THURSDAY, MAY 19, 1898.

AMBROISE PARÉ, SURGEON TO THE KING.

Ambroise Paré and his Times, 1510–1590. By Stephen Paget. Illustrated. (New York and London: G. P. Putnam's Sons; The Knickerbocker Press, 1897.)

ON October 1, 1889, Mr. Rickman J. Godlee delivered the introductory address in the Faculty of Medicine at University College, London. He chose for his subject a comparison of the methods of Ambroise Paré and those of a surgeon of the present time. This address, according to Mr. Paget's preface, was the moving cause of this present work. Seldom has it fallen to our lot to read a better bit of literary work, or a more stimulating biography. The author has extracted from the larger works of Malgaigue, Le Paulmier, and others the most salient points in Paré's life, and pieced them together in such a way that one has a real view of the life of the most celebrated surgeon of the sixteenth century. He has added to our literary medical store by a new translation of the "Journeys in Diverse Places," which, for faithful rendering and for the preservation of the quaint phraseology of the period, might have been done by Thomas Johnson himself, he who translated "The Works of that Famous Chirurgeon Ambrose Parey" into the vigorous and picturesque language of the earlier part of the seventeenth century. The interest to the modern general reader consists in the vivid picture of life as painted by one who saw it under every possible circumstance in the sixteenth century, and to the yet young practitioner, inasmuch as the surgery of Paré was practically the art of but yesterday until the total revolution, caused in it by the discoveries of Lister, had changed it to what it is now. Paré used to be mostly remembered at opening lectures as Hannibal was in Juvenal's time, "Ut pueris placeas et declamatio fias," and his memory was called to mind chiefly as the inventor of the ligature of arteries. Now this he did not, but only reintroduced the practice which had been restored about a century before by the German school of surgery, and lost sight of in the meanwhile. He was, however, the first to use the ligature in amputation wounds. He found out, by a scarcity of boiling oil on one occasion, that a mild application was infinitely to be preferred to that dreadfully severe one, and so set the practice of a more rational treatment of gunshot wounds. But Paré added little to the actual knowledge or practice of his art; his chief fame is due to the admirably clear writings he has left of that art as he practised it, and to the straightforward honest life he led in the midst of the most horribly cruel, licentious and debased surroundings it is possible to imagine. It is generally stated that Paré was a Protestant, and one of the very few who were spared at the St. Bartholomew massacre; but we think Mr. Paget has shown that there is good cause to believe that he was, nominally at least, a Gallican Romanist of the tolerant sort. We have selected a few extracts showing the conditions of war as Paré met with them. In the first journey, viz. to Turin, 1537, after the taking of the city, he writes:—

"We entered pell-mell into the city, and passed over the dead bodies and some not yet dead, hearing them cry under our horses' feet, and they made my heart ache to hear them. And truly I repented I had left Paris to see such a pitiful spectacle. Being come into the city, I entered into a stable, thinking to lodge my own and my man's horse, and found four dead soldiers and three propped against the wall, their features all changed, and they neither heard, saw, nor spoke, and their clothes were still smouldering where the gunpowder had burned them. As I was looking at them with pity, there came an old soldier, who asked me if there was any way to cure them. I said no. And then he went up to them and cut their throats, gently, and without ill-will toward them. Seeing this great cruelty, I told him he was a villain: he answered me, he prayed God, when he should be in such a plight he might find some one to do the same for him, that he should not linger in misery."

Again, on page 71 is an appreciation of the Spaniard of that time, which is the same that the English had, and is curiously like some of the denunciations one reads in the State papers and writings of the latter part of the reign of Elizabeth: it is as follows. After describing the departure of the Imperials from Metz, he goes on:—

"M. de Guise had their dead buried and their sick people treated. Also the enemy left behind them, in the abbey of St. Arnoul, many of their wounded soldiers, whom they could not possibly take with them. M. de Guise sent them victuals enough, and ordered me and other surgeons to go dress and physick them, which we did with a good will; and I think they would not have done the like for our men. For the Spaniard is very cruel, treacherous and inhuman, and so far enemy of all nations: which is proved by Lopez the Spaniard, and Benzo of Milan, and others who have written the history of America and the West Indies; who have had to confess that the cruelty, avarice, blasphemies and wickedness of the Spaniards have utterly estranged the poor Indians from the religion that these Spaniards professed. And all write that they are of less worth than the idolatrous Indians for their cruel treatment of these Indians."

As pointing out the immense slaughter in the battles of those times, note the account of the battle of Dreux, 1562:—

"The day after I came, I would go to the camp where the battle had been to see the dead bodies. I saw for a long league round the earth all covered. They estimated it at 25,000 men or more, and it was all done in less than two hours."

We believe that no modern battle of a like duration has produced such a loss. One more extract, and we have done; it relates to the evacuation of Havre by the English in 1563.

"When our artillery came before the walls of the town, the English within the walls killed some of our men and several pioneers who were making gabions; and, seeing they were so wounded that there was no hope of curing them, their comrades stripped them and put them living inside the gabions, which served to fill them up. When the English saw they could not withstand our attack because they were hard hit by sickness, and especially by the plague, they surrendered. The king gave them ships to return to England, very glad to be out of this plague-stricken place. The greater part of them died, and they took the plague to England, and they have not got rid of it since."

The book is well illustrated by reproductions of old prints and pictures and drawings of the places as they exist to-day. It is one of the most entrancing studies we have met with, and can be read over and over again. We heartily congratulate Mr. Paget on his work.

CAYLEY'S MATHEMATICAL PAPERS.

The Collected Mathematical Papers of Arthur Cayley, Sc.D., F.R.S. Vols. x., xi. Pp. xiv + 616; xvi + 644. (Cambridge: at the University Press, 1896.)

THIS instalment of the papers illustrates in a remarkable way Cayley's power of commenting upon and developing the work of his predecessors. The various memoirs on single and double theta-functions are, of course, based upon the results of Rosenhain, Göpel, and Kummer; and it is instructive to see how Cayley's instinct for symmetry and logical consistency has enabled him to present the theory in a compact and intelligible form. In the case of the single theta-functions, defined by their expansions in series, we have equations such as

$$\theta^2_{01}\theta_{01}(u+v)\theta_{00}(u-v) = \theta^2_{00}(u)\theta^2_{00}(v) + \theta^2_{11}(u)\theta^2_{11}(v) \quad . \quad . \quad . \quad \text{(i.)}$$

and from these it appears that any three of the squared functions $\theta^2_{gh}(u)$ are connected by a linear relation. Hence we may take the squared functions to be proportional to $A(a-x)$, $B(b-x)$, $C(c-x)$, $D(d-x)$ with x a variable, and the other quantities constant. Finally it is shown that x and u are connected by a differential equation of the form

$$du = \frac{M dx}{\sqrt{(a-x)(b-x)(c-x)(d-x)}}.$$

Proceeding next to the double theta-functions, Cayley gives a set of 256 equations analogous to (i.); from these are derived quadric relations between the 16 functions which give, in all, 72 asyzygetic relations; it is assumed, and is fairly evident, that these are *all* the independent relations. The existence of the Kummer hexads and Göpel tetrads gives a special character to these relations. The next step is to find algebraic functions of two variables x, y and a proper number of constants which, on being substituted for the 16 theta-functions, satisfy the quadric relations identically. This Cayley succeeded in doing, apparently by a series of happy guesses; and this is his main contribution to the theory. He also shows that the two sets of variables u, v and x, y are connected by differential relations of the form

$$\sigma du + \tau dv = \tfrac{1}{2}\left(\frac{dx}{\sqrt{X}} - \frac{dy}{\sqrt{Y}}\right), \quad \varpi du + \rho dv = -\tfrac{1}{2}\left(\frac{x dx}{\sqrt{X}} - \frac{y dy}{\sqrt{Y}}\right),$$

where ϖ, ρ, σ, τ are constants, $X = (a-x)(b-x) \ldots (f-x)$, a sextic in x, and Y is the same function of y that X is of x.

In order to complete the theory, from this point of view, it is necessary to find the connection between the constants which occur in the theta-functions as originally defined and those which are contained in the corresponding algebraical expressions. This can, in fact, be done for the single theta-functions (vol. x. p. 482); Cayley began, but did not finish the corresponding investigation for the double theta-functions (*ibid.*, pp. 563-564).

It would probably be well worth while to work out the relations of Cayley's theory to recent researches on hyperelliptic sigma-functions by Klein, Burckhardt and others. The best general view of Cayley's results is to be found in the "Memoir on the Single and Double Theta-Functions" (No. 704).

Suggested by the theta-function theory, there are several important geometrical papers, as, for example, on the 16-nodal quartic surface, and on the bitangents of a plane quartic.

The memoir "On the Schwarzian Derivative and the Polyhedral Functions" is chiefly valuable for its detailed analytical work, which is a great help to the proper appreciation of the papers of Kummer and Schwarz, especially the latter. In this connection it is proper to mention Cayley's own papers on the correspondence of homographics and rotations and on finite groups of linear substitutions (Nos. 660, 752).

Of the other papers on group-theory the most important is No. 690; this contains the "colour-diagram," and the maxim, adopted by Dyck as the motto of his "Gruppentheoretische Studien": "A group is defined by means of the laws of combinations of its symbols." This ultimate symbolical form of a group is, so to speak, its transcendental essence, which may become incarnate in an endless variety of shapes, such as sets of permutations, geometrical configurations, motions in space, and so on.

In the region of pure algebra we may notice the tenth memoir on quantics, which gives a very complete account of the binary quintic; tables for the binary sextic and ternary cubic; and a paper on the Jacobian sextic equation.

Vol. xi. contains a reprint of the articles contributed by Cayley to the "Encyclopædia Britannica." These, perhaps, will convey to the general reader some sense of his characteristic qualities as a writer; clearness, order, philosophical breadth and independence of view, combined with a studied restraint of manner which sometimes inclines to coldness. This reserve arose, probably, from an excess of sensitiveness, which made him follow an ideal of classic severity and shrink from any open expression of emotion. That he fully appreciated the æsthetic side of mathematics is clear from the well-known passage in his presidential address to the British Association, where he describes the extent and variety of modern mathematics by a metaphor of great beauty and appropriateness. But this is a rare, if not solitary exception to his usual custom; to gain a true idea of his personal charm we must appeal, not to his published work, but to the testimony of the friends who knew him well. For them the portrait prefixed to vol. xi., which shows Cayley as he was in 1885, will form a touching memorial.

Of the numerous minor papers, and of the problems and solutions contributed to the *Educational Times*, it is needless to say anything here. Diamond-dust from the lapidary's workshop, they will doubtless help to polish gems not yet extracted from the mine.

G. B. M.

OUR BOOK SHELF.

An Elementary Course of Physics. Edited by Rev. J. C. P. Aldous, M.A. Pp. 862 + vi. (London: Macmillan and Co., Ltd., 1898.)

IN this book an attempt is made to give a modern and practical course of natural philosophy in a compendious form, and it may be stated at once that the effort is a most successful one. It is the joint work of the editor, who is chief instructor on H.M.S. *Britannia*, Mr. W. D. Eggar, and Prof. F. R. Barrell. The editor is himself responsible for the sections dealing with mechanics, properties of matter, hydrostatics, and heat, in which the readers are provided with "a groundwork of theoretical knowledge which may enable them to understand and use the simple processes of the kinetic method, to express themselves with accuracy when necessary, and to deal with simple mechanical problems." Wave-motion, sound, and light are admirably treated by Mr. Eggar, while Prof. Barrell's contribution deals with the subjects of magnetism and electricity.

The treatment of the various subjects is most lucid and thorough, and is evidently based on an intimate acquaintance with the requirements of students. Great pains have been taken to avoid looseness of statement; and the fact that some of the sections have had the advantage of the criticisms and suggestions of Lord Kelvin, Lord Rayleigh, and others, makes it a trustworthy book of reference. Where everything is so well done it is difficult to select points for special mention, but it may be remarked that examples drawn from naval sources form a notable and valuable feature, and graphical methods of representing experimental results are largely utilised and encouraged. The generous supply of illustrations, which number nearly six hundred, and not one that fails to serve a useful purpose, enhances the value of the book, and will make it acceptable to a wider circle of readers than that comprised by students following a specified curriculum. The book is of convenient size, and is printed in very clear type; we believe it is destined to take a high place in our schools and colleges.

L'Algérie. Le Sol et les Habitants, &c. Par J. A. Battandier et L. Trabut. Pp. viii + 360. (Paris: Baillière et fils, 1898.)

THIS little volume is one of a class of books which is much better represented abroad than in this country—one, that is, in which a complete picture is given of a limited part of the earth's surface, under the varied aspects which make up its geography in the widest sense of the term. It is written on a scientific plan, the broad physical features of the country being taken as the basis of the whole description. In Algeria the authors distinguish three main zones, the Tell (or cultivable region), the Steppe, and the Sahara, holding that the plateaux, which some writers have made into a separate division, do not form a natural region, but fall within the Tell or the Steppe according to the amount of rain which falls. The determining factor, indeed, in the geography of the whole region, is the preponderance of the moist rain-bearing winds from the north-west, or of the parching desert winds from the south and south-east. Each of the zones is in turn described, special attention being given to their natural resources; and the fact that for over twenty years the authors have traversed the country in the prosecution of their botanical researches, enables them to speak with the accurate knowledge which can only be acquired at first hand. The inhabitants, the fauna and the geology of Algeria are also sketched in outline, so that we have in small compass a useful summary of all that is known of the country. The general conclusion arrived at is that Algeria is capable of supporting a large population, and that, in spite of the slow modification the climate has undergone since the dawn of history, cultivation will still be possible for many centuries to come.

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.*]

Electric Light Wires as Telephonic Circuits.

I WISH to put on record the following method of using electric lighting wires as telephonic circuits. I was requested some time ago to try to localise a fault in an electric light main, by means of a certain form of inductor used in conjunction with a telephone but not connected to the main. While using it, it occurred to me that probably the main might be used instead of a telephone wire. My first experiments were not productive of good results, as a small fraction of the Company's current passed continuously through the telephone. In October 1897, I placed $\frac{1}{3}$ microfarad condensers in my telephone circuit at each end; these stopped the current, but in no way reduced the telephonic effects. If the note given out by virtue of the rotation of the armature of the dynamo is great, it can be very greatly reduced by placing an inductively wound resistance in the circuit.

The resistance does not appear to modify the telephonic effects in any marked degree. This probably arises from the fact that the E.M.F. due to the secondary coil of the telephone transmitter is high. The experiment was successfully made over two miles of a main which was carrying the full load used in lighting the town. F. J. JERVIS-SMITH.

Oxford, May 16.

Sub-Oceanic Terraces and River Channels off the Coast of Spain and Portugal.

WILL you allow me once more to briefly describe in advance the physical features under the Atlantic off the coast of Spain and Portugal, continuous with those opposite the coasts of the British Isles and the Bay of Biscay, already reported in your columns (NATURE, March 24 and April 21)?

The great escarpment already described as descending into deep waters from the margin of the British-Continental platform is still traceable southwards along the coast of Portugal from Cape Finisterre as far at least as the mouth of the Tagus estuary, where it appears to begin to broaden out and merge into a generally rapid slope—or probably a succession of terraces. The breadth of the platform along this coast averages only 30 to 40 miles from the shore, and its margin very nearly follows the 200-fathom contour; but here the descent to the 1000-fathom contour is steep, though seldom precipitous, and is varied by numerous bays and headlands. Owing to the insufficiency of the soundings, especially off Vigo Bay, the definition of the cañons, or old river channels, is scarcely as clear as in the region further north. Still, I have been able to determine several with a great degree of certainty, such as those formerly continuous with the rivers Padron, Lima, Douro, and Tagus. There are also a few which cannot apparently be followed to their sources in the present land, such as one of special depth and precipitancy in lat. 40° 31′ N., distant about 40 miles off the coast of Portugal at Barra Nova. The continuation of these features to the Straits of Gibraltar and into the Mediterranean remains for future investigation.

20 Arundel Gardens, W., May 16. EDWARD HULL.

Bacteria on an Ancient Bronze Implement.

MR. NICHOLSON probably refers to what is known to archæologists as "bronze cancroid."

In the last number of the *Journal* of the Royal Society of Antiquaries of Ireland, March 31, this subject is referred to under the name of "Ulcerative Disease of Bronze or 'Bronze Cancroid,'" by Dr. William Frazer.

As many readers of NATURE interested in bacteria may not be able to conveniently refer to this journal, the following points brought forward by the author will be read with interest. He says, "all objects of antiquity fabricated from metallic copper, and its important alloy made by adding tin in certain proportions, are liable to be attacked by this destructive corroding affection." The "bronze disease," says Dr. Frazer, "produces a remarkable disintegrating effect on the object it attacks, and there are good reasons for considering that it possesses infective powers, spreading like a leprosy through the substance of the metal, and slowly reducing it to amorphous powder; further, there are substantial grounds for believing it capable of being conveyed from surfaces already suffering with it to those yet uninfected. So that dishonest counterfeiters of antiques now propagate it on their modern forgeries to deceive intended purchasers. This infamous act is as yet understood to be confined to Italy, where the greater part of these forgeries are made." "In genuine antiques, it unfortunately happens occasionally that the patinated surface of bronze, soon after its discovery from recent excavations, becomes affected with this distinctive bronze disease, which makes its appearance in a number of small spots of clear pale blue colour, that swell and form farinaceous elevations; in the course of time, especially when kept in a moist atmosphere, these spots enlarge, run together and multiply, gradually invading the greater part of the surface, and reducing the object to a powdery condition."

Dr. Frazer says a remedy is found in ink made from sulphate of iron and oak galls, and that scraping "risks a fresh outbreak of this infectious malady." Further on he says the chief operator in Rome is well known, and "It would appear that those skilful artists of false antiques having succeeded in counterfeiting genuine patinations, so as to deceive the most learned collectors, have subsequently gone to the length of infecting their reproductions with spots of the bronze disease. This is no mere superficial imitation which they cause, but absolute inoculation of the destructive canker itself."

In conclusion, Dr. Frazer refers to an article in the *Revue Archæologique* on the same subject by the late Count Michel Kyskiewicz, under the title, "Notes and Souvenirs of an Old Collector." W. G. S.

Dunstable.

I am not aware of any book on the subject, but Mr. Nicholson will find scattered notices in the *Zeitschrift für Hygiene* and *Arch. für Hygiene*, also the *Journals* of the Chemical Society and Society of Chemical Industry, and *British Journal of Photography* (development of bacteria in silver gelatine films).

The best way to sterilise ancient implements is to suspend them in an oven at a temperature of 150° C.–180° C. for two hours, and let them cool in a free current of air in order to prevent deposit of moisture. This method is quite harmless to the metal, and will sterilise the most resisting spores. It presents obvious advantages over the use of antiseptic fluids.

36 Finsbury Pavement, E.C. G. Lindsay Johnson.

Ebbing and Flowing Wells.

I have had occasion to live for many months of several years close to a well that was sometimes affected by the tide like that at Newton Nottage (Nature, May 12, p. 45). This was at Alibag, a few miles south of Bombay. The bed-rock is a sheet of basalt of rather uneven surface, sloping westwards at the general rate of about six feet to the nautical mile. Over this, at the spot in question, were low sand-dunes, covered with palm orchards, and full of brick wells. One of my wells was twenty or twenty-five yards from true high-water mark of spring tides, though the surf washed light objects much nearer.

