THURSDAY, AUGUST 2, 1906.

THE RAND THROUGH FRENCH SPECTACLES.

Étude sur l'État actuel des Mines du Transvaal. Les Gîtes—leur Valeur. Étude industrielle et financière. By George Moreau. Pp. iv+218. (Paris: Librairie polytechnique, Ch. Béranger, Editeur, 1906.)

THIS, the latest description of the Witwatersrand, is a curious medley of history, physiography, geology, mining, and finance, in which the author endeavours, and not without success, to picture to his readers the present condition of the gold-mining industry.

The geological portion of the book consists of a *résumé*, fairly accurate and complete, of recent publications of the Geological Society of South Africa, while the mining and economic statistics are derived chiefly from the excellent compilations of the Witwatersrand Chamber of Mines and the Government Mines Department of the Transvaal. The description of the methods employed in the exploitation of the mines, and of the processes in vogue for the recovery of the gold from the ore during its progress from the rock-crushers, through the stamp-mill and the cyanide works, to the residue dumps, is well done and up to date, such recent innovations on the Rand as tube-mills and filter-presses being described.

The use of the old chemical symbols (in which water is represented by HO) in giving the reactions of the cyanide process seems a strange reversion to the past. The author's reason for this procedure is found in a footnote on p. 165. It runs:—

"Nous avons hésité pour choisir les notations des formules chimiques et avons fini par adopter les vieilles formules des équivalents. Les nouvelles vues relatives à la constitution des corps ont provoqué bien des attaques contre les théories dites atomiques et beaucoup de bons esprits regardent cette notation comme insuffisante. Nous ne prenons nullement position dans le débat et choisissons simplement les formules pondérales comme commode pour les praticiens."

A curious commentary on the chemistry of the day!

Not the least interesting part of the book is that which contains the author's views on the labour supply for the mines—the burning question of the hour in the Transvaal. Speaking of Kafir labour, he says, "whereas among the white working classes continuous work is necessitated by the fact that a day's pay scarcely suffices to meet a day's requirements, the Kafir has no wants (his food and lodging being found), and he works only for six or eight months, during which time he accumulates sufficient capital to enable him to return to his kraal, where he invests his savings in women and cattle. The work of his wives then provides the wherewithal for an idle life. Formerly, war furnished forth slaves for the conquerors; now the males consent to a little temporary fatigue in order to assure a life of complete tranquillity and repose. The constant succession of fresh hands, inexperienced in mine work, depresses the standard of efficiency for Kafir labour. The best workers are, of course, the few who spend their earnings (unfortunately largely in the consumption of alcohol), and consequently remain on the mining field."

The author calculates that in the territories in which recruiting for native labour is permitted a supply of not more than 250,000 can be reckoned on. The labour requirements of South Africa (for mines, agriculture, and public works) amount at present to 380,000, and if the developments that are hoped for are realised, the demand for labour will have increased in five years' time to 600,000. It is evident that the importation of Chinese labour relieved a very pressing necessity.

The introduction of the Chinese receives the commendation of the author. It has, on the whole, he says, been a success.

"Very industrious and most desirous of gain, the Chinese make first-class miners. They take to underground work, and the results are excellent when they know that they are being paid in proportion to the work done. While they exert themselves as little as possible when on salary, they show great activity when put on piece-work."

There is no doubt that if they are employed on piece-work excellent results will be obtained. Moreover, the introduction of the Celestials has, according to the author, had a particularly favourable influence on the recruiting of the Kafirs, who now feel that they are no longer masters of the situation.

The white miners come in for some severe handling at the hands of the author. He ridicules their antagonism which forced the Transvaal administration, in admitting the Chinese, to impose restrictions which prevent their best qualities being utilised. The employment of a Celestial on anything approaching skilled labour is strictly prohibited. Yet, as the author points out, the machine-drills are often actually manipulated by a Chinese or Kafir assistant (whose pay does not amount to more than three or four shillings a day), while the white miner in charge (who draws one pound or more a day) looks on and smokes his pipe.

In concluding a chapter on the future of the Witwatersrand mining industry, the author says:—

"The Transvaal is a fine country, where Nature has been pleased to concentrate enormous mineral wealth, and where there is still a fertile field to exploit. Gold and coal have been found in abundance. The diamond occurs in an eminently favourable condition for exploitation, and a recent notable discovery has added tin to the metals—lead, silver, and copper—which were already known to exist. The *possibilities* of the Transvaal are considerable, and those who interest themselves in a good venture from the start are almost certain to net a profit. The reverse of the medal is that the European markets do not get the chance of participating in South African ventures until they have passed through the hands of a number of intermediaries, all of whom have exacted a profit, and the price at which they are finally offered to the investing public is more in harmony with the illusions of the purchasers than the reality of the facts."

F. H. H.

A NEW FLORA OF GREECE.

Conspectus Florae Graecae. Auctore E. de Halácsy. 3 vols. Vol. i., pp. 825; vol. ii., pp. 612; vol. iii., pp. 520. (Leipzig: W. Engelmann, 1900–1904.)

SINCE the publication of Sibthorp and Smith's great work, "Prodromus Floræ Graecæ," more than a century ago, a large number of individual workers have published floras of certain parts of Greece, and have described a very considerable number of new species. But no work dealing with the Grecian flora as a whole has—since Sibthorp and Smith—been attempted until now. The author of the present work is to be congratulated upon the success he has achieved. His book is most useful to every systematist who has to deal with European plants. He himself had travelled and collected in Greece, and had written on the botany of Greece. To the results of his own observations he has utilised the data furnished by previous authors, whose names and works are duly tabulated at the end of the third volume. The area treated in the "Conspectus" is Greece (as politically understood), as well as Epirus and Crete. The three volumes contain 825, 612, and 520 pages respectively. The species are accurately described, except in the case of the more well-known plants, of which bibliographical references and synonyms, as well as habitats, only are given. The larger genera have a key at the commencement of each to facilitate the "running down" of the species.

Practically the sequence of the genera is that of Bentham and Hooker's "Genera Plantarum," although some of the suborders of those botanists are given independent rank. For instance, Fumariaceæ is separated from Papaveraceæ, Oxalidaceæ from Geraniaceæ, Rosaceæ (as understood by Bentham and Hooker) is split up into Amygdalaceæ, Rosaceæ, and Pomaceæ. Silenaceæ (Caryophyllaceæ of most systematists) has Alsinaceæ separated from it.

It may be of interest to note the relative space occupied by some of the larger natural orders. Compositæ heads the list with 245 pages, Papilionaceæ comes next with 125, Gramineæ and Labiatæ have 120 each, Umbelliferæ 88, and Scrophulariaceæ 74. The largest genera in point of number of species are as follow. To show at a glance the relative proportions of the Greek to the general European flora as given in Nyman's "Conspectus Floræ Europææ," the number given by Halácsy is quoted first, and then the total number for the whole of Europe from Nyman. Of Centaurea, Greece boasts 71 species, the whole of Europe 171; Trifolium 61 species against 108, Euphorbia 44 against 107, Campanula 43 against 94; Allium has more than half the total number of species possessed by the whole of Europe, 41 against 78; in Verbascum Greece claims a still larger proportion, 39 species against 54. In Carex Greece has 36 species, the European flora altogether 163. Vicia has 35 species; Nyman enumerates 61 for Europe. Astragalus has 33 Greek species against 120 for the whole of Europe, and Hieracium has only 20 species against 185.

It is worthy of mention that the origin of the horse-chestnut is here definitely settled. In most books Asia is given as the native country of *Æsculus hippocastanum*; in others it is stated with equal certainty that its native country is uncertain or unknown. Sibthorp records it as occurring in a wild state near Pindus. Nyman, in a note in his "Conspectus Floræ Europææ," says, "Indicatur a Sibthorpio in Pindo, monte illo Graec. bor. sed post eum a nullo alio ibi inventa est." Halácsy, however, quotes Haussknecht as having found it truly wild in this and other localities (see *Mitth. thür. bot. Ver.* 1886, p. 71). It was, however, Heldreich (in *Sitzungsb. bot. Ver. Brandenb.*, 1879, p. 139, and 1882, p. 20) who first brought forward sufficient evidence to prove that the real home of the horse-chestnut was in the mountains of Northern Greece.

N.

SUBTERRANEAN GEOGRAPHY.

Höhlenkunde, mit Berucksichtigung der Karstphänomene. By Dr. W. von Knebel. Pp. xvi+222. (Brunswick: Vieweg und Sohn, 1906.) Price 5.50 marks.

THIS book is one of the handy monographs in the collection styled "Die Wissenschaft," which corresponds well in range with the English "International Scientific Series." It may be described as a clear introduction to the study of caves; but it is not so inspiring as the subject deserves. We cannot think, for instance, that it would enable anyone to realise the attraction that the hidden depths have had for certain specialists. There is a tendency in the book to classify phenomena, which may be of service to those who fully grasp their meaning; and perhaps we expect too much from an author who is so eminently exact. Somehow we do not quite see before us the great *gouffres* leading vertically down to unknown waterways; nor, on the surface, the real desolation of the Karstland, the white dust of waterless days, the fantastic rocks standing up in moonlight like ghosts upon the slabs of enormous tombs, the sudden edge of the ravine, and the clear green river sunk half-a-mile below. Well, if we are to study "Höhlenkunde," the emotions are for other moments. Yet what an emotional subject it all is!

Dr. von Knebel's account (p. 57) of the subterranean connection between the Danube at Immendingen and a tributary of the Rhine in the Hegau leaves, let us admit, nothing to be desired; and there are plenty of local touches here. Of equal interest is the description (p. 107) of the flow of sea-water into the limestone near Argostoli in Kephalonia, whereby two mills are kept going in the stream. A diagram shows us how this may be accounted for by the outflow of lighter brackish water into the sea at another point, this water being the result of the mingling of a fresh-water spring with the marine flow underground. We learn also how a fresh-water spring emerging under the sea may draw in sea-water from some point above it, through a cavity partly filled with air.

Among many useful discussions, we note (p. 26) that dolomite is stated to be equally soluble with calcite in water, and that hence dolomite-masses are capable of giving rise to typical karst-phenomena. It is observed (p. 195) that the air of caves is a remarkable conductor of electricity. The relation of typical karst-surfaces to the removal of forests is pointed out, and French areas, cleared after the Revolution, are cited as examples. The French *causses*, by-the bye, deserve rather longer mention, considering how accessible they now are from Millau, and how finely they illustrate the author's thesis. But we welcome the use made of the "dolinas" and "poljes," names that recall the fascination of the Slavonic east. The author's classificatory instinct introduces us also to marine erosion and to Fingal's Cave; to a glimpse of the fauna of caves; and to caves as the haunt of early man. But it is the treatment of the karst-phenomena that will probably give this book a place among works of reference, although precise references to original papers are rare in it, and although it has, strange to say, no index. G. A. J. C.

OUR BOOK SHELF.

The Outlook to Nature. By L. H. Bailey. Pp. ix+296. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1905.) Price 5s. net.

PROF. BAILEY is well known as one of the most fertile and inspiring of teachers of science as applied to agriculture and particularly to horticulture, who has built up a great school at Cornell and has also been the source of a wave of teaching from nature among the schools of the United States.

In all Prof. Bailey's work may be seen the qualities of the enthusiast, who is moved, and gets his power to move his followers, by considerations other than those which are the ostensible object of his work. The life of the country-side, farming and gardening, then, are to Prof. Bailey something more than a scientific study or a means of earning a livelihood—they are the great regenerating influences of modern life. He sees civilised existence getting every day more complex, more noisy, more hurried, more exacting; nor in the interests of efficiency does he expect or desire any wholesale return to a more primitive mode of living. But what he does plead for is the "return to nature" in "our personal and private hours" as a "means of restoring the proper balance and proportion in our lives." The book consists of four lectures, delivered in Boston, on such topics as the relation of country to city, the part that nature-teaching should play in school life and the organisation of rural teaching generally, with a final essay on the position of evolutionary conceptions with regard to religion.

We get a vivid and interesting presentment of the opinions and convictions which have made Prof. Bailey a living force in American education; we see that the writer is a passionate lover of nature with a strain of the poet in him, but we do not always find his treatment convincing. The book must be judged as literature, and in literature neither the best of intentions nor the finest of emotions count unless you can express them with something of the freshness and inevitability of a living thing; here we often find the thoughts and arguments of Thoreau, but without his clear-cut and startling intensity of expression. Prof. Bailey is rhetorical, and that means he is sometimes more concerned with the decorative value of his periods than with their absolute truth; for instance, he makes a point that we go to a gallery to see a picture of a sunrise when we might see the sunrise itself! forgetting that it is only the awakened eyes which can see at all. "I never see a sunset like that," objected the critic to Turner; "Don't you wish you could," answered the artist.

However, putting aside the question of these "airs and graces," Prof. Bailey's thesis is sound enough; civilisation is dying and will die of its own self-produced poisons; it is only by the *improbus labor* on the land that the human race seems able to persist. A. D. H.

Lecture Notes on Chemistry for Dental Students. By Dr. H. Carlton Smith. Pp. viii+273. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 10s. 6d. net.

THE connection between dentistry and chemistry is a two-fold one. The practical dental surgeon is a worker in metals; he has to prepare amalgams for stoppings and carry out a multitude of similar operations; hence his need for a knowledge of inorganic chemistry. No less important is the second link; he must know the composition of the teeth, the action upon them of the reagents and drugs he employs; he must understand the action of ferments, whether they are contained within the micro-organisms of the mouth or in the secretions, like saliva, which come in contact with the teeth; hence his need for a knowledge of organic, and especially of physiological, chemistry. Dr. Smith has produced a work which supplies such needs, and one is glad to see he has provided an over-supply; for instance, the sections on physiological chemistry do not deal exclusively with saliva, though naturally this subject is treated with special fulness. This is as it should be; the less specialised and narrow a dentist's education, the more is he likely to benefit those under his care.

In the analyses given of the different parts of the teeth, Dr. Smith states that enamel contains 3 per cent. of organic matter. He does not allude to the work of Tomes, in which it was shown that enamel contains no organic matter at all, and what was formerly given as organic matter (by difference) is really due to water. It is not a very important point, and possibly the author was not aware of Tomes's research on the question.

A Study of the Sky. By Prof. Herbert A. Howe. Pp. xii+340. (London: Macmillan and Co., Ltd., 1906.) Price 2s. 6d.

THIS is a cheap edition of a book that appeared originally several years ago. Written in attractive, simple language, Prof. Howe's volume is just the work for those readers who, knowing little or nothing of the oldest of sciences, wish to become personally acquainted with the wonders of the sky.

A very pleasing feature of this book is the way in which the reader is forced to observe and experiment for himself. Chapter i. gives a brief historical sketch of astronomy, and is followed by five chapters dealing with the constellations observable at various seasons, and their apparent diurnal and annual motions. Then come three chapters dealing with astronomers in general and particular, and their tools. A chapter on time and the method of keeping it is followed by five (xi.–xv.) chapters dealing *seriatim* with the members of the solar system. The concluding chapters discuss in a simple but instructive fashion comets and meteors, the fixed stars, and the nebulæ.

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.*]

The Positive Charge carried by the α Particle.

SOME time ago I made the suggestion in NATURE (March 9, 1905) that the α particle was initially uncharged on expulsion, and that it gained its charge subsequently by collision with atoms in its path. I need only now repeat that the suggestion was based on the brilliant work o Bragg in Australia, who showed that the α particle passes *through*, rather than collides with, the atoms of solid or gaseous matter in its path, and that whether uncharged or not initially, it must, equally with the atom struck, become charged positively after the encounter by the detachment of a negative electron.

Recently P. Ewers (*Physikalische Zeitschrift*, March 1), using the α particles from polonium, attempted to put the view to an experimental test with negative results, and concluded against the probability of the hypothesis. Bragg (*Phys. Zeit.*, July 1) has pointed out that Ewers's experiments by no means settle the question, and, indeed, he evidently considers it a question which cannot be settled experimentally. Certainly the requisite conditions to be fulfilled for a positive result are so rigorous that no one could be certain they had been fulfilled, and it is impossible to disprove the view by a negative result. But it is obvious that a positive result, that is, the actual isolation of the α particle in an uncharged state, would settle the question. This I have been fortunate enough to do, although only after a long experience of negative results where it might reasonably have been concluded the requisite conditions had been realised. "The best laid schemes of mice and men gang aft a-gley." A determining factor in the problem conditioning whether a positive or negative result is obtained could not possibly have been foreseen, and it was only when all hope of getting anything but a negative result had been abandoned, and what was intended to be a final experiment was being performed, that a slight change in one of the factors happened to eliminate the disturbing cause, and I obtained the coveted positive result. The precise nature of this disturbing influence is, perhaps, not yet fully demonstrated, although personally I think I now hold the clue. But there is not the slightest doubt that the α particle initially expelled is not charged as the experiments given prove.

The essential conditions are two. In the first place, the α particle must be examined in a vacuum such that during its path it does not encounter a single gas molecule. Secondly, the layer of radio-active matter from which it is expelled must not be more than one molecule thick, and must not be mixed with or overlaid by inactive matter. These conditions being fulfilled, the α particle will not traverse a single atom after expulsion, and if uncharged initially must remain so. As a third condition, it is desirable that the test for the charge shall be made on the particle during its flight. It is at least conceivable that an uncharged α particle striking a plate will convey to it a positive charge if the electron detached from the uncharged α particle on impact has sufficient energy to escape the plate.

The second condition is, as may be imagined, the difficult one to make sure of. I hoped to secure it by using radium C as the source of the rays. The rate of its disintegration is so rapid that there is only just the necessary time for an experiment to be carried out. Hence the actual number of atoms of the radio-active substance is for radium C the minimum it is possible to employ. Moreover, this number can readily be calculated, and since it is deposited from a gas uniformly on the exposed surface, not only can an experiment be devised so that the thickness of the deposited layer fulfils the monomolecular condition, but, what is equally important, it can be assumed with reasonable certainty that the radio-active layer is not overlaid or mixed with inactive matter.

With regard to the first condition, all the factors are known, and the necessary conditions can readily be calculated by two independent methods, which, as it proved, are strikingly verified by the actual results obtained. The only pitfall is in the altogether exaggerated impression which is abroad as to the ease with which a high degree of vacuum can be obtained by modern methods.

The third condition was realised by using the magnetic deviation of the α rays as a test for their charge. The rays passed out of the capillary tube from a deposit of radium C at the far end. This was obtained by the use of the emanation from 30 mg. of radium. Conditions were arranged so that the rays were completely deviated under ordinary conditions, and with the magnetic field on did not succeed in escaping from the tube, and the experiment consisted simply in re-examining the deviation in the highest vacuum that could be produced.

Long series of negative results led to the refinement of each essential condition until it seemed no further improvement was possible, and a wide margin of probability that the essential conditions had been realised had been secured. A most unmistakable negative result was obtained. But the next experiment intended to confirm this finally was as unmistakable a positive result as the other had been a negative one. In a partial vacuum the rays were completely deviated. In the highest vacuum the field made no perceptible difference. Between the two experiments there were two slight differences of conditions: (1) In the second experiment the radio-active deposit had been heated *in vacuo* after removal of the emanation and disappearance of radium A in order to remove a possible overlying film of condensed gas. (2) In the first experiment the emanation had been left in the capillary 2 hours 25 minutes, in the second 1 hour 30 minutes, the volume occupied by the emanation being less in the latter case.

In a third experiment the heating of the radio-active surface was omitted, and the emanation was allowed to act for only 45 minutes. The result was unequivocally positive.

In a fourth experiment the film was heated, and the emanation left in 1 hour 20 minutes, reproducing practically the conditions of the second experiment. Again the result was positive, and the magnetic field produced no appreciable effect in a high vacuum. But this experiment was continued for nearly two hours after the start, and at the end of the time the radiation, although, of course, much enfeebled, was quite intense enough for the purpose. As time elapsed a change came over the experiment. Little by little, the rays began to be affected by the field. This change was hastened by heating the active film in place in the high vacuum. At the end the result was as unequivocally negative, all the rays being deviated by the field in the highest vacua, as at the start it had been positive.

The clue, I think, is the change of the glass surface of the capillary, which it experiences under the excessive bombardment to which it is exposed, and which is indicated by the blackening of the glass. In the lead glass used it was remarked independently that the darkening appeared to commence somewhat suddenly. At the conclusion of the experiment it was always marked. But on cutting down the capillary before the commencement in the three final experiments with relatively short exposure to the emanation the darkening had not commenced, whereas in the last experiment, when the pole pieces were removed to allow the deposit to be heated in place it was noted that the darkening had begun. It can be imagined that the slightest roughening of the surface is all that is necessary to cause a negative result. The whole series of experiments from start to finish is explained if accompanying the darkening of the glass there is also a slight roughening. Whether this will prove sufficient to be within the range of the microscope remains to be seen.

I hope to examine the hypothesis that the blackening of the glass is accompanied by the roughening of the surface more in detail later. But whether this or some other explanation proves correct there can, I think, be no doubt about the conclusion that the α particle has been isolated under conditions in which it is not deviated by a magnetic field, and, therefore, is not charged. The theoretical consequences of the discovery need not here be dealt with. Certainly it looks as if the influence of electricity in radioactive change, and its importance generally in its relation to matter, could be overestimated.

FREDERICK SODDY.

The University, Glasgow, July 29.

Stress in Magnetised Iron.

THE important question whether there is any mechanical stress in an iron rod or ring when magnetised, and, if so, whether the stress is compressive or tensile, was discussed in NATURE ten years ago (vol. liii., pp. 269, 316, 365, 462, 533), but has not yet, so far as I know, received any generally accepted answer. That a magnetised rod must necessarily be in the same condition as if under a mechanically applied compressive stress tending to shorten the iron, was, I believe, first suggested by myself (Phil. Trans., vol. clxxix., p. 216, 1888). Those who support this view generally speak of the stress as "Maxwell's stress," and assume its value to be $B^2/8\pi$. The stress in question seems, however, to be quite unconnected with the "stress in the medium" proposed by Maxwell, and its value is not in general exactly $B^2/8\pi$, but $(B^2-H^2)/8\pi$. I have lately had occasion to consider the problem again, and perhaps I may be allowed to re-state my argument in a slightly altered form, and illustrate it by means of an imaginary model.

If a uniformly magnetised rod is divided transversely, and the cut faces are brought close together, the magnetic force inside the narrow gap will be $B=H+4\pi I$. The force acting on the magnetism of one of the faces, and urging this face towards the other, will be less than B by $2\pi I$, the part of the total force due to the first face itself; hence the force per unit of area with which the faces would press against each other if in contact is $P=(B-2\pi I)I=2\pi I^2+HI=(B^2-H^2)/8\pi$. (In the case of an endless permanent magnet, $H=0$, and $P=B^2/8\pi$.) The width of the gap may be diminished until it is no greater than the distance between two neighbouring molecules, when it will cease to be distinguishable; but, assuming the molecular theory of magnetism to be true, the above statement will still hold good for the intermolecular gap. The same pressure P will be exerted across any imaginary section of a magnetised rod, the stress being sustained by the intermolecular springs, whatever their physical nature may be, to which the elasticity of the metal is due. The whole of the rod, therefore, will be subject to a compressive longitudinal stress P, the resulting contraction, expressed as a fraction of the original length, being P/M, where M is Young's modulus for the metal.

Let a magnetic molecule of iron be represented by a rigid steel sphere, uniformly magnetised and covered with a closely fitting shell of india-rubber, to play the part of the "intermolecular springs." Imagine a straight row of these spheres in contact with one another, and kept in place by a force analogous to cohesion, which, while binding the spheres together, leaves them free to turn on their centres. This arrangement would, for present purposes, serve as a model of a filament of iron one molecule in diameter. If the magnetic axes of the spheres pointed indifferently in all directions, the attractions would be balanced by the repulsions, and the length of the filament would be the same as if the spheres were unmagnetised. If, however, the magnetic axis of every sphere pointed in the same direction along the filament, as would be the case when the filament was magnetised, the india-rubber between all the pairs of unlike poles would be compressed and the filament would be shortened. Let F be the compressive stress across the rubber between a single pair of poles, and s the amount, expressed as a fraction of a centimetre, by which the rubber is contracted; then, if there are n spheres, the total contraction will be ns (n being assumed so great that it is sensibly equal to $n \pm 1$), which is the same as would be caused by an equal compressive stress F applied at the two ends of the unmagnetised filament. The whole filament when magnetised may therefore be regarded as under compressive stress due to the magnetic forces, and since Young's modulus $M=Fl/ns$, where l is the length of the unmagnetised filament, the contraction expressed as a fraction of the length is, as originally stated, F/M, the value of F in an actual piece of iron being $2\pi I^2+HI$.

Sometimes there may presumably also be a longitudinal tension, as in the case of an iron rod placed along the lines of force in a uniform field, when the tension would be HI. In a ring electromagnet this would not exist.

