THURSDAY, MARCH 12, 1903.

THE UNIVERSITY IN THE MODERN STATE.[1]

II.

WHAT Germany thinks of the place of the university in a modern State can be readily gathered from the large and ever-increasing State endowments of the numerous universities in Prussia and the other constituent countries.

The university activity of Prussia itself dates from the time after Jena, 1806, when the nation was, as Sir Rowland Blennerhassett has told us, a bleeding and lacerated mass, so impoverished and shattered that there seemed to be little future before it. King Frederick William III. and his councillors, among them Wilhelm von Humboldt, founded the University of Berlin, "to supply the loss of territory by intellectual effort." Among the universal poverty, money was also found for the Universities of Koenigsberg and Breslau, and Bonn was founded in 1818. Observatories and other scientific institutions were not forgotten. As a result of this policy, carried on persistently and continuously by successive Ministers, aided by wise councillors, many of them the products of this policy, such a state of things was brought about that Palmerston, a typical English statesman, is stated by Matthew Arnold to have defined the Germany of his day as a country of "damned professors," and so well have the damned professors done their work since that not long ago M. Ferdinand Lot, one of the most distinguished educationists of France, accorded to Germany "a supremacy in science comparable to the supremacy of England at sea."

The whole history of Prussia since then constitutes indeed a magnificent object lesson on the influence of brain-power on history. There can be no question that the Prussia of to-day, the leader of a united Germany, with its armed strength both for peace and war and craving for a wider world dominion, is the direct outcome of the policy of "intellectual effort" inaugurated in 1806.

The most remarkable thing about the German universities in later years is the constant addition of new departments, added to enable them to meet and even to anticipate the demands made for laboratories in which each scientific subject, as it has been developed, can be taught on Liebig's plan, that is by experiment, observation and research.

It is in such State-aided institutions as these that the members of the German Ministry and Parliament, and the leading industrials are trained, while in our case, in consequence of the lack of funds for new buildings at Oxford and Cambridge, and, until not many years ago, the lack of other high-teaching centres, our leaders have had to be content with curricula extant before Galileo was born, the teaching being, perhaps, not so good and the desire to learn generally much less.

No one will deny that the brain-power of a nation must, in the last resort, depend upon the higher mental training obtainable in that nation. It is well, therefore, to see how we stand in this matter.

The following tables will show what the German Government is doing to provide brain-power in Germany. Those who know most about our British conditions will see how we are likely to fare in any competition with Germany in which brain-power comes in, if indeed there can be any important sphere of activity undertaken by either King, Lords or Commons in which brain-power does *not* come in.

We owe the first table giving the facts relating to the ordinary State endowments of the twenty-two German universities to the kindness of Mr. Alexander Siemens, who was good enough to obtain through official sources an extract from the "Preussische Statistik" containing an article by Dr. Petersilie. This deals with 1891–2, the last year dealt with by the statistical bureau.

TABLE I.—*Ordinary State Endowment, Year* 1891–2.

Universities.	Ordinary Total Income of Universities.	Sources of Income.					Expenditure.		
		Foundation Funds, Fees, &c.	State Funds.	Other Sources.	Percentage of		Salaries of Teaching Staff (including Lodging Allowance).	Various Personal Expenses.	Expenses Connected with Material.
					Foundation Funds.	State Funds.			
a. Prussian Universities.	£	£	£	£			£	£	£
1. Berlin	123,839	16,782	107,057	—	14	86	44,504	23,769	55,565
2. Bonn	56,467	10,661	45,806	—	19	81	24,404	8,334	23,729
3. Breslau	48,203	3,454	44,749	—	7	93	21,845	7,927	18,430
4. Göttingen	57,363	36,487	20,877	—	64	36	24,601	10,248	22,512
5. Greifswald	35,807	21,833	13,974	—	61	39	14,605	5,870	15,332
6. Halle	62,880	29,596	33,284	—	47	53	20,791	9,015	33,073
7. Kiel	37,722	9,584	28,188	—	25	75	13,471	5,682	18,618
8. Königsberg	46,405	6,475	39,930	—	14	86	17,193	7,374	21,836
9. Marburg	38,872	8,743	30,129	—	22	78	15,068	6,732	17,070
10. Munster Academy ...	12,312	4,202	8,110	—	34	66	8,000	1,737	2,574
11. Braunsberg Lyceum	2,040	1,046	994	—	51	49	1,741	82	216
Prussian Universities altogether ...	521,911	148,863	373,098	—	33	67	206,223	86,770	228,955

[1] Continued from p. 196.

TABLE I.—*Continued.*

Universities.	Ordinary Total Income of Universities.	Sources of Income.					Expenditure.		
		Foundation Funds, Fees, &c.	State Funds.	Other Sources.	Percentage of		Salaries of Teaching Staff (including Lodging Allowance).	Various Personal Expenses.	Expenses Connected with Material.
					Foundation Funds.	State Funds.			
b. Other than Prussian Universities.	£	£	£	£	£	£	£	£	£
1. Munich	45,678	13,069	32,609	—	29	71	24,669	10,981	10,028
2. Wurzburg	36,246	15,707	20,539	—	43	57	14,099	11,316	10,831
3. Erlangen	31,722	6,813	24,909	—	21	79	11,591	10,149	9,982
4. Leipzig	99,373	21,439	77,934	—	22	78	27,162	43,917	28,293
5. Tubingen	44,068	5,309	38,759	—	12	88	13,669	12,602	17,798
6. Freiburg	25,984	3,996	21,893	95	16	84	13,021	3,538	9,424
7. Heidelberg	34,949	987	33,895	67	3	97	16,569	3,541	14,839
8. Giessen	32,749	9,530	23,178	41	29	71	11,988	2,358	18,402
9. Rostock	16,614	113	16,290	211	2	98	7,722	795	8,097
10. Jena	—	—	—	—	—	—	—	—	—
11. Strassburg	49,750	3,917	45,575	257	8	92	26,300	3,611	19,838
Non-Prussian Universities altogether, excluding Jena ...	417,133	80,880	335,581	671	19	81	166,790	102,808	147,532
Prussian Universities	521,911	148,863	373,098	—	33	67	206,223	86,770	228,955
All the German Universities, excluding Jena ...	939,044	229,743	708,679	671	26	74	371,013	189,578	376,487

In the second table are given the *extraordinary* expenses incurred in the same year, also obtained from Dr. Petersilie's article. There have been added the State endowments for the years 1900–1 and 1902–3, so far as it has been possible to obtain them from "Minerva," in order that the considerable yearly increase in the endowments may be noted.

TABLE II.—*Showing Extraordinary Expenditure* 1891–2, *and Increase of Ordinary Endowment since then.*

Universities.	Ordinary State Endowment, 1891–2.	Extraordinary Expenditure Provided by the State in 1891–2.	Ordinary State Endowment, 1900–1.	Ordinary State Endowment, 1902–3.	Increase of Ordinary State Endowment in 11 years (in thousands).
a. Prussian Universities.	£	£	£	£	£
1. Berlin	107,057	61,714	130,743	142,155	35
2. Bonn	45,806	9,690	51,982	56,091	11
3. Breslau	44,749	38,900	57,435	57,435	13
4. Göttingen	20,877	6,260	27,403	30,414	10
5. Greifswald	13,974	5,762	20,490	23,925	10
6. Halle	33,284	15,919	51,666	54,419	21
7. Kiel	28,188	5,690	37,286	41,891	13
8. Königsberg	39,930	12,350	47,069	50,936	11
9. Marburg	30,129	2,660	36,255	38,931	8
10. Munster Academy	8,110	300	14,364	18,242	10
11. Braunsberg Lyceum	994	—	1,989	2,990	2
Prussian Universities; totals ...	373,098	159,245	476,682	517,429	144
b. Other than Prussian Universities.					
1. Munich	32,609	13,932	—	—	
2. Wurzburg	20,539	375	—	—	
3. Erlangen	24,909	3,766	—	—	
4. Leipzig	77,934	—	101,989	104,388	27
5. Tubingen	38,759	—	49,703	52,234	14
6. Freiburg	21,893	7,825	28,555	30,955	9
7. Heidelberg	33,895	14,771	39,125	41,225	8
8. Giessen	23,178	6,990	37,480	42,188	19
9. Rostock	16,290	—	17,812	—	
10. Jena	—	—	—	—	
11. Strassburg	45,575	12,440	49,150	49,862	4
Non-Prussian Universities; totals...	335,581	60,099	323,814	320,852	

It will be seen that those responsible for the continued well-being of the German State are as busily employed in increasing the efficiency of their universities as they are in adding to their navy.

In Britain, there is no concern shown by our Government and politicians in regard to the *real* sources of *national* brain-power, towards which primary instruction, now well endowed, is but the first step. Private endowment is still appealed to, though our present unfortunate position comes from the fact that since the necessary introduction of science into the curriculum of the higher teaching, private endowment in the past has not been, nor in the future will it be, able to supply a tithe of what is really wanted.

The State, however, while it allows the universities to remain inefficient, as if it were a matter of indifference whether we fail in brain-competition with foreign countries or not, does really concede the principle of State aid. Its present contribution to our universities and colleges amounts to 155,600*l.* a year; no capital sum, however, is taken for buildings.

This sum is made up of grants to:—

			£
(*a*)	4 universities in Scotland		72,000
	3 ,, ,, England		14,800
	1 ,, ,, Wales		4,000
(*b*)	13 colleges in England		26,000
	3 ,, ,, Wales		12,000
	3 ,, ,, Ireland—		
	Grants in aid	4,800	
	Consolidated Fund; for Salaries of Professors and Officers, and Allowances for Scholars and Prizes	21,000	
			25,800
	1 college in Scotland		1,000

The above tables show that the total sum given by the British Government for the whole of the United Kingdom is less now than the State endowment of one of the twenty-two German universities was more than ten years ago.

ASSYRIAN HISTORY.

Annals of the Kings of Assyria: the Cuneiform Texts, with Translations, Transliterations, &c., from the original documents in the British Museum. Edited by E. A. Wallis Budge, M.A., Litt.D., Keeper of the Egyptian and Assyrian Antiquities, and L. W. King, M.A., F.S.A., Assistant in the Department of Egyptian and Assyrian Antiquities. Vol. i. Pp. lxxv+391. (Printed by order of the Trustees, 1902.) Price 1*l.*

IT is an interesting fact that practically all the materials which exist for the reconstruction of the ancient history of Mesopotamia are to be found within the walls of the British Museum. Neither at Paris, nor even at Constantinople, far less at Berlin, does there exist any collection of ancient Babylonian and Assyrian records which can for a moment be compared to that of the British Museum. The researches of British archæologists have resulted in the transfer to London of the whole of the royal library of the palace of King Ashurbanipal (668-626 B.C.) at Nineveh; here the thousands of inscribed clay tablets of which it was composed have found their permanent home. It is then to London that every student must turn if he wishes to learn the story of ancient Mesopotamia. Here are preserved almost all the ancient monuments and records of those mighty monarchs of Assyria and Babylon, who lighten the background of the Biblical story with the splendour of their continual goings forth to war, and the rumour of whose glory makes so deep an impression on the history of Herodotus. The Trustees of the national Museum have now commenced to publish a national and official edition of all the most important of the Assyrian historical records preserved under their care. This edition will contain the original cuneiform texts, with their transliteration, a translation, and extremely useful footnotes and annotations below.

As yet only the first volume has appeared; if we are to judge of those that will follow from the first we may indeed congratulate the Trustees on their important publication—one of the most important, in fact, of their publications for many years past. To say that Dr. Budge, the Keeper of the Assyrian collections, and his able assistant, Mr. L. W. King (already known as an Assyrian historian since he edited "The Life and Letters of King Hammurabi of Babylon," and incidentally demolished the legend that a mention of Chedorlaomer, Tidal, and Arioch had been found on Assyrian tablets), have done their work well is unnecessary; one does not question the results arrived at by the first—almost the only—authorities on the subject. We can only wonder at the perspicacity of those pioneers of cuneiform research, Rawlinson, Hincks, Fox Talbot, George Smith (all Englishmen), and the rest, who made it possible for Dr. Budge and Mr. King to translate for us with such accuracy and *verve* the strange arrow-headed characters which march in procession along the top of each page of their monumental publication. *Verve* the translations undoubtedly have, and this energy of expression exists also in the originals whenever a triumphant war is being described.

It is in this respect that an Assyrian inscription differs greatly from an Egyptian; the Egyptian is a much calmer and quieter recital of events in poetical form, depending for much of its effect on artificial antitheses, alliterations, even on puns, and so losing energy and truth; the Assyrian is the pæan of a dervish, nothing less. Let us hear Tiglath-pileser (1100 B.C.) dancing and singing his war-song over the bodies of his victims (p. 49):—

"With the fury of my valour a second time against the land of Kummukhi I marched. All their cities I conquered; their spoil and their goods and their possessions I carried off; their cities I burned with fire, I laid waste, I destroyed. And the rest of their host, who in face of my terrible weapons were afraid and feared my mighty onslaught in battle, in order to save their lives, sought the strong heights of the mountains, a difficult region. To the heights of the lofty hills and to the tops of the steep mountains, where it was not possible for man to tread, after them I went up. War, and fighting, and battle they waged against me, but I defeated them, and the dead bodies of their warriors on the tops of the mountains like the Storm-god I cast down, and their blood in the valleys and on the high places of the mountains I caused to flow. Their spoil, their goods, and their possessions from the strong heights of the mountain I brought down. The land of Kummukhi in its length and breadth I conquered, and

I added it to the borders of my land. Tiglath-pileser, the mighty king, the snare of the disobedient, who overwhelmeth the resistance of the wicked! With the exalted might of Ashur my lord against the land of Kharia and the wide-spread troops of the Kurtê, over lofty hills which no king had ever reached, Ashur, my lord, commanded that I should march. My chariots and my host I gathered together, and between the mountains of Idni and Aia, a difficult region, I took my way. Among high mountains which were sharp as the point of a dagger, and which were impassable for my chariots, the chariots I left idle, and the steep mountains I traversed on foot. The whole of the Kurtê had assembled their wide-spread troops . . . in the mountain . . . with them I fought and I defeated them; the dead bodies of the warriors on the high places of the mountain I piled up in heaps, and the blood of their warriors in the valleys and on the heights of the mountains I caused to flow. . . . The people of the land of Adaush feared the mighty advance of my battle-array, and they deserted their territory and to the tops of the lofty mountains like birds they fled. . . . Their fighting men on the peaks of the mountain I piled up in heaps, with the blood of their warriors the mountain of Khirikha I dyed red like scarlet wool. Tiglath-pileser, the burning flame, the Terrible One, the storm of battle (am I)!" (p. 72).

Such is an Assyrian war-chronicle. Its fierce energy is no pretence. Nor can we wonder that this virile people were the masters of Western Asia in their time. This inscription dates to the dawn of their hegemony, when they were just beginning to strike the terror of them into the hearts of the kings of the earth. Most of the other inscriptions in this volume are of the same type.

"The soldiers escaped," says Ashur-nasir-pal (B.C. 885-860), "and occupied a steep mountain; the mountain was exceeding steep, and after them I did not go. The peak of the mountain rose like the point of an iron dagger, and no bird of heaven that flieth reacheth thereto. Like the nest of a vulture within the mountain was set their stronghold, into which none of the kings my fathers had penetrated. In three days the warrior overcame the mountain; his stout heart pressed on to battle; he climbed up on his feet, he cast down the mountain, he destroyed their nest, their host he shattered" (pp. 270, 271).

Always the same forcible and picturesque diction, which is well reproduced by the translator.

But the Assyrian monarch was not only a destroyer; he could build up as well as cast down.