In the dry weather the ebb and flow did not perceptibly affect the well; but during the monsoon the sand-dunes were saturated by the heavy rainfall, and all along their seaward foot, where the sand lay on the sheet-rock, well below high-water mark, the fresh water poured out at ebb tide. When high spring tides were coincident with heavy rain the water in this well rose a little later than the tide, and several feet higher, almost to the level of the ground around the well. Its taste was not affected. At such times the surface in the well was two feet higher than the floor of my house, which stood in a hollow of the dune, a few yards to the eastward. The house was a notorious death-trap (as might be expected); and it was in the course of endeavours to get it condemned and pulled down, that I made the observations related. As it was a Government building, the records are official; and I write from memory. But the well is probably still there; and the observations, in that case, could be verified during any monsoon.

May 13. W. F. Sinclair.

TECHNICAL HIGH SCHOOLS—A COMPARISON.

At different times attempts have been made to convey to English readers interested in scientific education some idea of the facilities provided abroad, particularly in Germany and Switzerland, for the higher technical instruction. The reports of the Technical Instruction Commissioners, and of other persons who have inspected the principal foreign schools, give full particulars of the courses of study pursued in those schools, of the rapidly increasing number of students in attendance, and of the large professorial staff attached to each institution. Exact details, however, as to the magnitude of the technical high schools of Germany have not been hitherto presented in such a form, as might readily show the full importance which our German neighbours attach to the higher scientific training, as a means of advancing their commercial interests. On my return, in the autumn of 1896, from a short visit to Bavaria and Würtemberg, in company with some of my colleagues of the Technical Instruction Commission, I gave some account, in the pages of this journal, of the new electro-technical and electro-chemical institutions, recently erected in Darmstadt in connection with the polytechnic of that town. A few weeks since, I had occasion to pay a flying visit to Aachen, and there I found close to the old polytechnic, erected in 1870, an entirely new building, opened only in 1897, and devoted almost exclusively to electrical work. This school, although not so large, nor so well equipped, as the schools in Stuttgart and Darmstadt, forms a very important addition to the facilities for the higher technical instruction which previously existed in the Rhenish city. It will be seen from the accompanying illustration (Fig. 1) that this new building is a plain structure of four stories, with no pretensions to architectural effect. It is about 140 feet long, and is of a mean depth of about 90 feet, the total area covered by the building being little less than that of the science schools of South Kensington, and about half of that of the Technical Institute of the City Guilds. Yet this building is devoted almost exclusively to the teaching of one branch of applied physics.

Dr. Bosse, the well-known energetic Minister of Education for Prussia, in his dedicatory address at the opening of this school in May last, correctly expressed German opinion when he said: "Neither the technical sciences nor the technical high schools can be said to have yet reached their goal. Both stand in the midst of a restless and irresistible movement and development pressing ever forwards." This recognition on the part of the Prussian Minister of the necessity of constantly improving educational facilities so that they may keep pace with the advance of science, is characteristic of the progressive policy of Germany.

The progress I found this year in Aachen, and eighteen months ago in Stuttgart and Darmstadt, might be observed equally in other parts of Germany, showing that our German neighbours are fully as determined, that their high schools of science shall be ahead of those of other countries, as we may be resolved, that our fleet shall be equal to that of any two other nations.

It is well known to most of the readers of this journal, but must be emphasised with a view to a comparison between the provision for scientific education in Great Britain and Germany, that the polytechnics or technical high schools are institutions exclusively devoted to the teaching of science in its practical application to engineering, manufacturing and professional pursuits. They are quite distinct from the universities, which, situated in the same town or in an adjoining city, as the case may be, comprise other faculties besides science, and, although far larger and more important, belong rather to the class of institutions known in this country as University Colleges. Not far from the polytechnic at Aachen is the University of Bonn; at Munich, and within a few yards of each other, are found the university and polytechnic, and the magnificent institution at Charlottenberg is almost as near to the science laboratories of the Berlin University as is University College to the City Guilds Institute. It must also be remembered that the universities comprise schools of science of the highest grade, for each of which, as at Zürich, Strassburg and Berlin, separate buildings are provided, presided over by professors of European celebrity. In the figures I am about to quote, it will be understood, therefore, that I am dealing with a part only of the accommodation which the different German States have made for the teaching of the higher branches of science.

In order to show the relative sizes of some of the Continental institutions for instruction and research work in technical or applied science, I have obtained plans, accompanied by descriptive matter, of certain typical technical high schools, and have made squares corresponding to the areas covered by the existing buildings. In most cases the buildings erected in the early 'seventies have proved too small and ill-adapted or such practical teaching as requires the use of steam power. Separate buildings have accordingly been added for the accommodation of the engineering, chemical, and electrotechnical laboratories, for engine and boiler houses, and for other purposes. The areas of these separate buildings I have added together, and where a building consists of a front portion, and of separate wings at right angles to it, as is so frequently the case, I have taken only those parts of the site which the buildings actually cover. With a view to further accuracy I have endeavoured, where the plans enabled me to do so, to reduce the several parts of the building to a uniform height. The figures quoted may be taken, therefore, as approximately correct.

The Central Technical College of London is the only building in this country which correctly corresponds with a German polytechnic, although its courses of instruction are restricted to fewer branches of professional work. The Royal College of Science embraces a much wider range of scientific work, but, except as regards its mining department, its functions differ in many respects from those of a technical high school. University and King's Colleges may be described as imperfect and undeveloped universities, the specially technical departments of which would alone correspond to the buildings now under consideration.

Taking the areas of the sites of some of the principal foreign schools, we have the following figures arranged in order:

	Square metres
Site of the Berlin Polytechnic	82,460
,, Aachen ,, ...	21,900
,, Darmstadt ,, ...	16,150
,, Hanover ,, ...	15,294
,, Chemnitz ,, ...	12,418
,, Stuttgart ,, ...	11,189
,, London—City Guilds College ...	3,344
,, ,, Royal College of Science	1,189

FIG. 1.—Electro-technical and Mining Laboratory—Aachen.

The relative areas of these sites are shown by the squares in Fig. 2.

If we consider the buildings erected on these sites, we have the following figures representing in square metres the areas already covered:—

	Square metres
Berlin	16,500
Zürich (exclusive of observatory building) ...	15,412
Aachen (exclusive of engineering laboratory, being built)	8,255
Stuttgart	6,375
Darmstadt	6,084
Chemnitz	3,964
London—City Guilds College...	1,837
,, Royal College of Science	1,189

The accompanying squares (Fig. 3) show the relativ sizes of the buildings.

I have not been able to obtain the dimensions of the building in Hanover, nor have I those of the site of the Zürich Polytechnic.

It will be seen at a glance how very inadequate is the provision in London for the higher scientific and technical teaching, as compared with what is found in even a small German town. But, as has frequently been pointed out, it is not only in the size and arrangements of the buildings devoted to science, that we in England are so

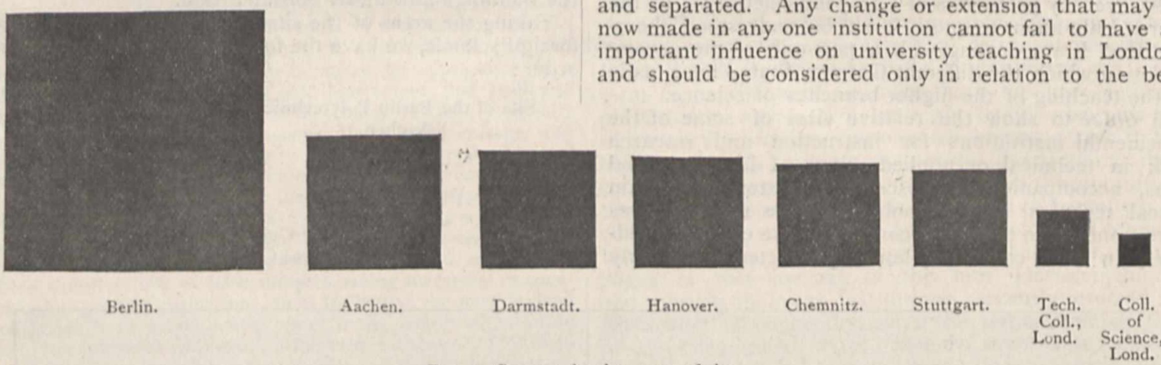


FIG. 2.—Squares showing areas of sites.

far behind our German and Swiss neighbours, but also in the organisation of the instruction. In some of our best schools at home each professor has to do the work of three or four experts abroad. In a German university or polytechnic, there is a large staff of professors, each occupied with a particular section of science, in which he is specially interested, and presiding over a laboratory in which he has time and opportunity to make investigations, with the view of advancing science in some one direction. It is the combination of professorial work and the coordination of teaching that make the German university or polytechnic so powerful a machine not only for scientific training, but also for discovery and research. In London, unfortunately, we have too many separate schools, each under-staffed, and each doing much the same kind of work, and the professors are consequently required to discharge a number of duties which are wisely divided in Germany among separate specialists. The multiplication of the schools, and the overlapping of the functions of the teachers stand in the way of any

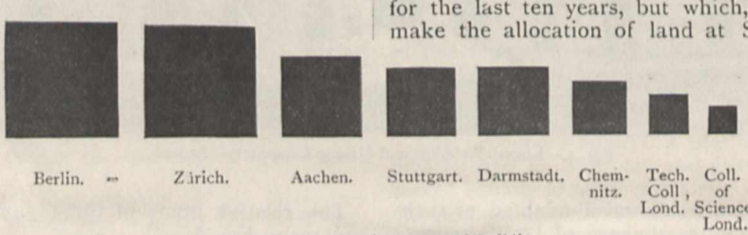


FIG. 3.—Squares showing areas of buildings.

organisation on broad lines of the higher scientific education in London. It appears that a much-needed extension of the Royal College of Science at South Kensington is now under consideration; and it is understood that a more ample site than was originally suggested will be provided for the new buildings on the west side of Exhibition Road, which will bring the Royal College of Science in closer proximity to the Central Technical College. This is as it should be. It is to be hoped, however, that no hasty and half measures will now be adopted. In these days of military and naval expenditure it may be well to point out that the sinews of war come not only from the tax-payers' pockets, but equally, if not to a greater extent, from our high schools of science. Advantage should be taken of the avowed intention of the Government to extend the Royal College of Science, to consider the wider but more important question of the organisation of a faculty of pure and applied science, in connection with the University of London, and of bringing together, for the advantage of the same students, the various agencies for the higher scientific training which are now scattered and separated. Any change or extension that may be now made in any one institution cannot fail to have an important influence on university teaching in London, and should be considered only in relation to the best possible arrangements for developing and improving the joint facilities which London now offers for scientific education of the highest grade.

PHILIP MAGNUS.

THE SCIENCE BUILDINGS AT SOUTH KENSINGTON.

IN NATURE for May 5 we printed the report of the Select Committee of the House of Commons which has recently been inquiring into the Museums of the Science and Art Department, relating to the recent proposal of the Government to build the new laboratories for the Royal College of Science on the east side of Exhibition Road. We have received for publication the following memorial recently presented to Lord Salisbury by Lord Lister, the President of the Royal Society, which has been signed by the president and officers, all the living past presidents, and many fellows of the Society, entirely endorsing the views of the Select Committee, and urging the Government to refrain from a step which is not only contrary to the policy which has been pursued for the last ten years, but which, if carried out, would make the allocation of land at South Kensington for Science and Art purposes respectively ridiculous. Nor is this all. So far as science and science teaching is concerned, we should be landed in a position far inferior to that occupied by such towns as Gratz, Chemnitz, or Aachen, not to speak of some chief cities of the Continent, Berlin, Vienna, Paris.

Memorial to the Most Honourable the Marquis of Salisbury, K.G., F.R.S., Premier and Secretary of State for Foreign Affairs.

I. Whereas in 1890 Parliament voted 100,000*l*. for the purchase of a site at South Kensington upon which to erect suitable buildings for the Science Museum of the Department of Science and Art, and for the extension of its Science Schools, in accordance with the recommendations of the Royal Commission over which the Duke of Devonshire presided in 1874, as well as of various Committees and other high scientific authorities, and of a Treasury Committee appointed in 1889.

II. And whereas when in 1891 the Government had proposed to erect an Art Gallery on the site, a Memorial, signed by the President and Officers of the Royal Society and representatives of the Universities of Oxford, Cambridge, and of many other learned bodies both in London and in the provinces, was addressed to the Most Honourable the Marquis of Salisbury, K.G., F.R.S., Premier and Secretary of State for Foreign Affairs, showing cause why the site should not thus be allocated.

III. And whereas the scheme was withdrawn, and it was stated by the late Right Honourable W. H. Smith, M.P., that "additions to the College of Science must, in any case, take the form of a separate building divided from the present building by Exhibition Road," and since then plans have been prepared on information supplied on the instructions of Her Majesty's Treasury by the professors concerned.

IV. And whereas this arrangement has been generally accepted since 1876, when the Royal Commission for the Exhibition of 1851 offered land and a building with a view of carrying out the recommendations of the Duke of Devonshire's Commission to provide the needed accommodation for Science at South Kensington.

V. And whereas it was expected that this arrangement would be carried out, when in 1890 the Government acquired the land on the West side of Exhibition Road, which was sold by the Royal Commission of the Exhibition of 1851 at one-third its market value, on the condition that buildings for Science and the Arts should be erected on it.

VI. And whereas we are informed that this arrangement is in danger of being altered by the erection of Science buildings on the East side of Exhibition Road.

We, the undersigned Fellows of the Royal Society, desire most respectfully to express to your Lordship our strong opinion that it is desirable to adhere to the policy, namely, that the needful expansion of the Science Buildings at South Kensington should be provided for on the West side of Exhibition Road, which has been acted upon and publicly acknowledged by the Government since 1890, and is in strict harmony with the recommendation of the Duke of Devonshire's Commission. We are confirmed in this opinion by the fact that the space which we understand is available for Science on the East side of Exhibition Road is but a small fraction of that which is devoted to similar purposes in many foreign towns.

(Signed)

LISTER, President of the Royal Society.
JOHN EVANS, Treasurer of the Royal Society.
M. FOSTER, Secretary of the Royal Society, Professor of Physiology, Cambridge.
ARTHUR W. RÜCKER, Secretary of the Royal Society.
E. FRANKLAND, Foreign Secretary of the Royal Society.
JOS. D. HOOKER, Past President of the Royal Society.
G. G. STOKES, Past President of the Royal Society.
KELVIN, Past President of the Royal Society.
WILLIAM CROOKES, Past President, Chemical Society and Institution of Electrical Engineers.
T. CLIFFORD ALLBUTT, Regius Professor of Physic, Cambridge.
G. CAREY FOSTER, Professor of Physics, University College, London.
A. W. REINOLD, Professor of Physics, Royal Naval College, Greenwich.
WILLIAM RAMSAY, Professor of Chemistry, University College, London.
JAMES DEWAR, Professor of Chemistry, Royal Institution.
OSBERT SALVIN.
LUDWIG MOND, Past President of the Society of Chemical Industry.
W. H. M. CHRISTIE, Astronomer Royal.
W. H. WHITE, Vice-President, Institute of Naval Architects.
BENJAMIN BAKER, Past President, Institution of Civil Engineers.
W. H. PREECE, Engineer in Chief, G.P.O.
RICHARD TEMPLE.
W. CAWTHORNE UNWIN, Professor of Engineering, Central Technical College.
R. H. INGLIS PALGRAVE.
W. M. HICKS, Principal, University College, Sheffield.
JOHN KIRK, G.C.M.G., K.C.B.
RICHARD STRACHEY, Chairman, Meteorological Council.
C. W. WILSON, Major-General R.E.
FRANCIS ELGAR, Vice-President, Institute of Naval Architects.
E. RAY LANKESTER, Linacre Professor, Oxford.
RICHARD T. THORNE.
A. B. KEMPE, Past President, Mathematical Society.
SHELFORD BIDWELL, President, Physical Society.
SILVANUS P. THOMPSON, Principal and Professor of Physics, Technical College, Finsbury.
ROSSE.
P. L. SCLATER.
JOHN PERRY.
G. M. MINCHIN.
SIDNEY MARTIN, M.D., Professor of Pathology, University College, London.
G. D. LIVEING, Professor of Chemistry, Cambridge.
HENRY E. ARMSTRONG, Professor of Chemistry, Central Technical College.
R. MELDOLA, Professor of Chemistry, Technical College, Finsbury.
P. H. PYE-SMITH, M.D.
A. A. COMMON, Past President, Royal Astronomical Society.
RAYLEIGH.
J. BURDON-SANDERSON, Regius Professor of Medicine, Oxford.
W. GRYLLS ADAMS, Professor of Natural Philosophy and Astronomy, King's College, London.
H. CHARLTON BASTIAN, M.D.
J. G. BAKER.
J. WOLFE BARRY, Past President, Institution of Civil Engineers.
G. JOHNSTONE STONEY, Vice-President, Royal Dublin Society.
HENRY E. ROSCOE, Past President, Chemical Society.
WYNDHAM R. DUNSTAN.
J. H. GLADSTONE, Past President, Chemical Society.
F. D. GODMAN, Past President, Entomological Society.
J. VIRIAMU JONES, Professor of Physics, University College, Cardiff.
EDWARD B. POULTON, Hope Professor of Zoology, Oxford.
FREDERICK J. JERVIS-SMITH, University Lecturer in Mechanics, Oxford.
J. NORMAN LOCKYER, Member of the Royal Commission for the Exhibition of 1851.
W. J. L. WHARTON, Hydrographer to the Admiralty.
W. PALMER WYNNE, Hon. Secretary, Chemical Society.
J. W. SWAN, President, Institution of Electrical Engineers.
C. V. BOYS, Vice-President of the Physical Society.

LIQUID HYDROGEN.

A VERY remarkable achievement, which will redound to the credit of English science, has been performed within the walls of the Royal Institution. For some time past it has been a matter of general knowledge that Prof. Dewar has been preparing for an attempt to produce liquid hydrogen on a large scale. Money has been freely subscribed for investigations to be carried on at low temperatures, and the laboratories of the Royal Institution have gradually approached more and more nearly to the likeness of an engineering workshop. Very grave difficulties had to be encountered, and success seemed long in coming; but on Tuesday, May 10, Prof. Dewar was able to inform the President of the Royal Society that on that day both hydrogen and helium had succumbed to his attack.

All this is typical of British methods. The members of a great private Institution have secured the services of a man in whose abilities they believe. They supply him freely with the sinews of war, and he justifies their confidence by achieving a success which, as far as our present knowledge goes, could only have been won by a combination of great resources and very great skill. We heartily congratulate Prof. Dewar and his supporters on this result, and on the fact that the world now possesses liquid hydrogen—so to speak—on tap.

The conditions of the experiment give some idea of the difficulties which have been overcome. Hydrogen cooled to $-205°$ C. escaped, under a pressure of 180 atmospheres, into a vacuum vessel surrounded by a space which was itself maintained at a temperature of $-200°$ C. Thus constrained it liquefied.

About 20 c.c. of the liquid were collected in another protected vessel, into which it dripped from that above described. It is transparent, colourless, with a well-defined meniscus, and apparently with a relatively high refractive index.

We sincerely hope that this great success will not be marred by a controversy as to priority, of which some symptoms have already appeared in a leading article in the *Standard* and elsewhere. The time is long past in which the liquefaction of a gas was interesting as proving that under proper conditions all substances can be liquefied. For many years nobody has had doubts on that point. We have learned to look upon the liquefaction of a gas as important, mainly because it affords a means of studying at very low temperatures not only the liquefied gas itself, but also other kinds of matter. Experiments in which momentary liquefaction is attained are chiefly interesting as showing that some approach is made to realising the condition under which more stable results may be expected. They take a much higher rank if the skilful experimenter can wrest from the substance in a transitory condition some information as to the properties which the material would have if it were reduced to the state which has been called a "static liquid." To attain these results in the case of so intractable a substance as hydrogen is an achievement of a very high order. But when this has been done it cannot be fairly contended that all the rest follows as a matter of course.

