THURSDAY, OCTOBER 19, 1905.

MECHANICS FOR STUDENTS.

Mechanics, a School Course. By W. D. Eggar, Pp. viii+288. (London: Edward Arnold, 1905.) Price 3s. 6d.

Elements of Mechanics. By Prof. Mansfield Merriman. Pp. 172. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 1 dollar net.

An Intermediate Course of Mechanics. By A. W. Porter. Pp. viii+422. (London: John Murray.) Price 5s.

MR. EGGAR is doing good work in the movement which aims at the extension of quantitative measurements in the courses of mathematical studies for youths, and a school book of mechanics from the author of the well known experimental introduction to geometry is sure to be received with favour and interest by teacher and pupil alike. We may say at once that readers are not likely to be disappointed, for the experimental work on which the fundamental principles are based is simple, suggestive, and thorough, and the essence of the subject is not obscured by an undue amount of mathematical dressing.

The first five chapters are concerned with the verification and elucidation of Newton's laws of motion, and some very efficient apparatus is introduced and described in this admittedly difficult portion of the subject; we agree with the author that "velocities, accelerations, moments, work, and momentum can be made clear to a student if he has to measure them." Experiments of Galileo by means of which the laws of falling bodies were discovered are introduced with suitable modifications; a clever method of measuring time by the use of a vibrating spring carrying a paint brush (due to Mr. Fletcher) is employed, and altogether this section, treating kinetics experimentally, is most interesting and very satisfactory. The next five chapters relate to statics and the equilibrium of forces, and the remaining portion of the book deals with work, friction, simple machines, projectiles, circular and simple harmonic motions, stress and strain, and fluids.

There is little in the book to which exception can be taken. When the author seems to imply that the unit of force in the "engineer's" system is a variable quantity, he appears to misapprehend the system. The experiments on change of motion are confined to straight-line motion. The student would have been led to a more comprehensive view of the subject if there could have been introduced an experiment illustrating vector change in plane motion, accompanied by the plotting of a hodograph. Then, instead of resorting to an antiquated and non-instructive proof for the acceleration in uniform circular motion, the hodograph could have been used to illuminate the principle that force is the time rate of change of momentum.

The test is arranged so that statics can be taken before kinetics if this procedure is thought desirable, but the sequence adopted by Mr. Eggar seems to us the right one. In addition to the experimental work, numbers of good and suggestive exercises are provided at appropriate intervals. The author has succeeded in producing a most admirable text-book, and one which we should like to see largely used throughout the schools of the country.

The aim of Prof. Merriman in his volume is to introduce mechanics to young engineering students in a manner whereby the principles are established by constant appeals to experience, and are not lost sight of by the introduction of a mass of algebraical matter. The intention is good, but the experience should be that gained first-hand by the student himself from experimental work in a laboratory. The method employed by the author is to base the science on axioms which the reader has to take largely on trust. After the first four pages, six of these are suddenly introduced. Thus:—"*Axiom* 1. Where only one force acts on a body, it moves in a straight line in the direction of that force."

As a professor of civil engineering, the author naturally gives more attention to statics than to dynamics. In fact, the latter branch is very feebly presented, and the subject does not gain by the substitution of the axioms for Newton's laws. For example, the fundamental principle that impulse is equal to change of momentum is nowhere found. For the acquirement of a knowledge of the subject reliance is largely placed on the working of the four hundred problems, mostly numerical, which are spread over the book.

In Prof. Porter's elementary text-book of theoretical mechanics the subject is presented so as to appeal to physicists rather than to engineers. Students reading for the intermediate pass examination of London University will find the book very helpful. A few experiments in verification of the laws of mechanics are described, but the treatment is almost wholly deductive. The author begins by discussing the kinematics and kinetics of the rectilinear motion of a rigid body, and is very happy in his explanations of the fundamental conceptions of space, time, mass, momentum, &c., particular attention being paid to the units of measurement and to the change from one set of units to another. In defining the several systems, however, the author seems to be mistaken in his view that the unit of force adopted by engineers is a variable one depending upon latitude.

The consideration of the mechanics of a particle is preceded by a chapter on the addition of vectors, in which some elementary trigonometry is introduced. The author might here have improved his definitions of the trigonometrical ratios for angles of any magnitude by making use of the projections of a rotation vector. The action of couples and the dynamics of rigid bodies having plane motion are next considered, and very logically, but here a few additional experiments personally carried out would have materially added to the student's grip of this somewhat difficult part of the subject. There is a chapter dealing mathematically with some simple mechanical contrivances such as the wedge, screw, lever, and pulley; another on simple harmonic motion, in which the pendulum is rather fully dealt with; and then follows a chapter devoted to the mechanics of fluids, and comprising an examination of the stability of floating bodies. The book concludes with a chapter on units and dimensions.

Sets of examples are given, the numerical answers being collected at the end of the volume. Specimens of recent intermediate science examination papers of University College in connection with the University of London are appended. Some will regret that the author does not assume a slight acquaintance with the Calculus such as must be possessed by most readers of the book. But taken altogether the subject is dealt with very thoroughly, and developed naturally and logically, and the book deserves a wide circulation.

MUSIC OF SINGING-BIRDS.

Field Book of Wild Birds and their Music. By F. Schuyler Mathews. Pp. xxxv+262. (New York and London: G. P. Putnam's Sons, 1904.) Price 2 dollars.

THIS is a very pretty little book, with many charming illustrations of American singing-birds, and numerous attempts to represent their songs in our musical notation. It would seem as if the songs of American birds lent themselves more readily than those of our European species to such notation, for this is by no means the first attempt of this kind which has recently been made on the other side of the water. The present reviewer is under the disadvantage of not having heard these birds in their native land, and is quite ready to believe that Mr. Mathews's musical notations may give an American some vague idea of what his birds sing; at the same time, as one whose knowledge of music is even older than his knowledge of birds, he must emphatically express a hope that British ornithologists will not imitate their American brethren in trying to render our familiar songs on this system. Our music is a highly artificial product, subject to strict limitations which have gradually been placed upon it as the art has developed in the course of many centuries; and to attempt to catch and (so to speak) to tame the songs of wild birds, bringing them forcibly under conditions which entirely deprive them of their natural freedom in regard to pitch, scale, time, and rhythm, is in almost all cases to do them cruel violence. A very few of our birds—the cuckoo, for example, and the song-thrush—have vocal utterances which can be expressed on our musical scale; but by far the greater number can only be represented in the amusing way in which Mr. Mathews has noted the song of the bobolink on pp. 50 and 51—by a cloudy jumble of notes and lines above the stave, which suggests a flute-player gone mad.

The sentence which he has prefixed to this curious bit of notation really explains his object and method, and forbids us to take him too scientifically. He says, "If one prefers not to *interpret* bird-music, but to take it from Nature exactly as it comes, this bit that follows may prove acceptable." What he has really been trying to do, it seems, is to *interpret* bird-music, by which he means that he has listened to it with a musical mind, and has gained from it certain musical impressions, which he again interprets to us in the language of our musical art, not only in the form of melody confined in the fetters of our musical scale, but in many cases enriched with ingenious accompanying harmonies. The reader will find a good illustration of this method in the treatment of the song of the American song-sparrow, pp. 110 foll. It is the method pursued by all who seriously attempt to transfer the notes of birds to music-paper, though it may be doubted whether they would all acknowledge this as frankly as Mr. Mathews. It follows that our knowledge of bird-music is not really increased by these efforts, charming and interesting as they often are to the musician; for what is put upon paper is not the song of the bird, but an interpretation of it by an artistic mind. Taken in this light, this little book may give much pleasure, and may add a good deal to our knowledge of some delightful American songsters.

W. W. F.

OUR BOOK SHELF.

Studien ueber Hautelektricität und Hautmagnetismus des Menschen. By Dr. Erik Harnack. Pp. 65. (Jena: Gustav Fischer, 1905.) Price 1.60 marks.

THE author takes a pocket-compass, about the size of a lady's watch, with metal case and watch-glass top, and having placed it on a level surface lightly rubs the glass with the tip of his finger. The needle is immediately deflected from the magnetic meridian, remaining so for a minute or more, and then returning to its original position. That magnetism has nothing to do with it is shown by the fact that the same phenomenon occurs when for the magnet there is substituted a needle of nickel, platinum, zinc, bismuth, or ivory, although the absence in such cases of a directive force makes it more difficult to observe. Static charges, apparently much stronger, are without effect. Some people can influence the needle much more than others, and the author's power is not always equally strong.

Quantitative experiments were undertaken by the author to measure the E.M.F. induced by rubbing a glass plate of the same size and shape in the same manner. Using a Braun electrometer graduated up to 1500 volts, the maximum value obtained by him was 1300 volts. It seems evident that a strong electric charge is developed on a part of the glass surface by the friction of the finger upon it, and that the needle being free to move, and, moreover, in metallic connection with the case, is attracted by the charged surface.

This is not disputed by the author, his contention being that the magnitude of the effect is out of all proportion to the force expended, and that, therefore, it is not due to physical but to physiological causes set in action by the slight friction of the finger-tips. In the present writer's opinion this contention is certainly not substantiated. The total energy of the charge of a condenser composed of a compass-needle and a square centimetre or so of glass with a P.D. of a thousand or, for that matter, of ten thousand volts is trifling, and since the work actually done consists in the mere turning of the needle through 90°, one is driven to ask whether if a cocoon fibre were attached to the end of the needle and to the operator's finger he would be able to feel the pull of the earth's magnetic force upon it. The work done by a few light touches of the finger must be amply sufficient to furnish all the energy required to deflect the needle. But to a modern electrician it certainly seems a remarkably efficient transformation.

GEORGE J. BURCH.

An Introduction to the Study of Colour Phenomena. By Joseph W. Lovibond. Pp. 48; 10 coloured plates. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1905.) Price 5*s.* net.

THE author states that his object has been to supply the long-felt want of a power of recovering a given colour sensation and of a colour nomenclature by which that sensation may be quantitatively described. To this end "scales of red, yellow and blue were constructed of glass slips, the slips of each scale being all of one colour with a regular variation in intensity from 0.01 to 20 units, equal units of the three scales being in colour equivalence with each other. . . . The test of equivalence is that a white light viewed through equal units of the three scales should give no evidence of colour. . . . The fogs on Salisbury Plain furnished the light actually used." It was found that red, yellow, and blue were the only colours suitable for systematic work, and that any colour could be produced by their combination. The dimensions of the unit are, it is said, necessarily arbitrary, but the scale-divisions are equal, while the unit itself is recoverable.

The colour to be tested is matched by that of the light transmitted by one of the glasses, or by several superposed, equality of luminosity being secured, when necessary, by the interposition of a neutral-tinted combination between the eye and the coloured object. A specification of the glasses employed is registered, according to certain rules, as a formula which defines in terms of the author's constants the colour "developed," and supplies data for its future reproduction.

To those who are accustomed to regard the spectrum as the natural basis of colour experiment the author's method cannot but appear crude and unscientific; but, given a sufficient supply of carefully selected glasses, it is probable that much useful work might be done in a rough and ready way by its means. An example occurs in the quantitative study of the colour of the human blood in health and in disease, which is illustrated in plate vi.

The book concludes with an exposition of Mr. Lovibond's new theory of colour.

Index Phytochemicus. By Drs. J. C. Ritsema and J. Sack. With introduction by Dr. M. Greshoff. Pp. 86. (Amsterdam: J. H. de Bussy.)

DR. GRESHOFF explains in the introduction to this volume that it originated in a card index to the literature of plant chemistry compiled for use in the laboratory of the Colonial Museum at Haarlem, where the work carried on consists principally of the investigation of the proximate constituents of plants.

The index enumerates the names of more than two thousand plant constituents, and gives in each case the percentage composition, formula, melting or boiling point, and at least one reference to the literature—usually Beilstein's "Handbuch," though in a few cases the references are to original papers. The volume also contains a short but useful bibliography of plant chemistry.

The information given in the tables, so far as can be judged from trials in a few cases, appears to be accurate, and the index should prove useful to chemists engaged in the investigation of plant products.

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.]*

Eclipse Predictions.

IT is always interesting to compare the results of observation with those predicted by calculation. In the case of the recent total eclipse of the sun this is rendered difficult by the want of agreement in the predictions of the two most used authorities, the Nautical Almanac and the Connaissance des Temps. The discrepancies in the predicted duration of totality and of the breadth of the band traced on the earth's surface by the total phase are made apparent in the following table. It is compiled from the table in the Nautical Almanac headed "Limits of total phase of the Solar Eclipse," and the corresponding table in the Connaissance des Temps entitled "Limites de l'Éclipse totale et Durée de la Phase totale sur la Ligne centrale." Entries for as nearly as possible the same time in each table have been taken and are placed together:—

Column A contains the authority, Nautical Almanac (N.A.) or Connaissance des Temps (C.T.).

Column B contains the time (G.M.T.) for which each prediction is made.

Column C contains the calculated distance (in nautical miles) and the bearing of the northern limit of totality from the corresponding southern limit.

Column D contains the durations of totality on the central line as predicted by the one authority and (in brackets) as interpolated from the prediction of the other.

Column E contains the differences of these pairs of values.

A	B	C		D		E
	1905 Aug. 30 G.M.T.	Distance	Bearing	N.A.	C.T.	
	h. m.	′	°	secs.	secs.	secs.
C.T.	0 22	113·5	N. 1 W.	(198·4)	206	7·4
N.A.	0 24	101·5	,, 2 W.	200·6	(208)	7·6
C.T.	0 35·2	109·5	,, 2 E.	(211)	219	8·0
N.A.	0 36	102	,, 11 ,,	211·8	(219·5)	7·7
C.T.	0 50·3	114	,, 6 ,,	(220·2)	228	7·8
N.A.	0 48	104	,, 19 ,,	219·1	(227·4)	8·3
C.T.	1 7·0	116·5	,, 10 ,,	(223·8)	231	7·2
N.A.	1 8·0	104	,, 31 ,,	223·8	(231·2)	7·4
N.A.	1 24	105·5	,, 37 ,,	22[illegible]·7	(226·6)	5·9
C.T.	1 24·9	116·5	,, 12 ,,	(220·2)	227	6·8
C.T.	1 43·1	115	,, 14 ,,	(209·2)	215	5·8
N.A.	1 44	106	,, 44 ,,	208·4	(214)	5·6

It will be seen that, for stations in Spain and the adjacent Mediterranean, the duration of totality on the central line was predicted by the French authority to be from seven to eight seconds longer than by the British authority. In the same region, the width of the band of totality is from ten to eleven nautical miles greater by the French than by the British prediction. The orientation of the line connecting the two limits of totality also differs considerably in the two tables.

It is reported that at Sousse and Gabes, two towns in Tunisia, the eclipse was partial, while a total eclipse had been predicted for them. The prediction for these places would surely rest on French authority: we are therefore entitled to conclude that the mistake has been made by the French calculators. An excessive estimate of the width of the band of totality would almost certainly be accompanied by an excessive estimate of the duration of totality, and the table shows that both estimates are considerably greater in the Connaissance des Temps than in the Nautical Almanac.

J. Y. BUCHANAN.

October 13.

Absence of Vibration in a Turbine Steamship.

RETURNING homeward to Paris the middle of September from the Tripoli eclipse, and finding passage to America difficult to obtain, I chanced to learn that the triple-screw turbine steamer R.M.S. *Virginian* was sailing from Liverpool for Montreal on September 30, so I was very glad to have the opportunity of a voyage in a ship full powered with this novel type of propulsion. After a week on board I have no hesitation in saying that for freedom from the nerve-annoying tremors incident to the usual reciprocating engines, the *Virginian* has proved far and away the quietest steamship I have ever voyaged on. Excellent evidence of this, I think, lies in the exceptionally large number of passengers who dined comfortably in the saloon at the roughest period of our entire passage. There was a fairly heavy sea on, and the ship was by no means free from wave-origined motion. So I am quite of the opinion that sea-sickness and all its train of discomforts must be greatly aggravated by the engine-borne tremors of the ordinary steamship, and that many people who are delicate sailors under ordinary conditions might take ocean journeys with comparative comfort in a turbined ship.

So unostentatious are the rotary engines of the *Virginian,* let alone their occupying but one-fourth the space of the usual expansion engines, that the quietness of their powerful and effective working, in every part of the ship, was continually deceiving one into thinking that the vessel had lost headway, or might have come to anchor altogether. Especially was this true in the dining saloon, that most critical of all spots, where one could rarely detect so much as a ripple on water in a glass, although going ahead at full speed of 15 knots.

To my mind the *Virginian* seemed to behave all the voyage quite as if her motive power were entirely without her; in fact, she could scarcely have ridden more smoothly, or with less of that exasperating vibration (the unceasing action of which, I am convinced, is a prominent factor in inducing *mal de mer*), if she had been towed at the identical speed by a huge hawser. DAVID TODD.

R.M.S. *Virginian,* Straits of Belle Isle, October 4.

A Parasite of the House-fly.

REVERTING to the recent correspondence under this heading between Mr. Davenport Hill and Prof. Hickson (NATURE, August 24 and 31), I recall that a few years back many house-flies with Chelifers attached were sent to me at the Natural History Museum for determination of the species and explanation of the phenomenon. The first task was as easy as the second was difficult. The Chelifer was in most, nay in all, cases, so far as my memory serves, *Chernes nodosus.* But those who suggest that the explanation is to be sought and found in the value of the habit as a means of securing dispersal hardly realise, I think, the difficulties in the way of its acceptance. Chelifers are minute, active, and, for arthropods, not exceptionally prolific. Hence the sufficiency of "elbow-room" for the survivors of a family of, say, forty, on the site chosen by the female for her progeny does not coincide with the view that they have special need of transportation. Moreover, when we remember that a Chelifer attached to a fly is exposed to the danger of being killed by the enemies of that insect, and also to the great chance of being landed in a wholly unsuitable environment, it can hardly be maintained that the advantage derived from this method of dispersal has been a sufficiently important factor in survival to preserve and foster an initial instinct to grab and hang on to the legs of flies. That the aërial porterage thus secured, whether fortuitously or "intentionally," must be a means of dispersal is too obvious to dispute; but I do not think more than that can be claimed for it, since it is as likely to end in failure as in success.

Chelifers may be found not uncommonly beneath the wing-cases of large beetles. Presumably this habitat has been adopted for the sake of the food supplied by the parasitic mites infesting the beetles. This fact, I think, suggests a line of investigation which may lead to a more satisfactory explanation of the association between Chelifers and flies than that put forward in Prof. Hickson's letter.

Zoological Gardens, October 14. R. I. POCOCK.

Incandescence of Meteors.

IT is with great diffidence that I approach this difficult subject, but the theory that the incandescence of meteors is due to the heat generated by the friction between these bodies and the molecules of gas composing our atmosphere I have always found difficult to believe. The following theory is one which has occurred to me, and seems quite a plausible one. Meteors are usually of a metalliferous nature, and consequently will have a comparatively low electrical resistance. When they approach the earth they will enter a magnetic field, and they will cut the lines of force of this field at a high velocity. A high electrical potential will be generated, and consequently electric currents which will be inversely proportional to the resistance. The electrical energy thus produced will be dissipated in heat, and if of sufficient intensity will raise the meteor to incandescence. The truth or otherwise of this theory could, I believe, be calculated, as the data necessary for doing so will be at the disposal of readers of NATURE who make this branch of astronomy their study. This theory may have already been advanced, as I am not in touch with the latest developments of the science.

Coatbridge, September 5. GEORGE A. BROWN.

THE electric currents which the author of the above letter regards as possibly constituting an efficient source of the luminosity of meteors must no doubt arise, and play a certain part in the heat and light development. But the measure in which they can be supposed to contribute to it must clearly be extremely small; or rather, it must be incomparably subordinate to the intense ignition of the air produced, not at all by friction,[1] but by the air's adiabatic compression against the front surface of the meteorite; which is certainly quite competent, by itself alone, to develop what may be said to approach pretty nearly to fabulous degrees of temperature. If the kinetic energy of translation, in foot-pounds ($v^2/2g$), of 1 lb. of the air propelled (at, say, 30 miles per second) with the meteor's speed (v feet/sec.) on its front face, be divided by 330, the number thus obtained (1,180,620° C., in the case supposed) will be the number of centigrade degrees through which it will be heated by the pure process of compression, supposing that the air can continue to subsist at all with its ordinary mechanical deportment and thermodynamical properties unaffected at that enormously high temperature. In the further forward, gradually advancing layers, and in the laterally escaping currents of the air, on which the high forward speed of the meteor is only partially impressed, and which move more slowly on their various courses, the compressions are correspondingly less, and the lower but still exceedingly high temperatures can be similarly calculated from any fair estimates of the air's collective or absolute velocity of translation in those different positions.

