially in Lorraine, Bourgogne, Isle de France, Normandy, le Bourbonnais, and that in these provinces there are scarcely any unproductive areas, which chiefly occur in the south of France. The communal forests are also chiefly in the east of France, or bordering on the Pyrenees and in Corsica; this distribution depends on political and not on natural causes, for the climate of the west of France is very favourable to forest growth, and this region contains some magnificent State forests and large areas of forests in private hands. As regards the mode of treatment, the State forests are distributed as follows:—

	Percentage of total area.
Simple coppice	2·5
Coppice-with-standards	29·2
,, under conversion to high forest... ...	16·8
High-forests	51·5

The simple coppice belonging to the State is chiefly situated in the south, where the State shares in the produce with certain communes, or the inhabitants have rights to fuel, which prevent any improvement in their treatment, and they are generally composed of *Quercus Ilex*, which yields tanning bark, and firewood rather than timber.

Coppice-with-standards is applied to large forest areas bordering on Belgium, and to another series of State forests stretching from the Jura towards Paris. These forests are generally situated near large towns or the northern coal mines, and find a ready sale for their somewhat branchy timber and underwood, as building material, pit-props, firewood, &c., provided their rotations are long enough to exclude a large supply of charcoal wood, for which the demands are being gradually restricted.

A large area of coppice-with-standards, which is remote from large towns and the coal mines, is being converted into high forest, to increase the supply of timber as compared with firewood.

[1] Statistique des forêts soumises au régime forestier, Année 1892. Extrait du Bulletin du Ministère de l'Agriculture. Paris: *Imprimerie Nationale*, 1894.

More than half the area of the State forests is already under the high-forest treatment, and consists chiefly of highly-productive silver-fir and beech forest in the Vosges; forests of *Pinus Laricio* and *Pinus Pinaster* in Corsica, which only yield poor returns on account of the frequency of forest fires; beech forests in Normandy with a small proportion of oak, and extensive oak forests on the Loire and its tributaries, where beech is kept subservient to the principal species. The maritime pine forests of the Landes and Gironde yield large quantities of resin and turpentine, as well as inferior timber, pit-props, &c.

The communal forests are distributed as follows:—

	Percentage of area.
Simple coppice	14·7
Coppice-with-standards	53·2
,, under conversion to high-forest ...	1·0
High-forests	31·1

The communal simple coppice areas chiefly supply fuel to villagers, and consist mainly of *Quercus Ilex* in the south, and of common oak and other species in the Ardennes and lower slopes of the Alps, near the villages and below the coniferous forests of the higher zones.

Coppice-with-standards is the commonest mode of management of communal forests, and is distributed chiefly in the temperate regions of hills and plains of the north-east of France, and little of this area is being converted to high-forest, as the people do not care sufficiently for the benefit of futurity to sacrifice a considerable part of their present revenues.

The high forests belonging to communes, &c., are chiefly situated in the Vosges, Jura, Alps, Pyrenees, and in Corsica, consisting chiefly of conifers mixed with beech.

Detailed tables are given regarding the yield of the forests in material and money.

Thus the production of the forests during the year 1892 was as follows:—

—	State forests.	Communal forests, &c.
	c. feet	c. feet.
Wood	96,051,592	169,275,133
	cwt.	cwt.
Cork	2,300	6,100
Bark for tanning ...	283,000	463,000
Crude resin	37,800	16,300
Total value ...	£846,144 at 25 fr. = £1	£1,321,804

The average annual production per acre of the wooded area of the forests is as follows:—

	c. feet.		s. d.
State forests	$43\frac{1}{2}$	...	9 5
Communal and other forests...	37	...	5 10

It is evident that the State forests yield more wood, and of a better quality, than the communal forests.

Leaving out the Departments of the Seine and Corréze, where the production in quantity of material and money is abnormally high, the areas of State forests in these Departments being inconsiderable, the forests of the Vosges head the list with an annual yield of 7·136 c.m. per hectare, equivalent to 101 c. feet per acre, and worth £1 3*s.* 4*d.*

This return is exceeded in value, though not in quantity, by the forests of the Doubs, where there is much oak grown as well as silver-fir, and the yield is 5·867 c. metres per hectare = 84 c. feet per acre, and worth £1 7*s.* 5*d.* an acre.

The productiveness in different classes of material of the different forests are as follows:—

STATE FORESTS.

Broad-leaved Species.

		Percentage of yield.
Timber	Oak 20 in. in diameter and above ...	5
	Do. less diameter	5
	Other broad-leaved species	6·1
Poles		3·8
Firewood		57·1

Conifers.

Timber	Exceeding 20 in. in diameter... ...	9·4
	Less than ,, ...	5·3
Poles		0·6
Firewood		7·7

The proportions of the yield of broad-leaved and coniferous timber is as follows:—

	Percentage.
Broad-leaved...	77
Coniferous	23

It is noted that the broad-leaved species yield 74 per cent. of firewood, while the conifers only yield 33 per cent.

In the communal and other forests the production is as follows:—

	Percentage.
Broad-leaved	81·3
Coniferous...	18·7

And the percentage of firewood in the former case is 86 per cent., whilst for the coniferous forests it is 25 per cent. These forests are less productive in timber, and especially in timber exceeding 20 inches in diameter, than the State forests, which accounts for their reduced money return.

If we omit the large sum of £99,300 spent in 1892 on planting-up dangerous mountain sides and regulating the beds of mountain torrents, and £8,400 spent on fixing shifting sands, the cost of maintenance of the whole of the productive forests referred to in 1892 was £397,080, or about 1*s.* 2*d.* per acre, which must therefore be deducted from the yield of the forests to determine their net revenues per acre.

The following is a complete statement of the French forest charges for 1892:—

	£
Establishment	231,800
Forest schools	6,880
Works of improvement in the forests ...	58,000
Mountain *reboisement*	99,300
Fixing shifting sands	8,400
Working plans and fellings	16,000
Management of *chasses* which are not leased	2,000
Taxes	72,400
Law and other charges	10,000
	£504,780

Of this amount £41,268, or about 2*d.* an acre, is refunded to the State by the communes and public establishments for the management of their property. W. R. FISHER.

THE PROPERTIES OF LIQUID ETHANE AND PROPANE.

A COMPREHENSIVE study of the properties of these primary hydrocarbons in the liquefied condition has been made by Dr. Hainlen in the laboratory of Prof. Lothar Meyer at Tübingen, and an account of his work will be found in the current issue of *Liebig's Annalen.* Owing to the greater ease with which it undergoes liquefaction, propane was first investigated. The hydrocarbon was obtained in a state of purity by means of the admirable method of preparation discovered in the same laboratory in the year 1883 by Köhnlein, which consists in heating propyl iodide with aluminium chloride in a sealed tube to 130°. After subjection to this temperature for twenty hours the tube was allowed to cool, and subsequently placed in a freezing mixture; while immersed in the latter it was found practicable to open it without danger or loss, the accumulated gas being readily transferred to a gas-holder over water.