There have been discoveries in which the first step was all-important. The discovery, for instance, of the Röntgen rays opened an entirely new range of facts to scientific investigation. In other cases the root-idea had long been common property, and the merit, like that of Captain Bunsby's observation, "lays in the application of it." It has long been known that if hydrogen were ever liquefied in quantity, both cooling to a very low temperature, and a rapid expansion would play a large part in the operation. The difficulties of the experiment lay, not in understanding these principles, but in applying them, and the difficulties were so enormons that the investigator who has overcome them deserves our admiration. He has performed not only a great "tour de force," but has cleared the way to a region hitherto unexplored, to a whole series of researches which become more interesting and important as the absolute zero is more nearly approached.

It appears to us, therefore, that there is no necessity to belittle the work either of Prof. Dewar or of others who have been active in the same line of research. Cailletet and Wroblewski obtained results which, to judge from his address to the French Academy, reported in the *Times* of May 17, are regarded as inconclusive by so high an authority as M. Moissan. At the best, and assuming the liquid obtained to have been hydrogen, its existence in the liquid form was very brief. Prof. Olszewski also has published a full account of how he obtained hydrogen for a moment in a mist-like state, in which he measured some of the constants of the liquid. Yet nothing but the paucity of language could lead to the idea that this feat was the same as that which Prof. Dewar has accomplished. Had we no other evidence of the existence of water, something might be learned from the study of clouds; but nobody contends, on that ground, that a cloud is the same thing as a duck-pond. Yet the difference between the two is hardly, if at all, greater than the practical difference between hydrogen without visible form or surface, in a state of momentary or "dynamical" liquefaction, and hydrogen as a "static" liquid, with a clearly defined meniscus, boiling away quietly under conditions which enable the observer to record its appearance, to handle and to use it.

By insisting on this difference, we do not for a moment wish to question the merits of Prof. Olszewski's work. He used the means at his disposal admirably, and made measurements of the critical temperature and boiling-point of hydrogen, which, tested as they were by check experiments on oxygen and ethylene, were of great value. Prof. Olszewski was, however, fully conscious of the difference between these results and those which Prof. Dewar has now achieved. He again and again explained with the utmost candour that he had seen no meniscus, and that he had failed to reduce hydrogen to the state of a "static liquid." He further expressed the opinion that these desiderata would not be attained until a cooling agent was discovered in the form of a gas, with a density between those of hydrogen and nitrogen. No such gas has been used by Prof. Dewar, yet hydrogen has now been seen by himself, by Lord Rayleigh and others as a well-defined liquid mass. The merits of this achievement will be in no wise diminished by a generous recognition of the researches of Olszewski, but on the other hand it would be most unfair to minimise the magnitude of Prof. Dewar's success by classing it merely as a repetition, on a larger scale, of another man's work. It is in the words of M. Moissan a "wonder of modern chemistry."

The following abstract of the paper will give further details:—

In a paper entitled "The Liquefaction of Air and Research at Low Temperatures," read before the Chemical Society, and published in the *Proceedings*, No. 158, an account is given of the history of the hydrogen problem and the result of my own experiments up to the end of the year 1895. The subject is again discussed in a Friday evening lecture on "New Researches on Liquid Air" (*Roy. Inst. Proc.*, 1896), which contains a drawing of the apparatus employed for the production of a jet of hydrogen containing liquid. It was shown that such a jet could be used to cool bodies below the temperature that could be reached by the use of liquid air, but all attempts to collect the liquid in vacuum vessels failed. No other investigator has so far improved on the results described in 1895. The type of apparatus used in these experiments worked well, so it was resolved to construct a much larger liquid air plant, and to combine with it circuits and arrangements for the liquefaction of hydrogen, which will be described in a subsequent paper. This apparatus, admirably constructed by the engineers, Messrs. Lennox, Reynolds, and Fyfe, took a year to build up, and many months have been occupied in testing and making preliminary trials. The many failures and defeats need not be detailed.

On May 10, starting with hydrogen cooled to $-205°$ C., and under a pressure of 180 atmospheres, escaping continuously from the nozzle of a coil of pipe at the rate of about 10 cubic feet to 15 cubic feet per minute, in a vacuum vessel double silvered and of special construction, all surrounded with a space kept below $-200°$ C. Liquid hydrogen commenced to drop from this vacuum vessel into another doubly isolated by being surrounded with a third vacuum vessel. In about five minutes, 20 c.c. of liquid hydrogen were collected, when the hydrogen jet froze up from the solidification of air in the pipes. The yield of liquid was about 1 per cent. of the gas. The hydrogen in the liquid condition is clear and colourless, showing no absorption spectrum, and the meniscus is as well defined as in the case of liquid air. The liquid must have a relatively high refractive index and dispersion, and the density must also be in excess of the theoretical density, viz. 0·18 to 0·12, which we deduce respectively from the atomic volume of organic compounds, and the limiting density found by Amagat for hydrogen gas under infinite compression. My old experiments on the density of hydrogen in palladium gave a value for the combined body of 0·62, and it will be interesting to find the real density of the liquid substance at its boiling-point. Not having arrangements at hand to determine the boiling-point, two experiments were made to prove the excessively low temperature of the boiling fluid. In the first place, if a long piece of glass tubing, sealed at one end and open to the air at the other, is cooled by immersing the closed end in the liquid hydrogen, the tube immediately fills, where it is cooled, with solid air. The second experiment was made with a tube containing helium.

The *Cracow Academy Bulletin* for 1896 contains a paper by Prof. Olszewski, entitled "A Research on the Liquefaction of Helium," in which he states "as far as my experiments go, helium remains a permanent gas, and apparently is much more difficult to liquefy than hydrogen." In a paper of my own in the *Proceedings* of the Chemical Society, No. 183 (1896–97), in which the separation of helium from bath gas was effected by a liquefaction method, the suggestion was made that the volatility of hydrogen and helium would probably be found close together, just like those of fluorine and oxygen. Having a specimen of helium which had been extracted from bath gas, sealed up in a bulb with a narrow tube attached, the latter was placed in liquid hydrogen, when a distinct liquid was seen to condense. From this result it would appear that there cannot be any great difference in the boiling points of helium and hydrogen.

All known gases have now been condensed into liquids which can be manipulated at their boiling points under atmospheric pressure in suitably arranged vacuum vessels. With hydrogen as a cooling agent, we shall get within 20° or 30° of the zero of absolute temperature, and its use will open up an entirely new field of scientific inquiry. Even as great a man as James Clerk Maxwell had doubts as to the possibility of ever liquefying hydrogen (see "Scientific Papers," vol. ii. p. 412). No one can predict the properties of matter near the zero of temperature. Faraday liquefied chlorine in the year 1823. Sixty years afterwards Wroblewski and Olszewski produced liquid air, and now, after a fifteen years' interval, the remaining gases, hydrogen and helium, appear as static liquids. Considering the step from the liquefaction of air to that of hydrogen is relatively as great in the thermo-dynamic sense as that from liquid chlorine to liquid air, the fact that the former result has been achieved in one-fourth the time needed to accomplish the latter, proves the greatly accelerated race of scientific progress in our time.

The efficient cultivation of this field of research depends upon combination and assistance of an exceptional kind; but in the first instance money must be available, and the members of the Royal Institution deserve my especial gratitude for their handsome donations to the conduct of this research. Unfortunately its prosecution will demand a further large expenditure.

During the whole course of the low temperature work carried out at the Royal Institution, the invaluable aid of Mr. Robert Lennox has been at my disposal; and it is not too much to say that but for his engineering skill, manipulative ability, and loyal perseverance, the present successful issue might have been indefinitely delayed. My thanks are also due to Mr. J. W. Heath for valuable assistance in the conduct of these experiments.

NOTES.

M. MARCELLIN BOULE, of Paris; Dr. W. H. Dall, of Washington (D.C.), U.S.A.; and M. A. Karpinsky, of St. Petersburg, have been elected Foreign Correspondents of the Geological Society.

PROF. MICHAEL FOSTER has been elected President of the British Association for the meeting to be held at Dover next year.

THE annual conversazione of the Society of Arts will take place at the Natural History Museum, Cromwell Road, S.W., on Wednesday, June 22. The reception will commence at 9 p.m.

A CONVERSAZIONE of the Metropolitan Counties Branch of the British Medical Association will be held in the Museum of the Royal College of Surgeons on Tuesday, June 7.

THE Prince of Wales and the Duke of York were present on Monday night at a special meeting of the Royal Geographical Society, held in commemoration of the 400th anniversary of the discovery of the Cape route to India by Vasco da Gama. The president, Sir Clements Markham, was in the chair, and the address delivered by him upon the occasion is published in another part of this issue. At Lisbon the Vasco da Gama celebrations were inaugurated on Tuesday by the firing of a salute of 101 guns by the forts and the ships anchored in the Tagus. At a meeting of the Lisbon Geographical Society, Baron von Kell, the Dutch Minister to Portugal, presented to King Charles an album and a gold wreath, as the homage of Holland to Vasco da Gama. His Majesty accepted the gift, and said that Portugal was grateful for this act of homage.

THE Judicial Committee of the Privy Council recently granted the Hon. C. A. Parsons an extension of five years for his patent, dated April 23, 1884, for "improvements in rotary motors actuated by elastic fluid pressure and applicable also as pumps." The reasons for this decision were stated on Saturday to be that Mr. Parsons had not yet been adequately remunerated for his invention.

DR. D. J. LEECH, Professor of Materia Medica and Therapeutics in the Victoria University; Prof. W. Ramsay, of University College, London; and Prof. Ira Remsen, the Professor of Chemistry at the Johns Hopkins University, Baltimore, have been elected honorary members of the Pharmaceutical Society of Great Britain.

IN the High Court of Justice on Saturday an application was made on behalf of the shareholders of the Sheffield Botanical and Horticultural Society, that the trustees might be ordered to sell its property in pursuance of resolutions passed at meetings of the members, and distribute the proceeds of the sale among the members. It was urged by the Attorney-General that the property of the Society ought not to be so divided, but ought to be given to some other institution of a like character. The judgment was, however, that the applicants were entitled to the order they asked for.

PROF. J. M. SCHAEBERLE has resigned his post as astronomer at the Lick Observatory, California.

MR. HENRY WILDE, F.R.S., has been elected an honorary member of the Institution of Electrical Engineers.

THE Boston Society of Natural History has awarded the Grand Honorary Walker Prize of one thousand dollars to Mr. Samuel Hubbard Scudder, of Cambridge, Mass., for his contributions to entomology. The prize is awarded every five years, and the four previous recipients have been Mr. Alexander Agassiz, Prof. Joseph Leidy, Prof. James Hall, and Prof. James D. Dana.

THE annual electrical exhibition was opened at New York City on May 2. The President of the United States, following the usual custom, set the machinery in motion by pressing a button at Washington. He also sent congratulatory messages, as did the Vice-President. The opening address was by Chauncey Depew, who supplemented his remarks by firing off a dynamite gun, without wires by the long-distance system of telegraphy, and by blowing up a mimic steamer in the tank by a submarine mine.

WE regret to record the death of Mr. W. C. Lucy, F.G.S., formerly of Brookthorpe, near Gloucester. For upwards of forty years Mr. Lucy was one of the most active and enthusiastic members of the Cotteswold Naturalists' Field Club. To the *Proceedings* of the Club he contributed numerous papers, including observations on the Drifts of the Severn, Avon and

Evenlode Valleys, on the Oolites and Lias of the Cotteswold Hills, &c. In 1887 he published an essay on the origin of the Cotteswold Club, with an epitome of its *Proceedings*. He died on May 11, aged seventy-five.

The *British Medical Journal* states that the Pasteur Institute at Constantinople, which recently had to close its doors owing to want of funds and the utter indifference as to its well-being shown by the Turkish Government, has been reopened. This gratifying result is due partly to the intervention of M. Boulinière, Chargé d'Affaires of the French Embassy, and partly to the action taken by the Imperial Society of Medicine, which addressed a strong protest on the subject to the Sultan. His Majesty's attention having thus been drawn to the condition of the institution, in which he had always taken the keenest interest, at once gave instructions that Dr. Nicolle should be furnished with everything that he required, and satisfactory guarantees were given that funds and all other assistance that might be needed should henceforth be abundantly supplied. It is expected that the outcome of the affair will be a considerable development of the usefulness of the Institute.

We regret to see the announcement, in the *Manchester Guardian*, of the untimely death of Dr. C. Herbert Hurst, formerly on the staff of the Zoological Department of the Owens College. Dr. Hurst was an alumnus of the Manchester Grammar School, and studied biology under Prof. Huxley with conspicuous success. After some experience as resident science master in a boys' school he entered the Owens College as a student in 1881, and in January 1883 was appointed to the post of demonstrator and assistant lecturer in zoology under the late Prof. Milnes Marshall. For eleven years he filled this office with conspicuous diligence and success, and not only earned the grateful recollection of several generations of students of the College, but also laid under obligation a much wider circle of zoologists by his share in the production of the "Text-book of Practical Zoology," which has made the names of Marshall and Hurst familiar in every biological laboratory not only in this country but in the world. In 1889 he took advantage of a prolonged leave of absence granted by the College authorities to pursue his studies at the University of Leipzig, where he carried out a valuable investigation into the life-history of the gnat *Culex*, for which he was awarded the degree of Ph.D. Latterly he had undertaken what he termed "a systematic criticism of biological theory," in the course of which he published discussions on "The Nature of Heredity," "Evolution and Heredity," "The Recapitulation Theory," and other kindred topics. In these essays certain modern views were subjected to trenchant and unsparing criticism, for Dr. Hurst was a keen controversial writer, and never hesitated to express himself clearly and forcibly even at the risk of obloquy and unpopularity. His last writings were "The Structure and Habits of Archæopteryx" and "A New Theory of Hearing." In 1895 Dr. Hurst left the Owens College to fill a similar position in the Royal College of Science, Dublin. His premature death deprives zoology of a zealous and upright worker, who was most esteemed by those who knew him best.

During the past two months the Plymouth laboratory of the Marine Biological Association has been well filled with investigators, particularly during the Easter vacation, when all the available space was in requisition. The following is a list of the gentlemen who visited the laboratory during this period, together with the subjects of their researches:—Dr. N. B. Hartman, St John's College, Cambridge (Sense-organs of Fishes), Mr. T. H. Taylor, Yorkshire College, Leeds (Polyzoa), Mr. F. W. Gamble, Owens College, Manchester (Nervous System of Polychæta), Mr. A. H. Church, Jesus College, Oxford (Algæ), Mr. E. T. Browne, University College, London (Hydroids and Medusæ), Mr. E. S. Goodrich, Merton College, Oxford (Nephridia of Polychæta), Mr. G. Brebner, University College, Bristol (Algæ), Mr. S. D. Scott, King's College, Cambridge (Excretory Organs of Tunicata), and Mr. W. I. Beaumont, Emmanuel College, Cambridge (General). Mr. Garstang's Easter class for the study of marine biology was attended by eight undergraduate students from Oxford, Cambridge, Eton, and the Yorkshire College, Leeds. Among the more recent captures of interest may be specially mentioned Mr. Browne's rediscovery in quantity of the remarkable bitentaculate Hydroid known as *Lar sabellarum*, which gives rise to the aberrant Medusa *Willia stellata*.

The Council and Parliamentary Bills Committee of the British Medical Association have drawn up a report on the Vaccination Bill now before Parliament. Referring to the clause for the extension of the age limit for infantile vaccination, the opinion is expressed that the proposal to extend the limit from three to twelve months is injudicious and would prove prejudicial in the presence of an outbreak of small-pox. In Scotland the age limit is six months; and this is the limit which is recommended. As vaccination should be practically an aseptic operation, it is suggested that some modification of the clause referring to domiciliary vaccination is needed. The home of a child may be in a slum, dirty, overcrowded, and infected; and asepsis cannot be secured in such surroundings. The proposal is therefore made that, where the house is uncleanly, it should be possible to insist on the child being taken not necessarily to a public station but to the consulting-room, either of the public vaccinator or of some private practitioner. The main defect of the Bill is considered to be the omission of all reference to re-vaccination, and the Council and Committee are of the opinion that re-vaccination should be insisted upon at the age of twelve years.

A plea for a kinematograph bureau is put forward by M. Boleslas Matuszewski, Paris, in a pamphlet of which a copy has been sent to us. His view is that a national or international bureau, directed by a responsible Government official, should be established to receive kinematographs and preserve them for their historical value.

From the *Bulletin* of the Royal Botanic Gardens, Trinidad, we learn that in the botanical department of the Agricultural Exhibition, recently held in the Colony, a new form of machine for the extraction of rubber was exhibited in action. The rubber in the space of two minutes is separated from the *latex*, or milk, of the Castilloa tree, and is then put to dry. In the space of some three hours, sheets or slabs of fine clear marketable rubber is produced, free from the usual amount of proteid and albuminoid matters which are usually found in rubber produced by the ordinary process.

An important contribution to the theory of warning colours and mimicry is made to the *Journal* of the Asiatic Society of Bengal (vol. lxvii. part 2, No. 4, 1897) by Mr. F. Finn, Deputy Superintendent of the Indian Museum. The paper is the final one of a series of four, and in it Mr. Finn gives an account of his experiments with birds other than the Babblers, to which his first paper was devoted, together with a general summary of the results and inferences. He concludes from his experiments: (1) That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen when wild to attack them. (2) That many, probably most, species dislike, if not intensely, at any rate in comparison with other butterflies, the "warningly-coloured" *Danainæ*, *Acræa violæ*, *Delias eucharis*, and *Papilio aristolochiæ*; of these the last being most distasteful, and the *Danainæ* the least so. (3)

That the mimics of these are, at any rate, relatively palatable, and that the mimicry is commonly effectual under natural conditions. (4) That each bird has separately to acquire its experience, and well remembers what it has learned. On the whole, therefore, the theory of Wallace and Bates is supported by the facts detailed in Mr. Finn's papers, so far as they deal with birds (and with the one mammal used). Prof. Poulton's suggestion that animals may be forced by hunger to eat unpalatable forms is also more than confirmed by Mr. Finn's experiments, as the unpalatable forms were commonly eaten without the stimulus of actual hunger—generally, Mr. Finn adds, without signs of dislike.

IN *Bulletin* No. 2 of the Blue Hill Meteorological Observatory, Mr. H. H. Clayton gives some very interesting examples of the diurnal changes in temperature and humidity at different heights in the free air. The observations were made by means of kites, and on two occasions these were maintained in the air during a large part of twenty-four consecutive hours. The results show that the diurnal variation of temperature was very slight or had entirely disappeared at about 2300 feet, and that the relative humidity curve at that height was exactly opposite in phase to that recorded at lower levels; the minimum humidity was recorded at night, and the maximum during the day. The records during the day show that to a certain height (which varies under different conditions) the temperature in the lowest stratum decreases with increase of altitude approximately at 1°·7 per 330 feet. Above that height the air is suddenly found warmer, and then the temperature decreases with increasing height at a somewhat lower rate. During the night there is a marked inversion of temperature between the ground and 600 to 1000 feet. Above that height the temperature decreases at a fairly uniform rate. The experiments were made under the superintendence of Mr. A. L. Rotch, the proprietor of the observatory.