It is in the different rates of transport of these heated air-streams, all of them, as well as the highly attenuated motionless atmosphere around, affording very easy passageways to electricity, across the earth's magnetic field or system of lines of magnetic force, that fitting circuits can certainly be found (either passing through, or else entirely omitting the meteorite itself), in which, in the way suggested in the above letter, electric currents may be quite certainly concluded to be magneto-electrically induced. For while one part of a closed air-circuit resting against the meteorite's front surface, and another part of it situated in the still atmosphere in front of or behind it, would be journeying towards or from each other with full meteor-speed, the circuits so composed would be most suitably conditioned for developing induced currents round them by

[1] Although a very general belief, it is as yet an entirely mistaken supposition that the high speed of impact of a meteorite into the rarer regions of the atmosphere reduces the air, by giving it no time to dissipate itself in front of the meteorite, to a state of granulation, or to a wedged throng of molecules producing heat by friction *inter se* and against the surface of the meteorite. Just the reverse of this condition is, however, really true, that the air remains a perfectly and frictionlessly elastic fluid, however much it is compressed and intensely heated by the impact. The speeds of sound-waves in the heated air which perform the office of transmitting and maintaining the orderly array of pressures in the streaming flows, at length differ in defect, in fact, from the air's speeds themselves in proportions which, as those mount up to meteor-speeds of many miles per second, only decline asymptotically to about the ratio $1:\sqrt{5}$, or nearly $1:2\frac{1}{4}$. Since, then, these sound-waves, which convey the strokes and shocks of the collision to and fro between the meteor-centre and the surrounding air, arise and travel in the moving field of the compressed air as if it were at rest, it is easy to perceive that by their extremely rapid actions a most exceptionally perfect elastic-fluid relation, or steady disposition of the lines, or lanes of air-flow and blast-pressure, must really be established and maintained in evenly persistent shapes and contour, in the swirl of incandescent air which forms the meteor's head.

their quickly altering enclosures of a constantly changing number of the earth's lines of magnetic force, while thus rapidly opening out or closing up. But the very short extent, not probably much exceeding some few feet or yards, which the swiftest moving part of such a circuit, in meteor-nuclei of various sizes, would embrace, and again the oft-proved weakness of the earth's magnetic field for exciting such induced electric currents, scarcely allow us to expect that any very high voltages would be attained in even the most select cases and the most favourable choices of conditions of such meteoritically produced air-circuits. The hottest, and therefore also probably the best conducting portion of each current's path, compressed against the meteorite's front surface, would also not, presumably, be that in which the heat and light producing action of the current would be strongest, since this would rather be used up in producing brush and glow discharges through the more resisting portion of the circuit in the outer air. The interior parts themselves of stony meteorites, when they have fallen, have not been found, by either sight or touch, to furnish any proofs of having been much heated, but intense effects of heat and fusion on the outer surfaces of fallen meteorites are always very obvious.

While nothing seems to point to any very easily discernible actions of electric currents immediately around a meteor's head, unless we may ascribe to electric agency the occasional production of an "aura" of sparks, or of a misty envelope of light enshrouding it, the stream of heated dust and vapours which travel in a meteor's wake, extending to considerable widths and lengths, as may be often noted, is perhaps a more visibly displayed, and a more evidently and distinctly active scene of luminous discharges of induced electric currents: for the accumulated flow behind the meteor-head resembles in some degree a columnar, vaporous follower of the meteorite itself, left to pursue its course along the meteor-track when the nucleus has disappeared. Being thus virtually a shooting-star of a long-extended shape, but of too dwarfed velocity to raise itself by heat to incandescence, the same induced electric currents as were above inferred to be developed in the meteor's head would here continue to evince themselves along the column by glow discharges in the vapours and the outer air, so long as sufficiently swift flow of the vapours can be persistently maintained through the retarding resistances of the opposing atmosphere. Thus a fairly intelligible *raison d'être* by electric current interventions may not impossibly have been incidentally divulged, by means of the recourse proposed by Mr. Brown to magneto-electric actions, of the long-enduring light-streaks left along the paths of all the swifter class of shooting-stars and larger meteors; the real *modus operandi* of those streaks having always presented to meteor observers a mysterious question for discussion, never admitting hitherto of satisfactory solution by known experimental illustrations, or of any quite surely sound elucidation by less trustworthy conjectures.

A. S. H.

A Rare Game Bird.

I THINK it is worth recording that on Thursday, October 5, Sub-Lieut. H. R. Sawbridge, R.N., shot a quail, *Perdix coturnix*, on Lopham Fen, close to the rising of the waters, the common source of the Waveney and the Ouse, near Diss, Norfolk.

The bird, either a hen or a young male, was very fat—a beautiful little specimen.

The last quail known (by me) to have been shot in this neighbourhood was in the 'fifties of the last century, by Mr. Henry Button, of this parish.

I understand that this bird was much more frequently found in the middle of last century in the neighbourhood of Great Yarmouth, and that, as a rule, it was found singly, as this was, in the autumn.

It is being preserved by Mr. Cole, of Norwich. What was a little foreign bird like this doing singly and alone on our eastern counties' heaths and fens?

Is it a case of lost or strayed, or what is it?

It would be interesting to know whether other specimens of the quail have been heard of inland in the eastern counties of late years.

JOHN S. SAWBRIDGE.

Thelnetham Rectory, Diss, Norfolk, October 16.

PHYSICAL LABORATORIES IN GERMANY.[1]

THE Director-General of Education in India has just published a valuable work in a report by Prof. Küchler, of the Presidency College, Calcutta, on physical laboratories in Germany. It forms one of a number to be included in a volume of the series of occasional reports.

Prof. Küchler "was placed on special duty to inquire into (1) the methods adopted at the universities and polytechnics of Berlin, Munich, Vienna, and other prominent universities and technical institutions in Germany with regard both to the ordinary study of physical science and to the character of the investigations and the system pursued in the case of students who are entering upon a course of independent research. (2) The construction and equipment of modern German laboratories, the special merits of scientific instruments of German manufacture, and the facilities for standardising these instruments which are offered at central institutions in Germany."

In the course of his tour, lasting more than six weeks, the principal universities and technical schools were visited, and the report sums up the information in a useful manner. It is naturally divided into two sections corresponding to the two parts of the reference; the first deals with the methods of study, the second treats of the construction, methods of equipment, &c., of the laboratories. The training of the university undergraduate of necessity differs from that of the pupil of the high school, and both methods are described at some length. Attention is directed to the importance of the set lecture in the scheme of education; the number of lectures given during the session in a university such as Berlin is very considerable, and each lecturer has the use of a properly equipped lecture-room and apparatus. The importance of the organised teaching of practical physics, for medical students, chemists, and engineers, in addition to the professed physicist, is now realised in Germany, and in an appendix, which, however, is not printed in the report, details of the practical instruction at some of the universities and technical colleges are given. In view of the large number of students in some of the German universities, the numbers attending practical classes, as given on p. 7, seem small. At Berlin there are 140 students in two divisions, each under three assistants. The average number of students in the charge of a single assistant comes to twenty-two or twenty-three, which is probably about the same as in one of our well organised English courses.

Students who propose to take a degree in physics work usually for two years at a dissertation. Prof. Küchler specially directs attention to the fact "that students are discouraged from commencing the final stages of their labours before they have been thoroughly trained in practical manipulation and have carefully gone through a complete course of laboratory work such as is represented, say, by Kohlrausch's very elaborate handbook." This fact is sometimes conveniently forgotten by those who urge the adoption of the introduction of research work at an earlier stage in our English training; the average number of these research students is said to be five or six, though, of course, at Berlin, as indeed at Cambridge, the number is much larger.

To illustrate the construction and equipment of the laboratories, Prof. Küchler has given in full the plans of a number of representative institutions, and these plans form a most valuable part of the report. They will enable a professor building or organising a

[1] A Report to the Director-General of Education in India by Prof. G. W. Küchler.

laboratory in India to see readily the arrangements which have commended themselves in Germany, and the report directs attention to the modifications which will be needed to adapt them to Indian conditions.

Perhaps the details which strike an English student most are the number and size of the lecture-rooms, the accommodation provided for the museum, and the absence of rooms specially designed for elementary classes of large numbers.

The Director-General deserves the gratitude of all interested in the organisation of the teaching of physics for having initiated this work, and Prof. Küchler is to be congratulated on the manner he has carried out his task. Still, a companion volume is needed.

British physical laboratories of to-day have many admirable points. A book that described the new laboratories at Liverpool, Manchester, the Royal College of Science, and the McGill University at Montreal, to say nothing of the historic laboratories in our two ancient universities, would contain much to interest those inhabitants of India to whom Prof. Küchler's report appeals, while in many respects, specially, perhaps, in the organisation of the practical work for large classes, the arrangements in the English laboratories seem to have the advantage.

In dealing with the last part of his subject, the construction and standardisation of instruments, Prof. Küchler again rightly directs attention to the important services rendered to German industry by the Reichsanstalt and the disadvantages under which English manufacturers find themselves from the incomplete equipment of the National Physical Laboratory.

THE ESSEX FIELD CLUB.[1]

IN order to mark the completion of a quarter of a century's scientific work in the county of Essex, the above society has published the first issue of a "Yearbook and Calendar" which will be found of interest to all who follow the work of our local scientific societies. This extremely active association was founded in 1880 by Mr. William Cole, the first president being Prof. Meldola. The work of the club has been noticed from time to time in our columns, and the present "Yearbook" contains, as an appropriate opening chapter, a history of the society by Mr. Miller Christy, who is now president. That the club has carried out the objects for which it was founded, and that it has more than justified its existence, is made perfectly clear in this introductory chapter. As the author says, "there is in Essex no other organised scientific body having the same or similar aims."

FIG. 1.—The Essex Museum of Natural History, Romford Road, Stratford, Essex.

The actual scientific achievements of the club were fully set forth in an address delivered by Prof. Meldola at the annual meeting in 1901.[2] As regards publications, the output has been not only large in quantity, but, what is more to the point, excellent in quality and strictly appropriate to the functions of a local society. Five volumes of *Transactions and Proceedings* were published down to 1887, after which the official publication was named the *Essex Naturalist*. The fourteenth volume of the latter is

[1] "Yearbook and Calendar for 1905–6." Edited by William Cole. (The Club's Headquarters, and Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 1*s*.

[2] "The Coming of Age of the Essex Field Club" (1901). Copies can be obtained on application to the Hon. Librarian, Mr. T. W. Reader, Essex Museum, Romford Road, Stratford, Essex.

now in course of publication. In addition to the above periodicals, three "special memoirs" have also been issued, and it is hoped that others will be added from time to time. In 1885 appeared Prof. Meldola's and Mr. White's "Report on the East Anglian Earthquake of 1884," in 1890 Mr. Miller Christy's "Birds of Essex," and in 1898 Mr. Henry Laver's "Mammals, Reptiles and Fishes of Essex." All these works were noticed in our pages at the time of publication. Four "museum handbooks" must also be credited to the club.

Not the least important part of the results achieved since 1880 is the establishment and maintenance of two museums, one of a strictly local character for the Epping Forest district at Queen Elizabeth's Lodge, Chingford, and the other of a county and educational character at West Ham in connection with, and attached to, the Municipal Technical Institute (see illustration). The first of these is carried on under an agreement with the Corporation of London, as conservators of Epping Forest. The other (county) museum was founded for the club by Mr. Passmore Edwards, and is maintained by the Borough Council of West Ham and the Essex Field Club, the library and headquarters of which are now in this same building. The *personnel* of the club as narrated by Mr. Christy is also of interest. The presidency has been held in succession by Prof. Meldola, Prof. Boulger, Mr. T. V. Holmes, Mr. E. A. Fitch, Mr. H. Laver, Mr. F. Chancellor, Mr. David Howard, Prof. Meldola, Mr. F. W. Rudler, and Mr. Miller Christy. All these are still living and active supporters of the club, while Mr. William Cole has acted as hon. secretary, editor of the publications, and curator of the museums during the whole twenty-five years of the society's existence.

There are few, if any, local societies in this country which can show such a good record. The Essex Field Club has earned the gratitude, not only of its own county, but of the world of field naturalists generally for the splendid example which it has set in showing how such organisations can keep alive the spirit of scientific research in the rural districts. In congratulating the club on its past achievements, we feel sure that the wish that its future work may be carried on with equal success will be cordially endorsed by all readers of NATURE.

THE MOSQUITOES OF PARÁ.[1]

IN 1859, when H. W. Bates returned from Pará, the town, though rapidly improving even then, was still a little-known Brazilian port, and Bates embarked on a North American trading vessel, "the United States route being the quickest as well as the pleasantest way of reaching England." At present, however, Pará is a very important place, and well up to date in scientific matters—if we may judge by the handsome publication before us, on one of the more recent branches of scientific inquiry—the transmission of yellow fever and other diseases by means of mosquitoes.

Four essays are included in the present volume, the first dealing with the mosquitoes of Pará regarded as a public calamity. This section is devoted to an historical sketch of the subject, the biology of mosquitoes, the views of various writers on the sanitary importance of the subject, and on the urgent need of practical efforts to abate the evil.

The second essay contains an abstract of the results of experiments undertaken in 1903, with special reference to *Stegomyia fasciata* and *Culex fatigans*, regarded from a sanitary point of view.

The third essay is devoted to biological details chiefly relating to the development of the principal indigenous species.

The fourth essay consists of a report on *Stegomyia*

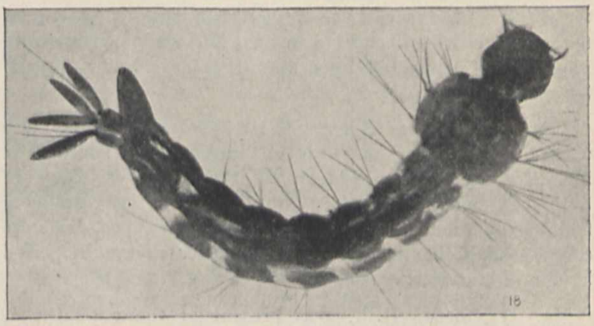

FIG. 1.—Larva of *Stegomyia fasciata*.

fasciata and its connection with the transmission of yellow fever. This was presented to the International Zoological Congress at Berne in August, 1904.

The book appears to be an extremely careful and valuable piece of work, and the paper, printing, and illustrations leave little or nothing to be desired. It must not be overlooked by any worker who is interested in mosquitoes either from a scientific or

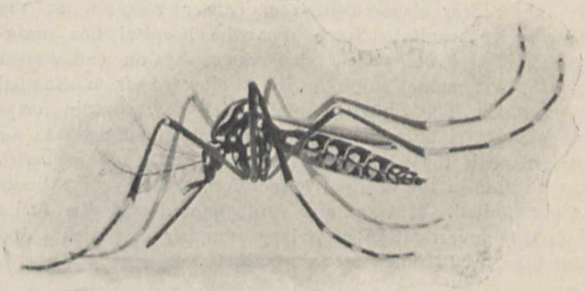

FIG. 2.—*Stegomyia fasciata* ♀ at rest.

from a medical point of view. Several new forms are described; and on p. 73 even the musical note of *Stegomyia fasciata* is discussed—a slight but significant illustration of the intimate connection and interdependence of all branches of human knowledge.

The figures which we have selected for reproduction represent the larva and imago of *Stegomyia fasciata*. W. F. K.

[1] "Memorias do Museu Goeldi (Museu Paraense) de Historia Natural e Ethnographia." IV. Os Mosquitos no Pará. Reunião de quatro trabalhos sobre os Mosquitos indigenas, principalmente as especies que molestam o homem. By Prof. Dr. Emilio Augusto Goeldi. With 100 figures in text and 5 chromo-lithographic plates. Pp. 154. (Pará, Brazil: C. Wiegandt, 1905.)

NOTES.

IN connection with the Conservatoire des Arts et Métiers, a museum of industrial hygiene will be opened this month at Paris by the President of the Republic.

PRINCE SERGE TROUBETZKOI, Rector of the University of Moscow, and professor of philosophy in that university, died at St. Petersburg on October 12.

THE death is announced of Mr. A. C. Pass, one of the early and most enthusiastic members of the Bristol Naturalists' Society, and for many years president of the geological section of the society.

A VIOLENT shock of earthquake occurred at Monteleone at 3.40 p.m. on October 14. The shock was felt at Messina at 3.42 p.m.; and a shock is reported to have occurred at Reggio di Calabria at 2.45 p.m.

WE learn from the *Times* that the Royal Prussian Aëronautic Observatory, recently completed, was opened on Monday, October 16, at Lindenberg, in the province of Brandenburg, in the presence of the Emperor William and the Prince of Monaco. The Emperor, in a speech, eulogised the many services rendered by the Prince of Monaco to science, and conferred upon him the large golden medal for science.

THE post-graduate college, West London Hospital, was opened on October 12 with an introductory address by Mr. Tweedy, the president of the Royal College of Surgeons, who emphasised the need for post-graduate training in medicine, and suggested that a post-graduate course should be made compulsory after a certain period in a man's career.

MR. WYNDHAM, M.P., was present at the annual conversazione of the Chester Society of National Science and Literature on October 12, and delivered an address. He accompanied Lady Grosvenor, who made a presentation to Mr. Robert Newstead, formerly curator of the Grosvenor Museum and now attached to the Liverpool School of Tropical Medicine. The gift consisted of a life-size carbon portrait of himself and a purse of more than two hundred guineas. Lady Grosvenor also presented the Kingsley medal to Dr. C. Theodore Green.

AN interesting account is given in the *Times* (October 10) of the cancer department and cancer research at the Middlesex Hospital. Since 1792 the hospital has maintained a separate cancer department by an endowment which first came through John Howard from Samuel Whitbread. The cancer wards, which now contain forty-nine beds, combine the functions of an almshouse or asylum with those of a hospital, for, in accordance with the purpose of the original foundation, the stay of patients is not limited. Howard also contemplated new discoveries from the investigation of a large number of patients and from the accumulated records of these.

THE programme of the London Institution for the session 1905–6 includes the following lectures among others:—The origin of the elephant, Prof. E. Ray Lankester, F.R.S.; submarines, Sir W. H. White, K.C.B., F.R.S.; geographical botany interpreted by direct response to the conditions of life, Rev. George Henslow; the Upper Nile, Sir Charles Eliot, K.C.M.G.; variation in man and woman, Prof. Karl Pearson, F.R.S.; our atmosphere and its wonders, Prof. Vivian B. Lewes.

THE Sociological Society has now issued its programme of meetings arranged for the winter session, along with a list of papers to be delivered before its affiliated societies in the universities of Oxford and Manchester. It is noticeable that a new departure has been made by the Sociological Society in the holding of research meetings (at which papers of interest to specialists only will be read and discussed) in addition to its ordinary monthly meetings for the reading and discussion of papers of general interest. The following papers have been arranged for the ordinary monthly meetings:—The biological foundations of sociology, Dr. Archdall Reid; the origin and function of religion, Mr. A. E. Crawley; and the Institut de Sociologie, its equipment and work, M. Waxweiler. The papers to be delivered at the research meetings are:—The study of the individual, Dr. J. L. Tayler; and biological methods in application to social problems, M. Waxweiler.

AN address of considerable importance from the standpoint of the connection between scientific training and industrial development was recently delivered by Mr. W. Burton on the occasion of the prize distribution to students of the county pottery classes at Tunstall, Staffordshire. At the outset Mr. Burton emphasised the fact that manufacturers in Staffordshire are beginning to realise the value of technical schools as a means of training students to be of real service to them. But, looking backwards, few industries in this country have during the past thirty years drawn so little aid from the resources of science as the pottery industry. The methods employed in pottery at the present day do not differ very greatly from those in use at the time of Josiah Wedgwood. But in science there has been an almost phenomenal advance since the early discoveries of Priestley, the contemporary and friend of Wedgwood. In taking up the study of pottery to-day, the student has to commence for himself almost entirely from the beginning; there is no accumulated store of knowledge and experience, such as exists in all branches of science, from which he may draw. The supreme gift of scientific training in method, Mr. Burton continues, is the power to see. "How many problems are there that present themselves to us every day in our businesses that really disappear—are no longer problems—if we once see them clearly?" The commercial organiser of a business has two problems always facing him, first the economic production of his goods, and secondly the disposal of these goods in the market. A scientific training, in so far as it gives knowledge tending to the solution of these problems, is of direct value to the commercial side of business; many problems can be solved only by scientific methods. But, Mr. Burton urges in conclusion, manufacturers should not look for too immediate results from the employment of a scientifically trained man. "Remember, he must have time to apply his science to your industry. He must have time for experiment, and must be given both leisure and the fullest opportunity to follow out those lines of prolonged and systematic investigation on which alone scientific knowledge has been built."

