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STEPS TOWARDS A NEW PRINCIPIA.

Electricity and Matter. By Prof. J. J. Thomson. Pp. 162; with diagrams. (Westminster: Archibald Constable and Co., Ltd., 1904.) Price 5*s*. net.

IT is an interesting fact that the British Association is going so soon to meet, under distinguished presidency, at Cambridge, for there of late years has the most splendid work in pure physical science been done, and there it seems to me an erection comparable in some respects to the Principia is being raised. One of the foundation stones was laid in 1881 by J. J. Thomson in a mathematical paper on the motion of a charged sphere, a paper in which the idea of real electric inertia took tangible and tractable form. The building has been growing ever since, and is now in full process of construction, though I hope it will be long before its development shall cease or the work be regarded as finished and ready to be left to the admiration of future generations.

The little book which constitutes the subject-matter of this review embodies a set of six lectures delivered on the other side of the Atlantic, at the invitation of Yale University, last spring, by the Cavendish professor of physics at Cambridge, England.

They are not exactly popular, for although no mathematics is introduced beyond what ought to be (but usually is not) familiar to all who have been in the sixth form at a public school, yet the ideas are definite and quantitative, and are briefly expressed because they are addressed to persons with some knowledge of physics; moreover, they are such as can hardly be made so childishly simple as to be apprehended of the general average of so-called educated men in this country, whose sense-perceptions in the direction of great and comprehensive ideas have not been developed.

To students of physics and higher chemistry this book serves as a very readable digest and summary of what is to be found worked out in more detail in other writings by the same author; and those who have studied his most recent papers can hardly avoid reading back into this little volume, which can be skimmed at a sitting, much that has really been elaborated since, and some things which still await elaboration, on lines which are merely suggested here.

It is difficult to exaggerate the suggestiveness of the wealth of theory which is now being lavished upon us in the domain of atomic structure and the mathematics of chemistry; it appears likely to lead to a definite microcosmic astronomy, based upon the known properties of electric lines of force, akin to the welding together of the observed facts of the heavens by a single comprehensive law, and forming the basis of a real chemical "Principia."

The discovery on which everything depends is the recognition of the atom of electricity, a discovery to which no one man can lay claim, and superposed upon this a detection of the extraordinary properties belonging to an electric line of force, at rest, in motion, and under acceleration, which is again a development to which several have contributed. But it is safe to say that a great bulk of the treatment of the subject, both on its experimental and mathematical side, emanates, with a few important exceptions, in some form or other from Cambridge, and it is difficult to overestimate the force and suggestiveness with which ideas connected with the most recent and still nascent steps in theory are presented in this small book.

The book is in six chapters, corresponding apparently with six lectures.

Chapter iv., on the atomic structure of electricity, gives the customary account of the evidence for electric atoms, and for considering the charge on a corpuscle to be identical with the ionic charge of a hydrogen atom; the experiments by which these conclusions were reached in the Cavendish Laboratory being summarised and explained on the usual lines. First, it was shown that the conductivity of a gas depended on something that could be filtered out of it; next, the aggregate charge of the ions in a given volume of gas was determined by the method of the saturation current; then these ions were counted by the highly ingenious "cloud" method, and thus the charge on each determined. The value, it may be noted in passing, is rather higher than what used to be roughly estimated for this fundamental electric unit. Whereas it used to be guessed as about 10^{-11} electrostatic units, measurement seems to show that it is more nearly $3{\cdot}4\times10^{-10}$; and, in order to make this quantity equal to the charge on a monad ion in electrolysis, the number of molecules in a cubic centimetre of gas, at standard temperature and pressure, must be rather fewer than used to be estimated as probable, and also rather definite, being about $3{\cdot}6\times10^{19}$, which means 8×10^{23} atoms of hydrogen per gram.

A new confirmatory method applied by Dr. H. A. Wilson is described, in which the settling of a cloud under gravity is opposed by a measured electric field; and on this plan the same result is obtained. Also Prof. Townsend and Dr. H. A. Wilson, by applying electrolytic considerations and experiments to ionised air, were able to show directly that the ionic charges in all cases are really identical, and are the same as that familiar in electrolysis.

A rapid summary of the now well known methods by which the mass of the carriers for negative and for positive electricity respectively has been determined is also given, and it is pointed out how striking is the resemblance of the result to Franklin's one-fluid theory of electricity:—

> "The 'electric fluid' of Franklin corresponds to an assemblage of corpuscles, negative electrification being a collection of these corpuscles. The transference of electrification from one place to another is effected by the motion of corpuscles from the place where there is a gain of positive electrification to the place where there is a gain of negative. A positively electrified body is one that has lost some of its corpuscles. We have seen that the mass and charge of the corpuscles have been determined directly by experiment. We in fact know more about the 'electric fluid' than we know about such fluids as air or water."

The next chapter (v.), on the constitution of the atom, begins still on familiar ground, and exhibits the evidence for the great intrinsic energy of electrically constituted atoms, and estimates the rate of radiation of energy from corpuscles variously distributed inside an atom, showing that the radiation from a single corpuscle is far greater than that to be expected from two or more, especially when their speeds are not excessive. [It may be observed that a pair of revolving electrons, at opposite ends of a diameter, will be equivalent to two equal opposite currents, and hence will tend to neutralise each other's influence at a distance, especially along the axis of revolution; unless indeed they are moving with the speed of light, in which case they could start the crest and trough of an advancing elliptically-polarised wave.] Hence a certain number of corpuscles are essential to the stability of an atom, a few would soon radiate their energy away; and this fact, on the doctrine of the evolution of matter, suggests a reason for the non-existence of permanent elements of lower atomic weight than hydrogen.

But a great deal more than that is made out towards the end of the chapter, where the electric constitution of the atom is applied to chemistry, and a beginning of the explanation of "the periodic law" is made in this chapter which is further developed by the author in a great paper in the March number of the *Philosophical Magazine* for the present year. Also the homologous series of lines in the spectrum, investigated by Rydberg, Runge and Paschen, and Kayser, is shown to be a fairly natural, or at least plausible, consequence of the groupings of various numbers of corpuscles or electrons inside an atom; though it must be admitted that unless attention is paid to the modern view that concussions and not regular motions are the real cause of perceptible visible radiation and line spectra, the theory remains obviously very incomplete. The mode in which the corpuscles would statically distribute themselves, if they were limited to a plane, under the combined action of a mutual inverse square repelling force and a direct-distance central attracting force, is treated much as Lord Kelvin had already treated it in his remarkable paper called "Æpinus atomized" (reprinted as an appendix in his Baltimore Lectures), and is illustrated by Alfred Mayer's experiments on floating magnets; and the deductions, although plainly only the nucleus of an investigation, are already very suggestive and promising. In the March *Philosophical Magazine* the investigation into the stability of moving electrons is carried much further, and a distinct step is made in mathematical chemistry.

One very simple and important remark is made near the end of chapter v. concerning the "bonds" of the chemist, which, being I suppose universally recognised as Faraday lines of electric force, must differ from ordinary stretched elastics in having opposite properties at the two ends. The bonds, in fact, must have "sense" as well as direction, they are not simple links; and hence when carbon atoms are linked together those atoms cannot really have identical properties, unless indeed they are linked to each other by an even number of bonds. Incidentally it becomes clear—at any rate in the March *Phil Mag.* it becomes clear to me—why carbon or tetrad atoms can link themselves into complex molecules: the foundation of organic chemistry.

A suggestion is also made concerning certain "additive" properties, such as the refractive power of different substances for light, which students of physical chemistry will do well to take up and press further.

The obvious question as to how an electrically constituted atom can acquire an additional charge, so as to become an ion, either positive or negative, and either monad, dyad, or triad, is discussed, and a guess is made as to the nature of molecular combination. It is also attempted to explain why a liquid, say liquid mercury, is so immensely better a conductor than mercury vapour, and why some gases may be conductors and others not. The violent motion of corpuscles going on inside an atom is styled by J. J. Thomson the "corpuscular temperature" of the atom, which may or may not be a convenient term; the ordinary temperature of the gas, called "molecular temperature," is generally very much smaller, and has no apparent relation with the corpuscular temperature. By the interaction of these two temperatures on one another, an attempt is made to account for certain chemical facts of combination. The whole of the chapter is so concentrated and full of suggestion that it is impossible effectively to abstract it further. What I wish to indicate to students is the desirability of studying the original.

Prof. Poynting has on this point made a remark to me which he permits me to incorporate, viz., that at high molecular temperatures there must be some distinct correspondence between molecular and corpuscular temperatures. For in the sun corpuscles are set free by collisions [as they may also be set free by the clash of chemical combination at more ordinary temperatures, a bright line spectrum resulting in both cases from the perturbation of those corpuscles which, although shocked, escape separation]. There would appear to be some high temperature at which the atoms go to pieces—a limiting molecular temperature beyond which they cannot exist (an atomic dissociation temperature), not *much* higher probably than the solar temperature. It is worthy of remark that no star is much hotter than the sun: possibly none so high as ten thousand degrees centigrade. If not, why not? unless it be because there is a natural limit at which matter goes to pieces.

The final chapter, on radio-activity and radio-active substances, emphasises the way in which atomic collapse, or re-distribution of corpuscles—a sort of atomic earthquake—may occasionally occur, after the radiation of a certain amount of energy has gone on for some time, by spontaneous re-arrangement of the constituents into a more stable form. For since orbital motion plainly tends to increase stability, enabling a greater number of corpuscles to resist central attraction than could hold out if they were stationary, it follows that, as the corpuscles slow down, they may at certain critical stages find it necessary to fall into an allotropic modification of the element, or else to expel some and re-arrange the remainder; the analogy being a spinning top which tumbles over when its velocity falls below a certain critical value. [Some varieties of "new star" may conceivably furnish another and different kind of analogy.]

A new suggestion also is made with respect to Röntgen rays, viz. that they may sometimes precipitate atomic disintegration and thus cause a substance to emit more energy than they themselves contain. It is also pointed out in a previous chapter how a shell of Röntgen radiation will not disturb particles over which it passes if it is below a certain thickness, but if thicker than that will communicate momentum to them; and in that way a kind of modified Le Sage's gravitation hypothesis is suggested, not, however, in a convincing manner, but rather as one of the possibilities that have to be discussed, and after further consideration probably abandoned. At the same time, the hypothesis concerning radium favoured by Lord Kelvin, viz. the reception of energy from a store of cosmic waves and the consequent production of radioactivity, is shown to be in many respects feasible, though taken all round unlikely and rather artificial.

But the most remarkable and novel portion of the book is the use made of Faraday's lines of force, and the great development and importance attached to them, in the first three chapters. Strangely enough, these lines are for the first time regarded as realities; no longer as a mere map of a state of things which is essentially continuous, but as an actual fibrous structure attributable to an electric field, and therefore also to a magnetic field, and therefore also to radiation. The lines of force are not only *like* elastic threads which repel each other, but really are such threads, though with varying thickness and with their tension everywhere proportional to their cross-section; and it seems possible to think of them as vortex filaments, thus reproducing in many respects FitzGerald's conception of a fibrous vortex ether consisting of filamental or cobweb vortices interlaced in every direction (see preface to "Modern Views of Electricity," 1889), only these do not become lines of force unless they are cut and terminated; the newer view regards the place where their intense ends terminate as a negatively charged corpuscle or electron, their wider opposite ends appearing to correspond with positive electricity, the nature of which, however, still remains a close secret. This seems to be J. J. Thomson's view—though it is not clear that he regards the vorticity as anything more than an analogy—his view is that the lines of force or vortex fibres actually exist, radiating from corpuscles, constituting electric lines of force, generating magnetic fields when they move, and conferring mass on the particle by reason of the amount of ether entangled inextricably in each filament; and he shows further how, when the fibres are accelerated, especially when they are suddenly started or stopped, a much more intense local magnetic field for a moment makes its appearance and rapidly spreads out as a wave of radiation, by reaction with the superposed electric field, just as Larmor and others have calculated, and of course in accordance with Poynting's theorem.

The whole treatment here, with simple geometrical conceptions, is exceptionally interesting; and the resulting view of the nature of light—that it consists, as it were, of pulses running along the fibres as along stretched strings, with constant speed because their tension is proportional to their mass per unit length—is especially noteworthy, and is quite in accordance with a guess which the genius of Faraday enabled him to throw out in his famous "Thoughts on Ray Vibrations," where he says:—

"The view which I am so bold as to put forward considers therefore radiations as a high species of vibration in the lines of force which are known to connect particles and also masses together."

It is clear that if this vibrating string method of regarding waves of light be substantiated, a wave front cannot be a continuous surface, but must be, as it were, a series of isolated specks of disturbance; so also must a Röntgen pulse, and hence J. J. Thomson is able to reconcile with theory the actually experienced small ionising power of such waves, as compared with what might be expected if they really and necessarily encountered every atom in the field. They would, on the fibrous view, be in some respects more akin to a stream of kathode rays penetrating between the actual corpuscular particles of matter, and only encountering them occasionally, just as a comet or meteoric stone only occasionally encounters a planet.

One of the interesting features of the book—though it is also contained in another volume by the same author, "The Conduction of Electricity by Gases"—is the summary of a re-calculation of the results of Kaufmann's excellent experiments on the magnetic deflection of flying particles moving with very high velocity, such as can be shot off from radium. It is well known that Kaufmann proved that the mass of such charged bodies increases measurably as the speed approaches that of light; and by comparison of his results with theory he deduced, by aid of a fairly plausible assumption, that the electrical portion of the mass was about a quarter of the whole.

His assumption, however, had been that the charged particles behave like conducting spheres, so that the lines of force would at high speeds re-distribute themselves on their surface in accordance with the calculations of G. F. C. Searle for metal spheres.

J. J. Thomson, however, prefers to regard electron or corpuscular particles as behaving like perfect points, only points the field of which is non-existent within a certain small sphere surrounding each, which therefore constitutes the charged surface. On this view, the distribution of the lines on the bounding surface of the flying particle would obey a different law from that of a conducting sphere at high speed, and the result of a re-calculation is to make electrical mass *equal* to the whole mass, to a remarkable degree of approximation. Thus, for instance, when the speed is $2 \cdot 85 \times 10^{10}$ centimetres per second, the observed mass is measured as 3·09 times the mass of the same particle for slow speed; calculation makes it 3.1 times. When the speed is 2.59×10^{10}, the observed mass ratio is 2.04; calculation makes it 2.0. When the speed is 2.36×10^{10}, observation gives the ratio 1.65, calculation 1.5, which is not quite so good an agreement; but even this is nearer than anyone could have anticipated, while the other results are extraordinarily close. If Kaufmann's results stand the test of criticism and repetition, they constitute a verification of a fact which is of the utmost importance and of the highest theoretical interest, for it has the effect of reducing the whole Matter in the universe to Electricity, not as a speculation, but as an established truth. It would be rash to jump to such an important conclusion too hastily; and there remains a great outstanding difficulty, hardly yet even faced, concerning the nature of positive electricity—that vague and cometary termination of lines which at the other end are intensely concentrated.

Moreover, the view taken by J. J. Thomson of the nature of the lines of force—whereby their momentum when moving depends upon the mass of ether vortically included in each and inseparable from it—cannot be said exactly to *explain* "mass." Material mass is first explained electrically, and then electrical mass is relegated to the inertia of ether,—not the great bulk of ether, which may be as regards locomotion immovable, but the core of the columnar vortices associated with and essentially constituting the particles of which atoms of matter are composed. The massiveness of ether itself would thus be an unexplained fundamental fact, and its density would have to be regarded as extremely great. The probably high density of ether had already been surmised by FitzGerald and others, and although by this means the cosmos is reduced to a kind of glorified hydrodynamics, yet the fundamental properties of the continuous fluid itself remain unexplained and to all appearance inexplicable.

This may be regarded as a defect, but, after all, explanation always proceeds by stages, reducing the complex to the simple and introducing unification; it can hardly be considered likely that any theory accessible to us here and now can give anything approaching an *ultimate* explanation even of the simplest thing. If the present theory can be substantiated, with whatever modifications and enlargements may be found to be necessary, it will be an immense step in advance; but it would be premature to suppose that these views are in any sense final, or that they will be promptly and universally accepted. They have been led up to by the progress of science during the last quarter century, and a welcome has been gradually prepared for some of them, but the discrete and real physical nature of the lines of force radiating from an electric charge seems to me a novelty; although, as said before, a fibrous vortex structure for the ether had already been suggested and shown to be competent to transmit transverse vibrations. This essential requirement for any ether, the transmission of transverse vibration, necessarily involves some "structure" in the ether, as Lord Kelvin and others have all along perceived. Lord Kelvin favoured at one time a laminar structure, FitzGerald a fibrous structure, and Hicks had his own conception of a vortex sponge. But the difficulty in most cases was to show that these arrangements were stable and could persist without mutual destruction or hopeless wire-drawing. It is not clear whether this difficulty has or has not yet been attacked by J. J. Thomson in connection with the pictorial representation which he now brings forward.

He shows clearly, somewhat on the same lines as Mr. Heaviside, how sudden jerks or accelerations given to the lines must result in radiation, and he makes many interesting thumb-nail calculations in connection with their behaviour, among other things showing that the mass of bound or associated ether in an electrostatic line is such that if moving with the speed of light it would exactly equal the electrostatic energy of the field per unit volume; though how an electric field is to be thus thought of in any *static* manner is not clear to me. Also he is able to regard the re-distribution of the lines of a charge in rapid motion (first calculated by Mr. Heaviside in the *Phil. Mag.*, April, 1889) as not only analogous to, but as really corresponding to, the tendency of a moving cylinder to set itself broadways to the direction of motion. Furthermore, the lines of force behave very exactly as stretched elastic threads; for though their section is not uniform, their tension, *i.e.* their total stretching force, varies everywhere with their mass per unit length, so that the rate of propagation of waves along them is constant.

Altogether a fascinating and most readable book for students of physics and chemistry.

OLIVER LODGE.

SIR A. GEIKIE'S RECOLLECTIONS.

Scottish Reminiscences. By Sir Archibald Geikie. Pp. xii+447. (Glasgow: Maclehose and Sons, 1904.) Price 6s. net.