"The palaces, the royal dwellings," says Tiglath-pileser (p. 88), "in the great cities of the provinces of my land, which from the time of my fathers during the course of many years had been deserted, and had decayed, and had fallen into ruins, I have rebuilt and restored. The walls of the cities of my land which were in ruins I have strengthened. The engines for watering the fields throughout the whole of Assyria I have repaired, and stores of grain in greater quantities than those of my fathers I have increased and heaped up. . . . Cedars and urkarinu-trees, and allakanish-trees, in the countries which I have conquered, such trees the like of which among the kings my fathers of old time none had ever planted, I took, and in the gardens of my land I have planted them. And rare garden-fruits, which were not found within my land, I took, and in the gardens of Assyria I have caused them to flourish. Chariots and teams of horses, that my land might be strong, more than formerly, I have increased and I have strengthened. Unto the land of Assyria I have added land and unto her peoples, peoples."

These extracts will serve to give some idea of the extremely interesting character of these "Annals of the Kings of Assyria." The present volume contains inscriptions dating from the early period to the reign of Ashur-nasir-pal (B.C 885-860). It is evident that many more volumes of the same size and scope as that which lies before us will have to be published before the editors come to the end of the rich material which lies ready to their hand. For Assyrian history covers another two centuries and a half, occupied by a continuous record of wars, conquests, city and palace building, &c., often containing information of the greatest possible use to the historian.

Isolated matters of interest often crop up in the course of the narrative. Thus we read that Tiglath-pileser I., one of the first of Assyrian kings to reach the Mediterranean, went for a pleasure trip in a Phœnician ship from Arvad, and slew a mighty dolphin in the course of his sail. To the same king the contemporary monarch of Egypt, who must have been one of the immediate successors of Rameses III., of the twentieth dynasty, sent a crocodile as a present, and also a great *pagutu*, whatever that may have been; perhaps it was a hippopotamus. We may wonder what condition the unlucky animals were in by the time they reached Assyria! They were evidently regarded as very remarkable creatures, as we can see from the care with which their arrival is recorded.

The sketch of Assyrian history which precedes the texts is extremely well written, and gives the reader a very good idea of the rise of the famous kingdom on the Tigris.

In conclusion, we must again congratulate the Trustees of the British Museum on their decision to undertake the publication of these important national treasures, and the editors, also, on the excellence of their work.

TRUSTWORTHY REAGENTS.

The Testing of Chemical Reagents for Purity. By Dr. C. Krauch. Third Edition. Authorised translation by J. A. Williamson, F.C.S., and L. W. Dupré. Pp. 350. (London: Maclaren and Sons, n.d.) Price 12*s*. 6*d*. net.

CAVEAT EMPTOR is a good maxim, if a somewhat hackneyed quotation. The principle it embodies need not be disregarded, even by the chemist. True, he is a protector of the purchasing public in certain cases where that public cannot take care of itself; but this does not absolve him from the necessity of keeping a watchful eye upon his own purchases. On the contrary, the very fact that he may be called upon, for instance, to certify to the purity of other people's food makes it all the more incumbent upon him to look well after the purity of his own reagents. It may happen—and it has happened—that through insufficient attention to the quality of his chemicals, an analyst may introduce into some article the very impurity which he is required to search for, or an investigator in pure chemistry may be led to propound some brilliant theory which more circumspect working presently renders untenable. As examples in point, one need only recall the testing of foodstuffs for arsenic, and the alleged conversion of this element into antimony. Wherefore, when the chemist buys his chemicals let him remember the legal tag above quoted, and not trust too implicitly to the manufacturer who supplies them.

The book before us will help to minimise the labour involved in satisfying oneself on this matter. It deals with some hundreds of reagents used by the chemist, and with a few of those generally employed by the microscopist. As regards its plan, the substances are arranged in alphabetical order, beginning with "acetic acid" and ending with "zinc sulphate." Under each heading are described, very briefly, a few of the more prominent characters of the reagent, such as its formula, molecular weight, boiling point, specific gravity, or crystalline form. Then follow, as a rule, a number of "tests for impurities," in which are indicated the probable foreign substances to be met with in the article under examination, and the characteristic methods of detecting them. A paragraph or two dealing with the "quantitative estimation" of the reagent is added in those cases where the addition is applicable. Following this come notes upon "uses" or "uses and storage," in which mention is made of the purpose for which the reagent is generally required, and hints given as to how it should be kept—*e.g.* whether protected from light, in a cool place, under oil, and so on. Finally the "commercial varieties" of the substance are shortly indicated.

On account of the number of articles dealt with, the information afforded is necessarily for the most part very brief, and is always concisely put. Fairly full descriptions, however, are given in the case of some of the more important reagents: thus ten pages are devoted to alcohols, six to ether, and eight to hydrochloric acid; whilst tables of the strengths corresponding to various values of specific gravity are appended to the sections dealing with such reagents as acetic acid, ammonia, alcohol, and the mineral acids. References, and useful ones, are frequently given to literature in which further information is to be found; and in place of the original German sources the translators have very considerately indicated abstracts and papers to be found in English journals and text-books.

All the ordinary reagents are described, and also a number of those less frequently used. As regards the inclusion of the latter, the present writer has tested the volume in respect of a few of the less common reagents, such as the persulphates, iodeosin, and nitroso-β-naphthol (which latter, by the way, can be recommended for the separation of cobalt from nickel), and finds them duly mentioned except in the case of the persulphate.

The book is hardly one which calls for much criticism. The value of such a work consists in its bringing conveniently together the chief data pertaining to the various substances, so far as they are criteria of purity. If a good selection is made, and if the information is accurate, the book saves labour and fulfils its purpose. Judged by this standard the volume can be unreservedly commended.

C. SIMMONDS.

OUR BOOK SHELF.

Text-book of Electrochemistry. By Svante Arrhenius. Translated by John McCrae. Pp. xi + 344. (London: Longmans and Co., 1902.) Price 9*s.* 6*d.* net.

THIS work, by the chief founder of modern electrochemical theory, is worthy of a hearty welcome in its English form. It is distinguished from other works on the same subject by being at once more thorough and more simple, the difference being specially apparent in the chapters dealing with potential and electromotive force. Too often the treatment of this branch of the subject leaves the impression (on the student of chemistry at least) that a simple and important result is arrived at from no premisses in particular by some unconvincing mathematical hocus-pocus, wholly devoid of concrete meaning. Prof. Arrhenius is necessarily somewhat mathematical, but the physical significance of each step is so carefully explained that no attentive student of physics or chemistry, with the most rudimentary knowledge of the calculus, can fail to gain a clear idea of the process of reasoning, and, if need be, to reproduce it with understanding. Whilst we have this very desirable treatment of theoretical matters, the practical side of the subject is no less satisfactorily dealt with. In small compass, an immense amount of well-selected and clearly-put information is conveyed; for example, in the two pages which are devoted to the electric arc, the essential features of the phenomenon are given with a precision and conciseness infrequent in physical text-books. The chapter on electroanalysis affords a similar instance of happy exposition. Throughout the book, and especially where matters of recent controversy are under discussion, there is manifested a temperateness of language and sobriety of judgment which cannot be too highly commended.

The first two chapters of the volume give an account of fundamental physical and chemical conceptions, and of the older electrochemical theories. The next five chapters are chiefly concerned with osmotic pressure and the thermodynamical deductions from it, the general conditions of equilibrium, and the velocity of chemical actions. Chapters viii.-xii. are devoted to electrolytic dissociation and the deductions to be drawn from that theory. In chapters xiii.-xv., electromotive force is dealt with; and in the last two chapters are taken up the practical subjects of electroanalysis and the development of heat by the electric current.

The present translation has been made from the German edition, which is a somewhat expanded form of the Swedish original. The English version is well done, and we have to thank Dr. McCrae in addition for an excellent index and a very useful appendix of references.

J. W.

A Manual of Indian Timbers. By T. S. Gamble, M.A., C.I.E., F.R.S., F.L.S. Pp. xxiii + 856; illustrated by photographs of wood sections. New (second) and revised edition. (London: Sampson Low, Marston and Co., Ltd., 1902.)

THE first edition of this important work appeared in 1881, giving the results of investigations made by Sir Dietrich Brandis and his assistants, Messrs. Gamble and Smythies. It was edited by Mr. Gamble, and it contained descriptions of 906 species of Indian timbers. The new edition has been entirely prepared by Mr. Gamble; it deals with about 1450 species, including all, or nearly all, really important timber-woods. The total number of species of trees, shrubs and climbers found in India and Ceylon is estimated to amount to about 5000, so that there is room for further extension should hereafter a third edition become necessary.

The book is a very storehouse of information, and this will be realised if we state that for every important, and most other, species the information extends to :—

(1) Size and appearance of tree ; whether evergreen or deciduous ; mode of branching.

(2) Description of bark.

(3) Description of wood, both sapwood and heartwood, with its colour, hardness, grain, scent, the character of the annual rings, pores, medullary rays, &c.

(4) Distribution, rate of growth, &c., of the trees.

(5) Weight per cubic foot of timber; transverse strength.

(6) Sylvicultural aspect of the species.

(7) Insects injurious to the tree; and other points of interest.

An admirable addition in this new edition are 96 photographs (enlarged 3½ times) of timbers ; these were prepared at the forest branch of Coopers Hill College from a large collection of negatives, started by Mr. C. A. Barber, now Superintendent of Botanical Survey, South India, when instructor in botany at the college.

Space is not available to enter upon a detailed account of the contents of this monumental book, but attention may be drawn to what, in our opinion, constitutes one or two shortcomings. India has been divided into eight regions for the purpose of indicating the main classes of forest growth, but, unfortunately, the author decided not to give a map showing these, because he thinks a map, to be of any real use, would have to be of a rather unwieldy size and would be difficult to insert. With this view we disagree. Considering that India comprises an area of about 1½ million square miles, a map indicating the above-mentioned eight regions would have been exceedingly useful. On this map, the exceedingly varying rainfall, which practically governs the distribution of the forests, might have been shown in a summary manner, or it might have been given on a separate map. The size of these maps need not have been larger than that of a double page, and they could have been inserted with the greatest ease. Nor does the binding seem to us sufficiently strong in the case of a book of nearly 900 pages, which will be taken about in camp by those who are most in need of the information given in it.

Apart from these minor matters, we may confidently say that the book is of immense importance in the economic development of the resources of the Indian forests, and it should be, as the old edition has been, the constant companion of every Indian forest officer, and of others who take an interest in the subject.

We heartily congratulate the author on the successful completion of this new edition.

Phyllobiologie, nebst Übersicht der biologischen Blatttypen von ein und sechzig Siphonogamenfamilien. Von Prof. Dr. A. Hansgirg. Pp. xiv+486; mit 40 Abbild. im Text. (Leipzig: Gebr. Borntraeger, 1903.) Price 10 marks.

PROF. HANSGIRG has written a big book that may have its use as a work of reference, but it certainly cannot be described as possessing an interest commensurate with its bulk. Long periods often extend over more than half a page, and are quite unbroken save for the commas delimiting the innumerable subordinate clauses that serve to qualify or define the main idea. An effort is made to classify the various kinds of leaves into different biological groups, and then the various types of leaves met with in different natural orders are successively indicated. As an example of the method, the case of the ericoid leaf-form may be cited. The type is briefly described, and then follows a *list* of plants, extending over eight pages, that are grouped under it.

In the concluding chapters a short summary of the main results is given, and their general bearing upon variation and evolution is briefly discussed. It is pointed out that closely related species often are found to possess very different kinds of leaves, and this fact is related to the combined interaction of the environment and the inherent constitution of the organism. The author seems to suggest that it may be possible to construct a sort of phylogeny of these adaptations, and so to refer them back to a primitive leaf-form. But it may be doubted whether such speculation can really advance matters very much. We know too little of the former climates and of the extent of adaptive variation these were able to evoke, and the more profitable line of inquiry would seem to be that which is directed towards an experimental treatment of plants at the present day. This line of investigation has already proved itself to be fruitful, and there is reason to think that it is by no means as yet worked out.

The Lepidoptera of the British Islands. A Descriptive Account of the Families, Genera, and Species Indigenous to Great Britain and Ireland, their Preparatory States, Habits, and Localities. By Charles G. Barrett, F.E.S. Vol. viii. Heterocera, Geometrina. Pp. 431. (London: Lovell Reeve and Co., Ltd., 1902.)

THE eighth volume of Mr. Barrett's great work on the British Lepidoptera deals with upwards of 120 species, referred to the families Acidaliidæ and Larentidæ, the latter being extended to include the genus Eubolia and its allies, sometimes treated as a distinct family. Consequently, this volume is devoted to the interesting groups of slender-bodied, broad-winged moths known as "Waves," from their white or yellow wings, crossed by waved dark lines; and "Carpets," from their intricate and festooned patterns. The great genus Eupithecia, which includes the smaller and darker moths called "Pugs" by collectors, which belongs, like the "Carpets," to the Larentidæ, stands over until the next volume.

The scope of Mr. Barrett's work is indicated by the title-page, and the workmanship, of which we have spoken fully in our notices of previous volumes, remains on the same level of uniform excellence. The present range of each species is given very fully, and this, though a subordinate point, is very useful, not at the present moment, but as supplying accurate data for a future comparison of the range of the same species in the British Islands at different periods. The works of Stephens, Stainton, Meyrick, Barrett, and of subsequent writers will enable this to be done with approximate accuracy whenever it seems desirable to make such a comparison, which will be more useful, perhaps, in the case of moths than butterflies, for the history of British butterflies, unfortunately, is one of increasing restriction of range and increasing rarity, ending, but too often, in utter extinction. Nevertheless, in the "Additions and Corrections" (p. 428), we read of the capture of a specimen of *Polyommatus Dorylas*, Hübn., near Dover, in 1902, a butterfly which, though figured as British by Lewin a century ago, has never been formally admitted into our lists, single specimens only being met with on the south coast of England, at intervals of many years.

We should mention that there is a large-paper edition of this work, illustrated by good coloured plates of all the species in their various stages; but at the moment of writing this is not before us.

The Design of Simple Roof Trusses in Wood and Steel. By M. A. Howe, C.E. Pp. viii + 129. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1902.) Price 2.00 dollars.

THIS little book is intended to serve the purposes of students in mechanical and electrical engineering, who desire to have some knowledge of the methods of design adopted in civil engineering, and hence the examples chosen are two very simple forms of roof trusses.

The first two chapters give a brief outline of the general principles on which are based the graphical determination of the stresses in the various parts of a roof truss; then follows a carefully written chapter on the strength of the various materials used in roof work in tension, compression, cross-bending and shear. The author then works out in complete detail the design of a 60-feet-span wooden roof truss, and of a 60-feet-span steel roof truss—one particularly good feature of this part of the book is the extreme care which has been shown in the explanation of the design of the various joints needed in such roof trusses.

There are three well-drawn plates to illustrate these two roofs and a series of seventeen tables, including a most useful set giving moments of inertia, radii of gyration, &c., for various rolled sections commonly used in the struts of roof trusses.

We can recommend the book as one likely to be of much use to both teacher and student in classes for the study of civil engineering design.

Stereotomy. By A. W. French, C.E., and H. C. Ives, C.E. Pp. iv + 115. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1902.) Price 10*s*. 6*d*.

THIS is another text-book for the student in civil engineering, and treats of masonry work, mainly in arches and domes.

The two first chapters give a brief account of the various stones used for building purposes, and their physical characteristics, and of the tools used in quarrying and cutting the blocks into their finished forms. The third chapter treats of plane-sided structures, such as bridge piers and abutments, with several practical examples illustrated by plates. Chapter iv. deals with structures containing developable surfaces, and includes a detailed treatment of the masonry arch; the geometry of the arch is explained, and the preparation of the working drawings for use by the stone mason, and also the methods employed in dressing the stones. The oblique or skew arch, difficult both in its geometry and in its constructional details, is worked out in a separate chapter, with several fine illustrative plates.