THE September issue of the *Proceedings of the Philadelphia Academy* contains the first portion of a long paper by Mr. C. S. Sargent on the species of thorns of the genus Cratægus found in eastern Pennsylvania, mainly based on collections and notes made by several local botanists.

THE *Irish Naturalist* for October opens with an illustrated paper by that enthusiastic ornithologist Mr. E. Williams on the recent occurrence in Ireland of a number of specimens of the Greenland and Iceland falcons, more especially the former. Previous records of the occurrence in Ireland of the Greenland falcon included nineteen instances, now raised to twenty-eight by the occurrence of no less than nine examples during the present year. On the other hand, only two previous records of the occurrence of the Iceland falcon were known, this number being raised to three by the capture of an immature female in Galway in March. The author speculates why the Iceland falcon should be so much more rare in Ireland than the far more distant Greenland species.

THE *Halifax Courier* of September 30 contains a full report of a long paper, read at the first meeting for the present session of the Halifax Scientific Society, on the educational value of the Bankfield Museum, by Mr. L.

Roth, the hon. curator. This institution, which is under the control of the Halifax municipality, is devoted to art, local history, numismatics, and ethnology, and it has been the object of the present curator during his whole term of office to make these collections thoroughly representative and of real educational value. Consequently he has rigorously excluded from the exhibition cases all specimens coming merely under the designation of "curios," and devoid of special local or educational interest—an example which might, by the way, be followed by the authorities of at least one rate-supported local museum we could name. Whether this rigid censorship has aroused ill-feeling we cannot say, but at the conclusion of his address Mr. Roth referred in somewhat bitter terms to the apathy displayed by the municipal authorities towards his efforts. Certainly thirty-six guineas a year is not a lavish sum for the needs of such a museum, and the committee appear to have funds at their disposal which they refuse to spend.

No. 13 B. of the *Publications de Circonstance*, recently issued in Copenhagen by the International Council for the Study of the Sea, contains an account of the present condition of the German fisheries in the Baltic, and is a continuation of the publication already issued (No. 13 A) on the Danish and Swedish fisheries in that sea. The present work has been prepared for the German Sea-Fisheries Association by Dr. E. Fischer in cooperation with Prof. H. Henking. It gives in a concise form information as to the different kinds of fishing practised in the area, as well as an account of the boats, nets, and other fishing gear employed, and of the quantities and values of the fish landed. The fluctuations of the various fisheries from year to year for the last ten years are shown in a series of tables and curves, and a number of lithographed charts illustrate the relative local abundance of different species of fish along the German coasts of the Baltic.

THE second part of the first volume of the useful little flora of the upper Gangetic plain, by Mr. J. F. Duthie, has been published recently; it includes the orders Caprifoliaceæ to Campanulaceæ, and the index to the volume.

THE late Prof. L. Errera showed a marked preference for physiological problems, and one of his last papers, which is published in vol. xlii. of the *Bulletin de la Société royale de botanique de Belge*, takes up the difficult subject of the ultimate cause behind reaction in plants. The paper deals with dominance and inhibitory action, as exemplified in the correlation existing between the directions assumed by the main vertical shoot of a tree and its branches under the influence of geotropic stimulus. Nutrition or polarity has generally been invoked to furnish an explanation, but Prof. Errera argues in favour of inhibiting action, possibly due to internal secretions.

REPORTS for 1904–5 on the botanic stations at Antigua and St. Kitts have been received. Owing to the want of uniformity in the amount of *fuzz* on the cotton seed imported from the Sea Islands into Antigua, some doubt was expressed as to its purity. To test the matter some of the seed was graded, and each grade was sown on a separate plot; however, on reaping the cotton, the lint from the different plots did not present any marked difference, and the seed was no more uniform than before. The conclusion is drawn that the character of the lint is fixed, and does not alter with variations in the character of the seed. In St. Kitts and Nevis interest attaches to the cacao and rubber plantations which have been recently started; the rubber plants consist of Castilloa and Funtumia. The work at the agricultural school in St. Kitts is worthy of mention; the practical course includes the cultivation of vegetables, the application of manures to pine and cotton crops, and the propagation of plants by budding and cuttings.

WE have received from the Minister of the Interior the twenty-fourth Bulletin issued by the Peruvian Corps of Mining Engineers. It contains the mineral statistics of Peru for 1904. The production in that year included 59,920 tons of coal, 38,683 tons of petroleum, 2209 tons of lead, 9503 tons of copper, 2675 tons of borates, 18,544 tons of rock salt, 21 tons of sulphur, 145,165 kilograms of silver, and 601 kilograms of gold. Compared with the production in the previous year, noteworthy increases are shown.

THE interesting paper on some phenomena of permanent deformation in metals read by Mr. G. H. Gulliver, of Edinburgh University, before the Institution of Mechanical Engineers in February has now been published in pamphlet form. In making a tension test of a metal bar as soon as the yield-point is reached, the deformation becomes visible to the naked eye as the well known Lüder's lines. Hitherto the lines occurring at the yield-point have been confused with the two straight depressions known as the "contractile cross." The author shows that the two phenomena are quite distinct. In his experiments flat steel bars were used $\frac{1}{8}$ inch in thickness and of various widths from $\frac{1}{2}$ inch to 4 inches.

THE second part of the mines and quarries general report for 1904 has been issued by the Home Office. It contains statistics of the persons employed and of the accidents that occurred. The total number of persons employed at mines and quarries in the United Kingdom and in the Isle of Man in 1904 was 974,634, of whom 877,057 were employed at mines. The death rate from accidents was 1·243 per 1000 persons employed at mines and 1·15 per 1000 at quarries. By the Act of 1903, the value of scientific training in mining is now shown to be appreciated by the Government, the holders of diplomas at institutions approved by the Secretary of State for the Home Department being eligible for managers' certificates after three years' practical experience instead of five as was formerly the case. The list of institutions that have been approved is given in the report, and comprises the Royal School of Mines, the universities of Birmingham, Cambridge, Durham, Glasgow, Leeds, London, Oxford, Sheffield and Wales, the University College, Bristol, the Glasgow Technical College, and the Wigan Mining College.

IN the *American Journal of Science* (vol. xx., No. 118) Mr. Bertram B. Boltwood quotes a number of analyses of minerals containing uranium and thorium, and interprets them by assuming that the ultimate disintegration products of the radio-active elements may include lead, barium, bismuth, the rare earths, argon, and hydrogen. The question is raised whether the quantities of these elements actually existing in nature have not been produced wholly by some such process of disintegration.

IN the *Atti dei Lincei* (vol. xiv. p. 188) B. Gosio describes how the decomposition of exceedingly dilute solutions of alkaline selenites, or, better, of alkaline tellurites, may be utilised as a delicate test for living bacterial contamination. Most living bacteria are capable of decomposing potassium tellurite with the production of a blackish precipitate, becoming themselves, when viewed under the microscope, tinged blackish grey. Dead bacteria or spores not undergoing actual development are totally without action on a solution of the tellurite. The test seems to be especially useful for ensuring sterility in the case of liquids or therapeutic sera destined for hypodermic injection.

THE many thermoelectric methods which have been devised during the past few years for the measurement of very high and of very low temperatures have proved themselves of a wide and general utility. But hitherto no instrument of a similar type has been made available for the accurate measurement of temperatures between 0° C. and 200° C. In the *Physical Review* (vol. xxi. p. 65) Mr. A. de Forest Palmer describes a thermojunction consisting of a soft iron wire in conjunction with an "advance" wire containing copper, nickel, and iron, by means of which temperatures within the extremes named may be determined with an error not exceeding 0·04 per cent. Such an instrument is easily calibrated, and in certain circumstances can profitably replace a mercury thermometer of a corresponding degree of accuracy.

Le Radium for September (2e année, No. 9) contains articles on the influence of the connections on the action of vacuum tubes, by M. Charbonneau, on the treatment of cancer with radium, by M. Darier, and a summary of current work connected with radio-activity.

THE *Journal of the Royal Sanitary Institute* for October (xxvi., No. 9) contains articles on the administration of the Food and Drugs Act, by Mr. Wellesley Harris, on the waste of infant life, by Dr. Nash, on hygiene in education, by Mr. White Wallis, and notes on common parasites found in bodies of animals used for food, by Mr. King.

WE have received "Contributions from the Research Laboratory and Sewage Experimental Station," Massachusetts Institute of Technology, Boston, vol. i., 1905. It contains several valuable papers, *e.g.* the mode of action of the contact filter in sewage purification, by Messrs. Phelps and Farrell, determination of organic nitrogen in sewage by the Kjeldahl process, by Mr. Phelps, a study of the methods in current use for the determination of free and albumenoid ammonia in sewage, by Mr. Phelps, and determination of the number of bacteria in sewage, &c., by Mr. Winslow.

MESSRS. F. VIEWEG AND SON, Brunswick, have published a fourth edition of "Hauptsätze der Differential- und Integral-rechnung," by Prof. R. Fricke.

MR. W. B. CLIVE has published a third edition of Dr. G. H. Bailey's "Second Stage Inorganic Chemistry (Theoretical)." This edition has been re-written and enlarged.

THE third, revised edition of "Leitfaden für das zoologische Praktikum," by Prof. W. Kükenthal, has been published by Mr. Gustav Fischer, Jena. The second edition of this work was reviewed in NATURE of April 24, 1902 (vol. lxv. p. 581).

THE first part of a work on "Die ätherischen Öle," by Dr. F. W. Semmler, has just been received from the publishers, Messrs. Veit and Co., Leipzig. It is proposed to issue the work in twelve parts which will make up three volumes, to be completed during next year. The work will be noticed when the whole of the parts have been received.

A THIRD edition of Mr. Tyson Sewell's "Elements of Electrical Engineering" has been published by Messrs. Crosby Lockwood and Son. The book was reviewed in NATURE of November 20, 1902 (vol. lxvii. p. 53), and it is only necessary to mention that more examples have been added to the appendix, and that particulars of the "Wright" and other electrolytic meters have been inserted.

A SECOND edition of Mr. J. W. Russell's "Elementary Treatise on Pure Geometry" has been published by the Clarendon Press. The first edition of the book was noticed in our issue of June 1, 1893 (vol. xlviii. p. 101). Besides numerous small improvements throughout, other changes have been made in the revised edition, and among these may be mentioned the re-arrangement of the examples and the omission of redundant ones. Each chapter has been made independent of following chapters; more use has been made of projection in proofs of theorems, and correlative theorems have been proved by reciprocation. An index has been added.

MESSRS. FLATTERS AND GARNETT, LTD., Deansgate, Manchester, have sent us a specimen of new storage cabinets made by them for lantern slides. Each drawer of the cabinet will hold 100 slides in five divisions, and is fitted with brass handle and space for movable card label. Single drawers are supplied, and cabinets are made with four, six, twelve, and twenty-four drawers. There are no grooves in the drawers, but the top edges are cut down a little, so that the slides rise above the edges and can readily be lifted out. The cabinets provide a convenient and neat means of storing lantern slides. A despatch box also submitted by Messrs. Flatters and Garnett is fitted at each end with a strip of brass which clasps the cover when the slides are in transit, and can be swung off immediately the slides are required. This box has the usual rubber packing to prevent shock and breakage.

OUR ASTRONOMICAL COLUMN.

ANOTHER LARGE SUN-SPOT.—Another large group of sun-spots, the fourth or fifth this year to be visible to the protected naked-eye, is now to be seen on the solar disc not very far from the centre. The group, which consists of a large number of separate small nuclei, is, roughly, 100,000 miles across its longest diameter, and was first seen coming round the limb on Saturday, October 14.

M. BIGOURDAN'S ECLIPSE RESULTS.—M. Bigourdan, who was placed in charge of the Bureau des Longitudes expedition to Sfax (Tunis) to observe the recent total eclipse of the sun, communicated the preliminary results of his observations to a meeting of the Paris Academy of Sciences held on October 2. The greater part of his communication consisted of descriptions of the instruments employed and the conditions they were employed under.

A coronagraph, designed to take numerous large-scale photographs, in order to show the relation between the details of the inner corona and those on the corresponding regions of the solar disc, became deranged after the second plate was exposed, but the two plates obtained show numerous details of the inner corona. In a second coronagraph, of 0·95 m. focal length and 0·15 m. aperture, a green glass screen, transmitting only those wave-lengths near to λ 530, was placed in front of the plate, and the exposure made to last throughout totality. The negative obtained shows the corona extending for about 30′ from the moon's limb.

Two spectroscopes having slits much longer than the diameter of the solar image were employed, the slits being so arranged that the spectrum of the coronal radiations at points situated at the ends of the sun's axis and equator respectively might be photographed. Photometric observations of the corona, both visual and photographic, were also made.

Observations of the terrestrial magnetic elements showed that the variations caused by the interposition of the moon were but small. The shadow bands formed a very striking feature of this eclipse, and were recorded by many observers at Sfax as being sinuous, undulating, and nearly parallel. They travelled at a rate equal to the average walking pace of a man (*Comptes rendus*, No. 14).

ATMOSPHERIC ORIGIN OF "SHADOW BANDS."—In No. 4049 of the *Astronomische Nachrichten* Signor T. Zona, of Palermo, suggests that the shadow bands observed during a total eclipse of the sun are of a purely atmospheric origin. He has observed that the rays of light projected from a man-of-war's searchlight on to a wall several kilometres from the ship exhibit just the same kind of light and dark bands that he observed at Sfax during the recent solar eclipse.

Similarly, he noticed that the light from Venus projected through a small window on to the opposite wall of the room in which he was seated exhibited the same appearance.

Signor Zona suggests that the atmospheric vibrations which cause the agitation seen at the sun's limb, when the latter is observed directly, are the cause of the oscillating bands seen during total eclipses.

A SPECTROGRAPHIC DETERMINATION OF THE SOLAR PARALLAX.—In Nos. 4048–9 of the *Astronomische Nachrichten* Herr F. Küstner describes in detail a method which he has employed to determine the sun's parallax spectrographically, from measurements of sixteen lines on each of eighteen spectrograms of Arcturus, obtained during the period June 24, 1904–January 15, 1905, with the Bonn spectrograph. From these measurements he found the radial velocity of Arcturus relative to the sun to be $-4·83 \pm 0·27$ km. for the epoch 1904·8, and the value for the mean velocity of the earth to be $29·617 \pm 0·057$ km., the accepted value for the velocity of light *in vacuo* being 299865 ± 26 km. per second.

As the solar parallax previously accepted, viz. $8''·800$, is based on the assumption that the earth's velocity is 29·765 km., and as these two quantities vary proportionally, it follows that with a more correct value for the latter a more refined value for the former may be determined.

Having made the determination, Herr Küstner arrives at the quantity $8''·844 \pm 0''·017$ as his final result for the value of the solar parallax.

NOVA AQUILÆ NO. 2.—The results of several recent observations of the Fleming Nova are published in No. 4049 of the *Astronomische Nachrichten*.

Prof. Wolf, observing on September 17 at 8h. 4·3m. (Konigstühl M.T.), found the Nova's magnitude to be 9·6, showing a decrease of not quite 0·3 mag. since September 4.

Dr. Guthnick, observing at Bothkamp, obtained the photometric results shown in the following table:—

1905	M.T. Berlin	Mag.	1905	M.T. Berlin	Mag.
Sept. 5	8 9h.	10·32	Sept. 14	8·3h.	10·47
,, 8	10·3h.	10·30	,, 19	9·2h.	10·55
,, 12	10·1h.	10·40	,, 22	9·3h.	10·66
,, 13	9 0h	10·52	,, 23	9·1h.	10·63

The magnitudes are based on those given for the comparison stars in the Harvard photometric revision of the B.D. catalogue.

LIGHT-VARIATION OF SATURN'S SATELLITES.—From observations made on twelve evenings, Dr. P. Guthnick, of Bothkamp Observatory, has determined the phases of the magnitude changes of Tethys, Dione, Rhea, and Titan.

He found that the first named is brightest when at easterly elongation (90°) and faintest at about 330°. Dione reaches its maximum brightness at 90° and its minimum at about 40°. Rhea apparently has two maxima, one at 40°–120° and a fainter one at 240°, the corresponding minima occurring at 180° and 330° respectively. The maximum brightness of Titan occurs at 240°, its minimum brightness at 20°. In regard to Japetus, Dr. Guthnick's observations confirm the results obtained by Prof. Pickering, viz. that the maximum brightness of that satellite occurs at the western, and the minimum at the eastern, elongation. The range of light-variation for each of the satellites Tethys, Dione, and Titan is about 0·75 mag., for Rhea about 1·0 mag., and for Japetus about 1·75 mag. (*Astronomische Nachrichten*, No. 4049).

INTERNATIONAL CONGRESS ON RADIOLOGY AND IONISATION.

THE first international congress for the study of radiology and ionisation, organised under the auspices of the Belgian Government, was held at Liége on September 12–14. The work of the congress was divided into two sections, devoted respectively to physical and biological science. The first section dealt with the following questions:—(1) physics of electrons, comprising also radiations of all kinds; (2) radio-activity and the accompanying transformations; (3) meteorological and astronomical phenomena attributable to ionisation, radio-activity, and to radiations of different kinds. The second section had for its scope the study of the physiological properties of the radiations and their application in medicine.

The opening session of the congress was held in the physics theatre of the University of Liége on September 12 under the presidency of Prof. Kuborn, member of the Royal Belgian Academy of Medicine. Among the members present may be named Profs. Becquerel, Bouchard, and Bergonié, representing the French Republic, Señor J. Muñoz del Castillo, officially representing Spain, Drs. E. F. Nichols and W. Dieffenbach (United States), Prof. Hurmuzescu (Roumania), Prof. Gillon (Italy), Dr. Yankorits (Servia), Lion Sy Thang (China), Dr. Arrago (Guatemala), Dr. Ortiz (Argentine). Prof. Lassar represented the Röntgen Association of Berlin, Prof. Onnen the Royal Society of Batavia, and Mr. Wilton the University of Adelaide, South Australia. The following were also present:—Messrs. Birkeland, Himstedt (Freiburg in B.), Gariel (Paris), and Legge (London).

Sir William Ramsay had intended to present an address on radio-thorium, but in his unavoidable absence it was read on his behalf. M. Becquerel gave a lecture on the analysis of the radiations of radio-active substances. The address will be published in the *Comptes rendus* of the congress, shortly to be issued by the organising committee (general offices, No. 1 Rue de la Prévôté, Brussels).

On September 13 a general meeting was held. Prof. Wind, of Utrecht, presented a communication on the diffraction and wave-length of the *n*-rays, and demonstrated the character of the apparatus designed by his colleague M. Haga and himself for the study of this much controverted question. Prof. Lassar, of Berlin, gave an account of the practical application of the new radiations. M. Tommasina, of Geneva, described a study of the radio-activity produced by atmospheric air (Elster and Geitel's phenomenon), and papers relating to the therapeutic action of the X-rays and of radium were read by Drs. Bergonié (Bordeaux), Dieffenbach (New York), and Kassabian (Philadelphia). The latter's hands, owing to their frequent exposure to the radiations used for therapeutic treatment, have during the past few years undergone characteristic changes.

The following papers of noteworthy interest were presented at later meetings:—Remarks relative to the terminology of ionisation, Prof. de Hemptinne (Louvain); disruptive discharge in gases at high pressures, Prof. Guye (Geneva); the spectroscopic study of radium light, Prof. Himstedt (Freiburg in B.); the kinetic theory of the electron serving as a basis for the electronic theory of radiation, Dr. Tommasina (Geneva); on the radio-active constituents of sediments from Echaillon and Salins-Moutiers, Dr. Blanc (Rome); a new apparatus for determining the radio-activity of spring-waters, Dr. H. Sieveking (Karlsruhe); Moser's radiations, Prof. Piltschikoff (Kharkoff); discharge phenomena caused by X-rays and radium radiations, and the transformation of these rays, Prof. Hurmuzescu; critical observations on the theories of atomic disintegration and chemicophysical dissociation, Prof. Muñoz del Castillo; the method of transmission of excited activity to the kathode, Mr. Makower (Manchester); radio-activity of the lava from Vesuvius (eruption of 1904), Dr. Tommasina; on the change of properties of the chemical elements, Prof. Fabinyi (Kolozsvar, Hungary); (1) the experimental methods of studying the transformations of the X-rays and the secondary rays resulting therefrom, (2) classification and mechanism of the different electric phenomena caused by the X-rays, Prof. Sagnac (Paris); absorption phenomena of radium and polonium rays, Prof. Riecke (Göttingen), paper presented by Dr. Emil Bose.