THE latest contribution to the question of the age of the earth comes from Mr. J. G. Goodchild, of H.M. Geological Survey, in the form of a presidential address delivered before the Royal Physical Society of Edinburgh, and just published in the Society's *Proceedings* (Session cxxvi., 1896-97). Many geologists have attempted to estimate the length of the interval between the present time and the period when the oldest strata containing fossils were laid down; and "vague, indefinite, but unquestionably vast beyond conception" have been the conclusions. Mr. Goodchild passes in review certain changes which are known to have taken place in the past, working backwards from the Glacial Period, and estimates the time required for the formation of the rocks of the various geological periods. He concludes that ninety-three millions of years have elapsed since the commencement of the Tertiary Period, and seven hundred millions of years since the commencement of the Cambrian Period. Moreover, the beginning of life upon the earth may be as much further back from Cambrian times as Cambrian times are removed from our own, so that the total estimate assumes tremendous proportions.

IN the paper referred to in the preceding note, Mr. Goodchild confines his attention to the purely geological side of the question of the age of the earth, leaving the physicists to take up the discussion and deal with it in the light of new facts and views. He suggests in conclusion that the following points need consideration: (1) Is it certain that the whole of the downward increment of heat within the earth is due to any vestige of the earth's original heat? If not, why may not part of it be due to the conversion of the energy of motion arising from terrestrial undulation (set up mainly by luni-solar gravitational energy) into the energy of heat? (2) Is it certain that radiant energy in general differs from gravitational energy in operating only between two solid bodies? If radiant energy acts only between any two material bodies, how do we know that the radiant energy of the sun, or the heat of the earth, is being dissipated into space at anything like the rate which is generally assumed to be the case?

WE learn from the *Lancet* that the use of Röntgen rays as a means of certifying the existence of death was demonstrated at a recent meeting of the Biological Society of Paris. M. Bougarde showed three photographs of the thorax, two of them from living persons and the third from a corpse, all taken by the X-rays. In the two first the different thoracic organs and the walls of the thorax itself exhibited a hazy outline, so that their limits could not be exactly made out. This, of course, was owing to the natural movements of the parts, the pulsations of the heart and the great vessels, and the movements of the diaphragm. Even when the subjects held their breath so as to minimise movement as much as possible the outlines were still hazy, and the outline of the diaphragm was seen as a shadow varying in depth and extending over the ninth and tenth intercostal spaces. The heart and great vessels were seen to occupy the centre of the chest as a dark oval mass, the shadow of which was dense in the centre, and gradually faded away towards the periphery until the almost transparent lungs were reached. In the radiograph of the corpse, however, the appearance was quite different, for all the organs had sharp and well-defined edges.

THE *Proceedings* of the Academy of Natural Sciences of Philadelphia contains an account of the discovery of a complete volcanic crater of Mesozoic age near Pottstown, Montgomery County, Pennsylvania, by Mr. E. Goldsmith. The chief interest of the paper centres round the microscopical examination of some varieties of de-vitrified obsidian and of gabbro-phonolite. Some specimens of amygdaloid were obtained from a boring which showed remarkable fluidal texture even to the unaided eye. Basaltic columns of exceptional size were observed, the diameters of the six-sided sections measuring in some cases ten, eleven, and even fifteen feet across.

MR. E. GOLDSMITH contributes an interesting note on the petrification of fossil bones to the *Proceedings* of the Academy of Natural Sciences of Philadelphia. In digging for human remains in the deposits of the Port Kennedy limestone quarry, a fissure in the Silurian limestone on the Schuylkill River, Pennsylvania, it was found that many of the fossil bones obtained "fell to a mealy powder" when touched. Mr. Goldsmith has subjected specimens in various stages of petrifaction to analysis, and finds that the "bone meal" contains little or no calcium phosphate, but that it consists essentially of dolomite. It is supposed that the change is effected by carbon dioxide in the water retained in the fissure, the phosphoric acid being transferred and reunited with ferric oxide and alumina to form vivianite (which was found in the neighbourhood), and magnesia being taken up at the same time.

THE current number of the *Annales de l'Institut Pasteur* contains the report for the past year of the anti-rabic inoculations carried out in Paris. No less than 1521 persons underwent the treatment, which is 213 in excess of the number recorded for the year 1897. In all, eight deaths from rabies occurred, two of which, however, took place during the course of treatment and before it could have taken effect. In one case a patient was admitted in April, and underwent the inoculations, but succumbed to rabies in the middle of October. Out of the total number of patients 175 were foreigners, and of the latter Egypt contributed 2, Greece 1, the United States 1, Germany 8, Belgium 14, Switzerland 33, British India 33; whilst England, as usual, far exceeds in its contribution that of any other nation, the substantial number of 83 being sent from this country. By far the largest number of patients were admitted suffering from bites on the hands; next in order come bites on the limbs, whilst in 151 cases the injuries were inflicted on the head. The Seine Department appears to be the district where rabies is most prevalent in France, more than one-third of all the cases coming from this part of the country.

A PAMPHLET on "Science and Engineering during the Victorian Era (1837–1897)," by Mr. Charles Bright, has been published by Messrs. Archibald Constable and Co. The pamphlet is a reprint of an introduction which Mr. Bright wrote for the Victorian Era Exhibition held at Earl's Court last year.

To encourage and facilitate the use of the metric system in the United Kingdom, the *Pharmaceutical Journal* recently published a series of tables of metric equivalents of Imperial Weights and Measures, and thermometric equivalents. The tables have been found of great assistance, and they have now been reprinted in a convenient form for reference by pharmacists, chemists, and medical men.

WE have received the fourth number of the new *Journal of Applied Microscopy*, published monthly by the Bausch and Lomb Optical Company, of Rochester, N.Y. The present part is chiefly devoted to methods of imbedding and staining sections, but photo-micrography also receives its share of attention.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. W. H. Lewis; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mrs. Eyre; a Red-backed Buzzard (*Buteo erythronotus*), captured at sea, presented by Mr. Ernest Hartley; two Banded Parrakeets (*Palæornis fasciata*, ♂ ♂) from India, presented by Lady Lumsden; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mrs. Harry Blades; two Crested Screamers (*Chauna cristata*) from Buenos Ayres, two Scaly-breasted Lorikeets (*Psittenteles chlorolepidotus*) from New South Wales, purchased; two Black-backed Geese (*Sareidiornis melanonota*) from India, two Grey-lag Geese (*Anser cinereus*), British, received in exchange.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF VARIABLE STARS.—A most useful and valuable series of variable star observations has just been published by Dr. Francesco Porro in a memoir in the *Pubblicazioni del Reale Osservatorinio Astronomico di Torino*, No. 4. The observations were made at Torino and Soperga, and extend over the years 1889–95.

COMET PERRINE (MARCH 19).—The following is a continuation of the ephemeris of Comet Perrine for the ensuing week:—

1898.		R.A. h. m. s.		Decl. ° ′		Br.
May 20	...	2 17 30	...	+55 36·6	...	0·30
21	...	22 25	...	43·4		
22	...	27 18	...	49·5		
23	...	32 6	...	55·0		
24	...	36 52	...	59·9	...	0·27
25	...	41 34	...	56 4·3		
26	...	46 13	..	8·1		
27	...	5 50 48	...	+56 11·3		

FRANCE AND INTERNATIONAL TIME.—Slowly but surely the scheme for dividing the time all over the world into an equal number of zones, differing from one another by one hour, is extending, and we hope before long that such a rational system of international time will be universally adopted. Even now there are some notable outstanding countries which as yet have not thought fit to adopt this principle. Before, however, one can say anything more in the matter, the case of Ireland must be remembered. There is no doubt that if we wish other countries to adopt a system of time zones, we should see that, at least, Great Britain, if not all British colonies, is one in the adoption of the scheme. There is absolutely no reason why Ireland should not adopt Greenwich time; but yet Dublin time is daily used, and all the while we are laughing at the prejudices of France for not instantly adopting the Greenwich meridian, which is only a matter of less than ten minutes. For Ireland there is absolutely no excuse for not coming under the new *régime*, but with France it is different. A change from mean Paris to mean Greenwich time would necessitate a great amount of work in altering their numerous publications, such as the *Connaissance de Temps* and other almanacks, to say nothing of charts, &c. Such difficulties have not, however, hindered her from adopting the international system of time zones; and although the new time she has adopted is really Greenwich time, yet the "national hour" is that "of the meridian of Paris diminished by 9m. 21s." In an interesting article (*Revue Scientifique*, May 7, 1898) on this subject, M. Bouquet de la Grye does not seem to advocate the step taken by France, and concludes that this adoption will be "contrary to the interests of our country, tradition, scientific spirit." The following list of meridians successively adopted, which is of interest, we have taken from the above-mentioned article:—

Dicéarque, of Messina, adopted the island of Rhodes, 300 B.C.

Eratosthenes chose the meridian of Alexandria, 270 B.C.

Marin de Tyr took for the origin the meridian of the islands of Fortune in the year 80 A.D.

The Arabians chose the meridian of Mecca, and also that of the column of Hercules, 800 A.D.

The Alphonsine tables assumed as their origin the meridian of Toledo, 1250 A.D.

Mercator took the Azores for the initial meridian, 1569 A.D.

The Paris Congress chose the island of Fer, 1633 A.D.

It was decided, after the example of Guillaume Delille, to place the meridian of the island of Fer 20° to the west of that of Paris, 1724 A.D.

A NEW LONG PERIOD VARIABLE.—Herren Müller and Kempf describe some observations which have led them to discover an interesting variable star of evidently long period (*Astr. Nachr.*, No. 3491). The star in question is B.D. + 30°·591, R.A. 3h. 49m. 8s., Decln. + 30° 46′·0 1900·0, and was included in their list of comparison stars for the Potsdam Photographic Durchmusterung. As soon as this star was found to vary its magnitude, observations were at once begun to determine its period. The following table shows the magnitudes, as yet, obtained.

Appearance in	Mean date.	No. of obs.	Mag.	Curve.	Mag. curve.
1887–88	1888 March 10	4	6·36	6·31	+ 0·05
1888–89	Nov. 24	16	6·29	6·31	− 0·02
1889–90	1890 Jan. 11	14	6·33	6·31	+ 0·02
1890–91	Dec. 12	16	6·30	6·31	− 0·01
1891–92	—	—	—	—	—
1892–93	—	—	—	—	—
1893–94	1894 Feb. 22	5	6·44	6·46	− 0·02
1894–95	1895 March 6	9	6·60	6·59	+ 0·01
1895–96	1896 Jan. 19	41	6·69	6·70	− 0·01
1896–97	Dec. 21	28	6·82	6·81	+ 0·01
1897–98	1897 Dec. 1	26	6·92	6·93	− 0·01

The fourth column gives the observed magnitudes of the variable, the fifth the magnitudes as obtained by drawing a curve through the points when plotted with the time as abscissæ and the magnitudes as ordinates; and, lastly, the sixth denotes the differences between the two latter. A glance at the curve shows that the star from 1887 to the middle of 1891 retained its original brightness, namely 6·31 mag. It began then to dim off, and from the beginning of 1894 it has decreased 0·01 magnitudes monthly, or a little over one-tenth of a magnitude in a year. This new variable is said to be of a yellowish-white colour. With the help of the 30-inch Pulkova refractor Herr Renz has examined the star for duplicity, but could not detect a second body. Probably the spectroscope may tell us more about the constitution of this interesting variable: it is hoped that both spectroscopic and photometric observations will be made to unravel the mystery of such a long period variable as this appears to be.

THE ROYAL SOCIETY'S CONVERSAZIONE.

THE first soirée this year was held on the 11th inst. It was numerously attended, and a large number of objects had been brought together. We have not space to refer to all the exhibits.

Prof. Hele-Shaw exhibited experiments on the flow of water. We have already given an account of some of these (p. 34). Prof. Hele-Shaw also showed instruments for describing cycloidal curves and envelopes. By means of the instrument exhibited, two surfaces of cardboard or paper are made to revolve so that imaginary pitch circles on each roll upon one another. This is effected by employing auxiliary circles within or without the pitch circles, the auxiliary circles being made to move at the same velocity by passing between two pairs of equal wheels, each wheel being connected by an axle with the corresponding wheel for the other auxiliary circle. By a further combination of wheels the actual centres of rotation are dispensed with, only virtual centres being used. Hence it is possible to draw with a small instrument cycloidal or involute curves for circles of any radius, however large, and to find envelopes or centrodes under any conditions of fixed or varying radii. A simple practical application is that to the teeth of wheels. examples of which were exhibited.

Mr. J. Mackenzie Davidson exhibited Röntgen ray apparatus for localisation purposes.

Mr. T. Andrews, F.R.S., exhibited (1) micrographic illustrations of deterioration in steel rails. These high power investigations of old rails, which have worn well, afford an indication of the microscopic structure and composition best adapted to ensure endurance and safety in rail service. (2) Micro-crystalline structure of iron. The micrographs indicate the existence of a primary and secondary crystalline formation in large masses of iron which have been slowly cooled.

Mr. C. Orme Bastian showed an electric current meter acting by electrolysis. The height of a column of liquid (sulphuric acid and water) contained in a glass tube is caused to decrease by electro-decomposition, and this decrease in height is utilised to indicate the quantity of current (in ampère hours) that has passed through the meter in any given time. Assuming the voltage of the supply to be constant, a perfectly accurate measure of the electric energy, which has passed through the meter, is recorded by means of a scale in front of the above-mentioned tube, which can be calibrated in Board of Trade or other units. A hole in a rubber plug at the top of the tube allows the gases resulting from the electro-decomposition of the liquid to pass away into the atmosphere, through the gauze tray and holes in the top of the meter case. Paraffin on the surface of the fluid prevents atmospheric evaporation. The instrument starts registering with an infinitely small current; it is accurate at all temperatures and at all loads; its accuracy is unaffected by temporary excess currents; and it is not capable of being affected by outside disturbing influences.

Dr. Leonard Hill and Mr. Harold Barnard showed simple forms of sphygmo-manometers.

Admiral Sir W. J. L. Wharton, K.C.B., F.R.S., and Prof. J. W. Judd, C.B., F.R.S., exhibited, on behalf of the Coral-Reef Committee of the Royal Society, charts, sections and specimens, illustrating some of the results of the investigations carried on in the atoll of Funafuti (Ellice Group), South Pacific.

Prof. Poulton, F R.S., showed insects captured in Canada and some adjacent States during a visit in connection with the meeting of the British Association in 1897. The insects in this collection are not of any special interest on account of rarity, but they serve to convey an impression of the general characteristics of this section of the fauna by which the traveller is surrounded as he proceeds, at the time of the year indicated in the labels, across the American Continent on a line not far distant from the Canadian southern boundary. The general similarity of the Lepidoptera to those of Europe is remarkable. Attention is directed to the geographical data on the small printed labels. The cases are arranged so that the left hand represents the westernmost locality (Vancouver Island), the right hand the easternmost (Quebec).

Dr. H. Gadow, F.R.S., and Mr. W. F. Blandford exhibited a series of models, illustrating the composition of vertebræ in the various groups of vertebrata.

Prof. T. Rupert Jones, F.R.S., and Mr. J. Ballot showed a series of large stone implements, collected by Sidney Ryan, Esq., from the tin-bearing gravels of the River Embabaan, in Swaziland, South Africa.

Mr. Alan A. Campbell Swinton exhibited (1) experiments upon the circulation of the residual gaseous matter in Crookes' tubes. Radiometer mill wheels are employed to detect the direction and velocity of the gaseous streams, and the experiments indicate that in very highly exhausted tubes of the focus type, in addition to the well-known negative stream from the kathode, discovered by Crookes, there exists also a positively electrified stream from the anode, which travels in the opposite direction to the kathode stream, and is exterior to the latter. Mill wheels of various forms and of both non-conducting and conducting material show these effects. (2) Röntgen ray camera, showing the position, dimensions and form of the source of the X-rays in a Crookes' tube. (3) Kathode ray lamps. The kathode rays from two concave kathodes placed opposite to one another and supplied with an alternating electric current of about 20,000 volts pressure, are focussed upon a button of refractory material, which is thus raised to a very high temperature and becomes brilliantly incandescent. The efficiency in terms of the amount of light produced for a given quantity of energy supplied to the lamp, appears to be much superior to that obtained in ordinary incandescent electric lamps, and under suitable conditions may even exceed that of the arc.

Mr. J. Wimshurst showed improved apparatus for holding, and for the excitement of Röntgen ray tubes; Mr. Killingworth Hedges, specimens of copper rapidly deposited at high current densities; and Prof. J. P. O'Reilly, a set of fourteen original coloured drawings of the principal cromlechs existing in the vicinity of Dublin. The drawings being plans and sections to scale, tend to show that the cromlechs in question were oriented truly: (*a*) either as regards their side walls (Druid's Glen) (Shankell), or (*b*) present in their arrangement indications, which point to bearings either N. by S. and E. by W., or to the points of the summer and winter solstices; or, as the case of the Glen Druid Cromlech, an inclination of the cap stone marking the altitude of the winter sun at the solstice (14° approx.), and consequently tending to prove that the cromlechs were designed, amongst other uses, to allow of astronomical observations being made with a view to the determination of fixed periods of the year or commencements of seasons.

The Rev. Walter Sidgreaves, S.J., showed the spectrum of Mira (*o* Ceti) compared with the spectra of other stars of Secchi's third type; and Mr. K. J. Tarrant, photographs of electrical discharges.

Mr. W. Ellis, F.R.S., showed smoothed curves of sun-spot frequency (Wolf), compared with corresponding curves showing the variation in diurnal range of the magnetic elements of declination and horizontal force from observations made at the Royal Observatory, Greenwich. A graphical representation of the periodical variation in frequency of sun-spots, and of the amplitude of the diurnal magnetic movement. The average length of the period is about eleven years, subject, however, to a variation of one or two years or more, which the sun-spot and the magnetic curves alike exhibit. There is also a corresponding variation in intensity at the different epochs of maximum effect.

Mr. R. B. Roxby had on view specimens of "Naturographs" (prints produced by Dr. Selle's process of photography in natural colours).

Mr. C. V. Boys, F.R.S., showed phase reversal and silver zone plates made by Mr. R. W. Wood, of the University of Wisconsin. These plates are made with 230 zones. In consequence of the great number, their equivalence to a lens in image-making is very complete. Some are printed on bichromated gelatine. These are stated to be "phase reversal," *i.e.* the thickness is such that alternate zones are in opposite phases, so the whole surface is operative. Two of these, of about 70 and 13 cms. focus, are mounted as a telescope, and show a magnified image of incandescent electric lamps. Others are photographed upon metallic silver by coating a deposited film on glass with bichromated gelatine, exposing, washing, exposing to iodine, dissolving with "hypo," and finally washing off the remaining gelatine when the lines acted upon by light are left as bright silver, the rest being transparent glass. One is elliptical, with axes in the ratio of $\sqrt{2} : 1$. If this is placed on the hypothenuse of a right-angled prism with Canada balsam, it will give images due to the difference of phase between the light totally reflected and that metallically reflected on alternate zones.

Three photographs, taken with some of the plates, were exhibited.

Dr. Armstrong, F.R.S., exhibited coloured photographs of Yellowstone Park, U.S.A., by Mr. F. Jay Haynes, of St. Paul, Minn.; Mr. A. E. Tutton, an interference dilatometer of increased sensitiveness; and Mr. Edwin Edser, apparatus exhibiting peculiarities of interference fringes when formed between silvered surfaces. When interference bands similar to Newton's rings are formed with monochromatic light between two partially silvered surfaces, the appearance presented is that of narrow sharply defined bright bands separated by broad dark intervals. When the light used consists of two different wave-lengths (such as that from a Bunsen burner into which some salt of sodium has been introduced) the interference bands become alternately double and single as the distance between the silvered surfaces is increased. This principle has been used by MM. Fabry and Perot to confirm Michelson's results as to the homogeneity or otherwise of spectral lines incapable of resolution by spectroscopic methods.