SCIENTIFIC readers will perhaps turn with most interest to the chapter in this charming book in which Sir Archibald, the last Scotchman for the time being who has directed the work of the Geological Survey of Great Britain, tells the story of the Scottish School of Geology. It is interesting to read along with it the pathetic lament of Principal Forbes, in Edinburgh, in 1862.

"It is a fact which admits of no doubt that the Scottish Geological School which once made Edinburgh famous, especially when the Vulcanist and Neptunian war raged simultaneously in the hall of this society"—the Royal Society of Edinburgh—"and in the class rooms of the University, may almost be said to have been transported bodily to Burlington House. Roderick Murchison, Charles Lyell, Leonard Horner, are Scottish names, and the bearers of them are Scottish in everything save residence—our younger men are drafted off as soon as their acquirements become known. Of all the changes which have befallen Scottish science during the last half century, that which I most deeply deplore, and at the same time wonder at, is the progressive decay of our once illustrious Geological School. Centralisation may account for it in part but not entirely."

But the nation, which did not greatly mourn when it sent its sixth King James to the sister country, did not, I think, suffer any more acutely when it saw its eminent sons, Sir Roderick Murchison, Sir Andrew Ramsay, and Sir Archibald Geikie, filling in uninterrupted succession the position of Director General of the Geological Survey of Great Britain. England may congratulate herself that she showed no narrow provincial jealousy, but chose the best men she could find in the island, to direct its geological survey, and their work and their fame are hardly less dear to their countrymen, because their later years were spent, as perhaps their best known work may have been done in the south. They owed their whole training and equipment to the Scottish School of Geology.

But the note of lamentation was a little too high pitched even for the days when Forbes struck it. It is true that the disputes of the Vulcanists and the Neptunists were rather forgotten with the names of Hutton and of Jamieson. In Forbes's time it had come to be recognised that both schools were substantially in the right—that volcanic forces on the one hand and water and ice on the other are forces almost equally potent in fashioning the earth as men knew it then and as they know it now, and Murchison, Lyell, Ramsay, Geikie brought people to recognise that each of the great elements took its own dominating part in sculpturing our hills and valleys, and in laying down and dislocating the strata of our rocks. In Scotland itself there were plenty of geologists to whose memories Sir Archibald Geikie pays loving and grateful tribute, who had never left their native Scotland. Two Edinburgh journalists, Charles Maclaren, who founded "The Scotsman," and Hugh Miller, who was "The Witness," spent a great part of their lives in the field of geology. Robert Chambers worked as hard on geological subjects as he did on the improvement of the literature and of the lives of his countrymen, and Principal Forbes himself, Mr. Peach, and Prof. James Geikie have not allowed the indigenous Scotchman to lose his claim to a great place among contemporary geologists.

Sir Archibald Geikie shows that his hand has lost none of its cunning, in the delightful word pictures he has given us of some of these famous and only half forgotten men of the early Victorian era. Here is a charming cameo :—

"The illustrious Principal Forbes himself was widely known to the geological world for his researches on the glaciers of the Alps and of Norway, and on earth temperature. As one saw him in the street or in the class room, he looked singularly fragile, and it was not easy to realise how such a seemingly frail body could have undergone the physical exertion required for his notable Alpine ascents. His tall, spare figure might be seen striding from the University to the rooms of the Royal Society, of which for many years he was the active secretary. His clear brown eyes wore a wistful expression and his pale face and sunken cheeks showed how his well-chiselled features had been preyed on by serious illness. Round his long neck he always wore one of the large neckcloths then in vogue, and above this, when out of doors, he carried a thick muffler, from under which as one passed him, one might hear now and then the cough that told of the malady from which he was suffering. In his own house, especially when showing some of the beautifully artistic water-colour drawings which he had made in the course of his wanderings, the then white, almost transparent, hands told the same tale of suffering."

Take another ameo, equally striking, of that wonderful stonemason and editor, Hugh Miller :—

"His appearance in the streets was certainly most uneditorial. Above the middle height, strongly built with broad shoulders, a shock of sandy hair, large bushy whiskers, and dressed in rough tweeds, with a shepherd's plaid across his shoulder, he might have been taken for one of the hill farmers, who on market days come to Edinburgh from the uplands of the Lothians He had the true 'Highland man's ling,' the elastic, springy and swift step of the mountaineer, accustomed to traverse shaking bog and rough moor. As he swung down the North Bridge, wielding a stout walking stick, looking straight before him, his eyes apparently fixed on vacancy, and his lips compressed, one could hardly help turning to look after him and to wonder what manner of man he could be."

Of the innumerable excellent stories which delight the readers of Sir Archibald's reminiscences I shall quote only two, and they shall be in connection with well-known scientific names. One tells us how "the late Professor Tait, so widely known, and so affectionately remembered, used to cite one of the answers he received in a class examination. The question asked was 'Define transparency, translucency, and opacity,' and the following was the answer, 'I am sorry that I cannot give the precise definition of these terms. But I think I understand their meaning, and I will illustrate it by an example. The windows of this class room were originally transparent, they are at present translucent, but if not soon cleaned they will become opaque.'"

Many old Edinburgh students will still "affectionately remember" these occasionally translucent windows, and will know how their never-to-be-forgotten professor would welcome the answer.

The only other quotation I shall permit myself is from a letter written by Ami Boué, a delightful old geological friend of Sir Archibald Geikie's younger days, who had been educated in Edinburgh, where he was caught up in his youth—about the time of Waterloo—in the maëlstrom of the great geological duello between the Vulcanists and the Neptunists. Boué wrote an "Esquisse Geologique sur l'Ecosse." which Sir Archibald describes as "a most valuable treatise, in many respects far in advance of his time." Born in Geneva, with German and Austrian connections, and educated in Scotland, he seems to have spoken most of the tongues of Europe with equal courage and inaccuracy. His Edinburgh days, however, were in 1870 far in the background of his life, but there are few Englishmen or Scotchmen who would have ventured to describe their feelings in a tongue with which they had been familiar in early life, as Ami Boué did, during the calamitous Franco-German war.

"The dreadful war pre-occupations did take me all time for thinking at scientific matter, and now perhaps that distress will approach till nearer our abode! When you will know that I have very good and near parents in both armies, and you perceive the possibility of parents killing themselves without recognising themselves, nor having the opportunity to do so, you will understand that I have often headach when I ride the newspapers or hear from the quite useless slaughters which have been provocated only by those men at the head of the human society."

Too much language must have made his charming old geological friend a little mad, for Sir Archibald tells us that "all the letters to me, extending over a period of thirteen years," of this too cosmopolitan man of science, "were written in broken English," of which the letter above is a specimen.

The book is full of passages which recall one of the most delightful, and one of the earliest of Sir Archibald's books on the scenery of Scotland. I take a grateful farewell of the "Reminiscences" if you will allow me one more extract in illustration :—

"The fate of the Celt in the Highlands has been far different. There he has found himself in a region of mountains too rugged and lofty for cultivation, save along their bases, and too continuous to permit easy access from one district to another. . . . Shut in among long, narrow, and deep glens, he has cultivated their strips of alluvium, but has too often found the thin stony soil to yield but a poor return for his labour. For many a long century he had to defend his flocks and herds from the wolf, the fox and the wild cat. The gloom of his valleys is deepened by the canopy of cloud which for so large a portion of the year rests upon the mountain ridges and cuts off the light and heat of the sun. Hence his harvests are often thrown into the late autumn, and in many a season his thin and scanty crops rot on the ground, leaving him face to face with starvation and an inclement winter. Under these adverse conditions he could hardly fail to become more or less subdued and grim."

In passages like this, admirable in description and rich in human sympathy, the book abounds.

W. J.

THE NEW ZEALAND FAUNA.

Index Faunae Novae Zealandiae. Edited by F. W. Hutton. Pp. viii+372. (London: Dulau and Co., 1904.) Price 10s. 6d. net.

WITH the exception of the valuable introduction, by the editor, which appeals to a somewhat wider circle, this is essentially a book of reference, and as such is all-important to the scientific worker. In drawing up the list of the fauna, Captain Hutton has had the assistance of specialists in various branches of zoology who have undertaken the groups with which they are most familiar, so that the work may be regarded as thoroughly complete and up-to-date. Only two land mammals—bats—are recognised as indigenous to the islands, the so-called Maori rat (*Mus exulans*) having apparently been introduced from Polynesia. This species, together with other wild forms introduced by human agency, are noticed in an appendix, and the reader will probably be surprised to find how large a list of foreigners has thus been added to the indigenous fauna. It should be mentioned that the text of the work is an "index" pure and simple, not even the local distribution of the various species being given.

After a brief historical survey of the acquisition of our present knowledge of the New Zealand fauna, Captain Hutton enters on a detailed discussion of the origin and relationships of that fauna, and since this is a subject to which he has for many years devoted special attention, his matured conclusions are of the highest value and importance.

The migratory portion of the fauna is very small, including only some half-dozen species of birds. The preponderating stationary portion may, according to Captain Hutton, be divided into a small aboriginal element, comprising species with no near relatives elsewhere, and larger Malay, Australian, and Antarctic elements, as well as several smaller ones. Among the aboriginal forms, that is to say, those which appear to have been inhabitants of the islands for a very long period, the author includes the short-tailed bat (Mystacops), the tuatera, and the kiwi. Taking a broad view of the fauna, it may be said that the terrestrial portion is mainly of Malay origin, but with somewhat strong Holarctic and Neogæic connections. This opinion is important in connection with the view that has been elsewhere expressed as to the Asiatic origin of the Australasian marsupials.

From the occurrence of a number of animals which it is impossible to believe could have crossed the sea, the author is of opinion that New Zealand is not entitled to be regarded as an oceanic island, but that at an epoch relatively remote it formed part of a large continent.

The land shells of the genus Endodonta, which range all through Polynesia, New Zealand, eastern Australia, New Guinea, and the Philippines, with an outlier in Ceylon, afford the best evidence in favour of a Polynesian continent, the Cingalese outlier pointing to the conclusion that this group of molluscs originally came from the north. The molluscan evidence will not, however, explain the South American connection.

The best zoological evidence of the latter connection, by way of Antarctica, is afforded by the earthworms of the family Acanthodrilidæ, which are unknown north of the equator, although their occurrence in Madagascar may point to a northern origin. The primary northern origin of the mainly fresh-water fishes of the genus Galaxias may perhaps also be indicated by the existence of the allied Cromeria in the Nile. Additional evidence of a connection with Patagonia is afforded by the occurrence in the Tertiary strata of South America and New Zealand of quite a number of shallow-water marine invertebrates, as, indeed, has been recently pointed out by Dr. von Ihering. Further, the occurrence of these forms in older strata in South America than in New Zealand points to the conclusion that the migration took place from the former to the latter area.

Lack of space alone prevents us from discussing in greater detail Captain Hutton's very interesting and suggestive views.

R. L.

OUR BOOK SHELF.

A History of the Daubeny Laboratory, Magdalen College, Oxford. By R. W. Günther, M.A., F.L.S. Pp. vi+137; 3 full page plates. (London: Henry Frowde, 1904.) Price 5*s*. net.

OXFORD chemistry is entering on a new phase of its existence. Up to the present time the theoretical teaching has been excellent, but partly owing to lack of accommodation and partly through other causes, the practical teaching has not reached so high a standard. Mr. Günther's book is a sort of commemoration of the opening of the reconstructed chemical laboratory at Magdalen College. The laboratory, apart from the Physic Garden, which is nearly four hundred years old, was founded in 1842, and it was the scene of Daubeny's labours both as chemist and botanist. His chemistry lectures were, however, given in a basement of the old Ashmolean building. It is to a certain extent typical of the earlier days of Oxford science that most of the work was relegated to cellars. Brodie's "last word on the formula of ozone" was said in a cellar at Balliol, and in the same cellar much of Dixon's excellent work on the rates of explosion in gases was done. Harcourt's classical experiments on velocity of chemical change were performed in a basement at Christ Church. Things are changing now. New laboratories have been built both at Christ Church and Magdalen, and in both, research laboratories, with the best appliances, give hope that chemical research in Oxford many be entering on a new lease of life.

Mr. Günther gives a very minute and interesting account of the laboratory now under his charge. Not the least interesting is his description of the collection of old apparatus which has been lying, fortunately unbroken, for many years in the laboratory. A complete meteorological record from 1869 has been kept, and the monthly averages are given in an appendix. A list of Daubeny's researches is also appended; the number of papers is very large, considering the fact that he was the holder of three several professorships—chemistry, botany, and rural economy. The researches of later workers in the laboratory are described in full. Mr. Günther has evidently been misled by the politeness of one of the learned societies. It is scarcely considered a mark of distinction for an author to have his paper "deposited in full in the Society's Archives."

The registers of attendance at the lectures of Daubeny are printed in full from 1826, with notes of the after careers of the students. It is a curious fact that fully three-quarters of the early attendants of science lectures in Oxford afterwards took Orders, and among them we find three archbishops, Tait, Whately and Thomson. In these later days science is apparently not so necessary for the education of the clergy.

Abriss der Biologie der Tiere. By Prof. H. Simroth. 2 vols. Pp. 157 each. (Leipzig: Göschen.)

THESE little books correspond to the series issued in this country by Messrs. Newnes, as the "Story of Fish-Life" and the like. But Dr. Simroth, possessing as he does a great knowledge of animal bionomics, has condensed within two small volumes all the essential facts of comparative physiology of animals in a way that is paralleled by no English work except Semper's "Animal Life." Unfortunately the Germans, with few exceptions, do not arrange and select their elementary science in a way that assists the beginner. Almost on the first page we meet with "idioplasma" and "chromosomes," a fact which is eloquent of the distance between writer and learner. Whilst this work is one of great value to teachers, it is well to understand that it is useless to those beginning the subject. The reviewer, however, as one who has known the stimulating character of Prof. Simroth's teaching, gladly acknowledges the suggestive and clear way in which the influence of gravity, light, heat, and other radiations are referred to. These, and the concluding chapters on reproduction, rudimentary organs, and habitat, are well worth the attention of those who have already acquired a practical knowledge of biology.

From India to Fergana. Description of a Journey made in 1898 by Lieut.-Colonel V. T. Novitskiy, being part of vol. xxxviii. of the *Memoirs* of the Russian Geographical Society. Pp. 297; with a map and 18 photographs. (St. Petersburg, 1903.)

STARTING from Srinagar, the author went first to Leh; thence, proceeding in a northern direction, he crossed the Karakoram Plateau, reaching the Karakash River, or Khotan-daria, at the Chinese post Shahi-dula. Then, instead of taking one of the usual passes across the Raskem Range, the Russian traveller went through a more western, formerly unknown pass, Karlik-davan, which proved to be extremely difficult, especially in the gorge of the Tagra-su. Descending next to the valley of the Ulyuch-su, the party soon reached Kargalyk, in Kashgaria, and Yarkand, and went to Russian Turkestan, following one of the usual routes. The author gives very good descriptions of Kashmir and of the dreary Karakoram Plateau, about 15,000 feet high in its high valleys, which are covered with alluvial deposits from old desiccated lakes, and are surrounded with bare mountains reaching an altitude of 24,600 feet in the Ak-tash group of peaks. He describes further the Alpine zone, intersected with wild gorges, which is usually known on the maps as the Raskem Range, but represents in reality an intermediate zone between the plateau and the plains of Kashgaria. He gives detailed lists of the plants he collected and of the birds he saw, and also most striking photographs, artistically reproduced. A map of the Pamirs and the surrounding regions, 27 miles to the inch, and a very interesting cross-section, based on the author's barometric measurements, are added to this valuable work.

Dissertations on Leading Philosophical Topics. By Alexander Bain. Pp. vi+277. (London: Longmans, Green and Co., 1903.) Price 7*s*. 6*d*. net.

THIS volume consists of fifteen essays on logical, psychological and ethical topics that have been previously published in the pages of *Mind* or elsewhere. Nevertheless. a special interest attaches to it because the essays represent the maturest conclusions of the late Prof. Bain upon subjects to which he had devoted his attention with so conspicuous success throughout his long and distinguished career, and were designed by him to supplement the two great works on psychology which ill-health prevented him from again reissuing. The essays exhibit all that wide learning, that clearness and vigour of intellect, and that width of sympathy and interest which gave Bain's works on psychology a place in the foremost rank and secured for him a world-wide reputation. Very characteristic are the two essays in which he insists on the importance for psychology of physiological considerations and psycho-physical experiment, and at the same time defines their scope and their true relations to the introspective method. The volume concludes with an essay on the examination-system that assumes ever vaster proportions in this country in spite of many denunciations. Here Bain, recognising the necessity of examinations, appears as an advocate of improvement in the art of examining and of restriction rather than abolition of the system.

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.*]

Relation between Uranium and Radium in some Minerals.

IN the course of an investigation which I am conducting on uranium-bearing minerals, the detailed results of which will be published shortly, I have come upon a point which seems to be of sufficient interest to warrant immediate publication. This is the close agreement between the amount of uranium and the amount of radium present in those minerals which have been examined.

The method which has been employed is briefly as follows:—A weighed quantity of the powdered mineral is introduced into a small glass bulb, which is connected with a larger bulb by a short tube. Attached to the bulb containing the mineral is another small bulb containing a small quantity of a suitable acid. The whole apparatus is sealed up at a slightly diminished pressure, and by tilting, the acid is brought into the bulb with the mineral, and the complete decomposition of the latter effected by gentle heating. At the end of a couple of days the larger bulb is sealed off from the smaller and allowed to stand for two hours to permit any rapidly decaying emanation which it may contain to dissipate. A small quantity of strong sodium hydroxide solution is introduced into the bulb, and the walls are thoroughly wetted in order to remove the acid fumes. The air contained in the bulb is then transferred to an air-tight electroscope and the rate of leak measured. In comparing the results obtained with different minerals the rate of leak at the end of three hours has been chosen, since at this time the rate of decay of the excited activity and its rate of formation are in equilibrium, and the readings of the electroscope are constant over considerable periods. The quantity of uranium in the solution is determined by analysis, and the ratio between the volumes of the two parts of the apparatus determined by measuring their separate capacities.