As to what effect would be produced in magnetised iron by Maxwell's distribution of stress in the ether, I cannot venture an opinion. But if there is a tension, it can hardly have the familiar value $B^2/8\pi$, which is possible only when B is equal to H, and there is no magnetisation ("Electricity and Magnetism," § 643). My point is that an important component of the stress in magnetised iron is a compression which can be calculated and allowed for. The question whether or not this view is tenable is of the highest interest in connection with the possible correlation of magnetic phenomena, and urgently needs an answer.

SHELFORD BIDWELL.

The Mixed Transformation of Lagrange's Equations.

I SHOULD fancy from the review by "G. H. B." in NATURE of July 19 (p. 265) that the papers of Prof. Levi Civita relate largely to the *mixed* transformation of Lagrange's equations, the complete theory (Proc. Camb. Phil. Soc., vol. vi., p. 117; "Hydrodynamics," vol. i., p. 171) of which was first given by myself so far back as 1887. But what I wish to point out is this, that this theory depends no more on any so-called theory of "ignored" coordinates (or *kinosthenic* coordinates as Prof. J. J. Thomson [Phil. Trans., 1885, part ii.] calls them) than it does on the existence of the hypothetical personage known as the Man in the Moon.

The theory is merely the result of a piece of elimination, and is as follows:—Let the coordinates of a dynamical system be divided into two groups θ and χ; let Θ and κ be the momenta of types θ and χ; and let T be the Lagrangean expression for the kinetic energy. Then it can be shown that

$$T=\mathfrak{T}+\mathfrak{R} \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$\frac{\partial T}{\partial \dot{\chi}}=\kappa \quad \ldots\ldots\ldots\ldots \quad (2)$$

$$\frac{\partial T}{\partial \dot{\theta}}=\Theta=\frac{\partial \mathfrak{T}}{\partial \dot{\theta}}+\overline{\Theta} \quad \ldots\ldots\ldots\ldots \quad (3)$$

where $\mathfrak{T}$ is a homogeneous quadratic function of the velocities $\dot{\theta}$, $\mathfrak{R}$ is a similar function of the momenta κ, and $\overline{\Theta}$ is a linear function of the κ's.

By means of (2) all the velocities and accelerations of type $\dot{\chi}$ can be eliminated from Lagrange's equations, and the result is expressed by means of the modified Lagrangean function

$$L=\mathfrak{T}+\Sigma(\overline{\Theta}\dot{\theta})-\mathfrak{R}-V \quad \ldots\ldots \quad (5)$$

and

$$\dot{\chi}=\frac{\partial \mathfrak{R}}{\partial \kappa}-\Sigma\left(\dot{\theta}\frac{\partial \overline{\Theta}}{\partial \kappa}\right) \quad \ldots\ldots\ldots \quad (6)$$

Equations (5) and (6) constitute the mixed transformation of Lagrange's equations, and include the equations of Hamilton as well as those of Lagrange.

When the coordinates χ are *kinosthenic* coordinates, that is to say, coordinates which enter into expression for the energy of the system only through their differential coefficients with respect to the time, all the κ's are constants, and (5) is sufficient to determine the motion.

In § 173 of my "Hydrodynamics," the words "the latter of which does not enter into the expression for the energy of the system" should be omitted.

A. B. BASSET.

Two Modifications of the Quartz Wedge.

SOME little time ago I wished to make a quartz wedge for producing interference colours with the polarising microscope. The usual wedge supplied by optical instrument makers seldom gives colours lower than "clearer gray" of Newton's colour-scale according to Quincke, while the lower colours are often particularly valuable in petrological work. The quartz wedge is described in the text-books on the subject (*e.g.* Rosenbusch's "Microscopical Physiography") as being cut "so that one of its faces is exactly parallel to the principal axis (optic axis, axis of least elasticity)." The difficulty in getting, say, iron-grey of the first order depends on the extreme thinness of the quartz required at the thin end of the wedge.

Now the interference colour given by plates of equal thickness of the same mineral depends on the direction in which they are cut, varying from a maximum when the plate is parallel to the optic axis to zero when the plate is perpendicular to that direction (assuming the mineral to be uniaxial). If, then, a wedge be made having one face parallel to some such direction as, say, an *r* or *z* face of the quartz crystal and its length in the direction of the trace of the vertical plane of symmetry through that face, it will give the same results as the ordinary quartz wedge, but, for the same thickness, will give a lower colour, so that the colours at its thin end may be got very low. On trial a wedge made in this way gave very satisfactory results.

The compound wedge described below, which, so far as I know, is also new, was found to be still better. Suppose a sheet of muscovite be taken, its axes of elasticity determined, and a strip cut of the same size and shape as the quartz wedge with the axis of greatest elasticity parallel to its greatest length. If the wedge is covered with the mica plate and examined between crossed Nicols, there will, of course, be a black compensation band in some position, and by cleaving the mica thinner this band can be made to move towards the thin end of the wedge, and finally to coincide with it. The mica is now cemented to the quartz, and a wedge is produced which gives *all* the colours of the first order. By the use of this compensation mica plate a very poor wedge may be converted into a first-class instrument, or one broken at its thin end restored to usefulness.

DANIEL JAMES MAHONY.

The Grand Hotel, Melbourne, Victoria, June 25.

Colour Phenomena in "Boletus cœrulescens."

ONE day recently in the woods at Lynton (where the soil is red) I found and gathered two very beautiful toadstools, with vermilion stem and bright, sulphur-coloured hymenium. In these individuals the striking colour phenomena peculiar to their family were remarkably in evidence; *in the brilliant sunlight* on the bright yellow under-surface of the pileus I found my name when traced in the most gentle way shine out almost immediately in the most magnificent of blues.

Will any of your readers kindly refer me to any recent papers concerning the chemical or physical processes which underlie this fascinating demonstration? From my own superficial observations it is evident, I think, that light plays an important part. The energy liberated by the very gentlest friction appears to be a sufficient initiative.

Parts that have been rendered blue, when left at rest, after a short time return to yellowness, but these same parts are capable under fresh stimulus, so long as the fungus is still alive, of again assuming temporary blueness.

The juice expressed from blue areas is itself bright blue, and imparts a bright blue stain to linen. Upon my handkerchief this colour remained so long (at least five hours) that I thought I had fixed it; but in the morning the *dry* blue patch of the night before was no longer blue, but yellow.

On cutting the stem its upper two-thirds was found endowed with the property of cœrulescence; but this was not in any degree possessed by its lower third, in which the cut surfaces remained of a reddish-brown colour. With the exception of the lower part of the stem and the cuticle, all the tissues of the fungus exhibited cœrulescence.

I take special interest in these observations on account of certain phenomena noticeable in human tissues in the course of a somewhat rarely met with pathological condition which has been described under the name chloroma.

Without entering into details, I may remark that along with the colour development which characterises this pathological condition hæmoglobin is probably being extensively set free from red blood cells, and presumably this body or its derivatives are abnormally abundant in the body fluids. Is there any known organic iron-containing body capable of being responsible for these quick-change effects?

EDGAR TREVITHICK.

Strength of a Beetle.

LAST night a small beetle (*Aphodius fossor*), the length of which is ½ inch, flew in at my window and alighted on a table next to me. As it buzzed about I put a lid of a tin box over it, but to my surprise the beetle walked about bearing the lid on its back. I then put the tin box on the top of the lid, and was absolutely amazed to find that the insect tilted up a corner of the combined box and lid, and nearly escaped. The weight of the beetle when dead was ½ grain, alive I suppose it was a little more; but the box and lid weighed 1758 grains! Assuming that the living insect weighed 1 grain, it must have tilted up 1758 times its own weight! Of course, the strength required to tilt up a box on edge is nothing like so great as that required actually to lift the weight, but nevertheless the feat seems to me sufficiently astounding. The dimensions of the box are $3\frac{1}{4} \times 2\frac{1}{4} \times 1\frac{1}{2}$ inches.

CHARLES R. KEYSER.

The Gables, Hayward's Heath, July 26.

THE INTERNATIONAL CELEBRATION OF THE JUBILEE OF THE COAL-TAR INDUSTRY.

DURING the last century no discovery, perhaps, has led to such far-reaching and important developments as that of mauve, the first aniline dye, by William Henry Perkin. Not only was the door thrown open to the never-ending procession of artificial colouring matters, but the raw materials necessary for their production were also the raw materials for the synthesis of whole series of entirely different substances, which have now assumed most important positions in the world's daily requirements.

It cannot be too often repeated that Perkin's discovery was the result of true scientific devotion to pure research. The synthetic preparation of quinine was the goal aimed at—a sufficiently ambitious one for a lad of seventeen, for the problem is yet unsolved. Perkin did not state, as is perhaps too often done nowadays, that "only a black mass was obtained." His persevering and scientific habit of mind led him to investigate the "black mass," with the result that by extraction with alcohol was isolated the violet dye which is so closely associated with his name.

Great though Perkin's discovery was, yet greater still were the zeal, industry, and genius of the boy of eighteen which enabled him to make the dyestuff on the large scale and place it on the market successfully. Only those who have had experience in large-scale preparations can realise what this must have meant. New plant, new materials, new conditions: all had to be undertaken, and in the introduction of iron vessels for the manufacture of his raw material, aniline, Perkin laid the vast aniline oil industry under lasting obligation.

The start thus given, many entered the field; by a slight variation of Perkin's process Renard and Franc introduced the splendid crimson dye "magenta" in France, whilst shortly afterwards Simpson, Maule, and Nicholson started the manufacture of this colour in London. The happy collaboration of A. W. Hofmann, the college professor, with the splendid technical chemist and business man, E. C. Nicholson, soon not only placed the London firm in a commanding position, but gave to the world those researches on rosaniline for which Hofmann became so famous.

In the meantime, Perkin not only manufactured mauve, but was steadily working at the artificial products of alizarine, which he was able to obtain in 1868, and immediately produced it on the large scale. In 1873, recognising that a very largely increased manufacturing scale was necessary for the highest degree of success (a principle since so thoroughly carried out by the large German firms), Perkin decided to retire from business, and his works were sold. After some vicissitudes the business was transferred to Silvertown, where the British Alizarine Company carries on a large and successful manufacture of alizarine dyes.

From the beginning the development of the industry steadily continued, both in England and on the Continent. In 1859 Griess, a chemist employed at Allsopp's Brewery, discovered the first azo dye, which was manufactured in 1863 by Simpson, Maule, and Nicholson. This was the starting point of one of the most important branches of the colour industry, and was rapidly followed by many brilliant discoveries by Hofmann, Nicholson, Caro, Martius, and Witt in England, Girard and De Laire and Poirrier in France, and Baeyer, Böttiger, Duisberg, and many others in Germany.

The outcome of this has been that the colour industry has progressed to one of enormous importance. The combination of scientific research and business skill so strikingly exampled by Perkin and Nicholson has been applied in Germany with marvellous success, and has resulted in the development of several great firms, each employing several thousands of workmen and hundreds of chemists and engineers.

The example set by Englishmen has not been followed to the same extent in this country, and the industry, affected by the fall of one or two historic houses, has progressed but slowly.

In failing to synthesise what is perhaps the most important aid known to medicine, Perkin gave to medicine its most potent drugs; for the separation of hundreds of products from coal-tar has enabled chemists to prepare phenacetin, antipyrin, antifebrin (the latter actually produced on the large scale as a bye-product by Perkin), and many others. Extensive manufactories of saccharin, photographic developers, and pharmaceutical products have been erected, and, indeed, it is difficult to say where the far-reaching influence of Perkin's discovery may end.

One thing is sure, it is not to be measured by mere statistics; in the words of Hofmann, "the moral of Mauve. . . . is transparent enough. Whenever one of your chemical friends, full of enthusiasm, exhibits and explains to you his newly-discovered compound, you will not cool his noble ardour by asking him that most terrible of all questions, 'What is its use? Will your compound bleach or dye? Will it shave? May it be used as a substitute for leather?' Let him quietly go on with his work. The dye, the leather, will make their appearance in due time. Let him, I repeat, perform *his* task. Let him indulge in the pursuit of truth,—of truth pure and simple,—of truth not for the sake of Mauve,—let him pursue truth for the sake of truth!"

It was a peculiarly happy circumstance that the meeting to honour Sir William Henry Perkin should have been held in the Royal Institution. The most elementary constituent of coal-tar, viz. benzene, was discovered here by Faraday in 1825, and this was followed by Perkin's own discovery of mauve in his home laboratory. "Let me tell you then," said Hofmann in the lecture room in 1862, "that Mauve and Magenta are essentially Royal Institution colours: the foundation of this new industry was laid in Albemarle Street."

The whole of the chemical world was represented at the meeting on July 26, which was presided over by Prof. R. Meldola, F.R.S. It is only necessary to mention such names as Emil Fischer, H. Caro, Albin Haller, P. Friedländer, C. Duisberg, G. Schultz, A. Bernthsen, C. Liebermann, R. Möhlau, in order to indicate that the very foremost of foreign chemists were present, and all the representative English men of science and technology were to be seen at this historic gathering. The presentation of the Hofmann and Lavoisier gold medals, the foreign university degrees, and the great number of congratulatory addresses gave ample proof, were it needed, of the admiration with which all chemists regard the founder of this great industry.

At the dinner in the Whitehall Rooms in the evening (Prof. Meldola in the chair), tributes were paid by an even wider circle of appreciative admirers. Mr. Haldane, His Majesty's Secretary of State for War (who proposed the toast of the evening), the Earl of Halsbury, Lord Alverstone, Sir William Broadbent, Sir Henry Roscoe, Profs. E. Fischer and A. Haller, Sir Robert Pullar, and the chairman pointed out the benefits accruing, not merely to the colour industry, the dyeing trade, the medical profession, and science at large, but also to the whole world.

On the following day Sir William and Lady Perkin entertained a large number of guests at The Chestnuts, Sudbury, near Harrow. The old Greenford works and Sir William's private laboratory were visited, whilst in the beautiful garden one saw the madder plants which came from the late Dr. Schunck's garden in Manchester.

Sir William and Lady Perkin's reception in the Hall of the Leathersellers' Company concluded the festivities, which will never be forgotten by those who were privileged to take part in them.

J. C. CAIN.

THE SPORADIC PUBLICATION OF SCIENTIFIC PAPERS.

IN these latter days the development of science has led to an inverted fulfilment of the old prophecy, "Men shall run to and fro and knowledge shall be increased." Nowadays men have to run to and fro because knowledge is increased. A very considerable portion of the time of a man of science is taken up in "running to and fro" seeking for the papers which he wishes, which, indeed, he is bound to consult. There are various ways in which much of the time thus spent might be saved, and some of these ways are being more or less successfully made use of. One cause, however, of this "running to and fro" deserves special attention, because it seems really unnecessary, and the time spent through its continuance may be said to be time wholly wasted.

It has been my lot to receive almost at the same time a number of the Journal of the Marine Biological Association, a volume of the Scientific Memoirs of the Officers of the Medical and Sanitary Departments of the Government of India, a volume of the Thompson-Yates and Johnston Laboratories Reports, and the annual Report of the Medical Officer of Health to the Local Government Board.

All these contained papers of great scientific value, and I feel sure that many besides myself are continually having brought before them similar instances of the abundance of what I venture to call the sporadic publication of scientific papers. This has been very strikingly brought home to those who have had to do with the Royal Society's Catalogue of Scientific Papers or the International Catalogue of Scientific Literature.

Now two channels for the publication of scientific papers must be accepted without cavil.

In each country (for international publications, however desirable, present almost insurmountable mechanical difficulties) it is well that there should be a periodical devoted to each "branch" of science, and as time goes on each "branch" will naturally become more and more subdivided. This may be regarded as the natural, and, putting on one side historical considerations, the first channel.

But the publications of established academies and of the older special societies must be accepted also. The newer special societies would do well to make use of the special journals, in some such way as the Physiological Society makes use of the *Journal of Physiology*, and perhaps even some of the older ones might adopt the same methods.

In any case, there is no reason for special comment on these two channels. But things are different when we come to consider the kind of publication of which I have given examples above.

Let me take, for instance, the Journal of the Marine Biological Association, and the Thompson-Yates and Johnston Laboratories Reports. The number of the former is almost wholly occupied by a memoir of systematic zoology, the number of the latter by papers on trypanosomiasis. Why should the student in systematic zoology, who has possibly at some expense taken steps to secure ready access to the publications of the Zoological and Linnean Societies, have also to run after the Journal of the Marine Biological Association?

Why should the student in tropical diseases have to run hither and thither, seeking in this and that report what he ought to find ready at hand either in the *Journal of Comparative Pathology* or *Journal of Hygiene*, or some still more special periodical?

Now there can be no doubt that the *causa causans* of the two periodicals in question is advertisement. One cannot but sympathise with the efforts of the Marine Biological Association to make its worth known; one has also sympathy with the University of Liverpool, but less acute since its great merits are in everyone's mouth. But I venture to put the question, Is it desirable that, for the mere sake of advertisement, the progress of science should be hindered? For anything which puts obstacles in the way of the student getting ready access to a knowledge of what has been done is a distinct hindrance to progress. Why should not the Marine Biological Association spend the money which it has spent in printing the Hon. C. Eliot's valuable memoir on British nudibranchs in subsidising some acknowledged channel of zoological publication. It is well that the association should have a journal, but that journal ought to be occupied exclusively by business matters; all scientific papers of permanent value produced by help of the association ought to be published elsewhere.

In the same way, why should not the Liverpool University spend some of the ample funds at its disposal in subsidising periodicals, many at least of which are in urgent need of support? This would in the end be even a better advertisement.

The Lister Institute sets in this respect a very good example. It too has need of advertisement, but the results of the varied work carried on there are published each in an appropriate acknowledged channel. It limits its direct advertisement to issuing in a collected form reprints of the various papers scattered over many periodicals.

The scientific papers in Government publications stand on a somewhat different footing from those just spoken of. The Annual Report of the medical officer of the Local Government Board referred to above contains, besides several papers of direct administrative value, under the term "report" a number of valuable papers of a purely scientific character, papers to which every inquirer in pathology ought to have ready access. But why should a scientific library, and why especially should the limited library of a pathological institute or laboratory, for the sake of a mouthful of pure science, burden its shelves with an intolerable mass of administrative details? The publications of the medical officer of the Local Government Board do not stand alone in this respect. In the enormous mass of printed matter which H.M. Government puts out every year there are hidden, buried, lost to view, records of scientific research of varying but not unfrequently of great value, records to which the scientific inquirer ought to have ready access. This official burial of scientific work does a double harm; it harms him who did the work, it harms all those who, through the burial, miss knowing what has been done.

Of course it must be recognised that H.M. Government, having ordered and supplied the funds for a scientific inquiry, has a right of possession in the records of that inquiry, so that by the official publication of that record it may justify before Parliament and the public the order for the inquiry. The matter is further complicated by the fact that when the order for inquiry is part of the work of a Royal Commission, the results of such an inquiry cannot be made known until the report of the commission on its work as a whole is laid before Parliament and published.

But these difficulties are not such as cannot be overcome. A small Commission of the nature of what is known as a Departmental Committee, appointed some little time back to investigate plague in India, has, with the approval of the authorities, adopted the following plan. While making the usual arrangements for the reports on administrative matters, it proposes to publish from time to time the scientific results of the work of the commission in an appropriate scientific journal, securing, by the purchase of extra copies of the records thus published, the means for the complete publication of the whole work of the commission at some future period.

Such a plan might be extended to all scientific inquiries carried out by order of H.M. Government; it needs nothing more than frank negotiations between persons responsible to H.M. Government and editors of scientific periodicals. Such a plan would bring many blessings. It would enable the man of science who is putting his best into the work which he is doing for Government to feel that the record of his work will not be hopelessly lost sight of. It would save other men of science the labour of hunting for scientific needles in Government bottles of hay, or the chagrin of finding out, when too late, that by shrinking from such uncongenial labour they had missed something of great price. It would save the nation a not inconsiderable sum of money, and yet furnish the editors of scientific journals with money, which many of them need for the conduct of their journals, and which most of them at least would use in helping the poor author to a more complete publication of the records of his work. Lastly, it would relieve the bibliographer from much wearisome labour. In every way, in fact, it would tend to advance natural knowledge.

X.

THE YORK MEETING OF THE BRITISH ASSOCIATION.

THE York meeting of the British Association, which was opened as we went to press last night, promises to be a very large one. The local arrangements and the programmes of the various sections have already been described in these columns. Among the representatives from abroad who are expected at the meeting are the following:—Section A, Prof. H. Rubens, the University, Berlin; Prof. C. G. Rockwood, Prof. F. P. Whitman. Section B, Prof. Paul Pelseneer, Ghent; M. G. Grandidier, Paris; Dr. and Mrs. Yves Delage, Paris; Prof. Looss, Cairo; Prof. Gary N. Calkins, New York; Prof. H. F. E. Jungerson, Copenhagen; Dr. Gustave Loisel, Utrecht. Section C, Prof. Edgworth David, Sydney. Section E, Prof. Loezy, Budapest. Section F, Prof. K. Wicksell, Lund. Section K, Prof. W. Johannsen, Copenhagen; Prof. C. H. Ostenfeld, Copenhagen; Dr. C. Rosenberg, Stockholm; Prof. E. Pfitzer, Heidelberg; Prof. and Mrs. Jeffrey, Harvard University; Prof. Ligrier, Caen; Prof. H. Potonie, Berlin. Corresponding member, Prof. C. Julin, Liége.

The Court of the University of Leeds has resolved to confer the honorary degree of D.Sc. upon the following in connection with this meeting of the Association:—Prof. E. Ray Lankester, F.R.S.; Prof. A. Grandidier, of Paris; Prof. P. Pelseneer, of Ghent; and Prof. H. Rubens, of Berlin. The degree of D.Sc. will be conferred upon the following in connection with the meeting of the Association and also with the coal-tar colour jubilee:—Sir W. H. Perkin, Dr. Heinrich Caro, of Mannheim; Prof. Albin Haller, of Paris; Prof. C. Liebermann, of Berlin; and Dr. C. A. von Martins, of Berlin.

INAUGURAL ADDRESS BY PROF. E. RAY LANKESTER, M.A., LL.D., D.Sc., F.R.S., F.L.S., DIRECTOR OF THE NATURAL HISTORY DEPARTMENTS OF THE BRITISH MUSEUM, PRESIDENT OF THE ASSOCIATION.

MY LORDS, LADIES AND GENTLEMEN,—It is, first of all, my privilege to thank you for the distinguished honour you have done me in electing me President of this great scientific Association—an honour which is enhanced by the fact that our meeting this year is once more held in the venerable city of York, in which seventy-five years ago the British Association for the Advancement of Science held its first meeting.

It is a great pleasure to me to convey to the Lord Mayor and the dignitaries and citizens of York your hearty thanks for the invitation to meet this year in their city. It seems to have become a custom that the Association should be invited at regular intervals to assemble in the city where it took birth and to note the progress made in the objects for the furtherance of which it was founded. A quarter of a century ago we met here under the presidency of that versatile leader in public affairs—Sir John Lubbock, now Lord Avebury. That occasion was the jubilee—the fiftieth anniversary—of the Association.

Lord Avebury on that occasion gave as his presidential address a survey of the progress of science during the fifty years of the Association's existence. He had a wonderful story to tell, and told it with a fulness which was only possible to one of his wide range of knowledge and keen interest in the various branches of science. If I venture on the present occasion to say a few words as to the great features in the progress of our knowledge of Nature during the last twenty-five years, it will be readily understood that the mere volume of new knowledge to be surveyed has become so vast that a full and detailed statement such as that which Lord Avebury placed before the Association at its jubilee is no longer possible in a single address delivered from the President's chair.

Let me ask you before we go further to take for a few moments a more personal retrospect and to think of the founders of this Association, then of the great workers in science who were still alive in 1881 when last we met here and have since gone from among us, leaving their great deeds and their noble enthusiasm to inspire now and for all future time those who have vowed themselves to the advancement of science in this realm of Britain.

There must be some here who had the privilege of personal acquaintance with several of the men who founded this Association in York seventy-five years ago. I myself knew Prof. John Phillips, Sir Charles Lyell, Sir Roderick Murchison, Sir David Brewster, Dr. Whewell, and Mr. Harcourt of Nuneham. All these fathers of our Association had passed away before our last meeting in York. And now, in the quarter of a century which has rolled by and brought us here again, we have lost many who took an active part in its annual meetings and were familiar figures in the scientific world of the later Victorian period. Huxley and Tyndall, Spottiswoode and Cayley, Owen and Flower, Williamson and Frankland, Falconer and Busk, Prestwich and Godwin Austen, Rolleston and Henry Smith, Stokes and Tait, and many others are in that list, including one whose name was, and is, more often heard in our discussions than any other, though he himself never was able to join us—I mean Charles Darwin. Happily some of the scientific veterans of the nineteenth century are still living, if not with us in York. Sir Joseph Hooker, who visited the Antarctic with Ross in 1839, is still hale and hearty, and so are Alfred Russel Wallace, Lord Kelvin, Sir William Huggins, and many others who were already veteran leaders in scientific investigation when last we visited York: they are still active in thought, observation, and experiment.