In order to determine the boiling-point of propane, the purified gas was first condensed to the liquid state in a U-tube surrounded by solid carbon-dioxide. It was then transferred to the special boiling-point apparatus by evaporation and recondensation, the last traces of impurities being eliminated by this process of repeated distillation. The special apparatus consisted of a glass tube closed at the lower end, furnished with a side tube for the entrance of the gas, and with a stopper at the open end perforated for the passage of an exit-tube and a thermometer. The upper half of the cylinder was surrounded by solid carbon-dioxide, and the lower portion was protected by a mantle of badly-conducting felt. Upon the entrance of the gas the air was expelled by the exit-tube, and the gas which condensed in the upper portion of the cylinder collected in the lower portion. When the protecting mantle was removed the relatively warm air soon promoted ebullition, and the escaping vapour was as rapidly recondensed in the cooled upper portion of the cylinder, and fell back into the lower. If the hand were brought into the proximity of the cylinder, the boiling became most vigorous. At first propane usually boils irregularly, quiescent intervals being succeeded by almost explosive ebullition; but after a short time the formation of vapour becomes perfectly regular, and a mercury thermometer dipping in the liquid registers a temperature of − 38°. After comparison of the latter with an air thermometer, the correct temperature of the boiling-point of propane is found to be − 37° at 760 m.m. pressure.

Propane may safely be sealed in strong glass tubes after condensation by means of solid carbon dioxide, and thus preserved in the liquid state. It is a perfectly colourless liquid, but much more viscous than liquid carbon dioxide. The critical temperature was determined by use of such a tube half filled with the liquid. The tube was immersed alongside a thermometer in a bath of liquid paraffin, furnished with a suitable stirrer. Upon heating the apparatus to 101° the liquid meniscus commenced to become hazy, and the distinction between gas and liquid became less and less pronounced until at 110° all trace of it had disappeared. Upon cooling, the well-known nebulosity was observed at 102°, and this temperature is considered to be a close approximation to the critical temperature of propane.

The vapour pressures of propane for different temperatures up to 12°·5 were determined by enclosing a quantity of the liquefied hydrocarbon in one limb of a U-tube and dried air in the other limb, the two being separated by means of a short column of mercury. The closed apparatus was then cooled to various temperatures in suitable baths, and the vapour pressures calculated from the amount of compression of the air column. The vapour pressures for temperatures superior to the ordinary were determined by use of the Caillétet apparatus and spring manometer. The following table represents a summary of the results:

Temperature.	Pressure in atmospheres.	Temperature.	Pressure in atmospheres.
− 33°	1·8	+ 1°	5·1
− 19°	2·7	+ 5°·5	5·9
− 15°	3·1	+ 12°·5	7·1
− 11°	3·6	+ 22°	9·0
− 5°	4·1	+ 53°	17·0
− 2°	4·8	+ 85°	35·0
		+ 102°	48·5

The critical pressure of propane corresponding to the critical temperature of 102° is consequently 48·5 atmospheres.

Dr. Hainlen has also determined the density of liquid propane at several temperatures. It is 0·536 at 0°, 0·524 at 6°·2, 0·520 at 11°·5, and 0·515 at 15°·9, compared with water at 4°.

An investigation of the properties of liquid ethane upon similar lines naturally presented greater difficulties, on account of the further removal of its boiling-point from the ordinary temperature. The pure gas cannot be so conveniently prepared by the method of Köhnlein, as the sealed tubes frequently explode with great force. It was therefore obtained by the well-known method of Gladstone and Tribe from ethyl iodide and the zinc-copper couple. A mixture of ether and solid carbon dioxide is insufficient to effect liquefaction of the gas, but liquid ethylene was found to bring about the necessary reduction of temperature, which latter was measured by means of a copper-silver thermo-element. Liquid ethane in the pure state is perfectly colourless.

The boiling-point of ethane was determined as in the case of propane, the upper part of the apparatus, however, being surrounded by the liquid ethylene instead of solid carbon dioxide. The ethylene was prevented from vapourising rapidly by allowing the extremely cold vapour produced by the evaporation to pass through an outer cylinder, and thus to act as a protective cold bath. The ethane was first cooled by means of ether and solid carbon dioxide before admission into the boiling-point apparatus, after which it was found to be rapidly condensed by the colder ethylene. One end of the thermo-element was immersed in the accumulated liquid instead of a thermometer. The temperature of the liquid when in regular ebullition, produced by removing the cap protecting the lower half of the cylinder, was found to be − 89°·5 at 735 m.m. pressure.

Liquid ethane cannot be sealed in a glass tube without considerable danger. Hence the determinations of vapour pressure and density were effected by the use of a modified Caillétet compressing apparatus and spring manometer. The various temperatures were obtained by surrounding the narrow thick-walled glass tube in which the liquid was produced by suitable baths. The critical temperature at which the curious cloudy appearance was observed, just before the complete disappearance of the liquid meniscus, was found to be 34°·5, and the corresponding critical pressure 50 atmospheres. The meniscus becomes hazy at 32° and only disappears completely at 40°, so that the critical temperature, as in the case of propane, does not appear to be so sharp as with many other liquids of low boiling-point. The following table represents the vapour pressures for a few intervals of temperature.

Temperature.	Pressure in atmospheres.	Temperature.	Pressure in atmospheres.
− 31°	11	0°	23·3
− 20°	14·5	+ 15°	32·3
− 11°	18·3	+ 34°·5	50

Prof. Dewar in 1884 determined the critical temperature and pressure of ethane, and gave them as 35° and 45·2 atmospheres. M. Caillétet had previously stated that at +4° the gas exerted a pressure of 46 atmospheres. Prof. Dewar's numbers are now found to be in close accordance with Dr. Hainlen's results, and the older statement of M. Caillétet must therefore be taken as founded upon an error.

The density of liquid ethane was found to be 0·446 at 0° and 0·396 at + 10°·5.

It may be interesting to compare the facts now established with reference to ethane and propane, with those previously well ascertained for marsh gas and for normal butane.

	Boiling point.	Critical temperature.	Critical pressure.	Density in liquid state.
	°	°	atm	°
Methane CH_4	− 164 (Olszewski)	− 81·8 (Olszewski)	54·9	0·415 at − 164
	− 160 (Wroblewski)	− 95·9 (Dewar)	50	
Ethane C_2H_6	− 89·5 at 735 m.m.	+ 34·5	50	0·446 at 0
Propane C_3H_8	− 37·0 at 760 m.m.	+ 102	48·5	0·536 at 0
n-Butane C_4H_{10}	+ 1	—	—	0·60 at 0 (Ronalds 1865)

If the above boiling-points are represented graphically along with those of the higher normal paraffins, molecular weight or the number of carbon atoms being taken as abscissæ and boiling-point as ordinates, a perfectly regular curve is obtained, slightly concave towards the axis of abscissæ, which very clearly indicates the dependence of the boiling-point upon the molecular weight.