The results which have been obtained are as follows:—

No.	Substance	Per cent. Uranium	Grams Uranium taken	Leak divisions per min.	Ratio leak to Uranium
1	Uraninite	82·5	0·1067	22·5	211
2	Gummite	66·1	0·0982	20·8	212
3	Uranophane	46·6	0·0671	12·1	181
4	Uraninite	83·9	0·0994	20·6	207·2
5	Samarskite	9·5	0·0292	6·4	218

Nos. 1, 2, 3 and 5 from North Carolina; No. 4 from Branchville, Conn.

The slightly low value of the constant in No. 3 can be explained by the fact that this mineral at ordinary temperature gives off constantly a small proportion of its emanation, and is therefore not in complete equilibrium.

These results show a direct variation from those obtained by Mr. Strutt (*Proc.* Roy. Soc., lxxiii., 191), which may perhaps be explained by the fact that he secured the emanation by heating his minerals. Experiments which I have made show that on heating samarskite to low redness only 10 per cent. of the total emanation is given off, and that heating to bright redness releases only 20 per cent. of the total emanation obtained when the very finely powdered mineral is completely decomposed by heating with concentrated sulphuric acid. BERTRAM B. BOLTWOOD.

139 Orange Street, New Haven, Conn., U.S.A., May 7.

The Source of Radium.

As the subject of the origin of radium is being discussed, I may perhaps be permitted to make a suggestion.

The source of radium is at present being looked for on the assumption that it is the disintegration product of a substance of higher atomic weight. If this is so, we have apparently to choose between uranium and thorium. Mr. Soddy's experiment throws serious doubts upon the former being the source. The products of the latter appear to have been sufficiently far traced to render it doubtful that it can be the source. Again, the element thorium seems to be scarce in, or even absent from, some radio-active pitchblendes, if the older analyses are to be relied upon.

I would suggest that radium may not be derived purely as a disintegration product, but as an atomic combination of radio-active products with some of the elements present in pitchblende. Thus radium would represent the synthesis of an element, not its decomposition. On this view some of the radio-active products of uranium (or thorium) can, in virtue of their great kinetic energy, enter into the atoms of intermixed substances, such as barium, bismuth, &c., giving rise to the new atom radium. The new atom is, however, not very stable, and is consequently short lived. Hence its radio-activity.

If this hypothesis is correct, we should seek to observe the genesis of radium not in any one of the radio-active elements, but in molecular intermixtures of these with the various bodies we know to be conspicuously present in pitchblende, seeking among the various combinations for a positive result. The quantities of radium (or its emanation) to be expected as generated in a given time remain, of course, the same as on the hypothesis of disintegration; thus the experimental investigation presents no additional difficulties beyond its greater prolixity. J. JOLY.

Trinity College, Dublin, May 17.

As Mr. Soddy is absent from England, it may be permitted to me to comment on Prof. Joly's letter. The idea had occurred to us; but, as remarked, the experiments would be very "prolix."

A more promising field of research appears to be to try to ascertain whether the immense amount of energy evolved in various forms during the disintegration of the radium emanation may not be able to cause chemical change of a constructive nature; for example, to change bromine into iodine. An attempt has been made to see if this was the case, but without a positive result. That iodine would be the product of an addition of energy to bromine is of course a mere guess; but iodine is easily tested for, and hence the experiment. The difficulty will be in recognising with certainty the product of any such change, for the quantity of matter to be produced is, of course, extremely small. It is only, however, by such "mad" experiments that the capabilities of the radio-active bodies can be ultimately gauged. WILLIAM RAMSAY.

Radio-activity of Russian Muds and Electrification of Air by Metals.

THE researches of Elster and Geitel (*Phys. Zeitschr.*, v. p. 11) having led to the detection of radio-active power in the fine mud or "Fango" of the Italian watering-place Battaglia, induced me to undertake a study of the Russian muds in this character. Out of the five kinds of muds hitherto obtained by me and studied in a desiccated state, two muds, viz. that of the Odessa Kooyalnitzky Liman and that of Arensburg, on the Isle of Oesel, have proved undoubtedly to possess radio-activity, the first being radio-active in a higher degree than the second. In these researches we proceeded in a manner quite analogous to that of Messrs. McLennan and Burton in studying the electrical conductivity of the air (*Phil. Mag.*, v. p. 699, 1903). The present experiments were carried out with the most active participation of Mr. Athanassieff.

We employed two cylinders, a brass one 8·3 cm. in diameter and 20 cm. high, and another of zinc, 22·5 cm. in diameter and 35 cm. high. In each cylinder there was fixed along the axis a brass wire which was supported by an amber cylinder placed in a brass guard tube. The latter was connected with the earth, and embedded in an insulating ring put into an opening of the upper base of the cylinder. The wire of either cylinder could at will be connected with one pair of quadrants of a Dolezalek electrometer, the other pair being connected with the earth, and the leaf was charged to 100 V by means of a battery of storage cells. The wire, also of brass, connecting the cylinder wire with the electrometer, and the point of connection of that wire with either cylinder wire, were surrounded by brass tubes connected with the earth. The sensitiveness of the electrometer was such as to produce for a ΔV of 0·01 V, a shifting of about 7 mm. on the scale. The connection of the cylinder wires with the earth was brought about by touching them with brass wires connected with the earth. In the whole there was not on the path from the cylinder wire to the electrometer any contact of two different metals. The cylinder was charged, as a rule, to 100 V by a battery of storage cells.

During the progress of these experiments a very interesting phenomenon presented itself. It was found that when either of the cylinders is connected with the earth, the wire enclosed within it, after being disconnected from the earth, immediately begins to get electrified, *i.e.* the electrometer thereupon indicates a rise of a potential, which continually increases during a certain interval of time, some hours in the main, before reaching a limiting value. (The electrification was observed when the mud was removed from the cylinders.) The wire contained in the zinc cylinder becomes positively electrified, whilst that in the brass cylinder becomes negatively electrified. Having remarked such a phenomenon, we introduced into the brass cylinder which opened from beneath, a zinc cylinder, placed coaxially so as to enclose the wire. This cylinder was in metallic connection with the surrounding brass one. In this case, too, the wire acquired a potential, but it was opposite in sign to that it acquired without such a zinc cylinder being merely enclosed in the brass cylinder, *i.e.* it became positively electrified. The maximum value of the potential produced in the wire amounted in our observations to 0·2 V. This maximum value depends, it seems, upon the degree of ionisation of the air in the cylinder.

We also replaced the zinc cylinder at the interior of the great brass cylinder by others of lead, aluminium, iron and silver, with the effect that the two former acted in the same direction as the zinc cylinder; the lead cylinder, which, by the bye, proved very radio-active, gave the strongest effect (about 0·35 V), whilst aluminium took the last place, zinc remaining in the middle. The iron and the silver cylinders, on the contrary, exerted the same action as the main brass cylinder, giving a negative electrification, but to a less degree.

The phenomenon we have observed seems to be in correspondence with effects produced in metals by air ionised with Röntgen rays (I. Borgmann and A. Gerchun, *C. R.*, cxxii. p. 378, 1896; Minchin, the *Electrician*, March 27, 1896; Rutherford, *Phil. Mag.*, xliii. p. 241, 1897). It may perhaps give the explanation of atmospheric electricity; and it is also of interest in the fact that here we take electrical energy directly from the air. I. BORGMANN.

Physical Institute, The University, St. Petersburg, May 9.

Graphic Methods in an Educational Course on Mechanics.

IT is difficult to reconcile Mr. Milne's opening statement (NATURE, May 5, p. 5) with the rest of his letter. He begins by venturing to think that no one will gainsay Mr. W. Larden's main contention (NATURE, April 28, p. 607) that "analytical methods give a grasp of the principles of statics while graphical methods disguise them," and he goes on to give half a dozen instances confuting it. Mr. Larden wrote to elicit opinions from those who have taught mechanics, and as I have had only one pupil, a very troublesome one, namely, myself, I cannot think that my opinions are invited. But when Mr. Milne thinks that no one will gainsay the contention, the challenge is a wide one, and I deny it emphatically, and know that there are hundreds of men who will agree with me. These men are not teachers or mathematicians, but those who have to use mathematics for their profession or trade.

I have the highest admiration for all those to whom science is an end in itself. I fully appreciate the attitude of mind (the butt of so many jokes) which feels that mathematics and other sciences become degraded by useful applications. But for one true mathematician there are a thousand men to whom mathematics are but a means to an end. Many of these, like myself, are not mathematically minded (as Mr. Larden probably counts mathematics), and with the exception of Maxwell's "reciprocal figures" and a few others, we have had to work out graphical methods mainly for ourselves. Teachers are now coming round, or as Mr. Larden would put it, giving way, or as I would put it, waking up, and are recognising that analytical language, powerful as it is for research, is not paramount for explanation. "I believe," wrote Prof. J. Perry in his "Spinning Tops," "that there are very few mathematical explanations of phenomena which may not be given in quite ordinary language to people who have an ordinary amount of experience. In most cases the symbolical algebraic expression must be given first by somebody, and then comes the time for its translation into ordinary language."

I agree with the whole of Mr. Milne's letter except the first few words, and, like him, "I believe the best results will be obtained when the two methods are used side by side." Of my own acquaintances, about one in five prefer analytical methods, but the others have a diagram in their heads, if not before them on paper as a guide to bring it vividly before the mind (to borrow Mr. Larden's words). Mr. Larden concludes, "graphical work consumes an amount of time that seems out of proportion to the mental training and knowledge of principles gained." The title of his letter shows that he has "an educational course" in view, and *qua* education, "mental training and knowledge of principles" is the true and only object. His pupils should emerge as mathematicians. But those who have to use statics professionally would not hesitate to consume twice or thrice the time on a graphical method if it carries conviction of truth with it, as it does to two or three at least out of five of my acquaintances.

Mr. Larden dates his letter from Devonport, and this suggests that some of his pupils hope to become naval officers and not wranglers; that mathematics will be used by them in after life as a means to an end. Would he deny the use of a piece of string on a globe to explain "great circle sailing," or does he use a formula applicable generally to figures of revolution, of which the earth and Saturn's ring are particular cases? Sumner's method may be disguised in algebra, but it must be confessed that the famous "line" as discovered by him was a bit of pure graphics.

It may be impossible for Mr. Larden to appreciate the geometrical point of view, for my contentions are exactly the opposite of his first and fourth. For us non-mathematicians, "graphical methods give a grasp of the principles of statics, while analytical methods disguise them," and "analytical methods confuse learners of statics." The second contention, "Analytical methods must be mastered in any case," needs the addition of the words "by the help of diagrams." If there be any truth in the third contention, that "analytical methods connect statics with dynamics," it is of small importance if they fail to elucidate dynamics. Nature herself gainsays these contentions with the parabola of the fountain, the ripple of the pond, and the slope of the sand hill.

A. P. TROTTER.

8 Richmond Terrace, Whitehall, S.W., May 13.

ANY educational course in mechanics should undoubtedly be based first of all on experiment. If such is the case, it is practically impossible for any student using "graphical methods" to make the wild "shots" referred to by Mr. Larden (vol. lxix. p. 607), who seems to have been very unfortunate in the kind of boy he has received from "a preparatory school"; or is it the boy who has been unfortunate in his previous training? Has Mr. Larden considered the possibility of the "method of teaching" adopted being wrong in the aforesaid school? Surely there is no inherent quality in "graphical methods" to cause these wildest of "shots." The writer's experience goes entirely against this idea, and supports the contentions set forth by Mr. Milne.

Mr. Larden writes:—"If then, there be not time for both, it is the latter (Graphics) that should be sacrificed." If time is so short that some sacrifice must be made, the writer is of opinion that it would be better to take a less comprehensive course than to omit "graphical methods" entirely.

The best method for mechanics, as for all physical sciences, is:—

(1) Experimental work to be carried out by the boys.

(2) Consideration of, discussion on, and deduction from the experimental data obtained by the boys, with an occasional demonstration by the teacher to clench any particular point. This treatment of the experimental work to involve both analytical and *graphical* methods.

In fact, a truly educational course in mechanics is impossible without experimental work. Granted this experimental work, the writer is of opinion that the aim of the students will be considerably improved, and not only so, but there will be a complete absence of wild "shots."

S. Irwin Crookes.

Secondary and Technical School Clay Cross, Chesterfield, May 15.

EUGENICS; ITS DEFINITION, SCOPE AND AIMS.[1]

EUGENICS is the science which deals with all influences that improve and develop the inborn qualities of a race. But what is meant by improvement? We must leave morals as far as possible out of the discussion on account of the almost hopeless difficulties they raise as to whether a character as a whole is good or bad. The essentials of eugenics may, however, be easily defined. All would agree that it was better to be healthy than sick, vigorous than weak, well fitted than ill fitted for their part in life. In short, that it was better to be good rather than bad specimens of their kind, whatever that kind might be. There are a vast number of conflicting ideals, of alternative characters, of incompatible civilisations, which are wanted to give fulness and interest to life. The aim of eugenics is to represent each class or sect by its best specimens, causing them to contribute *more* than their proportion to the next generation; that done, to leave them to work out their common civilisation in their own way.

The course of procedure that lies within the functions of a learned and active society would be somewhat as follows:—

(1) Dissemination of a knowledge of the laws of heredity so far as they are surely known, and promotion of their further study. Few seem to be aware how greatly the knowledge of what may be termed the *actuarial* side of heredity has advanced in recent years. The *average* closeness of kinship in each degree now admits of exact definition and of being treated mathematically, like birth- and death-rates, and the other topics with which actuaries are concerned.

(2) Historical inquiry into the rates with which the various classes of society (classified according to civic usefulness) have contributed to the population at various times, in ancient and modern nations. There is strong reason for believing that national rise and decline are closely connected with this influence.

(3) Systematic collection of facts showing the circumstances in which large and thriving families have most frequently originated; in other words, the *conditions* of eugenics, on which much more information is wanted than is now to be had. It would be no great burden to a society, including many members who had eugenics at heart, to initiate and to preserve a large collection of such records for the use of statistical students. The committee charged with the task would have to consider very carefully the form of their circular and the persons entrusted to distribute it. They should ask only for as much useful information as could be easily, and would be readily, supplied by any member of the family appealed to. The point to be ascertained is the *status* of the two parents at the time of their marriage, whence its more or less eugenic character might have been predicted if the larger knowledge that we hope to obtain had then existed. The reasons would have to be shown why the children deserved to be entitled a "thriving" family. A manuscript collection such as this might hereafter develop into a "golden book" of thriving families. The act of systematically collecting records of thriving families would have the further advantage of familiarising the public with the fact that eugenics had at length become a subject of serious scientific study by an energetic society.

(4) Influences affecting marriage. The remarks of Lord Bacon in his essay on death may appropriately be quoted here. He says, with the view of minimising its terrors:—

"There is no passion in the mind of men so weak, but it mates and masters the fear of death. . . . Revenge triumphs over death; love slights it; honour aspireth to it; grief flyeth to it; fear pre-occupateth it."

Exactly the same kind of considerations apply to marriage. The passion of love seems so overpowering that it may be thought folly to try to direct its course. But plain facts do not confirm this view. Social influences of all kinds have immense power in the end, and they are very various. If unsuitable marriages from the eugenic point of view were banned socially, or even regarded with the unreasonable disfavour which some attach to cousin-marriages, very few would be made. The multitude of marriage restrictions that have proved prohibitive among uncivilised people would require a volume to describe.

(5) Persistence in setting forth the national importance of eugenics.

There are three stages to be passed through before eugenics can be widely practised. First, it must be made familiar as an academic question, until its exact importance has been understood and accepted as a fact. Secondly, it must be recognised as a subject the practical development of which is in near prospect, and requires serious consideration. Thirdly, it must be introduced into the national conscience, like a new religion. It has, indeed, strong claims to become an orthodox religious tenet of the future, for eugenics cooperate with the workings of nature by securing that humanity shall be represented by the fittest races. What nature does blindly, slowly and ruthlessly, man may do providently, quickly and kindly. As it lies within his power, so it becomes his duty to work in that direction, just as it is his duty to be charitable to those in misfortune. The improvement of our stock seems one of the highest objects that can be reasonably attempted. We are ignorant of the ultimate destinies of humanity, but feel perfectly sure that it is as noble a work to raise its level as it would be disgraceful to abase it. I see no impossibility in eugenics becoming a religious dogma among mankind, but its details must first be worked out sedulously in the study. Over-zeal leading to hasty action would do harm by holding out expectations of a near golden age which would certainly be falsified and cause the science to be discredited. The first and main point is to secure the general intellectual acceptance of eugenics as a hopeful and most important study. Then let its principles work into the heart of the nation, which will gradually give practical effect to them in ways that we may not wholly foresee.

[1] Abridged from a note read before the Sociological Society on May 16 by Dr. Francis Galton, F.R.S.

SOME GERMAN PUBLIC LABORATORIES.

IN considering the success of German manufactures we are doubtless justified in regarding education as the ultimate cause. But proximate causes are also worth noting, and among these is the facility of access to the fountain-head of science enjoyed by German manufacturers. In England, as elsewhere, a manufacturer hesitates to take scientific experts into his employ unless his industry be on rather a large scale, but in Germany, at any rate, he has for some time been able to acquire the very best of scientific aid, as it were, retail. This fact is brought home by a study of some of the German industrial testing stations recently published by M. A. Granger in the *Bulletin de la Société d'Encouragement*.

The first of these institutions on M. Granger's list is also the most interesting, since it is not a State creation, but rests, in essence, on the historically English basis of cooperation. The laboratory of the Tonindustrie Zeitung in Berlin, together with the journal from which it takes its name, thrives upon the support of nine associations of manufacturers turning out pottery, cement, builders' materials, &c. It is housed in an admirably planned building of three stories, of which the uppermost is set apart for the business of the Zeitung. The laboratories are designed for the study of such goods as bricks and tiles, terra-cotta, fireclay, earthenware, porcelain, and cement, and their primaries. The clays serving as raw materials are subjected to elutriation, to determinations of plasticity, porosity, and fusibility, and to chemical analysis. In another department they are experimentally baked; here also Seger's cones are made and furnace gases analysed. The testing of cements includes rate of hardening, variation of volume, resistance to hammering, and tensile strength. Manufactured articles, finally, undergo tests for mechanical strength and for resistance to abrasion.