In attempting to give an outline of the advancement of science in the past twenty-five years I think it is necessary to distinguish two main kinds of advancement, both of which our founders had in view. Francis Bacon gave the title "Advancement of Learning" to that book in which he explained not merely the methods by which the increase of knowledge was possible, but advocated the promotion of knowledge to a new and influential position in the organisation of human society. His purpose, says Dean Church, was "to make knowledge really and intelligently the interest, not of the school or the study or the laboratory only, but of society at large." This is what our founders also intended by their use of the word "advancement." So that in surveying the advancement of science in the past quarter of a century we of the British Association must ask not only what are the new facts discovered, the new ideas and conceptions which have come into activity, but what progress has science made in becoming really and intelligently the interest of society at large. Is there evidence that there is an increase in the influence of science on the lives of our fellow-citizens and in the great affairs of the State? Is there an increased provision for securing the progress of scientific investigation in proportion to the urgency of its need or an increased disposition to secure the employment of really competent men trained in scientific investigation for the public service?

I. THE INCREASE OF KNOWLEDGE IN THE SEVERAL BRANCHES OF SCIENCE.

The boundaries of my own understanding and the practical consideration of what is appropriate to a brief address must limit my attempt to give to the general public who follow with friendly interest our proceedings some presentation of what has been going on in the workshops of science in this last quarter of a century. My point of view is essentially that of the naturalist, and in my endeavour to speak of some of the new things and new properties of things discovered in recent years I find it is impossible to give any systematic or detailed account of what has been done in each division of science. All that I can attempt is to mention some of the discoveries which have aroused my own interest and admiration. I feel, indeed, that it is necessary to ask your forbearance for my presumption in daring to speak of so many subjects in which I cannot claim to speak as an authority, but only as a younger brother full of fraternal pride and sympathy in the glorious achievements of the great experimentalists and discoverers of our day. The duty of attempting some indication of their work is placed upon me as your President, and it is for my effort to discharge that duty that I ask your generous consideration.

As one might expect, the progress of the knowledge of nature (for it is to that rather than to the historical, moral and mental sciences that English-speaking people refer when they use the word "science") has consisted, in the last twenty-five years, in the amplification and fuller verification of principles and theories already accepted, and in the discovery of hitherto unknown things which either have fallen into place in the existing scheme of each science or have necessitated new views, some not very disturbing to existing general conceptions, others of a more startling and, at first sight, disconcerting character. Nevertheless I think I am justified in saying that, exciting and of entrancing interest as have been some of the discoveries of the past few years, there has been nothing to lead us to conclude that we have been on the wrong path —nothing which is really revolutionary; that is to say, nothing which cannot be accepted by an intelligible modification of previous conceptions. There is, in fact, continuity and healthy evolution in the realm of science. Whilst some onlookers have declared to the public that science is at an end, its possibilities exhausted, and but little of the hopes it raised realised, others have asserted, on the contrary, that the new discoveries—such as those relating to the X-rays and to radium—are so inconsistent with previous knowledge as to shake the foundations of science, and to justify a belief in any and every absurdity of an unrestrained fancy. These two reciprocally destructive accusations are due to a class of persons who must be described as the enemies of science. Whether their attitude is due to ignorance or traditions of self-interest, such persons exist; and it is one of the objects of this Association to combat their assertions and to demonstrate, by the discoveries announced at its meetings and the consequent orderly building up of the great fabric of "natural knowledge," that Science has not come to the end of her work—has, indeed, only as yet given mankind a foretaste of what she has in store for it—that her methods and her accomplished results are sound and trustworthy, serving with perfect adaptability for the increase of true discovery and the expansion and development of those general conceptions of the processes of nature at which she aims.

New Chemical Elements.—There can be no doubt that the past quarter of a century will stand out for ever in human history as that in which new chemical elements, not of an ordinary type, but possessed of truly astounding properties, were made known with extraordinary rapidity and sureness of demonstration. Interesting as the others are, it is the discovery of radio-activity and of the element radium which so far exceeds all others in importance that we may well account it a supreme privilege that it has fallen to our lot to live in the days of this discovery. No single discovery ever made by the searchers of nature even approaches that of radio-activity in respect of the novelty of the properties of matter suddenly revealed by it. A new conception of the structure of matter is necessitated and demonstrated by it, and yet, so far from being destructive and disconcerting, the new conception fits in with, grows out of, and justifies the older schemes which our previous knowledge has formulated.

Before saying more of radio-activity, which is apt to eclipse in interest every other topic of discourse, I must recall to you the discovery of the five inert gaseous elements by Rayleigh and Ramsay, which belongs to the period on which we are looking back. It was found that nitrogen obtained from the atmosphere invariably differed in weight from nitrogen obtained from one of its chemical combinations; and thus the conclusion was arrived at by Rayleigh that a distinct gas is present in the atmosphere, to the extent of 1 per cent., which had hitherto passed for nitrogen. This gas was separated, and to it the name argon (the lazy one) was given, on account of its incapacity to combine with any other element. Subsequently this argon was found by Ramsay to be itself impure, and from it he obtained three other gaseous elements equally inert: namely neon, krypton, and xenon. These were all distinguished from one another by the spectrum, the sign-manual of an element given by the light emitted in each case by the gas when in an incandescent condition. A fifth inert gaseous element was discovered by Ramsay as a constituent of certain minerals which was proved by its spectrum to be identical with an element discovered twenty-five years ago by Sir Norman Lockyer in the atmosphere of the sun, where it exists in enormous quantities. Lockyer had given the name helium to this new solar element, and Ramsay thus found it locked up in certain rare minerals in the crust of the earth.

But by helium we are led back to radium, for it was found only two years ago by Ramsay and Soddy that helium is actually formed by a gaseous emanation from radium. Astounding as the statement seems, yet that is one of the many unprecedented facts which recent study has brought to light. The alchemist's dream is, if not realised, at any rate justified. One element is actually under our eyes converted into another; the element radium decays into a gas which changes into another element, namely helium.

Radium, this wonder of wonders, was discovered owing to the study of the remarkable phosphorescence, as it is called—the glowing without heat—of glass vacuum-tubes through which electric currents are made to pass. Crookes, Lenard, and Röntgen each played an important part in this study, showing that peculiar rays or linear streams of at least three distinct kinds are set up in such tubes—rays which are themselves invisible, but have the property of making glass or other bodies which they strike glow with phosphorescent light. The celebrated Röntgen rays make ordinary glass give out a bright green light; but they pass through it, and cause phosphorescence outside in various substances, such as barium platino-cyanide, calcium tungstate, and many other such salts; they also act on a photographic plate and discharge an electrified body such as an electroscope. But the most remarkable feature about them is their power of penetrating substances opaque to ordinary light. They will pass through thin metal plates or black paper or wood, but are stopped by more or less dense material. Hence it has been possible to obtain "shadow pictures" or skiagraphs by allowing the invisible Röntgen rays to pass through a limb or even a whole animal, the denser bone stopping the rays, whilst the skin, flesh, and blood let them through. They are allowed to fall (still invisible) on to a photographic plate, when a picture like an ordinary permanent photograph is obtained by their chemical action, or they may be made to exert their phosphorescence-producing power on a glass plate covered with a thin coating of a phosphorescent salt such as barium platino-cyanide, when a temporary picture in light and shade is seen.

The rays discovered by Röntgen were known as the X-rays, because their exact nature was unknown. Other rays studied in the electrified vacuum-tubes are known as kathode rays or radiant corpuscles, and others, again, as the Lenard rays.

It occurred to M. Henri Becquerel, as he himself tells us, to inquire whether other phosphorescent bodies besides the glowing vacuum-tubes of the electrician's laboratory can emit penetrating rays like the X-rays. I say "other phosphorescent bodies," for this power of glowing without heat—of giving out, so to speak, cold light—is known to be possessed by many mineral substances. It has become familiar to the public in the form of "phosphorescent paint," which contains sulphide of calcium, a substance which shines in the dark after exposure to sunlight—that is to say, is phosphorescent. Other sulphides and the minerals fluor-spar, apatite, some gems, and, in fact, a whole list of substances have, under different conditions of treatment, this power of phosphorescence or shining in the dark without combustion or chemical change. All, however, require some special treatment, such as exposure to sunlight or heat or pressure, to elicit the phosphorescence, which is of short duration only. Many of the compounds of a somewhat uncommon metallic element, called uranium, used for giving a fine green colour to glass, are phosphorescent substances, and it was, fortunately, one of them which Henri Becquerel chose for experiment. Henri Becquerel is professor in the Jardin des Plantes of Paris; his laboratory is a delightful old-fashioned building, which had for me a special interest and sanctity when, a few years ago, I visited him there, for, a hundred years before, it was the dwelling-house of the great Cuvier. Here Henri Becquerel's father and grandfather—men renowned throughout the world for their discoveries in mineralogy, electricity, and light—had worked, and here he had himself gone almost daily from his earliest childhood. Many an experiment bringing new knowledge on the relations of light and electricity had Henri Becquerel carried out in that quiet old-world place before the day on which, about twelve years ago, he made the experimental inquiry, Does uranium give off penetrating rays like Röntgen's rays? He wrapped a photographic plate in black paper, and on it placed and left lying there for twenty-four hours some uranium salt. He had placed a cross, cut out in thin metallic copper, under the uranium powder, so as to give some shape to the photographic print should one be produced. It *was* produced. Penetrating rays were given off by the uranium: the black paper was penetrated, and the form of the copper cross was printed on a dark ground. The copper was also penetrated to some extent by the rays from the uranium, so that its image was not left actually white. Only one step more remained before Becquerel made his great discovery. It was known, as I stated just now, that sulphide of calcium and similar substances *become* phosphorescent when exposed to sunlight, and lose this phosphorescence after a few hours. Becquerel thought at first that perhaps the uranium acquired its power similarly by exposure to light; but very soon, by experimenting with uranium long kept in the dark, he found that the emission of penetrating rays, giving photographic effects, was produced spontaneously. The emission of rays by this particular fragment of uranium has shown no sign of diminution since this discovery. The emission of penetrating rays by uranium was soon found to be independent of its phosphorescence. Phosphorescent bodies, as such, do not emit penetrating rays. Uranium compounds, whether phosphorescent or not, emit, and continue to emit, these penetrating rays, capable of passing through black paper and metallic copper. They do not derive this property from the action of light or any other treatment. The emission of these rays discovered by Becquerel is a new property of matter. It is called "radio-activity," and the rays are called Becquerel rays.

From this discovery by Becquerel to the detection and separation of the new element radium is an easy step in thought, though one of enormous labour and difficulty in practice. Prof. Pierre Curie (whose name I cannot mention without expressing the grief with which we all heard in April last of the sad accident by which his life was taken) and his wife, Madame Sklodowski Curie, incited by Becquerel's discovery, examined the ore called pitch-blende which is worked in mines in Bohemia and is found also in Cornwall. It is the ore from which all commercial uranium is extracted. The Curies found that pitch-blende has a radio-activity four times more powerful than that of metallic uranium itself. They at once conceived the idea that the radio-activity of the uranium salts examined by Becquerel is due not to the uranium itself, but to another element present with it in variable quantities. This proved to be in part true. The refuse of the first processes by which in the manufacturer's works the uranium is extracted from its ore, pitch-blende, was found to contain four times more of the radio-active matter than does the pure uranium. By a long series of fusions, solutions, and crystallisations the Curies succeeded in "hunting down," as it were, the radio-active element. The first step gave them a powder mixed with barium chloride, and having 2000 times the activity of the uranium in which Becquerel first proved the existence of the new property—radio-activity. Then step by step they purified it to a condition 10,000 times, then to 100,000 times, and finally to the condition of a crystalline salt having 1,800,000 times the activity of Becquerel's sample of uranium. The purification could go no further, but the extraordinary minuteness of the quantity of the pure radio-active substance obtained and the amount of labour and time expended in preparing it may be judged from the fact that of one ton of the pitch-blende ore submitted to the process of purification only the hundredth of a gram—the one-seventh of a grain—remained.

The amount of radium in pitch-blende is one ten-millionth per cent.; rarer than gold in sea-water. The marvel of this story and of all that follows consists largely in the skill and accuracy with which our chemists and physicists have learnt to deal with such infinitesimal quantities, and the gigantic theoretical results which are securely posed on this pin-point of substantial matter.

The Curies at once determined that the minute quantity of colourless crystals they had obtained was the chloride of a new metallic element with the atomic weight 225, to which they gave the name radium. The proof that radium is an element is given by its "sign-manual"—the spectrum which it shows to the observer when in the incandescent state. It consists of six bright lines and three fainter lines in the visible part of the spectrum, and of three very intense lines in the ultra-violet (invisible) part. A very minute quantity is enough for this observation; the lines given by radium are caused by no other known element in heaven or earth. They prove its title to be entered on the roll-call of elements.

The atomic weight was determined in the usual way by precipitating the chlorine in a solution of radium chloride by means of silver. None of the precious element was lost in the process, but the Curies never had enough of it to venture on any attempt to prepare pure metallic radium. This is a piece of extravagance no one has yet dared to undertake. Altogether the Curies did not have more than some four or five grains of chloride of radium to experiment with, and the total amount prepared and now in the hands of scientific men in various parts of the world probably does not amount to more than sixty grains at most. When Prof. Curie lectured on radium four years ago at the Royal Institution in London he made use of a small tube an inch long and of one-eighth inch bore, containing nearly the whole of his precious store, wrenched by such determined labour and consummate skill from tons of black shapeless pitch-blende. On his return to Paris he was one day demonstrating in his lecture room with this precious tube the properties of radium when it slipped from his hands, broke, and scattered far and wide the most precious and magical powder ever dreamed of by alchemist or artist of romance. Every scrap of dust was immediately and carefully collected, dissolved, and re-crystallised, and the disaster averted with a loss of but a minute fraction of the invaluable product.

Thus, then, we have arrived at the discovery of radium—the new element endowed in an intense form with the new property "radio-activity" discovered by Becquerel. The wonder of this powder, incessantly and without loss, under any and all conditions pouring forth by virtue of its own intrinsic property powerful rays capable of penetrating opaque bodies and of exciting phosphorescence and acting on photographic plates, can perhaps be realised when we reflect that it is as marvellous as though we should dig up a stone which without external influence or change, continually poured forth light or heat, manufacturing both in itself, and not only continuing to do so without appreciable loss or change, but necessarily having always done so for countless ages whilst sunk beyond the ken of man in the bowels of the earth.

Wonderful as the story is, so far it is really simple and commonplace compared with what yet remains to be told. I will only barely and abruptly state the fact that radio-activity has been discovered in other elements, some very rare, such as actinium and polonium; others more abundant and already known, such as thorium and uranium, though their radio-activity was not known until Becquerel's pioneer-discovery. It is a little strange and no doubt significant that, after all, pure uranium is found to have a radio-activity of its own and not to have been altogether usurping the rights of its infinitesimal associate.

The wonders connected with radium really begin when the experimental examination of the properties of a few grains is made. What I am saying here is not a systematic, technical account of radium; so I shall venture to relate some of the story as it impresses me.

Leaving aside for a moment what has been done in regard to the more precise examination of the rays emitted by radium, the following astonishing facts have been found out in regard to it: (1) If a glass tube containing radium is much handled or kept in the waistcoat pocket, it produces a destruction of the skin and flesh over a small area—in fact, a sore place. (2) The smallest trace of radium brought into a room where a charged electroscope is present, causes the discharge of the electroscope. So powerful is this electrical action of radium that a very sensitive electrometer can detect the presence of a quantity of radium five hundred thousand times more minute than that which can be detected by the spectroscope (that is to say, by the spectroscopic examination of a flame in which minute traces of radium are present). (3) Radium actually realises one of the properties of the hypothetical stone to which I compared it, giving out light and heat. For it does give out heat which it makes itself incessantly and without appreciable loss of substance or energy ("appreciable" is here an important qualifying term). It is also faintly self-luminous. Fairly sensitive thermometers show that a few granules of radium salt have always a higher temperature than that of surrounding bodies. Radium has been proved to give out enough heat to melt rather more than its own weight of ice every hour; enough heat in one hour to raise its own weight of water from the freezing-point to the boiling-point. After a year and six weeks a gram of radium has emitted enough heat to raise the temperature of a thousand kilograms of water one degree. And this is always going on. Even a small quantity of radium diffused through the earth will suffice to keep up its temperature against all loss by radiation! If the sun consists of a fraction of one per cent. of radium, this will account for and make good the heat that is annually lost by it.

This is a tremendous fact, upsetting all the calculations of physicists as to the duration in past and future of the sun's heat and the temperature of the earth's surface. The geologists and the biologists have long contended that some thousand million years must have passed during which the earth's surface has presented approximately the same conditions of temperature as at present, in order to allow time for the evolution of living things and the formation of the aqueous deposits of the earth's crust. The physicists, notably Prof. Tait and Lord Kelvin, refused to allow more than ten million years (which they subsequently increased to a hundred million)—basing this estimate on the rate of cooling of a sphere of the size and composition of the earth. They have assumed that its material is self-cooling. But, as Huxley pointed out, mathematics will not give a true result when applied to erroneous data. It has now, within these last five years, become evident that the earth's material is *not* self-cooling, but on the contrary self-heating. And away go the restrictions imposed by physicists on geological time. They now are willing to give us not merely a thousand million years, but as many more as we want.

And now I have to mention the strangest of all the proceedings of radium—a proceeding in which the other radio-active bodies, actinium and thorium, resemble it. This proceeding has been entirely Rutherford's discovery in Canada, and his name must be always associated with it. Radium (he discovered) is continually giving off, apart from and in addition to the rectilinear darting rays of Becquerel—an "emanation"—a gaseous "emanation." This "emanation" is radio-active—that is, gives off Becquerel rays—and deposits "something" upon bodies brought near the radium, so that they become radio-active, and remain so for a time after the radium is itself removed. This emanation is always being formed by a radium salt, and may be most easily collected by dissolving the salt in water, when it comes away with a rush, as a gas. Sixty milligrams of bromide of radium yielded to Ramsay and Soddy 0·124 (or about one-eighth) of a cubic millimetre of this gaseous emanation. What is it? It cannot be destroyed or altered by heat or by chemical agents; it is a heavy gas, having a molecular density of 100, and it can be condensed to a liquid by exposing it to the great cold of liquid air. It gives a peculiar spectrum of its own, and is probably a hitherto unknown inert gas—a new element similar to argon. But this by no means completes its history, even so far as experiments have as yet gone. The radium emanation decays, changes its character altogether, and loses half its radio-activity every four days. Precisely at the same rate as it decays the specimen of radium salt from which it was removed forms a new quantity of emanation, having just the amount of radio-activity which has been lost by the old emanation. All is not known about the decay of the emanation, but one thing is absolutely certain, having first been discovered by Ramsay and Soddy and subsequently confirmed by independent experiment by Madame Curie. It is this: After being kept three or four days the emanation becomes, in part at least, converted into helium—the light gas (second only in the list of elements to hydrogen), the gas found twenty-five years ago by Lockyer in the sun, and since obtained in some quantities from rare radio-active minerals by Ramsay! The proof of the formation of helium from the radium emanation is, of course, obtained by the spectroscope, and its evidence is beyond assail. Here, then, is the partial conversion or decay of one element, radium, through an intermediate stage into another. And not only that, but if, as seems probable, the presence of helium indicates the previous presence of radium, we have the evidence of enormous quantities of radium in the sun, for we know helium is there in vast quantity. Not only that, but inasmuch as helium has been discovered in most hot springs and in various radio-active minerals in the earth, it may be legitimately argued that no inconsiderable quantity of radium is present in the earth. Indeed, it now seems probable that there is enough radium in the sun to keep up its continual output of heat, and enough in the earth to make good its loss of heat by radiation into space, for an almost indefinite period. Other experiments of a similar kind have rendered it practically certain that radium itself is formed by a somewhat similar transformation of uranium, so that our ideas as to the permanence and immutability on this globe of the chemical elements are destroyed, and must give place to new conceptions. It seems not improbable that the final product of the radium emanation after the helium is removed is or becomes the metal lead!

It must be obvious from all the foregoing that radium is very slowly, but none the less surely, destroying itself. There is a definite loss of particles which, in the course of time, must lead to the destruction of the radium, and it would seem that the large new credit on the bank of time given to biologists in consequence of its discovery has a definite, if remote, limit. With the quantities of radium at present available for experiment, the amount of loss of particles is so small, and the rate so slow, that it cannot be weighed by the most delicate balance. Nevertheless it has been calculated that radium will transform half of itself in about fifteen hundred years, and unless it were being produced in some way all the radium now in existence would disappear much too soon to make it an important geological factor in the maintenance of the earth's temperature. As a reply to this depreciatory statement we have the discovery by Rutherford and others that radium is continually being formed afresh, and from that particular element in connection with which it was discovered—namely, uranium. Hypotheses and experiments as to the details of this process are at this moment in full swing, and results of a momentous kind, involving the building-up of an element with high atomic weight by the interaction of elements with a lower atomic weight, are thought by some physicists to be not improbable in the immediate future.

The delicate electric test for radio-activity has been largely applied in the last few years to all sorts and conditions of matter. As a result it appears that the radium emanation is always present in our atmosphere; that the air in caves is especially rich in it, as are underground waters. Tin-foil, glass, silver, zinc, lead, copper, platinum and aluminium are, all of them, slightly radio-active. The question has been raised whether this widespread radio-activity is due to the wide dissemination of infinitesimal quantities of strong radio-active elements, or whether it is the natural intrinsic property of all matter to emit Becquerel rays. This is the immediate subject of research.

Over and above the more simply appreciable facts which I have thus narrated, there comes the necessary and difficult inquiry, What does it all mean? What *are* the Becquerel rays of radio-activity? What must we conceive to be the structure and mechanism of the atoms of radium and allied elements, which can not only pour forth ceaseless streams of intrinsic energy from their own isolated substance, but are perpetually, though in infinitesimal proportions, changing their elemental nature spontaneously, so as to give rise to other atoms which we recognise as other elements?

I cannot venture as an expositor into this field. It belongs to that wonderful group of men, the modern physicists, who with an almost weird power of visual imagination combine the great instrument of exact statement and mental manipulation called mathematics, and possess an ingenuity and delicacy in appropriate experiment which must fill all who even partially follow their triumphant handling of nature with reverence and admiration. Such men now or recently among us are Kelvin, Clerk Maxwell, Crookes, Rayleigh, and J. J. Thomson.

Becquerel showed early in his study of the rays emitted by radium that some of them could be bent out of their straight path by making them pass between the poles of a powerful electromagnet. In this way have finally been distinguished three classes of rays given off by radium: (1) the *alpha* rays, which are only slightly bent, and have little penetrative power; (2) the *beta* rays, easily bent in a direction opposite to that in which the alpha rays bend, and of considerable penetrative power; (3) the *gamma* rays, which are absolutely unbendable by the strongest magnetic force, and have an extraordinary penetrative power, producing a photographic effect through a foot thickness of solid iron.

The *alpha* rays are shown to be streams of tiny bodies positively electrified, such as are given off by gas flames and red-hot metals. The particles have about twice the mass of a hydrogen atom, and they fly off with a velocity of 20,000 miles a second; that is, 40,000 times greater than that of a rifle bullet. The heat produced by radium is ascribed to the impact of these particles of the alpha rays.

The *beta* rays are streams of corpuscles similar to those given off by the kathode in a vacuum tube. They are charged with negative electricity and travel at the velocity of 100,000 miles a second. They are far more minute than the alpha particles. Their mass is equal to the one-thousandth of a hydrogen atom. They produce the major part of the photographic and phosphorescent effects of the radium rays.

The *gamma* rays are apparently the same, or nearly the same, thing as the X-rays of Röntgen. They are probably not particles at all, but pulses or waves in the ether set up during the ejection of the corpuscles which constitute the beta rays. They produce the same effects in a much smaller degree as do the beta rays, but are more penetrating.

The kind of conceptions to which these and like discoveries have led the modern physicist in regard to the character of that supposed unbreakable body—the chemical atom—the simple and unaffected friend of our youth—are truly astounding. But I would have you notice that they are not destructive of our previous conceptions, but rather elaborations and developments of the simpler views, introducing the notion of structure and mechanism, agitated and whirling with tremendous force, into what we formerly conceived of as homogeneous or simply built-up particles, the earlier conception being not so much a positive assertion of simplicity as a non-committal expectant formula awaiting the progress of knowledge and the revelations which are now in our hands.

As I have already said, the attempt to show in detail how the marvellous properties of radium and radio-activity in general are thus capable of a pictorial or structural representation is beyond the limits both of my powers and the time allowed me; but the fact that such speculations furnish a scheme into which the observed phenomena can be fitted is what we may take on the authority of the physicists and chemists of our day.

Intimately connected with all the work which has been done in the past twenty-five years in the nature and possible transformations of atoms is the great series of investigations and speculations on astral chemistry and the development of the chemical elements which we owe to the unremitting labour during this period of Sir Norman Lockyer.