Mr. Edwin Edser and Mr. C. P. Butler showed a simple interference method of calibrating a spectrometer. Two pieces of plate glass, each thinly silvered on one surface, are placed with these surfaces parallel and very nearly in contact. This arrangement is placed immediately in front of the collimator slit of a spectrometer. A ray of slightly convergent white light being directed on the slit through the air film between the silvered surfaces, the resulting spectrum consists of bright bands separated by dark intervals. If the wave-lengths corresponding to any two interference bands be known, that corresponding to any other band can be calculated or determined graphically with great accuracy. It is proposed to use such a system of interference bands as a reference spectrum, to facilitate the reduction of prismatic spectra in terms of wave-lengths.

Prof. W. C. Roberts-Austen, C.B., F.R.S., exhibited apparatus to illustrate M. Daniel Berthelot's interference method of measuring high temperatures. One of the beams of light in an interference apparatus traverses a heated porcelain tube, and the other beam traverses a tube of equal length containing rarefied air. When interference takes place it indicates that the air in the two tubes is equally rarefied, and therefore the temperature of the heated tube can be calculated from the pressure of the air in the other tube. The interference apparatus employed is that exhibited by Messrs. Edser and Stansfield at the conversazione last year. Prof. Roberts-Austen also showed a complete installation of apparatus for the microphotography of metals.

Mr. A. Stansfield exhibited (1) experiments of showing an exception to the law of Magnus; (2) a method of demonstrating the existence of an allotropic change in iron. An electric current may be generated by heating unequally a circuit composed of a single metal, if very steep temperature gradients are maintained in the wire of which it is composed. The Thomson E.M.F. must therefore be abnormal under these conditions. Experiments were arranged to demonstrate this in the case of platinum and other metals, and to show readily the allotropic change which takes place in iron at about 800° C.

Dr. Alexander Muirhead and Prof. Oliver Lodge, F.R.S., showed improvements in Hertz-wave space-telegraphy; Prof. Ewing, F.R.S., a magnetic balance for permeability tests of iron; Mr. J. E. Stead, specimen and photographs illustrating the crystalline structure of iron and steel; and Mr. Joseph Goold, experiments in relation to resonance.

An exhibit by the Hon. C. A. Parsons consisted of (1) one of the earlier Parsons steam turbines of three-horse power driving a dynamo; speed of working, 12,000 revolutions per minute; (2) photographs of the *Turbinia*; (3) screw propeller cavitating the water, the atmospheric pressure being removed from the surface by an air-pump. A small screw propeller is driven by an electric motor at a speed of 1000 revolutions per minute within a tank in the form of a hollow oval ring, around which the water flows under the action of the propeller, the conditions of flow resembling closely those in the case of an ordinary screw propeller driving a ship. The illumination is effected by a beam from an electric lamp reflected from a mirror attached to and rotating with the screw shaft, and again reflected on to the propeller by a concave fixed reflector. The propeller thus illuminated appears stationary, and the cavities in the water formed by and around the blades can be clearly seen or photographed. To facilitate the formation of cavities, and to reproduce the conditions of very fast ships at convenient speeds for observation, the whole of the atmospheric pressure is removed from the upper surface of the water by an air-pump. The pressure then remaining to hold the water together, is that due to the head of water above the screw, plus capillarity. The relation holding between the model and screws on fast ships, with the same slip ratio, when cavities are formed appears to be—lineal speed of blade varies as the square root of the total pressure holding the water together.

Prof. W. A. Herdman, F.R.S., and Prof. R. Boyce, exhibited healthy and unhealthy green oysters, showing the causes of the coloration, and the connection between oysters and disease.

The Marine Biological Association had an exhibit showing the adaptations of marine animals to their environment, illustrated by living examples of the higher Crustacea.

The Joint Permanent Eclipse Committee and Eclipse Commission of the British Astronomical Association showed photographic and other observations made in India at the total solar eclipse of 1898, January 22.

Prof. Sherrington, F.R.S., exhibited specimens of sensorial organs, illustrated by the microscope.

Sir Richard T. Thorne, F.R.S., and Dr. Copeman had an exhibit illustrating the bacteriology of calf vaccine lymph.

Mr. Horace Seymour, Deputy Master of the Mint, exhibited a case of medals bronzed by Japanese methods. Various solutions are employed by the Japanese for this purpose, but "rokusho," or verdigris, is the main constituent of most of them. The medals shown are the result of experiments made in the Mint with a view to reproduce Japanese effects.

Dr. Russell, F.R.S., showed pictures taken on photographic plates by vapours from certain metals and certain organic bodies.

Sir David Salomons, Bart., exhibited the pseudoscope for producing stereoscopic effects by means of a single picture.

Prof. Unwin, F.R.S., exhibited apparatus for indentation tests of metals. The relative hardness is measured by the indentation per ton per inch of knife edge.

Dr. MacMunn showed microscopic preparations illustrating the structure of the digestive gland of Mollusca and Decapod Crustacea.

Electrical recording apparatus was shown by Prof. H. L. Callendar, F.R.S.

Mr. C. T. R. Wilson demonstrated production of cloud by the action of ultra-violet light. When the light from an arc lamp is brought by means of a quartz lens to a focus within a vessel containing moist, dust-free air, a bluish fog gradually develops along the path of the light. The effect is entirely prevented if the ultra-violet rays be cut off by interposing a sheet of glass or mica, no cloud or rain resulting under these conditions even when supersaturation is brought about by sudden expansion. Possibly the small particles which give rise to the blue of the sky are produced by the ultra-violet rays of sunlight absorbed in the upper layers of our atmosphere.

Prof. Oliver Lodge, F.R.S., exhibited improvements in magnetic space-telegraphy. The discharge of a condenser or Leyden round a large wire coil sets up an alternating magnetic field, which excites induced currents in another distant condenser-circuit tuned to the same frequency, causing the second Leyden either to overflow into a coherer, or to disturb a Rutherford detector or a telephone so as to give a signal.

The detector shown was a special series of small free coils and granular microphones, each coil in a permanent magnetic field and so connected to the microphone of the next that a very feeble alternating current in the first of the series is able to make a telephone in the last emit a loud sound, or, through a Langdon-Davies relay, to ring an electric bell and work a Morse sounder. A tone-telephone was also shown, which acts as a highly syntonised "call."

The magnetic vibrations in the sending current can be maintained in various ways, but the way shown is a device due to Dr. Pupin, with a vibrating string and battery contact. A signalling key enables the ordinary Morse alphabet to be sent without any connecting wire, and independently of obstacles. It may be regarded as, in some respects, a modification and improvement of the induction method of telegraphy inaugurated by Mr. Willoughby Smith and practised by Mr. Preece; but, with suitable circuits, the tuning must be nearly exact to evoke much response, and with enough copper in each circuit there is no assignable limit of distance.

Prof. A. Barr and Prof. W. Stroud exhibited range-finders.

THE PRESENT POSITION OF SOME CELL PROBLEMS.

DURING the last two decades or so a new branch of science has been quietly, but rapidly, working its way from a position of comparative obscurity to one of considerable importance. This new-comer has been designated Cytology, and it embraces as its province that department of knowledge which centres around the cell, whether this body be regarded from its structural or from its functional aspect. And cytology, which is still a young offshoot both from botany and zoology, possesses one strongly marked advantage, viz. that of providing a common ground on which the botanist and the zoologist may still meet to discuss questions of equal interest to each. For in dealing with the cell we are approaching facts and phenomena which are essentially shared or exhibited by animals and plants alike, and, indeed, the measure of their relative importance can be gauged by the degree in which they reappear in each of the two great divisions of organic life; although in most other respects the animals and plants have followed widely diverging paths of development.

The cell was long ago recognised as the structural unit of an organism, but the relations of its various parts to one another were overlooked or misunderstood, and we are still far from arriving at a satisfactory solution of the difficulties which each investigator meets when attacking the problems presented by any special case; nevertheless, some general facts have been discovered which serve as landmarks to guide future exploration.

In all but the very lowest forms of life, and in some others which are probably degenerate, we recognise clearly enough that the protoplasm of an organism contains one or more nuclei within its substance. Commonly, though by no means invariably, each nucleus is associated with a definite mass of protoplasm which is segregated, more or less strictly, from the rest by means of membranous partitions. These partitions are not, however, necessarily always present. Some animals, and many of the lower plants, possess a protoplasm in which are distributed large numbers of nuclei, which thus appear to lie embedded in a common matrix. Instances of this are seen in *Vaucheria* and in the embryonic stages of *Peripatus*. But although the nuclei are thus scattered, there is a considerable body of evidence to show that their respective spheres of influence are tolerably clearly defined, just as are those of different countries, even when these are not delimited by obvious boundaries like rivers or mountain ranges.

On the other hand, just as there are roads and traffic between two neighbouring countries, so it has been shown by several observers that even where the "cells" are separated by walls from each other, the adjacent protoplasms are often connected by fine threads of the living substance which traverse the intervening cell walls. The phenomenon seems to have been occasionally seen without apparently its importance being realised, but Tangl clearly demonstrated it for plant cells (Endosperm) almost twenty years ago. Since that time the investigations of Gardiner, Kienitz-Gerloff, and others have shown that what were once thought to be merely isolated cases may possibly turn out to form rather the rule than the exception. There can be but little doubt that the improved uranium-osmium method of Kolossow, which has recently been employed with considerable success by Gardiner, will materially extend our knowledge in this direction, and will confirm what most of us have for a long time held, that the difference between such a plant as *Caulerpa* and the ordinary multicellular forms is rather one of degree, the result of specialisation, than one of kind. Thus during the germination of some algæ, certain of the *Fucaceæ* for example, the embryo exists for a considerable time in a multinucleate condition, the cell walls only appearing at a later stage. The same is also seen during the development of the endosperm in a flowering plant, and still more strikingly during the germination of the spore of *Isoëtes* or of *Selaginella*. The occurrence of a stage in the development of many plant tissues, during which the constituent cells are sliding past each other in adjacent rows, is seen to furnish no real argument for a protoplasmic discontinuity at this period, when it is remembered that not only are the walls still soft, but that they actually contain a nitrogenous body which is almost certainly protoplasm in their substance. On the animal side also evidence is not lacking to show that in some of the higher forms, at least in the earlier stages, protoplasmic continuity is of frequent occurrence; and it also obtains, according to Schuberg and others, between the cells of some tissues in the adult animal.

Nevertheless, the want of such a continuity in nerves, *e.g.* in the ganglionic cells, suffices to show that it is unsafe to generalise on *à priori* grounds too freely, for it is in nerves, perhaps more than in most other tissues, that a direct continuity might have been expected. And it is the more necessary to emphasise the lesson derived from a study of the histology of nervous tissues, inasmuch as a continuity of protoplasm has been generally assumed to exist in the tissues of motile organs of plants, on purely physiological grounds, although it may not have been demonstrated histologically.

The *rôle* played by the nucleus in influencing or in determining the mode of special activity manifested by its attendant protoplasm is one of great interest, and a great deal of light has been thrown upon it within recent years. Haberlandt and others have clearly shown that in cases where metabolism was more active in one region of the cell than in another, the nucleus commonly migrates to this locality. Beautiful examples of this may be observed during the thickening of the walls so frequently met with in the protective layer of seeds or fruits. Thus if the development of the seed of the common night-shade (*Solanum Dulcamara*) be followed, it will be seen that in the young stages of the large cells which ultimately give rise to the hard shell of the seed, the nucleus occupies a central position. Later on, the nucleus becomes lodged in close proximity to the inner wall of the cell, and this then begins to thicken. This deposition of thickening substances spreads to the lower (or inner) parts of the lateral walls; whilst their outer portions, as well as the whole of the external wall, which is remote from the nucleus, remains thin. Again, it has been observed by Istvanffi that when the hypha of a fungus is about to branch, the nucleus is discoverable at a spot just beneath which the outgrowth is about to arise.

The well-known and highly characteristic appearance of the large nuclei met with in tissues the cells of which are in an active state of division, is all evidence of the important influence of these bodies over the process. So also is the fact that those cells which are the last to lose the faculty of resuming an embryonic condition (*i.e.* of giving rise to fresh tissues) retain these nuclear peculiarities longest. This point is well brought out in a study of the cells of a growing root, for it is easily seen that those which form the layer known as the pericycle keep the primitive appearance of their nuclei the longest, and it is in this layer that the new structures, the lateral roots, when they occur do actually originate. Again, when new structures are about to be formed from tissues already adult, or even senescent, the first obvious sign of the new impulse is detected in a change in the nuclei of the cells, a change which depends as much on chemical as on physical differences. In cells which are secreting, whether belonging to animals or to plants, the nuclei are observed to pass through a remarkable series of changes, which may even result in the temporary differentiation of the peculiar so-called *chromatic* elements, resembling if indeed not identical with those appearing during nuclear division. Much the same is to be seen in the huge nuclei often present in the "foot cells" in an animal testis, around which the young immature spermatozoids cluster in groups, apparently deriving from the chemical activity of these cells the nourishment requisite for the completion of their development.

Even more conclusive evidence as to the close relation between the metabolism of the external protoplasm (conveniently distinguished as *cytoplasm*) and the nucleus is furnished by the different behaviour of nucleated and non-nucleated fragments of protoplasm respectively. It is quite possible, by taking appropriate measures, to vivisect a single cell, so that one portion shall contain a nucleus and the other not. The former half commonly regenerates itself, and if derived from a plant cell, forms around itself a new cell wall; on the other hand, the non-nucleated fragment sooner or later perishes, although it may continue for a time to exhibit normal vital functions. Usually, however, it is able neither to secrete on its surface a membrane, nor to engage on constructive metabolism.

But interesting and suggestive as are the relations which can be discerned between the cytoplasm and the nuclei of cells in a condition of comparative repose, they are almost eclipsed by the wonderful series of changes which recur with surprising uniformity each time the nucleus and the cell divides. Nor is it always easy correctly to estimate the relative importance of the various structural elements which are involved or concerned in the process.

Of late years we have heard a great deal about a minute particle which is present, sometimes in the nucleus, oftener in the external cytoplasm, and which is by many assumed to play the part of a directive agent in the matter of nuclear division. This body, known as the Centrosome, was first brought into prominence by the researches of Van Beneden on the developing eggs of *Ascaris*, and it has since been recognised in an enormous number of animals, and also in the cells of some plants.

The centrosome is frequently a body of extraordinary minuteness, and it is most easily recognised during certain stages of nuclear division, on account of the central position which it occupies with respect to the radiations which accompany the process.

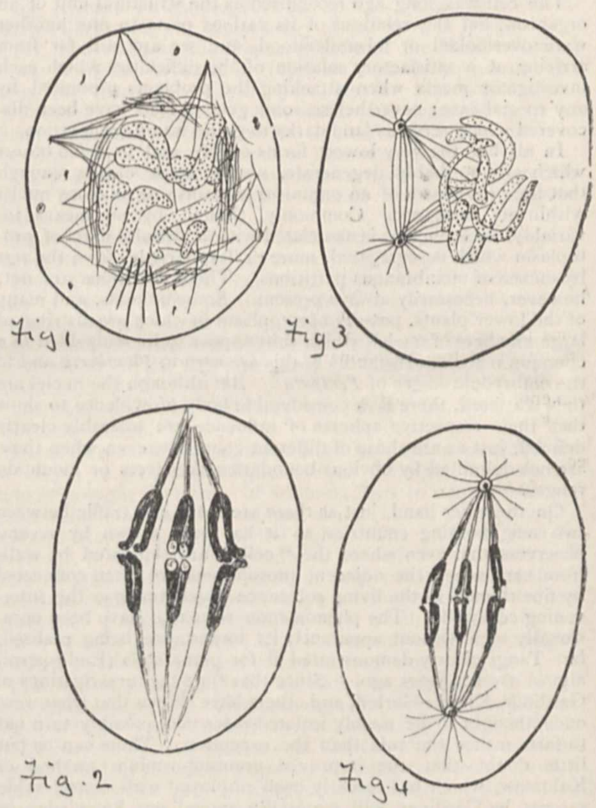
It has, however, been identified in many cells which are in a state of repose, as a minute particle which may or may not be surrounded by differentiated zones of specialised protoplasm, though it is certain that in many cases this appearance is due merely to a diffraction-phenomenon. Furthermore, it is not unfrequently observed that its division precedes any change in the nucleus, and that when the division of this latter body is approaching, the two daughter centrosomes diverge from each other, each situated in a definite protoplasmic mass and forming one of the two poles of the spindle structure which arises during the process of karyokinesis.[1] Sometimes, indeed, this spindle structure is seen to be spun out, as it were, between the two centrosomes at the moment of their separation, and to grow as they move further apart. Even more important, perhaps, than these observations was the statement made by Fol, that during the process of fertilisation both the male and female cells contributed a distinct centrosome, each of which then divided, and the half of the one then fused with the corresponding half of the other, a proceeding to which he gave the name of the Quadrille of the Centrosomes. This statement, which was supported by precisely similar statements on the part of Guignard for plants, as well as by other zoologists, has, however, proved to be due to misinterpreted or mistaken observation. It is quite certain that at present there is no really authenticated example of such a proceeding occurring either in plants or in animals, although a glance at many modern text-books testifies to the hold which these erroneous accounts have taken on receptive minds.

In the enthusiasm to which the first discovery of the centrosome, and its subsequent identification in so many kinds of cells, gave birth, it has not always perhaps been sufficiently remembered that *post hoc* by no means necessarily implies *propter hoc*; and that neither its reappearance at the period of karyokinetic activity, nor yet its observed persistence through the resting stage in some cells, are of themselves sufficient to establish its claims to be regarded as the *primary directive agent* in bringing about a nuclear division. Supposing, however, that it could be shown to be really possessed of all the occult powers which have been claimed for it by its numerous devotees, the main result would be to remove to an immeasurably greater distance all chance of penetrating more deeply into the mysteries of cell life. For its very minuteness renders it almost immune from the critical gaze of the curious.

Possibly some light may be thrown on the method of action (if indeed it really possesses any at all) of this enigmatical body, by a consideration of some of the cases in which it cannot be said to exist at all. For some years past it has been known (and the number of examples has been recently multiplied) that in certain plants the nuclear division is not inaugurated by the appearance of two diverging centrosomes, which could occupy a definite position with regard to the radiations at this time visible in the protoplasm. On the contrary, radiations start out from many centres in the cell, and run in various directions, though with a general tendency towards the nucleus. Later on these numerous centres become, so to speak, polarised, and commonly come together at two principal points occupying opposite ends of the cell. Thus a final condition of affairs is reached, resembling the more regular arrangement obtained by the centrosome mechanism (Figs. 1 and 2). What starts these radiations in the first instance? It is difficult to imagine them to be otherwise than due to a chemical change in the protoplasm, or of some of its included substances, and this view is strengthened by the observations made by Hertwig and others on the stimulating and modifying action of drugs, such as quinine or strychnine. Morgan, by merely altering the salinity of the sea-water, was able to produce centrosomes and radiations at will, and the irregularity in number and size which they displayed was just such as might have been expected, on the hypothesis here advanced.

[1] A word used to signify nuclear division, introduced by Schleicher; it is equivalent to the term *Mitosis*, employed by Flemming.