Limitations of space prevent the enumeration of papers not read at the congress but accepted for insertion in the *Comptes rendus*, as well as of the communications read before the biological section. The final meeting of the congress was held on September 14. After several interesting communications had been read, including one from Sir William Huggins, presented by Prof. Becquerel, the following motion was put before the meeting by the executive of the congress, acting at the wish of Prof. Jose Muñoz del Castillo:—

The International Congress for the Study of Radiology and Ionisation assembled in plenary session at Liége on September 14, 1905, considers that, although State regulation and protection may sometimes impede free research among men of science, it is, however, necessary that Governments should, without creating monopolies, be brought to apply to radio-active substances the same legislative measures that prevent the monopolisation of other useful substances, and should guarantee by the play of economic laws free scientific research and the application of these substances to the treatment of the sick; and considers also that it is desirable to be able to advise or remind the Governments of the importance of these measures and that a permanent commission invested with powers by the actual congress, an assembly of men of science devoted to the study of these questions and belonging to different countries, would carry weight in discussing with public authorities matters appertaining to the needs of science or the requirements of the sick. It has therefore decided

(1) That an international commission for examining all questions of general interest relative to radio-active substances shall be instituted.

(2) That the commission shall meet regularly each year, and may be convened on any exceptional occasion by the president, acting with the majority of the executive.

(3) That it shall organise periodically international congresses, to meet every five years, and shall also be empowered to convene the congress in extraordinary session.

(4) That the members of this commission shall be subject to re-election at each meeting of the International Congress.

THE COALFIELDS OF NORTH STAFFORDSHIRE.

THE memoir described below[1] contains detailed accounts of the coalfields of North Staffordshire, especially those of the Pottery and Cheadle Coalfields. The re-survey on the 6-inch scale was commenced in 1898 and completed in 1901. The present volume, which contains detailed descriptions furnished by each geologist of the area surveyed by himself, has been largely written and edited by Mr. Gibson, who personally carried out the greater part of the field-work. It was pointed out by Beete Jukes long ago that, so far as the higher portions of the Coal-measures were concerned, North Staffordshire provided the type development of the Midlands. Mr. Gibson has now established in that region a definite stratigraphical sequence in the comparatively barren strata which conformably overlie the productive Coal-measures, and he has also proved that the same sequence may be recognised in the other coalfields of the Midland area.

The chief points of interest are contained in chapter iv., which describes fully the determination of the Newcastle-under-Lyme group, the Etruria Marl group, and the Black Band group, and more particularly the removal of Hull's "Salopian Permian" into the Carboniferous. A full account of the palæontological and stratigraphical evidence on which this change is based is given at pp. 53 to 55. The evidence shows that the Salopian Permian of Staffordshire, Denbighshire, Worcestershire, Warwickshire, and in all probability Lancashire, occurs as the highest group of a definite sequence everywhere overlying the higher beds of the true Coal-measures, but never discordant to them, and that the Salopian Permian on either side of the Pennine Chain conforms to the Coal-measures, but is unconformably overlain on the eastern side by the Magnesian Limestone series.

It has been found advisable to adopt purely descriptive terms for various subdivisions, and for similar reasons the expressions Upper, Middle, and Lower Coal-measures have not been adopted, since the positions of the palæontological boundary lines which give a definite significance to the terms have not been determined with accuracy. Since the memoir was written, Mr. R. Kidston has contributed a paper to the Geological Society on the divisions and correlation of the upper portions of the Coal-measures, in which he proposes the name "Staffordian" for the series included between the Black Band group and the Newcastle-under-Lyme group, while the Keele group and similar beds in the Midland coalfields, hitherto referred to the Permian system, are classed with the Radstock group, previously called Upper Coal-measures. The distribution of the plants certainly favours such a classification, but there is evidence which seems to show a gradual passage of one group into another, and Dr. Hind, who has devoted considerable attention to the study of the lamellibranchs, is not in favour of the proposed subdivision.

One of the most pleasing features is the accurate and complete description of the palæontology, which is treated in detail by Mr. John Ward, and is accompanied by full lists, with six plates, of the common fossils of the Coal-measures. The Pottery Coalfield has long been recognised as an unrivalled field for the study of Carboniferous fishes, the study of which has to some extent overshadowed the examination of a numerous and varied series of molluscan remains and the equally abundant flora it has yielded. In this section Dr. W. Hind has given Mr. Ward a great deal of assistance. The fossil fishes have been named by Dr. Traquair and Dr. Smith Woodward, while the plants have been dealt with by Mr. Kidston. A complete geological bibliography of the North Staffordshire coalfields, covering fifteen pages, forms a valuable appendix.

The Triassic and Glacial deposits are described in separate chapters, and the economic products of the Pottery Coalfields are treated in chapter xii. The latter account includes the consideration of the future coal supply of the district from the concealed coalfield, to which considerable attention is paid. In addition descriptions are added of the local building stones, clays, and marls, supplemented by an enumeration of the chief source of water.

H. W. HUGHES.

[1] "Memoirs of the Geological Survey of England and Wales. The North Staffordshire Coalfields." By W. Gibson. With Contributions by G. Barrow, C. B. Wedd, and J. Ward. Pp. vii+494; with 1 Coloured Map and 6 Plates. (London: Edward Stanford, 1905.) Price 6s.

THE DISTRIBUTION OF POWER.[1]

TWENTY-SIX years ago, at the meeting of the British Association at Sheffield, August, 1879, a lecture, on "Electricity as a Motive Power," was delivered to some thousands of working men, and, for the first time, they realised that forks and spoons could not only be plated with the electric current, but could also be polished with a brush made to spin with the same agency.

The sea of upturned faces beamed with delight when Jack, their popular comrade, stepped on to the platform, took the newly plated spoon in his hands, and burnished it —a pair of thin wires tied to a church steeple being the only connecting link between the dynamo machine in a neighbouring works—ordinarily used there for electroplating—and the electro-motor driving the polishing brush in the Albert Hall, Sheffield.

But an electro-motor is only a toy, thought my audience; nobody could construct an electro-motor that we could not stop with our hands; and at the end of my lecture they actually tried, and—wondered.

As far as I am aware, it was at that lecture that the following composite suggestion was first put forward—to obtain economy in electric transmission of power the current must be kept small, while to transmit much power the electric pressure between the conducting wires must be made large; and, lastly, to secure safety and convenience

[1] Lecture delivered on Tuesday, August 29, at a meeting of the British Association in Johannesburg, by Prof. W. E. Ayrton, F.R.S., and illustrated with many experiments on moving machinery, diagrams and lantern slides, two lanterns being used, in the American fashion, for enabling pictures to be contrasted on the screen.

in working, this high pressure must be transformed down into a low one at the distant end of the transmission system.

But what did high pressure—produced with a dynamo—mean twenty-six years ago? Why, three or four hundred volts—what, in fact, is called low pressure to-day—a pressure less than is now often used for lifts in buildings, pumps in mines, and tramcars in streets. And how was it proposed to transform this so-called high pressure into a low one? Why, I suggested mechanically coupling a 400-volt direct-current motor to a 50-volt direct-current dynamo—the device that has since been called a "motor generator"—and such a combination was shown in operation at that lecture.

But it was in Paris, at the Palais de l'Industrie, the home of that electrical exhibition of 1881 which has now become classical, that modern electrical engineering was born, and shortly afterwards *Punch* exhibited the young infant thriving, and imbibing liquid nourishment from a storage cell.

"What *will* he grow to?" says the picture. What *has* he grown to? Aladdin's ring, Aladdin's lamp—whose slaves brought a fortune to him, and a fainting fit to his mother—were but poor magic makers compared with the ring evolved by Gramme and that boy, Paccinotti—compared with the lamp constructed by those veterans Edison and Swan.

In the "Arabian Nights" it is stated that Aladdin's would-be uncle, the noted and learned African magician, knew that the wonderful lamp was not fed with oil, and he anticipated by many centuries the plan for reconciling the inhabitants of Johannesburg to having the electric pressure in their houses raised from 110 to 230 volts—for did not he, like the municipal African magician, offer "new lamps for old?"

It is also described how the lamp enabled Aladdin to carry off the Princess Badroulboudour, and the wicked uncle to transport the palace. But electric traction has carried off whole neighbourhoods out of cities into suburbs, and, by transporting hundreds of thousands daily, has helped to solve the problem of housing the working class; while electric distribution of power has discovered, not caves of buried jewels, but waterfalls of ever-flowing wealth.

At the mines near Silver City, Idaho, for example, coal had reached seventy shillings a ton, wood thirty-six shillings a cord. For years the distribution of power was by donkeys, or by long teams of horses slowly hauling heavy loads of wood up the mountain road; and then the magician of this, the electric age, came to Idaho, and what those mines need—power, clean, dustless, weightless power, now courses up the mountain side from Swan Falls on Snake River in the valley below. What fairy of old, who could change dead leaves into jewels, ever worked such beneficent wonder? See how proudly those posts look down upon their conquest of the past. For have they not brought an end, not merely to wasteful extravagance in lifting fuel up to those mines, but also to needless toil for tired cattle?

In 1886, when the boy Electricity was five, the babe Johannesburg was born, and the two youngsters have raced along neck and neck. To-night I will tell you something of their lives.

Nine years after that first lecture, the British Association honoured me by asking for another. In 1888, however, it was beginning to be realised that a pressure of 2000 volts between electric mains might not make too great a call on the funds of life insurance companies. Alternate current transformers had come into use; Ferranti was employing them practically, for distributing electric current from the Grosvenor Gallery, Bond Street. A "transformation scene" Lord Kelvin called the apparatus at that lecture. The male white population of Johannesburg was now—2000.

But, although current, at 100 volts pressure, was beginning to be distributed for electric lighting, the distribution of power for working electro-motors was still but a dream of the future.

In exactly a decade after the Paris Electrical Exhibition of 1881 came the Frankfort Exhibition of 1891. More than ten times 2000 volts was there used to transmit more than 100 horse-power, more than 100 miles, with more than 75 per cent. efficiency.

A death's-head and cross-bones were painted on every post along that 109 miles of railway line, Lauffen to Frankfort, for he who should touch these bare wires, with a pressure of 25,000 volts between them, secured electrocution; and a similar suggestion of mortality greets the wayfarer—in his own language, be he English or Dutch—on the posts of the Rand Central Electric Works.

	1882 Hirschau to Munich	1883 Vizille to Grenoble	1886 Creil to Paris	1891 Lauffen to Frankfcrt
Pressure at transmitting end in volts	700	3000	6000	25,000
Horse-power delivered by electro-motor ...	5·8	7	52	114·2 to lamps
Distance in miles ...	3·5	8·75	35	108·7
Percentage commercial efficiency of transmission	36	62	45	75·3
Diameter of line wire in inches	0·18	0·079	0·2	3 wires each of 0·158
Material of wire... ...	—	Silicium bronze	Copper	Copper

The table shows that the use of higher and higher pressures has enabled larger and larger amounts of power to be transmitted longer and longer distances, with greater and greater efficiency, that is, with less and less waste. Now, why is this?

The electric current, as you know, is used for lighting buildings, driving machinery, propelling cars and trains. But throw away the notion, if any of you still have it, that electricity is a kind of gas, or oil, or fuel that is used up in these operations. The common expressions, buying electricity, consuming electric current, are most misleading, for just as much electricity flows away per minute—through the return conductor—from your electrically lighted house as flows to it through the coming conductor. If, therefore, it were electricity that you had undertaken to pay for, you must have made a very bad bargain, because you do not retain the smallest portion of what you would have agreed to purchase.

The electric current is like a butcher's cart carrying round meat—you no more consume current than you consume cart. It is not the vehicle, but what it leaves behind that the consumers buy—meat in the case of the butcher's cart, and energy in the case of the electric current.

Exactly the same considerations apply to the distribution of power, with air at 70 lb. pressure per square inch, to the thousands of rock drills on the Rand, to the distribution of power with water at 425 lb. pressure per square inch down the shaft of the Rietfontein Mine, and at 750 lb. pressure in the workshops of the Central South African Railways at Pretoria.

The energy conveyed with air, with electricity, or with water is made up of three factors—(1) the current, (2) the time during which it flows, and (3) the pressure under which it flows; while power depends on the current and the pressure only.

Few words are used more vaguely than this one "power." Before starting for South Africa some of us gave someone a power of attorney; we came on a ship of 12,000 horse-power; the voyage did us a power of good; at the concert on board we sang of the power of love.

In engineering, however, power has one very definite meaning—the rate of doing work—and a stream of air, of electricity, or of water exerts much power, that is, works rapidly, when it quickly loses pressure, or head. Quickly losing one's head, however, is not characteristic of large brain-power, and the power exercised by those who sit in high places is often much in excess of their rate of doing any kind of work.

When water has but a few feet of head, the quantity flowing over a water-wheel must be large if much work has to be done. But since the water usually comes to a low pressure wheel along an open stream, and flows away again also along an open stream, no expense has to be incurred in laying down large pipes. If, however, it were necessary to distribute much power over considerable distances through a pipe conveying such low-pressure water, the pipe would not only have to be long, but of large cross-section, and, therefore, very bulky and costly. For example, this model is a full-size representation of the transmission of only one horse-power with low pressure.

On the other hand, if the water possesses considerable head, the transmission pipe may be of small diameter. In this second model the three-cylinder pump produces a pressure of 425 lb. per square inch, exactly the pressure used in the hydraulic transmission of power down the shaft of the Rietfontein Mine, and with that pressure less than four gallons of water flowing per minute through this three-quarter inch pipe gives as much power to this turbine as would be delivered by 825 gallons pouring per minute over this water-wheel four feet in diameter.

The water pressures in these two illustrations bear about the same proportion to one another as the electric pressure in the Lauffen-to-Frankfort transmission bears to the electric pressure usually maintained between the terminals of a lamp in Johannesburg.

The value of using pressure water is grasped when you realise that at the Rietfontein Mine, by circulating about 85 gallons of water per minute, at 425 lb. pressure per square inch, through a pipe 16 square inches in cross-section, not only is the circulating water all returned to the top of the mine, but in addition 144 gallons are pumped up per minute from a depth of 546 feet through a pipe 38½ square inches in cross-section.

The water supplied by the London Hydraulic Power Company at 1700 feet head, although not filtered, costs nearly four times as much per gallon as the filtered water furnished by the Metropolitan Water Board. In England dirty pressure water is a relatively costly commodity, sparkling drinking water a relatively cheap liquid. In Johannesburg, on the other hand, until quite recently, the charge for drinking water was ten shillings a thousand gallons, plus two-and-six a month for meter rent, or about twenty times the London rate—the temptation to drink other things in Johannesburg must have been very great. Now, since the establishment of the Rand Water Board, it is six shillings a thousand gallons, which, without meter rent, is still ten times the London price, so that liquid with a head in London is still cheaper than plain drinking water here.

In the distribution of power, current and pressure are equally important. It is not merely because, even this month, August, after a phenomenally dry season, about 5,000,000 gallons of water are rushing per minute over the Victoria Falls, but it is because this water also thunders down about 380 feet that these falls are a potential source of power.

The Howick Falls, near Pietermaritzburg, have nearly as much head as the Victoria Falls, and twice as much as Niagara, while a syphon of soda water, when the gas is first pumped in, holds its head higher than any of the three. But, although in Johannesburg you probably pay a shilling for a syphon of soda water as an energy-producer in man, it is not worth 1/10,000th part of a penny as an energy-producer in a turbine, there is so little of it —only a pint and a half.

Probably, like myself, you have heard vague comparisons made between the power of the Victoria and the Niagara Falls. Now, what is the true comparison?

The flow at Niagara varies at different times of the year from about 62 to 104 million gallons per minute. At the Victoria Falls the flow can be as little as one-twelfth of the smaller number—for it is so now; and some authorities, well acquainted with the spot, say that at the end of another three months the flow will only be half of even that. The mean available drop at Niagara is about 160 feet; at the Victoria Falls about 380 feet. Hence, while the *minimum* Niagara flow represents about 3 million horse-power, the *present* Victoria flow represents about 580,000 horse-power, or only about one-fifth of the Niagara flow. Further, if those who predict the flow of the Zambesi sinking to something like 2½ million gallons per minute in November are true prophets, the Victoria Falls will then only give out about 300,000 horse-power, or, say, one-tenth of the *minimum* that Niagara produces.

In all that precedes, I have taken the full power of the direct drop in each case; that is, I have assumed in each case the intake to be close to the main drop, and I have deducted nothing for inefficiency of machinery.

Now, how exactly does the efficiency in the electric transmission of power depend on (1) the pressure, (2) the power transmitted, (3) the length of the transmission line, and (4) the resistance of the conductors composing it?

The very simple approximate formula connects these quantities :—

$$\left\{\begin{array}{c}\text{Percentage}\\\text{loss of}\\\text{power on}\\\text{the road.}\end{array}\right\} = \frac{\text{Horse-power transmitted}}{3\ (\text{thousands of volts})^2} \times \text{miles} \times \left(\begin{array}{c}\text{Resistance}\\\text{per mile of all}\\\text{the conductors}\\\text{in parallel.}\end{array}\right)$$

This formula tells us that as long as the electric pressure is limited to some 10,000 or 11,000 volts—a pressure boldly used as early as 1897 by the Rand Central Electric Works, and at the Moodie Mines, near Barberton, but the one that is still the maximum sanctioned in Great Britain—it will not be possible, even with a pair of conductors of good copper, each as thick as the one I hold in my hand, viz. three-quarters of an inch in diameter, to transmit more than about 6000 horse-power, or to transmit that power more than about 10 miles, without the loss on the road exceeding 10 per cent.

The actual efficiency will, of course, be less than 90 per cent., since there will be losses also in the machinery at each end of the transmission system.

If, however, the electric pressure be doubled, that is, raised to 20,000 volts, then through this pair of conductors (kindly put up by the Transvaal Technical Institute, to bring power from their dynamo room to this hall), which are not much more than one-fifth of the cross-section of the former, and therefore not much more than one-fifth of the cost, as regards copper, we can transmit 2700 horse-power 23 miles, and still only lose 10 per cent. on the road.

Now Brakpan, where is the generating station of the Rand Central Electric Works, is almost exactly 23 miles from Johannesburg. Six wires come thence to Johannesburg, three of which may be likened to the going conductor, and three to the return in a two-wire system like this, also any three of those wires have a joint cross-section rather larger than three times the cross-section of this. Hence, with 20,000 volts, about 8000 horse-power could be sent to Johannesburg from Brakpan through the existing wires with only 10 per cent. loss on the road, or about 3400 horse-power (which is rather more than the entire maximum output of that generating station on any occasion last year) could be sent with only 4 per cent. loss.

I should have liked to show you this experimentally, but Mr. Reunert, Principal Hele Shaw, and Prof. Dobson, who, since my arrival, have so kindly put themselves to so much trouble to give expression to my wishes, might have thought me a little exacting had I asked for a lecture hall big enough to include a transmission line from Brakpan; and so, instead of this pair of conductors connecting two places 23 miles apart, I am going to employ a pair of extremely fine wires, each less than 1/100th of the diameter, that is, less than 1/10,000th of the cross-section—so fine, in fact, that you cannot see them.

Switch on the current, more than 100 lamps glow. Now think of a wall of lamps ten times as high, then ten times as wide, and then six times as big as all that, and you will have 2700 horse-power; and that is the power which, put into this pair of wires 23 miles away, say at Brakpan, with this pressure of 20,000 volts, will cause about 2400 horse-power to come out at Johannesburg.

This experiment of transmitting *five* horse-power across the hall is the nearest approach to wireless transmission of power that I have ever seen. But there are wires, although invisible, for if I make them touch at one point with this long stick a flash occurs above your heads, and the glow lamps on the platform go out.

I directed your attention to the fact that in 1888 the male population of Johannesburg was 2000. By 1896, according to the census taken that year, it had grown to 32,387. Now, curiously enough, in 1897 two transmissions were arranged for at 33,000 volts—the one at Crofton, California, and the other at Redlands, California; and no pressure higher than that used on the Lauffen-Frankfort transmission seems to have preceded this 33,000 volts anywhere in the world. Indeed, it would almost appear as if electrical engineers were waiting to use a higher pressure than 25,000 volts until the publication of the census of Johannesburg.