Wireless Telegraphy.—Of great importance has been the whole progress in the theory and practical handling of electrical phenomena of late years. The discovery of the Hertzian waves and their application to wireless telegraphy is a feature of this period, though I may remind some of those who have been impressed by these discoveries that the mere fact of electrical action at a distance is that which hundreds of years ago gave to electricity its name. The power which we have gained of making an instrument oscillate in accordance with a predetermined code of signalling, although detached and a thousand miles distant, does not really lend any new support to the notion that the old-time beliefs of thought-transference and second sight are more than illusions based on incomplete observation and imperfect reasoning. For the important factors in such human intercourse—namely, a signalling-instrument and a code of signals—have not been discovered, as yet, in the structure of the human body, and have to be consciously devised and manufactured by man in the only examples of thought-transference over long distances at present discovered or laid bare to experiment and observation.

High and Low Temperatures.—The past quarter of a century has witnessed a great development and application of the methods of producing both very low and very high temperatures. Sir James Dewar, by improved apparatus, has produced liquid hydrogen and a fall of temperature probably reaching to the absolute zero. A number of applications of extremely low temperatures to research in various directions has been rendered possible by the facility with which they may now be produced. Similarly high temperatures have been employed in continuation of the earlier work of Deville, and others by Moissan, the distinguished French chemist.

Progress in Chemistry.—In chemistry generally the theoretical tendency guiding a great deal of work has been the completion and verification of the "periodic law" of Mendeléeff; and, on the other hand, the search by physical agents such as light and electricity for evidence as to the arrangement of atoms in the molecules of the most diverse chemical compounds. The study of "valency" and its outcome, stereochemistry, have been the special lines in which chemistry has advanced. As a matter of course hundreds, if not thousands, of new chemical bodies have been produced in the laboratory of greater or less theoretical interest. The discovery of the greatest practical and industrial importance in this connection is the production of indigo by synthetical processes, first by laboratory and then by factory methods, so as to compete successfully with the natural product. Von Baeyer and Heumann are the names associated with this remarkable achievement, which has necessarily dislocated a large industry which derived its raw material from British India.[1]

Astronomy.—A biologist may well refuse to offer any remarks on his own authority in regard to this earliest and grandest of all the sciences. I will therefore at once say that my friend the Savilian Professor of Astronomy in Oxford has turned my thoughts in the right direction in regard to this subject. There is no doubt that there has been an immense "revival" in astronomy since 1881; it has developed in every direction. The invention of the "dry plate," which has made it possible to apply photography freely in all astronomical work, is the chief cause of its great expansion. Photography was applied to astronomical work before 1881, but only with difficulty and haltingly. It was the dry-plate which made long exposures possible, and thus enabled astronomers to obtain regular records of faintly luminous objects such as nebulæ and star-spectra. Roughly speaking, the number of stars

[1] I had at first intended to give in this address a more detailed and technical statement of the progress of science than I have found possible when actually engaged in its preparation. The limits of time and space render any such survey on this occasion impossible, and, moreover, the patience of even the general meeting of the British Association cannot be considered as unlimited. With a view to the preparation of a more detailed review, I had asked a number of friends and colleagues to send me notes on the progress and tendency in their own particular branches of science. They responded with the greatest generosity and unselfishness. I must entirely disclaim for them any responsibility for the brief detached statements made in the address. At the same time I should wish to thank them here by name for their most kind and timely help. They are: Sir William Ramsay, Mr. Soddy, Prof. H. H. Turner, Dr. Marr, Dr. Haddon, Dr. Smith Woodward, Prof. Sherrington, Prof. Farmer, Prof. Vines, Dr. D. H. Scott, Prof. Meldola, Dr Macdougal, Prof. Poulton, Mr. C. V. Boys Major MacMahon, and Mr. Mackinder.

visible to the naked eye may be stated as eight thousand; this is raised by the use of our best telescopes to a hundred million. But the number which can be photographed is indefinite and depends on length of exposure: a thousand million can certainly be so recorded.

The serious practical proposal to "chart the sky" by means of photography certainly dates from this side of 1881. The Paris Conference of 1887, which made an international scheme for sharing the sky among eighteen observatories (still busy with the work, and producing excellent results), originated with photographs of the comet of 1882, taken at the Cape Observatory.

Prof. Pickering, of Harvard, did not join this cooperative scheme, but has gradually devised methods of charting the sky very rapidly, so that he has at Harvard records of the whole sky many times over, and when new objects are discovered he can trace their history *backwards* for more than a dozen years by reference to his plates. This is a wonderful new method, a mode of keeping record of present movements and changes which promises much for the future of astronomy. By the photographic method hundreds of new variable stars and other interesting objects have been discovered. New planets have been detected by the hundred. Up to 1881 two hundred and twenty were known. In 1881 only one was found; namely, Stephania, being No. 220, discovered on May 19. Now a score at least are discovered every year. More than five hundred are now known. One of these—Eros (No. 433)—is particularly interesting, since it is nearer to the sun than is Mars, and gives a splendid opportunity for fixing with increased accuracy the sun's distance from the earth. Two new satellites to Saturn and two to Jupiter have been discovered by photography (besides one to Jupiter in 1892 by the visual telescope of the Lick Observatory). One of the new satellites of Saturn goes round that planet the *wrong way*, thus calling for a fundamental revision of our ideas of the origin of the solar system.

The introduction of photography has made an immense difference in spectroscopic work. The spectra of the stars have been readily mapped out and classified, and now the motions in the line of sight of faint stars can be determined. This "motion in the line of sight," which was discernible but scarcely measurable with accuracy before, now provides one of the most refined methods in astronomy for ascertaining the dimensions and motions of the universe. It gives us velocities in miles per second instead of in an angular unit to be interpreted by a very imperfect knowledge of the star's distance. The method was in 1881 a mere curiosity, which Huggins was almost alone in having examined, though visual measures had been begun at Greenwich in 1875, and were continued for many years, only to be ultimately found to be affected by systematic error. The photographic method started by Vogel in 1887 really has made all the difference, and this work is now a vast department of astronomical industry. Among other by-products of the method are the "spectroscopic doubles," stars which we know to be double, and of which we can determine the period of revolution, though we cannot separate them visually by the greatest telescope.

Work on the sun has been entirely revolutionised by the use of photography. The last decade has seen the invention of the spectroheliograph—which simply means that astronomers can now study *in detail* portions of the sun of which they could previously only get a bare indication.

More of the same story could be related, but enough has been said to show how full of life and progress is this most ancient and imposing of all sciences.

A minor though very important influence in the progress of astronomy has been the provision, by the expenditure of great wealth in America, of great telescopes and equipments.

In 1877 my distinguished predecessor in the presidency of the British Association started a line of mathematical research which has been very fruitful and is of great future promise for astronomy. He was able himself last year to give some account of this research to the Association. On the present occasion I may mention that as recently as last April, at the Royal Astronomical Society, two important papers were read—one by Mr. Cowell and the other by Mr. Stratton—which have their roots in Sir George Darwin's work. The former was led to suggest that the day is lengthening ten times as rapidly as had been supposed, and the latter showed that in all probability the planets had all turned upside down since their birth.

And yet M. Brunettière and his friends wish us to believe that science is bankrupt, and has no new things in store for humanity.

Geology.—In the field of geological research the main feature in the past twenty-five years has been the increasing acceptance of the evolutionary as contrasted with the uniformitarian view of geological phenomena. The great work of Suess, "Das Antlitz der Erde," is undoubtedly the most important contribution to physical geology within the period. The first volume appeared in 1885, and the impetus which it has given to the science may be judged by the epithet applied to the views for which Suess is responsible—"the New Geology." Suess attempts to trace the orderly sequence of the principal changes in the earth's crust since it first began to form. He strongly opposes the old theory of elevation, and accounts for the movements as due to differential collapse of the crust, accompanied by folding due to tangential stress. Among special results gained by geologists in the period we survey may be cited new views as to the origin of the crystalline schists, favouring a return to something like the hypogene origin advocated by Lyell; the facts as to deep-sea deposits, now in course of formation, embodied in the "Challenger" reports on that subject; the increasing discrimination and tracking of those minor divisions of strata called "zones"; the assignment of the Olenellus fauna of Cambrian age to a position earlier than that of the Paradoxides fauna; the discovery of Radiolaria in Palæozoic rocks by special methods of examination, and the recognition of Graptolites as indices of geological horizons in lower Palæozoic beds. Glacially eroded rocks in Boulder-clays of Permo-Carboniferous age have been recognised in many parts of the world (*e.g.* Australia and South Africa), and thus the view put forward by W. T. Blanford as to the occurrence of the same phenomena in conglomerates of this age in India is confirmed. Eozoon is finally abandoned as owing its structure to an organism. The oldest fossiliferous beds known to us are still far from the beginning of life. They contain a highly developed and varied animal fauna—and something like the whole of the older moiety of rocks of aqueous origin have failed as yet to present us with any remains of the animals or plants which must have inhabited the seas which deposited them. The boring of a coral reef initiated by Prof. Sollas at the Nottingham meeting of this Association in 1893 was successfully carried out, and a depth of 1114½ feet reached. Information of great value to geologists was thus obtained.

Animal and Vegetable Morphography.—Were I to attempt to give an account of the new kinds of animals and plants discovered since 1881, I should have to read out a bare catalogue, for time would not allow me to explain the interest attaching to each. Explorers have been busy in all parts of the world—in Central Africa, in the Antarctic, in remote parts of China, in Patagonia and Australia, and on the floor of the ocean, as well as in caverns, on mountain tops, and in great lakes and rivers. We have learnt much that is new as to distribution; countless new forms have been discovered, and careful anatomical and microscopical study conducted on specimens sent home to our laboratories. I cannot refrain from calling to mind the discovery of the eggs of the Australian duckmole and hedgehog; the fresh-water jelly-fish of Regent's Park, the African lakes, and the Delaware River; the marsupial mole of Central Australia; the okapi; the young and adult of the mud-fishes of Australia, Africa, and South America; the fishes of the Nile and Congo; the gill-bearing earthworms and mud-worms; the various forms of the caterpillar-like Peripatus; strange deep-sea fishes, polyps and sponges.

The main result of a good deal of such investigation is measured by our increased knowledge of the pedigree of organisms, what used to be called "classification." The anatomical study by the Australian professors, Hill and Wilson, of the teeth and the fœtus of the Australian group of pouched mammals—the marsupials—has entirely upset previous notions, to the effect that these were a primitive group, and has shown that their possession of only one replacing tooth is a retention of one out of many such teeth (the germs of which are present), as in placental mammals; and further that many of these marsupials have the nourishing outgrowth of the fœtus called the placenta fairly well developed, so that they must be regarded as a degenerate side-branch of the placental mammals, and not as primitive forerunners of that dominant series.

Speculations as to the ancestral connection of the great group of vertebrates with other great groups have been varied and ingenious; but most naturalists are now inclined to the view that it is a mistake to assume any such connection in the case of vertebrates of a more definite character than we admit in the case of starfishes, shellfish, and insects. All these groups are ultimately connected by very simple, remote, and not by proximate ancestors, with one another and with the ancestors of vertebrates.

The origin of the limbs of vertebrates is now generally agreed to be correctly indicated in the Thatcher-Mivart-Balfour theory to the effect that they are derived from a pair of continuous lateral fins, in fish-like ancestors, similar in every way to the continuous median dorsal fin of fishes.

The discovery of the formation of true spermatozoa by simple unicellular animals of the group Protozoa is a startling thing, for it had always been supposed that these peculiar reproductive elements were only formed by multicellular organisms. They have been discovered in some of the gregarina-like animalcules, the Coccidia, and also in the blood-parasites.

Among plants one of the most important discoveries relates to these same reproductive elements, the spermatozoa, which by botanists are called antherozoids. A great difference between the whole higher series of plants, the flowering plants or phanerogams, and the cryptogams or lower plants, including ferns, mosses, and algæ, was held to be that the latter produce vibratile spermatozoa like those of animals which swim in liquid and fertilise the motionless egg-cell of the plant. Two Japanese botanists (and the origin of this discovery from Japan, from the University of Tokio, in itself marks an era in the history of science), Hirase and Ikeno, astonished the botanical world fifteen years ago by showing that motile antherozoids or spermatozoa are produced by two gymnosperms, the ginkgo tree (or Salisburya) and the cycads. The pollen-tube, which is the fertilising agent in all other phanerogams, develops in these cone-bearing trees, beautiful motile spermatozoa, which swim in a cup of liquid provided for them in connection with the ovules. Thus a great distinction between phanerogams and cryptogams was broken down, and the actual nature of the pollen-tube as a potential parent of spermatozoids demonstrated.

When we come to the results of the digging out and study of extinct plants and animals, the most remarkable results of all in regard to the affinities and pedigree of organisms have been obtained. Among plants the transition between cryptogams and phanerogams has been practically bridged over by the discovery that certain fern-like plants of the Coal-measures—the Cycadofilices, supposed to be true ferns, are really seed-bearing plants and not ferns at all, but phanerogams of a primitive type, allied to the cycads and gymnosperms. They have been re-christened Pteridosperms by Scott, who, together with F. Oliver and Seward, has been the chief discoverer in this most interesting field.

By their fossil remains whole series of new genera of extinct mammals have been traced through the Tertiary strata of North America and their genetic connections established; and from yet older strata of the same prolific source we have almost complete knowledge of several genera of huge extinct Dinosauria of great variety of form and habit.

The discoveries by Seeley at the Cape, and by Amalitzky in North Russia of identical genera of Triassic reptiles, which in many respects resemble the Mammalia and constitute the group Theromorpha, is also a prominent feature in the palæontology of the past twenty-five years. Nor must we forget the extraordinary Silurian fishes discovered and described in Scotland by Prof. Traquair. The most important discovery of the kind of late years has been that of the Upper Eocene and Miocene mammals of the Egyptian Fayum, excavated by the Egyptian Geological Survey and by Dr. Andrews of the Natural History Museum, who has described and figured the remains. They include a huge four-horned animal as big as a rhinoceros, but quite peculiar in its characters—the Arsinoitherium—and the ancestors of the elephants, a group which was abundant in Miocene and Pliocene times in Europe and Asia, and in still later times in America, and survives at the present day in its representatives the African and Indian elephants. One of the European extinct elephants—the Tetrabelodon—had, we have long known, an immensely long lower jaw with large chisel-shaped terminal teeth. It had been suggested by me that the modern elephant's trunk must have been derived from the soft upper jaw and nasal area, which rested on this elongated lower jaw, by the shortening (in the course of natural selection and modification by descent) of this long lower jaw, to the present small dimensions of the elephant's lower jaw, and the consequent down-dropping of the unshortened upper jaw and lips, which thus become the proboscis. Dr. Andrews has described from Egypt and placed in the Museum in London specimens of two new genera—one, Palæomastodon, in which there is a long, powerful jaw, an elongated face, and an increased number of molar teeth; the second, Mœritherium, an animal with a hippopotamus-like head, comparatively minute tusks, and a well-developed complement of incisor, canine, and molar teeth, like a typical ungulate mammal. Undoubtedly we have in these two forms the indications of the steps by which the elephants have been evolved from ordinary-looking pig-like creatures of moderate size, devoid of trunk or tusks. Other remains belonging to this great mid-African Eocene fauna indicate that not only the Elephants but the Sirenia took their origin in this area. Amongst them are also gigantic forms of Hyrax, like the little Syrian coney and many other new mammals and reptiles.

Another great area of exploration and source of new things has been the southern part of Argentina and Patagonia, where Ameghino, Moreno, and Scott of Princeton have brought to light a wonderful series of extinct ant-eaters, armadilloes, huge sloths, and strange ungulates, reaching back into early Tertiary times. But most remarkable has been the discovery in this area of remains which indicate a former connection with the Australian land surface. This connection is suggested by the discovery in the Sânta Cruz strata, considered to be of early Tertiary date, of remains of a huge horned tortoise which is generically identical with one found fossil in the Australian area of later date, and known as Miolania. In the same wonderful area we have the discovery in a cave of the fresh bones, hairy skin, and dung of animals supposed to be extinct, viz. the giant sloth, Mylodon, and the peculiar horse, Onohippidium. These remains seem to belong to survivors from the last submergence of this strangely mobile land-surface, and it is not improbable that some individuals of this "extinct" fauna are still living in Patagonia. The region is still unexplored, and those who set out to examine it have, by some strange fatality, hitherto failed to carry out the professed purpose of their expeditions.

I cannot quit this immense field of gathered fact and growing generalisation without alluding to the study of animal embryology and the germ-layer theory, which has to some extent been superseded by the study of embryonic cell-lineage, so well pursued by some American microscopists. The great generalisation of the study of the germ-layers and their formation seems to be now firmly established—namely, that the earliest multicellular animals were possessed of one structural cavity, the enteron, surrounded by a double layer of cells, the ectoderm and endoderm. These Enterocœla or Cœlentera gave rise to forms having a second great body-cavity, the cœlom, which originated not as a split between the two layers, as was supposed twenty-five years ago by Haeckel and Gegenbaur and their pupils, but by a pouching of the enteron to form one or more cavities in which the reproductive cells should develop—pouchings which became nipped off from the cavity of their origin, and formed thus the independent cœlom. The animals so provided are the Cœlomocœla (as opposed to the Enterocœla), and comprise all animals above the polyps, jelly-fish, corals, and sea-anemones. It has been established in these twenty-five years that the cœlom is a definite structural unit of the higher groups, and that outgrowths from it to the exterior (cœlomoducts) form the genital passages, and may become renal excretory organs also. The vascular system has not, as it was formerly supposed to have, any connection of origin with the cœlom, but is independent of it, in origin and development, as also are the primitive and superficial renal tubes known as nephridia. These general statements seem to me to cover the most important advance in the general morphology of animals which we owe to embryological research in the past quarter of a century.[1]

Before leaving the subject of animal morphology I must apologise for my inability to give space and time to a consideration of the growing and important science of anthropology, which ranges from the history of human institutions and language to the earliest prehistoric bones and implements. Let me therefore note here the discovery of the cranial dome of Pithecanthropus in a river gravel in Java—undoubtedly the most ape-like of human remains, and of great age; and, further, the Eoliths of Prestwich, in the human authorship of which I am inclined to believe, though I should be sorry to say the same of all the broken flints to which the name "Eolith" has been applied. The systematic investigation and record of savage races have taken on a new and scientific character. Such work as Baldwin Spencer's and Haddon's in Australasia furnish examples of what is being done in this way.

Physiology of Plants and Animals.—Since I have only time to pick the most important advances in each subject for brief mention, I must signalise in regard to the physiology of plants the better understanding of the function of leaf-green or chlorophyll due to Pringsheim and to the Russian Timiriaseff, the new facts as to the activity of stomata in transpiration discovered by Horace Brown, and the fixation of free nitrogen by living organisms in the soil and by organisms (*Bacillus radicola*) parasitic in the rootlets of leguminous plants, which thus benefit by a supply of nitrogenous compounds which they can assimilate.

Great progress in the knowledge of the chemistry of the living cells or protoplasm of both plants and animals has been made by the discovery of the fact that ferments or enzymes are not only secreted externally by cells, but exist in active and preformed *inside* cells. Büchner's final conquest of the secret of the yeast-cell by heroic mechanical methods—the actual grinding to powder of these already very minute bodies—first established this, and now successive discoveries of intracellular ferments have led to the conclusion that it is probable that the cell respires by means of a respiratory "oxydase," builds up new compounds and destroys existing ones, contracts and accomplishes its own internal life by ferments. Life thus (from the chemical point of view) becomes a chain of ferment actions. Another most significant advance in animal physiology has been the sequel (as it were) of Bernard's discovery of the formation of glycogen in the liver, a substance not to be excreted, but to be taken up by the blood and lymph, and in many ways more important than the more obvious formation of bile which is thrown out of the gland into the alimentary canal. It has been discovered that many glands, such as the kidney and pancreas and the ductless glands, the suprarenals, thyroid, and others, secrete indispensable products into the blood and lymph. Hence myxœdema, exophthalmic goitre, Addison's disease, and other disorders have been traced to a deficiency or excess of internal secretions from glands formerly regarded as interesting but unimportant vestigial structures. From these glands have in consequence been extracted remarkable substances on which their peculiar activity depends. From the suprarenals a substance has been extracted which causes activity of all those structures which the sympathetic nerve system can excite to action: the thyroid yields a substance which influences the growth of the skin, hair, bones, &c.; the pituitary gland, an extract which is a specific urinary stimulant. Quite lately the mammalian ovary has been shown by Starling to yield a secretion which influences the state of nutrition of the uterus and mammæ. Had I time, I might say a great deal more on topics such as these—topics of almost infinite importance; but the fact is that the mere enumeration of the most important lines of progress in any one science would occupy us for hours.

[1] See the introduction to part ii. of a "Treatise on Zoology," edited by E. Ray Lankester. (London: A. and C. Black.)

Nerve-physiology has made immensely important advances. There is now good evidence that all excitation of one group of nerve-centres is accompanied by the *concurrent inhibition* of a whole series of groups of other centres, the activity of which might interfere with that of the group excited to action. In a simple reflex flexure of the knee the motor-neurones to the flexor muscles are excited, but concurrently the motor-neurones to the extensor muscles are thrown into a state of inhibition, and so equally with all the varied excitations of the nervous system controlling the movements and activities of the entire body.

The discovery of the continuity of the protoplasm through the walls of the vegetable cell by means of connecting canals and threads is one of the most startling facts discovered in connection with plant-structure, since it was held twenty years ago that a fundamental distinction between animal and vegetable structure consisted in the boxing-up or encasement of each vegetable cell-unit in a case of cellulose, whereas animal cells were not so imprisoned, but freely communicated with one another. It perhaps is on this account the less surprising that lately something like sense-organs have been discovered on the roots, stems, and leaves of plants, which, like the otocysts of some animals, appear to be really "statocytes," and to exert a varying pressure according to the relations of these parts of the plant to gravity. There is apparently something resembling a perception of the incidence of gravity in plants which reacts on irritable tissues, and is the explanation of the phenomena of geotropism. These results have grown out of the observations of Charles Darwin, followed by those of F. Darwin, Haberlandt, and Němec.

A few words must be said here as to the progress of our knowledge of cell-substance, and what used to be called the protoplasm question. We do not now regard protoplasm as a chemical expression, but, in accordance with von Mohl's original use of the word, as a structure which holds in its meshes many and very varied chemical bodies of great complexity. Within these twenty-five years the "centrosome" of the cell-protoplasm has been discovered, and a great deal has been learnt as to the structure of the nucleus and its remarkable stain-taking bands, the chromosomes. We now know that these bands are of definite fixed number, varying in different species of plants and animals, and that they are halved in number in the reproductive elements—the supermatozoid and the ovum—so that on union of these two to form the fertilised ovum (the parent cell of all the tissues), the proper specific number is attained. It has been pretty clearly made out by cutting up large living cells—unicellular animals—that the body of the cell alone, without the nucleus, can do very little but move and maintain for a time its chemical status. But it is the nucleus which directs and determines all definite growth, movement, secretion, and reproduction. The simple protoplasm, deprived of its nucleus, cannot form a new nucleus—in fact, can do very little but exhibit irritability. I am inclined to agree with those who hold that there is not sufficient evidence that any organism exists at the present time which has not both protoplasm and nucleus—in fact, that the simplest form of life at present existing is a highly complicated structure—a nucleated cell. That does not imply that simpler forms of living matter have not preceded those which we know. We must assume that something more simple and homogeneous than the cell, with its differentiated cell-body or protoplasm, and its cell kernel or nucleus, has at one time existed. But the various supposed instances of the survival to the present day of such simple living things—described by Haeckel and others—have one by one yielded to improved methods of microscopic examination and proved to be differentiated into nuclear and extra-nuclear substance.

The question of "spontaneous generation" cannot be said to have been seriously revived within these twenty-five years. Our greater knowledge of minute forms of life, and the conditions under which they can survive, as well as our improved microscopes and methods of experiment and observation, have made an end of the arguments and instances of supposed abiogenesis. The accounts which have been published of "radiobes," minute bodies arising in fluids of organic origin when radium salts have been allowed to mix in minute quantities with such fluids, are wanting in precision and detail, but the microscopic particles which appear in the circumstances described seem to be of a nature identical with the minute bodies well known to microscopists and recognised as crystals modified by a colloid medium. They have been described by Rainey, Harting, and Ord, on different occasions, many years ago. They are not devoid of interest, but cannot be considered as having any new bearing on the origin of living matter.