A. E. TUTTON.

THE BRITISH CENTRAL AFRICA PROTECTORATE.

MR. H. H. JOHNSTONE opened the session of the Royal Geographical Society on Monday evening with a paper on British Central Africa, of which he is administrator. He contrasted the condition of the country ten years ago with what it is now, explaining how the Mission schools, the Scottish planters, and the Sikh police had produced changes in the manners, productions, and means of transport of the whole region, and had succeeded in effectually repressing the slave trade. A survey of the Protectorate has been in progress for the last three years, and the map is beginning to acquire some firmness of outline. The great advantage of the Protectorate over the surrounding districts lies in the greater proportion of high land over low swampy country. Roughly speaking, about four-fifths of its land-surface is 3000 feet and upwards above the level of the sea, and about one-fifth is between 5000 and 10,000 feet. The immediate result of this elevation of the land is the prevalence of a much cooler climate than is usually found in Central Africa so near the equator. There are portions of British Central Africa where the heat is never oppressive, even in the hot season, and where in the cold season bitter frosts prevail. Unfortunately, it is impossible to reach this delectable land from the coast without traversing the hot and unhealthy valleys of the Zambezi and Shire.

There is an average rainfall of 55 inches throughout the Protectorate, but it is not altogether uniform in character, some districts receiving about 75 inches, and others not more than 35 inches. Still, it is decidedly a well-watered country, endowed with many perennial streams, only a small number of which dry up in the height of the dry season. Consequently, it is a land which can almost everywhere be irrigated during the dry season, and can thus grow a continual succession of crops. The water is almost everywhere wholesome to drink.

The great attraction of the country lies in its beautiful scenery, in its magnificent blue lakes, its tumultuous cascades and cataracts, its grand mountains, its golden plains and dark green forests. A pleasant and peculiar feature also of the western portion of the Protectorate is the rolling grassy downs, almost denuded of trees, covered with short turf, quite healthy, and free from the Tsetse fly; these no doubt will in the future become actual sites of European colonies, districts in which Europeans can rear their children under healthful conditions.

The lofty plateau of Mlanje is a little world in itself, with the exhilarating climate of Northern Europe. These plains and valleys are gay with blue ground-orchids, with a purple iris, and with yellow everlasting flowers. Here and there great rocky boulders stand up in stern relief against the velvet turf, and out of these elevated plains again rise other mountains, gloomy in aspect and remarkably grand in outline. The forests, on closer inspection, turn out to be mainly composed of the handsome conifer *Widdringtonia Whytei*.

No one has succeeded in reaching the highest summit of Mlanje. Mr. Johnston ascended about as far as 9300 feet, and, estimating that there were fully 700 feet more of ascent, approximately fixed the highest point at 10,000 feet. The ascent of this high peak is rendered very difficult by the enormous size of the boulders with which it is strewn. The whole mountain mass of Mlanje probably occupies, with its outlying peaks connected by saddles, an area of 1600 square miles, of which 200 square miles consist of these level or gently undulating plateaux, admirably suited for European settlements. Many of the salient features of Mlanje are repeated in the striking mountains of Nyasaland, with the exception of the cedars, which, however, are reported to exist on one or two of the highest peaks of Zomba, but have never been seen elsewhere.

The low plains surrounding Lake Nyasa and bordering the rivers offer a sharp contrast to the plateaux. Zebras, hartebeests, water-buck, pallah, roan antelopes, and reed-buck may be found in numbers, often dwelling gregariously together on these hot plains; and a few vultures, eagles, kites, and Marabout storks wheel and float overhead in the dazzling bluish-white sky, on the look-out for offal. The sable antelope, the eland, the kudu, and the bush-buck seem to prefer the sparsely forested hill-slopes to the flat plain, where there is usually much less cover. The rhinoceros still ranges over these plains, and wallows in the stagnant pools of the half-dried rivers. The heat prevailing on the plains in the summer-time is very great—almost overpowering—but in the winter and spring the air is exhilarating.

The British settlements have now a settled and comfortable appearance, with uniformed native policemen and trained natives from the Mission schools working as printers and even as telegraph operators at Blantyre. The most interesting feature in the neighbourhood of these settlements at the present time is the coffee-plantation, which, to a great extent, is the cause and support of their prosperity. The variety which is cultivated in the Shire highlands was actually introduced from Scotland, having been derived from a small plant sent from the Edinburgh Botanical Gardens to Blantyre about sixteen years ago. From this plant the greater part of the five million coffee-trees now growing in this part of Africa are descended, while the original mother tree is still alive in the Mission grounds at Blantyre. The climate and soil of Nyasaland would seem to suit the coffee-tree to perfection, and the crops given are unusually large. As yet Nyasaland has been free from the coffee disease, which, as in Brazil and India, does not appear to be able to penetrate far inland from the coast, though it has already committed ravages in German East Africa and in Natal.

EARLY BRITISH RACES.[1]

BEFORE proceeding to trace the early history of man in Britain, it is necessary to refer briefly to the physical changes which geologists tell us have occurred since the close of the Tertiary period in the configuration and temperature of the north-western portion of Europe.

At the beginning of the Pleistocene period, the temperature of Northern Europe became colder, and an ice-cap, like that which now covers Greenland, gradually extended itself probably as far south as Middlesex, and covered the greater part of Wales and the northern half of Ireland. This epoch is known as the Great Ice Age. At that time also the land was more elevated than now, so that Great Britain and Ireland formed part of the continent of Europe, and the western coast-line extended some three or four hundred miles further into the Atlantic Ocean than it does at present. This period of cold was succeeded by a more genial one, during which, but before the ice had disappeared, a great submergence of land and of the glaciers still upon it took place, varying at different parts of the country from 600 ft. to over 3000 ft. The climate again became colder, and on the higher parts of Wales, the North of England, and Scotland, glaciers were formed once more, but not to the same extent as formerly. Then followed, in late Pleistocene times, a re-elevation of the land to at least 600 feet above the present level, Great Britain and Ireland once more became joined to the continent, and the climate became temperate. In all probability the geographical conditions of Britain, or rather the British corner of Europe, in early and late Pleistocene times, were almost identical. Finally the land connection with the continent became severed by submergence, which went on till almost the present coast-line was reached; the sea once more rolled in over the beds of the German Ocean and the English Channel. These changes in the geographical conformation of the north-western part of Europe took place slowly, and were consequently spread over an immense interval of time.