As the twenty-two plates which illustrate the text are drawn from actual masonry structures, such as the Worcester City Hall, the Trenton railway bridge, &c., they will prove extremely useful to the student, more especially as there are few recent text-books which deal at all fully with this branch of the art of the civil engineer.

Round the Horn before the Mast. By A. Basil Lubbock. Pp. x + 375. (London: John Murray, 1902.) Price 8*s*. net.

THESE experiences of a public school man, who at San Francisco turned himself into an ordinary seaman and "signed on for two pounds a month for a passage round the Horn, calling at Queenstown for orders, either for the British Isles or Continent," will interest most boys. Probably few adult readers will get to the end of the volume, but Mr. Lubbock can congratulate himself that most boys will read all he has written and pronounce it "good."

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.*]

Radio-activity of Ordinary Materials.

I SHOULD like to say a few words in answer to Prof. Armstrong's letter, in which he suggests that the effects observed by Prof. McClennam and myself are not due to radio-activity, but to chemical changes at the surface of the substances experimented upon. In speaking of the radio-activity of ordinary materials, I mean that they show effects differing only in degree from those exhibited by uranium and radium. These effects, as observed experimentally, are as follows:—

(1) There is a leakage of electricity from a charged body in the neighbourhood. This leakage is proportional to the E.M.F. for small E.M.F.'s, but for large ones independent of it.

(2) The effect varies with the pressure of the air, being for small pressures proportional to the pressure, and for large pressures independent of it, when the E.M.F. is sufficient.

(3) The rate of leak is the same for positive electricity as for negative.

(4) The rate of leak does not depend on the temperature.

(5) When other gases are substituted for air, the leak is nearly proportional to the density of the gas, except in the case of hydrogen, which gives about one-eighth the effect that air does.

In every one of these points there is exact agreement of behaviour between uranium and the ordinary materials. On the other hand, I am not aware that any difference has been brought to light, except as to the magnitude of the effects. Until such a difference should appear, I think we may fairly, and without dogmatism, apply the maxim that similar effects are due to similar causes. In other words, we may conclude that the other substances, like uranium, are radio-active. R. J. STRUTT.

A Case of Pseudo-mimicry.

IN Campbell Island, south of New Zealand, the breeze-fly (*Helophilus campbellicus*), one of the Syrphidæ, so closely resembles a blow-fly (*Calliphora eudypti*) that when, in 1901, I captured a specimen of the first, which is rare, I thought it was the blow-fly, which is common; and it was not until I was transferring my captures to boxes that I found out my mistake.

C. eudypti has the abdomen metallic bronzy green, with a dark thorax, and black and tawny legs. *H. campbellicus* has also a metallic bronzy green abdomen, a dark thorax, and black and tawny legs. There is a difference in the stripes on the thorax, but they are obscure. In size the two insects are the same.

Now in any other locality this resemblance could be put down to mimicry. The blow-fly is common and offensive. The breeze-fly is rare and feeds on flowers. Everything favours this explanation except that in Campbell Island there are no insect-eating birds and no lizards, and consequently mimicry would be useless. Evidently, in this case, the resemblance is only a coincidence and has no meaning.

F. W. HUTTON.

Museum, Christchurch, N.Z., January.

ACCIDENTAL resemblances between insects are to be expected. The immense number of species and the necessary limitation in the variety of colours and patterns must lead to coincidences, as, I believe, was first pointed out by Mr. F. E. Beddard in his book on "Animal Coloration." The coincidences would, of course, be relatively more numerous when the patterns are simple. Accidental resemblances being independent of locality and of an origin based upon utility, it follows that *a very small proportion* of the total number of cases are to be expected to occur under conditions which are the characteristic concomitants of true mimetic resemblance.

With regard to Captain Hutton's special instance, however, there appear to be certain points which require consideration before accepting the conclusion that the resemblance is merely a coincidence :—(1) The possible coexistence of the two species in other localities where the resemblance has a meaning; (2) the possible change of conditions in the struggle for life in the locality itself; (3) our possibly imperfect knowledge of the struggle which is waged there now. Furthermore, a careful comparison between both forms and their respective allies—a comparison which takes account of geographical distribution as well as of superficial appearance—would certainly throw light upon the origin of their present appearance, and probably upon the meaning of the likeness which they bear to each other.

When questions such as these have been answered so as to leave no doubt about the accidental nature of the resemblance, it will be necessary to ascertain whether the "offensive" qualities of the blow-fly are any defence against insect-eating animals. If they are not, the resemblance would still lack an essential characteristic of true mimetic likeness. E. B. POULTON.

Oxford, March 6.

Area of Triangle in Terms of Sides.

As the changes which are being introduced, in accordance with Prof. Perry's suggestions, into geometrical teaching are giving a stimulus to the production of text-books of practical geometry and mensuration, the present is a good time to point out a more direct proof of the formula for the area of a triangle in terms of its sides than that usually given.

From the centres of the inscribed and one escribed circle, drop perpendiculars on the sides or their productions. Also join these centres to the corners A, B, C.

We have then, by similar triangles,

$$\frac{s-c}{r_a}=\frac{r}{s-b}, \text{ whence } rr_a=(s-b)(s-c).$$

The area of the triangle ABC is equal to rs, and also to $r_a(s-a)$; and therefore to $\sqrt{\{rr_a s(s-a)\}}$ that is to

$$\sqrt{\{s(s-a)(s-b)(s-c)\}}.$$

11 Leopold Road, Ealing. J. D. EVERETT.

LEONARDO DA VINCI AS A HYDRAULIC ENGINEER.

IN the December number of the *Bulletin* of the French Society for the Encouragement of National Industry[1] is an article by M. M. A. Ronna on Leonardo da Vinci, in his capacity of hydraulic engineer; with extracts from his works and several reproductions of sketches of the numerous mechanical contrivances he invented for saving labour, for measuring the discharge of water, for lock gates and other hydraulic appliances.

Leonardo da Vinci, who was born in Italy in 1452, has generally been recognised as one of the most illustrious painters of the world, being classed as an artist with Raphael and Michael Angelo. His most celebrated work was the fresco representing the Last Supper, which was painted in his middle life. He was also the author of a treatise on painting, which was published in several different languages. His gifts as sculptor, musician and poet are less known; and it may be a surprise to many to be told that Leonardo da Vinci was by profession an engineer, engaged principally in designing and carrying out works for the construction of canals, the drainage and reclamation of marshes, and similar work in Italy; and in his later life in France, to which country he was invited by Francis I. to advise as to hydraulic works there. He held the appointment of engineer and director of works in Lombardy and Tuscany, and also acted as chief engineer in the army of the Pope. In addition to his executive work, he thoroughly investigated the laws relating to the movement of water and hydraulics generally, and anticipated many of the theories for which credit is

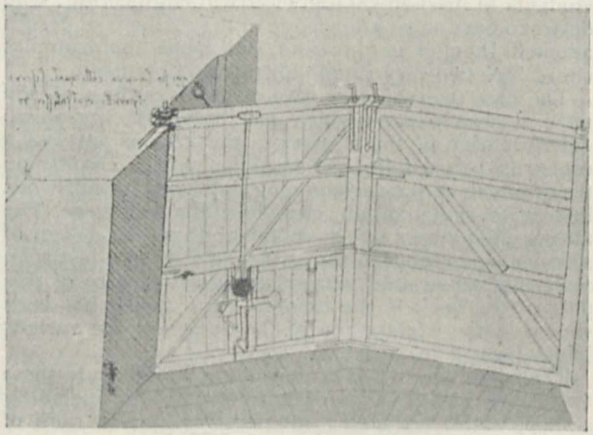

FIG. 1.

generally given to men of science who lived very many years later. He appears to have grasped a knowledge of the action of gravity more especially in its relation to the movement of liquids, and states his inability

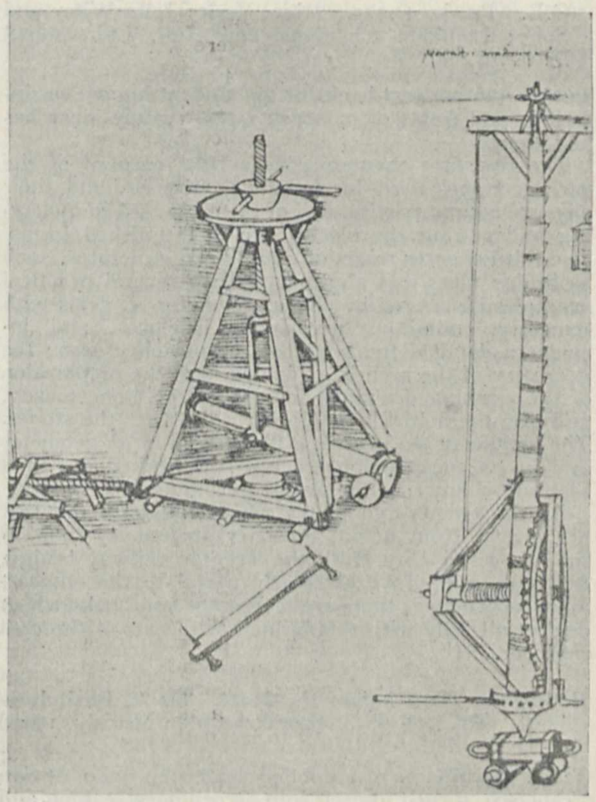

FIG. 2.

to furnish to the human mind a scientific proof of its existence, as he considered that, in common with magnetism and other phenomena, it was one of the secrets of Nature. Hallam, in his introduction to the

[1] *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, December, 1902. (Paris: Published by the Society.)

"Literature of Europe," referring to Leonardo, says the discoveries which made the names of Galileo, Kepler, Castelli and others famous, the system of Copernicus, the very theories of recent geologists, were anticipated by da Vinci within the compass of a few pages, not perhaps in the most precise language, or in the most conclusive reasoning, but so as to strike in with something like the awe of preternatural knowledge.

Leonardo da Vinci in his writings deals with and explains the formation of rain drops, the capillary action of liquids, the equal pressure of water in closed vessels, anticipating the application of this principle as carried out nearly three centuries later by Bramah in his hydraulic press. The theory of the motion of waves in water is fully dealt with. The illustration he gives of a field of corn under the influence of the wind when a wave motion traverses the field without the stalks moving, to show the action of the water in similar circumstances, has been often used since, and was adopted by Scott Russell in his report to the British Association on waves in 1836.

Leonardo da Vinci appears to have devoted much attention to the use of mechanical appliances for saving labour in the excavation and removal of earth in the various canals that he was engaged in constructing. He was the first engineer to adopt the use of weirs and locks for overcoming the varying levels of the country through which his canals were carried. A sketch of a pair of lock-gates (Fig. 1), as used on the canal from Ticino to Milan, called the "Naviglio Grande," as given in his "Codice Atlantico," is here reproduced. Gates of almost similar design may still be seen on many of the older canals of this country, where locks were not made use of until 1566. As specimens of the sketches of mechanical contrivances given in his treatise, the illustration of machinery for raising heavy weights (Fig. 2) bears a strong resemblance to appliances to be found amongst contractors' plant of the present day.

The theories set out by Leonardo da Vinci, and his laws for regulating the flow of water in open channels as derived from his own practice and observation, for ascertaining the velocity of discharge due to the balance of forces established between gravity and friction, as to the effect of the junction of two waterways, and the velocity of movement of water as affected by the form of the channel and the depth of the water, anticipated by fully a century the works of Gugliemini, of Paul Frisi and Castelli, to whom, generally, has been given the credit of first determining the problems of hydrology.

THE PHYSIOLOGICAL LABORATORY OF THE UNIVERSITY OF LONDON.

IT was the fear of some of those most interested in the renaissance of the University of London that the good effects of the transfer from Burlington House to the Imperial Institute would not become apparent until many years had elapsed. As scientific research is more and more taking its proper place as the highest duty that a university can perform, it is very gratifying to learn that the University of London has seized a favourable opportunity, and utilised its enlarged premises to this end. Even though this laudable endeavour must be at present regarded in the light of a preliminary experiment not yet included in any authorised programme, the physiological laboratory tentatively initiated by the University appears to be admirably adapted for the purposes to which it is applied, namely, for lectures on advanced physiology and for physiological research. But its chief value is as a concrete object-lesson of what the well-wishers of education in this country desire to see promoted by the University of London, and we are inclined to add, with bated breath, fed from the national exchequer. A municipal body may be expected to realise the importance of technical science, and to pay for its establishment. But it requires outlook towards a wider horizon to realise that apparently useless knowledge is in reality knowledge of which the reward is to be received by future generations.

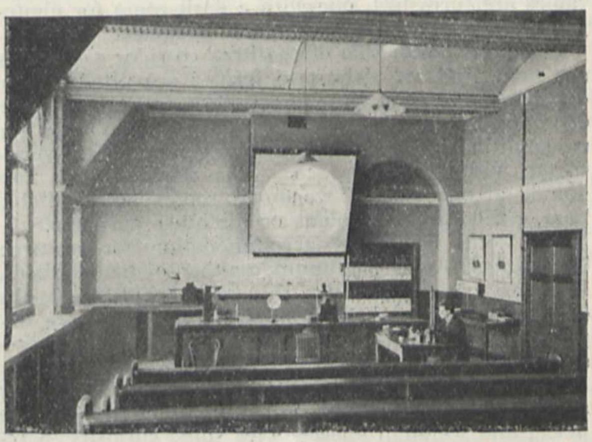

FIG. 1.—Room No. 17 (The Lecture Room).

The habitation of this infant laboratory at present comprises the top floor of one side of the main building. A long corridor extends throughout its whole length, and the various rooms open from this right and left. The first, counting from the entrance, is the workshop, where a 1 h.p. dynamo provides power for the various tools used in constructing the smaller apparatus required from time to time. Next is the lecture theatre, with seats for eighty students. Arranged for lectures in advanced physiology, this accommodation has so far proved sufficient; the average attendance has been about thirty, and as no attempt has been made to give merely popular demonstrations, and as only students are invited who already possess some knowledge of the subject, these numbers are very

FIG. 2.—Room No. 19 (General Laboratory).

encouraging. The rooms devoted to research are five in number. That next the lecture theatre, with furnaces and a fume chamber, is the chemical room, and contains in addition the apparatus used by the British Medical Chloroform Committee in its determinations. No. 19, with two dark rooms attached, is the general laboratory. This is the largest room on the landing; the centre is used for general purposes and the far end is half-shaded, and serves for galvanometers with the attendant apparatus. Two complete tables are furnished, one with a dark room for photography, and both are at present occupied.

On the opposite side of the long corridor are rooms 20A, 20B, and 21. The two former are fitted up for experiments on the circulation. No. 21 is the private room of the lecturer in charge; it is also used for research in experimental psychology; another galvanometer with resistances, &c., for the lecturer's use stands at one side. Two small rooms are available here, either as dark rooms or for other purposes.

The total laboratory accommodation for research is arranged for a maximum number of ten workers, it being considered that this was what might be reasonably expected, as quality is infinitely more important in work of this kind than quantity. The present workers are seven in number.

Several papers communicated to the Royal Society and other learned bodies testify to the activity of the place, and we shall expect, with some curiosity, a report on its first year of work. The University authorised the occupation of the laboratory in February last, and there does not appear to have been much time lost in getting to work.

PROF. WILLIAM HARKNESS.