The laboratory is entirely at the service of manufacturers not only for tests, but also for investigations, including geological prospecting. To round off its completeness, it carries on a patent agency and an instrument business. Altogether some fifty persons are employed.

Better known to the world at large is the Kgl. Mechanisch-Technische Versuchs-Anstalt of Charlottenburg, now removing to the remoter suburb of Gross-Lichterfelde. Founded by ordinances of the Prussian Government in 1880 and 1882, it performs investigations and tests for the various Government departments (including railways) and for private clients. There are four departments, with a supreme director. The metals department is equipped for all the usual engineers' tests and for photographic metallography; its chief glories are a 500 ton horizontal testing machine by Hoppe, and a machine for crushing tests, of which the monkey weighs 600 kg. and falls through 10 metres. The other departments are concerned with builders' materials, papers and textiles, and lubricants respectively. The paper testing of the Versuchs-Anstalt is, perhaps, the best of its kind; its methods have been rendered familiar by the book of Dr. Hertzberg, the head of the department.

M. Granger further mentions the Kgl. Chemisch-Technische V.-A. in central Berlin, which is also kept up by the Prussian Government. It appears to be practically a commercial analyst's laboratory on the large scale. The well known Physikalisch-Technische Reichsanstalt of Charlottenburg owes its maintenance not to Prussia, but to the Empire.

In this, as in other respects, Bavaria declines to stand by whilst Prussia makes the running. Since 1891, we learn, there have been a Material-Prüfungs-Anstalt and a Chem.-Techn. V.-A. in Nuremberg, both State institutions; though on a comparatively small scale, they are in a flourishing way, and are business-like enough to charge lower fees than their Prussian analogues.

W. A. C.

DR. G. J. ALLMAN, F.R.S.

GEORGE JOHNSTON ALLMAN was born in Dublin in the year 1824, the son of Dr. William Allman, who was professor of botany in the University of Dublin from 1809 until 1844. He entered Trinity College at an early age, and at the honour degree examination he obtained senior moderatorship and a gold medal in mathematics in the year 1843. He was thus a contemporary of Samuel Haughton, who was first senior moderator in Dr. Allman's year, and of Sir Thomas Moffett, with whom he was so long associated in Galway. Early in the 'fifties Dr. Allman was elected to the professorship of mathematics in Queen's College, Galway, one of the colleges affiliated to the then recently constituted Queen's University in Ireland, and at Galway he remained until the close of his long life. Soon after the foundation of the Royal University in place of the Queen's University, Dr. Allman was nominated one of the senators by the Crown—a signal testimony to the high reputation he had made among his friends and colleagues in the Queen's University. He held his professorship for nearly forty years, when he was obliged to retire in accordance with the Civil Service regulations respecting the age limit.

Dr. Allman's most remarkable mathematical works relate to the paraboloids (on some properties of the paraboloids, *Quarterly Journal of Mathematics*, 1874) and to the history of Greek mathematics. During the years 1877–87 he published a series of papers in Hermathena which formed the basis of his celebrated work, "Greek Geometry from Thales to Euclid" (Dublin University Press Series). He also wrote the articles in the ninth edition of the "Encyclopædia Britannica" on Ptolemy, Pythagoras and Thales. In 1884 he was elected a Fellow of the Royal Society.

Like his class-fellow, Dr. Haughton, Allman was much interested in natural history, especially in the collection and study of sea-shells. He was fond of chess, and though perhaps he would hardly have called himself a mountaineer, he thoroughly enjoyed a ramble in some mountainous district and had full experience of the fascination the mountains have exerted over so many men of science.

NOTES.

THE delegates attending the assembly of the International Association of Academies were entertained by the Royal Society at a banquet at the Hôtel Métropole on Tuesday. Sir William Huggins, president of the society, occupied the chair. Lord Goschen, in proposing the toast of the evening, "The International Association of Academies," said that a hundred years ago the metaphysical interests seemed to predominate over the interests of physical science, but the conditions were now entirely reversed, and it seemed as if physical science were going to rule the world. Nations seemed to look to physical sciences as if on them their prosperity depended, and the nation which paid the greatest homage to physical sciences would be the nation which would win among the nations of the universe. But might he put in a plea at the same time for the moral and metaphysical and the political sciences? He was glad to think that in most of the academies there was a section of the moral and political sciences side by side with the physical sciences, but they could not achieve the same striking results. He thought it highly desirable that side by side with physical sciences the societies which devoted themselves to moral and political sciences should be able to hold their own, and he appealed to the representatives of those academies to try to vie in energy and in determination to succeed with those who represented physical science alone. Replying to the toast, the Comte de Franqueville remarked that science belonged to no country, and was essentially the patriotism of humanity. Every scientific discovery, every conviction, every step of progress, whoever the author might be, in whatever country it took place, was spreading to every land like the beams of the sun illuminating the worlds. It was natural that all should contribute to that which should be a profit to all; to individual efforts and labours they gave a common impetus, in grouping and classifying the numerous problems which humanity had not yet solved.

Sir William Huggins, K.C.B., has been elected a foreign associate of the U.S. National Academy of Sciences; and also an honorary member of the Royal Philosophical Society of Glasgow.

The *Times* correspondent at Colombo announces that Dr. Castellani has discovered the bacillus of dysentery, and will shortly read a paper upon the subject before the Medical Association.

The *Globe* reports that Dr. Gottfried Merzbacher, who has been engaged for two years on a scientific expedition in the Thian-shan Mountains, in Central Asia, has returned to Munich with many objects of geological, palæontological, zoological and botanical interest.

A Reuter telegram from Malta states that a slight shock of earthquake was felt there at 6.13 a.m. on May 21.

A Reuter message from Copenhagen, dated May 21, states that the Danish scientific expedition to Greenland has arrived in the Danish colony of West Greenland, and reports that the Gjoea expedition, which started in August of last year, was found at Dalrymple Rock. All the members of both expeditions are well.

We learn from the *British Medical Journal* that the International Congress of Physiologists will hold its sixth meeting at Brussels this year from August 30 to September 3. All communications relative to the congress should be addressed to Dr. Slosse, Institut Solvay, Parc Leopold, Brussels, before July 1.

The annual meeting and conversazione of the Selborne Society will be held at the Civil Service Commission, Burlington Gardens, to-morrow, May 27. Lord Avebury, the president of the society, will give an address. There will also be a lecture, by Prof. B. H. Bentley, on "Flowers and their Insect Visitors," and one by Mr. Fred Enoch on "Colour Photography of Living Insects."

We have received from the secretary of the Library Association a report of the proceedings of the committee of the Library Association on binding leathers. We notice that more than sixty institutions have undertaken to try the new leathers prepared—in accordance with the recommendations of the committee appointed by the Society of Arts—to obviate the rapid deterioration of book-binding leathers. It is hoped that British producers will take care to prepare the light leathers specified.

At a sale recently held by Mr. Stevens in King Street, Covent Garden, a great auk's egg in fine condition was sold for two hundred guineas, the purchaser being Mr. Pax. This is a considerable falling-off from the three hundred guineas obtained for the last specimen sold by Mr. Stevens, the reason being attributed to the fact that several other fine examples are in the market. Mr. Pax's specimen was originally bought for two sovereigns. The next highest price obtained at the recent sale was 8*l*. 18*s*. 6*d*. for a clutch of four eggs of Bonaparte's sandpiper. For a single egg, the highest price was 27*s*. 6*d*. for one of Pallas's sand-grouse.

Mr. A. W. McCurdy, at a recent meeting of the Canadian Institute, gave an account of his invention of the device for developing photographs without a dark room, now so well known as the Kodak developing machine. It appears that his first idea was to use one solution that would both develop and fix, containing pyrocatechin as the developer. He afterwards employed a combined developer and fixer containing pyrogallol and sodium carbonate to avoid the troublesome caustic alkali. But separate developing and fixing solutions have always been recommended by the commercial makers of the apparatus, doubtless because of the greater certainty when the operations are individually controlled.

The death is announced of Mr. J. N. Tata, the millionaire philanthropist of Bombay. A correspondent of the *Times* points out that Mr. Tata made experiments extending over a series of years for the acclimatisation of Egyptian cotton in India, and in suitable localities these met with some measure of success. In many other directions, notably that of sericulture after the Japanese method in Mysore, the extension of the use of artesian wells and the introduction of cold storage, Mr. Tata contributed to the industrial expansion of the country of his birth. Mr. Tata, by means of his scholarships, tenable by Indian youths of special promise in this country as well as on the Continent and in America, afforded many of his young fellow-countrymen exceptional opportunities for gaining technical knowledge. The Indian University of Research, to be created at Bangalore as the outcome of his offer of an endowment of 200,000*l*., will be the monument of his beneficent career.

In the death of Mr. Frank Rutley, geological science has lost an enthusiastic worker on rocks and rock-forming minerals—one of the earlier investigators who brought the microscope to bear on petrological studies. His interest in geology was kindled at the Royal School of Mines, but he served as lieutenant in the army for a few years before 1867, when he joined the staff of the Geological Survey under Murchison. After carrying on field work for a time in the Lake District, he began to devote his special attention to the study of igneous rocks, and was transferred to the office in Jermyn Street, where he laboured for a number of years as acting petrologist. In 1876 he described the volcanic rocks of east Somerset and the Bristol district, and subsequently wrote memoirs on the eruptive rocks of Brent Tor and on the felsitic lavas of England and Wales. He was the author of the first English text-book of petrology, "The Study of Rocks" (1879), also of "Rock-forming Minerals" (1888) and "Granites and Greenstones" (1894). He likewise published a very useful handy book of mineralogy which passed through several editions. To the Geological Society he communicated papers relating to perlitic and spherulitic structures, fulgurites, novaculites, &c., and a special memoir on the rocks of the Malvern Hills. In 1881 the Murchison fund was awarded to him by the council of the society. He resigned his post on the Geological Survey in 1882, when he was appointed lecturer on mineralogy in the Royal School of Mines (afterwards merged in the Royal College of Science). A few years ago he was stricken down with paralysis, and was forced to retire from the public service; but he laboured on as far as his strength permitted with wonderful patience and interest, animated by a cheery nature, and he was able to accomplish much useful work until within about two years of his decease.

WE are glad to find that the study of the meteorological conditions of the Transvaal and Orange River Colony has been taken up seriously by the respective Governments. With regard to the service in the Transvaal, we find some interesting particulars given in *Symons's Meteorological Magazine* for May. The director of the service is Mr. R. T. A. Innes, and the central observatory, which is three miles north-east of Johannesburg, stands at a height of about 5900 feet above sea-level. The grounds cover 10½ acres, and were obtained partly by purchase and partly by gift of a Dutch family named Bezuidenhout. There are already 200 rainfall stations in operation, in addition to about 30 stations of the second and third orders. All the rainfall observers have come forward voluntarily, many of them being farmers and school teachers in thinly populated districts. A weather report is already issued daily, based on observations received by telegraph, and self-recording instruments are on the way to South Africa, and will probably be in working order by the beginning of July.

MESSRS. D. SCHULTE AND Co. have submitted a sample of their self-lighting Bunsen burner, in which the well known property of finely divided platinum igniting under the influence of a stream of hydrogen is employed. The burner proper is of the usual type, but is furnished with a byepass tube at the side, controlled by a cross stopcock. At the top of the byepass, close to the open end of the burner, there is fitted a small bracket holding the bundle of several fine platinum filaments, so constructed that the thin stream of gas from the byepass tube impinges on the stretched wires. A movable metal hood fits over the lighter to direct the pilot flame produced by the action of the platinum to the Bunsen tube, and on turning the stopcock to give full supply, the burner is lighted. The arrangement works very readily, and if the old difficulties with regard to the durability of the delicate portions can be surmounted, the apparatus should be of considerable convenience to laboratory workers.

IN the *Bulletin* of the Johns Hopkins Hospital for March (vol. xv., No. 156), Dr. Eugene Opie writes on the relation of leucocytes with eosinophile granulation to bacterial infection, finding that they are attracted from the blood to the site of the bacterial invasion. Dr. Thomas McCrae gives an interesting biographical notice of George Cheyne, an old London and Bath physician of the seventeenth century. The other papers are of purely medical interest.

THE report of the Inter-Departmental Committee on the Model Course of Physical Exercises has recently been published. The committee was instructed "to examine the model course now in use, to judge how far it should be modified or supplemented, and to consider what principles should be followed, in order to render a model course, or courses, adaptable for the different ages and sexes of the children in public elementary schools." The conclusion arrived at is that the "model course" as at present in use is not completely satisfactory. An elaborate scheme of exercises, no less than 109 in number, has therefore been drafted, and should prove of considerable service to teachers and others.

Two papers on invertebrates have just been received. In the first Miss H. Richardson (*Proceedings* U.S. Nat. Mus., No. 1369) describes numerous new types of isopod crustaceans collected in Alaska and Hawaii. In the second, which is extracted from the *Mark Anniversary Volume*, Mr. J. H. Gerould discusses certain features in the embryology of the sipunculid annelids, dealing more especially with the structure and homology of the peculiar embryonal envelope and its amniotic cavities.

THE Leishman-Donovan body or parasite has been the subject of a research by Lieut. Christophers (*Sc. Mem. of the Gov. of India*, No. 8). It is met with in India in patients suffering from chronic fever, cachexia, and enlarged spleen. It occurs as a small round or ovoid body 1·5 to 3·5μ in diameter, free or contained within the leucocytes in the liver and spleen and bone-marrow, but not in the muscles or in the peripheral blood. Christophers observed the parasites also in the arachnoid and in ulcers of the large intestine. He agrees with other British observers that the organism is not a *piroplasma*, as stated by Laveran.

IN the April number of the *Journal* of the Quekett Microscopical Club (ix., No. 54), Mr. Julius Rheinberg directs attention to a point concerning the resolving power of a microscopical objective that has been overlooked. As is well known, the numerical aperture of an objective must be of a certain degree in order to resolve a number of equidistant points or lines, and it has been tacitly assumed that the same numerical aperture is required whether the number of lines be two, four, six, or a large number. If, however, there be only two lines, it will be found that they can be resolved with a numerical aperture sensibly less than that required to resolve a large number. The mathematical explanation has been given by Dr. Johnstone Stoney and by Lord Rayleigh.

Two *Bulletins* have been received from the Experiment Station of the Colorado Agricultural College. In the first Mr. Paddock deals with "crown gall," the name applied to irregular outgrowths which are formed just below the ground at the base of trees, principally fruit trees. It has been referred to the irritation set up by a slime-fungus, and Prof. Toumey has succeeded in developing galls by inoculation. The pamphlet by Mr. Blinn directs attention to the importance of careful selection of seed as illustrated in the case of the Canteloupe.

THE movements of the stomata of leaves is a subject of which Mr. F. Darwin, F.R.S., has made a special study, and the latest paper published in the *Botanical Gazette* furnishes an account of observations made with a Callendar recorder, which is a form of resistance thermometer. Platinum wires are arranged in a zig-zag on plates of talc, and two of these act as "bulbs" against which the leaves are pressed. In general, a withered leaf is used as a control. The results agree with those obtained with the horn hygroscope, and, to quote one instance, the curve produced by severing a leaf shows very clearly the preliminary opening followed by a gradual closing of the stomata.

"INSECTS Injurious to Fruits in Michigan" is the title of an illustrated *Bulletin* issued by the Agricultural College of that State.

IN the course of a paper on metabolism and division in the Protozoa, published in the *Proceedings* of the American Academy, Mr. A. W. Peters points out the important influence exercised by the particular salt contained in the water on the growth and normal action of free-living cells; cell division in the animalcule Stentor being both accelerated and modified in character by an excess of potassium chloride in a normal medium.

THE London County Council is to be congratulated on the issue, at the price of one penny, of a handbook to the collection in the Horniman Museum at Forest Hill, arranged as an introduction to the study of animal life. Although some of the words and sentences are perhaps a little too technical for the class who will use it, the book forms an admirable guide to the general principles of zoology, and is an honest attempt to put them in a popular guise.

WE have received the prospectus of what promises to be a very useful and interesting work, "The Animals of New Zealand," by Messrs. Hutton and Drummond. As it deals only with the air-breathing vertebrates of the colony and its coasts, the bulk of its contents will be devoted to birds. Another faunistic work on our table is the second part of the Boston Society's "Fauna of New England," containing the Batrachia, drawn up by Mr. S. Henshaw.

THE contents of the February number of the *American Naturalist* are restricted to four articles, of which three are devoted to the lower vertebrates. In the first, Prof. H. F. Osborn emphasises in popular language his views with regard to the classification of reptiles, in the course of which he urges the propriety of forming families on phylogenetic lines. He would, for instance, include the Eocene Hyracotherium in the horse family (Equidæ), while a closely allied contemporaneous genus is included among the tapirs. The early stages in the development of an American salamander (*Desmognathus fuscus*) form the subject of a communication by Prof. Wilder, while Miss Townsend discusses the histology of the light-organs of the fire-fly *Photinus marginellus*. Apparently the author accepts the view that the latter organs are modified fat-bodies. Finally, Mr. E. G. Mitchell points out the relation of the breathing valves in the mouths of bony fishes to the shape of the mouth itself.

A USEFUL summary of the metalliferous mining in Ireland has been contributed by Mr. G. H. Kinahan to the *Transactions* of the Institution of Mining Engineers.

WE have received the annual report of Mr. H. B. Kümmel, State Geologist of New Jersey. It includes accounts of floods, forest fires, and underground waters, and reports on iron, zinc and copper mining, and on the Portland cement industry.