According to some eminent geologists, man first took up his abode in the British portion of Europe, either during the early glacial or pre-glacial period. The evidence of his existence here at that early period rests upon the discovery of many flint implements of peculiar and special type on certain high chalk plateaus in Kent in drift resting on Pleiocene beds, in drift deposits of Norfolk and Suffolk, and in certain caves in which glacial drift is believed to be deposited over the flints. All these implements are of the rudest make, more or less stained, like the drift flints with which they are associated, of a deep brown colour. They show a considerable amount of wear, as though they had been rubbed and knocked about a good deal, so that the worked edges are commonly rounded off and blunt. In few instances have the implements been wrought out of larger flints, and the amount of trimming they have received is very slight, and has been generally made on the edges of rude natural flints picked up from old flint drift; indeed, sometimes the work is so slight as to be scarcely apparent; in other specimens it is sufficient to show design and object. These implements indicate the very infancy of art, and are probably the earliest efforts of man to fabricate tools and weapons from other substances than wood or bone. They give us some slight insight into the occupations and surroundings of the race who used them, as they appear to have been employed for breaking bones to extract the marrow, scraping skins, and rounding sticks and bones for use as tools or poles. From the absence of large massive implements, it would seem as though offensive and defensive weapons had not been much needed, either from the absence of large mammalia, or from the habits and character of these early people. Many archæologists are not satisfied with the evidence yet adduced as to the age of these flints, consequently of man's existence in Britain at this early date, and the question cannot be considered settled one way or other.

Whatever may be the ultimate decision as to the existence of pre-glacial man in Britain, all geologists and others are agreed that after the glacial period had passed away, and Britain had once more become a part of the continent of Europe after its submergence, a race of men known to us as Palæolithic man migrated into the country from the continent, across the valley of the English Channel, in late Pleistocene times. Man of this period is known to us from remains found in the river-drifts of

[1] A lecture delivered at the Royal Institution by Dr. J. G. Garson. We are indebted to Prof. Boyd Dawkins for permission to use the accompanying illustrations.

post-glacial age, and in the lower deposits of certain caves. As some evidence has been brought forward to show that the river-drift people, as they are called, are earlier than the cave-dwellers, we will consider the river-drift people first.

Remains of man from the river-drifts have only been found in the south of England from Chard, Axminster, and the Bristol Channel, in the west to the Straits of Dover, the lower Thames,

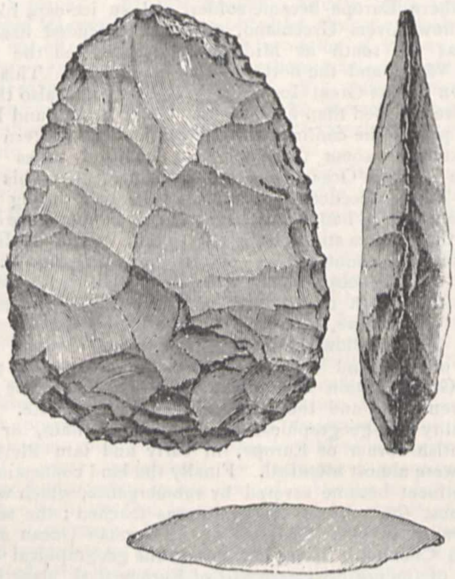

FIG. 1.

Suffolk, and Norfolk on the east, and as far north as Cambridge. They are conspicuous by their absence north-west of a line passing from Bristol to the Wash. The remains consist of a small portion of a skull, reputed to be of this period, implements of flint, quartzite, and chert, antlers of deer, and of certain fossil shells, probably used as ornaments.

The portion of skull was found by the late Mr. Henry Prigg,

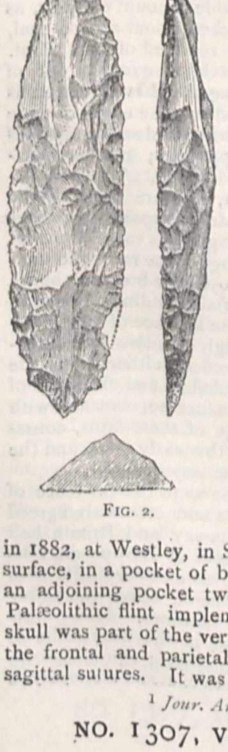

FIG. 2.

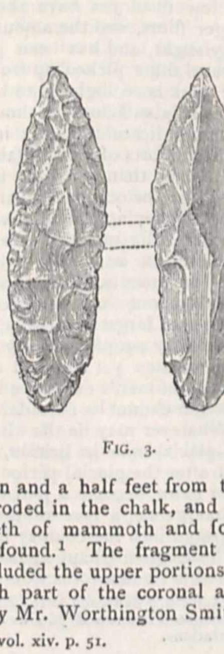

FIG. 3.

in 1882, at Westley, in Suffolk, seven and a half feet from the surface, in a pocket of brick earth eroded in the chalk, and in an adjoining pocket two molar teeth of mammoth and four Palæolithic flint implements were found.[1] The fragment of skull was part of the vertex, and included the upper portions of the frontal and parietal bones, with part of the coronal and sagittal sutures. It was examined by Mr. Worthington Smith, and in transit to the finder of it was unfortunately smashed. As it was not a characteristic part of the skull, it shed little light on the cranial characters of its owner. With this exception, no human bones have been found in fluviatile deposits in Britain.

The implements from the river-drift consist principally of oval-pointed flints which have been fashioned by chipping, and were used without handles, oval or rounded flints with a cutting edge all round, scrapers for preparing skins, pointed flints used for boring, flakes struck off from blocks or cores by means of large hammer-stones, often of quartzite, and choppers of pebbles chipped to an edge on one side. The tools with which these implements were manufactured consisted of anvil stones of large blocks of flint, pointed flints or punches, and carefully

FIG. 4.

FIG. 5.

made fabricators. All the implements, though simple and rude, show signs of manufacture, the more finely finished specimens having been prepared by delicate chipping. Their manufacture seems to have been carried on at certain spots, on the banks of rivers and other places, where there was plenty of material to make them from. It will be observed that at this time there were no flint arrow-heads, and that man was but poorly equipped for the chase, although it was undoubtedly by that means he gained his livelihood. Besides these flints, man doubtless used wood and bone implements; indeed, pieces of pointed stakes of wood have been found on the Palæolithic floors where he worked, by Mr. Worthington Smith. Bead-like fossil shells

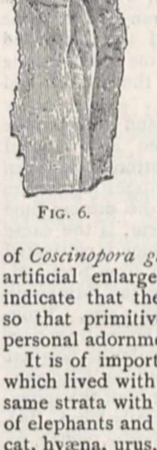

FIG. 6.

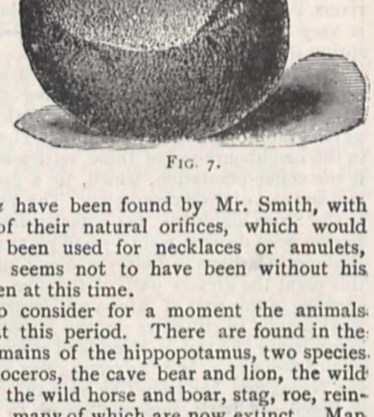

FIG. 7.

of *Coscinopora globulosa* have been found by Mr. Smith, with artificial enlargement of their natural orifices, which would indicate that they had been used for necklaces or amulets, so that primitive man seems not to have been without his personal adornments even at this time.