By the lamented death of Prof. Harkness, America loses one of the most devoted of her scientific workers, and the staff of the Washington Observatory one who has laboured strenuously to bring its reputation to the high level it at present enjoys. It is true that his official connection with that institution has recently ceased, but his abiding interest in its future welfare did not end with his enforced retirement. In the few words of farewell in which he announced his approaching resignation, he still evidenced his interest in the Observatory he had served so long and so faithfully, and in a spirit of true loyalty to practical astronomical science, he indicated the direction in which he considered the equipment deficient and the lines on which further extension should proceed.

In 1862 we first find his name mentioned as an assistant, working with the mural circle and prime vertical instrument at a time when Prof. Hubbard, whose name recalls another and a different sphere of scientific activity, had the control of those instruments, and determined the direction in which they should be employed. In the following year Prof. Hubbard died, and the new assistant was elected to the professoriate, but remained in charge of the same apparatus. From this time onward, the history of Prof. Harkness is written in the *Annals* of the Observatory, and in its activity and its development he found ample occupation, as in its increasing reputation and influence he found his reward. There is no need to go over in detail the various works in which he was engaged, whether as an accurate or painstaking observer, or as one singularly capable in the management and arrangement of large pieces of laborious, and perhaps uninteresting, work. Let his work on the reduction of the observations of Gilliss' zones, or his perhaps unthankful task in reducing the observations of the transits of Venus in 1874 and 1882 speak for his patience and energy. Just as little need we refer to his various determinations of differences of longitude, or of his participation in the observations of solar eclipses and their subsequent discussion; it is sufficient to say that no astronomical inquiry, that occasionally in the course of long years falls to the lot of an observatory assistant of the highest class, passed without his contribution to its success, or his suggestion for its improvement. Finally, we find him occupying the position of astronomical director of the Observatory and superintendent of the Nautical Almanac, a twofold task which must have taxed his activity, but it cannot be said that he was found wanting in either capacity.

Perhaps he will be best remembered, as he is best known, by his work on the "Solar Parallax and its Related Constants," though we should doubt if he would consider it as his best contribution to astronomical inquiry. In it he undertook the difficult, perhaps impossible, task, to assign a relative degree of accuracy to observations differing in character, in principle and in design, and to deduce from the multifarious evidence a precise value of the solar parallax, in which each of the different processes contributes its just share to the final result. But the extent and completeness of the inquiry constitute it a valuable historical record. His theoretical writings and his mechanical ethos each call for a word of remark. As evidence of the former, we may refer to his paper on the "Colour Correction of Achromatic Telescopes," and of the latter to the share he took in the transfer of the old observatory to its new site, to his remodelling of instruments, and, in particular, to his invention of the spherometer-calliper, which, we believe, was used with success in the testing of the instruments employed in the transit of Venus expeditions. In him astronomy loses one who has spent himself without stint in her service, and his colleagues, to whom we offer our respectful sympathy, a sincere friend and an able director.

W. E. P.

NOTES.

THE council of the British Association has unanimously nominated the Right Hon. Arthur James Balfour, F.R.S., to the office of president for the Cambridge meeting in 1904. It has also been agreed to recommend to the Association the acceptance of the invitation to South Africa for the year 1905.

MAJOR P. A. MACMAHON, F.R.S., has been elected a member of the Athenæum Club under the rule which empowers the annual election by the committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE death is announced of M. Gaston Paris, distinguished by his critical contributions to philological science. M. Gaston Paris was a member of the French Academy, and head of the Collège de France.

THE death is announced of Dr. Hénocque, assistant director of the laboratory of biological physics in the Collège de France.

THE officers elected by the French Physical Society for the current year are as follows:—Vice-president, Prof. D'Arsonval; secretary, M. H. Abraham; vice-secretary, Prof. Jules Lemoine; treasurer, M. de la Touanne. The president (M. H. Poincaré) announces that the Society has received an anonymous donation of 2000 francs.

A NEW series of the *Journal des Savants* commences with the present year. It will in future be under the control of an editorial committee, consisting of a representative of the Académie Française; M. Léopold Delisle, representing the Académie des Inscriptions et Belles Lettres; M. Berthelot, representing the Académie des Sciences; M. Jules Guiffrey, representing the Académie des Beaux Arts; and M. R. Dareste, representing the Académie des Sciences Morales et Politiques. M. Henri Dehérain is secretary of the committee.

MOUNT VESUVIUS is reported to be in a state of eruption and to be ejecting scoriæ and incandescent masses which explode.

MR. T. H. HOLLAND has been appointed director of the Geological Survey of India, in succession to Mr. C. L. Griesbach, who has retired.

A SEVERE and prolonged earthquake is reported to have occurred in the island of Dominica on March 7. An earthquake shock has also been felt at Aquila, sixty miles northeast of Rome.

A REUTER'S despatch from Mexico announces another eruption of the volcano Colima on the morning of March 6, this being the most violent yet recorded. The eruption was accompanied by showers of ash, dense clouds darkened the sky, and there were deep subterranean roars. Shocks of earthquake were felt at intervals along the west coast. It is reported that ashes have fallen in great quantities at Uruapan, a hundred miles distant.

A REUTER'S message reports that earthquake shocks were felt in the Saxon district of Vogtland and the Erzgebirge on March 5 and March 6. At Graslitz, some twenty miles to the west of Karlsbad, the inhabitants left their houses and passed the night in the streets. The tremors were felt as far as Plauen, Reichenbach and Zwickau, situated within a radius of twenty-five to thirty miles to the north of Graslitz. At Unter-Sachsenberg, in the Zwickau district, the houses trembled for several seconds. Great excitement prevailed at Karlsbad and Asch, where shocks were also experienced, although they were of a less violent character.

ON March 4 Dr. M. W. Travers gave a lecture before the University College Chemical and Physical Society on "The Attainment of Low Temperatures." An account of the various methods of liquefying gases was given. The simplest case of all, where a gas such as sulphur dioxide can be liquefied by the application of pressure alone, was first experimentally shown. Those cases in which intense cold as well as pressure is needed were next considered; of the methods used in such cases the principle of adiabatic expansion as used by Olszewski to liquefy oxygen and hydrogen was explained and experimentally demonstrated. By this means, however, very little more than a mist of liquefied gas can be obtained. The regenerative cooling process first successfully applied by Hampson in England and Lindé in Germany was then described, and a brief account was given of its application to the liquefaction of hydrogen by the lecturer. Dr. Travers also described in detail his latest form of hydrogen liquefier, in which the regenerative cooling is practically perfect, and the escaping hydrogen is only one or two degrees below the air temperature. During the lecture the solidification of hydrogen was repeated, and a spectrum tube was filled with helium and neon by solidifying everything but helium and neon from a sample of air by means of liquid hydrogen.

IN December last several gentlemen engaged in various departments of scientific work in Newcastle-upon-Tyne met to consider the possibility of enabling local workers in science to meet together in a less formal manner than is possible at the ordinary meetings of the various scientific and technical societies, and resolved to establish a club "to serve as a social meeting place for men interested, professionally or otherwise, in scientific work." Such a club has now been established under the name of "The Northern Scientific Club"; a club room has been engaged, and informal meetings are held every Saturday evening. At the first annual meeting the Hon. C. A. Parsons, F.R.S., was elected president, Mr. F. T. Marshall chairman of committee, and Messrs. F. C. Garrett and T. Hanning hon. secretaries. Nothing but good can result from such a mingling of the professor and the works manager, and from the bringing into more friendly relationship men connected with different branches of science. The new club should become an important and useful institution in Newcastle.

THE Agricultural Organisation Society has arranged a conference on agricultural cooperation to be held at University College, Reading, on Saturday, March 21, under the presidency of the Lord Lieutenant of Berks, Mr. J. Herbert Benyon.

A MEETING in commemoration of the tercentenary of the reign of Queen Elizabeth will be held at the Royal Geographical Society on March 23. Addresses will be delivered by the president, Sir Clements Markham, K.C.B., Mr. Edmund Gosse (Raleigh), Mr. Julian Corbett (Drake), Prof. Silvanus P. Thompson, F.R.S. (William Gilbert and terrestrial magnetism), and others. There will also be an Elizabethan exhibition of portraits, globes, maps, atlases, instruments, navigation books and various relics.

A REUTER message from Brisbane, dated March 10, states that a disastrous storm has visited Townsville. The damage done by the storm is estimated at 200,000*l*. The town is practically wrecked.

THE Postmaster-General has appointed the following delegates to represent this country at the International Telegraph Conference to be held in London at the end of May:—Mr. J. C. Lamb, C.B., C.M.G., Mr. John Ardron, Mr. P. Benton, Mr. R. J. Mackay, and Mr. F. W. Home.

THE Post Office authorities have agreed to connect the Marconi wireless telegraph station at Poldhu, Cornwall, with the Post Office station at Falmouth. Though this will facilitate the transmission of ethergrams, it represents but a slight concession to the requirements of Mr. Marconi, inasmuch as the Marconi messages will, at Falmouth, have to take their turn with ordinary messages, which, in the case of commercial communications, might result in serious delay. The company has for some time past been urging the Department to grant it the same facilities which other cable companies enjoy—viz. that a cable may be handed in at any post office and transmitted by the Marconi system at an inclusive charge, and negotiations with this object are still proceeding.

THE use of wireless telegraphy for communication between lightships and lighthouses and the shore was referred to at the annual meeting of the Royal National Lifeboat Institution on March 5 by Lord Charles Beresford. Mr. Gerald Balfour, M.P., in his remarks upon the matter, said it naturally took time to deal with the question of the adoption of wireless telegraphy, owing to the fact of private and other interests being involved, but he assured the meeting that the question was receiving the careful attention of the Board of Trade, and he hoped it would not be long before such communication as that suggested by Lord Charles Beresford would be effected.

SPEAKING at the Chambers of Commerce conference on March 5, Mr. Marconi said wireless telegraphy had now, he thought, reached a stage in which it could be satisfactorily employed for communications between lightships, lighthouses and the shore. In England at present there is no lighthouse connected with the land by this system, but instances outside England where such communications have been established and have performed useful service can be quoted. In England the system was once tried between the East Goodwin lightship and the shore, and Mr. Marconi said he believed it was in the records of Trinity House that it worked satisfactorily. As to the cost, up to twenty or thirty miles, or even a greater distance, this would amount to from 300*l*. to 400*l*. Cables, he pointed out, cost at least 200*l*. per mile.

THE New York Central Railway has, the *Westminster Gazette* announces, made arrangements with the American Deforrest Wireless Telegraph Company to instal its apparatus on the twenty-hour express from New York to Chicago. The installation is to be complete by April 1. It will be run for two months as an experiment, and if successful the plan will be permanently adopted.

BY the joint efforts of the Middlesex Field Club and the Selborne Society, a committee has been formed with the view of organising a Home Counties Nature-Study Exhibition, to be held in London during the coming summer.

AN international exhibition is to be held at Limoges from May to September this year. The exhibits will be comprised under the heads of education, the liberal arts, general mechanics, electricity, civil engineering, agriculture, horticulture, forestry, metallurgy, social economics, hygiene, special applications of medicated alcohol to motive power, lighting and warming, and other departments.

ON Tuesday next, March 17, Sir Robert Ball will commence a course of three lectures at the Royal Institution on "Great Problems in Astronomy." The Friday evening discourse on March 20 will be delivered by Prof. E. A. Schafer, on the "Paths of Volition"; on March 27 by Prof. Herdman, on the "Pearl Fisheries of Ceylon"; and on April 3 by Lord Rayleigh, on "Drops and Surface Tension."

A LETTER received by Sir Alfred Jones, chairman of the Liverpool School of Tropical Medicine, from Prince d'Arenberg, president of the Suez Canal Company, informs him that the Campagnie du Canal de Suez is anxious to assist in the work that the Liverpool School is carrying on in West Africa, and has accordingly resolved to subscribe 50*l*. sterling to the school.

THE officials of the Sanitary Department of the Egyptian Government, into whose hands the expenditure of the recent gift of 40,000*l*. entrusted to Lord Cromer and his successors in office by Sir Ernest Cassel for the relief of ophthalmia and eye diseases has virtually passed, have decided to employ it in establishing a "travelling dispensary" in the form of a tent, to suffice for all purposes of operation and treatment, and to work solely in the provinces.

IN the House of Commons on March 4, in reply to a question as to the course the Government proposed to take on the expiration of the present Vaccination Act, and whether legislation would be proposed this Session to make revaccination generally compulsory, Mr. Balfour stated that it is proposed to renew the existing Act for this year, and to defer any further legislation on the subject to a future Session.

THE council of the Zoological Society of London has just sold to an American purchaser the Society's African elephant "Jingo," we believe on account of periodical outbreaks of temper, which rendered him dangerous and practically unmanageable. "Jingo" was purchased by the Society in July, 1882, at which date he stood 4 feet 2 inches in height and weighed 788 lb. He was then believed to be about three or four years old. At the time of his departure he was considered to be the largest elephant ever kept in captivity.

IT is reported by Reuter that at the Ministry of Foreign Affairs in St. Petersburg a Russian committee is being created for historical, archæological, linguistic and ethnographic research in Central and East Asia. The regulations applying to the committee allow all men of science without distinction of nationality to take part in the labours of the committee. The president and delegates of the foreign committee of the International Association for Research in north-east Asia will have the right to attend the sittings of the Russian committee at St. Petersburg.

THE Viceroy has decided, it is announced in the *Pioneer Mail*, to devote the donation of 20,000*l*. from Mr. Henry Phipps to two objects, a laboratory for agricultural research, to be called the Phipps Laboratory, which will probably be situated at Dehra Dun, and the provision of a second institute in the south of India similar to that at Kasauli, which has already conferred such immense benefits upon Europeans and natives alike by saving them from hydrophobia. The donation will be devoted to the requisite buildings, while the site will in both cases be provided by Government, which will also in the first case contribute to and in the second undertake the cost of maintaining the institution.

THE *Athenaeum* announces the death of Ritter von Scherzer, the Austrian explorer, who from 1852 to 1855, in company with the naturalist Moritz Wagner, carried out extensive scientific exploration in Northern and Central America. In 1857 he was appointed chief scientific adviser to the famous expedition of the *Novara*, the results of which were published in the volumes of the "Voyage of the Austrian Frigate *Novara* Round the World," which has appeared in many editions since its first issue in 1861-2, and has been translated into English.

THE following countries took part in the international balloon ascents on the morning of January 9:—France, Germany, Austria, Spain, Russia and the United States (Blue Hill). At Itteville, the new balloon station established by M. Teisserenc de Bort, twenty-five miles south of Paris, the lowest temperature, $-65^{\circ}\cdot2$ C., was at a height of 10,650 metres, temperature on the ground $5^{\circ}\cdot1$; an inversion, $9^{\circ}\cdot2$, occurred at 520 metres. At Strassburg a temperature of $-63^{\circ}\cdot1$ was registered at 10,600 metres, temperature at starting $1^{\circ}\cdot5$; inversion $9^{\circ}\cdot5$ at 500 metres. At Berlin the minimum temperature was $-50^{\circ}\cdot0$ at 11,400 metres, temperature on the ground $5^{\circ}\cdot8$, inversion $6^{\circ}\cdot3$ at 537 metres. At Vienna the readings were: on the ground $1^{\circ}\cdot0$, $-10^{\circ}\cdot0$ at 4090 metres, $-60^{\circ}\cdot0$ at 10,230 metres. Ascents in manned balloons were made at Munich, Berlin, Vienna and Guadalajara. An area of high barometric pressure lay over the south-east of the Continent; the ascents from Itteville and Strassburg appear to have been made under the influence of a depression lying to the westward.