WE have received the *Transactions* of the Geological Society of South Africa, vol. vi., parts i. to vi., a well illustrated and clearly printed volume, dealing, as might be expected, largely with the metalliferous and coal deposits, and also with petrological questions. Mr. J. P. Johnson contributes a paper on the discovery of implement-bearing deposits in the neighbourhood of Johannesburg. In high-level drift near Roodekop Farm he has found water-worn implements of quartzite of Eolithic type, much resembling those of the plateau gravel of the Thames basin. At lower levels, along the bottom of the Bezuidenhout valley, he obtained implements of Palæolithic type, the deposits being evidently of later date than the high-level drift. Elsewhere he has found implements of Neolithic type. In his opinion the facts indicate that "South Africa saw much the same evolution in the culture of its Stone age as did that of the Thames basin and the rest of Britain and Western Europe." The fossil flora of Vereeniging is treated of by Mr. T. N. Leslie, who, aided by the researches of Mr. A. C. Seward, gives revised lists of the plant remains from the Permo-Carboniferous strata.

THE Permian fossils of the central Himalayas are described by Dr. Carl Diener (*Mem.* Geol. Survey India, series xv., vol. i., part v., 1903). In previous parts of this volume, Nos. 2 to 4, the fossils obtained by the Geological Survey up to the year 1893 from the "Anthracolithic series" (Permian portion) were described. In the present work Dr. Diener deals with specimens collected during the years 1898–1900. Under this method the fossils are treated according to their stratigraphical horizon and locality. The localities include Chitichun, Malla Sangcha, the Lissar Valley, Byans, and Spiti. In Spiti the Anthracolithic system is divided into two groups separated by a great unconformity—the upper group is regarded as Permian, and the lower as of Upper Carboniferous age. In the Permian system, to which attention is now directed, two facies are recognised in the Himalayas, and these differ in lithological and faunistic characters. One facies is represented by the white and red limestones of Chitichun and Malla Sangcha, and it corresponds with the topmost zone of the middle Productus limestone of the Salt Range and with the Tibetan series. In the other facies, developed in the main region of the Central Himalayas, the Permian strata comprise dark shales and calcareous sandstones; the fauna is composed of cephalopods, lamellibranchs, gasteropods and brachiopods, while corals and Bryozoa are wanting, and the majority of the leading fossils are autochthonous species, none of which has been found outside the Himalayas. Only a small percentage of species is identical with Salt Range forms, and the affinities with the Tibetan facies are less distinctly marked.

THE account of the genus Diospyros, contributed by Mr. H. Wright to the *Annals* of the Royal Botanic Gardens, Peradeniya, constitutes a monograph of the Ceylon species. *Diospyros Ebenum*, which is the main source of ebony-wood in Ceylon, is found both in the dry and wet regions of the island, and is considered to be ready for felling when the tree has attained a breast-height circumference of 9 feet. The different species vary considerably in the colour of their heart-wood; in *D. Ebenum* the black heart-wood owes its colour mainly to chemical and physical changes of the materials stored in the elements of the wood, and to a less degree to a change in composition and colour of the cell walls. Considerable variation occurs also in the types of flowers, and in *D. Ebenum* the flowers may be diœcious, monœcious, or polygamous.

IN the *Proceedings* of the Royal Dublin Society, Dr. T. Johnson describes a fungal disease which was found upon the willows known as "black mauls" growing in osier beds in Connemara, and identifies the fungus as *Physalospora gregarina*, a member of the Sphæriaceæ. The willows were growing on poor and sour land, and owing to their impoverished condition were especially liable to the attacks of the fungus.

THE development of scientific investigation and methods in connection with the agriculture of the West Indies has been a prominent feature in the policy of Sir D. Morris, the Commissioner of Agriculture, and an instance of the valuable work which is being carried on is furnished by the reports on sugar cane experiments which have been conducted at Antigua and St. Kitts under the superintendence of Mr. F. Watts. The first part deals with the cultivation of selected varieties of canes grown in the same way as the ordinary crops on the estate. The Barbados seedling B. 208 again heads the list, both in the matter of providing the heaviest canes and producing the purest juice; at the same time it retains its excellent character as a ratoon cane. Another set of experiments, continuing the work of former years, deals with the question of manuring. The evidence is opposed to the value of artificial manures for plant canes when the land has been well prepared with pen manure, but for obtaining maximum crops with ratoons the addition of nitrogenous salts is necessary.

THE first part of vol. i. of the new series of the *Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne* has now been issued. Among other interesting contents may be noticed "Notes on Entomostraca Found at the Roots of Laminariæ," by Dr. G. S. Brady, F.R.S., and papers by Mr. Clephan on ancient Egypt, and by Mr. Alex. Meek on the fishes of the north-east coast.

THE seventieth annual report of the Bootham School (York) Natural History, Literary, and Polytechnic Society, a copy of which has been received, affords abundant evidence of the importance attached by the masters of this school to the development in boys of an interest in practical work in science and in open-air study of natural phenomena. The report should be seen by science masters in secondary schools where little is done to create and foster interest in personal observations of nature.

THE British Fire Prevention Committee has issued, as number eighty-one in its series of publications, a descriptive paper by Mr. Edwin O. Sachs on the fire at the Iroquois Theatre, Chicago, on December 30, 1903. The publication also contains the new theatre regulations at Chicago, and notes on constructional particulars by the U.S.A. National Fire Protection Association. It appears that the stage of the Iroquois Theatre was of the ordinary type with the usual wood equipment. The stage accessories, scenery, properties, &c., were of the ordinary highly inflammable character, and had been in use for a considerable time, which involved the usual fraying and high grade of inflammability. The electric arc lamps used on the stage were not properly enclosed or suitably protected, and the fire appliances and exits were equally unsatisfactory. Mr. Sachs, after reviewing the whole circumstances of the fire, gives a number of general conclusions which deserve attention. He insists that fire prevention on the stage—where the Iroquois fire originated—can only be obtained by suitable incombustible construction and equipment. The scenery, properties, and furnishings of the stage must be thoroughly impregnated, so that they do not catch or spread fire by any spark or flame. When it is remembered that this Chicago fire resulted in 572 deaths, it is not too much to demand that city authorities should make the best use of the means provided by science to prevent such outbreaks of fire.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE :—

June 1. 12h. Jupiter in perihelion.
5. Ceres in opposition to the Sun. Ceres mag. 7·4.
,, 14h. 13m. to 16h. 30m. Transit of Jupiter's Sat. III. (Ganymede).
8. 8h. Mercury at greatest elongation, 23° 46′ W.
9. 12h. 34m. Minimum of Algol (β Persei).
12. 9h. 23m. ,, ,, ,,
15. Venus. Illuminated portion of disc = 0·994, of Mars = 0·999.
18. Saturn. Major axis of ring = 41″·62. Minor axis = 9″·73.
19. 5h. Uranus in opposition to the Sun.
24. 11h. 55m. to 12h. 30m. Moon occults θ Libræ (mag. 4·3).
29. 17h. Venus in conjunction with Neptune, ♀ 1° 24′ N.

COMET 1904 *a*.—In No. 3947 of the *Astronomische Nachrichten*, Prof. Strömgren publishes a new set of parabolic elements, and a daily ephemeris extending from May 18 to June 19, for comet 1904 *a*. The following is taken from his ephemeris :—

12*h*. (*M.T. Berlin*).

1904		α h. m. s.	δ ° ′	log *r*	log Δ	Brightness
May 26	...	14 17 17	+58 9	0·4534	0·4033	0·72
,, 30	...	14 0 55	+58 4	0·4554	0·4136	0·68
June 3	...	13 45 51	+57 48	0·4576	0·4241	0·64
,, 7	...	13 32 15	+57 22	0·4598	0·4349	0·61
,, 11	...	13 20 8	+56 49	0·4621	0·4457	0·57
,, 15	...	13 9 27	+56 11	0·4644	0·4564	0·54
,, 19	...	13 0 10	+55 29	0·4668	0·4671	0·51

In No. 3946 of the same journal, Prof. Pickering reports that on a spectrogram taken with an objective prism at the Harvard College Observatory on April 16, the nearly continuous spectrum shows a slight increase of intensity at two points, the distribution of the light being the same as that recorded on a similar spectrogram of comet 1898 VII.

The comet was independently discovered by M. Lucien Rudaux at his private observatory at Donville (Manche) on April 16. Using a portrait lens of 4 cm. aperture, he photographed the region about the nebula M92 with an exposure lasting from 10h. 15m. to 10h. 45m. (Paris M.T.), about 4 hours before Mr. Brooks discovered the comet at Geneva (U.S.A.). On developing the plate he discovered an unknown nebulous patch to the north of the nebula, but cloudy weather prevented him from confirming his discovery (*Astronomische Nachrichten*, No. 3946).

THE STABILITY OF SOLAR SPECTRUM WAVE-LENGTHS.—In a paper published in No. 19 (1904) of the *Comptes rendus*, M. Hamy again refers to the apparent change of wave-length of the green cadmium line at λ 508, with the conditions under which the radiation is produced. He states that on increasing the temperature surrounding the vacuum tube from 295° to 310° C., the relative intensities of the single line and the doublet, referred to by Prof. Fabry (*Comptes rendus*, cxxxviii. p. 854), are considerably modified, so much so that the mean wave-length is appreciably altered.

He then suggests that a change of mean wave-length of this character may largely affect the stability of the wave-lengths of lines in the solar spectrum, because the conditions of radiation in the solar atmosphere are probably considerably modified during the various epochs of solar disturbance.

VARIABLE STAR OBSERVATIONS.—The variable star observations made at Rousdon by the late Sir Cuthbert Peek have been edited by Prof. H. H. Turner, and the work is now ready for press. At the meeting of the Royal Astronomical Society held on April 8, Prof. Turner stated that on subjecting the few available light curves to harmonic analysis, he found that the different harmonics appear to form a regular series. Another point of interest discovered was that on subjecting the sun-spot activity curve, obtained by plotting Wolf's numbers, to similar analysis, the coefficients fitted fairly well into the formulæ obtained from the Rousdon star variations if the sun-spot *maxima* be taken as corresponding to the variable star *maxima* (*Observatory*, No. 344).

PROVISIONAL RESULTS OF THE INTERNATIONAL LATITUDE SERVICE.—Prof. Albrecht publishes in No. 3945 of the *Astronomische Nachrichten* the provisional results obtained by the International Latitude Service during 1903–4. From a diagram and a table, which show the variation of the momentary pole from the position of the mean pole, it is seen that the amount of this variation increased during 1903, and is now probably near its maximum value.

THE TISSUE-LYMPH CIRCULATION.[1]

After paying a warm tribute to the memory of his teacher in physiology, the late Prof. Sharpey, F.R.S., the lecturer proceeded.

I propose to submit to you the results of a study on the circulation of the tissue fluid in man, or, in other words, on the fluid transfers between the blood and the tissues. Apart from its intrinsic physiological interest this subject has important bearings on the practice of medicine.

Some of the conclusions suggested to me by this inquiry were so unexpected that I was naturally led to repeat my observations in every department of it over and over again, and to scrutinise all the facts with more than ordinary diligence. More than 3000 observations have been made in health and disease, but I propose in these lectures to use mainly the physiological material.

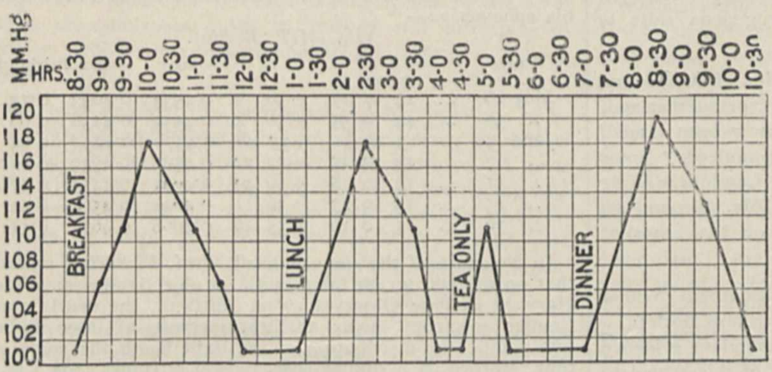

Fig. 1.—Chart showing rise of arterial pressure after food.

Methods and Apparatus.

[Dr. Oliver here described the methods and apparatus employed with certain improvements in the hæmocytometer, hæmoglobinometer, and hæmodynamometer.]

The Effect of the Ingestion of Food on the Tissue-lymph Circulation.

Elsewhere[2] I have shown that the ingestion of food initiates an interesting series of variations in the blood and blood pressures which culminates in a prolonged wave-like exudation of tissue-lymph, and that this excitation in the circulatory system recurs with perfect regularity after each meal. Subsequent inquiry has amply confirmed this position.

The digestive variations in the blood pressure.—The ingestion of food invariably raises the arterial blood pressure (Fig. 1). In an hour after a meal it rises 15 or even 20 millimetres of mercury, then it begins to fall, and in from two and a half to three and a half hours it becomes stationary until the next meal or until exercise is taken. The curve of the venous pressure rises and falls throughout with that of the arterial pressure. It may, I think, be inferred from these facts that the capillary blood pressure follows the same curve after meals, for we know that this pressure is more closely related to the venous than to the arterial, and that if both these pressures rise or fall together we may fairly assume that the capillary pressure will also rise or fall. After food the pulse-rate also increases, and in an hour it may have gained from eight to fifteen beats a minute. When the pulse pressure gauge is applied so as to arrest the pulsation of the radial artery (the finger being used as the indicator), the reading becomes cardiometric, and is generally increased in an hour after a meal from 15 to 20 millimetres of mercury. Therefore it would seem that digestion very considerably stimulates the heart, augmenting the output and the contractile energy of the ventricle.

The essential aim of the digestive excitation of the circulatory system is to raise the capillary blood pressure, and according to my observations this end is attained by the increased activity of the cardiac muscle. But it can likewise be secured by taking with a meal some substance which dilates the arteries and arterioles, and thus lowers the arterial pressure; then the venous pressure is greatly increased, and the capillary pressure must be raised, being between two pressures higher than the normal capillary pressure.

We may therefore infer that we may have a rise in the capillary pressure either with an increase or a decrease of the arterial pressure according as we have cardiac stimulation (as after meals) or vaso-dilation.

Digestive Variations in the Blood.

I have followed three series of alterations in the blood during digestion, namely, in the corpuscles, in the hæmoglobin, and in the specific gravity. As the variations in the chromocytes and in the hæmoglobin are identical, they are taken together.

Digestive variations in the corpuscles and haemoglobin.—The finger, having been subjected to the compression of the rubber rings, yields blood which shows a progressive rise in the percentages of the corpuscles and of the hæmoglobin until an hour has elapsed, when the increment amounts to from 8 to 10 per cent.; then the percentages gradually fall, and they finally settle down to normal in from two and a half to three and a half hours (Fig. 2, A). Should, however, the blood be derived from the finger in the ordinary way (without compression), the successive readings of the blood elements indicate a progressive fall in the percentages, which in an hour amounts to from 6 to 8 per cent., when a rise sets in and recovery is eventually established (Fig. 2, B).

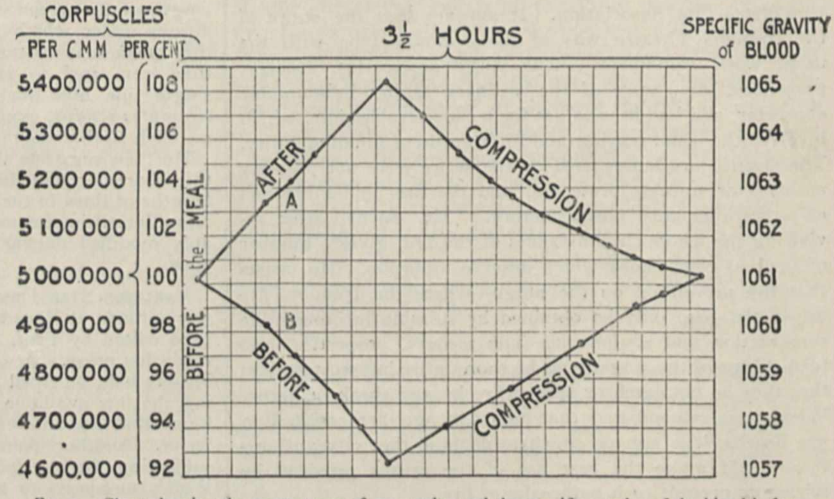

Fig. 2.—Chart showing the percentages of corpuscles and the specific gravity of the blood before and after compression. Observations made before a meal and at frequent intervals afterwards.

Digestive variations in the specific gravity of the blood.—The blood, as shown by compression of the finger, rises in

[1] Abstract of the Oliver-Sharpey Lectures on Recent Studies on the Tissue-lymph Circulation, by Dr. George Oliver. Delivered before the Royal College of Physicians of London on April 12 and 14.

[2] *Proceedings* of the Royal Society, June 11, 1903; *The Lancet*, October 3, 1903, p. 940; and the *Journal* of the British Balneological and Climatological Society, 1903.

specific gravity after meals, the rise reaching its maximum point (*e.g.* from 1061 to 1065) in an hour. The specific gravity then begins to fall, settling down to the initial point at the conclusion of the wave-like disturbance (Fig. 2, A). On the other hand, the blood derived from the finger uncompressed affords a specific gravity which follows the contrary course, that is to say, it falls and then rises (Fig. 2, B). When the digestive disturbance is over, the variations in the blood, like those in the circulation, cease, and the readings in normal subjects at rest continue to be alike in both samples (before and after compression) until the following meal.