It is of importance to consider for a moment the animals which lived with man at this period. There are found in the same strata with him remains of the hippopotamus, two species of elephants and of rhinoceros, the cave bear and lion, the wild cat, hyæna, urus, bison, the wild horse and boar, stag, roe, reindeer, and other animals, many of which are now extinct. Man at that time had no domestic animals. The only clothing he had, if he wore any, was made from the skins of the animals he

[1] *Jour. Anthrop. Inst.*, vol. xiv. p. 51.

killed in the chase and used for food. Being far from the sea, if he used fish as food, they would be such as he was able to catch in the rivers.

Let us now trace man of this period on the continent. In the fluviatile deposits of the Somme and the Garonne, stone

FIG. 8.

mplements have been found and recognised by such competent authorities as Sir John Evans, Mr. Franks, Prof. Boyd Dawkins, and others, as identical with the drift Palæolithic implements found in England. Similar ones have been

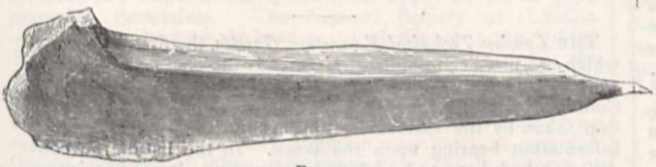

FIG. 9.

found in Spain, near Madrid, in Italy, Greece, Germany, and other places in Europe; also in Northern Africa, Palestine, and India. From these finds we learn that man has lived in a similar state of civilisation to what he did in Britain,

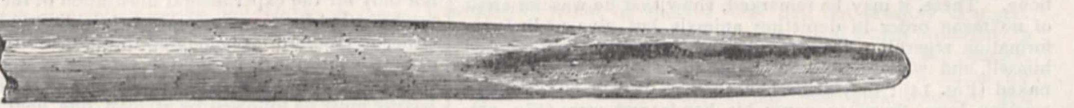

FIG. 10

over a very wide area; they also show that he must have existed in this stage of culture for a very long time.

As regards his skeletal remains on the continent, a few have been found. At Canstadt, near Stuttgart, it has been stated that

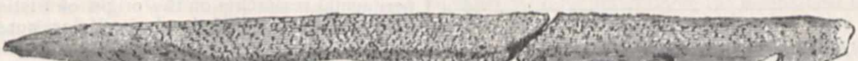

FIG. 11.

portion of a skull was discovered, in 1700, in loess deposits, with bones of the cave bear, hyæna, and mammoth. At Eguisheim, near Colmar, Schaffhausen, portion of another cranium was found with mammoth and other animal remains of this period. At

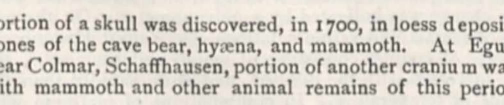

FIG 12.

Clichy, in the valley of the Seine, a skull and some bones were found at depths varying from 4 to 5·4 metres from the surface in undisturbed strata, with mammoth, woolly rhinoceros, horse, and stag. The skull in these instances is long and narrow in

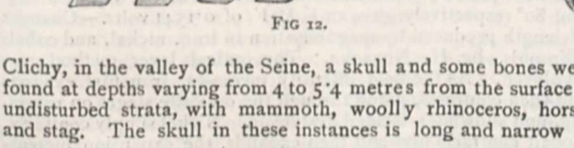

FIG. 13.

shape, with very prominent supraorbital ridges and glabella; the thigh and leg bones of the Clichy skeleton are laterally compressed, the former having a greatly developed *linea aspera*, the latter being markedly platycnemic. Further reference will be made to these specimens when we deal with the cave skeletons.

Caverns and rock shelters are well known to have been used not only by man, but also by animals, from remote times down to the present day. The strata which have been deposited in them at different times by their successive occupants, and the vicissitudes

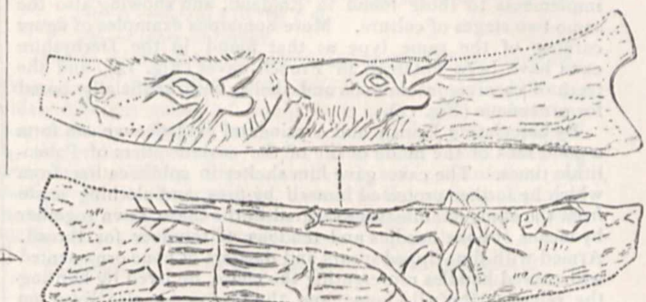

FIG. 14.

of climate, are often well marked, and give much valuable and reliable information, but great care is required in discriminating the different periods which their contents represent. The remains of Palæolithic man deposited in caves are much more widely distributed over England than those from the river-drifts, having been found as far north as Yorkshire and Derbyshire, in North and South Wales, Gloucestershire, Monmouthshire, Somersetshire, and Devonshire, also in Ireland, although these latter have not been much worked. The Palæolithic cave strata shows three sub-strata; in the two lower ones the flint implements are precisely similar to those of the river-drifts, but flat pebble implements of quartzite are also found with part of the

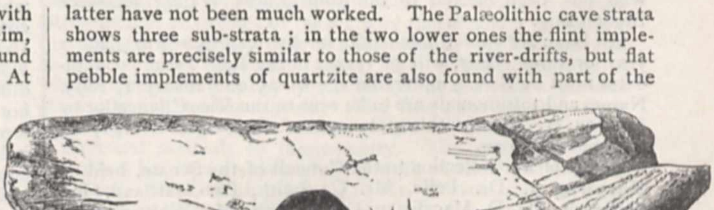

FIG. 15.

natural smooth surface retained, while the rest is chipped and fashioned into an implement.

In the upper substratum more highly finished articles, which would point to a higher and probably a different social condition, later in time, are obtained. We have in this higher substratum flints of oval and lanceolate form, trimmed flakes, borers, and rounded hammer-stones (Figs. 1, 2, 3, 4, 5, 6, and 7). These are of smaller size than the earlier implements, and some of them had evidently been let into handles of wood. Bone needles, with an eye bored at one end (Fig. 8), bone awls (Fig. 9), scoops (Fig. 10), and harpoons (Figs. 11 and 12), barbed on one or both sides of deer's antler, are also met with. Of great importance are the representations of animals which have been found incised on bone, as, for example, the portion of rib with the incised figure of a horse upon it, found in this layer in Robin Hood Cave in Derbyshire (Fig. 13).

No portions of the human skeleton have been found in the Palæolithic stratum of British caves, except a single tooth.