Psychology.—I have given a special heading to this subject because its emergence as a definite line of experimental research seems to me one of the most important features in the progress of science in the past quarter of a century. Thirty-five years ago we were all delighted by Fechner's psychophysical law, and at Leipzig I, with others of my day, studied it experimentally in the physiological laboratory of that great teacher, Carl Ludwig. The physiological methods of measurement (which are the physical ones) have been more and more widely, and with guiding intelligence and ingenuity, applied since those days to the study of the activities of the complex organs of the nervous system which are concerned with "mind" or psychic phenomena. Whilst some enthusiasts have been eagerly collecting ghost stories and records of human illusion and fancy, the serious experimental investigation of the human mind, and its forerunner the animal mind, has been quietly but steadily proceeding in truly scientific channels. The science is still in an early phase—that of the collection of accurate observations and measurements—awaiting the development of great guiding hypotheses and theories. But much has been done, and it is a matter of gratification to Oxford men that through the liberality of the distinguished electrician, Mr. Henry Wilde, F.R.S., a lectureship of Experimental Psychology has been founded in the University of Oxford, where the older studies of Mental and Moral Philosophy, Logic and Metaphysics have so strong a hold, and have so well prepared the ground for the new experimental development. The German investigators W. Wundt, G. E. Müller, C. Stumpf, Ebbinghaus, and Munsterberg have been prominent in introducing laboratory methods, and have determined such matters as the elementary laws of association and memory, and the perceptions of musical tones and their relations. The work of Goldschneider on "the muscular sense," of von Frey on the cutaneous sensations, are further examples of what is being done.

The difficult and extremely important line of investigation, first scientifically treated by Braid under the name "Hypnotism," has been greatly developed by the French school, especially by Charcot. The experimental investigation of "suggestion," and the pathology of dual consciousness and such exceptional conditions of the mind, has been greatly advanced by French observers.

The older work of Ferrier and Hitzig on the functions of the parts of the brain has been carried further by Goltz and Munk in Germany, and by Schäfer, Horsley, and Sherrington in England.

The most important general advance seems to be the realisation that the mind of the human adult is a social product; that it can only be understood in relation with the special environment in which it develops, and with which it is in perpetual interaction. Prof. Baldwin, of Princeton, has done important work on this subject. Closely allied is the study of what is called "the psychology of groups," the laws of mental action of the individual as modified by his membership of some form of society. French authors have done valuable work here.

These two developments of psychology are destined to provide the indispensable psychological basis for Social Science, and for the anthropological investigation of mental phenomena.

Hereafter, the well-ascertained laws of experimental psychology will undoubtedly furnish the necessary scientific basis of the art of education, and psychology will hold the same relation to that art as physiology does to the art of medicine and hygiene.

There can be little doubt, moreover, of the valuable interaction of the study of physical psychology and the theories of the origin of structural character by natural selection. The relation of the human mind to the mind of animals, and the gradual development of both, is a subject full of rich stores of new material, yielding conclusions of the highest importance, which has not yet been satisfactorily approached.

I am glad to be able to give wider publicity here to some conclusions which I communicated to the Jubilee volume of the "Société de Biologie" of Paris in 1899. I there discussed the significance of the great increase in the size of the cerebral hemispheres in recent, as compared with Eocene Mammals, and in Man as compared with Apes, and came to the conclusion that "the power of building up appropriate cerebral mechanism in response to individual experience," or what may be called "educability," is the quality which characterises the larger cerebrum, and is that which has led to its selection, survival, and further increase in volume. The bearing of this conception upon questions of fundamental importance in what has been called genetic psychology is sketched as follows.

"The character which we describe as 'educability' can be transmitted; it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired afresh. With increased 'educability' they are more readily acquired and a larger variety of them. On the other hand, the nerve-mechanisms of instinct are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations."

"To a large extent the two series of brain-mechanisms, the 'instinctive' and the 'individually acquired,' are in opposition to one another. Congenital brain-mechanisms may prevent the education of the brain and the development of new mechanisms specially fitted to the special conditions of life. To the educable animal the less there is of specialised mechanism transmitted by heredity, the better. The loss of instinct is what permits and necessitates the education of the receptive brain."

"We are thus led to the view that it is hardly possible for a theory to be further from the truth than that expressed by George H. Lewes and adopted by George Romanes, namely, that instincts are due to 'lapsed' intelligence. The fact is that there is no community between the mechanisms of instinct and the mechanisms of intelligence, and that the latter are later in the history of the development of the brain than the former, and can only develop in proportion as the former become feeble and defective."[1]

Darwinism.—Under the title "Darwinism" it is convenient to designate the various work of biologists tending to establish, develop, or modify Mr. Darwin's great theory of the origin of species. In looking back over twenty-five years it seems to me that we must say that the conclusions of Darwin as to the origin of species by the survival of selected races in the struggle for existence are more firmly established than ever. And this because there have been many attempts to gravely tamper with essential parts of the fabric as he left it, and even to substitute conceptions for those which he endeavoured to establish, at variance with his conclusions. These attempts must, I think, be considered as having failed. A great deal of valuable work has been done in consequence; for honest criticism, based on observation and experiment, leads to further investigation, and is the legitimate and natural mode of increase of scientific knowledge. Amongst the attempts to seriously modify Darwin's doctrine may be cited that to assign a great and leading importance to Lamarck's theory as to the transmission by inheritance of newly "acquired" characters, due chiefly to American palæontologists and to the venerated defender of such views, who has now closed his long life of great work, Mr. Herbert Spencer; that to attribute leading importance to the action of physiological congruity and incongruity in selective breeding, which was put forward by another able writer and naturalist who has now passed from among us, Dr. George Romanes; further, the views of de Vries as to discontinuity in the origin of new species, supported by the valuable work of Mr. Bateson on discontinuous variation; and lastly, the attempt to assign a great and general importance to the facts ascertained many years ago by the Abbé Mendel as to the cross-breeding of varieties and the frequent production (in regard to certain characters in certain cases) of pure strains rather than of breeds combining the characters of both parents. On the other hand we have the splendid series

[1] From the Jubilee volume of the Soc. de Biol. of Paris, 1899. Reprinted in Nature, vol. lxi., 1900, pp. 624, 625.

of observations and writings of August Weismann, who has, in the opinion of the majority of those who study this subject, rendered the Lamarckian theory of the origin and transmission of new characters altogether untenable, and has, besides, furnished a most instructive, if not finally conclusive, theory or mechanical scheme of the phenomena of Heredity in his book "The Germ-plasm." Prof. Karl Pearson and the late Prof. Weldon—the latter so early in life and so recently lost to us—have, with the finest courage and enthusiasm in the face of an enormous and difficult task, determined to bring the facts of variation and heredity into the solid form of statistical statement, and have organised, and largely advanced in, this branch of investigation, which they have termed "Biometrics." Many naturalists throughout the world have made it the main object of their collecting and breeding of insects, birds, and plants, to test Darwin's generalisations and to expand the work of Wallace in the same direction. A delightful fact in this survey is that we find Mr. Alfred Russel Wallace (who fifty years ago conceived the same theory as that more fully stated by Darwin) actively working and publishing some of the most convincing and valuable works on Darwinism. He is still alive and not merely well, but pursuing his work with vigour and ability. It was chiefly through his researches on insects in South America and the Malay Islands that Mr. Wallace was led to the Darwinian theory; and there is no doubt that the study of insects, especially of butterflies, is still one of the most prolific fields in which new facts can be gathered in support of Darwin and new views on the subject tested. Prominent amongst naturalists in this line of research has been and is Edward Poulton of Oxford, who has handed on to the study of entomology throughout the world the impetus of the Darwinian theory. I must here also name a writer who, though unknown in our laboratories and museums, seems to me to have rendered very valuable service in later years to the testing of Darwin's doctrines and to the bringing of a great class of organic phenomena within the cognisance of those naturalists who are especially occupied with the problems of Variation and Heredity. I mean Dr. Archdall Reid, who has with keen logic made use of the immense accumulation of material which is in the hands of medical men, and has pointed out the urgent importance of increased use by Darwinian investigators of the facts as to the variation and heredity of that unique animal, man, unique in his abundance, his reproductive activity, and his power of assisting his investigator by his own record. There are more observations about the variation and heredity of man and the conditions attendant upon individual instances than with regard to any other animal. Medical men need only to grasp clearly the questions at present under discussion in order to be able to furnish with ease data absolutely invaluable in quantity and quality. Dr. Archdall Reid has in two original books full of insight and new suggestions, the "Present Evolution of Man" and "Principles of Heredity," shown a new path for investigators to follow.

The attempt to resuscitate Lamarck's views on the inheritance of acquired[1] characters has been met not only by the demand for the production of experimental proof that such inheritance takes place, which has never been produced, but on Weismann's part by a demonstration that the reproductive cells of organisms are developed and set aside from the rest of the tissues at so early a period that it is extremely improbable that changes brought about in those other tissues by unaccustomed incident forces can be communicated to the germ-cells so as to make their appearance in the offspring by heredity. Apart from this, I have drawn attention to the fact that Lamarck's first and second laws (as he terms them) of heredity are contradictory the one of the other, and therefore may be dismissed. In 1894 I wrote:

"Normal conditions of environment have for many thousands of generations moulded the individuals of a given species of organism, and determined as each individual developed and grew 'responsive' quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions of the species in the case of a young individual taken to-day from the site where for thousands of generations its ancestors have responded in a perfectly defined way to the normal and defined conditions of environment; reduce the daily or the seasonal amount of solar radiation to which the individual is exposed; or remove the aqueous vapour from the atmosphere; or alter the chemical composition of the pabulum accessible; or force the individual to previously unaccustomed muscular effort or to new pressures and strains; and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual under the new quantities of environing agencies shows *new* responsive quantities in those parts of its structure concerned, new or *acquired* characters.

"So far, so good. What Lamarck next asks us to accept, as his 'second law,' seems not only to lack the support of experimental proof, but to be inconsistent with what has just preceded it. The new character which is *ex hypothesi*, as was the old character (length, breadth, weight of a part) which it has replaced—a response to environment, a particular moulding or manipulation by incident forces of the potential congenital quality of the race—is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared by Lamarck and his adherents to be capable of transmission by generation; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it. In opposition to Lamarck, one must urge, in the first place, that this thing has never been shown experimentally to occur; and in the second place, that there is no ground for holding its occurrence to be probable, but, on the contrary, strong reason for holding it to be improbable. Since the old character (length, breadth, weight) had not become fixed and congenital after many thousands of successive generations of individuals had developed it in response to environment, but gave place to a new character when new conditions operated on an individual (Lamarck's first law), why should we suppose that the new character is likely to become fixed after a much shorter time of responsive existence, or to escape the operation of the first law? Clearly there is no reason (so far as Lamarck's statement goes) for any such supposition, and the two so-called laws of Lamarck are at variance with one another."

In its most condensed form my argument has been stated thus by Prof. Poulton: Lamarck's "first law assumes that a past history of indefinite duration is powerless to create a bias by which the present can be controlled; while the second assumes that the brief history of the present can readily raise a bias to control the future" (NATURE, vol. li., 1894, p. 127).

An important light is thrown on some facts which seem at first sight to favour the Lamarckian hypothesis by the consideration that, though an "acquired" character is not transmitted to offspring as the consequence of the action of external agencies determining the "acquirement," yet the tendency to react exhibited by the parent *is* transmitted, and if the tendency is exceptionally great a false suggestion of a Lamarckian inheritance can readily result. This inheritance of "variation in tendencies to react" has a wide application, and has led me to coin the word "educability" as mentioned in the section of this address on Psychology.

The principle of physiological selection advocated by Dr. Romanes does not seem to have caused much discussion, and has been unduly neglected by subsequent writers. It was ingenious, and was based on some interesting observations, but has failed to gain support.

The observations of de Vries—showing that in cultivated varieties of plants a new form will sometimes assert itself suddenly and attain a certain period of dominance, though not having been gradually brought into existence by a slow process of selection—have been considered by him, and by

[1] I use the term "acquired" without prejudice in the sense given to that word by Lamarck himself.

a good many other naturalists, as indicating the way in which new species arise in Nature. The suggestion is a valuable one if not very novel, but a great deal of observation will have to be made before it can be admitted as really having a wide bearing upon the origin of species. The same is true of those interesting observations which were first made by Mendel, and have been resuscitated and extended with great labour and ingenuity by recent workers, especially in this country by Bateson and his pupils. If it should prove to be true that varieties when crossed do not, in the course of eventual inter-breeding, produce intermediate forms as hybrids, but that characters are either dominant or recessive, and that breeds result having pure unmixed characters—we should, in proportion as the Mendelian law is shown to apply to all tissues and organs and to a majority of organisms, have before us a very important and determining principle in all that relates to heredity and variation. It remains, however, to be shown how far the Mendelian phenomenon is general. And it is, of course, admitted on all sides that, even were the Mendelian phenomenon general and raised to the rank of a law of heredity, it would not be subversive of Mr. Darwin's generalisations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms.

Two general principles which Mr. Darwin fully recognised appear to me to deserve more consideration and more general application to the history of species than he had time to give to them, or than his followers have accorded to them. The first is the great principle of "correlation of variation," from which it follows that, whilst natural selection may be favouring some small and obscure change in an unseen group of cells—such as digestive, pigmentary or nervous cells, and that change a change of selective value—there may be, indeed often is, as we know, a correlated or accompanying change in a physiologically related part of far greater magnitude and prominence to the eye of the human onlooker. This accompanying or correlated character has no selective value, is not an adaptation—is, in fact, a necessary but useless by-product. A list of a few cases of this kind was given by Darwin, but it is most desirable that more should be established. For they enable us to understand how it is that specific characters, those seen and noted on the surface by systematists, are not in most cases adaptations of selective value. They also open a wide vista of incipient and useless developments which may suddenly, in their turn, be seized upon by ever-watchful natural selection and raised to a high pitch of growth and function.

The second, somewhat but by no means altogether neglected, principle is that a good deal of the important variation in both plants and animals is not the variation of a minute part or confined to one organ, but has really an inner physiological basis, and may be a variation of a whole organic system or of a whole tissue expressing itself at several points and in several shapes. In fact, we should perhaps more generally conceive of variation as not so much the accomplishment and presentation of one little mark or difference in weight, length, or colour, as the expression of a *tendency to vary* in a given tissue or organ in a particular way. Thus we are prepared for the rapid extension and dominance of the variation if once it is favoured by selective breeding. It seems to me that such cases as the complete disappearance of scales from the integument of some osseous fishes, or the possible retention of three or four scales out of some hundreds present in nearly allied forms, favour this mode of conceiving of variation. So also does the marked tendency to produce membranous expansions of the integument in the bats, not only between the digits and from the axilla, but from the ears and different regions of the face. Of course, the alternative hairy or smooth condition of the integuments both in plants and animals is a familiar instance in which a tendency extending over a large area is recognised as that which constitutes the variation. In smooth or hairy varieties we do not postulate an individual development of hairs subjected one by one to selection and survival or repression.

Disease.—The study of the physiology of unhealthy, injured, or diseased organisms is called pathology. It necessarily has an immense area of observation and is of transcending interest to mankind, who do not accept their diseases unresistingly and die as animals do, so purifying their race, but incessantly combat and fight disease, producing new and terrible forms of it by their wilful interference with the earlier rule of Nature.

Our knowledge of disease has been enormously advanced in the last quarter of a century, and in an important degree our power of arresting it, by two great lines of study going on side by side and originated, not by medical men nor physiologists in the narrow technical sense, but by naturalists, a botanist, and a zoologist. Ferdinand Cohn, Professor of Botany in Breslau, by his own researches and by personal training in his laboratory, gave to Robert Koch the start on his distinguished career as a bacteriologist. It is to Metschnikoff the zoologist and embryologist that we owe the doctrine of phagocytosis and the consequent theory of immunity now so widely accepted.

We must not forget that in this same period much of the immortal work of Pasteur on hydrophobia, of Behring and Roux on diphtheria, and of Ehrlich and many others to whom the eternal gratitude of mankind is due, has been going on. It is only some fifteen years since Calmette showed that if cobra poison were introduced into the blood of a horse in less quantity than would cause death, the horse would tolerate with little disturbance after ten days a full dose, and then day after day an increasing dose, until the horse without any inconvenience received an injection of cobra poison large enough to kill thirty horses of its size. Some of the horse's blood being now withdrawn was found to contain a very active antidote to cobra poison—what is called an antitoxin. The procedure and preparation of the antitoxin is practically the same as that previously adopted by Behring in the preparation of the antitoxin of diphtheria poison. Animals treated with injections of these antitoxins are immune to the poison itself when subsequently injected with it, or, if already suffering from the poison (as, for instance, by snake-bite), are readily shown by experiment to be rapidly cured by the injection of the appropriate antitoxin. This is, as all will admit, an intensely interesting bit of biology. The explanation of the formation of the antitoxin in the blood and its mode of antagonising the poison is not easy. It seems that the antitoxin is undoubtedly formed from the corresponding toxin or poison, and that the antagonism can be best understood as a chemical reaction by which the complex molecule of the poison is upset, or effectively modified.

The remarkable development of Metschnikoff's doctrine of phagocytosis during the past quarter of a century is certainly one of the characteristic features of the activity of biological science in that period. At first ridiculed as "Metschnikoffism," it has now won the support of its former adversaries.

For a long time the ideal of hygienists has been to preserve man from all contact with the germs of infection, to destroy them and destroy the animals conveying them, such as rats, mosquitoes and other flies. But it has now been borne in upon us that, useful as such attempts are, and great as is the improvement in human conditions which can thus be effected, yet we cannot hope for any really complete or satisfactory realisation of the ideal of escape from contact with infective germs. The task is beyond human powers. The conviction has now been arrived at that, whilst we must take every precaution to diminish infection, yet our ultimate safety must come from within—namely, from the activity, the trained, stimulated, and carefully guarded activity, of those wonderful colourless amœba-like corpuscles whose use was so long unrecognised, but has now been made clear by the patiently continued experiments and arguments of Metschnikoff, who has named them "phagocytes." The doctrine of the activity and immense importance of these corpuscles of the living body which form part of the all-pervading connective tissues and float also in the blood, is in its nature and inception opposed to what are called the "humoral" and "vitalistic" theories of resistance to infection. Of this kind were the beliefs that the *liquids* of the living body have an inherent and somewhat vague power of resisting infective germs, and even that the mere living quality of the issues was in some unknown way antagonistic to foreign intrusive disease-germs.

The first eighteen years of Metschnikoff's career, after his undergraduate course, were devoted to zoological and embryological investigations. He discovered many important facts, such as the alternation of generations in the parasitic worm of the frog's lung—*Ascaris nigrovenosa*—and the history of the growth from the egg of sponges and medusæ. In these latter researches he came into contact with the wonderfully active cells, or living corpuscles, which in many low forms of life can be seen by transparency in the living animal. He saw that these corpuscles (as was indeed already known) resemble the well-known amœba, and can take into their soft substance (protoplasm) at all parts of their surface any minute particles and digest them, thus destroying them. In a transparent water-flea Metschnikoff saw these amœba-like, colourless, floating blood-corpuscles swallowing and digesting the spores of a parasitic fungus which had attacked the water-fleas and was causing their death. He came to the conclusion that this is the chief, if not the whole value of these corpuscles in higher as well as lower animals, in all of which they are very abundant. It was known that when a wound bringing in foreign matter is inflicted on a vertebrate animal the blood-vessels become gorged in the neighbourhood and the colourless corpuscles escape through the walls of the vessels in crowds. Their business in so doing, Metschnikoff showed, is to eat up the foreign matter, and also to eat up and remove the dead, wounded tissue. He therefore called these white or colourless corpuscles "phagocytes," the eater-cells, and in his beautiful book on Inflammation, published twenty years ago, proved the extreme importance of their activity. At the same time he had shown that they eat up intrusive bacteria and other germs; and his work for the last twenty years has mainly consisted in demonstrating that they are the chief, and probably the only, agents at work in either ridding the human body of an attack of disease-causing germs or in warding off even the commencement of an attack, so that the man or animal in which they are fully efficient is "immune"—that is to say, cannot be effectively attacked by disease-germs.

Disease-germs, bacteria, or protozoa produce poisons which sometimes are too much for the phagocytes, poisoning them and so getting the upper hand. But, as Metschnikoff showed, the training of the phagocytes by weak doses of the poison of the disease-germ, or by weakened cultures of the disease-germ itself, brings about a power of resistance in the phagocytes to the germ's poison, and thus makes them capable of attacking the germs and keeping them at bay. Hence the value of inoculations.

The discussion and experiments arising from Metschnikoff's demonstrations have led to the discovery of the production by the phagocytes of certain exudations from their substance which have a most important effect in weakening the resistance of the intrusive bacteria and rendering them easy prey for the phagocyte. These are called "sensitisers," and have been largely studied. They may be introduced artificially into the blood and tissues so as to facilitate the work of the phagocytes, and no doubt it is a valuable remedial measure to make use of such sensitisers as a treatment. Sir A. E. Wright considers that such sensitisers are formed in the blood and tissues independently of the phagocytes, and has called them "opsonins," under which name he has made most valuable application of the method of injecting them into the body so as to facilitate the work of the phagocytes in devouring the hostile bacteria of various diseases. Each kind of disease-producing microbe has its own sensitiser or opsonin; hence there has been much careful research and experiment required in order to bring the discovery to practical use. Metschnikoff himself holds and quotes experiments to show that the "opsonins" are actually produced by the phagocytes themselves. That this should be so is in accordance with some striking zoological facts, as I pointed out nearly twenty years ago. For the lowest multicellular animals provided with a digestive sac or gut, such as the polyps, have that sac lined by digestive cells which have the same amœboid character as "phagocytes," and actually digest to a large extent by swallowing or taking into their individual protoplasm raw particles of food. Such particles are enclosed in a temporary cavity, or vacuole, into which the cell-protoplasm secretes digestive ferment and other chemical agents. Now there is no doubt that such digestive vacuoles may burst and so pour out into the polyp's stomach a digestive juice which will act on food particles outside the substance of the cells, and thus by the substitution of this process of outpouring of the secretion for that of ingestion of food particles into the cells we get the usual form of digestion by juices secreted into a digestive cavity. Now this being certainly the case in regard to the history of the original phagocytes lining the polyp's gut, it does not seem at all unlikely, but on the contrary in a higher degree probable, that the phagocytes of the blood and tissues should behave in the same way and pour out sensitisers and opsonins to paralyse and prepare their bacterial food. And the experiments of Metschnikoff's pupils and followers show that this is undoubtedly the case. Whether there is any great variety of and difference between "sensitisers" and "opsonins" is a matter which is still the subject of active experiment. Metschnikoff's conclusion, as recently stated in regard to the whole progress of this subject, is that the phagocytes in our bodies should be stimulated in their activity in order successfully to fight the germs of infection. Alcohol, opium, and even quinine, hinder the phagocytic action; they should therefore be entirely eschewed or used only with great caution where their other and valuable properties are urgently needed. It appears that the injection of blood-serum into the tissues of animals causes an increase in the number and activity of the phagocytes, and thus an increase in their resistance towards pathogenic germs. Thus Durham (who was a pioneer in his observations on the curious phenomena of the "agglutination" of blood corpuscles in relation to disease) was led to suggest the injection of sera during surgical operations, and experiments recently quoted by Metschnikoff seem to show that the suggestion was well founded. After years of opposition bravely met in the pure scientific spirit of renewed experiment and demonstration, Metschnikoff is at last able to say that the foundation-stone of the hygiene of the tissues—the thesis that our phagocytes are our arms of defence against infective germs—has been generally accepted.

Another feature of the progress of our knowledge of disease—as a scientific problem—is the recent recognition that minute animal parasites of that low degree of unicellular structure to which the name "Protozoa" is given, are the causes of serious and ravaging diseases, and that the minute algoid plants, the bacteria, are not alone in possession of this field of activity. It was Laveran—a French medical man—who, just about twenty-five years ago, discovered the minute animal organism in the red blood-corpuscles, which is the cause of malaria. Year by year ever since our knowledge of this terrible little parasite has increased. We now know many similar to, but not identical with it, living in the blood of birds, reptiles, and frogs.

It is the great merit of Major Ross, formerly of the Indian Army Medical Staff, to have discovered, by most patient and persevering experiment, that the malaria parasite passes a part of its life in the spot-winged gnat or mosquito (Anopheles), not, as he had at first supposed, in the common gnat or mosquito (Culex), and that if we can get rid of spot-winged mosquitoes or avoid their attentions, or even only prevent them from sucking the blood of malarial patients, we can lessen, or even abolish, malaria.

This great discovery was followed by another as to the production of the deadly "Nagana" horse and cattle disease in South Africa by a screw-like, minute animal parasite, the *Trypanosoma Brucei*. The Tsetze fly, which was already known in some way to produce this disease, was found by Colonel David Bruce to do so by conveying by its bite the Trypanosoma from wild big-game animals, to the domesticated horses and cattle of the colonists. The discovery of the parasite and its relation to the fly and the disease was as beautiful a piece of scientific investigation as biologists have ever seen. A curious and very important fact was discovered by Bruce—namely, that the native big game (zebras, antelopes, and probably buffaloes), are *tolerant* of the parasite. The Trypanosoma grows and multiplies in their blood, but does not kill them or even injure them. It is only the unaccustomed introduced animals from Europe which are poisoned by the chemical excreta of the Trypanosomes and die in consequence. Hence the wild creatures—brought into a condition of tolerance by natural selection and the dying out of those susceptible to the poison—form a sort of "reservoir" of deadly Trypanosomes for the Tsetze flies to carry into the blood of new-comers. The same phenomenon of "reservoir-hosts" (as I have elsewhere called them) has since been observed in the case of malaria; the children of the native blacks in Africa and in other malarious regions are *tolerant* of the malarial parasite, as many as 80 per cent. of children under ten being found to be infected, and yet not suffering from the poison. This is not the same thing as the immunity which consists in *repulsion* or *destruction* of the parasite.