In 1898 the highest working pressure in the world was 40,000 volts for a 34-mile transmission at Provo, in Utah, and the male white population in Johannesburg was also about 40,000. Then came the war, and volts beat white man, for, according to the census of last year, while the white male population was 52,106, there were several examples of transmissions at 60,000 volts, as seen from the following table.

Year	From	To	Country	Transmission distance in miles	Horse-power transmitted	Pressure at transmission end in volts
1897	Crofton	—	California	—	—	33,000
,,	Redlands	—	,,	—	—	,,
	—	Bangalore	India	92	4,300	35,000
1898	Provo	—	Utah	32	—	40,000
—	Gromo	Nembro	Lombardy	22	3,300	,,
—	Logan	Salt Lake City	Utah	150	2,600	,,
—	Canyon Ferry	Butte	Missouri	70	5,700	50,000
—	Shawingan	Montreal	Canada	90	15,000	,,
—	Moutiers	Lyons	France	112	—	57,600
—	Spokane	Washington	—	100	3,000	60,000
—	—	Guanaguato	Mexico	104	4,000	,,
—	Electra	San Francisco	California	147	10,000	,,
—	Colegate	Stockton	,,	218	5,000	,,

But with the influx of the white members of the British Association doubtless the tide will turn, white man will make a spurt and catch up electric pressure, and in this respect, at any rate, the Witwatersrand will become a white man's country.

Indeed, not only have various successful 60,000-volt transmission schemes been carried out, but the Kern River Power Company in California is constructing one for transmitting 4020 horse-power over 110 miles at 67,500 volts.

Transmission at 67,500 volts over 110 miles. Why, when the new railway—Brakpan to Witbank—is completed, 110 miles will be 20 more than will separate the Rand from the coalfields at Witbank—fields that produce such good coal that the Central South African Railways have contracted to purchase 84,000 tons during this year, at six shillings per ton at the pit's mouth. Now, at a pressure of 67,500 volts, these two small wires could, without becoming too warm, bring about 9000 horse-power from Witbank and deliver 7600 of it to the Rand.

Or if six wires were used like those now employed by the Rand Central Electric Works, then, at 67,500 volts, 9000 horse-power might be put in at Witbank and only 5 per cent. lost on the road, that is, about 8550 horse-power delivered on the Rand.

But the insulators would have to be placed much farther apart than on the existing Rand posts to prevent the starting of a brush discharge between the wires—a subject to which I will return.

You will now grasp why in 1895, ten years ago, it was a bold and pioneering policy to equip the Rand Central Works for 10,000 volts, and to use 13,000 volts during times of full load, and why in 1905 the recommendation of some advisers to distribute power at only 10,000 volts to the proposed substations of the contemplated 57 miles of electrified railways—Springs to Randfontein—is most retrograde of those advisers to the railway.

In 1879, a firm of electrical contractors, well known then, and equally well known now, told me that they had been asked to tender for the construction of an electric transmission system to convey a comparatively small amount of power 10 miles. But since they considered that they could not possibly hope to deliver more than half, while, in practice, they feared that they would only succeed in delivering much less, the proposal had to be ranked with the exploits of Gulliver and Baron Munchausen, and so even that firm declined to tender. To-day, twenty-six years later, electric power is, from an engineering and from a business point of view, being successfully transmitted 232 miles—nearly as far as some of you took fifteen hours the night before last in being transmitted from Ladysmith.

Now, how are these electric pressures of 10, 20, 30, 40, 50, 60,000 volts produced? Why, by means of the alternate current transformer, which does for electric power exactly what the lever does for mechanical power. Exert a small force through a long distance at the long end of this lever, and you have a large force exerted through a short distance at the short end. Apply a small electric pressure with a large current at one side of this transformer, and you have a large pressure with a small current at the other. But there are no moving parts, therefore the arrangement is called a "static transformer." It requires no adjustment from day to day, therefore it may be kept entirely immersed in oil to improve its insulation.

Such statical transformers I used to step up the pressure from 100 to 20,000 volts at the transmitting end, and to step down the pressure from 20,000 to 100 volts at the lamp end in the last experiment. Everything looked quite harmless until I intentionally brought the transmission wires into contact. So does the transformer, immersed in a huge cylinder of oil, now projected on the screen, although it regularly produces 60,000 volts, and can supply 1100 horse-power at that pressure. So does this water-cooled transformer (the interior of which is seen in an X-ray picture to the right, and the exterior to the left), although it can supply 2000 kilowatts, that is, 2700 horse-power. Its size can be realised by comparing it with the tiny transformer by its side—the size of the one which I have on this table.

60,000 volts, well, what of it? some of you may say. It cannot start a discharge between even sharp needle points separated by a greater distance than about six inches, and some of you have produced such a spark with an electrical machine—I am producing such a one now.

But each time that a spark passes between the terminals of the electrical machine the pressure is relieved, so no arc is maintained. Bring the terminals of that transformer within six inches of one another, however, and a roaring arc of 2700 horse-power will be kept up, dealing destruction around.

Let me show you a spark started with a 70,000-volt transformer when supplied with only one horse-power. What a banging is produced. Now picture to yourselves what would be the result if the power were not of one, but of 2700 horses, such as that transformer can furnish.

The photographs show the sort of discharge that may occur over the surface of an insulator 1 foot high—such as is used on a high voltage transmission line—when the testing voltage is 80,000 in this case and 105,000 in that, and when there is plenty of power to maintain the arc. It is veritable lightning, not a mere flash, but a continued flame; and the sort of insulator that is used in practice for a 70,000-volt transmission is realised by looking at the specimens, which are only intended for 10,000 volts.

There is nothing new in high voltage by itself—it existed in the period of the frictional electrical machine more than 100 years ago, but it was associated with only a very small current; next, dating from the development of the dynamo, came the low voltage large current period; and now we have entered on a third era, the high pressure moderate current period, that is, the period of high pressure combined with horse-power.

Next I come to a very important question, and one that merits far more consideration than it has yet received. There are two kinds of electric current—direct current and alternating current. Direct current is like a continuously flowing stream of water, such as, for example, the one that flowed through this pipe and drove this turbine. Alternating current, on the contrary, is like this band, which, although swinging backwards and forwards, also turns a wheel in one direction at the other end. Now, which kind of electric current should be used for the distribution of power over *long distances?* Practically, every electrical engineer will at once reply, alternating, of course. Well, I am going to preach heresy. I say direct current!

The alternating current has undoubtedly the great advantage that a motor can be constructed with no rubbing electric contacts, every wire may be permanently soldered in position, a condition of considerable importance in dusty places like mines. Here is such a motor—the first polyphase motor ever sent from America to Europe, the first ever seen in Great Britain, constructed seventeen years ago by Tesla with his own hands, when he was too poor to employ a workman.

Another advantage possessed by an alternating current is that an alternating current dynamo can be constructed to produce a large horse-power at a high voltage, and further, as we have already seen, this alternating voltage can be transformed into a still higher one without the use of moving machinery.

This is one of the five largest dynamos in the world. Its size you can better estimate by looking at the ring standing on end, now projected to the left. The latter is the stationary portion of a 5000 horse-power horizontal shaft dynamo, while the photograph to the right is that of a vertical shaft machine of double that power, viz. a dynamo that can develop 10,000 horse-power at a pressure of 11,000 volts. Fifteen years ago, Ferranti—the Brunel of electricity—spent a mint of money constructing some of the parts of a 10,000 horse-power, 10,000 volt alternator, which were, however, never put together. This dynamo projected on the screen stands complete, with its four sisters, in the Canadian Niagara Power House, and the tests already made show that its efficiency reaches the extremely high value of 98·2 per cent., that is, 1·8 per cent. of the power developed is sufficient to cover all losses. Ferranti's dream is more than realised, and the old story is repeated. We break up the pioneer leviathan, the *Great Eastern* steamship, as a great unwieldy giant very weak in its knees, a little later we build the *Baltic*, a third as large again, and with twice the engine power.

Without any transformation at all, these dynamos will economically drive machines some miles away, and, with the pressure transformed up from 11,000 to 60,000 volts, power will be distributed in Toronto, 85 miles away from the falls.

Contrasted with this, no single large *direct* current machine has ever been constructed to generate more than about 3500 volts, and no means is known for efficiently converting a direct current voltage into a higher, or a lower one, without the use of moving machinery.

So far, then, my case seems weak! The advantages of using great electric pressures we have seen. Are there any disadvantages? This is a disadvantage, the risk of piercing the insulation! See how thick the insulating material has to be on cables, how far apart the conductors have to be placed, even when the cable is intended for only 10,000 volts. But does this consideration supply any argument for or against the use of one kind of current rather than the other? Small current and high pressure must be used for the economical transmission of power over long distances, whether the current be alternating or direct, I agree; but, ladies and gentlemen of the jury, I submit that, while from the point of view of economic transmission, 60,000 volts alternating means exactly the same as 60,000 volts direct, from the point of breakdown of the insulation, 60,000 volts alternating is as bad as 85,000 volts direct, indeed may be worse than 100,000 volts direct. For an alternating current consists of waves like the waves of the sea. In a storm, the waves may be running mountains high, and yet the average depth of the sea remains the same as in a calm. But what does it benefit the poor passengers, when tossed helplessly backwards and forwards in their berths, and feebly calling "steward," to be assured that, although the waves be peaked, and the maximum elevation large, the square root of the mean square of the amplitude of oscillation is quite consistent with perfect internal tranquility? And so feels the poor insulating material—the mean electric pressure may not be very large, and yet the crests of the waves may be so high, and the troughs so low, that its strength cannot stand the electric tossing.

Each of those waves of electric pressure on the diagram gives the same reading on a voltmeter, but the peaked one has far more destructive action than the flat topped one.

But there are other disadvantages in the use of alternating current. This coil of wire represents one of the conductors which, when unwound, might join two places, the one where incandescent lamps (for example) have to be made to glow, and the other where is the water-power which drives the dynamo that generates the current. If a *direct* pressure of 100 volts be applied at one end of the system, the lamps at the other end glow brightly, as you see, whereas if now I apply an *alternating* pressure, although of exactly the same value, the lamps are quite dull.

The explanation of this striking difference is that in such a case only a fraction of the *alternating* pressure is used in making the lamps glow, the remainder being employed in maintaining a rapidly reversing magnetic field.

This magnetic effect—this self-inductive effect as it is called—is small if the going and return conductors be straight, short, and near together. But if the distance over which the power is to be transmitted be long, the wires obviously cannot be short, and if to obtain economy high electric pressure be used, the wires cannot be put very near together, since that would lead to a brush discharge through the air from one conductor to the other, producing leakage.

Indeed, the minimum distance that must separate the conductors has to be increased very rapidly with the pressure unless their diameter is greatly increased at the same time. The table gives this minimum distance for conductors 1/10th, 2/10ths, and 4/10ths of an inch diameter respectively, and it will be seen that increasing the thickness of the wire greatly diminishes this minimum. For instance, at 80,000 volts, doubling the thickness of the wire from 1/5th to 2/5ths of an inch diminishes the minimum distance from 6½ feet to 13½ inches.

JOHANNESBURG.

Elevation, 5689 feet, January, 1905. Barometer, 24·3 inches. Temperature, 91°·5 F.

Minimum distance that must separate two parallel wires to prevent the starting of a Brush Discharge.

Root mean square electric pressure in volts between wires	Diameter of wires in inches		
	1/10	2/10	4/10
40,000	8·8 in.	—	—
50,000	32·2 in.	—	—
60,000	9·9 ft.	14·7 in.	—
70,000	35·7 ft.	33·8 in.	—
80,000	—	6·5 ft.	13·6 in.
90,000	—	—	23 in.
100,000	—	—	38 in.

It must, of course, be remembered that these are minimum distances, and that the distances apart at which the wires have actually to be fixed in practice are much greater.

But that is not the whole indictment against the use of alternating current for *long distance* transmission. Leakage from wire to wire can be rendered small, but still, if the current be alternating, it always flows along the wires, even if all the apparatus at the distant end be entirely disconnected from them. Let me show you this.

I apply a direct pressure of 100 volts, and no current enters the transmission line, for it is well insulated along its length and at its ends. I apply instead an alternating pressure of the same value, without making any other change, and you observe a very perceptible current. The very first thing that struck Ferranti when he commenced transmitting power with alternating current at 10,000 volts pressure, from Deptford to London, was that the current flowing into the system at Deptford was as large during the daytime, when practically no lamps were turned on in London, as during the evening, when many were glowing. Again, in the case of the 150 miles transmission, at 50,000 volts, by the Bay Counties Power Company, in California, it was found that to charge even the aërial lines as a condenser required 40 amperes, so that the current flowing into the system remained practically unchanged when the useful load was decreased from several thousand horse-power down to nought.

Now this is the very opposite of the effect we previously noticed, for in that case it was the alternating pressure that left the lamps dull by failing to send enough current into the transmission system. Surely, then, the one effect is a correction of the other. That is so, and I will give you a practical illustration.

I have here two transmission lines, the one with its going and return conductors placed far apart so as to exaggerate the first effect, the other with its going and return conductors near together to exaggerate the second effect; indeed, as I am employing for this experiment only a pressure of 100 volts, there is no risk of brush discharge, and so I have put the wires extremely near together on the second transmission line. The alternating current produced by the dynamo divides itself between the two transmission lines, and the two branch currents are about equal.

But, as you may see by means of the oscillograph—an instrument developed in my laboratories by Mr. Duddell, one of my students, for giving us a picture of the current and pressure waves in each of the two circuits—there is a great difference between the waves in the two circuits. In the transmission line with the wires far apart, the reversals of the alternating current occur after the reversals of applied pressure, the crests of the current wave lag behind the crests of the pressure wave, whereas in the case of the transmission line, with the wires very near together, the exact opposite occurs, viz. the crests of the current wave are in advance of the crests of the pressure wave.

Now, in the circuit coming from the dynamo, both current waves exist together, and as the crests of the one wave coexist with the troughs of the other there is interference, and the result is practically no current at all. So here we have the rather surprising result of practically no current in a main circuit, and yet a considerable current in each of the branch circuits into which the main circuit divides.

This may perhaps be regarded as a beneficial result, and should be added to the score of alternating current. But just as a very small alternating current in the main circuit can be split up into two large currents in the branch circuits, a small alternating pressure can be split up into two large alternating pressures, and in that case the result must be scored against the use of alternating current.

In this experiment I use also two circuits, one with the conductors very far apart, and the other with them very near together; but instead of employing these circuits as two *branch* transmission lines I put them end on, so that they constitute *successive* portions of the same transmission line. An alternating pressure of only 100 volts is provided by the dynamo and applied to the whole arrangement, and yet you observe that, between the going and return conductors in that part of the circuit in which they are far apart, as well as in that part in which they are near together, a pressure exists of 2400 volts, which is twenty-four times as great as the entire pressure supplied by the dynamo to the mains.

This result with alternating electric pressures is not unlike that obtained with mechanical forces when a small force is resolved into two very large ones, with each of which it makes nearly a right angle.

Much damage has been done to electric cables, used for the distribution of power, by these unexpected high pressures produced by resonance in alternate current circuits. A cable may have been tested at twice or thrice the working pressure and passed as satisfactory. But if there is a liability of a pressure being applied, which, as you see, may in somewhat extreme cases be twenty or thirty times the working pressure, what avails it that there is a factor of safety of 2 or 3?—disaster must follow.

Now with direct current for long distance transmission there is no question about the electric pressure at the top and bottom of a wave being much greater than the mean pressure, no question about self-induction reducing the current—no objection, therefore, to putting the conductors as far apart as the risk of brush discharge may necessitate—no question about capacity current, no resonance troubles, &c.

I wonder whether any of you are thinking—Well, perhaps there may be something in this heresy after all. No? Oh! then you are thinking, if the arguments were sound, the direct current system would have been already employed for long distance transmission. Well, but it has! Power up to 3000 horse has been transmitted with direct current, at 14,000 volts, from Combe Garot to Le Locle and La Chaud de Fonds, round a circuit 32 miles long; 4600 horse-power has been transmitted with direct current, at 23,000 volts, 35 miles from St. Maurice to Lausanne; and a transmission system for 6000 horse-power, at 60,000 volts, over 114 miles from Moutiers to Lyons, is in course of construction.

Another advantage that is possessed by all these examples of direct current transmission carried out by M. Thury is that it is the current that is kept constant and the electric pressure that is automatically raised when the demand for power is increased, whereas with the ordinary alternate current system it is the pressure at the lamp end that they aim at keeping constant, and the current that varies automatically with the demand for power

Now it is far more easy to maintain the constancy of the current flowing round a long circuit than to prevent the bobbing up and down of the electric pressure at the distant end of a long transmission line, and that irritating dancing of the lights, with which Johannesburg is so familiar, would be particularly difficult to avoid if the transmission line were long and the electric pressures at its two ends differed by some thousands of volts.

Constant current has also its well known disadvantages, but these would not come into play if the constant current were not taken into houses, mines, &c., but used to drive motor generators in substations, the dynamo portion of the motor generator being of any type desired.

The pioneering development that American boldness, enterprise, initiative, and originality have brought about in the electric distribution of power, combined with the extraordinary commercial success that it has won on both sides of the Atlantic, have made people ask, "Is such an industrial revolution in store for South Africa?"

At first sight one is inclined to answer "No!" This country is dotted with coalfields—coalfields blacken the map, and the produce of some of them is reported to be nearly equal to the best Welsh coal in quality. A humorous English paper said that I was going to give this lecture standing on a coal waggon to indicate how superior, as a carrier of energy, was a coal cart to a current.

When, on the one hand, one hears that good coal is brought from Witbank and delivered to the mines on the Rand at 13*s*. a ton, and that even this price will be lowered on the completion of the new railway from Witbank to Brakpan, one feels that long distance electric distribution has not much chance—indeed, a proposal to burn slack coal at Vereeniging, only 33 miles from Johannesburg, and electrically distribute the power on the Rand, fell through.

On the other hand, when one finds that at the Wankei coalfields themselves large coal costs 15*s*. a ton *at the pit's mouth*, and that Salisbury pays 36*s*. 5*d*., Umtali 43*s*. 6*d*., and Kimberley 67*s*. per ton, one feels that electric distribution in this country possesses possibilities.

South Wales has many coal mines—cheap slack coal lies heaped at the pit's mouth. Let me put this question to you: "If an electric supply distributing company were to start in South Wales to obtain their electric energy, *not* from waterfalls, mark you, but from coal brought to their generating stations from coal mines, would you anticipate, I ask, that such a company would obtain customers for their electric energy at coal mines themselves?" "No, emphatically no," you would reply, for that would be taking coals to Newcastle with a vengeance. Yet, what does that map tell us? Why that, within four years since that South Wales company was merely applying to Parliament for an Act to enable them to establish a distribution of power system, fourteen of the largest colliery companies and thirty of the mines are taking power at about one halfpenny a horse for an hour, the demand three months ago having reached 13,000 horse-power, and rapidly increasing.

That the North-Eastern Railway, and such a large number of manufactories along the Tyne, should, as seen from that other diagram, take power from the Tyneside Electric Power Supply Company—which also has been but four years in existence—was perhaps to be expected, but that coal mines should obtain power by the burning of the product of distant collieries resembles at first sight the method of earning a living attributed to a certain village, viz. by taking in one another's washing.

But this result is but an example of the subdivision of labour. At a coal mine getting coal, and at a gold mine getting gold, is the business, and at both, especially in the early days of sinking the mine, it should pay better to buy electric energy from an outside source than to generate the current on the spot.

Niagara sends 24,000 horse-power to Buffalo, 30 miles away, and sells it at 0.7*d*. per horse-power hour to an eight-hour user there—a price which is *not* cheaper than the total cost of generating a horse-power hour at Buffalo with a *large* steam engine. But tapping electric wires to obtain any amount of power that may be needed, and just at the time that it is required, is far more convenient than erecting steam engines and getting up steam, and certainly cheaper in the early days of sinking a mine.

It has been objected that the total steam-power curves of all the gold mines on the Rand show the same sort of falling-off during the hours 4 to 7 a.m. and 5 to 8 p.m., and, therefore, that, apart from using larger and more economical engines, and from diminishing the cost of superintendence for the energy sent out, there would be no saving by supplying many mines with electric power from a common generating station. But if there be a railway in the neighbourhood, largely used by workmen, the slack hours on the mines will be the busy hours on the railway. Hence, if that railway be run electrically from the same generating station, the load curve will be flattened and much improved.