On the continent many caves have been discovered in France, Belgium, Germany, and Switzerland, with similar deposits and implements to those found in England, and showing also the same two stages of culture. More numerous examples of figure carving of the same type as that found in the Derbyshire cave have been obtained in French caves (Fig. 14), and the teeth of carnivorous animals and shells, both artificially bored for ornaments (Fig. 15).

By associating British and continental evidence we can form a good idea of the mode of life of the cave-dwellers of Palæolithic times. The caves gave him shelter in cold weather, from which he further protected himself by fires, and clothing made from the skins of animals he secured in the chase, sewn together by means of bone needles and tendons of reindeer for thread. Armed with flint-tipped spears and daggers of bone ornamented with carved handles representing the chase, he lived by hunting the reindeer, the wild horse, and the bison; he also lived on birds and fish, which he speared with barbed harpoons. The game he brought home was cut up with flint knives, and cooked; the long bones were broken with heavy flints for the marrow they contained, which was evidently considered a delicacy. When not engaged in the chase, the manufacture of flint implements must have formed an important part of his home work. He must also have spent much time in carving ornaments on bone. These, it may be remarked, show that he was an artist of no mean order in depicting animals, but give us little information regarding his own form, as he seldom represented himself, and when he did he figured himself in miniatures and naked (Fig. 14); they also show that he was in the habit of wearing long gloves to cover his hands and arms (Fig. 15). Besides ornamenting himself with perforated shells, pieces of bone, ivory, and teeth, he probably painted his body of a red colour. He, like the river-drift people, possessed no domestic animals, and had no dog to assist him in hunting.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. J. Lorrain-Smith has been appointed Demonstrator in Pathology, in the place of Mr. L. Cobbett, who has been elected to the John Lucas Walker Research Studentship.

An Isaac Newton Studentship in Astronomy, worth £200 a year for three years, will be vacant in the Lent Term. Candidates must be B.A.'s under the age of 25 on January 1, 1895. Names and testimonials are to be sent to the Vice Chancellor by January 31, 1895, with a statement of the course of study or research proposed.

At the biennial election to the Council of the Senate, held on November 7, Dr. Peile, Mr. C. Smith, Dr. Maitland, Dr. Sidgwick, Dr. D. Macalister, Dr. Forsyth, Mr. Whitting, and Mr. R. T. Wright were returned for a period of four years.

Dr. Donald Macalister was, on November 9, elected without opposition to represent the University on the General Medical Council for a second term of five years.

This year has been memorable as the twenty-first anniversary of the establishment of the University Extension Lectures, the system having been founded by the University of Cambridge in the year 1873. The twenty-first annual report of the Cambridge Syndicate has just appeared. During the past session seventy-five science courses have been delivered at various centres. This number is less than those of the last two or three years, the diminution being attributed almost entirely to the decrease in the temporary work undertaken by the Syndicate during the preceding sessions for the technical instruction committees of various County Councils. Whereas in some places grants of money from the local authorities have enabled local committees to arrange more easily courses of University Local Lectures on scientific subjects, in others the cheap technical classes organised independently by the local authorities have influenced very injuriously the attendance at the local lectures, and in some cases caused their discontinuance. The County Councils are just beginning to feel their feet, but it seems ungenerous of them to forget that they were helped over their initial difficulties by University Extension Lectures. The Technical and University Extension College at Exeter, which is under the joint management of the local authorities and the Cambridge Syndicate, has now completed its first session's work, and about six hundred regular students have already joined the College. Its success affords a striking illustration of the method by which under the Local Lectures system permanent educational institutions can be established. It should not be forgotten that the Cambridge University Extension movement was similarly largely instrumental in the foundation, a few years ago, of University College, Nottingham, Firth College, Sheffield, and other local colleges.

THE *London Technical Education Gazette*, the first number of which has just been published, is intended to contain the official announcements of the Technical Education Board of the London County Council; notices of important steps in technical education taken by the various institutions in London; and useful information bearing upon the work. In the list of the conditions which have to be fulfilled by evening classes in science, in order to obtain grants from the Board, we are glad to note the following:—"That as a condition of aid being granted by the Board for the teaching of chemistry, metallurgy, physics, mechanics, and botany, it will be regarded as indispensable that provision should be made, to the satisfaction of the Board, not only for the experimental illustration of the lectures or class teaching, but for experimental work by the students themselves, either in laboratories belonging to the institution, or, where this cannot be arranged, in the laboratories of some neighbouring institution with which the class should be associated; and every lecture must be followed by at least one hour's practical work on the same evening, or some other evening in the same week."