A BLUE-BOOK has been issued containing the report of the Departmental Committee appointed to prepare a draft of the regulations to be made in pursuance of Section vii. of the Cremation Act, 1902. The objection which has always been urged against cremation is that it might render the detection of crime impossible, as all evidence is necessarily destroyed by the process. To obviate this as far as possible, it is recommended that no cremation should be allowed to take place unless the cause of death can be definitely certified by the medical attendant, who is required to fill up an exhaustive certificate, which has to be submitted to, and must be approved by, a medical referee, unless an autopsy has been performed by an expert pathologist appointed for the purpose, or an inquest has been held.

THE applications of electricity in the treatment of disease are now being carefully studied, and almost every hospital has its X-ray department. Introduced originally for diagnostic and localising purposes, Röntgen rays have been found to possess properties which may in the future revolutionise the treatment of certain diseases. Carelessly applied, the rays may set up considerable inflammation of the skin exposed to their action, while lupus and malignant growths may be considerably benefited, or even be cured, by a number of exposures to these remarkable emanations. The rays seem to possess a selective action, destroying diseased tissues and bringing about reparative action, but leaving the healthy ones untouched. In cases of cancer hopeful results have been obtained; the treatment is painless, and it seems to relieve pain and to inhibit the progress of the disease. The mode of action of Röntgen rays is doubtful; by some it is supposed to be a bactericidal one, but more probably an inflammatory reaction is set up leading to phagocytosis and leucocytosis, whereby the wandering "scavenger" cells of the body accumulate, attack and destroy the morbid tissues.

A PAMPHLET has been received urging the adoption of Mr. J. Jackson's "System of Upright Penmanship." There can be no doubt that sloped writing necessitates a strained and asymmetrical posture, and has contributed to the production of countless cases of lateral curvature of the spine and of eye-strain, while upright writing is compatible with a natural and healthy posture. This fact alone constitutes a sufficient, and, indeed, urgent, reason for the teaching in all schools of upright in place of the old-fashioned sloped writing. But it seems that some of the advocates of upright writing claim as one of its principal advantages the fact that it can be easily executed with the left hand. They propose to form an association to promote the teaching of upright writing with both hands, believing that the child taught to write equally well with both hands will easily acquire left-handed skill in all other manipulations. This belief is probably well founded, but there are at present no sufficient grounds for the assumption that a child's mental development will be aided by the training of his left equally with his right hand. The balance of probability seems to be against it. It is further proposed to teach children to write different matter simultaneously with the two hands, a feat which appears to have been accomplished in one or two instances. If this proposal should be carried into practice the results should be of great interest to psychologists, but the process may be prejudicial to the development of strong and sane personalities by the subjects of the experiment.

Two "meters" for testing the penetrating power of Röntgen ray tubes have been described by Dr. B. Walter in the *Fortschritte auf dem Gebiete der Röntgenstrahlen.*

PROF. B. SRESNEWSKY sends us some interesting geometrical constructions for the curvature of an air current in the presence of a vortex or cyclone, published in the *Bulletin* of the St. Petersburg Academy.

IN the *Transactions* of the Scotch Institution of Engineers and Shipbuilders, Mr. C. A. Matthey investigates the effect of the inertia of the connecting rod in communicating vibration to an engine, and discusses the possibility of so balancing the engine as to remove the vibration entirely.

IN connection with an epidemic disease discovered among the eels of the ponds at Orbetello, a new bacillus has been discovered by Dr. F. Inghilleri, whose investigations are published in the *Atti dei Lincei.* The disease in question is known as the "red plague," and the author considers it undesirable that eels so attacked should be used for food.

THE second part of M. Lucien Poincaré's annual review of progress in physics is contained in the *Revue générale des Sciences* for January 30. It deals with optics; magnetism and electricity; mechanics, including acoustics, elasticity and gravitation; thermodynamics, including the phase law, and low-temperature researches.

PROF. LUSSANA AND DR. CARNAZZI discuss in the *Nuovo Cimento* the effect of interposing a solid dielectric body on the length of the electric spark-discharge in air, anu in particular the remarkable fact that, by placing the body close to the anode, the length of the spark may be considerably increased.

PROFS. LUMMER AND PRINGSHEIM propose in the *Berichte* of the German Physical Society a scale of temperature based on the theory of radiation which possesses many of the advantages of the absolute scale, but has the further advantage of being better adapted to the practical measurement of high temperatures.

IN connection with the calculation of the self-induction of a ring of rectangular section, Prof. Garbasso (Turin) has communicated to the *Nuovo Cimento* a demonstration that the assumption that the current is uniformly distributed across the section of the ring leads only to an error of the order of 5 per cent.

PROF. AUGUSTO RIGHI has communicated to the Bologna Academy (1902) some researches on the acoustical phenomena presented by the discharges of condensers. The sounds were obtained when the charge took place in a vacuum tube or through a flame, and the phenomena presented several points of difference from the effects observed by Duddell in the case of the electric arc.

FROM Signor Riccò's report in the *Atti dei Lincei,* we gather that the work connected with the photographic survey of the heavens is making substantial progress at the Observatory of Catania. During the year 533 photographs have been taken, and 31,200 measurements of stars have been made on 170 plates. In addition, the catalogue of stars of reference has been continued, and a number of redeterminations have been made and referred to the year 1900.

FROM a generalisation of Carnot's cycle, Mr. Sanford A. Moss, writing in the *Physical Review*, gives a proof that in a gas engine where the working substance may be regarded as a perfect gas, the efficiency is the same as for a Carnot engine, with the same range of compression temperatures.

SOME observations on the heat produced when powders are wetted have been published in the *Atti* of the Venetian Institution by Messrs. M. Bellati and L. Finazzi. The results, so far as they concern the influence of the size of the grains, differ from those of Linebarger. The authors further find that the quantities of heat produced by the addition of equal quantities of water decrease as more water is added.

Some observations on seiches and their relation to sea waves are given by Messrs. S. Nakamura, Y. Yoshida and H. Nagaoka in No. 15 of the Tokio Physico-mathematical *Reports*. Investigations were begun in 1901 on the seiches of Lakes Biwa and Hakone, and this year the instrument—a portable tide gauge described by Mr. Nakamura—was carried to the bay of Osaka. Mr. Nagaoka finds that seiches in lakes and the destructive sea waves observed on the coast of Japan are similar from the hydrodynamical point of view, and considers that the latter waves may be predicted, resulting in saving of life.

It is proposed to publish an index volume of the three first series of the *Journal de Physique*, including an analytical subject-index and an index of authors' names. The volume will be drawn up by MM. E. Bouty and B. Brunhes, with the collaboration of MM. Bénard, Carré, Couette, Lamotte, Marchis, Maurain, Roy and Sandoz.

Prof. Ernest Lebau has published a short note on the manuscript of a course of lectures delivered at the Collège Royal by Prof. J. N. Delisle on the geometry of the celestial sphere. The manuscript, which he calls manuscript D, was obtained from a dealer in old books, and is a quarto volume of 460 pages, written neatly in the handwriting of a good copyist of the eighteenth century; and from references to the prediction of a transit of Mercury, as well as the documents of the college, its date has been fixed as 1719. It has been presented to the library of the Paris Observatory.

A very interesting essay on Mendel's law of heredity, by Mr. W. E. Castle, appears in the January issue of the *Proceedings* of the American Academy.

In *Annotationes Zool. Japonensis*, Mr. I. Ikeda records the occurrence in Japanese waters of an Australian species of the aberrant annelid-like genus Phoronis.

The feature in the *Entomologist's Monthly Magazine* for March is the record of two additions to the British fauna. The first is *Kermes quercus*, a continental scale-insect, of which colonies were taken at Wimbledon and in Sherwood Forest; while the second is the beetle *Œdemera virescens*, of which examples were obtained some years ago in Norfolk, although not at the time identified with the common continental form.

The osteology and affinities of American Cretaceous and Eocene birds are discussed by Mr. F. A. Lucas in No. 1320 of the *Proceedings* of the U.S. National Museum. Marsh's *Hesperornis gracilis* is assigned to the new genus Hargeria.

To *Naturwissenschaftliche Wochenschrift* of February 15 and 22 Herr J. Meisenheimer contributes an interesting article on the method of estimating the degree of variation occurring in the individuals of a species, and the bearing of the results thus obtained on zoology.

The scientific *Bulletin* of the Royal Belgian Academy contains the report of an address, by Prof. E. van Beneden, on the reproduction of animals and the continuity of life. In another address M. Masius discourses on immunity to infection in man and the lower animals.

Remarks on the Atlantis problem forms the title of a paper by Dr. R. F. Scharff in the *Proceedings* of the Royal Irish Academy. The author is of opinion that until the Miocene the Azores and Madeira were connected with Portugal, and that a land-bridge extended from Morocco *viâ* the Canaries to South America. Further, it is urged that the Atlantic islands were again connected with Europe and Africa after man made his appearance.

The movements and reactions of fresh-water planarians, or flat-worms, form the subject of a long article by Dr. R. Pearl, of Michigan, in the February number of the *Quarterly Journal of Microscopical Science*. These movements are, in the main, what may be termed reflex; that is to say, they are dependent upon external impulses, and are not due to anything resembling volition. In another article Miss Sollas describes a new generic type of compound ascidian, from the Malay Peninsula, under the name of *Hypurgon skeati*.

In his notes on whaling and sealing during 1902, Mr. T. Southwell (*Zoologist* for February) records the capture of twelve Greenland whales by British vessels, most of which were full-grown individuals with "bone" from 10 to 10½ feet in length. Whalebone now fetches as much as 2500*l*. per ton; the total value of the seals and whales taken by British vessels is estimated at 32,420*l*. In the same journal Mr. Frohawk adduces arguments to show that the common British bean-goose is *Anser arvensis*, and not, as generally supposed, *A. segetum*.

Two papers—one on mammals, by Mr. Miller, and the other on birds, by Mr. Richmond—in the *Proceedings* of the U.S. National Museum are devoted to specimens collected by Dr. Abbott on the coast of Sumatra and certain adjacent islets. It is considered that every distinguishable form of mammal from these islets is entitled to rank as a species—a course of procedure that will render mammaliology an almost impossible science. The most interesting mammal is a rat, referred by Mr. Miller to a new genus and species, under the name *Lenothrix canus*.

If only it be adequately carried out, an excellent scheme is announced in the February number of the *Field Naturalist's Quarterly*. This is a "symposium" in which the various members of the British fauna, commencing with the lowest, will be treated by different writers, mainly from the point of view of habits and adaptation to surroundings. The first of the series will commence in the next issue. It is perhaps not very hopeful to find, in the very next article, the marten called *Martes sylvatica*, which is certainly not its proper name.

In its report for 1902 the council of the Royal Zoological Society of Ireland has to record a most successful year, the list of donations having been probably more numerous and more valuable than on any previous occasion, and including a fine giraffe from the Sudan. The expenses connected with the carriage of the latter animal, and the outlay on the "Roberts' house" (which was opened during the year) have, however, seriously crippled the finances of the Society. Lion-breeding has, as usual, been successful, and attention is called to certain cubs of abnormal form which, it is thought, may be reversions to an extinct type. The report is illustrated with some excellent photographs.

A third edition of Mr. Andrew Pringle's "Practical Photo-Micrography" has been published by Messrs. Iliffe and Sons, Ltd., at 3*s*. 6*d*. net. The work has been largely rewritten, and important advances in photographic science and method have been utilised in the new edition.

Messrs. Macmillan and Co., Ltd., have published Mr. S. L. Loney's "Arithmetic for Schools" in two parts at 2*s*. 6*d*. each. The first part takes the subject as far as proportionate division, and includes contracted methods of multiplication and division; the second part completes the whole subject, concluding with upwards of five hundred miscellaneous examples.

AN exceptionally fine series of plates, reproduced from photographs, accompanies Dr. Tempest Anderson's paper on the recent volcanic eruptions in the West Indies, contained in the March issue of the *Geographical Journal.* The plates, together with Dr. Anderson's descriptions, constitute a concise and graphic story of the characteristics of the eruptions of Mont Pelée and the Soufrière of St. Vincent.

SEVERAL of the monthly magazines for March contain articles upon scientific subjects. Under the title "What shall we be?" Mr. Gustave Michaud discusses in the *Century* the question as to what will be the distinguishing characteristics of the coming race in America, and Prof. F. H. Giddings comments on the conclusions arrived at. Major-General Sir C. W. Wilson, K.C.B., contributes to the *Monthly Review* an account of the excavation of a Levitical city—Gezer. Dr. A. R. Wallace, F.R.S., in the *Fortnightly Review*, considers man's place in the universe as indicated by astronomy; and the general nature of his article may be gathered from a sentence near the end:—"The three startling facts—that we *are* in the centre of a cluster of suns, and that that cluster *is* situated not only precisely in the *plane* of the Galaxy, but also *centrally* in that plane—can hardly now be looked upon as chance coincidences without any significance in relation to the culminating fact that the planet so situated *has* developed humanity." Mr. W. A. Shenstone, F.R.S., writes in the *Cornhill* on the new chemistry, and Mr. Charles Richardson attempts in the *Westminster Review* to answer the question: Is natural science self-contradictory?

THE additions to the Zoological Society's Gardens during the past week include a Moustache Monkey (*Cercopithecus cephus*) from West Africa, a Crested Porcupine (*Hystrix cristata*) from South Africa, two Mexican Eared Owls (*Asio mexicanus*) from Mexico, two Westermann's Cassowaries (*Casuarius westermanni*) from New Guinea, two King Crabs (*Limulus polyphemus*) from North America, deposited.

OUR ASTRONOMICAL COLUMN.

ELEMENTS AND SEARCH-EPHEMERIS FOR COMET 1896 V (GIACOBINI).—In No. 3848 of the *Astronomische Nachrichten* Herr M. Ebell gives the following set of elements and ephemeris for this comet:—

Epoch 1896 *October* 5·5, *M.T. Berlin.*

$$M = 356^\circ\ 39'\ 7''\cdot4$$
$$\left.\begin{aligned}\omega &= 140\ 31\ 51\cdot1\\ \Omega &= 193\ 29\ 4\\ i &= 11\ 21\ 47\cdot7\end{aligned}\right\}1900\cdot0.$$
$$\mu = 533''\cdot805$$
$$\log a = 0\cdot548416$$
$$T = 1896 \text{ October } 28\cdot079$$
$$P = 6\cdot647 \text{ years.}$$

Taking the period of 6·647 years as correct, the next perihelion passage should take place on June 22 or 23, and for this time the ephemeris which accompanies the elements is calculated.

Ephemeris 12*h. M.T. Berlin.*

1903.	α. h. m. s.	δ. ° ′	log r.	log. Δ	Brightness.
March 18	20 10 50	−10 32·9	0·2492	0·3313	0·63
,, 26	20 32 46	− 8 59·0	0·2381	0·3118	0·72
April 27	22 3 40	− 1 7·0	0·1975	0·2363	1·23
May 29	23 38 44	+ 7 53·7	0·1697	0·1733	1·88

The ephemeris is extended to November 29, and it indicates that the maximum brightness (2·7) will occur on August 25.

TRANSPARENCY OF COMET 1902 *b*.—In order to test the accuracy of the assertion that comets are perfectly transparent, Prof. O. C. Wendell, of Harvard College Observatory, made a series of observations, with the polarising photometer attached to the 15-inch equatorial, of the magnitudes of two faint stars when the comet 1902 *b* was passing before one of them on October 14.

On tabulating the results of the measurements, it was found that the mean difference of the magnitude interval of the two stars under normal conditions, and when the comet was passing before one of them, was only ± 0m.·02, thereby indicating that the absorption of light by the comet, if any, was insensible, and probably did not exceed one or two hundredths of a magnitude (*Astronomische Nachrichten*, No. 3848).

FEBRUARY METEORS.—In No. 329 of the *Observatory* Mr. Denning describes a bright meteor which he observed at 9h. 46m. on February 18, the apparent path being from 35°+44° to 19°+42°.