These observations—and many similar ones could be cited—go to show that the impulse to division, which some have tried to identify exclusively with the centrosome, is more probably dependent on the condition of the protoplasm as a whole. It is quite probable that, as in so many other cases, the stimulus may be at bottom a chemical one, connected with the elaboration of some substance producing the disturbances which result in the formation of the machinery for cell division. It is even possible that the substance may, in the more specialised cells, or in those of rapidly dividing tissues, be aggregated into a mass which assumes the manifold appearance that one finds in the centrosomes, centrospheres, and so on. From what we know of protoplasm it would hardly be surprising if this were so. Carbohydrate can be stored as starch, to be again lost to sight as sugar, &c.; why not the substance which may be supposed to be capable of reacting with the rest of the protoplasm in the



production of the karyokinetic phenomena? But this is a very different thing from considering the centrosome as a sort of autocrat presiding over the destinies of the cell, as its more enthusiastic supporters have claimed. It would not even be necessarily a *permanent structure* inaugurating the cell changes, but would represent a substance, which might merely be formed *ad hoc*, and which, after the period of activity, might either lose its identity—sinking to the general level of the substances contained in the protoplasm—or if present, in sufficient quantity, over and above what proved to be needed for a given occasion, it might remain as a formed substance to be used up later.

There is a large body of evidence to show that, when present, it is intimately associated with the processes of nuclear division, though whether in an active or passive connection it is difficult, perhaps impossible, to say. Certainly, taking the most favourable view as to its autocratic powers, it can effect nothing unless the protoplasm be ready to receive it. The centrosome of a spermatozoid introduced into a ripe egg may become the centre of a system of radiations, but none are produced if the ovum happens to be immature. And on the whole, especially in view of the behaviour of those cells in which no centrosomes have been discovered in spite of infinite toil having been spent on the attempt to prove their existence, it seems more probable that they are not to be regarded as morphological structures ranking with nuclei or plastids, but at most as consisting of matter which may be condensed to a granular form, or which may be present or be manufactured in a state diffused through the protoplasm. Indeed this matter may perhaps not be inappropriately compared with zymogens, which, when suitably acted upon, liberate substances capable of exerting an influence altogether incommensurable with their amount on materials within the scope of their power. But no one would probably go so far as to elevate a lump of zymogen, if it could be shown to exist in a given cell or tissue, to the rank of a cell organ, any more than most people regard the elaborated spindle fibres as representing anything but a specialised phase of protoplasmic structure, at most temporarily differentiated from the rest of the cell substance, and destined, sooner or later, to be re-absorbed into it, although the remains of some spindles persist long after the cells in which they were formed (*de novo*) have completed their division.

Having briefly glanced at the centrosome, we may pass on to consider some of the more important peculiarities connected with the actual process of division of the nucleus. And, first, we will consider the mode of the formation and division of those remarkable structures—the chromosomes. During its resting state, a nucleus presents a granular or spongy appearance, and is commonly seen to contain one or more refractive bodies—the nucleoli. As the stages of approaching division are passed through, a substance (which can be identified also in the resting state), known as the chromatin, begins to assume a growing importance. This substance, which consists largely of nucleic acid, aggregates along more or less definite tracts of the colourless and less stainable matrix (linin) within the nucleus, and finally nearly all the linin is used to provide a substratum in which the chromatin is embedded. This linin scaffolding assumes the appearance of a much convoluted thread or threads, and, owing to the predominance of the chromatin, its existence is easily (and often) overlooked. The thread then shortens and thickens, and eventually breaks transversely into a definite number of segments constant for the particular species. Meantime the well-known *spindle* is formed, and the chromosomes become arrayed around it (Figs. 2, 4). They are now seen to split longitudinally, and finally the two halves separate, passing to opposite ends of the spindle, where they help to reconstitute the daughter-nuclei which arise in this way. Now, since the original chromatin containing thread appears to be symmetrical about its long axis, it is clear that there exists no obvious grounds for assuming that the two groups of chromosomes, which have ultimately arisen as the result of a longitudinal fission of this thread, represent anything but the reflected images of each other; and indeed there is a great deal which strongly suggests that the significance of the complicated stages passed through, lies in the ensuring of a qualitatively equal distribution of material to each of the two daughter cells; *quantitative* equality is also secured far more accurately than would probably be the case if each chromosome divided transversely instead of longitudinally.

The reappearance of a definite number of chromosomes, as well as *à priori* considerations, based on the relations which on good grounds believed to obtain between the chromosomes and the existence of hereditary qualities in an organism, have led many investigators to believe that they are the *same* chromosomes which constantly reappear at each karyokinetic period; although, in the majority of instances, they cannot be recognised in the intervening state of rest between the successive divisions. This view is, perhaps, hardly sufficiently warranted by the facts, and some of its warmest supporters have been obliged to take refuge in expressions such as a "physiological persistence"; a sort of persistence which may be entertained as a pious opinion, but which, when one tries to rigorously define it, proves as elusive as metaphors usually are.

But the chief interest which centres in the chromosomes depends on the remarkable part played by these bodies in connection with the reproductive processes. Since every act of fertilisation consists essentially in the union of two cells and of their contained nuclei, it is clear that the resulting nucleus will possess twice as many chromosomes as that in each of the cells which have fused together. And if this is repeated in consecutive generations it is obvious that the chromosomes, increasing in geometrical progression, will soon become too numerous to be contained within the limits of any one nucleus. Hence the necessity of a reduction in their number at some period between each act of fertilisation. This reduction regularly occurs, and always happens at a definite period in the history of the organism, although the exact epoch may differ considerably in different groups of plants or animals.

A considerable discussion has arisen as to the exact significance to be attached to the process, over and above the bare fact of the halving of the number of the chromosomes. Some have tried to show that variation, so characteristic of animals and plants, is ensured by the distribution of entire chromosomes between the two daughter-nuclei; others have seen in it a return to an "embryonic condition" which renders the act of fertilisation a necessary antecedent to further development; others, including Strasburger, whilst recognising that it is preparatory to fertilisation, and that it indirectly promotes variation by rendering the fusion with another cell possible, regard it as the expression of a return to an ancestral condition, which prevailed before fertilisation by the union of two individuals had come into existence. Of the explanations here mentioned the first is the most consistent, or at least is, at first sight, less obviously contradicted by facts than the rest. But, nevertheless, it will be seen that it does not by any means embrace all the well worked-out cases, and therefore cannot be considered as of general application. It will, however, be specially considered here, because it is so often brought forward as a most important argument in support of Weismann's theory of Heredity.

Weismann, as is well known, regarded the hereditary qualities of an individual as closely bound up with certain cellular structures, and he has identified these with the minute particles of chromatin which in the aggregate go to form a chromosome. Each chromosome is conceived of as possessing the material substrata for all the specific characters of the organism, but the arrangement or constitution of these is slightly different in the different chromosomes. The actual course of development, followed by the organism as a whole, depends on the degree in which one or other group of characters becomes predominant, or on the result of a compromise between them.

Clearly, therefore, whilst an organism which had lost half its chromosomes could not be expected to exhibit as many possibilities of variation as one which retained its full number (if development were possible at all under such circumstances), by the elimination of the half, and subsequent replacement of them by corresponding (but slightly differing) chromosomes from another individual, the chances of new variation would certainly, if we accept the premises, be greatly increased.

These views have been worked out in great detail, and they have received quite a remarkable confirmation as the result of the researches of Rückert, Häcker, vom Rath, and others. But, whilst recognising the great interest attaching to the results obtained by these investigations, it is at present quite impossible to regard them as affording more than a local confirmation of Weismann's theories, simply because, although they may possibly bear this interpretation, there are (as already indicated) other cases which even Procrustes himself could not fit into the same bed.

As regards the general character of the "reduction divisions," there naturally exists a certain amount of variety in detail; but in the following summary an attempt will be made to present the more salient and fundamental features of the process. If one takes as an example a higher animal, the reduction divisions are seen to be closely related with the formation of the actual sexual cells—ova and spermatozoa; up to the penultimate divisions the line of cell generations have possessed nuclei with a definite number of chromosomes, which we will designate as $2n$. Then follows a long period of repose and of growth, and when the nuclei of these cells emerge from their quiescent condition, the number of their contained chromosomes is seen not to be $2n$, but only n. That is to say that a numerical reduction has, somehow, been accomplished in the resting period. There is no question here of any chromosomes having been *eliminated*; nothing has been expelled (so far as can be seen) from the nucleus, but there has been a rearrangement. It has been suggested, and the view is stoutly maintained by Häcker and others, that the reduction here is only *apparent*, and that what has really occurred is that the original thread has only, so to speak, broken transversely at every other joint, leaving two chromosomes attached end to end. Each apparent chromosome then would be really double. Be this as it may, these chromosomes behave essentially like those of other preceding cells as regards their fission, dividing longitudinally, as before. But the process is here very complicated, and it is only as the result of very many and careful researches that this fact has been definitely ascertained. Quite apart from the altered (reduced) numbers of the actual chromosomes present, the course of their development deviates so widely from the normal type of karyokinesis in whatever the animal or plant one may happen to be investigating, that it has been designated by Flemming as the Heterotype[1] division.

It has already been stated that some writers hold that no true reduction has occurred at this period, and by them (Häcker, Rückert, &c.), it is termed a *pseudo-reduction*, for they consider that in the next, and rapidly following, division the real reduction occurs. In the latter division it is believed, in the cases investigated, which belong chiefly to the Arthropoda, that a real *qualitative* reduction occurs by the splitting transversely of each of the pseudo-chromosomes, and by the distribution of the halves thus produced to the two daughter-nuclei. In other words, the two genuine chromosomes which remain united as a pseudo-chromosome during the heterotype karyokinesis, now separate from each other, and thus each daughter-nucleus receives half the number of original entire chromosomes, and consequently comes to contain slightly different sets of hereditary potentialities. However this may be for Arthropoda, in which the process is by no means easy to follow, it is certain, as the researches of Meves, conducted under the auspices of Flemming, clearly prove, that such a sorting of chromosomes does not occur during the development of the sexual cells of Salamander, but that the second (and last), like the heterotype division preceding it, passes through a longitudinal-fission stage. And it is equally certain that the same is true, at least, for the higher plants. Ischikawa's recent results with *Allium*, which seem to point to a contrary conclusion, can hardly be admitted as evidence one way or another, since, judging from his own account of the process, he seems to have misunderstood the stages with which he was dealing. And in any case, the existence of numerous exactly worked-out examples in which a transverse fission certainly does not occur, obviously disposes of any attempt to make it serve as the basis for a general theory of the mechanism by which variation may be supposed to be secured.

In spite of all the efforts which have been made, we are still without a certain clue to the meaning of the reduction. Unquestionably Weismann's view, which has been supported by Häcker and others, offers the most attractive solution of the puzzle; but, as has been pointed out, it clearly will not explain the facts in all cases. Others believe the essential feature to lie in the sudden reduction in the amount of chromatin consequent on two so rapidly consecutive divisions. But the divisions do not invariably succeed each other with no intervening period of rest. Strasburger has suggested that it represents a return to an ancestral pre-fertilisation state, and it is possible that there may be found to be some probability for this. But against it is to be set the question why organisms with different numbers of chromosomes in their nuclei always halve that number, whatever it may happen to be, and do not all come to possess a common number of reduced, and consequently of duplicated chromosomes, for even closely related forms often differ widely in this respect. However we explain it, it seems clear that no theory which depends on the continued permanence of chromosomes can be admitted. Each one of the reduced number cannot be compounded of two original ones, as such, but must be a new structure; else it is obvious that we have no real reduction at all, but only a series of pseudo-reductions—a view which would soon land us into an impossible position. But if the chromosomes are not really permanent structures, then the whole process of the two divisions of which we are speaking, resolves itself into a mechanism which, whilst providing for a halving, provides equally for an accurate distribution of the halved substance between the two final daughter-nuclei.

[1] The chief differences which distinguish the heterotype from other divisions lies in (α) the long period of growth preparation; (β) the relatively early appearance of longitudinal fission in the chromatic thread; (γ) the frequent separation of the halves thus formed at this early stage, and their subsequent approximation to one another of the halves in a variety of ways, *before* they become grouped on the spindle; (δ) the curious and very characteristic appearance of the mature chromosomes on the spindle, sometimes taking that of closed rings, with (commonly) local equatorial thickening, or the chromosome at this stage may, in some forms, assume the form of four spheres, loosely held together, constituting the *vierer gruppe* of the German authors.

And although the acceptance of such a view of the matter would involve a modification of those opinions shared by many as to the nature of the architectural configuration of the hereditary substance, in accordance with which discrete particles of it are commonly assumed to be associated with definite hereditary qualities, still the alternative hypothesis by no means negatives the possibility of regarding heredity as the outcome of the constitution of some such substance taken as a whole. The qualities of the organism would depend on the structure of the material basis, just as the structure of a crystal—to use an old illustration—depends on the ultimate configuration of the constituent molecules. An analogy of this sort is perhaps not worth much—it is a comparison of a relatively simple with an infinitely complex case—but still we are more likely to make a definite advance by arguing, even imperfectly, from things of which we know something, than by abandoning ourselves to phantasies which are intangible, and consequently incontestible.

During the course of a nuclear division, there are few phenomena which are more striking than the genesis and mode of operation of that extraordinary structure known as the achromatic spindle. This body provides the framework for the whole process, as well as the machinery by which it is effected. It originates in many different ways, and exhibits various degrees of perfection in different organisms; but the ultimate result attained is much the same in all.

Two extreme types of its modes of origin may be briefly outlined. In the less perfect form, as the period of nuclear division is about to commence, radiations are seen to start out in the protoplasm. Sometimes these are connected with the nucleus itself, but more often they seem to be focussed in groups on many of the granules with which, at this stage, the protoplasm is filled. But there is no sort of order in their arrangement. Later on it is seen, however, that the lines become gradually and with increasing rapidity focussed to two opposite spots in the cell, and then the normal spindle is fully formed. It is idle here to speak of the existence of centrosomes as initiating a process which thus begins so irregularly; and the assumption that they are really secretly existent all the time, and by their hidden activity cause the astral radiations to converge to the two poles, suggests if not a *petitio principii*, at least a revelation derived from some source from which mere mundane minds are debarred.

In the more perfectly formed mechanism, the spindle originates from a definite mass of protoplasm which is intimately related to centrosomes, and consequently it only is formed in this manner when these structures are actually present.

It appears to be, so to speak, spun out between the diverging centrosomes, and either to pass into a groove in the nucleus, or to rope up towards itself the chromosomes which by this time are differentiating. But whatever be the manner of its origin, when it is fully formed it provides a structure upon which the chromosomes are arrayed, and upon which, after the separation of the two halves into which they severally split, the daughter chromosomes travel to the respective poles. In many cases additional fibres can be distinguished which have become attached to these retreating bodies, and thus, by contracting, drag them towards the two ends of the spindle.

The advantage, mechanically speaking, of two poles to which all the achromatic fibres running between them converge, is clearly recognised during the changing conditions of stress and strain which occur during the course of a karyokinesis, and it serves to throw some light on certain phenomena which have attracted less attention than they seem to deserve.

Hitherto the poles have been treated of here as though they were only marked by the convergence of the nuclear spindle fibres; but, over and above these, there are numerous other fibres which radiate into the cell protoplasm, and which may even reach the cell wall. Now, it is a significant fact that these radiations are most apparent during the first formation of the spindle and during the end phases of division, *i.e.* whilst the daughter chromosomes are being pulled up to the poles. Often, as in germinating spores of *Pellia* (a liverwort), they entirely die away in the interval separating these two stages. The whole appearance strongly suggests that the function of these radiations, differentiated out of the cytoplasm, is to steady the poles, and thus render the achromatic framework a rigid one. Indeed without some such arrangement it is difficult, if one watches the process going on, to imagine how the necessary stability would be secured.

When the chromosomes have reached their respective destinations, and whilst they are gradually forming into the daughter-nuclei, a curious change usually occurs at the equator of the spindle in the fibres which still stretch across the intervening space between the two poles. The threads become more numerous and present over the area mentioned a thickening of their substance, and by the fusion of the swellings a cell wall, dividing the original cell into two halves, may be formed. And whilst this is happening, there is evidence to show that the fibres themselves, which become strongly arched, are in a state of compression and thus the young wall is stretched to its utmost extent. The plane of equilibrium within the spindle depends on the shape of the cell; and thus at first, and whilst still plastic, one can predict what position it will

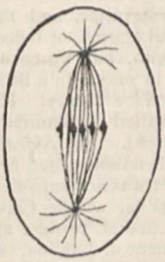


Fig. 5

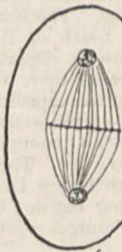


Fig. 6

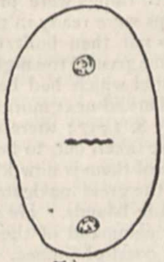


Fig. 7

take up as regards the existing boundaries of the cell. Indeed the resemblance of such a nascent wall to a soap film has struck more than one investigator, and has been worked out in some detail by Wildemann.

The general relation of cell division to mechanical conditions is well illustrated during the development of pollen cells. In the monocotyledons the original pollen-mother-cell gives rise to the pollen grains by two succeeding divisions with an interval of rest between them. The first karyokinesis is followed by a partitioning of the cell, which is thus divided into two symmetrical halves, often hemispheres. When the latter finally divide, they also are symmetrically partitioned, though this, of course, can (and usually does) happen by means of walls which are not similarly orientated in both of the two first formed cells. In Dicotyledons, on the other hand, in which also there are two successive bipartitions of the nucleus, the appearance of the cell walls is deferred until the full number (four) of nuclei has been produced. And, just as might have been expected, the way in which the actual partitioning takes place is consequently modified. If spherical, as is commonly the case, the quadrinucleated cell is simultaneously divided into four tetrahedral cells by walls converging to the centre at an angle of 60°.

It would be difficult to find an example which more strongly witnesses to the influence of the form of the cell as governing

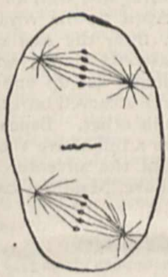


Fig. 8

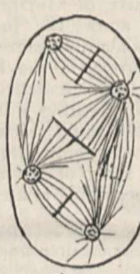


Fig. 9

the disposition of the walls which partition it, than is furnished by the spore formation of a common liverwort, *Fegatella conica*. And as it also illustrates some other points touched upon in the preceding pages, this paper may be fitly brought to a close by a description of the more salient peculiarities attendant on the process. The spore-mother-cell, which ultimately gives rise to four spores, is shaped like an oval box flattened above and below. When its nucleus divides (Fig. 5), the two daughter-nuclei lie in the line of its major axis, and a rudimentary cell wall begins to be formed at the equator of the spindle (Fig. 6), after the fashion already indicated above. But, unlike most structures of this kind, it does not extend to the peripheral walls owing, apparently, to the relatively small size of the spindle. As the two daughter-nuclei pass into the resting condition, the spindle fibres die away, and an interesting change comes over the character of the uncompleted division-wall. It ceases to be stretched out, and becomes somewhat crumpled and obviously thicker, whilst its area correspondingly diminishes (Fig. 7).

Then, after a time, the two daughter-nuclei again divide (Fig. 8), and after this division, resulting in the production of four nuclei, preparations for the real partitioning of the cell begins. Whatever position they may have previously occupied, the nuclei now take up that shown in Figs. 9 and 11; and they are apparently compelled to do so by the action of the radiations, which extend from each one of them into the surrounding cytoplasm. Whilst they are settling down to their final positions, the original cell-plate, above spoken of, is caused to rotate through an angle of 90°, so that it now is parallel with, instead of at right angles to, the major axis of the elliptical cell. Its motion is clearly seen to be the result of a directive action on the part of the highly developed systems of radiating fibres, and when it has turned round it is seen to have lost its thick crumpled appearance, and to have become thin and tense. As soon as it has ceased to cut across the line of protoplasm between the nuclei belonging to opposite pairs, the radiations are seen to arrange themselves into a spindle form, just like that formed between the daughter-nuclei of each pair, a fact of considerable theoretical importance in the elucidation of the genesis of spindle structures generally. In the equators of these two newly differentiated spindles, as in each of the two normal ones, cell-plates are formed, four in all, and they become attached in pairs to the ends of the primary plate, now lying longitudinally in the cell (see Figs. 9 and 10), and thus the partition of the space is completed (Fig. 11). A point of special interest in

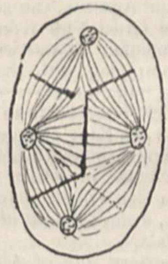


Fig. 10

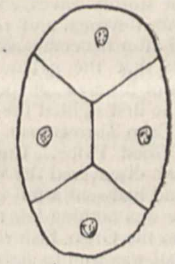


Fig. 11

this case of *Fegatella* lies in the remarkable fact that we here meet with two perfectly different conditions of cell division, and that the transition from the one to the other can be followed in every stage. Theoretical requirements are here demonstrably satisfied in a manner such as we can seldom hope to equal in our attempts to solve the many problems with which cytology has to deal.