The digestive exudation of tissue lymph.—On reviewing the foregoing data it is obvious that they indicate strictly concurrent events. All the four series of variations follow exactly the same curve. What is the link which binds them together? If we suppose that the ingestion of food in some way raises the capillary blood pressure which exudes a filtrate of a portion of the liquor sanguinis into the areolar spaces, all the changes in the blood which I have described will naturally follow (see Fig. 2). In proportion to the exudation under a rising capillary blood pressure, the blood will become more and more concentrated in chromocytes and in hæmoglobin, and inasmuch as its specific gravity mainly depends on the corpuscles, the density of the blood will rise *pari passu* with the increased concentration. Then, when the capillary pressure begins to fall, as it does after the acme of the digestive disturbance has been attained, the concentration of the blood diminishes, and we may assume that either absorption of the watery elements of the effused lymph overbalances exudation or that the effusion is being returned by the lymphatics to the blood. Now I have shown that none of these alterations in the blood could have been ascertained by the examination of blood derived from the finger in the ordinary way; they only become apparent after the compression of the tissues by the rubber rings, which removes the extra-capillary fluid and enable us to obtain the blood undiluted by that fluid. But the progressive readings of the ordinary samples of blood, though valueless, and actually misleading when accepted as independent testimony of blood changes during digestion, become instructive when compared with the readings of samples obtained after compression, for they then afford a measure of the amount of fluid withdrawn from the blood. The differential readings of the hæmocytometer tubes made every fifteen minutes after a meal show the greatest divergence, and therefore the largest quantity of tissue fluid, just at the time (an hour after a meal) when the digestive blood pressure wave and the concentration of the blood attain their maximum development. The difference, indicated by the scale on the tubes, will amount to from 15 to 20 per cent.; it will then gradually diminish, and will finally disappear in from two and a half to three and a half hours, and will not reappear until after the next meal or until exercise is taken. The amplitude and duration of the lymph wave are influenced by various conditions, such as the tone of the subject, the bulk and nature of the meal, the use of beverages, rest, or exercise.

Other rhythmical digestive variations.—I will now direct your attention to other physiological variations produced by the ingestion of food, synchronous with the foregoing. These are:—(1) the digestive curve of augmented respiratory exchange determined by Fredericq and other observers; (2) the gastric juice curve of Pawlow; and (3) a digestive rhythmical variation of muscular contractility, which came to light while studying the effects of muscular tension on the arterial pressure. It was found that when tissue-lymph was not apparent (*e.g.* before meals), the tension raised the arterial pressure to a maximum degree (*e.g.* 40 mm.), whereas when the lymph was fully effused (an hour after a meal) the pressure could only be slightly raised (5 or 10 mm.). The digestive curve of muscular contractibility (*i.e.* the capability of being contracted) is therefore the reverse of the lymph curve, and it is inferred that the exudation of the lymph into the muscular tissue checks the shortening of the muscular fibres, and thus diminishes the effect of their contraction on the intra-muscular vessels.

These observations on the condition of the muscles during digestion, therefore, confirm the teaching as to the outflow and absorption of lymph furnished by the differential examination of the blood. At the termination of the digestive disturbance there is apparent a gain in the contractile energy, as expressed in an additional rise of the arterial pressure produced by muscular tension. This gain (which only becomes evident after the absorption of the lymph) varies from 5 to 20 millimetres, according to the nature of the food consumed and the need for recuperation.

The effects of typical meals on the digestive lymph flow.—Let us now study the digestive curves of lymph exudation produced by four different kinds of meals. First, the ordinary mixed meal containing the usual proportions of animal food, vegetables, and farinacea; secondly, the meat meal, consisting of animal food in various forms, with cheese and butter and a very little toast; thirdly, the vegetable meal, with farinaceous puddings, fruit, and cheese; and fourthly, the milk meal, milk, bread, and farinaceous puddings. In each case the fluid supplied was a tumbler of water, and the amount of food was merely limited by a feeling of satisfaction. Sugar and salt (two grams of each) were taken in the same quantity at all the solid meals. The meal was at one o'clock, and the same subject was throughout submitted to observation. No exercise was permitted for an hour before and after meals, nor until the digestive disturbance had quite subsided. Observations were made just before the meals and every fifteen minutes after them. The results are epitomised in the following table (Table I.):—

TABLE I.

The meal	Lymph effusion	
	Maximum per cent.	Duration hours
Roast meat	30·0	5
Mixed	17·5	3
Vegetable	12·5	3
Milk	7·5	1½

You see that the lymph curves produced by these several kinds of meals vary enormously in amplitude and length, and in the following descending order:—meat meal, ordinary meal, vegetable meal, and milk meal. The net gain in muscle contractility shown by the tension test after the subsidence of the digestive disturbance and the removal of the lymph is in the same order, expressed by the following figures:—15 (meat meal), 10 (ordinary meal), 7 (vegetable meal), and 3 (milk meal). Some light will be thrown on these results by studying the effect of the separate food elements.

The effect of the food elements on the production of tissue lymph.—I will first mention those substances which, according to my observation, do not alter the blood pressure or cause the flow of tissue lymph:—cold water, starch, fats, gelatin, proteid as represented by myosin or egg-albumin, the sugars (cane sugar, glucose, maltose, galactose, mannose, dextrose, and inulin), pepsin, and hydrochloric acid. Cold water (*e.g.* 500 cubic centimetres, or a little more than 16 ounces) has no effect, but the same amount of warm water lowers the arterial pressure. This is therefore a temperature effect. In regard to proteids, I selected chemically pure myosin (muscle proteid) and white of egg as representative of the group. So far their effects have been negative. In support of this conclusion we have also the fact that the lymph exudation produced by a meal of roast beef is 30 per cent., whereas that caused by a meal of boiled meat is only 7 per cent. All the sugars named also produce negative results. There are, however, other sugars (glycogen, lævulose, and lichenin) which have been found decisively to affect the blood pressure and the flow of lymph.

Inorganic salts.—I will here only refer to sodium and potassium chlorides, as my observations on the effects of other salts are not sufficiently advanced for publication. Sodium chloride, in percentages varying from 1·5 to 2·0, invariably raises the arterial pressure and increases the outflow of tissue lymph; four grams produce in thirty minutes the exudation of 15 per cent. lymph, which is completely absorbed in thirty minutes more. Potassium chloride lowers the arterial pressure, four grams producing a fall of from 10 to 12 millimetres of mercury. Sodium chloride increases and potassium chloride diminishes the digestive curves. When these two salts are taken in equal proportions—*e.g.* two grams of each—their effects on the blood pressure and lymph flow neutralise each other.

Muscle extractives.—The lymph exudation produced by home-made beef-tea, derived from half a pound of beef infused first in cold water and then in hot, is similar in amplitude to that of a meat meal (see *supra*), only it is of shorter duration. Two well known beef extracts, selected out of several as typical of the rest, gave a somewhat smaller amount of lymph exudation, the quantities taken being those directed by their proprietors. No salt or other seasoning was added to the preparations. The following products derived from muscles have been administered, dissolved or suspended in six ounces of cold water:—creatin, creatinin, xanthin, hypoxanthin, uric acid, carnin, and glycogen.

[Dr. Oliver here described how the matter of dosage was settled.]

The doses thus worked out may seem to the experimental physiologist to be absurdly small, but the uniform results obtained in different subjects showed that it was not necessary to experiment with larger quantities. My observations show that uric acid (either as uric acid or as ammonium urate), xanthin, creatinin, carnin, and glycogen produce a decided rise in the blood pressures (arterial, capillary, and venous) and increase the exudation of tissue lymph, the pressure and the exudation rise being proportionate to each other. This effect from ingesting glycogen was quite unexpected. The accompanying table gives the doses, the maximum lymph exudation and arterial pressure, and the duration of these effects.

TABLE II.

	Maximum rise: Lymph per cent.	Maximum rise: Arterial pressure mm. Hg	Duration of effect in minutes
Carnin, gram 0·0325 (½ grain)	15	115	30
Creatinin, gram 0·0325 (½ grain)	14	114	30
Glycogen, gram 0·0325 (½ grain)	6	106	23
Ditto, gram 0·13 (2 grains)	20	120	90
Uric acid, gram 0·0325 (½ grain)	17	117	85
Ammonium urate, gram 0·13 (2 grains)	25	125	110
Xanthin, gram 0·0325 (½ grain)	20	120	105

A long latent interval (about twenty minutes) elapsed after swallowing uric acid or ammonium urate and xanthin before any effect on the blood pressure was apparent, a fact which may be accounted for by the low solubility of these products, which, however, produced effects more decided and more prolonged than those which followed the other products. Creatin and hypoxanthin differ from the other allied products in their effects on the arterial pressure. Creatin produces at first a fall which is followed by a rise, and hypoxanthin causes a marked fall in the arterial and an equally decided rise in the venous pressure.

When xanthin is combined with it in equal parts, the blood pressures remain unaltered. In like manner when creatinin is taken with creatin (equal parts) the preliminary fall of arterial pressure produced by creatin fails to appear, and the effects of the two agents balance each other for twenty minutes, after which the rise of creatinin combined with the ultimate rise of creatin take their normal course. All the muscle-derived products raise the capillary blood pressure, increase the exudation of tissue lymph, and are cardiac stimulants.

The active principles contained in beverages.—Allied to most of the foregoing products in their chemical constitution and physiological action on the blood pressure and lymph circulation are the active principles of tea, coffee, and cocoa, caffein and theobromin being methylxanthins, the former being called tri- and the latter di-methylxanthin. They are therefore bodies with a purin basis (C_5N_4), and, like most of the other purin bodies, they raise the blood pressure in a long, well sustained curve, with an accompanying wave-like exudation of tissue lymph, and they are also like the other purins in being cardio-stimulants.

The effects of alcohol on the blood pressure and lymph circulation are modified very considerably by the presence of other constituents in spirits, wines, malt liquors, &c. The arterial pressure curve of absolute alcohol at first falls and then rises, the fall below the normal being equivalent to the rise above it. It therefore resembles that of creatin, and differs from that of xanthin, uric acid, creatinin, and glycogen.

Whisky follows the compound curve of absolute alcohol; brandy, wines, and beer conform to the simple curve of the bodies just mentioned, and gin follows the curve of hypo-

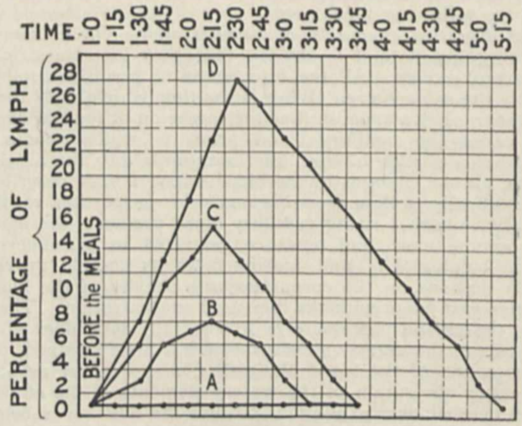

FIG. 3.—A, lymph record from purin-free meal. B, purin-free meal with sodium chloride 2·0 grams. C, purin-free meal with sodium chloride 4·0 grams. D, purin-free meal with sodium chloride 2 grams and uric acid 0·016, creatin 0·033, creatinin 0·033, xanthin 0·016, hypoxanthin 0·016, and glycogen 0·048.

xanthin, this marked difference being due to the juniper it contains.

I conclude from the foregoing data that caffein, theobromin, and the alcoholic beverages (but more especially brandy, wines, and malt liquors) excite the flow of tissue lymph like the purin and the other products previously mentioned.

HOW IS THE DIGESTIVE EXUDATION OF TISSUE LYMPH PRODUCED?

We are led by the foregoing data to the following conclusions:—(1) That the food constituents themselves (proteids, fats, and carbohydrates) do not possess the power of starting the mechanism by which lymph is dispensed to the tissues throughout the body. (2) That nature, however, associates with our food-stuffs small quantities of certain very active substances which bring into play that mechanism, though these substances themselves are practically devoid of food value; and that man frequently increases this natural lymph stimulation by the use of salt and beverages containing bodies which also incite the flow of lymph.

But let us put this matter to the test of experiment. It is possible to arrange a meal containing a fairly large quantity of nutrient elements in such a way that it will not react on the circulation at all, and will not induce the flow of tissue lymph. Such a meal consists of three or more eggs, a full supply of white bread, boiled rice or tapioca, cream, sugar, and cheese, with a tumbler of cold water. I have taken this meal several times with the feeling of repletion, and yet it has not produced a rise of blood pressure or the slightest flow of tissue lymph.

In Fig. 3 A shows the negative effect of this meal on the tissue lymph; B and C indicate two exudations produced by adding two and four grams of sodium chloride to the meal; and D is a voluminous lymph wave resulting from the addition of a mixture of the following products with two grams of salt:—uric acid, 0·016 gram; creatin, 0·033 gram; creatinin, 0·033 gram; xanthin, 0·016 gram; hypoxanthin, 0·016 gram; and glycogen, 0·048 gram. The meal produced a much more refreshing and sustaining effect when the digestive lymph flow was excited by the addition of salt, and more especially by that of salt associated with the physiological products than when taken alone.

EXERCISE.

The fundamental effects of exercise on the blood pressure may be readily studied in an epitomised form by placing the pad of the hæmodynamometer over a small superficial artery, like the superficialis volæ, and then throwing all the muscles into a state of tension for sixty seconds (the arm on which the observation is made being excluded from the contraction). In Fig. 4 you observe that the complete arterial pressure curve of muscular contraction is made up of two elevations, (A) primary and (C) secondary, separated by a fall (B) which is just as decidedly below the normal pressure as the second rise is above it. The first elevation (A) is synchronous with the tension, and the second (C) appears after the muscles are relaxed.

Now these oscillations of the arterial pressure are all seen on a larger scale in ordinary exercise, each stage being, of course, prolonged in proportion to the duration of the exercise. The primary rise is invariably followed by a gradual fall, even during the continuance of the exercise, and by a rapid and decisive fall on its cessation, and that fall is succeeded during rest by a second rise.

Sir Lauder Brunton and Dr. Tunnicliffe are, I believe, the only observers who have furnished trustworthy data on the blood pressure in man, both during muscular movement and immediately after its cessation, and their data accord with my own.[1]

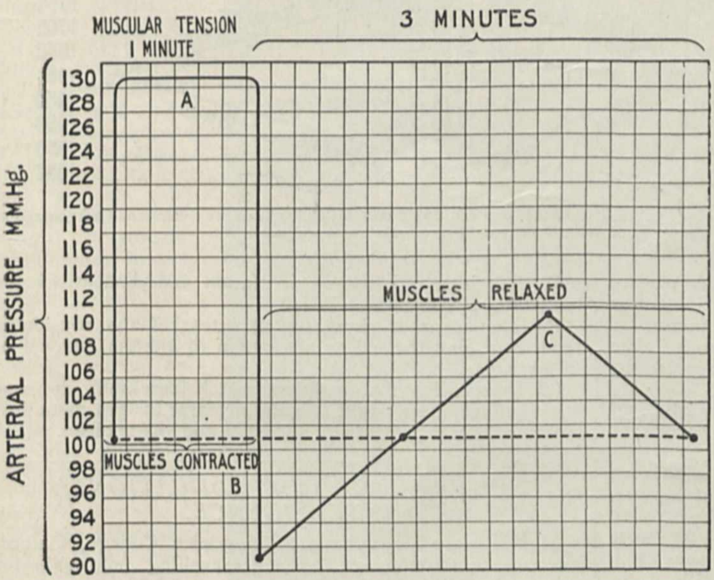

FIG. 4.—The effect of muscular tension on the arterial pressure; (A) rise from muscular tension; (B) fall on relaxing the muscles; (C) secondary rise during rest.

The secondary rise of blood pressure which I have invariably found to supervene during rest after exercise does not, however, seem to have been recognised by other observers.

Exercise invariably increases the exudation of tissue-lymph. Inasmuch as it is rapidly absorbed on the cessation of exercise, the observation must be made without delay.

How are these effects of exercise produced? According to Ludwig and Gaskell (Ludwig's "Arbeiter," 1877), during a short tetanus the flow from the efferent vein of the muscle, after the first spurt of blood, may fall to practically *nil*. Therefore we may infer that muscular contraction causes partial or temporary occlusion of the intra-muscular vessels, and that this increase of peripheral resistance, along with reflex cardiac stimulation, will go far to explain the rise in the arterial pressure.

At the same time, the capillary pressure within the muscle will fall, and lymph will not be exuded. But the state of the circulation is different in the non-muscular parts, for all the blood pressures (arterial, capillary, and venous) are markedly raised during the sustained tension of the muscles. Hence the effusion of lymph in the finger. On the other hand, when the contraction ceases, the intra-muscular capillary pressure will rise, and lymph will then be effused into the muscles. That the muscles when relaxed after contraction become full of blood is shown by the work of Ludwig and his pupils, and by Sir Lauder Brunton and Dr. Tunnicliffe, who have furnished graphic evidence of the dilatation of the intra-muscular arteries which follows contraction (*op. cit.*).

As after food so after exercise the contractibility of the muscles (as indicated by the tension test) diminishes in proportion to the amount of lymph effused.

Exercise likewise provides us with some instructive facts as to how tissue-fluid is removed. Observation has shown that a short muscular contraction of sixty seconds will produce two effusions, one during the contraction which is entirely absorbed in sixty seconds, and another which is immediately afterwards thrown out, and disappears just as quickly, so that in four minutes we have two successive effusions which entirely clear up. The rapidity with which lymph disappears from the tissues in a state of rest certainly favours the notion of absorption rather than that of transmission along the lymphatics. Now, experimentation on animals has shown that muscular action of some kind is necessary to ensure a flow of lymph along the lymphatics, so we may conclude that during exercise the muscular action will more particularly favour that passage for the lymph.

FATIGUE.

Observation has shown that the rise in the arterial pressure produced during the continuance of exercise becomes less and less pronounced in proportion to the duration of the exercise; for example, the initial increase of from 15 to 20 mm. gradually subsides until, after the lapse of a certain time (which varies with the tone of the individual and with the external temperature), the arterial pressure will not exceed 100 mm. Hg, and if the exercise is further continued it will even fall lower, to 95, 90, or 85 mm. This point was also observed by Sir Lauder Brunton and Dr. Tunnicliffe.

Why should the rise of pressure, normally induced by exercise, be effaced or even replaced by a fall when exercise is prolonged?

Inasmuch as the lymph exuded during exercise obstructs the contractile pressure of the muscular fibres on the intra-muscular arteries and arterioles, the peripheral resistance caused by exercise will be reduced, and the arterial pressure will gradually fall. In fatigue, no amount of will exerted over the muscles can raise the arterial pressure at all; the muscles, though capable of ordinary contraction, become, as it were, lymph-logged. But massage quickly disperses the lymph, and the contractibility is restored. Human instinct, without knowing the "why," practised what is now taught by physiological inquiry. We read in the "Odyssey" how the women rubbed and kneaded their weary heroes returned from battle, and thus invigorated them, and we know that from time immemorial rubbing was the sovereign remedy for fatigue.