The Trypanosomes have acquired a terrible notoriety within the last four years, since another species, also carried by a Tsetze fly of another species, has been discovered by Castellani in cases of sleeping sickness in Uganda, and demonstrated by Colonel Bruce to be the cause of that awful disease. More than 200,000 natives of Uganda have died from it within the last five years. It is incurable, and, sad to relate, not only a certain number of European employés have succumbed to it in tropical Africa, but a brave young officer of the Army Medical Corps, Lieutenant Tulloch, has died from the disease acquired by him in the course of an investigation of this disease and its possible cure, which he was carrying out, in association with other men of science, on the Victoria Nyanza Lake in Central Africa. Lieutenant Tulloch was sent out to this investigation by the Royal Society of London, and I will venture to ask you to join that body in sympathy for his friends, and admiration for him and the other courageous men who risk their lives in the endeavour to arrest disease.

Trypanosomes are now being recognised in the most diverse regions of the world as the cause of disease—new horse diseases in South America, in North Africa, in the Philippines and East India are all traced to peculiar species of Trypanosome. Other allied forms are responsible for Delhi-sore, and certain peculiar Indian fevers of man. A peculiar and ultra-minute parasite of the blood cells causes Texas fever, and various African fevers deadly to cattle. In all these cases, as also in that of plague, the knowledge of the carrier of the disease, often a mite or acarus—in that of plague the flea of the rat—is extremely important, as well as the knowledge of reservoir-hosts when such exist.

The zoologist thus comes into closer touch than ever with the profession of medicine, and the time has arrived when the professional students of disease fully admit that they must bring to their great and hopeful task of abolishing the diseases of man the fullest aid from every branch of biological science. I need not say how great is the contentment of those who have long worked at apparently useless branches of science, in the belief that all knowledge is good, to find that the science they have cultivated has become suddenly and urgently of the highest practical value.

I have not time to do more than mention here the effort that is being made by combined international research and cooperation to push further our knowledge of phthisis and of cancer, with a view to their destruction. It is only since our last meeting at York that the parasite of Phthisis or Tubercle has been made known; we may hope that it will not be long before we have similar knowledge as to Cancer. Only eighteen months have elapsed since Fritz Schaudinn discovered the long-sought parasitic germ of Syphilis, the *Spirochaeta pallida*. As I write these words the sad news of Schaudinn's death at the age of thirty-five comes to me from his family at Hamburg—an irreparable loss.

Let me finally state, in relation to this study of disease, what is the simple fact—namely, that if the people of Britain wish to make an end of infective and other diseases they must take every possible means to discover capable investigators, and employ them for this purpose. To do this, far more money is required than is at present spent in that direction. It is necessary, if we are to do our utmost, to spend a thousand pounds of public money on this task where we now spend one pound. It would be reasonable and wise to expend ten million pounds a year of our revenues on the investigation and attempt to destroy disease. Actually, what is so spent is a mere nothing, a few thousands a year. Meanwhile our people are dying by thousands of preventable disease.

II. The Advancement of Science as Measured by the Support given to it by Public Funds, and the Respect Accorded to Scientific Work by the British Government and the Community at Large.

Whilst I have been able, though in a very fragmentary and incomplete way, to indicate the satisfactory and, indeed, the wonderful progress of science since this Association last met in York, so far as the making of new knowledge is concerned, I am sorry to say that there is by no means a corresponding "advancement" of Science in that signification of the word which implies the increase of the influence of science in the life of the community, the increase of the support given to it, and of the desire to aid in its progress, to discover and then to encourage and reward those who are specially fitted to increase scientific knowledge, and to bring it to bear so as to promote the welfare of the community. I am speaking on a privileged occasion to a body of men who are met together for the Advancement of Science, and I claim the right to say to them, without offence to the representatives of institutions which I criticise, what is in my mind.

It is, unfortunately, true that the successive political administrators of the affairs of this country, as well as the permanent officials, are altogether unaware to-day, as they were twenty-five years ago, of the vital importance of that knowledge which we call science, and of the urgent need for making use of it in a variety of public affairs. Whole departments of Government in which scientific knowledge is the one thing needful are carried on by ministers, permanent secretaries, assistant secretaries, and clerks who are wholly ignorant of science, and naturally enough dislike it since it cannot be used by them, and is in many instances the condemnation of their official employment. Such officials are, of course, not to be blamed, but rather the general indifference of the public to the unreasonable way in which its interests are neglected.

A difficult feature in treating of this subject is that when one mentions the fact that ministers of State and the officials of the public service are not acquainted with science, and do not even profess to understand its results or their importance, one's statement of this very obvious and notorious fact is apt to be regarded as a personal offence. It is difficult to see wherein the offence lies, for no one seeks to blame these officials for a condition of things which is traditional and frankly admitted.

This is really a very serious matter for the British Association for the Advancement of Science to consider and deal with. We represent a line of activity, a group of professions which are in our opinion of vital importance to the well-being of the nation. We know that those interests which we value so highly are not merely ignored and neglected, but are actually treated as of no account or as non-existent by the old-established class of politicians and administrators. It is not too much to say that there is a natural fear and dislike of scientific knowledge on the part of a large proportion of the persons who are devoid of it, and who would cease to hold, or never have held, the positions of authority or emolument which they now occupy, were scientific knowledge of the matters with which they undertake to deal required of them. This is a thorny subject, and one in which, however much one may endeavour to speak in general terms, it is difficult to avoid causing personal annoyance. Yet it seems to me one which, believing as I do that it is of most urgent importance, it is my duty as your President to press upon the attention of the members of the British Association. Probably an inquiry into and discussion of the neglect of science and the questionable treatment of scientific men by the administrative departments of Government would be more appropriate to a committee appointed by the Council of the Association for this purpose than to the Presidential Address.

At the same time, I think the present occasion is one on which attention should be drawn in general terms to the fact that science is not gaining "advancement" in public and official consideration and support. The reason is, I think, to be found in the defective education, both at school and university, of our governing class, as well as in a racial dislike among all classes to the establishment and support by public funds of posts which the average man may not expect to succeed by popular clamour or class privilege in gaining for himself—posts which must be held by men of special training and mental gifts. Whatever the reason for the neglect, the only remedy which we can possibly apply is that of improved education for the upper classes, and the continued effort to spread a knowledge of the results of science and a love for it amongst all members of the community. If members of the British Association took this matter seriously to heart they might do a great deal by insisting that their sons, and their daughters too, should have reasonable instruction in science both at school and college. They could, by their own initiative and example, do a good deal to put an end to the trifling with classical literature and the absorption in athletics which is considered by too many schoolmasters as that which the British parent desires as the education of his children.

Within the past year a letter has been published by a well-known nobleman, who is one of the Trustees of the British Museum, holding up to public condemnation the method in which the system laid down by the officials of the Treasury and sanctioned by successive Governments, as to the remuneration of scientific men, was applied in an individual case. I desire to place on record here the Earl of Crawford's letter to the *Times* of October 31, 1905, for the careful consideration of the members of the British Association and their friends. When such things are done, science cannot be said to have advanced much in public consideration or Governmental support.

To the Editor of the "Times.

Sir.—The death, noted by you to-day, of my dear friend and colleague, Dr. Copeland, His Majesty's Astronomer for Scotland, creates a vacancy in the scientific staff of Great Britain.

Will you permit me, Sir, to offer a word of warning to any who may be asked to succeed him?

Students or masters of astronomy are not, in the selfish sense, business men nor are they as a general rule overburdened with this world's goods. It behoves them henceforth to take more care as to their future in case of illness or physical infirmity, and not to trust to the gratitude or generous impulse of the Treasury Department.

In old days it was the custom when a man distinguished in science was brought into a high position in the Civil Service that he was credited with a certain number of years service ranking for pension. This practice has been done away with and a bargain system substituted. A short while ago the growing agonies of heart disease caused Dr Copeland to feel that he was less able to carry on the duties of his post, and he determined to resign; but he learnt that under the scale, and in the absence of any special bargain, the pension he would receive would not suffice for the necessities of life. The only increase his friends could get from the Treasury was an offer to allow him about half-a-crown a week extra by way of a house.

Indignant and ashamed of my Government, I persuaded Dr. Copeland to withdraw his resignation and to retain the official position which he has honoured till his death.

I trust, Sir, that this memorandum of mine may cause eminent men of science who are asked to enter the service of the State when already of middle age to take heed for their future welfare.

I am, Sir, your obedient servant,

2 Cavendish Square, October 28. CRAWFORD.

It is more agreeable to me not to dwell further on the comparative failure of science to gain increased influence and support in this country, but to mention to you some instances on the other side of the account. As long ago as 1842 the British Association took over and developed an observatory in the Deer Park at Kew, which was placed at the disposal of the Association by Her Majesty the Queen. Until 1871 the Association spent annually a large part of its income—as much in later years as 600*l.* a year—in carrying on the work of the Kew Observatory, consisting of magnetic, meteorological and physical observations. In 1871 the Association handed over the Observatory to the Royal Society, which had received an endowment of 10,000*l.* from Mr. Gassiot for its maintenance, and had further devoted to that purpose considerable sums from its own Donation Fund and Government grant. Further aid for it was also received from private sources. From this Observatory at last has sprung, in the beginning of the present century, the National Physical Laboratory in Bushey Park, a fine and efficient scientific institution, built and supported by grants from the State, and managed by a committee of really devoted men of science who are largely representatives of the Royal Society. In addition to the value of the site and buildings occupied by the National Physical Laboratory, the Government has contributed altogether 34,000*l.* to the capital expenditure on new buildings, fittings, and apparatus, and has further assigned a grant of 6000*l.* a year to the working of the laboratory. This institution all men of science are truly glad to have gained from the State, and they will remember with gratitude the statesmen—the late Marquis of Salisbury, the Right Hon. Arthur J. Balfour, Mr. Haldane, and others—as well as their own leaders—Lord Rayleigh, Sir William Huggins, and the active body of physicists in the Royal Society—who have carried this enterprise to completion. The British Association has every reason to be proud of its share in early days in nursing the germ at Kew which has at length expanded into this splendid national institution.

I may mention also another institution which, during the past quarter of a century, has come into existence and received, originally through the influence of the late Lord Playfair (one of the few men of science who have ever occupied the position of a Minister of the Crown), and later by the influence of the Right Hon. Joseph Chamberlain, a subsidy of 1000*l.* a year from the Government and a contribution of 5000*l.* towards its initial expenses. This is the Marine Biological Association, which has a laboratory at Plymouth, and has lately expended a special annual grant, at the spontaneous invitation of His Majesty's Treasury, in conducting an investigation of the North Sea in accordance with an international scheme devised by a central committee of scientific experts. This scheme has for its purpose the gaining such knowledge of the North Sea and its inhabitants as shall be useful in dealing practically and by legislation with the great fisheries of that area. You will, perhaps, not be surprised to hear that there are persons in high positions who, though admittedly unacquainted with the scientific questions at issue or the proper manner of solving them, are discontented with the action of the Government in entrusting the expenditure of public money to a body of scientific men who give their services, without reward or thanks, to carrying out the purposes of the international inquiry. Strange criticisms are offered by these malcontents in regard to the work done in the international exploration of the North Sea, and a desire is expressed to secure the money for expenditure by a less scientific agency. I do not hesitate to say here that the results obtained by the Marine Biological Association are of great value and interest, and, if properly continued and put to practical application, are likely to benefit very greatly the fishery industry; on the other hand, if the work is cut short or entrusted to incompetent hands it will no doubt be the case that what has already been done will lose its value—that is to say, will have been wasted. There is imminent danger of this perversion of the funds assigned to this scientific investigation taking place. There is no guarantee for the continuance of any funds or offices assigned to science in one generation by the officials of the next. The Mastership of the Mint held by Isaac Newton, and finally by Thomas Graham, has been abolished and its salary appropriated by non-scientific officials. Only a few years ago it was with great difficulty that the Government of the day was prevented from assigning the Directorship of Kew Gardens to a young man of influence devoid of all knowledge of botany!

One of the most solid tests of the esteem and value attached to scientific progress by the community is the dedication of large sums of money to scientific purposes by its wealthier members. We know that in the United States such gifts are not infrequent; they are rare in this country. It is, therefore, with especial pleasure that I call your attention to a great gift to science in this country made only a few years ago. Lord Iveagh has endowed the Lister Institute, for researches in connection with the prevention of disease, with no less a sum than a quarter of a million pounds sterling. This is the largest gift ever made to science in this country, and will be productive of great benefit to humanity. The Lister Institute took its origin in the surplus of a fund raised by Sir James Whitehead when Lord Mayor, some sixteen years ago, for the purpose of making a gift to the Pasteur Institute in Paris, where many English patients had been treated, without charge, after being bitten by rabid dogs. Three thousand pounds was sent to M. Pasteur, and the surplus of a few hundred pounds was made the starting-point of a fund which grew, by one generous gift and another, until the Lister Institute on the Thames Embankment at Chelsea was set up on a site presented by that good and high-minded man, the late Duke of Westminster.

Many other noble gifts to scientific research have been made in this country during the period on which we are looking back. Let us be thankful for them, and admire the wise munificence of the donors. But none the less we must refuse to rely entirely on such liberality for the development of the army of science, which has to do battle for mankind against the obvious disabilities and sufferings which afflict us and can be removed by knowledge. The organisation and finance of this army should be the care of the State.

It is a fact which many of us who have observed it regret very keenly, that there is to-day a less widespread interest than formerly in natural history and general science, outside the strictly professional arena of the school and university. The field naturalists among the squires and the country parsons seem nowadays not to be so numerous and active in their delightful pursuits as formerly, and the Mechanics' Institutes and Lecture Societies of the days of Lord Brougham have given place, to a very large extent, to musical performances, bioscopes, and other entertainments, more diverting, but not really more capable of giving pleasure than those in which science was popularised. No doubt the organisation and professional character of scientific work are to a large extent the cause of this falling-off in its attraction for amateurs. But perhaps that decadence is also due in some measure to the increased general demand for a kind of manufactured gaiety, readily sent out in these days of easy transport from the great centres of fashionable amusement to the provinces and rural districts.

In conclusion, I would say a word in reference to the associations of our place of meeting, the birthplace of our Society. It seems to me not inappropriate that a Society for the Advancement of Science should have taken its origin under the walls of York Minster, and that the clergy of the great cathedral should have stood by its cradle. It is not true that there is an essential antagonism between the scientific spirit and what is called the religious sentiment. "Religion," said Bishop Creighton, "means the knowledge of our destiny and of the means of fulfilling it." We can say no more and no less of Science. Men of Science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal.

NOTES.

SIR WILLIAM CROOKES, Prof. Eduard Suess, Prof. Luigi Palazzo, and Prof. Orazio Marucchi were elected honorary members of the Royal Academy of Acireale (Sicily) at a meeting on July 24.

THE Highways Committee of the London County Council has taken the necessary steps in connection with the appointment of the committee suggested by the Admiralty to inquire whether the working of the Greenwich electricity generating station will have any injurious effect upon the Royal Observatory, Greenwich. Sir Benjamin Baker will act as the Council's representative on the committee, and Prof. C. V. Boys will act in an advisory capacity from the astronomical and scientific point of view. The representatives appointed by the Admiralty on the committee are Prof. J. A. Ewing and Lord Rosse.

THE seventy-fourth annual meeting of the British Medical Association will be held at Toronto, Canada, on August 21. The president-elect is Dr. Richard A. Reeve, of the University of Toronto. Addresses will be delivered in medicine by Sir James Barr, in surgery by Sir Victor Horsley, F.R.S., and in obstetrics by Dr. Walter S. A. Griffith. The business of the meeting will be carried on in thirteen sections, dealing respectively with anatomy, dermatology, laryngology, medicine, obstetrics and gynæcology, ophthalmology, pædiatrics, pathology and bacteriology, physiology, psychology, State medicine, surgery, and therapeutics. Several receptions and soirées have been arranged, and the last day of the meeting is to be devoted to outings.

ON Tuesday the Natural History Museum received, from Mr. Rowland Ward's establishment, a mounted specimen of a wild male African elephant, standing 11 feet 4 inches at the shoulder. The animal was shot in Rhodesia. The specimen could only be brought into the museum by taking down the doors, and, after considerable difficulty, was duly installed in the central hall, facing the entrance. This is the first wild African elephant's skin that has ever been mounted. The architect should be congratulated upon his clever achievement in one of the largest buildings in London with really one of the largest doors until he had artistically obliterated it.

THE contents of Nos. 7 and 8 of *Naturen* include articles on the habits of humble-bees, Chilian nitre, squirrels' nests, and "animalcules."

IN a paper on the development of the cusps on mammalian cheek-teeth, published in the Proceedings of the Washington Academy (vol. vii., pp. 91–110), Mr. J. W. Gidley points out that, in his opinion, the tritubercular theory cannot be maintained in its original form. It appears that the three main cusps of the upper tritubercular molar are by no means always homologous. Despite the want of homology in the cusps, the author deprecates any change in Prof. Osborn's nomenclature for tritubercular molars, which is found to be exceedingly convenient in practice.

A COLLECTION of skulls of Californian Indians forms the subject of an elaborate paper by Mr. A. Hrdlicka constituting No. 2 of vol. iv. of the Archæological and Ethnological Publications of the University of California. These ancient Californian Indians, like those of Santa Barbara Island, show no affinity to the aborigines of Arizona and Sonora, but appear akin to the Otomi of the States of Hidalgo and Mexico. "A large group of peoples in the States of Puebla, Michoacan, and further south, even including the Aztecs, and finally the Tarahumare, in Chihuahua, are all physically related to the Otomi as well as to the Californians."

CORALS from California and Brazil form the subject of No. 1477 of the Proceedings of the U.S. National Museum, a Californian Cœnocyathus being described by Mr. T. W. Vaughan, the author of the paper, as new. In No. 1478 of the same serial Messrs. Evermann and Clark describe certain new fishes from a small river in the centre of Santo Domingo. Six specimens were obtained, referable to four species, three of which are regarded as new, two being assigned to the genus Platypœcilus and the third to Sicydium.

A NUMBER of new South African Palæozoic fossils—both vegetable and animal—are described by Mr. E. H. L. Schwarz in the sixth part of the first volume of the Records of the Albany Museum. It is noteworthy that the plants, which appear to be either of Upper Devonian or Lower Carboniferous age, are referable to the "Lepidodendron flora." In the same issue Mr. J. E. Duerden reviews the South African tortoises of the genus Homopus, and describes and figures, under the name of *H. boulengeri*, a species regarded as new to science. In regard to the tortoises of the *Testudo geometrica* group, the author points out that some of the named species appear to intergrade, thus suggesting that in this group we may have species in course of evolution. A fourth contribution, by Mr. P. Cameron, on the Hymenoptera in the Albany Museum, completes this issue.

THE first issue of the Memoirs of the National Museum, Melbourne, consists of a paper by Dr. A. Smith Woodward on a Carboniferous fish-fauna from the Mansfield district, Victoria. It appears that the fish-remains described were discovered so long ago as 1888, and that a brief notice of them was published by the late Sir F. McCoy in the following year. Coloured plates were, moreover, prepared under that palæontologist's direction, and these have been utilised in the present issue. Of the six generic types recognised, one is too imperfectly known for its affinities to be exactly defined, four others, Acanthodes, Ctenodus, Strepsodus, and Elonichthys, occur in the Permian and Carboniferous of Europe and the Carboniferous of North America, but the sixth, Gyracanthides, although related to a northern Carboniferous type, is altogether peculiar and of exceptional interest. It appears, indeed, to be an acanthodian referable either to the Diplacanthidæ or a kindred family group, but of a highly specialised nature, the specialisation displaying itself in the enlargement of the pectoral fins, the reduction and forward displacement of the pelvics, and the absence or modification of the intermediate spines. A restored figure of this remarkable shark is given.

IN the annual report of the U.S. National Museum, 1904, Mr. G. P. Merrill, whose writings on geology are always acceptable, has produced a treatise entitled "Contributions to the History of American Geology." Sir Archibald Geikie and the late Prof. Zittel have already provided geologists with historical accounts of the growth of their subject, mainly from the European standpoint. In these "Contributions" Mr. Merrill takes up the story from the American point of view, thereby filling a serious gap in a manner that will earn the gratitude of everyone interested in the science. The mode of presentation of the subject is the chronological one, but several topics that were at one time of outstanding prominence are treated separately; such are the Laramie question, the Taconic succession, and the Eozoon problem. Not the least interesting feature in this extremely interesting work is the assemblage of portraits of American geologists, including many early workers whose names must be almost unknown in this country.

THE latest addition to the publications of the Geological Survey of Western Australia is an exhaustive report (Bulletin No. 21) on the geology and mineral resources of the Norseman district, Dundas goldfield, by Mr. W. D. Campbell. The mining plans and sections, of which five accompany the report, mark an advance on any of the official mining plans yet issued in that their most prominent features are the lodes, faults, and dykes, rather than the underground roads. These data, together with the descriptions given in the report, form a permanent record of the Norseman mines up to the date of publication. The area dealt with in the report up to the end of 1904 has yielded 266,004 ounces of gold, or 1·019 ounces for every ton of ore treated.

IN the *Engineering Magazine* (July) Mr. Clarence Heller gives some interesting personal observations on the effect of earthquake and fire on steel buildings at San Francisco. His photographs give a graphic record of the failure of structural materials and systems under various conditions. Riveted connections showed their superiority over bolts when called upon to resist twist by earthquake. The great losses by fire were due to poor material, bad mortar, and miserable workmanship.

IN his presidential address to the Norfolk and Norwich Naturalists' Society at the meeting held on March 27, which is published in the second part of vol. viii. of the Transactions of that body, Mr. Eustace Gurney, after surveying recent progress in "limnology," directed attention to the opportunities for research presented by the Norfolk Broads. He pointed out that after the compilation of complete lists of the fauna, much might be done in regard to a knowledge of the life-history of many species by keeping them in tanks. In addition to this, we ought to be acquainted with the physical and chemical characteristics of each sheet of water, the nature of the bottom-deposits, and so on. The papers in the same issue include one by Mr. T. Southwell on the share taken in former times by Lynn and Yarmouth in the Greenland whale-fishery, one by Mr. T. J. Wigg on last year's herring-fishery, and a third, by Mr. W. G. Clarke, on the classification of Norfolk flint-implements.

IN the Annual Report and Proceedings of the Belfast Naturalists' Field Club for 1905–6, the secretary announces a small excess of expenditure over receipts. The two most important papers in this issue are a *résumé* of the club's recent work with regard to local glaciation, by Madame Christen, and an account of the Carnmoney chalcedony, by Mr. J. Strachan. As the results of his investigations on the latter subject, the author is disposed to reject the theory that deposits in lava of chalcedony of the nature of the one in question are due to decomposition changes in favour of the idea that they are contemporaneous products of the rock, and that they were formed during the final stages of cooling and drying. He is also of opinion that the associated zeolitic or calcitic layer, as well as the siliceous contents of the veins or cavities, owes its origin, not to the decomposition of the parent rock, but to the last stages in its formation.

ACCORDING to the observations of Mr. A. Toyama, of the College of Agriculture, Tokyo University, published in the June issue of *Biologisches Centralblatt*, Mendel's law of heredity is strictly applicable, in a very large number of cases, to cross-bred silkworms. The colours of the cocoons and the larval markings are, for instance, strictly Mendelian, while other features appear to conform to certain laws not yet formulated. No single instance was observed in which an irregular development of Mendelian phenomena took place. In another article issued in the same number Dr. H. Simroth urges that the sporadic development of a black phase of the hamster affords an instance of undoubted mutation among mammals. In giving *Cricetus vulgaris niger* as the equivalent of Schreber's "Mus cricetus Linné niger," the author is unwittingly founding a new subspecies, as no *C. v. niger* occurs in any of the published lists.

THE Department of Agriculture in India has commenced the issue of a chemical series of memoirs. Part i. contains an article by Dr. J. W. Leather, agricultural chemist to the Government of India, on the composition of Indian rain and dew. The author points out that the amount of ammonia and nitric or nitrous acid found in the annual rainfall by observers in different parts of the world has varied within wide limits. The observations at Rothamsted during fifteen years, 1889–1903, show mean quantities of 2·78 lb. of "ammonia" nitrogen and 1·19 lb. of "nitric" nitrogen per acre per annum, the total being 3·97 lb.; but there has been a tendency among observers in the East to attribute to tropical rainfall much greater amounts. A record of these compounds was kept recently for twelve months at Dehra Dun and Cawnpore, both stations being nearly within the tropics, and is of interest as additional evidence upon the subject. The results obtained were, approximately, in lb. per acre:—Dehra Dun, ammonia 2·04, nitrate and nitrite 1·37, total 3·41; Cawnpore, 2·48 and 0·77 respectively, total 3·25, the amount of ammonia being less at both stations than at Rothamsted; of nitric acid, the Dehra Dun rain contained somewhat more, the Cawnpore rain a good deal less, than at the English station. Information regarding the quantity and composition of dew is but limited. Observations were made at Cawnpore between September, 1904, and March, 1905; the amount of dew was only 0·17 inch, and contained approximately 0·055 lb. of "ammonia" nitrogen and 0·056 lb. of "nitric" nitrogen per acre. Dr. Leather thinks it probable that the method adopted at Cawnpore for registering the amount of dew gave a low result.