Mr. Denning further remarks that this meteor appeared to come from a position near to the radiant point of a shower, the Aurigids, of which he has observed seven members, and of which the mean radiant point is about 75°+41°, and he suggests that this particular stream is worthy of further consideration by meteor observers in order to determine more accurately its radiant point and the time of its maximum.

The duration of the shower is at present doubtful, but it certainly extends over the period February 7-23, and there is reason to believe that it is sustained during March and April.

PROPER MOTIONS OF STARS.—Vol. xvii. No. 1 (January) of the *Astrophysical Journal* contains a discussion, by Mr. Gavin J. Burns, of the proper motions of the 2641 stars given in Bossert's catalogue, which was published in the *Annales de l'Observatoire de Paris* in 1896.

After analysing the data Mr. Burns comes to the following conclusions:—(1) The stars increase in number as they decrease in size; (2) the stars thin out as their distances from the solar system increase; and, lastly, it appears that double stars generally have large proper motions, as is shown by the following comparison:—The average proper motion of 778 stars (from the first to the fifth magnitudes) as given in Dunkin's list is 0″·15, whilst the average proper motion of 54 double stars (from first to seventh magnitudes) as obtained from Struve's catalogue is 0″·37.

OBSERVATIONS OF JUPITER'S MARKINGS.—In the February *Bulletin de la Société Astronomique de France*, Senor José Comas Sola publishes the observations of Jupiter's markings which he has made since a previous publication of results in the September *Bulletin*.

These later observations fully confirm Senor Sola's previous statement that the trails of dark spots are at a level below that of the Great Red Spot, and that they form a current which flows beneath, and independent of, that spot.

This is plainly shown in the drawings which accompany the communication, for whereas in the drawing made on September 15 the trail of dark spots is seen adjacent to, and apparently emerging from behind, the Great Red Spot, on the later drawings it is seen that the distance between the two sets of phenomena is gradually increasing. The observations also indicate that the grey markings, which have been observed in the zone between the two dark bands in the southern temperate region, are in reality trails of dark material joining together the black spots which appear on the separate bands.

SOLAR PHENOMENA AND METEOROLOGY.—M. l'Abbé Loisier, of Thoisy-la-Berchère (Gold Coast), has just completed a daily record of the solar and meteorological phenomena for the past eleven years. The record contains daily drawings of the spots and faculæ on the sun's disc, and the ordinary daily meteorological data. Recognising the intimate relations which have been shown to exist between these two sets of phenomena, M. Loisier now proposes to investigate carefully this accumulation of material with a view of obtaining evidence for, or against, the suggested inter-relations (*Bulletin de la Société Astronomique de France*, February).

THE GEOLOGICAL SURVEY OF THE UNITED STATES.

THE twenty-first annual report of the United States Geological Survey is divided into seven parts. The first and sixth parts were received some time ago and were noticed in NATURE for December 26, 1901.

PART II.—*General Geology, Economic Geology, Alaska.*

There is an elaborate report on the geology of Rico Mountains in south-west Colorado, by Messrs. Whitman Cross and A. C. Spencer. The structure is that of a dome-like uplift of sedimentary and igneous rocks, out of which a compact group of peaks, rising above 12,000 feet, have been carved. The igneous rocks appear partly in the form of laccoliths, but the elevation is not in large degree due to the intruded masses.

Devonian and Carboniferous rocks occur in the centre of the uplift, with faulted masses of Algonkian quartzites and schists. The great "Red beds" of Colorado succeed; they are partly Permo-Carboniferous, but in the upper portion Triassic fossils have been found. Jura-Trias and Cretaceous rocks also occur, and igneous intrusions are found at various horizons throughout the series. Some notable landslides are described, and it is mentioned that, in recent geological times, the central mountain region suffered severe shocks, which shattered the rocks at the surface and to unknown depths. In consequence, landslides have occurred when other conditions were favourable.

A study of the glacial sculpture of the Bighorn Mountains of Wyoming, by Mr. F. E. Matthes, leads to the consideration of cirques. It is maintained that they have not been due to scour, but rather to a natural quarrying process, essentially the product of a "bergschrund"—a crevasse or line of crevasses—which opens at a point between the moving névé and the quiescent névé, and is practically the upper limit of glacial motion. The author deals also with the effects of the occupation of valleys by névé, and introduces the term *nivation* to indicate its action as distinct from glaciation.

The Esmeralda formation in western Nevada, a freshwater-lake deposit, is described by Mr. H. W. Turner. It is of Middle Tertiary age, and contains fossil fishes and remains of ferns, fig, oak, willow, sumach, soap berry, and tree trunks 6 to 8 feet in diameter. It yields lignite, which may be of local value for stationary engines, house use, &c. The plants are described by Mr. F. H. Knowlton, and a new species of fossil fish, *Leuciscus turneri*, is named and figured by Mr. F. A. Lucas.

The origin of mineral veins at Boulder Hot Springs in Nevada is discussed by Mr. W. H. Weed. The veins have no special economic value, yielding but small quantities of gold, silver, copper, &c., but they are regarded as true mineral veins and as due to deposition from hot water. The Boulder Hot Springs are probably deep seated and connected with rhyolitic intrusions which formed the latest manifestation of volcanic activity in the region. It is believed that the gold is derived from granite into which the rhyolitic rocks were intruded.

The Eastern Choctaw coal-field is described by Messrs. J. A. Taff and G. I. Adams. It is of Upper Carboniferous age and forms part of the Indian territory, connecting the coal-fields of Arkansas with those of Kansas, Missouri and Iowa. It yields good bituminous coal. The Camden coal-field of south-western Arkansas is reported on by Mr. Taff. This is of Eocene age, and it yields a lignite which as a gas producer is said to be inferior only to the best cannel coals.

Reconnaissances in Alaska are reported on separately by Messrs. A. H. Brooks, O. Rohn and F. C. Shrader. These reports will be serviceable to future travellers and prospectors, as, in addition to geological and mineralogical notes, there are observations on the climate, timber, game, natives, &c. A useful list and explanation of Alaskan geographical names is contributed by Mr. Marcus Baker.

PART III.—*General Geology, Ore and Phosphate Deposits, Philippines.*

Mr. W. H. Hobbs contributes a memoir on the Newark (Triassic) system of the Pomperaug valley, Connecticut. The greater portions of the clastic rocks are reddish-brown sandstones and shales the constituents of which are mainly quartz, felspar and mica; they are, in fact, arkoses, composed of the débris of granite and gneiss. The associated igneous rocks are contemporaneous intrusions of lava, and attention is called to the production of secondary enlargement of quartz grains in a shale-conglomerate at its contact with an overlying sheet of basalt. The geological structure of the area is considered in detail. Vertical or nearly vertical joint-planes have developed in great numbers within the area, and an attempt is made to determine the nature of the faults along the joints and the manner in which the area as a whole has been deformed through the depression of the orographic blocks which the joints have conditioned. Compression of the area in a nearly east-west direction is believed to have found relief in the prevailing dislocations. The drainage-system of the area is finally considered, and it is found that the streams have been directed in their courses to correspond with the direction of the prevailing fault-series. The work of ice is also briefly discussed. Mr. F. H. Knowlton reports on the silicified wood from the Newark formation.

The laccoliths of the Black Hills in South Dakota and Wyoming are described by Mr. T. A. Jaggar, jun. It is shown that igneous intrusions of rhyolite and phonolite accompanied or immediately followed a great uplift in the area. This uplift arched the horizontal strata of the plains into an elongated dome, while schists beneath moved up irregularly on nearly vertical plains of schistosity. The igneous matter arose through the steeply inclined schists and spread out among the sediments which lay unconformably across the older rocks. The intrusion is regarded rather as an effect than as a cause of the great uplift. Mr. Ernest Howe describes a number of experiments undertaken to imitate the processes involved in the formation of laccoliths. These prove that low viscosity favours wide lateral extension to form sills; high viscosity produces thick lenticular bodies. Moreover, the intrusive material thickens into domes where a resistant overlying stratum locally thins. A stratigraphical obstacle may also cause a sill to thicken into a laccolith.

The iron-ore deposits of the Lake Superior region are further treated of by Mr. C. R. Van Hise. He points out that the region is the most important in the world for the production of the metal. In 1900, it yielded more iron than the maximum product of Great Britain. He, however, mentions that the exhaustion of the high-grade ores of Lake Superior within a few decades is little short of a certainty. He therefore urges that the material in which the percentage of iron is below the present market demand and which must be handled during present operations should be stock piled. The iron-bearing formations are the Archæan, Lower and Upper Huronian. The ores originated from cherty iron-bearing carbonate, and to some extent the ore bodies are due to the oxidation of the iron carbonate in place; but they are mainly to be attributed to the secondary enrichment by downward percolating waters below crests or slopes, where such waters were converged by the pitching troughs in the strata.

The Arkansas bauxite deposits are described by Mr. C. W. Hayes. At present, this mineral has been discovered in commercial quantities in only three areas in the United States. The Arkansas bauxite occurs in the Fourche Mountain district and in Bryant Township. At Bryant, it rests on kaolinised syenite and has a thickness of 10 or 15 feet, and in some places possibly 40 feet. While largely a chemical precipitate, it has some features of an ordinary detrital sediment. Some of it is pisolitic, while the whole is of this character in the Fourche Mountain district. The deposits are considered to have been due to the action of heated alkaline waters on the syenite, and to subsequent superficial chemical reactions on the deposits left by the springs.

The Tennessee white phosphate is also described by Mr. Hayes. Much of it appears to have been formed by deposition from solution in cavities of limestone.

Mr. G. F. Becher's report on the geology of the Philippine Islands has previously been noticed, a reprint in advance having been received.

PART IV.—*Hydrography.*

This volume contains an elaborate report on the progress of stream measurements for the year 1899, by Mr. F. H. Newell. There is also a preliminary description of the geology and water resources of the southern half of the Black Hills and adjoining regions in South Dakota and Wyoming, by Mr. N. H. Darton. More precise and comprehensive knowledge of the artesian waters in the Dakota sandstone and other widely distributed water-bearing rocks rendered necessary a detailed study of the area. Cambrian, Carboniferous, Jura-Trias, Cretaceous, Tertiary and Pleistocene strata are described, with especial reference to underground and surface waters, soils and mineral resources. Cretaceous coal, also gypsum, petroleum, fuller's earth in Tertiary strata, and other economic products are noted.

A report on the High Plains and their utilisation is contributed by Mr. W. D. Johnson. This region lies on the borders of Colorado, Kansas, New Mexico and Texas, and it corresponds approximately to what is sometimes called the Central Plains region. In the broad sense, it is a plain; in reality, it is a surface of degradation with topographic diversity. There is practically no drainage, the local precipitation being absorbed. The question of utilisation must depend on wells. The author deals fully with the origin and capabilities of the area, but his report has been left incomplete.

PART V.—*Forest Reserves.*

This volume, with accompanying atlas, deals exhaustively with timber regions.

PART VII.—*Texas.*

This contains an account of the geography and geology of the Black and Grand Prairies, Texas, with detailed descriptions of the Cretaceous formations and special reference to artesian waters, by Mr. R. T. Hill.

Pre-Cambrian schists, granites and crystalline limestones, and a series of Palæozoic and Permo-Triassic rocks form the floor of this region, and above are Cretaceous formations which are by far the most important in area and economic value. Their texture and stratigraphic arrangement conduce to the transmission or retention of underground waters in extensive and prolific artesian well-systems. They yield the most valuable soil, building material, cement, and some oil-fields. These Cretaceous strata are therefore described in considerable detail, and numerous plates of fossils are given. Various superficial deposits are likewise described.

We have received several series of *Bulletins* of the United States Geological Survey.

Series A. *Economic Geology.*—No. 180 is on the occurrence and distribution of corundum, by Mr. J. H. Pratt. The localities for corundum in the United States, with the exception of those in Montana, Colorado and California, are limited to the Appalachian region, and the mining has been confined to Georgia and North Carolina, and to the emery mines at Chester, Mass. The author includes, not only the ordinary translucent to opaque varieties of corundum, but also the sapphires and emery, which is a mechanical admixture of corundum, magnetite and hæmatite. He deals very fully with the uses and distribution of the minerals.

No. 182 is a report on the economic geology of the Silverton Quadrangle, Colorado, by Mr. F. L. Ransome. Gold, silver, copper and lead have been obtained, and it is probable that zinc ores may be worked. Fissures carrying variable amounts of ore occur in all the rocks of the area, from the Algonkian schists to the later monzonitic intrusions that cut the Tertiary volcanic series. By far the greater number are found in the volcanic rocks of the San Juan series (andesitic breccias) and of the Silverton series (massive andesite, rhyolitic and other breccias), both of Tertiary age. Detailed descriptions of the mines and of special areas are given, and the origin of the lodes is discussed.

No. 184, on the oil and gas fields of the Western Interior and Northern Texas Coal-measures, and of the Upper Cretaceous and Tertiary of the Western Gulf Coast, is by Mr. G. I. Adams. The shales of the Coal-measures are very bituminous and give evidence of the presence of organic matter in great abundance at the time of their deposition. The burying of this material and its subsequent decomposition gave rise to the oil and gas. The reservoirs are usually sandstones which vary in porosity, while the shales serve to seal in the oil and gas. The oil which occurs in the Cretaceous and Tertiary strata is associated with sulphur, gypsum and rock salt. Mendeléeff's theory, that petroleum is formed by the action of heated water on carbide of iron, is briefly discussed. Particulars are given of the production of oil and gas in different localities.

No. 193, geological relations and distribution of platinum and associated metals, by Mr. J. F. Kemp. This gives a general account of these metals, and of their mode of occurrence and distribution. It is concluded that platinum is very sparsely distributed in its mother rock. It has been mostly derived from peridotites, and the chances of finding it in quantities sufficient to mine are small.

No. 178 (not included in the economic series) deals with the El Paso tin deposits in Texas. The ores comprise abundant cassiterite and wolframite in a quartz gangue, and the veins exhibit characters similar to those of Cornwall.

Series E. *Chemistry and Physics.*—No. 186, on pyrite and marcasite, by Mr. H. N. Stokes. The author points out that much uncertainty exists in distinguishing these minerals by the usual methods. Specimens crystallising in the regular system are true pyrite, while those forming rhombic crystals are marcasite.

Series F. *Geography.*—Comprises Nos. 181, 185 and 194, which deal with the results of primary triangulation, of spirit levelling and observations on the north-west boundary of Texas. Nos. 183, 187, 190 and 192 are gazetteers of Porto Rico, Alaska, Texas and Cuba.

Series G. *Miscellaneous.*—Comprises No. 188, bibliography of North American geology, &c., for 1892–1900, inclusive, and No. 189, index to the same. These will prove of great value for reference. With them we may include No. 179, a bibliography and catalogue of the fossil vertebrata of North America, and No. 177, catalogue and index of the publications of the United States Geological Survey, 1880–1901.

Monograph vol. xli. of the United States Geological Survey (1902) contains an essay on the Glacial formations and drainage features of the Erie and Ohio basins, by Mr. Frank Leverett. He describes in some detail the drift deposits which extend over a large area southwards from those lake-basins to the vicinity of the Allegheny and Ohio rivers. The soils, peat-beds and weathered zones which mark intermediate stages in the glaciation; the lakes which were formed in front of the retreating ice; and, generally, the past and present systems of drainage are discussed and explained.

A separate volume on the mineral resources of the United States for the year 1900, by Mr. David T. Day, is the seventeenth annual report on this subject issued by the United States Geological Survey. It shows a continuation of the remarkable activity in the mineral industries of the country. While coal and iron are the most important products, copper, lead, gold and manganese ores show an increase, as do petroleum, natural gas, stone, clays and other materials. The production of quicksilver, antimony and nickel, of phosphate rock, bauxite and fuller's earth has decreased.