The physiology of fatigue includes another important factor, namely, diminished gravity control over the blood pressure. The outcome of exercise is the production of hypotonia in the vaso-motor mechanism, which is the central fact, as it were, of fatigue.

REST.

During rest after exercise there is developed a steady and persistent rise of the blood pressures and a corresponding effusion of lymph, and the volume and duration of this second outflow of lymph are always proportionate to the vaso-dilator or reducing effect of exercise. The physiological intent of it is to repair and recharge the muscles,

[1] "Remarks on the Effect of Resistance Exercises upon the Circulation in Man, Local and General," by Sir Lauder Brunton and F. W. Tunnicliffe, M.D. (*Brit. Med. Journ.*, October 16, 1897.)

for after the lymph is absorbed the contractibility is always found to be restored. How are the muscles thus automatically renovated without food? It seems highly probable that the reparative lymph exudation which follows exercise is produced by the agency of chemical substances generated by muscular contraction, just as the digestive lymph flow is caused by exogenous lymphagogues. Creatin and lactate of ammonium produce the double curve of arterial pressure induced by exercise and rest.

Sleep.

A large volume of lymph (not less than 20 per cent.) is exuded into the somatic tissues during sleep.

In sleep the arterial pressure falls very low (from 78 to 82 mm. Hg) and the venous pressure rises to a high point (40 to 50 mm. Hg). There is complete physiological vaso-motor relaxation, consequently the veins not only of the somatic, but of the splanchnic area are filled with blood. The splanchnic stasis is shown by the fact that when a weight (a shot bag of 14 lb.) is applied to the abdomen, the arterial pressure is raised at once from 80 to 100 mm. Hg. In a few minutes, however, when the subject is fully awake, the arterial pressure rises to 95 mm. Hg or so, the venous pressure falls to 15 or 20 mm. Hg, the shot bag no longer raises the arterial pressure, and the effused lymph of sleep, having become absorbed, is no longer apparent.

What is nature's intent in thus supplying the tissues so liberally with lymph during our sleeping hours? The answer admits of no doubt—restoration; and how true to fact is the old proverb, "He who sleeps, dines"! For during sleep nature provides the maximum amount of tissue-lymph, which we only obtain intermittently after meals. Can this be proved? The answer is provided by the tension test.

[Dr. Oliver here epitomised the results of a night and morning record, demonstrating in figures the restorative power of sleep.]

[The effects of gases (oxygen, carbonic acid, sulphurous acid, sulphuretted hydrogen, and the atmosphere of sewers), of gravitation, of temperature, and of internal secretion (supra-renal, thyroid) on the tissue-lymph circulation were described, and the vexed question as to whether tissue-lymph is a secretion or a pressure product was discussed.]

Is there an intermediary circulation?—The rapid removal of lymph from the tissues when the muscles are at rest, for example, after exercise and on awaking from sleep, suggests absorption rather than transmission by the lymphatics. Therefore I think there is evidence in support of a circulation of fluid independent of the lymphatic circulation, though controlled by the capillary circulation, of which it may be said to be an extension.

There is not time to discuss the forces involved. The best account of them, as at present known, is that given by Prof. Starling, of University College, than whom no one has done more valuable work in support of Ludwig's pressure theory (Schäfer's "Text-book of Physiology," vol. i.). Ludwig pointed out that the prime factors in the effusion of lymph are filtration and diffusion. My observations refer only to filtration, and they suggest such a scheme of the intermediary circulation as is represented in Fig. 5, which shows the mechanism, as it were, for the supply of pabulum to the tissues (AA) and for the removal of soluble waste from them (BB). The view there represented explains why the ingestion of food restores the tissues at once, and long before the food itself can be assimilated into the blood. The exhausted tissues have not, therefore, to remain unsupplied until the food becomes part of the common store of pabulum, which the blood keeps ready for distribution. Each supply of food may be viewed as a deposit paid to our banking account, but it is not merely a deposit, for nature combines with it a cheque for payment; the banker therefore is compelled to reimburse at the same time that he receives, so that the balance is kept fairly uniform.

In normal subjects each effusion of tissue-lymph is intermittent, rising out of and subsiding into an apparently lymph-free state of the tissues when the capillary blood-pressure (as indicated by the venous pressure) touches its minimum point. Probably at such times some trace of tissue fluid is actually present, but insufficient to be made apparent by the ordinary use of the differential test.

[Some practical deductions were here drawn, and new remedies suggested by the inquiry were described.]

There is much more work to be done, but meanwhile let me summarise a few provisional conclusions:—

(1) Tissue-lymph is intermittently effused, for example, after the ingestion of food, during exercise, rest after exercise, and during sleep.

(2) The rapid effusion and removal of it in states of rest suggest the existence of a circulation between the blood and the tissue spaces—a circulation independent of the lymphatic circulation.

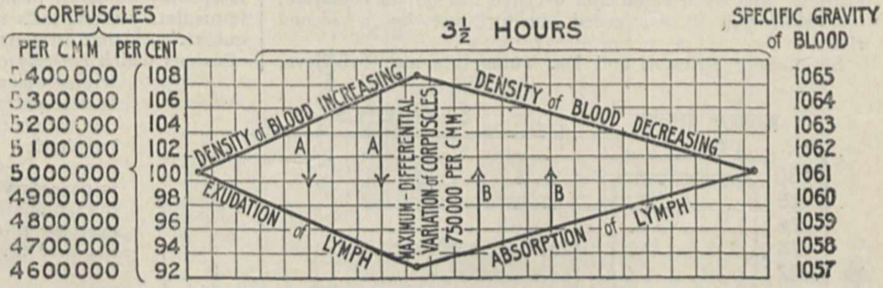

Fig. 5.—Schema showing (AA) exudation of lymph conveying proteids and salts to the tissues and (BB) absorption of tissue fluid containing soluble waste and salts.

(3) The apparent physiological intent of the effusion is reparative, and that of its absorption to aid the removal of tissue waste.

(4) By studying the conditions which increase or decrease lymph effusion, we ought to gain a clearer insight as to how to control derangements of nutrition and metabolism.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. Hubert M. Turnbull, Magdalen College, Oxford, has been elected to a Radcliffe travelling fellowship for three years.

The Rede lecture at Cambridge will be delivered on June 11 by Dr. J. A. Ewing, F.R.S., upon "The Structure of Metals."

Dr. F. G. Donnan, lecturer in chemistry in the Royal College of Science, Dublin, has been elected to the chair of physical chemistry recently founded by Sir John T. Brunner in the University of Liverpool.

The *British Medical Journal* states that the new medical laboratory of the University of Pennsylvania is to be opened on June 30. Exclusive of site and equipment, the building has cost nearly 140,000*l*. It is the first of a group of buildings it is proposed to erect, which when completed will, it is hoped, form the largest system of buildings devoted to the teaching of medicine in the world.

As a general result of the various movements in recent years to establish a centre of veterinary education in Liverpool, it has been arranged, we learn from the *Times*, that Prof. Williams, of the New Veterinary College, Edinburgh, shall transfer his teaching centre to Liverpool and take up the professorship of veterinary medicine and surgery offered by the Institute of Comparative Pathology, and shall act as principal or dean of the veterinary school. Prof. Williams will be placed upon the same footing as professors in the university, and the cost of the professorship has been privately guaranteed for a period of years. In accordance with a scheme drawn up five years ago by the professors of pathology, physiology, zoology, and botany, veterinary students will be taught in their respective laboratories, and will enjoy, without increase of fees, all the facilities possessed by medical and science students. They will, in addition, have the advantage of the Tropical Medicine, Cancer Research, and Comparative Pathology Schools. This arrangement will provide for the scientific training of the veterinary student upon a scale equal to that of the medical student.

AT the concluding meeting of the session 1903–4 of the Architectural Association, Mr. A. E. Munby read a paper on the value of science in an architectural curriculum, in which he urged that science should receive more attention from architectural students. He mentioned some interesting particulars as to the number of hours per week devoted to science by students studying in architectural courses in the great technical schools of the world. To give a few examples, Mr. Munby stated that the architectural student at McGill University devotes 7·9 hours a week to science classes; at University College, London, 6·8; at Glasgow Technical College, 5·3; at the University of Illinois, 4·9; and at the Technischen Hochschule, 2·5. To conclude his paper, Mr. Munby made suggestions as to the subjects of science an architectural student should study at the outset of his career. These should include, he thought, a general experimental course on physics, including laboratory work; a similar course dealing with the elements of inorganic chemistry; and a short course outlining the principles of geology and dealing with the stratigraphical arrangement of rocks and with petrology. The whole of this work might be undertaken by a person of average intelligence at the age of, say, sixteen, and completed in one year with some twelve hours' teaching per week.

IN connection with the recent opening of the new buildings, extending the South-Western Polytechnic at Chelsea, the heads of the electrical and mechanical engineering departments have prepared a pamphlet describing the aims and equipments of their respective laboratories. In these laboratories two classes of students receive instruction, viz. those who attend the engineering day courses and those who form the evening classes. The standard of the courses extends far enough to include preparation for the engineering degree of the University of London, and attention is given to the requirements of candidates for the associate membership of the Institution of Civil Engineers. But no particular syllabus is followed, and students are able easily, if necessary, to take other public examinations in engineering. So far as funds have permitted, an attempt has been made to provide in the mechanical engineering laboratory more than one type of some pieces of apparatus, in the belief that the range of experience thus gained by a student is of value, while such a variety enables a number of students to be less thickly distributed over the apparatus. Many of the larger pieces of apparatus have not been specially designed for experimental purposes, but are ordinary standard commercial machines which have been fitted with the necessary measuring appliances by students and the workshop instructor. The electrical engineering laboratories are divided into three principal rooms—the large laboratory where the testing of electrical instruments and the measurement of electrical quantities are carried out; the dynamo room where the experiments and investigations on dynamos and motors are conducted, and the "advanced" laboratory where the standard instruments are kept and used for calibrating the instruments used in experimental work, and where the more advanced alternating and polyphase current experiments are made. In addition to these rooms, there are two rooms fitted up for photometric tests on incandescent and arc lamps respectively. There is also a large wiring shop for instruction in practical wiring and jointing, and two workshops for repairing and making apparatus for the electrical laboratories. There are in all six steam engines specially fitted up for experimental work. Recently, when the electric lighting plant had to be duplicated, advantage was taken of the opportunity for fitting the new engines with measuring appliances, so that experiments could be carried out on them whenever desired. The plant available permits of the setting aside of either of the new engines for experiment, or the unit experimented upon can be made to provide electrical energy for lighting the building (Fig. 1). The pamphlet contains a full description, with illustrations, of all the more important pieces of apparatus in both departments of engineering.

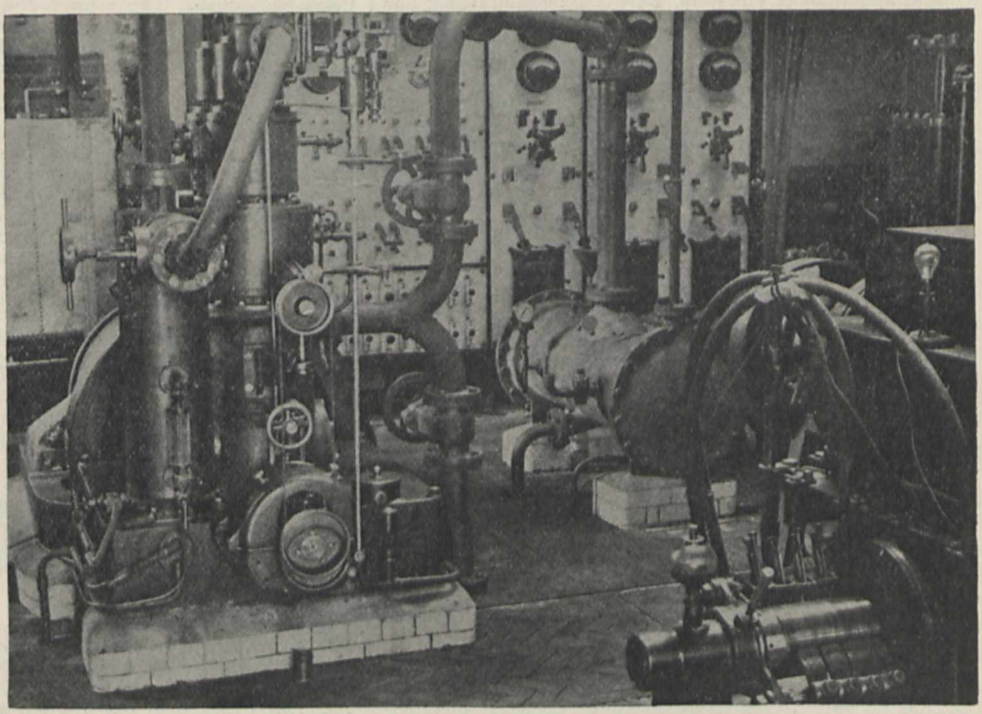

FIG 1.—Main Lighting Plant of the South-Western Polytechnic.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 28.—"The Effects of Changes of Temperature on the Modulus of Torsional Rigidity of Metal Wires." By Dr. Frank **Horton.**

An account of some experiments performed at the Cavendish Laboratory with the view of ascertaining as accurately as possible the manner in which the modulus of torsional rigidity varies with the temperature. The metals experimented on were copper, iron, platinum, gold, silver, aluminium, tin, lead, cadmium, all chemically pure, and also specimens of commercial copper and of steel pianoforte wire. A dynamical method of experimenting was employed, the torsional oscillations of the wire under test being timed by a method of coincidences capable of great exactness. The method of coincidences is usually only applied to the comparison of two nearly equal times, but it is shown to be equally applicable to any two periods, even if they are quite different. Observations were made, in general, at five temperatures, viz. at the temperature of the room, about 16° C., at 35° C., 55° C., 75° C. and 100° C., and also in some cases at 126° C., the higher temperatures being obtained by using the vapours of various liquids boiling under atmospheric pressure. The coefficients of expansion of the wires used (which are required in order to compare observations at different temperatures) were determined by means of the measuring bench in the physical laboratory of the University of Birmingham. The internal viscosities of the wires, and the effect of increased amplitude of vibration, were also investigated. The main observations for the rigidity determinations were all taken at an average amplitude of fourteen minutes.

The following is a summary of the principal results:—

(1) In all the materials examined, with the exception of pure copper and of steel, the modulus of rigidity at one temperature is not constant, but increases as time goes on.

(2) The diminution of the modulus of rigidity per degree rise of temperature between 10° C. and 100° C. is constant for pure copper and for steel, but not for any of the other materials examined.

(3) In general, the effect of heating to a high temperature is to increase the value of the rigidity modulus at lower temperatures.

(4) The internal viscosity of all the metals examined, with the exceptions of soft iron and steel, increases with the temperature. The internal viscosity of soft iron decreases rapidly with rise of temperature, and reaches a minimum value at about 100° C. There is a slight decrease also in the case of steel.

(5) Repeated heating and continued oscillation through small amplitudes decrease the internal friction.

(6) Both the internal friction and the period of torsional vibration increase with the amplitude of oscillation.

(7) Vibration through a large amplitude considerably alters both the logarithmic decrement and period of oscillation at smaller amplitudes.

(8) The internal viscosity of a well annealed wire suspended and left to itself gradually decreases.

"On the Sparking Distance between Electrically Charged Surfaces." By Dr. P. E. **Shaw.**

Recent investigation (1901) on this subject has been made by R. F. Earhart, who used voltages from 1000 to 38, the corresponding distances being from 100 microns to ¼ micron. In the present paper the voltages range from 150 to ¼, and the distances of discharge from 1 micron to 1/500 micron. The instrument used to measure these small distances is the electric micrometer, which works on the principle of electric touch, and is therefore specially suitable to measurements of this kind.

The relation between voltage and sparking distance is found to be linear, and direct from the origin; hence it is evident that there is no change in dielectric strength in any film or films existing on the surfaces of the solid bodies used at the points of discharge. Since 1 volt or thereabouts is so frequently employed in electric circuits, there is especial interest in knowing the sparking distance for this voltage; it is about 1/100 micron, and unless sufficient pressure is used to squeeze out dust or films until the metal surfaces approach to this distance, no current can pass.

The two surfaces used for discharge are a bead and a plane, generally of polished iridio-platinum. The pressure used is atmospheric. In working with such minute distances care must be taken to exclude extraneous vibrations, and the surfaces must be re-polished after every discharge except when the voltages are less than 10. In every case the discharge is observed by a telephone suitably shunted.

Geological Society, April 27.—Dr. J. E. Marr, F.R.S., president, in the chair.—On a new species of Eoscorpius from the Upper Carboniferous rocks of Lancashire: W. **Baldwin** and W. H. **Sutcliffe.** The specimen described was found in an ironstone-nodule occurring on a fairly well marked horizon, about 135 feet above the Royley Mine (or Arley Mine) coal-seam, at Sparth Bottoms, south-west of Rochdale Town Hall. The nodules occur in a band of blue shale, in which are well preserved remains of *Carbonicola acuta*, ferns, Calamaria, *Prestwichia rotundata*, and *Bellinurus bellulus*. The animal is well represented by both the intaglio and relievo impressions; these, however, only show its dorsal aspect. The specimen is referred to a new species. Dr. Peach is of opinion that the ancient species visited the sea-shore in search of the eggs of invertebrates, and the association of this new scorpion with king-crabs at Sparth Bottoms is in favour of this view.—The genesis of the gold-deposits of Barkerville (British Columbia) and the vicinity: A. J. R. **Atkin.** The gold-bearing area of Cariboo is roughly confined, within a radius of 20 miles of Barkerville, to the band of crystalline rocks known as the Cariboo schists, generally assigned to the Lower Palæozoic group. The veins follow the strike but not the dip of the rocks; the gangue is similar to that associated with the nuggets in the placers. While all the reefs carry gold, none have been found rich enough to account for the placer-gold. The placer-gold has probably been derived from the enriched outcrops of the veins which once existed above water-level. Such enrichment is due to the leaching out of pyrites leaving the less soluble gold in lighter quartz, and to actual enrichment by precipitation. While the enriched zone was being formed, the weathering of the surface kept removing the leached outcrop, and constantly exposing fresh surfaces to atmospheric influences. To the weathering of these outcrops the rich placers are attributed. The denudation of the reefs and the deposition of gold in the gravels appear to have taken place in Tertiary times.