THE value of statistical researches in the subject of heredity and variation is well illustrated by a paper lately published in the Proceedings of the American Academy of Arts and Sciences, under the joint names of W. E. Castle, F. W. Carpenter, A. H. Clark, S. O. Mast, and W. M. Barrows, on the effects of inbreeding, cross-breeding and selection upon the fertility and variability of Drosophila, a genus of Diptera which feeds in the larval stage on over-ripe fruit. The experiments were conducted with great care, and their results recorded with minuteness, the outcome being a valuable set of conclusions on various moot points connected with the subject. The authors consider that their experiments prove that, although long-continued inbreeding (extending in one case to fourteen generations) may possibly cause a decline in fertility, this effect may be more than counterbalanced by selection of the most productive among closely inbred pairs. No falling-off was observed in either strength, size, or variability in the inbred generations. Different degrees of fertility are characteristic of different stocks; inheritance of such differences does actually take place, and gives material for selection. Indications were found of a cyclical change in fertility. This appeared to be due to external conditions, *e.g.* temperature. The quality of low productiveness was found to conform imperfectly with Mendel's law, but the alternative character of high and low fertility is not sharply defined. Sexual maturity was shown to be reached at some time between twenty-four and thirty-nine hours after emergence from the pupa, and a single male was proved to be capable of fertilising at least four females.

DR. SHADWORTH H. HODGSON'S paper on the inter-relation of the academical sciences, read to the British Academy on March 14, has been published by Mr. Henry Frowde. Dr. Hodgson asks what is the common ulterior end of the four sections of the British Academy, dealing as they do with the different sciences of history, philology, philosophy, and law. These four branches of inquiry, he discovers, have to do with man, and his conscious activities in every direction, and the relations of men with men and with other conscious beings; and the whole group has as its differentia from the positive physical sciences the fact that it takes consciousness as the point of view. So the ulterior aim of all the sections is the harmonising and organising into a system of the knowledge obtained in each section and subsection of those conscious activities which are its special province, with the further purpose of harmonising those conscious activities themselves into a concerted life of mankind on earth. The lecturer further claims that internal organisation of the academical sciences can only be effected by connecting the sciences of history, philology, and law with philosophy, "which alone possesses in its metaphysical department a secure foundation for any science whatever, being itself founded, alone among all, upon the analysis of consciousness, or experience, without initial assumptions of any kind."

THE "Year-book of Agriculture" for the State of Victoria for the year 1905, recently issued under the supervision of its new director of agriculture, Dr. Cherry, contains a series of valuable articles on economic biology. It supplies an interesting case of the rapid spread of a European plant in Australia, which is of value from the exact information available as to its rate of movement. Some seeds of a species of St. John's wort (*Hypericum perforatum*) were planted at Bright twenty-five years ago by a lady who wanted the plant for medicinal purposes. From her garden it spread to the Bright racecourse, where it grew so luxuriantly that it gained the popular name of the "racecourse weed." Thence it has been carried by cattle, as shown by a map of the present distribution of the plant in Victoria, along all the main stock routes from Bright. Among other directions it has crossed the main water-shed of Victoria into Gippsland, and now occupies more than 10,000 acres of good land. Methods proposed for its eradication are engaging the attention of the Agricultural Department of Victoria, which has tried an extensive series of experiments. Treatment of the ground with pyrites, at the cost of more than 5*l.* an acre, has been the most successful. The cost of some of the methods tested is prohibitive, ranging up to 47*l.* an acre. Amongst other valuable articles in the volume are those on the soils of Victoria, by Dr. Cherry; on farm irrigation from small dams, by Mr. A. S. Kenyon; and on various branches of dairy farming

THE report of the committee on ancient earthworks and fortified enclosures, presented to the seventeenth congress of archæological societies held at Burlington House on July 4, is now available. The committee regrets that the archæological societies have not yet been able to undertake the systematic scheduling of the ancient earthworks and defensive enclosures in their respective districts. The report contains a list of the additions to the literature of the subject of the committee's inquiries, a list of recent cases of the destruction or mutilation of defensive outworks, tumuli, and barrows, and some account of the excavations during the year.

A VALUABLE memoir of the Geological Survey on "Soils and Subsoils from a Sanitary Point of View, with especial Reference to London and its Neighbourhood," was issued nine years ago. The second edition of this memoir has just been published by the Board of Agriculture and

Fisheries. Questions of water-supply, of ground-water, and of drainage are dealt with in their sanitary aspects; the geology of the district is described according to the nature of the subsoil, whether clayey, sandy, gravelly, or chalky. A small colour-printed map accompanies the letterpress, and the memoir is further illustrated by twenty-two sections and drawings. Copies may be obtained from any agents for the sale of Ordnance Survey maps, or directly or through any bookseller, from the Ordnance Survey Office, Southampton. The price is 1*s*. 6*d*.

THE first mention of petroleum in North America is due to Father de la Roche d'Allion, the Franciscan, in 1629. Mr. Alfred Sang, of Pittsburg, U.S.A., suggests, in a note to us, that the first mention of oil in South America may be that by Albaro Alonso Barba, of Potosi, eleven years later, in 1640, in "The Art of Metals," translated by the Earl of Sandwich in 1669. The part referring to petroleum is contained in the following extract sent by Mr. Sang:—"*La Naphte* is a sulphurous liquor, sometimes white, and sometimes black also, and is that which is called Oyl of *Peter*, of admirable vertue to cure old pains, proceeding from cold causes. It will draw fire to it (as the Loadstone does Iron) with that force, that it will take fire at a great distance from the flame, as hath been confirmed by the miserable experience of the *Conde de Hercules de Icontrarii*, of the Country of Ferara, who having a well in his ground, the water whereof was mixed with *Petreol*; and by some breaches or cracks in the well, much of this water ran to waste; commanded it to be repaired; the Laborer that was let down into the bottom of the Well desired a Candle, the better to see his work, which was furnished him in a Lanthorn, and immediately through the holes of the Lanthorn the *Naphte* suckt the flame into it self and set fire on the whole Well, which discharged it self instantly like a great piece of Cannon, and blew the poor man into pieces, and took off an arm of a Tree that hung over the Well."

IN the "Ethnography of the Macedonian Slavs" (London: Horace Cox), translated from the second edition of Dr. Cvijić's well-known booklet, we have a useful criticism of many wild statements which have been made with regard to racial relations in Macedonia. After treating of the sense of nationality and showing its connection with religion in the area in question, the author discusses the value of ethnographical maps published in the peninsula and elsewhere; he has little difficulty in showing that the majority are quite untrustworthy. Most of them are dominated by erroneous conceptions as to the term Bulgarian, adopted by Macedonian Slavs, and often used by the peasant to denote simply one who speaks the Slav tongue; an additional complication is introduced by the attribution of the same name by the Macedonian peasants to the Serbs, so that Russian, Serb, and Bulgarian all bear the same name. The maps published in the peninsula reflect only the political aims of the cartographer. In such circumstances Dr. Cvijić's impartial evidence is of the highest value. A comparative table at the end of the booklet shows the variations of the statistical tables. The translation would have gained if an anthropologist had revised the terminology.

AN article on pure food legislation, by Mr. Robert McD. Allen, in the *Popular Science Monthly* for July has a special interest at the present moment. Its object is to show the difficulties which have retarded legislation with regard to the adulteration of food in the United States in the past, and the proposals by which the Hepburn Pure Food Bill, which has passed the House of Representatives, suggests a remedy. The Bill aims at the correct labelling of foods, drugs, and liquors in such a way as to show the source of the material, its treatment, and whether colouring matters or preservatives have been added. It is pointed out that not only has the chief of the Bureau of Chemistry, assisted by the medical staff of the Army, reported against the use of salicylic, benzoic, and boric acids as preservatives, but that preservatives are used in many cases as a substitute for cleanliness and careful handling, thus discouraging better methods, such as chilling, sterilising, and curing. The use of artificial colouring matters, if not actually injurious, is at the best a fraud; genuine colour is one of the best indications of quality, and with artificial colour to depend upon there is less need for the selection of the best materials. With regard to tinned meats, the "Government inspection," which is supposed to be a guarantee, refers only to the state of the original carcass, and antiseptics, colouring matters, filling materials, and other adulterants may be freely added. The extreme difficulty of the problem of pure food legislation is owing to the fact that adulteration has become "so strongly entrenched in business systems that a proposition to put truthful labels on foods and drugs intended for interstate commerce has met continuous defeat for more than fifteen years at the national capital."

IN the *Atti dei Lincei*, xv., 10, Dr. G. Almansi discusses how far the principle of virtual work is applicable to systems in which friction exists.

AN interesting note on "Americanism" is contributed to the *Rendiconti* of the Lombardy Institution, xxxix., 10–11, by Dr. Bassano Gabba. It deals largely with religious thought in America, with special reference to Catholicism.

A SIMPLE machine for compounding sine-curves is described by Prof. W. G. Cady in *Science*, xxiii., 597. While not possessing the same capabilities as Michelson's harmonic analyser, the instrument is convenient for demonstration purposes, and gives the resultant of a fundamental sine-curve and either its second, third, or fifth harmonic with any desired amplitude and phase-relation.

A COMMEMORATION of Christopher Columbus, read on the 400th anniversary of his death by Dr. Dalla Vedona, is published in the *Atti dei Lincei*, xv., 11. It is pointed out that the work of Columbus initiated a new method of research by applying to navigation the theory of the sphericity of the earth. As the author remarks, the fundamental conception of Columbus was absolutely rational and absolutely scientific.

STEREOPHOTOMICROGRAPHY forms the subject of two papers in the Journal of the Royal Microscopical Society for June. One, by Mr. W. P. Dollman, of Adelaide, is illustrated by a photograph of polyzoa (*Idmonea radians*), the other, by Mr. H. Taverner, by groups of Foraminifera and the water mite (*Ecpolus papillosus*, Soar). In both cases the photographs were taken by successive exposures on the same plate with a screen cutting off half the objective.

MOST teachers of geometrical optics have, at one time or another, devised arrangements for showing the paths of rays reflected at a mirror or transmitted through a lens; in general, however, such arrangements require time to be spent in their adjustment, and the results obtained are often very poor when the trouble taken in attaining them is considered. Prof. Hartl has laid all teachers of experimental optics under an obligation by designing a piece of apparatus which he calls the "optical disc"; this, at a moment's notice, can be adjusted so as to show the path of the rays in any one of the important cases usually dealt with in elementary lectures on geometrical optics. The reflection of a single ray, or a number of rays (parallel or divergent) from a plane, concave, or convex mirror; the refraction of a ray at a plane surface, including the case where total internal reflection occurs; the path of a single ray or a number of rays through a convergent or a divergent lens; the nature of spherical and chromatic aberration; the theory of the rainbow, these are a few of the experiments which can be performed by its aid. The apparatus, which is sold by Messrs. A. Gallenkamp and Co., Ltd., is very compact, and its general arrangement is so good that one experiment may be changed for another in about half a minute. The same firm supplies an appliance comprising bent glass rods, which show the total reflection phenomena generally demonstrated by the aid of the illuminated fountain; a simple polarising apparatus, consisting of a pile of plates and a black glass reflector, which may be attached to the optical disc described above; and a simple form of polariscope, together with specimens of strained glass showing the characteristic coloured figures associated with double refraction.

AN interesting light is thrown on the difficult problem of the behaviour of manures in soils by some recent observations, made under the auspices of the Bureau of Soils of the United States Department of Agriculture, by Messrs. Oswald Schreiner and George H. Failyer, and published in the form of two communications in the *Journal of Physical Chemistry* (Nos. 4 and 5). One of these deals with the absorption by different soils of the phosphates of calcium and sodium from dilute solutions, whilst in the other the removal by a soil of potassium from an aqueous solution of potassium chloride is studied. It is shown that the soils dealt with take up the phosphates and potassium from aqueous solution according to the law of a monomolecular reaction, and that the action is strictly reversible. Water washes out the absorbed material according to a similar law. Each soil is characterised by a definite limiting capacity of absorption, which differs with different soils. It is remarkable that for certain clay soils and clay loams this capacity is the same for sodium phosphate as for calcium phosphate, pointing to the occurrence of definite reversible chemical actions. It is particularly noteworthy that when water percolates through a soil the amounts of phosphate or of potassium in the transmitted liquid give no clue to the quantities of these materials present in the soil itself. The results are determined, not by solubility alone, but by a special law governing the removal of the absorbed substances.

THE Institute of Chemistry has published a "List of Official Chemical Appointments held in Great Britain and Ireland, in India and the Colonies." The list has been compiled under the supervision of the proceedings committee of the institute by Mr. R. B. Pilcher, the secretary of the institute, and its price is 2*s*. net. The list is arranged in two main divisions; the first contains appointments under the departments of State and professorial appointments in the British Isles; the second section deals similarly with India and the colonies. The information provided indicates the steadily increasing demand for professional chemical services in connection with State and municipal administration, and it should prove of service to chemists everywhere.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST:—

Aug. 4. 1h. 0m. Eclipse of the Moon invisible at Greenwich.
,, 9h. 3m. to 10h. 13m. Moon occults ι Capricorni (mag. 4·3).
6. 10h. Saturn in conjunction with Moon (Saturn 0° 49′ N.).
,, 12h. 21m. to 12h. 54m. Moon occults ψ′ Aquarii (mag. 4·5).
7. Saturn. Major axis of rings = 43″·82, Minor = 3″·02.
10. 13h. 18m. to 14h. 13m. Moon occults ξ^2 Ceti (mag. 4·3).
10–12. Epoch of the Perseid meteoric shower. Radiant 45° + 57°.
15. Venus. Illuminated portion of disc = 0·650; of Mars = 0·997.
18. 12h. 15m. Minimum of Algol (β Persei).
19. 13h. 13m. Eclipse of the Sun invisible at Greenwich.
21. 9h. 4m. Minimum of Algol (β Persei).
24. 11h. 47m. to 14h. 37m. Transit of Jupiter's Sat. III. (Ganymede).
29. 6h. 29m. to 7h. 43m. Moon occults ξ^2 Sagittarii (mag. 3·5).
,, 11h. Mercury at greatest elongation (18° 11′ W.).
31. 16h. 2m. to 18h. 54m. Transit of Jupiter's Sat. III. (Ganymede).

FINLAY'S COMET (1906*d*).—The following approximate elements, corrected for planetary perturbations, are published in No. 4106 of the *Astronomische Nachrichten* by M. L. Schulhof for Finlay's comet at the present epoch:—

Epoch 1906 *August* 1·0 *M.T. Paris.*

	°	′	″			°	′	″
M =	354	22	45·7		φ =	46	23	22·9
π =	8	10	55·2	1906·0	μ =	542″·557		
☊ =	52	22	37·7	1906·0	log a =	0·815560		
i =	3	3	5·5	1906·0	T =	Sept. 7·3 (Paris)		

A daily ephemeris, from which the following has been extracted, has been calculated by M. Fayet:—

1906	α (true) h. m. s.	δ (true) ° ′	log r	log Δ	Brightness
Aug. 1	1 55 25	−1 27	0·04347	9·43680	23·4
3	2 13 6	+0 15	0·03807	9·43308	
5	2 30 47	+1 58	0·03288	9·43202	25·1
7	2 48 21	+3 39	0·02780	9·43350	
9	3 5 38	+5 17	0·02292	9·43742	25·7
11	3 22 31	+6 50	0·01823	9·44356	

The brightness of the comet when discovered in 1886 is taken as 1·0.

The observation of this comet at Heidelberg on July 16 gave corrections of −12m. 11s. and −1° 37′·5 to this ephemeris, and thereby brought the calculated time of perihelion to about September 8·35, 1906 (Paris M.T.). Applying these corrections to the above ephemeris, it will be seen that the comet will be about 3° north of Mira Ceti on August 4.

AN UNEXPLAINED OBSERVATION.—In No. 4106 of the *Astronomische Nachrichten* Prof. Barnard places on record the following observation, which he made so far back as August 13, 1892, and for which he has not yet been able to find any explanation. While examining Venus with the 36-inch Lick refractor at 0h. 50m. (G.M.T.) on August 13, 1892, he saw a star of about the seventh magnitude in the same field as the planet, and about 1′ south and 14s. ± preceding. The position of this object would be, therefore, α = 6h. 52m. 30s., δ = +17° 11′·0; this position reduced to 1855 becomes α = 6h. 50m. 21s., δ + 17° 13′·6, and there appears to be no such bright star in this place, neither does it agree with the position of any B.D. star. The actual elongation of Venus would exclude the possibility of the unknown object being an intra-Mercurial planet, although it does not preclude an improbable planetary body interior to Venus.

Although fourteen years have elapsed since the observation was made, Prof. Barnard has hitherto hesitated about publishing the results, but now thinks that they should be placed on record, especially as his notes are very definite, and there could have been no known possibility of mistake.

Unless the unknown body was one of the brighter asteroids—and Ceres, Pallas, Juno, and Vesta were known to be elsewhere—the result is, as yet, entirely incomprehensible.

THE RIO DE JANEIRO OBSERVATORY.—We have just received the "Annuario" of the Rio de Janeiro Observatory for 1906, a useful volume which is published by the observatory, under the direction of the Minister of Industry and of Public Works, and which is the twenty-second of the series.

In addition to the usual calendars and tables of astronomical events, this volume contains numerous tables employed in astronomical reductions and conversions, tables for the reduction of meteorological observations, data employed in physical and chemical operations, and a *résumé* of the meteorological observations made in the Rio de Janeiro area during the year 1904.

IRON AND STEEL INSTITUTE.

IN place of the usual autumn meeting, the Iron and Steel Institute held a largely attended meeting in London on July 24 and following days jointly with the American Institute of Mining Engineers. At the opening meeting the president of the Iron and Steel Institute, Mr. R. A. Hadfield, gave an address of welcome to the American guests, expressing satisfaction that so many American engineers had been able to be present at this important international meeting. Sir James Kitson, who was president when the society first visited America in 1890, followed with a similar address of cordial welcome. Mr. Robert Hunt, president of the American society, in acknowledgment, said they felt as though they were part of the Iron and Steel Institute in that their society was formed on the same lines, and was equally comprehensive in its character and membership. The president announced that the King had consented to receive a deputation of the American guests, and also to honour the institute by accepting the Bessemer gold medal. He also announced that Sir Hugh Bell had been unanimously elected as his successor to the presidency in May next. Papers on Continental practice in blast-furnace gas engines were then read in abstract by the secretary, Mr. Bennett H. Brough. The first of these, by Prof. Hubert (Liége), dealt with the design of blast-furnace gas engines in Belgium. It reviewed the history of the direct utilisation of blast-furnace gas in engines since the early attempts in 1895, and gave particulars of detailed tests of a 1400 horse-power two-cylinder double-acting and tandem engine made by the Cockerill Company. Mr. Reinhardt's paper, on the application of large gas engines in the German iron and steel industries, formed an exhaustive treatise on the subject. The author showed that in the German ironworks there are 349 gas engines with a total effective horse-power of 385,000. He reviewed the practical experience gained by working, and with the aid of a large number of illustrations explained the present design of large gas engines in Germany. The old arrangement of the single-acting four-cycle motor, with one or more cylinders, has in recent years not been generally used, and, on the other hand, double-acting four-cycle motors, mostly with tandem cylinders, are in keen competition with two-cycle motors. The author described in detail the cylinder and exhaust-valve chest, valve gear, shifting boxes, cooled pistons and piston rods, ignition and starting, and various engines of the double-acting four-cycle type of the leading German makers, the remainder of the paper being devoted to two-cycle engines on the Oechelhäuser and the Körting systems. Suitable trials concerning the consumption of gas, Mr. Reinhardt remarked, are not available for comparison, and therefore it is not yet known how far the two-cycle engine is at the present time in this respect still inferior to the four-cycle engine. In conclusion, the author stated that the present position of the application of gas engines in German ironworks shows the value the managers of these undertakings attribute to the better and less dangerous utilisation of the waste gases of their furnaces.

Mr. T. Westgarth (Middlesbrough) followed with a paper on large gas engines built in Great Britain. All the British builders were, he said, using the four-cycle system, except the builders of the Körting and Oechelhäuser engines, who worked on the two-cycle system.

In discussion, Mr. Julian Kennedy pointed out that in the United States gas engines were only in their infancy. After further well-sustained discussion, the meeting adjourned. During the afternoon visits were paid to the National Physical Laboratory, to the London County Council's electricity generating station at Greenwich, to the Mercers' Hall, and to the Hall of the Armourers' and Brasiers' Company, and in the evening a reception was given by the Lord Mayor at the Mansion House.

On July 25 a crowded meeting was presided over by Mr. Robert W. Hunt (Chicago), president of the American Institute of Mining Engineers. His presidential address dealt chiefly with American rolling-mill practice, and concluded with the announcement that Mr. J. E. Stead, F.R.S., and Mr. R. A. Hadfield had been elected honorary members of the American society. The first paper read dealt with a comparison of American and foreign rail specifications, with a proposed standard specification to cover American rails rolled for export. The author, Mr. A. L. Colby, read the paper in abstract, and the proposal to admit 0·1 per cent. of phosphorus was adversely criticised by Mr. Windsor Richards and other British members, the 0·07 per cent. recommended by the Engineering Standards Committee being considered safest for British practice. A paper by Mr. R. H. Lee, on producers in blast-furnace work, was briefly discussed, and the meeting adjourned. In the afternoon visits were paid to the works of Messrs. John I. Thornycroft at Chiswick, to the works of Messrs. J. and E. Hall at Dartford, to the halls of the Inner and Middle Temples, to Kensington Palace, the Imperial Institute, and the museums at South Kensington. In the evening there was a *fête* at the Imperial Royal Austrian Exhibition at Earl's Court.

On July 26 Mr. Hunt occupied the chair, but upon his proposal Mr. Hadfield presided. The first paper taken was by Mr. James P. Roe, on the development of the puddling process, and this was followed by a paper by Mr. James E. York on improvements in rolling iron and steel. These two papers, which are of extreme importance from a practical point of view, elicited an excellent discussion. The remaining papers on the British and American lists were taken as read. Many of these are of great interest and value, and we hope to publish abstracts of them in a subsequent issue. During the afternoon, visits were paid to the works of Messrs. Fraser and Chalmers at Erith, to the works of the Associated Portland Cement Manufacturers at Northfleet, to the Chelsea Power Station, and to the hall of the Ironmongers' Company. In the evening there was a banquet and special firework display at the Crystal Palace.

On July 27 the King received at Buckingham Palace a deputation of the councils of the Iron and Steel Institute and of the American Institute of Mining Engineers, and accepted from the president, Mr. Hadfield, the Bessemer gold medal and a suitable illuminated address. The general body of members visited Windsor Castle, where special facilities were given them for seeing the palace and gardens. In the evening there was a banquet at the Guildhall; Mr. Hadfield presided, and the company numbered 600 and included many distinguished guests. The American ladies, numbering 100, were entertained at dinner in two of the committee rooms, with Mrs. Hadfield and Lady Lloyd-Wise presiding.

On July 28 there were alternative excursions to Messrs. Butlin's blast furnaces at Wellingborough and to the Dover harbour works. These two successful visits brought the Iron and Steel Institute meeting to a close. For the American guests visits were arranged, on Sunday, July 29, to St. Paul's Cathedral, the Roman Catholic Cathedral at Westminster, the Zoological Society's Gardens, the Botanic Society's Gardens, and to Hurlingham and Ranelagh Clubs, and on July 30 they started on a provincial tour, organised by the Iron and Steel Institute, to York, Ripon, Middlesbrough, Durham, Newcastle-on-Tyne, Glasgow, and Edinburgh.

SOME RECENT ASTRONOMICAL WORKS.[1]

THE appearance of another star catalogue from the Radcliffe Observatory shows how loyal that institution has remained to the traditions that Main and Stone received from Johnson and the earlier observers. The result is in every way worthy of those traditions. Other duties may have divided the attention of the director. The maintenance of the observatory in the first rank has demanded within the last few years that new and larger instruments should be erected, and the adjustment of these has necessarily taxed the energies of the small staff at the observers' disposal. But these imperative tasks have only had the effect of diminishing somewhat the number of stars observed. The accuracy and the independence of the observations, which have ever been a feature in the Radcliffe meridian measures, have in no whit suffered. In these respects the tradition of the observatory has been unflinchingly upheld.