On the Rand, however, there is an indisposition, apparently, to utilise distribution of power on a large scale. The labour conditions in this country are certainly peculiar. My friend Mr. Denny, in his book on "Deep Level Mines of the Rand and their Future Development," expresses this opinion—and there is no man whose opinions on such matters I value more highly:—"It has, however, been fairly conclusively proved that in average conditions hand labour is both speedier and cheaper than machine drilling."

But when one watches this hand labour one thinks of this picture rather than that. Contrary to American and Australian experience, it may be true that in this country white men and machinery may be dearer and slower than black machinery and man rolled into one. But it makes one uncomfortable, even unhappy, to think it possible, for it means that the muscular machine is more valuable than the inventor's brain.

Another objection felt by mine owners here to investing much capital in machinery is the somewhat uncertain character of their business, and a third against a mine depending for a supply of power on an electric current coming from a distance is the climatic conditions.

South Africa has various unique big things, but it has not a monopoly of big atmospheric disturbances, and these disturbances do not prevent electrical distribution of power schemes being pushed forward by leaps and bounds in the other three quarters of the world—the list given on p. 615 is merely a selection from some of those using the highest working voltages. During my short stay in this country I have been giving this matter much consideration. Without stopping this evening to discuss the subject in detail, I may mention that, after the admirable work of Mr. Wilms, Mr. Spengel, Mr. Heather, and others here on the improvement of lightning arrestors for electric transmission lines, I think I also see my way to putting a nail into the coffin of these bugbear lightning troubles.

But while advocating electric transmission of power I should not start by constructing a transmission line from the Victoria Falls to Johannesburg; and I say that, not because I am of opinion that it could not be made to work, nor that, if direct current were used, it could not be relied on to give as satisfactory results as, or even better results than, some shorter existing ones on the alternate current system, but because it does not appear to me that along the route there is at present sufficient demand for power to justify as large an expenditure of capital as would be compatible with a transmission line 586 miles long as the crow flies, and which would be no less than 745 miles long if made along a railway through Pietersburg and Gwanda, should the missing stretch of railway between these two places ever be constructed.

Those who hold the opposite view will doubtless urge that when the Cataract Construction Company of Niagara acquired in 1890 the right to use 100,000 horse-power, and a further right to use subsequently another 100,000 horse-power, it required an extraordinary belief in the future of electrical engineering to expect that 200,000 horse-power could ever be distributed at a price that could compete with large local steam engines, and they will ask, did not even Mr. George Westinghouse, in 1890, advise Mr. Stetson, the first vice-president of the Cataract Construction Company, that it would only be by compressed air that power could be commercially transmitted from Niagara to Buffalo? And now what is the state of things? Power House No. 1, with ten 5000 horse-power dynamos, has been working for some time, Power House No. 2, with eleven more 5000 horse-power dynamos, was completed last year. Hence 105,000 horse-power can be developed, and of this 75,000 horse-power is regularly distributed.

Further, the Canadian Niagara Power Company is constructing an electric station of an ultimate capacity of 110,000 horse-power, the Ontario Power Company an electric station, a little lower down, of 200,000 horse-power, and the Toronto Power Company one, a little higher up, of 100,000 horse-power, all these three being on the Canadian side.

Also the Electric and Hydraulic Company, which in 1881 started with a station, on the American side, to supply only 1500 electrical horse-power, has in hand a third station which will bring its plant capacity up to 135,500 electrical horse-power.

Consequently the total electrical horse-power that could be sent out from these various Niagara power houses, when completed, will approach 700,000 horse-power, and represents about 30 per cent. of the water going over the falls at the time of *minimum* flow. But taking into account the further fact that water is already abstracted to feed the Welland Power Canal and the Chicago Drainage Canal, and that other canals are projected, Mr. A. D. Adams has estimated that about 41 per cent. of the minimum flow of Niagara will cease to pass over the falls. In fact, I conclude that *the water that will, in the near future, cease to pass over the Niagara Falls will be nearly five times as large as the total amount passing over the Victoria Falls this month, August.*[1]

The "Thunder of the Waters," the "Cataract of Fearful Height," in America, which have inspired us and our ancestors with reverential awe, may appeal to our descendants as only a vast electric generating station. Very gratifying to us as engineers, extremely distressful to us as lovers of the beautiful.

Now what has caused this vast development in the distribution of power, what is the secret of this extraordinary success? It is that in the immediate neighbourhood of the falls there have grown up works which take some 60,000 horse-power, works which not only want cheap power, but power in an electric form for electrochemical processes, and need it in an undiminished amount day and night, week-day and Sunday. The Carborundum Company, which manufactures emery's rival grinding material, furnishes an absolutely steady load of 5000 electric horse-power; the Union Carbide Company 15,000, and so on; loads which, from their magnitude and their absolute steadiness, make the electric light engineer's mouth water.

Now what is the prospect of such a steady load growing up locally within, say, 3 miles of your falls? Even

[1] The Resident Commissioner of the Bechuanaland Protectorate, writing to *The Times* from Mafeking the day after the delivery of this lecture, said:—"The volume of water passing over the (Victoria) Falls, was, it is true, infinitely less on August 16, 1905, than on the same date in 1883. It is less to-day than it has ever been in the memory of man."

on the spot it is difficult to obtain trustworthy information; by some it is said that one condition of the contract for the construction of the railway, which is being pushed forward to the copper, lead, and zinc fields at Broken Hill, 400 miles to the north-east, is that 100,000 tons of the ore must be sent to Beira yearly for ten years. If true, then that ore will not be available for reduction at the falls.

There is a convenient spot for a power station near the water at the end of the second gorge—all the Niagara power stations are on the top of the falls, with the exception of those of the Ontario Power Company, and the old Electric and Hydraulic Company—and it is the latter method of construction that would be the most suitable to follow at a Victoria power station.

But jealously guard the beauty of your falls. The protection of the grandeur of their American sister was the underlying idea of Thomas Evershed's hydraulic power scheme of 1886. How little has that object been kept sight of?

Niagara *was* glorious nature, to-day it is power, Victoria is poetry.

FORTHCOMING BOOKS OF SCIENCE.

MR. EDWARD ARNOLD gives notice of:—"The Great Plateau, being an Account of Exploration in Central Tibet, 1903, and of the Gartok Expedition, 1904–1905," by Captain C. G. Rawling, illustrated; "In the Desert," by L. M. Phillipps, illustrated; "Two Years in the Antarctic, being a Narrative of the British National Antarctic Expedition," by Lieut. A. B. Armitage, illustrated; "Common Ailments and their Treatment," by Dr. M. H. Naylor; "Electric Lighting for the Inexperienced," by H. Walter; "Races of Domestic Poultry," by E. Brown, illustrated; "Recent Advances in Physiology," by Drs. A. P. Beddard, L. Hill, F.R.S., J. J. R. Macleod, B. Moore, and M. S. Pembrey; "Valves and Valve Gear Mechanisms," by Prof. W. E. Dalby, illustrated; "Surgical Nursing and the Principles of Surgery for Nurses," by Dr. R. Howard, illustrated; "The Laws of Health," by Dr. D. Nabarro, illustrated; and new editions of "Practical Physiology," by Drs. A. P. Beddard, J. S. Edkins, L. Hill, F.R.S., J. J. R. Macleod, and M. S. Pembrey, illustrated; and "Food and the Principles of Dietetics," by Dr. R. Hutchison, illustrated.

Messrs. Baillière, Tindall and Cox's list includes:—"Psychiatry," by Prof. Bianchi, translated by Dr. J. H. MacDonald; "Manual of Anatomy," by Dr. A. M. Buchanan, illustrated; "Manual of Military Hygiene," by Lieut.-Colonel R. Caldwell, illustrated; "Aids to Surgical Diagnosis," by H. W. Carson; "Sound and Rhythm," by Dr. W. Edmunds, illustrated; "Aids to Pathology," by Dr. W. d'Este Emery; "Trypanosomata and the Trypanosomiases," by A. Laveran and F. Mesnil, translated and edited by Dr. D. Nabarro; "Nodal Fevers," by Dr. A. A. Lendon, illustrated; "Applied Bacteriology," by C. G. Moor and Prof. R. T. Hewlett; "Practical Agricultural Chemistry," by F. Robertson; "Sanitary Science Laboratory Work," by Dr. D. Sommerville, illustrated; and new editions of "Heart Disease, with Special Reference to Prognosis and Treatment," by Sir W. H. Broadbent, Bart., F.R.S., and Dr. J. F. H. Broadbent, illustrated; "Physical Diagnosis," by Dr. R. C. Cabot; "Lectures on Clinical Psychiatry," by Dr. E. Kraepelin, authorised translation revised and edited by Dr. T. Johnstone; "Ambulance Work," by Drs. J. W. and J. Martin; "Manual of the Diseases of the Eye, for Students and Practitioners," by Dr. C. H. May and C. Worth, illustrated; "A Manual of Surgery for Students and Practitioners," by Dr. W. Rose and A. Carless; "The Nature and Treatment of Cancer," by Dr. J. A. Shaw-Mackenzie; "Manual of Physiology, with Practical Exercises," by Dr. G. N. Stewart, illustrated; "The Röntgen Rays in Medical Work," by Dr. D. Walsh, illustrated; and "The Deformities of the Human Foot; with their Treatment," by Drs. W. J. Walsham and W. K. Hughes.

Messrs. George Bell and Sons announce:—"Integral Calculus for Beginners," by A. Lodge; and a new edition of "Elementary Dynamics," by W. M. Baker.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Indian forestry probationers elected last August have come into residence, and the India Office has issued a notice that thirteen more probationers will be selected at the end of October. Candidates must have passed Responsions at Oxford or the previous examination at Cambridge, or some equivalent examination, and will be expected to have some knowledge of chemistry, physics and mechanics, and to be between the age of eighteen and twenty-one years, but the selection board will have the power to relax the superior age limit in the case of candidates who have taken a university degree. Names of intending candidates must be sent to the Under-Secretary of State for India not later than October 26; forms of application can be obtained from Dr. Schlich, 29 Banbury Road, Oxford.

CAMBRIDGE.—The syndicate appointed to consider the desirability of establishing in the university a diploma in forestry is of opinion (1) that a diploma in forestry should be established; (2) that forestry should form the principal subject of the final examination for the diploma; (3) that the diploma should be granted only to graduates of the university; (4) that candidates for the diploma should show evidence of having resided for the equivalent of one year in some recognised centre of instruction in practical forestry. If these recommendations be approved by the senate, the syndicate proposes to draw up and submit to that body detailed regulations for the scope and conduct of the proposed examinations and for the courses of lectures and practical instruction to be required of candidates for the diploma.

At Emmanuel College a studentship of the value of 150*l*. is offered for the encouragement of research in any branch of study recognised by the university. The studentship is open to graduate members of the university whose age does not exceed twenty-eight on January 1, 1906. It is tenable in the first instance for one year from January 1, 1906, but the student may be re-elected for a second period of one year. The latest date for receiving applications is November 20. Further information may be obtained from the master. The student elected is not required to become a member of Emmanuel College.

Mr. J. L. Tuckett, of Trinity College, has been appointed senior demonstrator of physiology until September 29, 1908, and Mr. S. W. Cole, of the same college, will succeed Mr. Tuckett as additional demonstrator in the same subject. Dr. H. B. Roderick, of Emmanuel College, has been re-appointed demonstrator of surgery. Prof. Hopkinson has been elected to represent the board of physics and chemistry on the general board of studies. Mr. J. J. Lister has been re-elected demonstrator of comparative anatomy.

MR. JAMES MILLIKAN, who has given 180,000*l*. for the establishment of a university at Decatur, Ill., which shall bear his name, has offered, we learn from *Science*, to give a further 200,000*l*. to the institution.

A COMMITTEE has been appointed to inquire into the expenditure on public education in England and Wales from Exchequer grants, local rates, and other sources, with the view of ascertaining the various causes for the existing diversity in the amount of rate levied for education by local authorities, and the varying relation which this amount bears to the total local rates in each area. All the members of the committee are officially connected with the Civil Service.

THE London County Council School of Marine Engineering in High Street, Poplar, has been established to enable

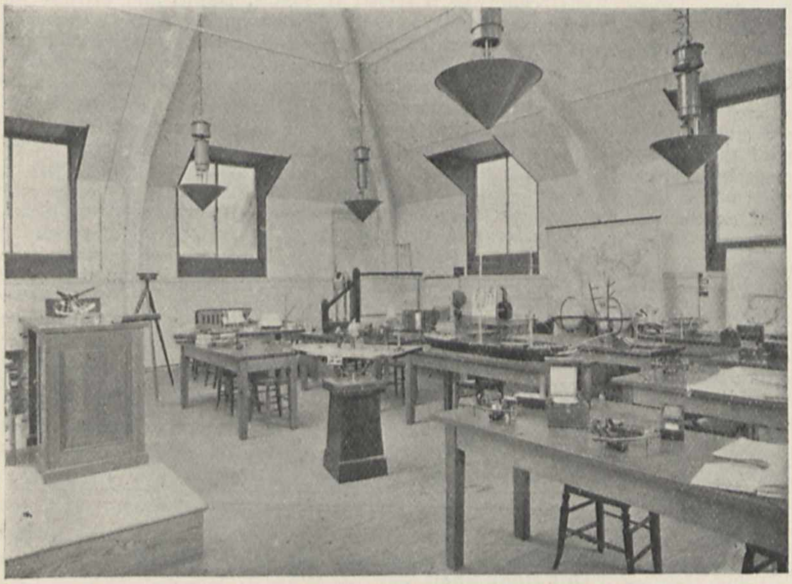

FIG. 1.—Navigation Room of the London County Council School of Marine Engineering, Poplar.

persons in the engineering and shipping industries of the Poplar and neighbouring districts to acquire an intimate knowledge of the principles which underlie the work on which they are engaged, instruction being given in physics, chemistry, and mathematics, as well as in the more practical subjects dealt with in the drawing offices, chart room, and engineering laboratories and workshops. The nautical day school is equipped with modern nautical instruments and seamanship models, and a portion of the roof of the building is arranged so as to form an observing terrace for meteorological and astronomical observations. Provision is also made for the thorough teaching of the principles of electrical engineering, and in the chemical laboratories students have opportunities of making investigations in connection with the calorific value of fuels, methods of purifying feed waters, and other subjects. The accompanying illustration shows the navigation room of the school.

PROF. R. MELDOLA, F.R.S., distributed, on October 11, the prizes and certificates gained during the session 1904–5 by the students of Herold's Institute, the London School of Leather Manufacture. The report of the director of the school, Dr. J. Gordon Parker, was read at the meeting, and showed that during the year a large amount of research work has been done, and the staff of the institute has contributed in no small degree to the important investigation connected with the deterioration of bookbinding leather carried out by the Society of Arts committee on bookbinding leather. Prof. Meldola, replying to a vote of thanks, reminded those present that in other countries there is a direct relationship between technical institutions and the industries. In this country, unfortunately, there is too often indifference or open hostility. Manufacturers have suffered through their unwillingness to modify old procedure and to face new sets of conditions, but it is gratifying to know that hostility to technical instruction is being overcome.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 11.—"On the Cytology of Apogamy and Apospory. —II. Preliminary Note on Apospory." By Miss L. **Digby.** Communicated by Prof. J. B. Farmer, F.R.S.

Apospory is the direct vegetative process which leads from the sporophyte to the gametophyte without the intervention of spores.

The fronds of *Nephrodium pseudo-mas,* Rich., var. *cristata apospora,* Druery, were layered in pans of earth, and soon showed aposporal growth. This arises from the surface and edge of the pinnule, and assumes prothalloid characters. These prothalli have no cushion; the embryo is a vegetative outgrowth.

The nuclear divisions of prothallus and embryo have been studied, and the calculated number of chromosomes is forty-three and forty-one respectively (see Fig.). This approximation undoubtedly proves that there is *no reduction* during the transition from the sporophyte to the gametophyte. A similar result has been obtained in *Athyrium Filix-faemina,* var. *clarissima,* Jones.

The apogamous prothalli of *Nephrodium pseudo-mas*

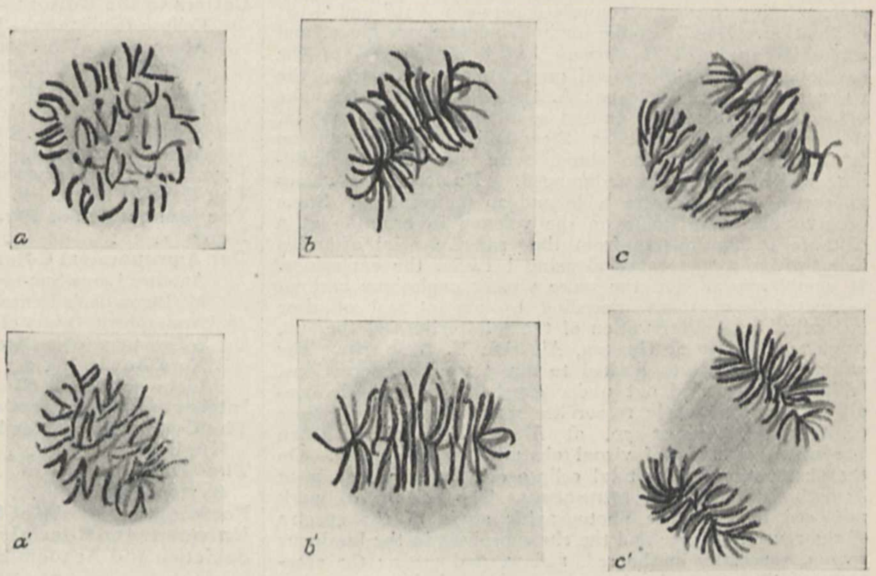

FIG. 1.—Diagrams of nuclear divisions. *a b c* in prothallus. *a' b' c'* in embryo.

cristata apospora show no nuclear migration, whereas about 73 per cent. of those of *Nephrodium pseudo-mas,* Rich., var. *polydactyla,* Wills,[1] exhibit this phenomenon. This is easily explained. Whereas in the former the nuclei of the aposporously developed prothalli have already the full complement of somatic chromosomes, in the latter

[1] J. B. Farmer, J. E. S. Moore, and L. Digby, "Preliminary Note on Apogamy," *Roy. Soc. Proc.,* vol. lxxi., 1903, pp. 453 to 457.

they have only half the number, as the prothalli germinate from spores, the origin of which undoubtedly involves a reduction. Hence the sporophytic number in that case is regained by migration and subsequent fusion of two prothallial nuclei.

MANCHESTER.

Literary and Philosophical Society, October 3.—Sir William H. Bailey, president, in the chair.—Note on the buccal pits of peripatus: C. G. **Hewitt.** A general outline of the characters of peripatus was given. Recently, tracheal structures had been described in an Australian species, *Ooperipatus oviparus,* in connection with the buccal pits. These pits are formed by the hollowing out of the long, chitinous levers which are attached to the inner pair of jaws; they are continuous with the cavity of the mouth. The paper embodied the results of an investigation into the nature of these buccal pits in *Ooperipatus oviparus* and two other species. It was found that tracheæ do not occur in this region of the body, and that the striated muscle fibres which work the jaw-levers had been mistaken for tracheæ.

PARIS.