We have, further, received the fourth volume issued by the Maryland Geological Survey, a work, as usual, sumptuously printed and illustrated. Mr. Bailey Willis contributes an essay on the history of Maryland during Palæozoic time. He gives an account of the growth and wasting of several mountain systems, the expansion of great plains and their submergence, and of the folding and dislocation of the strata. He concludes with a brief account of the influence of the older history on the later geological changes.

Other portions of this volume deal with the economic geology, the highways and tests of road-materials, and there is an important report on the clays of Maryland, by Mr. Heinrich Ries, the leading clay expert in the country. He discusses the properties of clay, chemical and physical, and shows how their bad qualities can be offset by the addition of proper ingredients. There is also a full account of the principal clay deposits of the State. A great variety of clays is found, but at present no fuller's earth. The essay may be profitably studied by all interested in clay-deposits.

ANTHROPOLOGY: ITS POSITION AND NEEDS.[1]

THE practical difficulty of drawing a dividing line between the legitimate scope of anthropology and that of other studies is so great that we are often told there is no science of anthropology. This absence of definiteness adds a charm to the subject and is fertile in the production of new ideas, for it is at the fringe of a science that originality has its greatest scope. It is only by a synthesis of the various studies which are grouped together under the term anthropology that one can hope to gain a clear conception of what man is and what he has done. After giving

[1] Abstract of an address to the Anthropological Institute by the retiring president, Dr. A. C. Haddon, F.R.S., January 26.

a brief classification of the subjects included under the general term of anthropology, Dr. Haddon said his reason for touching on the subject at all was to suggest a general survey in the hope that fellow-students may carefully consider the lines upon which future research may be undertaken with profit, as there are times and occasions when one branch of inquiry is more immediately desirable than another. A few remarks were made on certain aspects of anthropological research, and various lines for future investigation were indicated.

A claim was made that the ethnological material now being collected from all over the earth is an indispensable contribution to the science of history. It is a truism that history repeats itself, and historians were invited to consult the modern instances that are accumulating, as they will find many suggestions that will serve to throw light upon past events, which otherwise might remain obscure. It is hardly an exaggeration to say that new life has been given to classical studies by the introduction into the universities of original archæological investigations, comparative archæology, ethnology and folklore. Allusion was made to the recent signs of an interest in ethnological inquiry by various Governments of the British Empire. "Is it too much to hope," it was asked, "that at last it is being recognised that a full knowledge of local conditions and a sympathetic treatment of native prejudices would materially lighten the burden of government by preventing many misunderstandings, and by securing greater efficiency would make for economy? . . . We have not yet exhausted other methods of advancing anthropology, we have scarcely yet endeavoured to educate the masses or to interest individuals who have time or money at their disposal. Few people have any idea of the great wealth of human interest there is buried in the data in the journals of our societies, or locked up in the cases and drawers of our museums. It is this practically unexploited wealth of interest and information that we should endeavour to disseminate. The apathy of the public to our science probably is largely due to its students. . . . I have indicated some of the lines upon which our Cinderella science is advancing, but before I finally vacate the honourable position to which you have called me, I must return once again to its most pressing need.

"Students at home spend laborious hours in reading, transcribing or collating the records of travellers, and in endeavouring to make them yield their secrets. The safety of the student usually depends upon the bulk of his material, but when one considers the sources of his information, one is sometimes appalled at the dangers he runs. The data that are available have been collected in varied circumstances by men of every degree of fitness and reliability. There are but two remedies for this state of affairs—trained observers and fresh investigations in the field. Fortunately, we are now in a position to say that means do exist for the training of field-anthropologists. Those who have had practical experience in Oceania, or who followed the literature of that region, will fully acknowledge the urgent need there is for immediate field-work. But the same pressing necessity is manifest in every quarter. Nor is it a call that we can neglect with impunity and postpone until a more convenient season. Each year sees a decrease in the lore we might have garnered, and this diminution of opportunity is taking place with accelerating speed. Oh! if we could only agree to postpone all work which can wait, and spend the whole of our energies in a comprehensive and organised campaign to save for posterity that information which we alone can collect."

ELECTRICITY AND MATTER.[1]

THE subject I have chosen is an enormous one, but it is one of exceptional interest at the present time. It is one of general interest as well as of scientific interest to students of physics. The fundamental properties of matter are now coming to be understood in a way in which they have never been understood before. What are these fundamental properties? One is cohesion, another is gravitation, and another is inertia. Concerning gravitation, we remain pretty much in the dark. It is an empirical fact that a body has weight, that two lumps of matter attract one another, with an extremely small force when we are dealing with ordinary pieces of matter, but extremely large when we are dealing with astronomical masses, such as planets or suns; but the cause of that gravitative attraction is not known, and at present appears to have little chance of becoming known. Cohesion ten years ago was in the same predicament, but cohesion now seems to be on the eve of yielding up its secret. The most striking fundamental property of matter, however, that we are beginning to understand in some degree, is that of inertia. Inertia is a popular term, but it is not always clearly understood what is meant by it. Let me explain the meaning. It may be defined as the power of overshooting the mark, or the power of moving against force. It is by inertia that a rifle bullet travels after it has left the gun. In the barrel it is urged by force; in the air the bullet goes on against an opposing force of friction because of its inertia—often in that case called the momentum. It is by reason of inertia that water runs uphill; we are sometimes told that water will not flow uphill, but that is a mistake. Heat will not flow uphill—heat will only flow from hot to cold; you cannot give it impetus and let it rush up of its own momentum, for heat has no momentum; it is not a substance, it only goes when it is pushed, and the instant you remove the force it stops. That is the case with heat, but that is not the case with any form of matter—it is not the case with anything possessing inertia. The water from a fountain rises because of the initial velocity imparted to it; for the same reason a cricket ball rises when it is thrown up; the propelling force has ceased, but the motion continues. It is the same with tides; for three hours the water is running uphill, for three hours it is running downhill. The head of the inflowing water is for three hours higher than the water behind it—the first three hours of the flow impart to the water its momentum, and the last three hours destroy that momentum gradually. The swinging pendulum is another illustration. [Having illustrated this point by a liquid in a horseshoe tube, showing the return to the position of equilibrium after a series of oscillations, the lecturer continued.] Oscillations like that are known to occur in electricity when a Leyden jar is discharged; the electricity does not go simply from the more highly charged to the less highly charged and there stop, but it goes beyond, it overshoots the mark and charges up that which was negative to positive, and then backwards and forwards, very like the oscillations in the tube. Hence it would appear as if electricity had a property resembling inertia. When I lectured here a quarter of a century ago I should have said that electricity had a property *resembling* inertia—I should have called it a mechanical analogue—an apparent inertia, simulating by inductive electromotive force the real inertia of matter. I should now go further than that, and should say that electricity has real inertia, just as real as matter; I should even go still further, and should say that in all probability there is no inertia but electric inertia; that the inertia of matter itself is to be explained electrically. In other words, what we are now arriving at gradually is *an electric theory of matter*. We are endeavouring to explain the properties of matter in terms and by means of what we know concerning electricity.

Although it may sound paradoxical to people who have not studied physics, we know more about electricity than we do about matter. Its properties have been more clearly investigated and more clearly understood than the inertia of matter, which is not understood at all. We only know its behaviour:—If a body is subject to a positive force it gradually increases its speed; if it is subject to an obstructive force it does not move in the direction of that force necessarily at once, but its motion begins to decrease, gradually stopping, and ultimately reverses its direction, if the force is continuous and if it is an active force. Many obstructive forces are only able to oppose motion like friction. In the text-books a bad example of a body obeying the first law of motion is given in the throwing of a stone upon ice, or some smooth surface. That is a bad example, because a single obstructive force acts all the time. The best example to give of the first law of motion is a case

[1] A lecture delivered at Bedford College for Women, on February 5, by Sir Oliver Lodge, F.R.S. Reported from shorthand notes.

where there is a pair of balanced forces, where a propelling force acts all the time, just sufficient to overcome friction; *e.g.* a barge pulled by a horse, or a train drawn by a locomotive. When such a thing starts, the force is greater than the resistance, and the speed accelerates; when it stops, the resistance is greater than the propelling force; but when it is going on at a steady speed, *i.e.* for the major part of its journey, the force and the resistance precisely balance. The resultant force acting upon it is nothing. It is obeying the first law of motion. The barge moves, or the ship moves, or the train moves, simply and solely because of its own inertia. All the energy of an engine goes to generate heat and to overcome resistance. There is no propulsion in that; when it is going at a steady pace the positive and negative forces balance; the body is subject to zero force and obeys the first law of motion.

Now this property, a property analogous to inertia, belongs also to electricity; it was called self-induction, and its laws have been made out for a long time, a law known as Lenz's law, which says that any change in a current is such as to oppose the motion. If you have a current of certain strength any cause which increases that strength calls out an antagonistic force. The force called out is always antagonistic to any change in the current. When a current is weakened, self-induction tends to make it persist in retaining its old strength. It is a property precisely analogous to inertia, and I now wish to suggest or maintain that it is a property which actually is inertia. It depends on a property which was first brought out mathematically by considering the case of acceleration of a charged body.

In a sphere charged with electricity, as long as it is at rest, we have the phenomena of electrostatics; directly it is in motion we get the phenomena of current electricity. A charged sphere in motion is a current, and we have to realise that there is no other current but that; a current is surrounded by magnetic lines of force; and when a sphere or other body charged with electricity is put into movement, a set of concentric circles of magnetic force surrounds its path, giving rise to a magnetic field. That magnetic field may seem extremely weak, but it is the measure of the current; and whether weak or not, it is now believed to be the only kind of magnetic field which exists. We are coming to realise that there are three things—a charged body, a charged body in motion, and a charged body in accelerated motion; the first gives us electrostatics, the second gives us magnetism, and the third gives us two things, first the evidence of inertia, and secondly radiation. Inertia and radiation are not the same thing, but both are manifest throughout the accelerated period. Inertia no doubt exists all the time; and instead of radiation I will use the more general term of "light"—light being the best known form of radiation. I will put inertia in a class by itself, because, although it is only manifested when there is radiation, it exists all the time. It does not depend on the speed, it is constant, and may be taken to exist equally well when a body is at rest. I want you to realise that just as there is no other electric field but that due to a charged body, so there is no other current or magnetism except that due to a charged body in motion, and there is no other radiation except that due to an accelerated charge; further, that one kind of inertia is the inertia of the charge on a body, and that *probably*, but not yet certainly, there is no other inertia except electric inertia.

With the time at our disposal it is impossible to give you all the steps leading to this conclusion, I can only give you a summary of the results. The idea of electric inertia as a reality and as due to a moving charge took shape and form in a magnificent paper by Prof. J. J. Thomson, of Cambridge, which appeared in the *Philosophical Magazine* in 1881, one of the most striking productions in the recent history of mathematical physics. It was a paper on the properties of a moving charged sphere, and it showed that a charged body possesses inertia because it is charged. It is important to remember that a body when it possesses a charge has, in addition to its ordinary mass, a supplementary mass, as it were, proportionate to the square of the charge, and inversely as the radius of the sphere on which it exists; or, as we may also put it, it is proportional to the quantity and to the potential. No great importance was attached to the statement at the time because of the difficulty of detecting any increase of inertia due to the electric charge in the case of a sphere of appreciable size. The extra inertia would be excessively small and impossible to detect if the sphere is of any perceptible size. Even if the sphere is reduced in size until it is a mere atom, and charged as highly as the atom can be charged, still the inertia due to the charge would only be an insignificant amount of the whole—not more than one hundred thousandth part of the whole. That is to say, if you had one atom of matter charged with the maximum quantity which it can possess, and which you know in electrolysis or in chemistry, and if the inertia of the atom itself was one hundred thousand units, then when the charge was added it would be one hundred thousand and one; no important difference and not experimentally to be detected.

It depends, however, entirely how small the body is; the smaller the radius the bigger the inertia, due to the charge, will be. For a long time nobody thought of anything smaller than the atom, that was thought to be the limit, hence electric inertia seemed to be no more than a matter of mathematical curiosity. But about the year 1870 Sir William Crookes called attention to the phenomena that went on in vacuum tubes, and considered that the kathode rays were matter in a "fourth state," neither solid, liquid, nor gaseous. Sir William Crookes was not believed, and was rather jeered at for speaking of matter in a fourth state. However, the subject was investigated by a great number of different people in this country and in Germany; and the result of these researches, in which Prof. Schuster and many others, and notably Prof. J. J. Thomson, engaged, has been to show that Sir William Crookes was perfectly right; that the matter in the vacuum tube flying in these kathode rays is not solid, nor liquid, nor gaseous, does not consist of atoms as had been thought propelled by the kathodes and flying through the tube and causing phosphorescence where they strike, or X-rays, as the case may be, but that they consist of something much smaller than the atom, fragments of matter, ultra-atomic corpuscles, minute things, very much smaller, very much lighter than atoms—things which appear to be the foundation stones of which atoms are composed. Thomson measured the mass of these particles and found that they were of less mass than the atom of hydrogen; whereas the atom of hydrogen had been the lightest body hitherto known. These small corpuscles were about the one-thousandth of an atom of hydrogen in mass, and he further made this important observation, that whether hydrogen or oxygen or carbonic acid or any other gas was in the tube, the particles into which these substances seemed to be broken up by electric action were identical and independent of the nature of the gas in the tube. That is to say, the things shot out by the kathode did not depend upon what gas was in the tube; they seemed to be fragments of the atoms of the gas, but they were the same fragments in each case. This at once suggested the hypothesis, not yet by any means completely verified, that all atoms of matter may be composed of these same corpuscles, or electrons as Dr. Johnstone Stoney had called them. Dr. Stoney had a habit of being in the van and of naming things before they had been discovered; thus they were called electrons long before they were known to exist separately—only the name belonged to the charge of an ion in electrolysis—a charge associated with matter; but in a vacuum tube these same charges are detached from the atom and fly free, a thing previously unheard of. In liquid conduction the charge and the atom travel together, they are inseparably associated; at an electrode or solid conductor the electron or charge is handed on to the metal and goes along the wires by some other means, but while they are travelling they are definitely united or attached to atoms all the time, although passed from hand to hand; in a gas it is not so, for it is just as if charges had been knocked off, charges of electricity dissociated from the matter, disembodied charges or electric ghosts flying through the tube at a tremendous speed. It was not only possible to measure the mass of the particles, it was also possible to measure their speed, and their speed was found to be something comparable to that of light, about one-thirtieth or sometimes even one-tenth of the velocity of light. Anything moving with that prodigious speed of several thousand miles per second must have a great amount of energy, and when stopped by a target naturally considerable results are produced.

Now for radiation of any kind there must be acceleration. The greater the acceleration the stronger the radiation. If you want violent radiation take a quickly moving charged body, and stop it dead; which is just what you do in the production of X-rays, and what is done to some extent by minerals exposed to the kathode rays. These corpuscles have extremely small mass, and so their inertia is extremely small, but a body, no matter how small, moving with the speed of light, must have terrible energy; thus, by way of illustration, the energy of a gramme of matter (15 grains) travelling at the speed of light would be sufficient to lift the British Navy to the top of Ben Nevis. After the speed of these corpuscles that of bullets is rest in comparison. [Having shown by experiment a vacuum tube containing electrons in motion, the lecturer proceeded.] To show that these are charged particles in motion, it is only necessary to show that they have the properties of a current, that is, that they are amenable to magnetism—such as that of an ordinary steel magnet—and what you see going on in the tube is the nearest approach you have to seeing electricity. In that tube electricity is as isolated and as separated as we can ever hope to have it.