Zoological Society, May 3.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—Mr. Oldfield **Thomas,** F.R.S., read a paper on the osteology and systematic position of the rare Malagasy bat *Myzopoda aurita*.—Mr. F. E. **Beddard,** F.R.S., read a third of a series of papers on the anatomy of the Lacertilia, which dealt with points in the vascular system of chamæleon and other lizards.—A communication was read from Mr. A. D. **Imms** containing notes on the gill-rakers of the ganoid fish Polyodon.—Dr. W. G. **Ridewood** read a paper on the cranial osteology of the fishes of the families Elopidæ and Albulidæ, with remarks on the morphology of the skull in the lower teleostean fishes generally.

Entomological Society, May 4.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. W. J. **Kaye** exhibited a piece of the plant *Eupatorium macrophyllum* from British Guiana, attractive to Lycorea, Melinæa and Mechanitis species of that region, and a remarkable larva-like twig of birch. The resemblance was so complete that even the head, the segments, the appressed legs and the anal claspers appeared to be represented. It had been found on Oxshott Heath while searching for larvæ of *Geometra papilionaria*. He also exhibited on behalf of Mr. C. P. Pickett a pupa of *Rumia crataegata* which had spun up in an empty pupa case of *Pieris brassicae*. The latter was on the roof of a breeding-cage, and the geometrid larva had completely crept inside to spin its cocoon.—Mr. J. E. **Collin** exhibited *Corethra obscuripes*, v. d. Wolf (?=*C. fusca*, Staeg.), a little known species of the genus, and new to the British list, which he had found in some numbers at Newmarket.—Mr. G. T. **Porritt** exhibited a living larva of *Agrotis ashworthii*, of which species he had found considerable numbers on one of the mountains of Carnarvonshire during the last week in April.—Commander J. J. **Walker,** R.N., exhibited a gall sent him by Mr. Harold S. Mort, identified by Mr. Froggart as *Brachyscelis duplex*, Schrader, and found at Wentworth Falls, Blue Mountains, N.S.W., where it was by no means common.—Mr. G. H. **Verrall** exhibited three specimens from the Hope collection at Oxford of *Neoitamus cothurnatus*, Meig., an Asilid not previously recorded as British. They were taken near Oxford by Mr. W. Holland. He also stated that the Anthrax exhibited at the last meeting on behalf of Mr. R. G. Bradley was *A. circumdata*, Meig., a species recorded before, but not observed for more than fifty years past.—

The **President** exhibited a Longicorn beetle captured near Malvern, Natal, by Mr. C. N. Barker, together with a large Bracon from the same locality, to which, on the wing, it showed a close superficial resemblance.—Mr. H. J. **Turner** exhibited living larvæ and cases of several species of the lepidopterous genus Coleophora, and contributed notes on them.—Dr. A. Jefferis **Turner** communicated a paper entitled "A Classification of the Australian Lymantriadæ."—Dr. F. A. **Dixey** read a paper by Major Neville Manders, R.A.M.C., entitled "Some Breeding Experiments on *Calopsilia pyranthi*, and Notes on the Migration of Butterflies in Ceylon."

Chemical Society, May 5.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—The slow combustion of ethane: W. A. **Bone** and W. E. **Stockings**. The hydrocarbon is first oxidised to acetaldehyde, the latter then passes into formaldehyde, and this is eventually oxidised to carbon dioxide, carbon monoxide and steam.—The action of radium rays on the halides of the alkali metals, and analogous effects produced by heat: W. **Ackroyd**. The γ-rays from radium bromide produced no colour change with lithium chloride, but with sodium, potassium, rubidium and cæsium chlorides produced yellow, violet, bluish-green and green transitory colorations respectively. These changes are analogous to the thermal effects produced in other substances, and are probably like these purely physical.—The mutarotation of glucose and galactose. Solubility as a means of determining the proportions of dynamic isomerides in equilibrium: T. M. **Lowry**. The author has applied the method already used in the case of β-bromonitrocamphor to these sugars, and finds that the stereoisomerides are approximately equally stable, and are present in about equal proportions in solutions.—A study of the substitution products of *ar*-tetrahydro-α-naphthylamine. 4-Bromotetrahydro-α-naphthylamine and *ar*-tetrahydro-α-naphthylamine-4-sulphonic acid: G. T. **Morgan**, Miss F. M. G. **Micklethwait** and H. B. **Winfield**.—Studies in the tetrahydronaphthylamine series, part ii., halogen derivatives of *ar*-tetrahydro-β-naphthylamine; part iii., reaction between *ar*-tetrahydro-β-naphthylamine and formaldehyde: C. **Smith**. A description of the derivatives obtained in these reactions.—The resin acids of the Coniferæ, part i., the constitution of abietic acid: T. H. **Easterfield** and G. **Bagley**. A description of the various decomposition products of abietic acid is given; a study of these led the authors to the conclusion that this resin acid is a decahydroretenecarboxylic acid, and they suggest that in retene the methyl and *iso*propyl groups occupy a *meta* position relatively to each other.—Additive products of benzylideneaniline with ethyl acetoacetate and ethyl methylacetoacetate: F. E. **Francis** and Miss M. **Taylor**. These additive products are shown to exist in one form only.—Studies on ethyl carboxyglutarate, part i., action of acids on ethyl sodiocarboxyglutarate: O. **Silberrad** and T. H. **Easterfield**.—Studies on optically active carbimides, part i.: A. **Neville** and R. H. **Pickard**.—The comparison of the rotation values of methyl, ethyl and *n*-propyl tartrates at different temperatures: T. H. **Patterson**. It is shown that a connection between the rotation values of these esters may be traced when the comparison is made at corresponding temperatures.—Note on the action of hydrogen sulphide on formaldehyde and acetaldehyde solutions: J. **Drugman** and W. E. **Stockings**. A description of a number of complex thio-derivatives obtained in these reactions.—The viscosity of liquid mixtures: A. E. **Dunstan**. The effects of the chemical affinity, molecular aggregation, and to some extent of the chemical constitution of the constituents on the viscosities of liquid mixtures are discussed.—The conversion of *iso*propyl alcohol into *iso*propyl ether by sulphuric acid: F. **Southerden**. In opposition to the experience of previous investigators, the author has obtained a small yield of *iso*propyl ether by this reaction.

Royal Astronomical Society, May 13.—Prof. H. H. Turner, F.R.S., president, in the chair.—The secretary gave an account of a paper by Dr. **Downing** on the definitive places of the standard stars for the northern zones of the Astronomische Gesellschaft, and also of two papers by Mr. **Cowell** on the moon's errors in longitude.—A brief account was given of a second series of double star measures by the Rev. T. E. **Espin**.—The **Astronomer Royal** read a paper on the new Greenwich micrometer for measurement of photographs of Eros. As the measures were required for determination of the solar parallax, a greater degree of accuracy was necessary than for the Astrographic Chart. A new instrument was therefore constructed, on the lines of Mr. Hinks's Cambridge measuring machine, and the results obtained with it were extremely satisfactory, the measures being remarkably accordant. The micrometer was described and illustrated by photographs shown on the screen.—Mr. **Franklin-Adams** read a paper on his photographic chart of the heavens, to Argelander's scale $1° = 20$ mm. After much preliminary work and an extended series of experiments, a 10-inch photographic lens was made by Messrs. Cooke and Sons from designs by Mr. Dennis Taylor, and this was provided with a specially constructed mount of the English form, with two guiding telescopes instead of one, and various other improvements. The instrument was taken to the Cape in June, 1903, and by the kindness of Sir D. Gill was erected in the grounds of the observatory. The work of photographing the southern heavens on 115 plates, each 15 inches square, with two hours' exposure, was practically completed, as well as a set with triple exposures, and another taken with a 6-inch lens. The star images were very good, even towards the edge of the plates, the lenses having proved extremely satisfactory, and the driving arrangements specially good. Photographs of the instrument and specimens of the plates were shown on the screen.—Mr. **Bellamy** gave an account of his paper on a new cluster in Cygnus, and other papers were taken as read.

PARIS.

Academy of Sciences, May 16.—M. Mascart in the chair.—The president announced to the Academy the loss by death of M. Marey, member of the section of medicine and surgery, and of M. Sarrau, member of the section of mechanics. The death of Prof. Williamson, correspondant for the section of chemistry, was also announced.—The cooling power of a feebly conducting fluid current on a body limited in every direction: J. **Boussinesq**.—On the electrolysis of calcium chloride: H. **Moissan**. A reply to some criticisms of M. Bullier with reference to a claim for priority.—The effect of small oscillations of temperature on a system affected by hysteresis and viscosity: P. **Duhem**. Small oscillations of external action and of temperature have no appreciable influence on the transformation of a system when the coefficient of viscosity of this system is large with respect to the amplitude of the oscillations.—Researches relative to the resistance of the air made by means of a new apparatus called the dynamometric balance: Ch. **Renard**. Two different forms of apparatus are described, the simple balance, which permits of the calibration of wind vanes for dynamometers, and the double balance, specially employed in the study of helices. Three illustrations are given.—On the function of the *n*-rays in causing changes of visibility in feebly illuminated surfaces: Jean **Becquerel**. The conclusion is drawn from the experiments described that the change in the distinctness and luminosity of feebly lighted surfaces submitted to the action of the *n*-rays is probably to be attributed, at least in great part, to a variation in the sensitiveness of the vision arising from the *n*-rays directed on the surfaces, and not to an appreciable variation in the light emitted.—The explanation of some colour phenomena shown by a tube containing rarefied gas: H. **Pellat**.—On the microscopic state of the poles and the discharge spectra: B. **Eginitis**.—On the density of aqueous saline solutions considered as an additive property of the ions, and on the existence of some hydrated ions: P. **Vaillant**.—A new method for the exact determination of the molecular weights of the permanent gases; the atomic weights of carbon, hydrogen and nitrogen: Ph. A. **Guye**. The author, with M. Friderich, has previously established that the van der Waals equation leads to the relation $V_m(1+a)(1-b)=R$, where V_m represents a gram-molecule at 0° C. and under the pressure of one atmosphere, a and b the two constants of the equation of fluids with respect to unit volume, and R the gas constant. In the present paper R is replaced by $R - mT_c$. By applying this relation to the experimental results of Leduc, Morley and Rayleigh, the values of the atomic weights of hydrogen, carbon and nitrogen are determined. For the last named element the mean value is 14·004, as against the figure of 14·057 of Stas.—On the preparation and properties of hypophosphorous acid: C. **Marie.** Two methods are given, starting from the barium and sodium salts respectively, both of which yield a pure crystalline acid of melting point 26·5. The decomposition by heat was also studied, and the equation ordinarily accepted for this change shown to be erroneous.—On a crystallised chromous tartrate: G. **Baugé.**—Colouring matters derived from triphenylmethane: Charles **Lauth.**—The preparation of the α-β-ketonic esters: L. **Bouveault** and A. **Wahl.** A study of the reaction between nitrogen peroxide and ethyl isonitrosoacetoacetate.—The action of phosphorus trichloride and some primary cyclic amines at the boiling point; the reduction of the chloride with the formation of phosphorus: P. **Lemoult.**—On some new polymers of formaldehyde: A. **Seyewetz** and M. **Gibello.**—The action of paraformaldehyde upon the sesquiterpenes: P. **Genvresse.** Carophyllene, clovene and cadinene all combine with formaldehyde.—Researches on the mechanism of the circulation of aromatic compounds in plants: Eug. **Charabot** and G. **Laloue.**—The action of heat and acidity on amylase: P. **Petit.**—The organisation and morphogeny of the Ætheridæ: R. **Anthony.**—Observations on Gymnoascus and Aspergillus: P. A. **Dangeard.**—Some remarks on the ancient Cryptogams and fossil plant soils: B. **Renault.**—Study of the spinal cord by means of the *n*-rays: André **Broca** and A. **Zimmern.** From their preliminary observations the authors conclude that the examination of the spinal cord by means of the *n*-rays allows of the demonstration on the living man of the existence of medullary centres, and even to gain some idea of their degree of activity.—On the presence of geminal nuclei in the cells of certain tissues of the guinea pig: Maurice **Pacaut.**—Light, food, and chlorophyll as modifying factors in the development of Amphibia: Georges **Bohn.**—On a mode of bacterial extraction of spring and river water by means of fine sand: P. **Miguel** and H. **Mouchet.**

DIARY OF SOCIETIES.

THURSDAY, May 26.

Royal Institution, at 5.—Literature and the State: H. G. Wells.
Institution of Electrical Engineers, at 8.—High Speed Electric Railway Experiments on the Marienfelde-Zossen Line: Alexander Siemens.

FRIDAY, May 27.

Royal Institution, at 9.—The Progress of Oceanography: H.S.H. Albert Prince of Monaco.
Physical Society, at 5.—The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers: Dr. C. Chree, F.R.S.—On the Ascertained Absence of Effects of Motion through the Ether in Relation to the Constitution of Matter on the FitzGerald-Lorentz Hypothesis: Prof. J. Larmor, Sec.R.S.—On Coherence and Recoherence: Dr. P. E. Shaw and C. A. B. Garrett.

SATURDAY, May 28.

Royal Institution, at 3.—Spitsbergen in the 17th Century: Sir W. Martin Conway.

MONDAY, May 30.

Royal Geographical Society, at 8.30.—A Journey to the North of the Argentine Republic: F. O'Driscoll.

TUESDAY, May 31.

Royal Institution, at 5.—The Solar Corona: H. F. Newall, F.R.S.
Society of Arts, at 4.30.—The Economic and Industrial Progress and Condition of India: J. E. O'Conor.

WEDNESDAY, June 1.

Entomological Society, at 8.
Society of Public Analysts, at 8.—The Analysis of Condensed Milk: J. B. P. Harrison.—Roasted Beetroot: E. G. Clayton.—A Collection of Readings with the Zeiss Oleo-Butyrometer: William Chattaway and C. G. Moor.—Note on the Estimation of Sugars and Starch in Vegetable Substances: John S. Ford.

THURSDAY, June 2.

Royal Society, at 4.30.—*Probable Papers*:—On the Aurora Borealis and the Electric Charge of the Sun: Prof. S. Arrhenius.—Colours in Metal Glasses and in Metallic Films: J. C. Maxwell Garnett.—On a Direct Method of Measuring the Coefficient of Volume-elasticity of Metals: A. Mallock, F.R.S.—A Method of Measuring Directly High Osmotic Pressures: The Earl of Berkeley and E. G. J. Hartley.—The Advancing Front of the Train of Waves Emitted by a Theoretical Hertzian Oscillator: Prof. A. E. H. Love, F.R.S.—On the General Circulation of the Atmosphere in Middle and Higher Latitudes: Dr. W. N. Shaw, F.R.S.—On the Magnetic Changes of Length in Annealed Rods of Cobalt and Nickel: Shelford Bidwell, F.R.S.—On the Electric Effect of Rotating a Dielectric in a Magnetic Field: Dr. Harold A. Wilson.
Royal Institution, at 5.—Literature and the State: H. G. Wells.
Linnean Society, at 8.—The Species of Impatiens in the Wallichian Herbarium: Sir Jos. D. Hooker, G.C.S.I., F.R.S.—Biscayan Plankton. Part III. Chætognathia: Dr. G. H. Fowler.—The Flow of Fluids in Plant-stems: Prof. R. J. Anderson.
Röntgen Society, at 8.30.—Experiments to Determine the Effects of Form and Winding upon Resonance Phenomena: Dr. Clarence A. Wright.
Institution of Mining Engineers, at 11 a.m.—Suggestions respecting the Institution of Mining Engineers: Prof. R. A. S. Redmayne.—Coal-mining in the Faroe Islands: G. A. Greener.—Tin-mining in the Straits Settlements, with a few Notes regarding Chinese Labour: W. T. Saunders.—Underground Temperatures, especially with regard to Coal-mines: Dr. Hoefer.—The Hammer-Fennel Tachymeter-theodolite: A. O. Eoll.—Notes on the Report of the Departmental Committee on the Use of Electricity in Mines: Sydney F. Walker.—A Comparison of Three-phase and Continuous Currents for Mining Purposes: Roslyn Holiday.—Electric and Compressed-air Locomotives: B. S. Randolph.—Work of Conveyors on Longwall Faces: Robert G. Ware.
Chemical Society, at 8.—*iso*Nitrosocamphor: M. O. Forster.—Imino-Ethers and Allied Compounds corresponding with the Substituted Oxamic Esters: G. D. Lander.—The Action of Heat on α-Hydroxycarboxylic Acids: Part I. α-Hydroxystearic Acid: H. R. Le Sueur.—The Basic Properties of Oxygen. Additive Derivatives of the Halogen Acids and Organic Compounds and the Higher Valencies of Oxygen. Asymmetric Oxygen: E. H. Archibald and D. McIntosh.

FRIDAY, June 3.

Royal Institution, at 9.—The Development of the Theory of Electrolytic Dissociation: Prof. Svante Arrhenius.
Institution of Mining Engineers, at 10.30 a.m.—The Firing of Babcock Boilers with Coke-oven Gases: T. Y. Greener.—Explosives and Lamp Testing Station at Frameries: Victor Watteyne.—The Transvaal Kromdraai Conglomerates: A. R. Sawyer.—The Southern Rand Goldfield: A. R. Sawyer.—The Occurrence of Cinnabar in British Columbia: G. F. Monckton.—Prevention of Accidents in Winding: John H. Merivale.—Petroleum and its Use for Illumination, Lubricating and Fuel Purposes: P. Dvorkovitz.—The Analytical Valuation of Gas Coals: G. P. Lishman.—A New Process of Chlorination for Mixed Gold and Silver Ores: H. F. Brown.—Graphite-mining in Ceylon and India—Part I. Ceylon: G. A. Stonier.

SATURDAY, June 4.

Royal Institution, at 3.—Spitsbergen in the Seventeenth Century: Sir W. Martin Conway.

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