Academy of Sciences, October 9.—M. Troost in the chair.—The president announced the death of Prof. Baron de Richthofen, correspondant in the section of mineralogy.—Observation of the total eclipse of the sun of August 30 at Alcosebre (Spain): J. **Janssen.** Just before totality the sky was not absolutely clear, a few light clouds interfering somewhat with the photography of the phases, but some minutes before totality the clouds disappeared, and the whole period of totality was studied under the best conditions. Three good photographs of the corona were obtained by M. Pasteur, M. Millochau was able to obtain photographs of the spectrum of the reversing layer and of the corona, and M. Stefanik made ocular observations on the green ray of the corona and of the extreme red. Numerous photographs of the phases were obtained.—On the creation of an international association for solar studies: J. **Janssen.** A *résumé* of the principal resolutions passed at the recent meeting at Oxford.—On the first volume of the "Catalogue photographique du Ciel," published by the Observatory of Bordeaux: M. **Lœwy.** This catalogue contains the rectilinear coordinates of 49,772 stars relating to a zone comprised between $+16°$ and $+18°$ declination. Details of the methods adopted are given, and a special study of the errors has been made.—On the earthquake felt at Stromboli on September 8, and on the present state of the volcano: A. **Lacroix.** The earthquake of September 8, which caused such disasters in Calabria, was also severely felt at Stromboli, as, although no fatalities resulted in the island, there was hardly a building which remained undamaged. Numerous crevasses appeared, some a metre wide and 20 metres long. Some observations were made on the volcano in eruption at a distance of 150 metres from the crater, special attention being given to the times elapsing between the explosions. It would appear that the more violent explosions are not separated from those preceding by an interval of time specially long.—Observation of the total eclipse of the sun, August 30, made at Guelma, Algeria: E. **Stephan.** The work attempted was limited to direct visual observations, which were carried out under excellent atmospheric conditions.—Spectroscopic researches made during the eclipse of the sun, August 30, at Alcosebre (Spain): Milan **Stefanik.** Details of visual observations are given.—On the observation of the total eclipse of August 30, made at Alcosebre (Spain): G. **Millochau.** The scheme of work proposed included the photographic study of the spectra of the reversing layer and the chromosphere in the luminous region, especially in the red, yellow, and green; the spectrum of the corona in the same region; similar researches in the ultra-violet; photographs during totality with plates sensible to the red rays, utilising a red screen to cut off other radiations. Details of the instruments are given, the full discussion of the results being reserved for a later paper.—On the polarised light of the solar corona: J. J. **Landerer.**—Mathematical groups containing several operations of the second order: G. A. **Miller.**—On some derivatives of cyclohexane: P. **Freundler** and E. **Damond.** The starting point of this work was cyclohexanol, prepared by Sabatier and Senderens' method. This was converted into the monobromo- and monoiodo-derivatives by the action of phosphorus bromide and iodide, and rectifying under reduced pressure. These compounds do not, as a rule, give good yields in condensation with sodium derivatives, an exception being in the reaction with sodiomalonic ester, the yield in this case being 27 per cent.—On the decomposition of meta- and para-nitrobenzylic alcohols under the influence of aqueous and alcoholic soda: P. **Carré.**—On some phenolic ethers with the pseudo-allyl chain $ArC(CH_3)=CH_2$: MM. **Béhal** and **Tiffeneau.**—On sambunigrin, a new hydrocyanic glucoside extracted from the leaves of the black elder: Em. **Bourquelot** and Em. **Danjou.** The existence of this glucoside has been indicated in a previous note, and in the present communication details are given of the method by which the sambunigrin has been obtained in a pure state. The new glucoside appears to be isomeric with the amygdonitrile glucoside of Fischer, from which it differs in its rotatory power.—Statistical researches on the evolution of the size of plants: Mlle. **Stefanowska.** The results are expressed in the form of curves.—Study of the blood in the case of a "bleeder": P. Émile **Weil.** Numerous experiments have been made on the coagulation of the blood from this case. The most important result obtained was the observation that the anomalous coagulation in these cases is not due to the presence of any anti-coagulating substances in the blood, but arises from the absence or alteration of certain normal substances, probably the coagulating ferment. It is sufficient to add traces of normal serum to cause a normal coagulation.—On the direct proofs of the existence of counter trade winds: Lawrence **Rotch** and Léon Teisserenc **de Bort.**

CONTENTS.

SUPPLEMENT TO "NATURE."

A TIBETAN DICTIONARY.

A Tibetan-English Dictionary with Sanskrit Synonyms. By Sarat Chandra Das. Revised and edited by G. Sandberg, B.A., and A. W. Heyde. Pp. xxxiv+1353. (Calcutta: Bengal Secretariat Press, 1902.)

THE chief attraction which the Tibetan language possesses for the western reader is that it is the Latin of Central Asia, and preserves in its bulky literature the old-world lore and vestiges of early culture which the priestly schoolmen of Tibet believed to be all that was worth knowing, not only about their own country, but of the outside world, and more especially ancient India, regarding which so little is known to us. For Tibet, upon receiving its Buddhism from India in the seventh century A.D., adopted at the same time the Indian characters for the purpose of reducing its hitherto unwritten Mongolian language into writing, and forthwith translated into its new vernacular the Indian Buddhist scriptures and other works, the originals of which were afterwards destroyed by the fanatical Mohammedan invaders on the expulsion of Buddhism from India in the twelfth century A.D. From these scripts, thus preserved in their Tibetan translations, much invaluable information has already been gleaned by European scholars; but owing to a habit of the learned monks to translate most of the proper names, of persons, places, and things, root by root etymologically into the Tibetan, it so happens that without a copious Tibeto-Sanskrit lexicon to re-convert these translated names into their recognisable Indian equivalents, a great deal of the mass of information locked up in the Tibetan volumes, now accumulating in our national libraries, remains to some extent sealed.

This is what the present dictionary claims to facilitate to a greater extent than has been done by the lexicons of the pioneer Csoma, the Hungarian, the scientifically equipped Moravian missionary, Jäschke, and Père Desgodins. It has been compiled by Babu Sarat Das from vernacular dictionaries brought by him from Tibet, when he visited that country some years ago. His revisers complain that they found "the material had been put together in somewhat heterogeneous fashion hardly systematic enough for a dictionary," so that they had to take "the greatest freedom in correcting or rejecting the matter set forth in the work." This task of correction has obviously not been carried far enough, for in its published form this ponderous volume still retains serious shortcomings in the elementary requirements of a dictionary. The definitions offered are too often wanting in accuracy to be trusted, or too wanting in necessary details and useful references to be very helpful. The Sanskrit synonyms are not so numerous as they might have been, and their definitions are usually made up of indiscriminate extracts from the Sanskrit-English dictionaries of English lexicographers, reproduced often without acknowledgment and with strange confusion and errors.

For instance, to refer to some of the botanical matters in the first few pages, under "Kakola," an aromatic spice, the author has taken the látter part of his definition from Wilson's dictionary without acknowledgment, and included with it part of the definition of the next following word; he also states that cardamom is "the fruit of *Cocculus indicus*," and mistakes Erandi or cubeb pepper for Erand, or the castor-oil plant. Again, "Kapi" is given in trustworthy Tibetan lexicons as the Sanskrit equivalent of "Ka*p*ittha," not "Ka*b*ittha" as stated by the Babu, and secondarily "Pithanaja," which is omitted by him. The primary meaning, therefore, is the wood-apple tree (*Feronia elephantum*) and not "resin of the juniper plant" as given by him. As secondary meanings he inserts five lines taken without acknowledgment from Wilson, and in so doing misspells each of the three botanical names, and alters "waved-leaf fig tree" into the nonsensical "manefig tree." In the next word, also, both the Sanskrit and botanical terms, taken unacknowledged from Wilson, are misspelt.

Again, "Chu-sing kar-po," or "the white water-tree," is absurdly stated by him to be *Aconitum ferox*, which, however, is black rather than white, and never called a "tree" by the Tibetans, to whom it is familiar. The vernacular lexicon, however, gives for "water-tree" the Sanskrit "Kadali," or "water-wood," which is the appropriate name of the watery plantain tree, and it gives the further synonym "Mochaka," or the "horse-radish-tree," which the Babu omits. Of this tree, the "Sajina" of Indian cooks, there are two varieties, namely, a red and a white kind, the latter of which is the one that has been wrongly identified with the deadly aconite by our compiler. Still another synonym for this word, "Nālam," a reed or "stalked water-plant," is incorrectly given as "the ratan" (*sic*); and the author frequently confuses cane with bamboo.

Not infrequently the precise shade of meaning is missed; thus *Rig-dsin*, which literally and invariably means "a holder of knowledge" or sage, is defined by him as "comprehension of a science (*sic*) with ease"; and seldom is any hint given of the useful literal meaning of such names as the common word for small-pox, which is euphemistically called "God's granules" in deference to the malignant disease spirit.

As instances of common words altogether omitted are *La-lis*, the respectful form of "yes," which after the mystic "*Om*" formula is perhaps the word most frequently uttered in Tibet; *Choma*, the common Potentilla, the root of which is eaten as a food; *pin-kyur-ma*, the kestrel, being onomatopœtic for its call; the word for "bribe," which is ethically interesting as meaning literally "a secret push."

His orthography disregards some of the accepted rules of scientific philologists, so as to give "Daipung" for the great monastery of Däpung, although no *i* occurs either in the vernacular spelling or pronunciation. We miss, too, in a dictionary of this size, which owing largely to clumsier type is thrice the weight of Jäschke's, any illustrations of the interesting process of organic change whereby so many of the bristling consonants of the written speech have dropped out of hearing in the spoken dialects of the temperate central province, probably for physiological and climatic reasons.

Nevertheless, despite its many defects, it embodies a good deal of new material from the vernacular Tibetan lexicons which must prove suggestive to those engaged in Tibetan researches who are sufficiently advanced not to be misled by its serious mistakes.

L. A. WADDELL.

FINGER-PRINT IDENTIFICATION.

Guide to Finger-print Identification. By Henry Faulds, L.F.P.S., late Surgeon Superintendent of Tsukiji Hospital, Tokyo, Japan. Pp. viii+80. (Hanley: Wood, Mitchell and Co., Ltd., 1905.) Price 5s. net.

DR. FAULDS was for some years a medical officer in Japan, and a zealous and original investigator of finger-prints. He wrote an interesting letter about them in NATURE, October 28, 1880, dwelling upon the legal purposes to which they might be applied, and he appears to be the first person who published anything, *in print,* on this subject. However, his suggestions of introducing the use of finger-prints fell flat. The reason that they did not attract attention was presumably that he supported them by no convincing proofs of three elementary propositions on which the suitability of finger-prints for legal purposes depends. It was necessary to adduce strong evidence of the, long since vaguely alleged, permanence of those ridges on the bulbs of the fingers that print their distinctive lineations. It was necessary to adduce better evidence than opinions based on mere inspection, of the vast variety in the minute details of those markings, and finally, for purposes of criminal investigation, it was necessary to prove that a large collection could be classified with sufficient precision to enable the officials in charge of it to find out speedily whether a duplicate of any set of prints that might be submitted to them did or did not exist in the collection. Dr. Faulds had no part in establishing any one of these most important preliminaries.

But though his letter of 1880 was, as above mentioned, apparently the first *printed* communication on the subject, it appeared years after the first public and *official use* of finger-prints had been made by Sir William Herschel in India, to whom the credit of originality that Dr. Faulds desires to monopolise is far more justly due. Those who care to learn the facts at first hand should turn to NATURE, vol. xxii. p. 605, for Dr. Faulds's first letter, to vol. l., p. 518, for a second letter from him in reference to the Parliamentary Blue-book on the "Identification of Criminals," then just issued, and lastly to Sir Wm. Herschel's reply in vol. li., pp. 77–8, where the question of priority of dates is placed beyond doubt, by the reprint of the office copy of Sir William's "demi-official" letter of August 15, 1877, to the then Inspector of Prisons in Bengal. This letter covers all that is important in Dr. Faulds's subsequent communication in 1880, and goes considerably further. The method introduced by Sir Wm. Herschel, tentatively at first as a safeguard against personation, had gradually been developed and tested, both in the jail and in the registering office, during a period of from ten to fifteen years before 1877, as stated in the above quoted letter to the Inspector of Prisons.

The failure of Sir Wm. Herschel's successor, and of others at that time in authority in Bengal, to continue the development of the system so happily begun, is greatly to be deplored, but it can be explained on the same grounds as those mentioned above in connection with Dr. Faulds. The writer of these remarks can testify to the occasional incredulity in the early 'nineties concerning the permanence of the ridges, for it happened to himself while staying at the house of a once distinguished physiologist who was the writer when young of an article on the skin in a first-class encyclopædia, to hear strong objections made to that opinion. His theoretical grounds were that the glands, the ducts of which pierce the ridges, would multiply with the growth of the hand, and it was not until the hands of the physiologist's own children had been examined by him through a lens, that he could be convinced that the lineations on a child's hand might be the same as when he grew up, but on a smaller scale.

The literature concerning finger-prints is becoming large. An excellent index to it will be found in a memoir by Otto Schlaginhaufen, just published (*Morphol. Jahrbuch,* Bd. xxxiii., H. 4, and Bd. xxxiv., H. 1., Leipzig). But even this is incomplete, for it takes no notice of Mr. Tabor's efforts in San Francisco to obtain the official registration of the finger-prints of the Chinese immigrants, whom it was found difficult to identify otherwise. This seems to have occurred at some time in the 'eighties, possibly before them, but dates are now wanting.

Dr. Faulds in his present volume recapitulates his old grievance with no less bitterness than formerly. He overstates the value of his own work, belittles that of others, and carps at evidence recently given in criminal cases. His book is not only biased and imperfect, but unfortunately it contains nothing new that is of value, so far as the writer of these remarks can judge, and much of what Dr. Faulds seems to consider new has long since been forestalled. It is a pity that he did not avail himself of the opportunity of writing a book up to date, for he can write well, and the photographic illustrations which his publisher has supplied are excellent. The experiences of other countries ought soon to be collated with those of England, in order to develop further the art of classifying large collections of finger-prints. In Argentina, for example, their use has wholly superseded Bertillonage, and one would like to know with what success. A bureau that can deal effectively with very many thousands of cases would require a staff of particularly intelligent officials, and the tradition of dealing in the same way with certain transitional forms that are of frequent occurrence. The more highly the art of classifying, or as it might be phrased of "lexiconising," finger-prints is developed, the more wide will their use become. They ought to be especially valuable in checking desertions from the Army and Navy. But there may be moral objections to the use of finger-prints in these cases for, according to the present system of recruiting, many take refuge in the Army who are "wanted" by the police, and would strongly object to being finger-printed.

A few words should be added concerning the ancient usage of finger-prints in China, Japan, and India for legal purposes. Good evidence as to this has at length been supplied by Minakata Kumagusu in two letters to NATURE, vol. li., pp. 199 and 274. It is clear that it *was* used to some extent, but there is nothing as yet to show that the impressions were made and scrutinised with anything like the precautions now considered to be essential to the good working of the system. Blurred finger-prints cannot be correctly deciphered except by a trained expert, using lenses and photographic magnification. Negative evidence is often of conspicuous value, such as should leave no reasonable doubt in the mind of the most stupid juryman; but expert analysis and severe cross-examination are required when the prints to be compared are generically alike and when one of them is imperfect or blurred. F. G.

EDUCATION AND PHYSIQUE.

Mécanisme et Éducation des Mouvements. By Prof. Georges Demeny. Pp. ii + 523; 565 figures. (Paris: Félix Alcan, 1904.) Price 9 francs.

THERE are few more important or more opportune considerations in connection with practical hygiene than those which are furnished by the subject-matter of the two books written by M. Demeny. The first of these books, a second edition of which appeared in 1903, is entitled "Les Bases scientifiques de l'Éducation physique"; this is now supplemented and given a direct practical bearing by the present work, which sets forth in some detail the technical aspects of the subject. As regards its general character the method of treatment remains distinctly scientific; but since the avowed aim of the author is to set forth the real advantages to be derived from bodily exercises conducted along proper lines, the scope of this later book is eminently educational, and thus it appeals to all those who take a broad view of education and its requirements. This appeal is accentuated by the mode of presentation, which is such as to render the extensive subject-matter intelligible to those who make no pretensions to special physiological knowledge.

It is true that the opening chapter deals of necessity with such physiological questions as the structure and functions of muscle, the mechanism of joints, and the capacity for movement which are allowed by the skeletal articulations; but these and other fundamental points of like nature are treated in a manner which, whilst in strict accord with the present state of scientific knowledge, is of such a character as to render these various topics easy of comprehension. This introduction leads up to a most interesting analysis of the part played by the muscles in producing various well known body movements. In this stress is laid upon the comparatively modern discovery that any movement, for instance the flexion of a limb, is produced not only by the pulling force of those muscles which move it in the desired sense, the flexors, but also by the relaxation of those which oppose this movement, the extensors. It is this two-fold muscular mechanism which permits of the movement being graduated so finely as regards both its extent and its force. Some illustrations of a striking character are given in support of this aspect of a volitional or secondary automatic movement.

For the majority of readers, the great interest of the book will probably lie in the interesting account which it gives of various familiar movements. These are all accompanied by numerous illustrations which are excellent for their purpose, and greatly enhance the attractiveness of the text. Many of these are spirited diagrammatic representations of the skeleton, the form of which in all manner of bodily postures is drawn with that piquancy and verve which constitute to English eyes the special charm of French draughtsmanship; humour cannot be expected in a letterpress which deals with subject-matter so technical and serious, but it is supplied by the illustrations, which give a humorous fillip to the work without detracting in the least from their undoubted service in helping the reader to follow the exposition.

The section which deals with the various forms of locomotion, walking, running, jumping, &c., is perhaps the most elaborate. The author is here on ground which he has studied minutely for many years. As chief of the laboratory at the physiological station in the Collège de France, he is able to set forth with authority the results of the elaborate and prolonged investigations initiated by Prof. Marey and carried on under his inspiring influence. It is probable that the summary of these investigations given by M. Demeny is the most valuable short exposition of this really difficult subject which has been published up to the present time. The lucidity of the author's style and treatment is conspicuous in this portion of the book, for the matter dealt with is not easily set forth in a way which admits of being readily understood, since it involves mathematical considerations which are apt to prove a stumbling block to physiological students.

But, as stated before, the description of the factors concerned in the production of familiar postures of the body and the side-issues which these raise, will for most readers probably prove the most attractive portion of the work. From standing, sitting, and lying down, the author proceeds to carrying loads, vaulting, kicking, throwing, swimming, rowing, cycling, horse-riding, dancing, singing, fencing, boxing, wrestling, and all the various bodily movements which are concerned in the various forms of athletic or industrial exercise. It would be impossible to give any detailed account of his treatment of these subjects, but it may be confidently stated that this treatment, whilst scientifically sound, is rendered entertaining by the copious illustrations and interesting through the many novel points which are touched upon. As an example of the latter, the question is raised as to the physiological limits of the rapidity of effective response in fencing and boxing, and experiments are cited bearing on this point.

A more serious, and at the present moment more important, aspect of the subject-matter is that which deals with body movements in relation to the improvement of general bodily physique. These are dealt with in the same comprehensive manner as those just referred to, for the author includes most of the gymnastic exercises used in France, Swedish drill, the use of clubs and of apparatus of different kinds.

The malformation of the body is also referred to, whether due to the under-development or to the over-development of special muscular groups; as an example of the first, the malformation of the chest through the weakness of the trunk muscles, abdominal muscles, &c., is conspicuously shown; as an example of over-development, the malformation of the thigh in fencing masters.

The closing chapters are devoted to the conditions which may be presumed to determine how muscular force can be most economically directed towards the production of body movements. The author realises that it would be undesirable in a treatise of a semi-popular character to present this extremely important subject in detail; nor, indeed, can it be set forth in a very convincing manner, since several questions of a fundamental type are still from the scientific point of view in an unsettled state. Thus it is still a matter of doubt how closely the heat-producing properties of muscle are associated with those of mechanical tension or change of form. M. Demeny is well aware of this, and warns his readers that it is impossible to deduce the energy relationships of the animal mechanism from those of artificially constructed machines. In this as in other departments of physiology the hope of arriving at a more precise intellectual standpoint is that expressed by one of Bacon's aphorisms; it will "only be well founded when numerous experiments shall be received and collected into natural history which, though of no use in themselves, assist materially in the discovery of causes and axioms."

In this spirit the various experiments detailed in the concluding chapter of the book must be approached. Most of these are concerned with the influence of walking with definite loads for definite distances; the points noted were the number of steps per minute, the length of the stride, and the posture of the body. It appears that when, as in walking, muscular movements are repeated many times, then there is an optimum rhythm which, by permitting appropriate reparation, allows the maximum of effect with least expenditure of muscular power. The author considers this to be the case in almost all body movements, although experiments are not given in support of this generalisation.

The book as a whole is likely to prove of very considerable value in connection with the subject of physical degeneration, which has been for some time agitating the mind of the public. Methods of education it is now realised should, from the hygienic point of view, concern themselves with the posture of the body. In the code for 1905 issued by the Education Department stress is laid upon the importance of "the careful cultivation of a correct posture at writing and other lessons." This tardy awakening of the authorities to the importance of cultivating the bodily physique of the children who are taught in the national schools renders it probable that teachers will desire to instruct themselves in the fundamental scientific aspects of the various methods for improving the bodily structure and functions. In this respect a work such as that now under review is likely to prove of very real service; it is trustworthy, it approaches the whole question of body posture from a point of view at once scientific and utilitarian, it attacks the fundamental question (that, namely, of the effective action of the muscles), and finally, it is written in a style which makes the subject-matter intelligible without presupposing special technical knowledge on the part of the reader. The only drawback to its utility is one which is susceptible of removal by its translation into English.