SCIENTIFIC SERIALS

Wiedemann's Annalen der Physik und Chemie, No. 11.—Experimental researches on the origin of frictional electricity, by C. Christiansen. Friction by itself does not generate electricity. The appearance of the latter is due to chemical decompositions which are initiated by contact and completed on separation. These results are those of experiments with a tube coated on the inside with various insulators, arranged so that mercury could be brought into contact with them and withdrawn, after which a charge was indicated by a galvanometer.—On thermocouples of metals and saline solutions, by August Hagenbach. In the case of couples consisting of metals and their salts, the E.M.F. increases with the dilution, and more rapidly than the difference of temperature. In combinations of platinum with hot and cold saline solutions the same acids give about the same forces, and differences of concentration have a very marked influence. The highest E.M.F. obtained was that of a platinum-cupric-chloride couple, which, with a 5·6 per cent. solution, and with the two communicating portions of the liquid at 25° and 80° respectively, gave an E.M.F. of 0·1541 volts.—Changes of length produced by magnetisation in iron, nickel, and cobalt ellipsoids, by H. Nagaoka. The optical lever method was employed. As the field intensity increases, iron first expands and then contracts, going through the opposite stages on reversing, and showing a decided hysteresis. Nickel simply contracts. Cobalt contracts first and then expands, the expansion increasing to a limiting value as the field intensity increases.—On elliptically-polarised rays of electric force, and on electric resonance, by L. Zehnder. The author shows how to produce circularly and elliptically polarised electric rays by two wire gratings placed one behind the other, with the directions of wires crossed.—On refraction and dispersion of rays of electric force, by A. Garbasso and E. Aschkinass. To produce a prism capable of affecting ether waves of the length of those due to Hertzian oscillations, a prism was constructed of a series of parallel glass plates, upon which were stuck "resonators" made of strips of tinfoil. This was placed between an exciter and a suitable resonator. It was found that the rays were refracted by angles differing according to the wave-length. The deviations for three different resonators were 9° 6′, 7° 18′, and 5° 24′ respectively.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 26.—Prof. A. W. Rücker, F.R.S., President, in the chair.—The meeting was held in the rooms of the Chemical Society, Burlington House.—In opening the proceedings the President said the occasion might be regarded as another sign that the boundary between Chemistry and Physics was breaking down. On behalf of the Council he tendered the thanks of the Physical Society to the Chemical Society for the use of the rooms.—Prof. H. E. Armstrong, President of the Chemical Society, said his Council offered a cordial welcome to the Physical Society. The change, he thought would prove of much greater importance than a mere removal. Now that the childhood of the Physical Society was passed, its manhood involved new responsibilities, and great opportunities for good presented themselves. The Physical Society of London ought now to become the head-centre of physics in the United Kingdom. He (Dr. Armstrong) was pleased to learn that the Society had undertaken the preparation and publication of abstracts of physical papers appearing in foreign periodicals, and said the matter was of such great importance that it should be done thoroughly. In a work of such a magnitude, he regarded the co-operation of other societies, such as the Institution of Electrical Engineers, as absolutely necessary.—The President, in acknowledging the welcome, said the Physical Society was extremely obliged to the President and Council of the Chemical Society for the great benefits conferred. Dr. Armstrong's advice to go ahead would not be forgotten. He then announced that at future meetings tea would be provided for members at 4.30.—The exhibition of a voltameter by Mr. Naber was postponed.—Mr. E. H. Griffiths read a paper on the influence of temperature on the specific heat of aniline. After pointing out that most observations of specific heat depend on water, whose capacity for heat varies considerably with temperature, the author said large differences existed between the values obtained by different observers as the latent heats of evaporation of water and other liquids, and these differences were probably due to the variability of the water standard, which had been erroneously assumed constant. Precise measurements in calorimetry were of such great importance that the exact relation between the capacity for heat of water and its temperature should be completely determined. With apparatus such as he had used with aniline, this could be done in six months, provided someone could be found who could devote his whole time to the subject. The results of his own experiments were expressed in terms of the capacity for heat of water at 15° C. (at which $J = 4{\cdot}198 \times 10^{7}$ ergs.), and hence were referred to a definite standard. A great desideratum in calorimetric work was a calorimeter whose surroundings could be kept at a very constant temperature. This he had obtained by using a tank holding about 20 gallons of water, in which a steel vessel, shaped like a hat-box with hollow sides and bottom, was immersed. The cavity was filled with about 70 pounds of mercury, and served as the bulb of a thermometer; a tube communicating with this bulb acted as a regulator to control the gas supply which heated the water in the tank. The tank water was circulated rapidly by a screw-propeller. Under ordinary conditions the temperature of the outside of the steel chamber could be kept constant within 1/100° C. The calorimeter itself was of brass, and suspended by glass tubes from the lid of the steel chamber. A stirrer worked by an electromotor kept the contents in rapid motion. In the experiments on aniline, heat was supplied to the liquid in the interior by maintaining known potential differences (equal to some multiple of the E.M.F. of a Clark's cell) between the ends of a coil of German silver wire placed inside. The rate of rise of temperature of the inside over the outside was measured by platinum thermometers, one of which was placed in the calorimeter, and the other embedded in the walls of the steel vessel surrounding the calorimeter. By this means differences in temperature of 1/1000 of 1° C. could be detected with certainty. A special method of adjusting the potential difference between the ends of the German silver wire was employed, by which the constancy could be maintained within 1 part in 10,000. To minimise corrections arising from heat generated by stirring the liquid, and that lost by radiation, &c., from the calorimeter, the experiments were made about temperatures at which these corrections balanced each other; the rise of temperature was then due to the electric supply alone. The specific heat, S_1 of the liquid at temperature θ_1 could then be determined from the formula

$$\frac{d\theta_1}{dt} = \frac{E^2}{JR_1(S_1M + w_1)}$$

where $\frac{d\theta_1}{dt}$ = rate of rise of temperature at temperature θ_1

J = mechanical equivalent of heat,
E = potential difference between the ends of the coil,
R_1 = resistance of the coil,
M = mass of liquid,
and w_1 = water equivalent of calorimeter at temperature θ_1.

Experiments were made with different values of E, and two widely different masses of liquid were used. The author was thus enabled to find S_1 without knowing w_1. Having found S_1, the water equivalent of the calorimeter could then be determined. Many important details of construction and manipulation of the apparatus, as well as the method employed in reducing the results, are given in the paper. The final values for S_1 and w_1 at several temperatures are given below.

Temperature.	Specific heat of aniline.	Water equivalent of calorimeter.
15°C.	0·5137	79·82
20	0·5155	80·11
30	0·5198	80·90
40	0·5244	82·19
50	0·5294	83·39

The aniline employed was supplied by Messrs. Harrington Bros. as "pure colourless," but had initially a light brown tinge. After being in use some time, the colour had darkened considerably, but its specific heat had not sensibly changed. Recently he had tried a hydrocarbon liquid which promised to be still more satisfactory as a standard liquid in calorimetry. In the course of his remarks the author said a name for "capacity of heat per unit volume" was greatly needed, and invited suggestions. Dr. Armstrong thought the author had made a particularly happy selection in aniline, for it could now be obtained in any quantity absolutely pure. When pure it did not discolour on exposure, and would probably be very satisfactory as a standard liquid. He doubted whether any hydrocarbon could be better. Prof. Ayrton congratulated the author on the extreme accuracy obtained. Recently he had arranged an experiment for determining the mechanical equivalent of heat by the electrical method, which gave very accurate results without any corrections whatever being necessary. Prof. S. P. Thompson thought the whole phraseology of specific heat required revising. Prof. Perry agreed with Mr. Griffiths that a name for "capacity for heat per unit volume" was greatly needed, and Mr. Lucas suggested "heat density," but this was not satisfactory. Dr. Sumpner said most text-books on physics attributed the advantage of the mercury thermometer to the low specific heat of mercury, whereas the capacity for heat per unit volume was the important factor. Mr. Watson inquired to what temperature the alloy which the author had used to connect glass to metal had been tested? The President said the paper was of great importance because it dwelt with the application of electrical methods to thermometry. The mercury thermometer had been quite superseded for work such as had just been described. Mr. Griffiths, in reply to Mr. Watson, said the alloy had been used successfully between 10° and 62° C. It gave way at 71° C. He was glad to learn from Dr. Armstrong that aniline could now be got pure. Prof. Ramsay had written to say he did not think the slight impurities in ordinary aniline would have much effect on its specific heat. Mr. Blakesley asked if aniline could be taken as pure if it did not change colour on exposure. Dr. Armstrong, in reply, said yes, if the boiling point was also constant.

PARIS.