J. B. FARMER.

VASCO DA GAMA.[1]

WE are assembled this evening to commemorate one of the greatest events in the history of the world—the discovery of the ocean route to India by the Portuguese. Vasco da Gama completed the mighty enterprise on the day when the ghâts of India were sighted from the deck of his ship just four hundred years ago to-morrow. The credit of this discovery is due to the Portuguese people, to their constancy and heroic perseverance, even more than to the skill and ability of their leaders; and I think that many of the illustrious navigators of Portugal are equal in merit, and should be equal in renown. We contemplate the perseverance of this people and the continuity of their work during a century and a half of mighty effort, rather than a single stroke of genius. Yet it is right that Vasco da Gama, who forged the last link, should have the first place which Camoens has assigned to him, *primus inter pares*.

Prince Henry gave the first impetus, and during a quarter of a century he created a school of seamen who rounded Cape Bojador in 1435, Cape Blanco in 1443, Cape Verde in 1445, and

[1] Address delivered before the Royal Geographical Society, on May 16, by the President.

reached the Gambia in 1454. All this was done in the lifetime of the Prince Navigator. At his death the work was continued, with almost equal zeal, by the kings—his nephews—Alfonso the African, Joaõ the Perfect Prince, Manoel the Fortunate. Portugal was indeed fortunate in her sovereigns of the house of Avis, fit guides and leaders of the little hero nation, as Schlegel calls her. The ships of Alfonso reached Sierra Leone in 1462, made a colony at Lamina, on the coast of Guinea, crossed the equator, and sailed as far south as Cape St. Catherine. His son, "O Principe perfeito," sent Diogo de Azambuja to found the castle at Lamina, and Diogo Cam to push southward, until at length the Congo was reached.

The *padraos* were intended to be eternal monuments of Portuguese achievement. They were stone pillars with an inscription, and the arms of Portugal carved upon them—the well-known "cinco chagas," with the orle of the seven castles of Algarve.. Each explorer was to plant one on a conspicuous point at his furthest point. The "padraos" were named after saints. That of Santo Agostinho (once planted in 13° 27′ 15″ S., south of Benguela) is now in the museum of the Geographical Society at Lisbon, as well as that once on Cabo Negro, in 15° 40′ 30″ S. Two of these "padraos" were on the arms granted to Diogo Cam, the discoverer of the Congo.

It was the ambition of each successive Portuguese voyager to plant a national monument beyond the furthest point reached by his predecessor. None had been so zealous in this glorious work as the family of Diaz, whose first sailor scions were trained in the school of Prince Henry. Joaõ Diaz rounded Cape Bojador, Dinis Diaz first reached Cape Verde, and Bartholomew Diaz was destined to complete the maritime fame of his family by being the first to round the southernmost point of Africa, planting "padraos" as he proceeded. In 1487, Bartholomew Diaz passed the Table mountain undiscerned amidst the stormy waves, rounded Cape Agulhas, the southernmost point of Africa, and reached the Great Fish river, which he named after his companion, Joaõ Infanta. It was with great reluctance that the gallant Diaz, complying with the urgent entreaties of his crew, shaped a course homewards; and then it was that he first sighted the cape, which received from him the name of Cabo Tormentoso, and which the King changed to the Cape of Good Hope. Covilham, exploring southwards from Egypt, had discovered the whole east coast of Africa as far as Sofala, and had sent a full report from Cairo to King Joaõ. So that there was nothing left to discover, except the bit of African coast from the Great Fish river to Sofala.

The goal was well in sight. The eastern side of Africa had been reached by Diaz, and was known through the report of Covilham. Thence the next explorer would stretch across to the shores of India. King Joaõ prepared for the final and crowning expedition by the building of two suitable ships, which were commenced under the superintendence of Bartholomew Diaz, the ablest and most successful Portuguese explorer of that age. But in 1495 the king died, and the great work remained to be achieved in the reign of his successor, King Manoel ("O Fortunado"), who was at the head of Portuguese affairs for the next fifty-six years. He continued the equipment of the expedition, which had been commenced by his predecessor.

Then it was that Da Gama appeared on the scene. Camoens introduces him—

> "Vasco da Gama, valiant capitayne,
> For deiring do the noblest volunteer;
> Of notable courage and of noble strain,
> Whom smiles of constant fortune love to cheer."

The Da Gamas came of an ancient, valiant, and loyal house, their ancestors having fought by the side of Alfonso III. in the conquest of Algarve from the Moors, and by the side of Alfonso V., "the Brave," at the battle of Salado. Estevan da Gama, their father, was chief magistrate of Sines; and here Vasco and his brothers were born. The little town of Sines is situated in a bay, about half-way between Lisbon and Cape St. Vincent. To the west are the blue waves of the Atlantic, but to landward an undulating sandy plain extends for several leagues. On the north side of the bay there is a granite ridge running out into the sea, and on the top of the cliff there is a small church built by Vasco da Gama towards the end of his life.

The four sons of Estevan da Gama appear to have been born and brought up at Sines; but I believe that little or nothing is known of them before the date of the great expedition. The two ships had been built, the *Sam Gabriel* of 120 and the *Sam Rafael* of 100 tons; another vessel was purchased from a Lagos pilot named Berrio, and named after him; and a provision-ship of 200 tons was also got ready. Then it was that Vasco da Gama was selected by King Manoel to command the expedition. He was not more than twenty-eight years of age. His eldest brother, Paulo, was equally fitted for the post, and he insisted upon accompanying and serving under Vasco, in command of the second ship. They both looked upon Nicholas Coelho, who was captain of the *Berrio*, as their brother.

Paulo da Gama was one of the kindest and most lovable of men, and his presence in the fleet was an influence for good. The best trait in the character of Vasco was his love for and devotion to his elder brother.

All things were prepared for the great enterprise, and the ships were ready in the Tagus. The beautiful church of Belem was not then built on the beach of Restrello, but Vasco da Gama passed the night before his departure in prayer in a little chapel which had been erected there by Prince Henry. He embarked next morning, and the expedition sailed on Saturday, July 8, 1497; there were about 160 souls all told. Six *padraos* were taken out, to be set up on prominent headlands, but not one of them is now known to exist. The fleet was accompanied by the great navigator, Bartholomew Diaz, as far as the Cape Verde Islands. He was going out in a fast caravel, to take up his command of the new Portuguese settlement of Lamina, on the coast of Guinea.

In December the expedition reached the "Rio do Infante," the furthest point of Bartholomew Diaz on the eastern side of Africa, and entered upon new ground. There was a mutiny at this critical time. The men feared to proceed further, and wanted to return, according to Correa, who adds that Vasco da Gama put the master and pilot in irons for giving the same advice, and threw all their instruments overboard. His brother Paulo induced his crew to obey orders by argument and persuasion, and interceded for Vasco's prisoners. This mutiny is not mentioned in the "Roteiro."

The first experience of the explorers on entering the previously unknown ocean was the force of the current, so strong that they feared it might frustrate their plans, until a fresh stern wind sprang up, which enabled them to overcome it. This Agulhas current was first scientifically investigated by Major Rennell in 1777.

Vasco da Gama passed the coast, which was named by him "Natal," on Christmas Day, and was well received by the natives of Delagoa Bay. He was at Quillimane in January 1498; at Mozambique in March; and he reached Melinde on April 15. There was a terrible outbreak of scurvy off Mozambique, and again on the way home; and then it was that Paulo da Gama proved the guardian spirit of the expedition, giving up all his own private stores for the use of the sick, ministering to them, and warding off despondency by his words of encouragement and by his example.

The King of Melinde supplied the Portuguese with an Indian pilot, a native of Gujarat, and on April 24 the voyage was commenced across the Indian Ocean, from the east coast of Africa to Malabar. Before starting, Vasco da Gama, with the hearty concurrence of the King of Melinde, set up one of the *padraos*, with the escutcheon of the *Quinas* carved on one side, and a shield bearing a sphere on the other. Beneath was King Manoel's name. It was placed on a hill above the town.

A voyage of twenty-three days brought the adventurous discoverers in sight of the mountains above Malabar—an event which Camoens thus relates:

> "Pale shone the wave beneath the golden beam,
> Blue o'er the silver flood Malabria's mountains gleam;
> The sailors on the maintop's airy round
> 'Land! Land!' aloud with waving hands resound.
> Aloud the pilot of Melinda cries,
> 'Behold, O Chief, the shores of India rise!'
> Elate the joyful crew on tiptoe trod,
> And every breast with swelling raptures glowed.
> Prone on his manly knees the hero fell;
> 'Oh, bounteous Heaven!' he cries, and spreads his hands
> To bounteous Heaven, while boundless joy commands
> No further word to flow."

Then the immortal poet, in words of fire, declares how this mighty deed was done, and by what kind of men:

> "*Not* those who ever lean on ancient strain,
> Imping on noble trunk a barren chain;
> *Not* those reclining on the golden beds,
> Where Moscow's zebelin downy softness spreads;

Not with the novel viands exquisite;
Not with the languid wanton promenade;
Not with the pleasures varied infinite,
Which generous souls effeminate, degrade;
Not with the never conquer'd appetite,
By fortune pamper'd as by fortune made.
But by the doughty arm and sword that chase
Honour which man may proudly hail his own;
In weary vigil, in the steely case,
'Mid wrothsome winds and bitter billows thrown,
Suffering the frigid rigours in th' embrace
Of South, and regions lorn and lere, and lone,
Swallowing the tainted rations scanty dole,
Salted with toil of body, moil of soul.
Thus honour'd hardness shall the heart prevail,
To scoff at honours, and vile gold di-dain.
Whoso shall rule his life by reasons light,
Which feeble passion ne'er hath power to hide,
Shall rise (as rise he ought) to *honour true*.
Maugre his will that ne'er hath stooped to sue."

And thus was the Portuguese empire in India founded by two of Portugal's noblest sons, Vasco and Paulo da Gama. Time will not allow us to linger with them on the coast of Malabar. On March 20, 1499, they cleared the Cape, and returned to Lisbon on September 18. But Paulo da Gama had died at Terceira, in the Azores. Equal to Vasco in heroism and constancy, Paulo excelled him in the more Christian virtues, and was, as I have already said, the guardian spirit of the voyage. When Vasco is remembered, Paulo da Gama should never be forgotten. They are equal in merit, and both equally deserve to have their memories honoured by their country, and by the civilised world.

True to the spirit of perseverance and energy which had led the Portuguese to this crowning success, a large fleet was despatched to India in the year after the return of Vasco da Gama, and in each succeeding year. Vasco da Gama commanded the fourth voyage in 1502, and on his return he was created Count of Vidigueira. Then followed the brilliant achievements of Alfonso d'Albuquerque, who occupied Goa, Ormuz, and Malacca, and established Portuguese power in India on a solid foundation. It was to last unchallenged for eighty years, when the disaster of El Kasr-el Kebir brought on what the Portuguese called the sixty-years captivity.

For twenty years Vasco da Gama was unemployed, living at a house in Evora, the walls of which were painted with figures of Indian animals and plants, and hence the street in which it stood is still called "Rua das Casas Pintadas." Here he brought up a family of six sons; but in 1524 he was called from his retirement to rule over Portuguese India. He went out with a large fleet, surrounded by all the pomp and circumstance of a viceroy, and he died at Cochin, on the scene of his discoveries, on Christmas Day 1524, aged 55.

Vasco da Gama is described as a man of middle stature, rather stout, and of a florid complexion. The portrait, which belonged to Count Lavradio, is given by Lord Stanley of Alderley, in his translation of the account of Da Gama's voyages in the "Lendas da India," of Correa. It is a copy of the portrait in the Museu das Bellas Artes at Lisbon, a photograph from which is given in Ravenstein's "Roteiro." It represents a handsome man, aged about fifty, with a white beard and severe expression, wearing a furred robe, and the cross of the order of Christ hanging from a chain round his neck. *His crest* was a girthed doe trippant, or. *Arms*—chequy of fifteen, or and gules; two bars argent; over all an escutcheon with the *quinas* of Portugal.

Luis Camoens, the great epic poet, is said to have been born in the year that Da Gama died; and Lord Stanley says, I think truly, that the name Vasco da Gama has left in history is due largely to the great genius of Camoens "The discovery of India," says Schlegel, "the greatest event of modern times, could only be worthily celebrated by one who had himself passed a portion of his life in those regions. A warrior could only thus have written."

"At the proudest moment of that brief but glorious period of Portugal's greatness, one great national song broke forth, like the dying note of the fabled swan, a dirge for the departing hero-nation. The remembrance of her departed glory is enshrined in this immortal work, created by the divine genius of her national poet to immortalise her fame. The exquisite bloom and grace of the diction of Camoens are unparalleled among modern writers." [1]

The most learned and accomplished English traveller of modern times, the late Sir Richard Burton, devoted twenty years of his life to the study and translation of the "Lusiads of Camoens." He declared that he felt a glow of pleasure at having undertaken it—at having lived so long in contact with so noble a spirit as that of his master. He also took pride in the ambition of familiarising his fellow-countrymen with a workman and a work not readily to be rivalled in the region of literature. No single publication extant gives so full and general a portrait of Camoens, his life and his work, as that of Sir Richard Burton, and his translation is undoubtedly the most faithful and the best in our language. The Hakluyt Society, of which I have the honour to be President, has also laboured to make the achievement of Vasco da Gama better known in this country. In 1869 we brought out the "Lendas" by Gaspar Correa, translated and edited by Lord Stanley of Alderley; and this year, with a view to celebrating the present commemoration, we have published the "Roteiro" of the first voyage, which has been ably translated and edited by Mr. Ravenstein.

After the sixty years of captivity came to an end, Portugal rose like a phœnix from its ashes. The old alliance with England was renewed. It was commenced when the founder of the house of Avis, the great King Joaõ of Good Memory married that English princess, who bore him five noble sons, including Prince Henry the Navigator. Since 1640, the year of liberation, English and Portuguese have fought side by side on many a battle-field for freedom, we have formed alliances, and now our royal houses are nearly related. There are many reasons why England should feel warm sympathy for Portugal in the commemoration of the mighty deeds of her sons. The nation of heroic memories has a glorious history to be proud of; and by the commemoration of the discovery of India by Vasco da Gama, we hope that those memories will impress themselves even more strongly than ever on the minds of her sons, leading them on to an honourable and prosperous future. We wish health and happiness to his faithful Majesty, and success and prosperity to our old and tried ally, the noble Portuguese nation.

[1] Schlegel.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A proposal to establish a final honour school of agricultural science, the examination in which was to be partly of a practical character, with the condition that the candidates must have obtained honours or passed the preliminary examinations in natural science, was rejected by Congregation on Tuesday.

CAMBRIDGE.—Mr. H. Yule Oldham, of King's College, has been appointed Reader in Geography for five years from Midsummer 1898. Mr. A. C. Seward, of St. John's College, has been reappointed University Lecturer in Botany.

The grace for the recognition as a public hostel of St. Edmund's House, established as a place of general education for candidates for the Roman Catholic priesthood, has been rejected by 471 votes to 218.

MRS. ELIZABETH H. BATES, of Port Chester, N.Y., has left, by her will, property valued at 135,000 dollars to the University of Michigan.

A COURSE of six lectures on electric traction, by Prof. Schwartz and Dr. D. K. Morris, was commenced on Tuesday evening at the South-West London Polytechnic, Manresa Road, Chelsea, and will be continued on succeeding Tuesdays.

THE Town Council of the county borough of West Ham have made the following appointments on the teaching staff of the new Municipal Technical Institute: Head of the Chemical department, Dr. Harold A. Auden, of the Owens College, Manchester; Lecturer in Mechanical Engineering, Mr. John Duncan, of University College, Nottingham.

THE fifth annual report of the Technical Education Board, presented to the London County Council on Tuesday, is a document of fifty foolscap pages. It includes a general account of the work of the Board, showing the lines on which the work has been organised, and giving a survey of the provision for technical education which now exists in the metropolis. Several maps are appended at the end of the report, which give a general idea of the character and locality of the various institutions in which technical and scientific education is provided. During the year covered by the report, the Board has continued its policy of attempting primarily to coordinate and develop the provision for technical education made by the various public institutions of the metropolis. In the secondary schools the Board's regulations have lead to a great increase in the number of teachers of science and of domestic economy, while facilities for teaching practical chemistry and practical physics have been provided in the majority of boys' schools, some of which possess first-class physical laboratories and workshops. At the same time, the School Board has done much to equip its upper standard schools with laboratories and appliances for the practical teaching of science. To the polytechnics and the established schools of art, and to many secondary schools, the Board has made annual or maintenance grants. Provision has also been made in two polytechnics for courses of practical work for elementary teachers, and special classes of somewhat similar type have been provided at the cost of the Board in connection with University College, King's College, and Bedford College. Day classes in particular branches of science and technology are, in addition, conducted at some of the polytechnics. The Board contemplates making provision for developing commercial education, and is considering how to advance the interests of electro-chemistry, electro-metallurgy, and other subjects. The "Monotechnic" schools for particular subjects are also engaging its serious attention. When the Board commenced its work in 1893, there were only six polytechnics at work in London; there are now eleven. Last year the Board contributed a sum of 28,129*l.* to these institutions. During the year a total of 117,744*l.* 12*s.* 11*d.* was expended by the Board, leaving a balance in hand of 41,144*l.* 14*s.* The aggregate expenditure and liabilities for the year ended March 31, 1898, may be stated in round figures to be 150,000*l.*, but this amount cannot be precisely estimated until all the claims for attendance grants are received. The Board estimates that during the year 1898-99 170,000*l.* will be required for the Council to meet the increased expenditure (possibly amounting to 184,175*l.*) necessitated by the development of the work of the Board.

The Chancellor, Lord Herschell, presided over the annual celebration of the University of London, at the presentation of degrees last week. After congratulating the winners of distinctions he referred to the University of London Bill in the following words:—They were all aware that the Government had introduced a Bill which was to effect a reorganisation of the University, and that Bill had already passed one of the Houses of Parliament. The Government had announced their intention to bring the subject to a discussion and, if possible, to a solution in the House of Commons. On this question there were certain facts which were beyond dispute which it was necessary that they should take into account in estimating the situation as it stood to-day. In the first place there was a very strong public opinion—he might say conviction—that the University work of London needed some fresh organisation. There was also, he believed, a preponderating public opinion that those needs should be supplied, not by the creation side by side of the existing University of another University in London, but by the organisation of that existing University. But when they got beyond this they came no doubt into the region of controversy. There was, however, a further proposition about which they might be quite agreed, and that was this. If there was some further University provision to be made in London, and if it was to be accomplished by the reorganisation of the University of London, it would be utterly impossible to frame any scheme or to produce any solution of the question which would satisfy everybody. There were two points on which there seemed to be some misapprehension. He referred first to the position taken by some that the existing charter gave to the graduates a right which would be infringed if any measure were passed dealing with the University or its reorganisation except with their sanction and consent. That view he held to be quite erroneous. It was quite true that in the existing charter a provision was to be found that no new charter could be applied for by the Senate if Convocation vetoed the proceedings. It was, however, to be observed that the right was given by the charter to Convocation and not to the graduates otherwise than by or through Convocation. The Senate remained the executive of the University, and it was from the Senate that the petition for a new charter must come. Thus it was merely a domestic provision regulating the rights of the Senate and Convocation as between themselves. But since the charter was granted a most important change had taken place. Parliament was not content that the Government of the day should have power to advise Her Majesty to grant a charter to a new University or a new charter to the old University, and consequently every new charter had to be placed upon the table of Parliament; and Parliament had a distinct right of intervention with reference to the grant or refusal of a new charter. It was, therefore, a false attitude to say that the members of that University were in a position to dictate to Parliament what change should take place when it had come to the conclusion that some change was necessary in the public interest. It was Parliament alone which could finally determine such a question.