F. G.

GEOMETRY OF POSITION.

On the Traversing of Geometrical Figures. By J. Cook Wilson. Pp. x+154. (Oxford: Clarendon Press, 1905.) Price 6*s*. net.

SUPPOSE that an outline figure of any kind is drawn upon a blackboard. In its construction the chalk describes a certain number of closed or open paths, a path being defined as the mark made by the chalk during the whole time of any one of its contacts with the board. But the number of paths thus actually described is not necessarily the smallest by which the figure can be produced, and it is an interesting problem to analyse a given figure into its minimum number of paths, each traversed once. As a simple example, let two oval paths be drawn intersecting in four points; the resulting figure can be traversed as one closed path. If two of the intersections are joined, the new figure can be traversed as one open path; if the remaining intersections are joined, the figure cannot be reduced to less than two paths.

The first two parts of Mr. Wilson's book deal with the problem above stated and various associated questions. The most interesting result is one of greater generality than might have been expected. Let a point in the figure be called odd or even according as an odd or even number of lines radiate from it; then a figure with $2n$ odd points can be analysed into n paths, but no fewer. (To include the case when $n=0$ a slightly modified statement is necessary, which will be found in the book.)

In part iii. the author enters upon new ground by applying the principle of duality; this is the most novel part of the book, and a few comments on it may not be superfluous. The results of the first two parts may, of course, be directly reciprocated without introducing any metrical considerations; but this is not what Mr. Wilson does, and the consequences of his procedure are very instructive, especially from the point of view of absolute geometry. He practically confines himself to rectilineal figures, and reciprocates segments into angles, thus introducing metrical elements, and becoming necessarily faced by the complications which they involve. It is now familiar to pure mathematicians that, with an "absolute" conic to define our metrical system, there is a consistent and reciprocal definition of *angle* and *segment* (or *distance* of two points) by which each of these is the product of a constant and the logarithm of a cross-ratio. But to identify these with the expressions for angle and segment obtained by elementary methods with rectangular coordinates it is necessary to suppose the absolute conic to degenerate into one which, considered as a point-locus, is the line at infinity counted twice, and considered as an envelope is the pair of circular points at infinity. This complicated character of the absolute is at the base of all the puzzling difficulties which beset such attempts as this of Mr. Wilson's—difficulties, it is true, which he often surmounts in an ingenious manner.

For example, in the appendix he introduces a system of angular coordinates, both for lines and points, and obtains point and line equations for the ellipse. Now the unmistakable drift of his thought is that if point and line can be defined by coordinates which measure segments, then "reciprocally" line and point can be determined by coordinates which measure angles. But his angular coordinates are not really reciprocal to the segmental coordinates, as is clear from the fact that his equation of the ellipse is trigonometrical and not algebraical. It might be interesting to decide whether any simple functions of Mr. Wilson's angular coordinates are the direct reciprocals of the ordinary Cartesian segmental coordinates.

A remark should also be made on the note (pp. 120–6) on the most general form of the construction of reciprocal figures, as it may prevent possible misunderstanding. In the ordinary process of reciprocation with an auxiliary conic, F and F′ being the corresponding figures, we may say that F′ is derived from F by a process, or rule, of polarising, and that F is derived from F′ by the same rule. Mr. Wilson gives an example in which F′ is derived from F by one process, and F from F′ by another—F and F′ being reciprocal in the general sense of projective geometry. He adds that this is "wider than the usual method," which, of course, it is, if "the usual method" means employing an auxiliary conic. But the figures obtained by his method can be constructed each from the other by the general method of making four points (or lines) in F correspond at pleasure to four lines (or points) in F′, and then to every linear way of constructing F′ from F there is a dualistically corresponding way of deriving F from F′. So that it must not be supposed that Mr. Wilson has discovered any essentially new way of constructing reciprocal figures, though his remark might be misunderstood in that sense.

To return to the more popular aspect of this interesting book. The figures are, strictly, strips of black on a white ground. For the author they represent geometrical lines, and are reasoned upon as such. But the reader may give them different interpretations, and make up problems for himself accordingly. For example, let the lines in a diagram represent cuts made in a single piece of wood by a fret-saw; how many pieces are produced? What is the simplest wire model that will give a shadow like a given diagram? and so on. Stencilling, again, is full of problems analogous to those which Mr. Wilson discusses; knitting and netting give any number of examples of single-path figures. The proverb that "extremes meet" is curiously illustrated by these purely topographical questions, which suggest puzzles for children, problems for designers, and tools for logicians; while they appear with startling unexpectedness in the most abstruse mathematical theories—Abelian functions, group-theory, hydrodynamics, and electricity. G. B. M.

ORGANIC PREPARATIONS AND THE COAL-TAR COLOUR INDUSTRY.

The Synthetic Dyestuffs and the Intermediate Products from which they are derived. By J. C. Cain and J. F. Thorpe. Pp. xiv+405. (London: Chas. Griffin and Co., Ltd., 1905.) Price 16*s.* net.

THE publication of this work is not without significance in its bearing on the oft-repeated statement that the great industry represented by the manufacture of coal-tar dyes is decaying almost to vanishing point in this country. The fact of publication presumes a demand which, in this case, must be mainly confined to those connected with, or training for, the manufacture referred to. It is unlikely that any great number of students in the colleges of this country are preparing for positions in colour works abroad, and it is therefore reasonable to assume that those concerned with the production of the book have satisfied themselves that the industry is not in such a parlous state as pessimists would have us believe. In any event, the book will powerfully influence one factor in the case—the proper instruction of students who are training for the industry.

Whether this touches the root of the matter is, however, doubtful. The gradual decline in importance of the manufacture of coal-tar products in this country has been variously ascribed to the deficient training given in the colleges, the bad patent laws, and the cost of alcohol, relatively to the conditions existing in Germany with regard to these matters. Concerning the work of the colleges, it is now generally conceded that the best of our schools of organic chemistry need fear no comparison with those abroad. The effect of our patent laws, both past and present, in handicapping the industry, has doubtless been very great; but possibly the inquiry of a Royal Commission, such as recently reported into the question of industrial alcohol, would show that, as has been conclusively proved with regard to the cost of alcohol, the effect of the patent laws on the nondevelopment of the English coal-tar colour industry has really been much less than has been supposed. A cause fundamental to those enumerated above, and lying at the basis of many other of our industrial lapses, may be defined as the lack of an appreciation of the importance of science on the part of the public generally. This has rendered the development of many industries quite impossible. It is reputably stated that the Badische Anilin- und Soda-Fabrik spent upwards of one million pounds sterling during a period extending over twenty years in solving the industrial problem of the synthesis of indigo. What English board of directors, even if themselves satisfied to do so, would venture to spend any such sum on apparently unproductive scientific experiments? Public opinion in this country, as reflected in the shareholders, would not allow it, any more than a six or seven years' college science course is considered a paying investment. Nor will satisfactory reform of the patent laws and the excise laws come about until the Government is made to realise, by the pressure of public opinion, that the future of the national industries largely depends upon the proper utilisation of scientific fact and method.

The work under review consists of three parts and an appendix. Part i. comprises a description of the various synthetic dyestuffs and the intermediate products from which they are derived. Part ii. gives methods for preparing typical products on a laboratory scale, but as far as practicable by works processes; and part iii. deals with the analysis and identification of dyes and with the detection of dyestuffs on the fibre. The appendix contains tables giving the specific gravities of various solutions.

The first chapter of the book gives a very short account of coal-tar and the separation and purification of benzene, naphthalene, anthracene, and phenol. A little more space might usefully have been devoted to this section.

Subsequent chapters deal with the nitration and sulphonation products of the hydrocarbons, and the production and properties of amido, hydroxyl, and carboxyl derivatives. The second section of part i. gives in seventeen chapters, occupying about one-third of the book, a systematic description of the various groups of dyes, the classification being, of course, based on the chemical constitution, and not upon the mode of application, of the dyes. The treatment of this section is excellent, the descriptions being very lucid and sufficiently exhaustive without too much detail.

Part ii., which deals with the preparation of colouring matters and intermediate products, is at once the most novel and the most useful feature of the book. It is evidently the outcome of much personal experience on the part of the authors, and the limitations of ordinary college laboratories have very sensibly been kept in view, though at the same time only such materials are employed as would be used in the technical preparation of the several products in the works.

Perhaps the least satisfactory portion of the book is the chapter dealing with the application of the colouring matters. It is very doubtful whether any useful purpose is served by such a short treatment of the science of dyeing as can be compressed into thirteen pages. Condensation to this extent inevitably results in misleading generalisation, and the authors would probably have been well advised to have referred their readers to some of the well known treatises on dyeing for this part of the subject.

The chapters on the valuation and analysis of dyes are to some extent open to the same criticism. As an example of their deficiencies, the method given for the analysis of indigo may be referred to. The method described would be entirely untrustworthy if applied to the estimation of natural indigos, and such is evidently the intention. In its main and essential sections, however, the book is a noteworthy addition to the literature of specialised organic chemistry, and both authors and publishers are to be congratulated on its production. WALTER M. GARDNER.

SCIENCE AND MYSTICISM.

Prinzipienfragen in der Naturwissenschaft. By Max Verworn. Pp. 28. (Jena: Gustav Fischer, 1905.) Price 80 pfg.

PROF. VERWORN detects mystical murmurs in the scientific camp, and is full of apprehension of coming dangers, for "mysticism is the negation of scientific thinking." Naturalists have been working out a monistic interpretation of the world, but there have been symptoms of faint-heartedness lately, especially before two questions, which the author states in the following terms:—Do vital processes depend on the same principles as the processes in inanimate nature? Are psychical processes referable to the same principles as those on which bodily processes depend? Verworn assures us that both these questions may be confidently answered in the affirmative, for the world is one, with the same principles, or rather with one principle throughout. What that "principle" is we have not been able to discover from the lecture, but we are assured that it is not a "mystical principle."

In regard to the first question, Prof. Verworn says that when we sufficiently analyse the criteria of life we find none requiring other principles than those which we require in interpreting the inorganic world. The only feature distinctive of life is the combination of potencies which are seen separately apart from life. Chemical ferments illustrate metabolism without growth; the condensations and polymerisations of chemical compounds illustrate growth without metabolism; the organism combines both. How it does so we are not told, but it is not by any peculiar vital principle. There is no need to assume a secret "organisation" transcending physical and chemical principles; there is no warrant for postulating a persistent protoplasmic architecture, either microscopic or molecular, as the physical basis of life; the form and structure of a cell is just like that of a fountain or a flame; life is a flux; "Πάντα ῥεῖ" is true throughout nature. To suppose, as Driesch, for instance, does, that an Aristotelian "entelechy" resides in living matter and accounts for its purposive behaviour and development is to resurrect the buried concept of a *nisus formativus*. To do this is quite gratuitous, since Verworn supplies us with a guaranteed modern concept of a "self-steering" metabolism—the "self-steering" quality depending, of course, on the laws which physical chemistry has been revealing during recent years. He also assures us that there are no facts of organic being or becoming which warrant us in losing faith in the sufficiency of the monistic interpretation in terms of chemistry and physics. It is true that the illustrious physiologist has not found time in this lecture to give us any illustration of how any vital phenomenon may be formulated in terms of "the principles of the inorganic world," but he seems to have no doubt that it can be done.

As to the second question, before which so many have fallen away from monism—the question of psychical life as distinct from bodily life—Verworn finds satisfaction in boldly denying that any dualism exists. The dualistic idea was born out of ignorance fathered by desire, and it has been nurtured and refined by philosophy. The material ghost that escaped *in articulo mortis* has become a spiritual soul, but both are fallacious abstractions. It is pathetic to think of all the wrestlings with the problem of dualism since Descartes's day, for dualism is but one of man's many inventions with which he makes himself miserable. Just as the organism is a mere bundle of metabolisms, so the "ego" is but a changeful bundle of sensations, and perceptions, thoughts, and feelings derived from these—a complex the components of which are not continuously or simultaneously held in combination, though certain components, *e.g.* sensations of our body, occur so frequently and uniformly that the illusion of a persistent personality is produced. The material for the up-building of the "ego" is the external world or corporeal world—the world of sensations; the "make-up" of the "ego" is the same as the "make-up" of the world; the antithesis of soul and body is "a fossil idea." "Either everything is body in the world or everything is soul: however I like to put it, the main fact is that there is only one kind of thing." How a flux of sensations can give origin to that unified outlook and inlook which is called monism remains somewhat mysterious, but to think of any mystical principle being involved is "a negation of scientific thinking." But which is mysticism and which scientific thinking? J. A. T.

THE PLANT KINGDOM.

Das Pflanzenreich. Regni vegetabilis conspectus. Edited by Prof. A. Engler. (Leipzig: W. Engelmann; London: Williams and Norgate.)

AN account of the inception of this work was given in NATURE, October 30, 1902 (p. 657), with a list of the earliest parts. Twenty-one volumes have now been published, of which ten are devoted to monocotyledonous orders. The late Dr. K. Schumann has contributed, in addition to the Musaceæ, two memoirs on the Marantaceæ and the Zingiberaceæ respectively. In both these orders there is a large increase in numbers and a considerable amount of change as compared with the account given by Pedersen in the "Pflanzenfamilien." This is explained by the fact that an enormous number of new species have been made out of copious material received from Indo-Malaya and tropical Africa. The new species of Zingiberaceæ described for Malaya alone exceed a hundred. Dr. Schumann formulates very definite arguments in favour of the changes which he proposes in reviewing the history of the orders, and also presents a comprehensive discussion on the flower and on the relationships of the four orders which compose the series Scitamineæ.

Many of the orders are obviously too large to admit of their being treated in a single volume. The Orchidaceæ, as in the case of the "Pflanzenfamilien," have been entrusted to Prof. Pfitzer, and the first instalment contains the section Pleonandræ—formerly called Diandræ—which consists mainly of the Cypripediums as generally understood. A special feature of this volume is the list of hybrids, both natural and artificial. Similarly, the Araceæ require several parts, and Dr. Engler, who undertakes this order, begins with the tribe Pothoideæ. Dr. Engler gives a full description of the branching, and distinguishes nearly 500 species of Anthurium. A short volume includes the orders Scheuchzeriaceæ, Alismataceæ, and Butomaceæ, which are all worked out by Prof. Fr. Buchenau. Dr. W. Ruhland is responsible for the Eriocaulaceæ, and gives a detailed account of the geographical distribution, taking up the origin, evolution, and dispersal of the order. Owing to a large influx of new specimens from Brazil, the number of species of Eriocaulon now exceeds two hundred, and the genus Pæpalanthus, after being shorn of many species that form three new genera, still shows a slight increase.

The first volume dealing with a group of the gymnosperms, that on the Taxaceæ, has been written by Dr. R. Pilger. The Taxaceæ are profoundly interesting on account of the primitive forms which characterise some of the genera, but, as is usually the case with such genera, the number of species is small, and no great increase may be expected, although some new species may be looked for from the unexplored areas of China and eastern Asia.

Of dicotyledonous orders, the Tropæolaceæ, by Prof. Fr. Buchenau, appeared in 1902, and the Cistaceæ, by Dr. W. Grosser, and the Theophrastaceæ, by Prof. C. Mez, were issued in 1903. Since that time a larger volume on the Lythraceæ has been contributed by Dr. E. Koehne, who has gone very fully—in fact, more fully than seems necessary—into the varieties and forms of the more variable species. The genus Cuphea is amplified to 200 species, and the genus Rotala is extended to include some species previously assigned to Ammannia. A list of plant collectors and their contributions is added. One of the most complete and interesting memoirs is that by Prof. H. Winkler on the Betulaceæ. The general sketch contains sections on the geographical distribution and the history of the order. The fossil forms, which are numerous, are enumerated without comment, but with references, and—a feature that one would have expected in every volume—maps are provided to indicate generic distribution.

The main purpose of the "Pflanzenreich," as contrasted with the "Pflanzenfamilien," is to provide an authentic description of species, and criticism of this work has largely to deal with considerations that are best known to the learned authors who have undertaken to write on the different orders. One of the main difficulties consists in reconciling the diverse views held by different writers who have made a special study of the same orders and groups. The discussion of certain forms under *Betula papyrifera* furnishes an instance in which Dr. Winkler holds different views from Prof. C. S. Sargent; without attempting to judge between the two opinions, it would seem that Prof. Sargent has had better opportunities of studying these forms, but it should be added that in this case the writer has fully stated both views: the ideal solution in such a case would be a collaboration of both authorities, if such a collaboration were practicable. It is from this point of view that one could have wished to see the names of other besides German botanists associated with this great undertaking; so far, Dr. Rendle, who wrote the volume on the Naiadaceæ, is the only exception. The commendable spirit of *camaraderie* which exists between botanists has been amply demonstrated in the various international meetings, of which the latest was recently held in Vienna, and it would not appear to be a matter beyond practical realisation to give a more international character to this *magnum opus*.

AN ITALIAN TEXT-BOOK OF PHYSIOLOGY.

Physiologie des Menschen. By Dr. Luigi Luciani. Ins Deutsche übertragen und bearbeitet von Dr. S. Baglioni und Dr. H. Winterstein. Dritte Lief., pp. 323+502+viii. Vierte Lief., pp. 160. (Jena: G. Fischer, 1905.)

THE general features and aims of Dr. Luciani's text-book of human physiology have already been alluded to in the review of the first two parts, and need not be recapitulated here. The first few pages of the third part complete the account of the physicochemical phenomena of respiration. The following chapter gives an excellent account of the mechanics of respiration, including the influence of the respiratory movements on arterial and venous blood pressures.

The succeeding chapter, on the nervous mechanism of respiration, is specially good, and one cannot fail to admire the mastery of the literature of the subject shown by the author, every page giving evidence of knowledge of the original sources. The subject of the localisation of the bulbar, spinal, and cerebral respiratory centres is fully dealt with, the results obtained by the earlier observers—Legallois, Flourens, Schiff and others—being well epitomised. A good *résumé* is also given of the important later results obtained by Gad and Marinescu on the localisation of the bulbar respiratory centres. Reference is also made to the interesting results yielded by Aducco's research on the action of cocaine upon the respiratory centres.

The author next gives an account of the influence upon the respiratory centres exerted by stimuli transmitted by afferent nerves. A considerable amount of space is devoted to the important work of Hering, Breuer, and others on the self-regulatory mechanism subserved by the vagi. The later experiments of Head have been omitted.

The subjects of apnœa and periodic respiration are discussed with great fulness, much of the author's own work being given.

The next chapter deals with lymph—its sources, physical, chemical, and morphological characters, its circulation, and the theories of its formation. An excellent critical account is given of the secretion theory of Heidenhain, as compared with physico-chemical theories of the majority of later workers in this field. In the concluding pages of this chapter the structure and functions of the lymph glands and lymphoid organs—bone marrow, thymus, and spleen—are fully described.

The first chapter of the second volume is devoted to the subject of the internal secretions of the ductless glands. After a brief introductory account of the historical development of our knowledge of glandular secretion, the author passes to a detailed description of the structure and functions of the thyroid and parathyroids. The treatment of the physiology of the thyroid and parathyroids is so complete and full of interest that only a brief reference to the most salient points is possible. The various theories which have been held with regard to the results of removal are critically reviewed. Very full treatment is accorded to the experimental foundations for the theory of an auto-intoxication. In this connection, the results obtained by Colzi and others by means of the method of crossed transfusion are of great interest and importance. Gley's ingenious experiments on the relative toxicity of the blood serum of normal dogs as compared with that of dogs from which the thyroids had been previously removed are also fully described. An important section of this chapter is devoted to the theories of independent specific functions of the thyroid and parathyroids, and to the experimental basis on which these theories are founded.

The structure and still obscure physiology of the pituitary gland are briefly epitomised. A satisfactory account is next given of the structure and functions of the suprarenal glands, although in this case the results obtained by English workers have not been sufficiently recognised by the author.

The following chapter deals with the external digestive secretions of the salivary glands, pancreas, gastric and intestinal mucosæ, and liver. The final chapter is devoted to the mechanical and chemical phenomena of buccal and gastric digestion. The account has been kept well abreast of the most recent advances, many important additions being made by the translators.

A perusal of the third and fourth parts strengthens the impression that the complete work will prove itself to be a most trustworthy and illuminative guide to modern physiology. J. A. MILROY.