Academy of Sciences, November 5.—M. Lœwy in the chair.—On an apparatus serving to demonstrate certain consequences of the theorem of areas, by M. Marcel Deprez. This is an apparatus designed to show that a body passing freely through space may rotate on its own axis without suffering the application of any exterior force, such rotation being produced by interior movements of parts of its system.—On the theorem of areas, by M. P. Appell.—On the theory of flow for a weir with depressed or partly submerged liquid sheet, in the case where a horizontal *armature* gives the inferior maximum contraction, by M. J. Boussinesq.—On the vaporisation of carbon, by M. Henri Moissan. The heat of the electric furnace enables carbon to be volatilised; the sublimed carbon is always deposited under the form of graphite at ordinary pressures, and there is no evidence whatever of the liquefaction of the carbon, for instance the lid of a carbon crucible did not adhere when the whole mass had been converted into graphite, and a carbon needle heated in a carbon tube did not in any case become attached to the latter. Previous experiments have, however, shown that under great pressures carbon may be fused, and diamond is then formed.—New observations on the menhirs of the Meudon woods, by M. Berthelot.—Note by M. Maurice Lévy accompanying the presentation of his "Study of the mechanical and electrical methods of traction of boats." The author gives a short account of the contents of the first volume of his work dealing with cable traction only.—M. Bouquet de la Grye, in the name of the Bureau des Longitudes, presented the "Connaissance des Temps" for the year 1897. This volume contains, on the maps of solar eclipses, the curves passing through the points on the earth at which the commencement and end of the eclipse are simultaneous. The ecliptic elements of the great planets and their satellites, including their elongations and the elements of Saturn's ring, are also given.—Observations of the new planet BE, made at Paris Observatory, by M. G. Bigourdan.—The polar snows of Mars, by M. C. Flammarion (see "Our Astronomical Column").—Relations between the vapour pressures of a body in the solid and in the liquid state: influence of pressure on the temperature of fusion, by M. A. Ponsot.—Influence of form on the sensitiveness to light and aberration of the eye, by M. Charles Henry.—Researches on mercuric nitrates, by M. Raoul Varet. The heats of formation are determined. In the dissociation of mercuric nitrate by water the least endothermic of the possible reactions is the one that takes place. Nitric acid, like sulphuric, picric, acetic, and oxalic acids, is displaced completely from mercuric combinations by hydrochloric and by hydrocyanic acids.—On the campholenic acids and the campholenamides, by M. A. Béhal.—On the presence of methyl salicylate in some native plants, by M. Em. Bourquelot.—On the formation of new colonies by *Termes lucifugus*, by M. J. Pérez.—The defence of the organism against parasites among insects, by M. L. Cuénot.—External characteristics of chytridiosis of the vine, by M. A. Prunet.—On a mycobacterial disease of *Tricholoma terreum*, by M. Paul Vuillemin.—Defence of "Saharien" as a name for the last geological period, by M. Mayer-Eymar.—On the presence and distribution of glycogen in tumours, by M. A. Brault.

BERLIN.

Meteorological Society, October 9.—Prof. Hellmann, President, in the chair.—After the President had dwelt on the loss sustained by meteorology owing to the death of von Helmholtz, Dr. Schwalbe spoke of his own endeavours to utilise for scientific purposes the curves of temperature obtained from the "Uranus" pillars. He found among the many meteorological pillars in Berlin which had given continuous records during the years 1892 and 1893, very few whose readings corresponded with those of control instruments. Taking the month of July for each year, he had endeavoured to arrive at the mean daily temperature by taking the mean of the temperatures registered every hour of each day in the month. He found this mean temperature to lie between the values of the expressions $\frac{6+2+10}{3}$ and $\frac{7+2+9+9}{4}$.—Dr. Kassner had instituted observations during the year on cloud-waves, to which, since Helmholtz' researches on the formation of waves when two layers of air of different density and travelling with different velocity move past each other, meteorologists have devoted very special attention. From these it appears that the above form of cloud, consisting mostly of cirrus and cirrocumulus, usually causes deposits. The speaker expressed the wish that thorough and continuous observation of this phenomenon might be made in order to test it.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Integral Calculus: J. Edwards (Macmillan).—A Treatise on Chemistry: Sir H. E. Roscoe and C. Schorlemmer, Vol. 1, new edition (Macmillan).—Reise nach Südindien: E. Schmidt (Leipzig, Engelmann).—Lehrbuch der Petrographie; Dr. F. Zirkel, Dritter Band (Leipzig, Engelmann).—Resultaten der Aetzmethode in der Krystallographischen Forschung: Dr. H. Baumhauer, Text and Atlas (Leipzig, Engelmann).—Electric Lighting and Power Distribution: W. P. Maycock, new edition (Whittaker).—Electric Light Installations: Sir D. Salomons, Vol. 3: Application, 7th edition (Whittaker).—Forest Birds, their Haunts and Habits: H. F. Witherby (K. Paul).—By Order of the Sun to Chile to see his Total Eclipse, April 16, 1893: J. J. Aubertin (K. Paul).—The Vaccination Question: A. W. Hutton (Methuen).—Reports from the Laboratory of the Royal College of Physicians, Edinburgh, Vol. 5 (Edinburgh, Clay).—Dr. William Smellie and his Contemporaries: Dr. J. Glaister (Glasgow, MacLehose).—The Dawn of Civilisation: G. Maspero, translated by M. L. McClure (S.P.C.K.).—Preparatory Physics: Prof. W. J. Hopkins (Longmans).

PAMPHLETS.—The Maya Year: C. Thomas (Washington).—Tableau Métrique de Logarithmes: C. Dumesnil (Paris, Hachette).—On Pedal and Antipedal Triangles: A. S. Ghosh (Calcutta, Patrick Press).—Weismannism once more: H. Spencer (Williams and Norgate).—On the Use of Detached Coefficients in Elementary Algebra: J. D. Paul (Bell).—Pearl and Chank Fisheries of the Golf of Manaar: E. Thurston (Madras).—Die Temperatur: Dr. A. E. Forster (Wien, Hölzel).—Mean Density of the Earth: E. D. Preston (Washington).—Analytische Theorie der Organischen Entwickelung: H. Driesch (Leipzig, Engelmann).—Das Verhältnis der Philosophie, &c.: D. Wetterhan (Leipzig, Engelmann).—Gedächtnisserede auf Hermann von Helmholtz: Th. W. Engelmann (Leipzig, Engelmann).—Grundzüge der Mathematischen Chemie: Dr. G. Helm (Leipzig, Engelmann).—Verhandlungen der Deutschen Zoologischen Gesellschaft auf der vierten Jahresversammlung zu München, den 9, bis 11, April 1894 (Leipzig, Engelmann).

SERIALS.—Science Progress, November (Scientific Press, Ltd.).—Scientific Roll—Climate: Baric Condition, No. 6 (Castle Printing and Publishing Company).—Medical Magazine, November (Southwood).—Zeitschrift für Physikalische Chemie, xv. Band, 2 Heft (Leipzig, Engelmann).—Imperial University, College of Agriculture, Bulletin Vol. 2, No. 2 (Tokyo).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 8, No. 3 (Manchester).—Himmel und Erde, November (Berlin).—American Journal of Science, November (New Haven).—Engineering Magazine, November (Tucker).—Journal of the Sanitary Institute. October (Stanford).—Portfolios of Photographs: Beautiful Britain, Art Series, No. 1. (Werner Co.).—Journal of the Asiatic Society of Bengal, Vol. lxiii. Part 2, No. 2 (Calcutta).

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