The introduction to the volume shows that the stability of the instrument has been increased by structural alterations. The examination of the division errors, that tedious and laborious work, involving in this case more than ten thousand readings of the circle, has been manfully tackled with apparently greater care than Stone bestowed upon this fundamental work. The pivots have been tested by an apparatus that Dr. Rambaut himself has perfected. The results are apparently quite satisfactory. Finally, we are brought face to face with that troublesome R-D correction, the origin of which defies satisfactory explanation, as its treatment taxes ingenious applications. The method employed at Oxford is not the same as that which recommends itself to the authorities at Greenwich. At the former observatory no correction for this discordance has been made to the direct measures, the whole difference being applied as a correction to the reflexion observations in order to render the two series homogeneous. In the Greenwich observations of zenith distance, a correction is applied which has practically the effect of making the final result a mean between the direct and reflected observations. One may not say that it is a consequence of these different methods of reduction that the declinations obtained at Oxford and Greenwich show systematic differences. But when a comparison between the star-places common to the two catalogues (Radcliffe, 1900, and Greenwich, 1890) is instituted, a systematic discordance is disclosed, the greater portion of which can be removed by reducing the Greenwich and Radcliffe observations in substantially the same manner. The zone catalogue of Albany also includes a large number of stars that have been observed at Oxford. A comparison between these two catalogues is most satisfactory. The difference between the two is practically the same as between Albany and Romberg's Pulkova catalogue. Of the accuracy of this latter Prof. Auwers has spoken in the highest terms. We may offer our congratulations to Dr. Rambaut on the successful completion of a heavy piece of work, and express the hope that the large equatorial, the mounting of which has interfered so much with the progress of his meridian measures, will amply fulfil its early promise.

The parcel from Groningen contains specimens of those laborious calculations to which the astronomers of that University are so much attached, and by which other astronomers have profited. Prof. Kapteyn here gives the results of his discussions of the proper motions of the greater part of the Bradley-Auwers stars on different assumptions of the value of the precessional constant, the position of the solar apex, and of systematic corrections to the proper motions in declination. Of the 3222 stars contained in Auwers-Bradley, 2640 have been discussed. Satisfactory reasons are given for omitting the remainder, so that the material may be considered exhausted. The results, grouped according to the galactic latitude of the stars or the type of spectrum, have been made the groundwork of special investigations. Since these have been before the astronomical world some time, it is not necessary to enter into any lengthy description here. The tables indicate a great amount of care and industry, and will be useful to those who wish to make independent investigations based on the proper motions of the stars.

Dr. Sitter's contribution contains new and useful matter. The tables here arranged show at a glance the times of the year most suitable for making stellar parallax observations, on the assumption that the method of photography will be adopted and that the plates will be taken near the meridian. Some tables are also given that will be of use in the subsequent reduction of the measures. Profs. J. C. and W. Kapteyn add a collection of differential formulæ connected with the solution of spherical triangles. The authors believe that such formulæ would be of more general use if the amount of the neglected terms was known with certainty. To remove this difficulty, the formulæ here given are correct to the squares of the differences. Convenience rather than originality seems to have influenced the authors, both here and in other formulæ applicable to plane and spherical triangles in which certain of the elements are small. Another table for which we have not yet found any extended use is one giving the trigonometrical functions for each degree in the circle to two places of decimals. But the authors say that mathematically trained persons have found it so useful in relieving their mind from mental strain, that they contemplate publishing a similar table giving the natural trigonometrical functions to three places of decimals for every tenth of a degree throughout the entire circle.

Such tables might possibly be of service to the readers of the next work on our list, "Cours d'Astronomie," by M. Louis Maillard, though, as the author does not vouchsafe any word of preface, it is uncertain for what class of students his book is intended. The purpose of the book is the more difficult to comprehend since we have but one volume of the work from which to judge of its aim and extent. But the writer of a text-book on astronomy has to keep within lines which are very well recognised. Especially is this the case when dealing with spherical astronomy. The facts do not materially change or increase. The only choice the writer can exercise is to decide between a work of reference which shall be as encyclopædic as possible, or a text-book which shall present to the reader a manageable amount of matter from which he may acquire an adequate grasp of the facts and principles upon which the science is supported. M. Maillard apparently prefers the text-book, and proceeds on the usual unheroic lines. He begins with the derivation of the ordinary formulæ of spherical trigonometry, to which he adds a few pages giving some elementary notions on the theory of least squares. But these few pages serve no useful purpose, and might have been omitted with advantage. When it is added that the author has some chapters on problems connected with diurnal motion, and a description of the constellations, it will be understood that he is catering for a class that is not very far advanced in astronomical study. But the chapters on parallax and aberration are generally full enough for all who have not to make any practical application of the theory. Finally, the section on the earth and geodetic measurement is made quite interesting. The book ought to have a ready appreciation among students in high schools and colleges, and is an advance on some of those which have long done duty in this country, and still enjoy an honoured position. The book is apparently lithographed, but it is very handsomely finished, and the diagrams are new and well reproduced.

Of a very different calibre and purpose is Mr. Stirling's work. M. Maillard has been developed in an atmosphere of extreme orthodoxy. He is not, and has no wish to be thought, original. His methods have received the sanction of many generations of teachers. For good or for evil,

1 "Catalogue of 1772 Stars chiefly comprised within the Zone 85°–90° N.P.D. for the Epoch 1900, deduced from Observations made at the Radcliffe Observatory, Oxford, during the years 1894–1903, under the direction of Prof. Arthur A. Rambaut, F.R.S. Pp. xxxvi+81. (Oxford: Henry Frowde, 1906.)

"Publications of the Astronomical Laboratory at Groningen." Edited by Prof. J. C. Kapteyn. Components of the Proper Motions and other quantities for the Stars of Bradley. Tables for Photographic Parallax-Observations by Dr. W. de Sitter. Some useful trigonometrical formulæ and a table of goniometrical functions for the four quadrants, by Prof J. C. Kapteyn and Prof. W. Kapteyn. (Groningen: Hoitsema Bros., 1906.)

"Cours d'Astronomie," par Louis Maillard. Tome I. Pp. 243. (Paris: Librairie scientifique, A. Hermann, no date.) Price 7.50 francs

"New Theories in Astronomy." By William Stirling. Pp. xv+336. (London: E. and F. N. Spon, Ltd., 1906.) Price 8s. 6d. net.

these methods have become stereotyped. But the late Mr. Stirling, as an engineer, had to think for himself, and, moreover, his occupation removed him to places far from the busy crowd. He could scarcely have had the opportunity of examining and testing his opinions by comparison with those of others who have been differently trained, for he passed much of his life in furthering railway enterprise in Chili and Peru. There he was free to follow the lines of thought that his uncurbed fancies suggested. His book is therefore marked with much freshness, but also with some errors. In many respects it is interesting, since it shows the confusion which an intelligent mind may create for itself when it disregards the trammels of authority and attacks problems for the study of which it is not fitted by previous training.

We get the first insight into this mutinous disregard for authority when we find our author describing, in his first chapter, the experiments which the late Sir George Airy carried out at the Harton Colliery. It cannot be denied but that these experiments are open to some objection, though possibly not entirely on the grounds on which the author insists. But there is a certain refreshing keenness in his criticism which one can read and enjoy. We next find our author hopelessly blundering over that terrible question of the moon's rotation, and we cannot help thinking that the late Mr. Stirling must have had in his nature a considerable spice of obstinacy. He was far too intelligent not to have recognised the true character of the problem and to have found its solution. It is to be regretted, perhaps, that he did not rely upon his own good sense, and that he consulted so many authorities. He has our sympathy to the extent that these authorities have not always expressed themselves with clearness, and in some cases not even with accuracy. But with perverted ingenuity he seems to have fastened upon any looseness of expression he could find, and has endeavoured to give it a construction that it will not legitimately bear. But when we find the centrifugal force due to the moon's rotation introduced as a cause to explain the transference of air and water from the visible hemisphere of the moon to the hemisphere that we do not see, we are disposed to give up our author as incorrigible. It is not at all surprising after this that he should turn his attention to the nebular hypothesis, that he should find its explanation inadequate, and to need some finishing touches which he is ready to supply. For this is a subject that attracts those most keenly who are least qualified to handle it intelligently. Unfettered by close reasoning and unfamiliar with the bearing of material facts and deductions, they lose themselves in apparently plausible intricacies, and hopelessly puzzle those who attempt to follow them.

W. E. P.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. H. W. Marett Tims, of King's College, demonstrator of anatomy in the University, has been appointed professor of biology at the Royal Veterinary College, London.

At a meeting of the president and fellows of Queens', held on Wednesday, July 18, Prof. H. T. Bovey, F.R.S., professor of engineering in the University of Montreal, was elected an honorary fellow. Mr. Bovey was formerly a fellow of the society.

The master and fellows of Christ's College have elected Mr. Francis Darwin, foreign secretary to the Royal Society, honorary fellow. Mr. Darwin for many years held the readership of botany in the University and a fellowship at Christ's. Dr. G. H. F. Nuttall, F.R.S., has been elected a fellow of the same college. Dr. Nuttall has held teaching posts at the Johns Hopkins University, Baltimore, and at the University of Berlin. He is at present reader in hygiene at Cambridge and chief editor of the *Journal of Hygiene*, which he largely helped to found.

DR. G. C. BOURNE has been appointed Linacre professor of comparative anatomy at Oxford, in succession to the late Prof. Weldon.

A CLASS in experimental psychology, including practical work and demonstrations, will be held by Prof. C. S. Myers on Saturdays in the psychological laboratory of King's College, London, beginning on October 6.

MR. V. H. BLACKMAN has been appointed lecturer in plant cytology in the department of botany of University College, London. In view of the new relationship between the college and the University of London, and in order to avoid confusion with the principal of the University of London, the title of the Principal of University College will be changed to that of Provost of University College.

MR. CLARENCE H. MACKAY and Mrs. John W. Mackay have given 20,000*l*. to the University of California, to endow the chair of electrical engineering. It will be known, says *Science*, as the John W. Mackay, jun., professorship, in memory of Mr. Mackay's brother, and will be filled by Prof. C. L. Cory, head of the department of mechanical and electrical engineering.

THE Board of Education has issued its instructions for the year August 1, 1906, to July 31, 1907, to technical schools, schools of art, and other day and evening schools and classes for further education. As is becoming common in the Board's publications, the volume begins with a prefatory memorandum, and in it great stress is laid upon the value to the student of science and technology of what is commonly called "general" education. Steps are detailed by which the Board proposes to encourage this side of the work of these schools and classes. It is pointed out that the lower classes of a good evening school afford to pupils, who have just left an elementary school, both a continuation of their general training and instruction in the application of that training to matters that come before them in their daily work. It is where, says the memorandum, this double aspect of evening schools is best developed, and where the lower and higher classes are most fully knit together, that the best records of attendance and of real progress are to be found. A distinct advance is recorded, we are glad to find, in the preliminary education of students entering higher classes in day technical schools, and this is to be traced to more efficient evening continuation schools. These regulations also make provision for an inclusive grant to local education authorities, other than London, in place of the separate grants assessed by taking into consideration the number of hours of instruction received by registered students in approved subjects. An authority wishing to receive such an inclusive grant must submit to the Board particulars of the manner in which it is proposed to make provision for the educational needs of the area and for the coordination of the several types and grades of this instruction with the other forms of education available for the area. All such endeavours to prevent overlapping and duplication of educational facilities, and to bring about economy and efficiency, are welcome. It is to be hoped the new plan proposed by the Board will effect the object in view.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"The Transition from the Liquid to the Solid State and the Foam-structure of Matter." By Prof. G. **Quincke**, For.Mem.R.S.

On June 19, 1905, the author laid before the Royal Society the results of his researches on ice-formation and glacier-grains (see NATURE, September 28, 1905, vol. lxxii., p. 543). The further prosecution of these researches has shown that phenomena similar to those observed in the freezing of water occur in all bodies in nature, and are in agreement with the structure of metals as observed by the author and also by other investigators. Solid bodies, then, are never homogeneous, but always exhibit a foam-structure.

All liquids in nature resemble water in forming, as they cool, oily foam walls, which may be very thin and invisible. The shape and position of these foam walls become visible on freezing or thawing in the following ways:—(*a*) By fissures or fractures at the surface of the foam walls, whenever the liquid contents of the foam cells contracted on solidification, or when the walls and the contents of the foam cells contracted differently as they cooled. (*b*) By the bounding surfaces of the doubly refracting crystals (glacier-grains), which are differently orientated in neighbouring foam cells. (*c*) On illumination with sunlight or electric light, or on warming, when the doubly refracting contents of the foam cells melt and are transformed into singly refracting liquid. (*d*) By lens-shaped masses, foam flakes or air bubbles, suspended in the foam walls. (*e*) By the furrows, or network of lines on the solidified surface formed by the intersection with that surface of the foam walls in the interior of the solidified mass. (*f*) By polishing or etching the natural or artificial surface, in cases when the walls and the contents of the foam cells differ in hardness or in the rapidity with which they are attacked by chemical reagents.

The surfaces of solidified drops of pure molten *metals* show a network of straight lines or arcs of circles (usually inclined to one another at 120° or 90°), or foam walls with embedded lens-shaped masses. This is so in the case of gold, silver, platinum, palladium, iridium, indium, copper, zinc, iron, nickel, cobalt, bismuth, sodium, potassium and mercury. Similar phenomena are to be observed on the surface of solidified drops of sulphur and selenium, or on the surface of carbon which has been distilled with the electric arc in a magnetic field, and deposited on the kathode.

The shapes of the bounding surfaces of molten metals, and the circular arcs in the network of lines on the surface of metals raised to red or white heat, show that these bounding surfaces must be regarded, not as they have hitherto been, viz. as crystalline faces, but as solidified oily foam walls, which, as in the glacier-grains of ice, enclose foam cells with contents differing from the walls. Just as the glacier-grains of ice run together and enlarge by the bursting of the foam walls, so also larger foam cells with fewer foam walls are formed in metals heated nearly to melting point.

Pure molten metals after solidification exhibit on artificial polished and etched surfaces a network of lines or foam cells (similar to the glacier-grains of ice), which are bounded by thin foam walls. These thin foam walls themselves contain still smaller foam cells, as is proved by the visible lens-shaped masses embedded in them, and the wave-like furrows on their surface, which are capable in reflected light of giving diffraction colours like mother-of-pearl. This foam structure of pure metals when solidified after fusion has been demonstrated in the case of bismuth, cadmium, cobalt, copper, gold, iron, indium, iridium, lead, manganese, mercury, nickel, palladium, platinum, potassium, rhodium, sodium, tin, and zinc.

Molten metals solidify on cooling to a liquid jelly, and later to a solid jelly. The walls and contents of the foam cells of such a jelly still consist of viscous liquid, *i.e.* the jelly itself is still liquid—like ice—at temperatures lower than the melting points of the respective metals. The welding of two pieces of metal corresponds to the running together of the cell walls and cell contents of two lumps of jelly, or the regelation of ice.

All the other substances in nature behave like these metals. The soft, plastic condition, which all bodies assume for a larger or smaller interval of temperature on the transition from the solid to the liquid state, proves the presence of jelly, *i.e.* of oily, visible or invisible foam walls, over this interval of temperature.

The heterogeneous oily liquid, which as solidification occurs becomes visible in all substances in nature in the form of thin foam walls of different surface tension, must also appear as a thin liquid skin on the surface of solidifying drops. This explains the variations in the measurements of the surface tension of molten metals and salts, and of liquids in general.

The walls and contents of the foam cells consist of heterogeneous substance. That foreign matter in very small quantities—1/1000000 per cent. and even less—does form oily layers and foam walls in pure liquids is proved by the author's observations on ice and benzene. Traces of foreign matter (gases, carbon, metals, &c.) too small to be shown in any other way are present even in the purest liquids, and are sufficient to explain the observed foam structure of all solidified substances in nature.

June 28.—"On the Ultra-violet Spectrum of Ytterbium." By Sir William **Crookes**, F.R.S.

The rare earth, ytterbia, was discovered in 1878 by Marignac (*Comptes rendus*, vol. lxxxvii., p. 578). In 1880 Nilson (*Ber.*, vol. xii., p. 554), in purifying Marignac's ytterbia, found that it contained another earth, which he named scandia. Cleve, and more recently his daughter Astrid Cleve, have worked much on ytterbia, and within the last few years M. Urbain has taken up the subject, and has succeeded in purifying ytterbia in larger quantities. During the author's own work on the fractionation of the rare earths he also has prepared and worked with ytterbia.

M. Urbain's ytterbia was prepared by the fractional crystallisation of the ethyl-sulphates of crude gadolinite earths (*Comptes rendus*, vol. cxxxii., p. 136). The subsequent separation is by the fusing nitrate method. This after twenty series of fusions gave in the least basic portions a mixture of ytterbia and thoria, which are easily separated by Wyrouboff and Verneuil's method.

The examination for absorption bands in a strong solution is a fairly good test for an earth such as erbia and thulia giving absorption spectra, but it is not so delicate as an examination of the spark spectrum photographed through a quartz train, for dominant lines, which most elements show in some part of their spectrum. For instance, the dominant lines of yttrium are at wave-lengths 3600·9, 3710·4, 3774·5, 4177·7, and 4375·1. The dominant lines of erbium are at 3499·3, 3692·8, and 3906·5. They are, however, not strong, and fortunately the absorption bands of this element are striking and characteristic. The spark spectrum of thulium has only been slightly examined by the author, and he does not think it has any strong lines. Its absorption spectrum, as with erbium, is a very characteristic one. The spark spectrum of ytterbium has strong dominant lines at 3289·5 and 3694·4. Scandium has dominant lines at 3572·7, 3614·0, 3630·9, 3642·9, and 4247·0.

The author's photographs were taken with the quartz apparatus already described, the spectrum of pure iron being used as a standard. The ytterbium spark was taken from a strong solution of the nitrate between platinum poles, sufficient self-induction being introduced to eliminate nearly all the air lines. The ytterbium, by this very severe spectrum test, is seen to be not absolutely free from impurities—thulium, copper, and calcium being present. Thulium is seen by its lines at 3020·7, 3131·4, 3425·2, 3441·6, 3462·4, and 3848·2. Copper is seen by its dominant lines at 3247·7 and 3274·1, and calcium by its dominant lines at 3933·8 and 3968·6.

The platinum lines which are present are easily recognised, and are useful as an additional measure of identification. Besides these, a number of fainter and indistinct lines are seen. These may be due to ytterbium or to traces of hitherto unrecognised impurities.

The wave-lengths of all the recognisable lines of ytterbium are given on the photograph, and also those of thulium, calcium, and copper, but the platinum lines are not marked.

PARIS.

Academy of Sciences, July 16.—M. H. Poincaré in th chair.—The absorption of nitrogen by organic substances, determined at a distance under the influence of radio-active materials: M. **Berthelot**. The action of air upon cellulose in the presence of a radium salt has been studied; the effects are comparable with those produced by the silent discharge.—A photometer specially designed for measuring the circumsolar light. Its use during the total eclipse of August 30, 1905: H. **Deslandres** and A. **Bernard**. The standard light used in the comparisons was a small osmium lamp. Two diagrams are given showing the arrangement of the photometer and telescope. The apparatus was used at Burgos during the last total eclipse, but the meteorological conditions were unfavourable.—Study of an apparatus designed by M. Lippmann for the photographic measurement of right ascensions: W.

Ebert and C. **Le Morvan.** A description of the modifications found necessary in the original apparatus, by means of which the error of a single point is less than 0·06s. The results are obviously free from personal error, and the deformations produced by the objective are eliminated, since the images of the stars and the slit fixing the meridian, being produced by the same lens, undergo the same deviations.—The rigorous determination of two instrumental constants which intervene in certain meridian observations: H. **Renan.** A method for determining the exact angular relations between the two cross wires of the micrometer and the plane of the telescope.—The arbitrary character of developments of solutions, even unique, of the problems of mathematical physics, and on new properties of generalised trigonometrical series: A. **Buhl.**—Measurements of wave-lengths in the iron spectrum for the establishment of a system of spectroscopic standards: Ch. **Fabry** and H. **Buisson.** The measurements were made photographically by the interference method, the green mercury line given by the Cooper-Hewitt lamp being used as a basis. The measurements given fall between λλ 3606·687 and 6494·994.—The photography of the infra-red rays: Walter **Ritz.** The author has subjected Abney's method of preparing sensitive collodion films to a critical examination, and gives details for the preparation of plates highly sensitive to the infra-red radiations. Photographs were taken of the spectrum from the blue decreasing regularly to 1·4 μ, none of the discontinuities inseparable from the use of colouring materials being apparent.—The reduction of molybdenum dioxide by boron, and the combination of boron with molybdenum: Binet **du Jassoneix.** Previous work on this subject has been vitiated by the use of carbon crucibles, the formation of carbides of molybdenum being unavoidable under these conditions. The author uses a magnesia boat, and readily obtains pure molybdenum by heating boron and molybdenum dioxide in the electric furnace. By increasing the proportion of boron, products, free from carbide, and containing up to 46 per cent. of boron, can be prepared. These are attacked by dilute nitric acid, and show no trace of crystalline structure.—The electrical conductivity of colloidal ferric chloride: G. **Malfitano.**—The influence of non-electrolytes on the mutual precipitation of colloids of opposite electrical sign: J. Larguier **des Bancels.**—The composition of an acetic ferment: E. **Alilaire.** Five grams of a very active mycoderma were obtained from a vinegar works, the conditions allowing of the production of a pure culture on the large scale. Alcohol extracted 1·56 per cent. of a fatty substance containing phosphorus, from which, after saponification with soda, potassium iodide gave iodocholine crystals. The substance thus freed from fat contained 6·9 per cent. of nitrogen and 5·9 per cent. of ash, the analysis of which is given. The presence of a considerable proportion of iron and copper in the ash is noteworthy, the latter metal, according to the author's views, playing an important part in the process of acetification. —The microlitic rocks collected in Grahamsland by Dr. Charcot's Antarctic Expedition: Ernest **Gourdon.**—The presence of neon amongst the gases from some hot springs: Charles **Moureu** and Robert **Biquard.** Previous notes published on the gases from twenty-two hot springs have shown the general presence of argon and helium. A direct examination of these gases for neon gave negative results, owing to the fact that the neon spectrum is completely masked by argon. By the application of the selective absorption of charcoal cooled to −100° C., neon was proved to be present in every case.—The cyanogenetic principles of *Phaseolus lunatus*: M. **Kohn-Abrest.**—The estimation of malic acid and some fixed acids in the juices of fruits, fermented or unfermented: W. **Mestrezat.** The method is based on the insolubility of barium malate, tartrate, and succinate in dilute alcohol.—The phosphohumic compounds of soil: J. **Dumont.**—Remarks concerning the artificial development of *Ascaris vitulorum*: L. **Jammes** and A. **Martin.**—The histological composition of the lymph of ruminants: E. **Forgeot.**—The pigmentation of hair and beard by the X-rays: A. **Imbert** and H. **Marquès.** Light hair darkens under the action of the X-rays.—The geology between Zinder and Tchad: René **Chudeau.**

CALCUTTA.

Asiatic Society of Bengal, July 4.—Some freshwater Entomostraca in the collection of the Indian Museum, Calcutta: R. **Gurney.** An account of the freshwater phyllopods, cladocera, and copepods in the collection of the Indian Museum. Fourteen species new to the Indian fauna are recorded; new species of Daphnia and Estheria, and a new variety of a Streptocephalus are described.—Preliminary note on the chemical examination of the milk and butter-fat of the Indian buffalo: E. R. **Watson.** Pappel and Richmond found that the milk of the Egyptian buffalo contains no lactose, but a different sugar that they name tewfikose. This is not the case with the milk of the Indian buffalo, which contains lactose. In the butter-fat the Indian buffalo's milk proves to contain more butyric acid than either the European cow or the Egyptian buffalo, and also apparently more palmitic or stearic acid.—A new gecko from the eastern Himalayas: Dr. N. **Annandale.** A description of a new form of Gymnodactylus closely allied to the Malayan *G. marmoratus*.—Freshwater fauna of India, No. viii., some Himalayan tadpoles: Dr. N. **Annandale.** The larvæ of *Bufo himalayanus* and *Rana liebigii* are described, and that of *Megalophrys montana* is recorded from the Darjeeling district. Notes are given on the different ways in which different tadpoles which inhabit mountain torrents in the Himalayas are protected against sudden floods.—A parasite upon a parasite. A Viscum—apparently *V. articulatum*—on *Loranthus vestitus* on *Quercus incana*: I. H. **Burkill.** The paper gives an account of the double parasitism recorded in the title together with a review of the geographical distribution of such double parasitism and the names of the associated plants in recorded cases.—Gentianacearum species Asiaticas novas descripsit I. H. **Burkill.** Diagnoses of new species of the genera Gentiana and Swertia from Asia.—Swertiam novam Japonicam ex affinitate Swertiæ tetrapteræ, Maxim., descripserunt S. le M. **Moore** and I. H. **Burkill.** Diagnosis of a new Swertia from Japan.

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