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 12.—"A Study of the Phyto-Plankton of the Atlantic." By George Murray, F.R.S., Keeper of Botany, British Museum, and V. H. Blackman, B.A., F.L.S., Hutchinson Student, St. John's College, Cambridge, and Assistant, Department of Botany, British Museum.

The authors record their observations on a year's work in collecting phyto-plankton along a track from the Channel to Panama carried out by Captains Milner and Rudge, and also during one voyage to Brazil by Captain Tindall. They also give the results of their own observations on living material at sea. The material was obtained by the pumping method.

One of the objects of their work was to determine, if possible, the nature of the Coccospheres and Rhabdospheres. They describe the minute structure of the calcareous plates or coccoliths and rhabdoliths, and record the existence in the Coccospheres of a single central green chromatophore, separating into two on the division of the cell. They regard Coccosphæraceæ as a group of Unicellular Algæ, and they define the group, the limits of the genera and species. The Coccospheres and Rhabdospheres from the surface are compared with those of the deep-sea deposits and their identity established. They are also compared with geological coccoliths and rhabdoliths from various beds, and many objects regarded by geologists as true coccoliths and rhabdoliths are rejected. A large number of new Peridiniaceæ were discovered and are formally described and figured. No specific diagnoses of marine Peridiniaceæ have previously been published, authors of species having depended on figures, and, at most, a few words of description. It is hoped that the present systematic treatment of the subject will conduce to greater order in the group. The authors record the occurrence of all the forms in seven tabular statements, one for each collecting voyage.

Observations of the diatoms and Cyanophyceæ are also made, and are briefly treated.

A study was also made of the species of Pyrocystis, of which they describe a new one. The facts they record tend, in their opinion, to confirm the view originally expressed of it by Dr. John Murray, its describer, that it is an unicellular alga, doubts having been entertained of the accuracy of this opinion by several biologists.

Zoological Society, May 3.—Prof. Howes, F.R.S., in the chair.—Sir Harry Johnston, K.C.B., made remarks on the larger mammals of Tunisia, and selected for special mention the lion, leopard, cheetah, wild cat, Caracal lynx, hyæna, jackal, Fennec and common foxes, genet, ichneumon, porcupine, Barbary wild sheep, Addax antelope, hartebeest, and three gazelles. He mentioned the possibility of the leucoryx penetrating into Southern Tunisia, and noted the importation into Tunis from Morocco of a baboon (*Cynocephalus hamadryas?*), which was brought there by natives of Morocco. He also commented on the representations of the African elephant as a Tunisian animal in the Roman mosaics.—A communication was read from Prof. Robert Collett containing descriptions of three species of pigeons and two species of parrots from Northern Australia, of which the following were characterised as new: *Petrophassa rufipennis*, *Ptilopus* (*Leucotreron*) *alligator*, and *Psephotus dissimilis*.—A communication was read from Mr. W. T. Blanford, F.R.S., stating his reasons for regarding *Lepus oiostolus* Hodgs. and *L. pallipes* Hodgs. as identical, suggesting that the hare identified with *L. oiostolus* by Büchner was *L. hypsileius* Blanford, and showing that *Macacus rhesus villosus* True was identical with *M. assamensis* McClelland.—A communication was read from Dr. F. A. Dixey, Mr. Malcolm Burr, and the Rev. O. Pickard Cambridge, F.R.S., on the insects and arachnida collected in Socotra by Mr. E. N. Bennett, who had visited that island in 1896 and 1897 in company with the late Mr. Theodore Bent. It was pointed out that though the Socotran lepidoptera showed, as might have been expected, strongly marked African affinities, some of them, by their relation to forms belonging to West Africa and South Africa and the Mascarene group, suggested the conclusion that remains of a more primitive fauna still survived in Socotra.—A communication was read from Miss E. M. Sharpe on a collection of lepidoptera from San Domingo. This was accompanied by field-notes by the collector, Dr. Cuthbert Christy. Ninety-one species were enumerated, of which one—*Telegonus christyi*—was described as new.—A second communication from Miss Sharpe contained a list of lepidoptera lately collected by Mrs. Lort Phillips in Somaliland. Two new species of *Lycænidæ* were described, viz. *Tarucus louisæ* and *Spindacis waggæ*.

Geological Society, May 4.—W. Whitaker, F.R.S., President, in the chair.—The carboniferous limestone of the country around Llandudno, by G. H. Morton. At Llandudno the precipitous Great Orme's Head presents fine sections of the carboniferous limestone and its subdivisions referred to, and may be easily examined in a continuous series of cliffs, ridges, and quarries. The entire succession is, however, not perfect, for the highest beds of the "Upper Grey Limestone" have been denuded, and at the Little Orme's Head the subdivision is altogether absent. Copper-lodes on the Great Orme's Head appear to have been worked by the Romans, and again in recent years until abandoned fully thirty years ago. Some of the lodes are faults, but little can be ascertained about them now, and only two or three are faults with any appreciable amount of dislocation. It is to the undulation of the limestone that the ever-varying dip of the beds is attributed. Numerous fossils occur in the "Upper Grey Limestone," and a few are peculiar to the subdivision and the locality, but of these only a single specimen of each has been found.—The dolomitisation of the carboniferous limestone is remarkable, and almost peculiar to that around Llandudno, though it also occurs at Penmon in Anglesey. The "Lower Brown Limestone" has been almost entirely converted into dolomite, and portions of the overlying subdivisions. The filling of the faults has often been changed into dolomite, and the alteration of the limestone has generally been very capricious: the author's opinion being that the change took place after the dislocation of the strata in post-Triassic times.—The graptolite-fauna of the Skiddaw Slates, by Miss G. L. Elles. This paper deals, not only with the collections of the author, but with the Dover Collection and others preserved in the Woodwardian Museum, with the collections of Prof. H. A. Nicholson, Mr. Postlethwaite, and that of the Keswick Museum of Natural History. An account of the literature, both stratigraphical and palæontological, of the Skiddaw Slates is given, followed by a list of all the graptolites known from the beds. This list comprises twenty-two genera and fifty-nine species.

Entomological Society, May 4.—Mr. G. H. Verrall, Vice-President, in the chair.—Colonel Verbury exhibited a series of Diptera collected at Hyères during March and April 1898, and including *Brachypalpus valgus*, Panz., *Callicera fagesii*, Guér., and a species of *Platystoma* which appeared to be undescribed.—Mr. Barrett showed aberrant forms of British species of Lepidoptera from Gloucestershire and Warwickshire.—Mr. Waterhouse exhibited two burnished golden beetles, *Anoplognathus aureus* from Queensland, and *Plusiotis resplendens* from Panama, which he stated to be interesting examples of a similar result being attained by a process of natural selection in two species of the same family in widely separated localities. Many members of the family had a slight tendency to show metallic colours. It would be interesting to ascertain whether there were any similarity in their surroundings in the two countries which would make this golden appearance an advantage, or whether it might be considered a "warning colour." Allied species, however, appeared to be edible.—Mr. Walker exhibited specimens of the rare *Philonthus fuscus*, Grav., found in a *Cossus*-eaten poplar in Chatham Dockyard at the end of April.—Mr. R. McLachlan communicated a paper on "Neuroptera-Planipennia belonging to the families Osmylidæ, Hemerobiidæ and Chrysopidæ, taken by the Rev. A. E. Eaton in Algeria."

PARIS.

Academy of Sciences, May 9.—M. Wolf in the chair.—Method for detecting and estimating small amounts of carbon monoxide in air in presence of traces of hydrocarbons, by M. Armand Gautier. The method described in previous papers on the same subject at 60° C. (the action of carbon monoxide upon iodic anhydrides) is here further developed. It is shown that the iodine set free can be determined with great exactness by passing the gases over copper at 100° C.; the loss of weight of the iodic anhydride, and the amounts of carbon dioxide and water produced can also be accurately estimated. Test analyses of known gas mixtures containing 1 part per 1000, and 1 part per 10,000 respectively, gave very satisfactory results: samples of Paris air taken at different times gave from 0·0 to 0·9 parts CO per million, while the air of the laboratory contained as much as 12·3 parts per million.—On the losses of ammonia which accompany the manufacture of farm manure, by M. P. P. Déherain. The results of the experiments are given in the form of three rules to be followed by the farmer, the chief point being that in presence of an excess of carbonic acid the losses of ammonia are much reduced.—Researches on the progressive development of the grape, by MM. Aimé Girard and Lindet. A series of proximate analyses of the pulp, skins and stones of the grape at various stages in its development.—The modifications undergone by strips of skin in autoplastic grafting, and the conditions which favour their growth in area, by M. Ollier.—On a mode of obtaining cultures and homogeneous emulsions of the human tuberculosis bacillus in a liquid medium, and on a mobile variety of this bacillus, by M. S. Arloing. Minute details are given of the methods of preparing homogeneous liquid cultures and emulsions of the tubercle bacillus. The immobility of this bacillus is not absolutely characteristic, as has hitherto been supposed.—Simple explanation of some celestial phenomena by the kathode rays, by M. H. Deslandres. A recognition of priority of M. Goldstein in his work on kathode rays, and a discussion of the application of this to the solar chromosphere and comets.—On the magnification of the discs of the sun and moon on the horizon, by M. D. Éginitis. The observations of the author show that none of the suggestions hitherto put forward to explain the increase in size of the sun and moon when low down in the horizon are sufficient. They may contribute to the phenomenon to a small extent, but the principal cause is still unknown.—On the explicit determination of differential equations of the second order at fixed critical points, by M. Paul Painlevé.—On the general theory of the characteristics of partial differential equations, by M. E. Goursat.—On total differential equations, by M. Alf. Guldberg.—On the evaporation of iron at the ordinary temperature, by M. H. Pellat. The effect previously shown to be produced upon a sensitised plate is shown to be due to a vapour given off by the iron, and not to any radiations of the nature of uranium rays.—On the kathode rays, by M. P. Villard.—Strengthening the X-rays, by M. Virgilio Machado. The tubular portion of the bulb is wrapped round with metal foil, or with an insulated spiral of copper wire.—The effect of diffusion in developing baths, by M. Adrien Guébhard.—On the limits of inflammability of carbon monoxide, by MM. H. Le Chatelier and Boudouard. Under ordinary conditions gas mixtures containing between 16 and 75 per cent. of carbonic oxide are inflammable. The effects of the size of tube, temperature, and pressure of gas were also studied.—On a boro-carbide of beryllium, by M. P. Lebeau. The substance $C_4B_6Be_6$ is produced by heating an intimate mixture of glucina and boron in a carbon boat at the temperature of the electric furnace.—On some halogen salts of lead, by M. V. Thomas. Treatment with nitrogen peroxide distinguishes between mixtures of lead chloride and iodide, and a true chloro-iodide, only the latter giving the corresponding oxychlorides.—Note on the micro-structure of the alloys of iron and nickel, by M. F. Osmond. The study of the micro-structure of these alloys confirms the classification into three groups based upon their mechanical properties.—Thermal data relating to ethyl-malonic acid. Comparison with its isomers glutaric and methyl-succinic acids, by M. G. Massol.—Formation of furfurol by cellulose and some of its derivatives, by M. Léo Vignon.—Preliminary note on the geographical distribution and evolution of the *Peripatæ*, by M. E. L. Bouvier. The specimens studied were collected in Africa by the late M. Thollon, in whose memory the one new species is named *Peripatus Tholloni*. This species is intermediate between the American forms and those of the Cape.—On the organisation of the *Pleurotomariæ*, by MM. E. L.

Bouvier and H. Fischer.—On the structure and evolution of the protoplasm of the Mucorinaceæ, by M. L. Matruchot.—On the resistance of seeds to immersion in water, by M. Henri Coupin. Seeds differ greatly in their resistance to water, some living about the same time whether the water be renewed or not, others dying much sooner in the latter case.—Contributions to the knowledge of volcanic rocks in the French Alps, by MM. W. Kilian and P. Termier.—On a quaternary tufa recognised at Montigny, near Vernon, by M. Gustave F. Dollfus.—On the landslip of Saint-Pierre de-Livron, and the infiltration of layers of tufa, by M. E. A. Martel.—Embryological notes on the migration of spinal ganglia, by M. A. Cannieu.—Contribution to the study of the albumenoid materials contained in cereal and leguminous flours, by M. E. Fleurent.—On the periods of treatment of black rot in the south-east of France.—A local magnetic pole in Europe, note by M. Mascart. M. Leist, of Moscow, has discovered at Kotchétovka, a village in the province of Koursk, a local magnetic pole where the magnetic needle stands vertically. A distance of 20 metres from this spot suffices to change the angle of dip by 1°.—Earthquake of May 6, 1898, communicated by M. Lœwy.

ST. LOUIS.

Academy of Science, April 18.—Mr. Carl Kinsley read a paper on series dynamo electric machines. He showed, by the results of tests of machines, that the relations between electromotive force, current, and speed can be represented by a surface. This is easily done, since for widely different currents, and for both dynamos and motors, the total induced electromotive force is strictly proportional to the speed when the current is constant. He stated that Frölich's empirical equation can be used to represent large portions of this surface, as suggested by Prof. F. E. Nipher. It was stated that the way in which a series motor will operate from a series generator can be predetermined; and, for cases reported, it was shown that computed results, throughout the complete range of working conditions, gave an average agreement with observed results to within 0·05 per cent. The method explained in the paper enables an engineer to design such a power transmission circuit accurately from shop tests of the machinery, and to operate the series motor at constant speed under all loads. It was shown that the resistance of the generator does not vary with the speed. This makes it possible to use a small series generator as a speed indicator, and so obtain instantaneous values of engine speeds from the voltmeter or ammeter readings, if the resistance of the outside circuit is kept constant. The practicability of this method of determining engine speeds was fully shown by the results reported in the paper.—Prof. J. H. Kinealy made some informal remarks on the ventilation of schools, and by means of a number of stereopticon views showed the different methods adopted for supplying the air required to the different rooms of schoolhouses.

DIARY OF SOCIETIES.

THURSDAY, MAY 19.

ROYAL INSTITUTION, at 3.—Heat: Lord Rayleigh.
CHEMICAL SOCIETY, at 8.—The Action of Formaldehyde on Amines of the Naphthalene Series: G. T. Morgan.—On the Constitution of Oleic Acid and its Derivatives. Part I.: F. G. Edmed.

FRIDAY, MAY 20.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Experiences with Röntgen Apparatus in Afghanistan: Surgeon-Major Beevor.

SATURDAY, MAY 21.

ROYAL INSTITUTION, at 3.—Biology of Spring: J. Arthur Thomson.
GEOLOGISTS' ASSOCIATION (Paddington Station, G.W.R.), at 1.40.—Excursion to Penn and Coleshill. Director: W. P. D. Stebbing.
ESSEX FIELD CLUB (at Chingford), at 7.—On the Preparation of Marine Animals as Transparent Lantern Slides: Dr. H. C. Sorby, F.R.S.

MONDAY, MAY 23.

SOCIETY OF ARTS, at 8.—Electric Traction: Prof. Carus Wilson.
ROYAL GEOGRAPHICAL SOCIETY, at 3.—Anniversary Meeting.

TUESDAY, MAY 24.

SOCIETY OF ARTS, at 8.—The Goldfields of British Columbia: W. Hamilton Merritt.
LINNEAN SOCIETY, at 3.—Anniversary Meeting.
ROYAL VICTORIA HALL, at 8.30.—Wood: Prof. H. Marshall Ward, F.R.S.

THURSDAY, MAY 26.

ROYAL SOCIETY, at 4.30.
ROYAL INSTITUTION, at 3.—Heat: Lord Rayleigh.
INSTITUTION OF ELECTRICAL ENGINEERS at 8.

FRIDAY, MAY 27.

ROYAL INSTITUTION, at 9.—Sir Stamford Raffles and the Malay States: Lieut.-General the Hon. Sir Andrew Clarke.
PHYSICAL SOCIETY, at 5.—A Simple Interference Method of Reducing Prismatic Spectra: Mr. Edser and Mr. Butler.—Some further Experiments on the Circulation of the Residual Gaseous Matter in Crookes' Tubes: Campbell Swinton.

SATURDAY, MAY 28.

ROYAL INSTITUTION, at 3.—The Biology of Spring: J. Arthur Thomson.
GEOLOGISTS' ASSOCIATION (Liverpool Street Station, G.E.R.), at 11 45.—Long Excursion to Aldeburgh and Westleton. Directors: W. Whitaker, F.R.S., F. W. Harmer, and E. P. Ridley.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Praktikum der Wissenschaftlichen Photographie: Dr. C. Kaiserling (Berlin, Schmidt).—Industrial Electricity: translated and adapted from the French of H. de Graffigny, and edited by A. G. Elliott (Whittaker).—Alternating Currents of Electricity: A. Still (Whittaker).—The Angora Goat: S. C. Cronwright Schreiner (Longmans).—Scientific Method in Biology: Dr. E. Blackwell (E. Stock).—Report of Investigations on the Life History of Salmon (Glasgow).—Supplement to the Bibliography of Algeria from the Earliest Times to 1895: Sir R. L. Playfair (Murray).—The Blood: how to examine and diagnose its Diseases: Dr. A. C. Coles (Churchill).—Applied Bacteriology: T. H. Pearmain and C. G. Moor, 2nd edition (Baillière).—Elementary Conics: Dr. W. H. Besant (Bell).—Examples in Analytical Conics for Beginners: W. M. Baker (Bell).—Five Years in Siam: H. Warington Smyth, 2 Vols. (Murray).—De Danske Barkbiller: E. A. Lovendal (Kjobenhavn, Det Schubotheske Forlag).

PAMPHLETS.—West Florida and its Relation to the Historical Cartography of the United States (Baltimore).—Die Jungfraubahn Elektrischer Betrieb und Bau: C. Wüst-Kunz and L. Thormann (Zürich, Fussli).—Second Annual Report of the New York Zoological Society (New York).—London County Council: Report of the Technical Education Board for the Year 1897–98 (King). Light and Fire Making; H. C. Mercer (Philadelphia, MacCalla).—Metric Equivalents of Imperial Weights and Measures and Thermometric Equivalents (*Pharmaceutical Journal* Office).—The Adulteration of Dairy Produce: R. H. Wallace (Edinburgh, Anderson).—Krömscöp Colour Photography: F. Ives (Photochromoscope Syndicate).

SERIALS.—Engineering Magazine, May (222 Strand).—Journal of the Franklin Institute, May (Philadelphia).—American Journal of Science, May (New Haven).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1897, No. 3 (Moscou).—Notes from the Leyden Museum, January (Leiden, Brill). Psychological Review, May (Macmillan).—Papers and Proceedings of the Royal Society of Tasmania for 1897 (Hobart).

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