All electrical phenomena seem to depend upon these electrons. In the case of gaseous conduction what we observe is the flying of the particles—the bullet method or electric particles in free flight. When we deal with liquid conduction it is the slow travelling charges moving, but retarded or loaded with the atom of matter, having to convey the atom of matter with it; hence they travel very slowly, the atoms jostle and have to work their way through the rest of the material, and instead of going something like 1000 miles a second they go more like an inch an hour; it depends upon what gradient of potential is applied. That I call the bird-seed method, meaning that the charge is carried as a bird carries a seed, the bird and seed travelling together until they arrive at an electrode, when the electron is dropped. In the case of solid conductors or metals the atoms cannot move along as they do in the liquid, they can only vibrate a little, are fixed, rigid, crystallised into their places. So when the electrons travel it must be because they are handed on from one to the next; each receives one and passes it on, not necessarily the same one; and this may be called the fire-bucket method.

A word more about radiation. If conduction is explicable in this way, how is radiation to be explained? Until quite recently radiation has been a puzzle. Atoms of matter vibrate; radiation is waves in the ether. Hence it used to be thought, and it did not seem puzzling at that time, that vibrating atoms of matter could generate waves in the ether just as a bell can generate waves in the air. The method by which light is generated was not clearly understood, but it was thought to be something analogous to the production of sound by a tuning fork or bell. But certain experiments made by me at Liverpool showed that matter and ether are disconnected from one another—that matter alone cannot generate these waves. It becomes necessary to assume that it is not matter which is vibrating so much as the charge on the matter—that radiation is caused not by the atom itself, but by the electron which it carries. It is during the accelerative period that radiation occurs. If the atom simply carries a charge along there is no radiation. There is nothing visible in the kathode rays as long as they are travelling with uniform speed and direction; it is when they are accelerated, started or stopped, or curved, that radiation occurs. The electron instead of simply vibrating might be revolving round the atom like a satellite; that would be centripetal acceleration, which is just as effective as longitudinal acceleration.

But if radiation is due to an orbital motion of an electric charge, it ought to be amenable to a magnetic field; every motion of an electron constitutes an electric current, and electric currents are amenable to a magnet. A source of light put between the poles of a magnet ought to show some difference. Faraday tried many experiments in this direction and failed, because the appliances available in his day would not show it. Nowadays, with a Rowland grating, the spectrum is much better defined, and a few years ago Zeeman, of Amsterdam, was able to see the difference when light is magnetised.

It often falls to men of genius to predict a great deal more than their generation can realise. A theory had been given by sundry people, including Fitzgerald, Larmor, Lorentz, and others. Perhaps the theory has been given more completely by Lorentz than by anyone else. It was an interesting case of prophetic prediction. They predicted that the effect observed by Zeeman would follow if light were due to revolving electrons. Time only permits me to indicate the explanation. It comes near to astronomy, and, indeed, it had been worked out six years before by Dr. Johnstone Stoney on astronomical principles. He had fully worked out the perturbations, but had not suggested that they would be caused by a magnet. But Larmor and the others did. They perceived that on applying to an orbit or circular current a strong magnetic field, that orbit will tend to be deflected; the effect of a magnetic field in general is a deflecting force. But as the circulating electron has inertia, the application of a deflecting force will not make it simply obey the force that is applied, but will make it move sideways, like any planetary orbit or a spinning top. A precessional motion is set up. Anything spinning that has inertia does not obey the force but moves at right angles. Thus the revolving electron will not, when the force is applied immediately, set itself normal to the field, but will go round the magnetic lines in a precessional motion; and that precessional motion will analyse the original lines of the spectrum into three. [Here the lecturer gave an illustrative experiment, and proceeding, pointed out that when the polarisation of the lines is examined, the vibrations are precisely as predicted.] It was further found that by the amount of separation of these lines a calculation could be made of what the magnitude of the electric charge was in relation to the inertia of the revolving portions of matter. It was thus found that the radiating particles have just the same inertia and just the same charge as the particles in the kathode rays. All the known phenomena connected with conduction and radiation are allied to these very small particles—the same inertia, the same electric charge, and the same kind of velocities, the mass being something like the thousandth part of a hydrogen atom.

Passing over chemical affinity and cohesion, the lecturer proceeded to discuss other phenomena which are due to these small particles. These particles, in order to give rise to visible radiation, revolve with terrific velocity. The number of vibrations which constitute visible light is from 400 to 800 million million times per second; and although it is no great distance round an atom, yet these particles have to go at very high speed; hence, naturally, some of them occasionally fly off. This will occur from various causes; they will fly off under the action of ultra-violet light, and so give rise to leakage of negative electricity. But there are certain substances which will emit these particles without any stimulus, and the first discovered was uranium. Although there may be aluminium or other screen between a piece of uranium and a photographic plate, something will penetrate through to the photographic plate. This constituted the discovery, by Becquerel, of the radio-activity of substances. In the researches of Dr. Russell various substances were found to possess this quality of giving out something on their own account. But the subject has gone ahead very far and fast. The most important developments have been made by Monsieur and Madame Curie in France, discovering polonium and radium, which latter has the properties possessed by uranium in a most extraordinary degree. The rays given off by these substances are of extraordinary interest; they have marvellous penetrating powers and are very intense, more intense than the X-rays given by a Röntgen tube. Radium rays will not only penetrate a foot of aluminium or wood, but they will penetrate three-eighths of an inch of lead, and then be as strong as are the rays from uranium. The full mechanism of the giving off of this great amount of radiation has still to be further investigated. It is a kind of electric evaporation, an emission of particles; this seems clear. There are three kinds of radiation, (1) particles which are readily stopped by obstacles, absorbable rays;

(2) the particles which penetrate obstacles with singularly penetrating power; and (3) the ordinary X-rays. X-rays are waves in the ether, not light, something of that nature; the penetrating rays are electrons which are shot off. But the most interesting are the first rays, those which are easily stopped; for these turn out to be atoms of matter shot off with a speed comparable to that of light. It is the first time that matter has ever been known to have such a speed as that. Rutherford, now of Montreal, has measured for the first time the speed of these readily stopped absorbable particles, and also their mass. He shows that they are atoms of matter, and that they are moving with one-tenth of the velocity of light.

All hot bodies and all negatively charged bodies are now believed to be giving off these particles; radio-activity is becoming quite a common feature. Recently fallen rain drops are radio-active, leaves of plants and most things in sunshine are radio-active; the difficulty will be to find something which is not radio-active in some degree, and the commonest kind of radio-activity appears to be the detachment of an electron. Loose charges seem to fly off, apparently by centrifugal force or the jostling of the atoms.

The *size* of electrons is known, on the hypothesis that the atom of matter is composed of them, *i.e.* on the hypothesis that the inertia of matter is electrical, or that it is electrically composed of the inertia of these charges. Evidence of this is accumulating, and there is reason to believe, not only on philosophical grounds, but in accordance with direct physical experiment, that electric inertia is the only inertia that exists. The size of an electron can then easily be determined. Regard the radius as unknown, the charge as known, the mass as known; then the size is at once calculable. The size of these electrons is about one hundred thousandth part of the diameter of an atom, otherwise they would not have sufficient inertia. They are the smallest bodies known. There was a time when the atom felt small; it is not big, it is true, but it is getting to feel quite a large thing beside the electron. To illustrate the difference between an atom and an electron, imagine an electron to be the size of a full-stop as here printed, and an atom a church 160 feet long, 80 feet broad and 40 feet high—in an atom of hydrogen there are nearly 1000 electrons—imagine those thousand full-stops thrown into that church, and some idea will be obtained of the relative sizes of the electron and the atom. The electrons *occupy* the atom very effectively; they are energetic and pushful, though not big. They occupy the atom in the sense that soldiers occupy a country, that is, they will not let anybody else in. The electrons, by the force they exert, will not let anything else in, they make the atom impenetrable; they also give the atom its other properties and enable it to act chemically. That chemical affinity is electrical force has been known for a long time; it was suspected by Sir Humphrey Davy. I believe if the atom has no extra or odd electron it has no chemical force; the atom may have molecular force, which is cohesion, and this point might be explained at greater length; for in my ideas cohesion is turning out to be electrical too, though not in the sense of attraction between ordinary positive and negative electricity.

The relation of the electron to the atom is a matter of the most intense interest. But it is not to be supposed that the electron is stationary in the atom. The electrons are revolving round one another at tremendous speed, so that the atom is a region of intense activity. The electrons are not in the least crowded, although there are a thousand in the hydrogen atom, twenty or thirty thousand in the sodium atom and one hundred thousand in the mercury atom; for consider how far apart are they in proportion to their size. Just as far apart as planets in the solar system are in proportion to their size. The distance of the earth from the sun is to the size of the earth very much as the distance of electrons from each other is to their size in a mercury or platinum atom. The fact is, we come to an atomic astronomy, and the atom is becoming like a solar system, or like nebulæ or Saturn's rings or something of that kind, composed of a number of small particles in a violent state of revolving motion and occupying very little of the whole space with their actual substance. They are so small that collisions are infrequent; so it is in the solar system and heavens generally, collisions do occur, but seldom, because of the excessively small sizes compared with the distances at which they are spaced out.

Taking any family belonging to a sun, *i.e.* a solar system, it forms something like the same kind of collection as the electrons form in an atom. So when we get in an atom a sort of solar system we begin to question whether there is anything in absolute size at all. It is a question I cannot answer. It has been suggested that solar systems may be atoms of a still larger universe. These are questions that are too hard. But there appears to be no end to the infinity of the universe, and all that we can say is that the probability is that it is infinite in an infinite number of ways.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The subject for the Adams prize essay of 1905 is "Wave Motion of Finite Amplitude and Unchanging Type, in Deep Water." The prize is open to the competition of all who have at any time graduated in the University. The value of the prize is about 225*l*. Further particulars are given in the *University Reporter* for March 10.

The new Lucasian professor will next term lecture on "The Theory of Gases and the Molecular Statistics of Energy."

Dr. Anningson and Prof. Woodhead will represent the University at the congress of the Royal Institute of Public Health to be held in Liverpool next July.

IT is reported through Reuter's Agency that a sum of more than 200,000*l*. has been given to Barnard College, New York, to be used for the purchase of the land adjoining the buildings. The name of the donor is not given.

A JUBILEE of the University of Heidelberg will be held next August in commemoration of the revival of the University in 1803 by Charles Frederick of Baden. Though the *fêtes* will be on a more modest scale than those which marked the celebration in 1886, an extensive programme is being arranged for the occasion.

THE London School of Tropical Medicine announces that the Craggs research prize of 50*l*. will be awarded in October to a past or present student of the school who, during the current year, has made the most valuable contribution to tropical medicine. Full information may be obtained from the medical tutor at the school, Royal Albert Docks, London.

THE senate of the Madras University has passed a resolution, it is reported in the *Pioneer Mail*, disapproving of the recommendations of the Indian Universities Commission that the system of examinations by compartments should be abandoned. The Vice-Chancellor of the Bombay University at the recent annual convocation advocated the establishment of a science school, and urged the raising of a fund of twenty lakhs of rupees for the purpose. Part of this money, he said, must come from the public and part ought to be provided from the funds for higher education in the Presidency. He thought the Government might be trusted to provide the remainder.

THE will of Dr. H. E. Schunck, F.R.S., who died on January 13, shows that he bequeathed to Owens College in trust for the foundation of a "Dr. Schunck's Endowment for Promoting Chemical Research," the contents of his laboratory and the apparatus, appliances and instruments, to be administered by the principal and professors of chemistry in Owens College and by two other trustees, to be nominated by the council, and by his son, Mr. C. A. Schunck, if he shall be willing to serve. The endowment is for the purpose, not only of research in chemical science, but also of geological, physiological and other sciences, and reports are to be annually presented to the council of the college.

IN the House of Commons on Monday Mr. Brodrick stated that many of the recommendations of the Military Education Committee are to be accepted. The new Director-General of Military Education and Training is to have an advisory board as suggested by the Committee. This body is to consist of the heads of Woolwich, Sandhurst, the Staff College, and the Ordnance College, of two representatives of the Universities, a representative selected by the Incorporated Association of Headmasters, another selected by the Headmasters' Conference, another by the Royal Society, and two members nominated by the Secretary of State. The settlement of the syllabus of examination will be left in their hands. There is to be one and the same examination for Woolwich and Sandhurst for the Army and for the Militia. For University candidates, whom Mr. Brodrick is anxious to encourage, a scheme has been prepared which will enable them to enter the Army on equal terms with other candidates. A student will have to pass Moderations at Oxford or some equivalent examination at another University before he is twenty, and he will also have to do six weeks' training with a Regular unit at Aldershot or elsewhere. He will then be given a provisional commission. Before he is twenty-two he will have to take honours at the University and to go through another six weeks' training. He will then receive a commission dating back two years. The Universities are to be asked to include in their honours examination two or three military subjects—*e.g.* military topography and military history.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 22.—"Characteristics of Electric Earth-current Disturbances and their Origin." By J. E. **Taylor**. Communicated by Sir Oliver Lodge, F.R.S.

The paper deals with disturbing effects, produced by rapidly varying earth-currents, on a telephone receiver, connected in a short line of telegraph having both ends earthed in the sea. The sounds produced have certain well-marked characteristics. In these latitudes they are always stronger and of more frequent occurrence in summer than in winter. They are daily in evidence for a few hours at, or about, the time of sunset, *i.e.* whilst daylight is fading. In general they do not evidence themselves to any great extent during broad daylight, but are readily precipitated by a state of electrical tension in the atmosphere which may culminate in a thunderstorm, and rarely fail to herald the approach of a storm or gale.

Particularly noticeable among the various types of disturbance enumerated, there are some which resemble the distant scream of a rocket rising in the air. These commence with a shrill whistle, and die away in a note of diminishing pitch. They vary in intensity, but always have a similar duration of from two to four seconds, are freely heard at night, and only occasionally during the day. The sound is characteristic of an initial high velocity rapidly damped and dissipated. This type of disturbance is assumed to be produced by the passage of meteoric bodies in sufficient proximity to the circuit, which set up rapidly intermittent electrical discharges in the upper regions of the atmosphere, inducing electric currents in the sea which affect the circuit. That they are only occasionally heard during broad daylight is explained by the ionisation of the upper atmosphere by solar radiations, possibly electronic, which interposes a conducting screen. A high state of electrical tension in the atmosphere nullifies or modifies the conductivity produced. At nightfall solar radiations cease to act, and conductivity disappears gradually. The nightfall disturbances are accounted for by aërial electric currents associated with the disappearance of ionic conductivity, the effects of these aërial currents becoming perceptible so soon as the conductivity becomes sufficiently small to act no longer as a screen. It is suggested that similar causes influence the diurnal variations of the earth's magnetic field, and that the changes of ionisation of the atmosphere offer a reasonable explanation of the greater night-time efficiency in signalling recently observed by Mr. Marconi in experiments with Hertzian wireless telegraphy.

"Some Dielectric Properties of Solid Glycerine." By Ernest **Wilson**, Professor of Electrical Engineering, King's College, London. Communicated by Sir William Preece, K.C.B., F.R.S.

February 12.—"The Brain of the Archæoceti." By Dr. G. Elliot **Smith.** Communicated by Prof. G. B. Howes, F.R.S.

"Primitive Knot and Early Gastrulation Cavity Coexisting with Independent Primitive Streak in Ornithorhynchus." By Prof. J. T. **Wilson** and Dr. J. P. **Hill.** Communicated by Prof. G. B. Howes, F.R.S.

Linnean Society, February 19.—Prof S. H. Vines, F.R.S., president, in the chair.—Mr. John **Clayton,** of Bradford, presented a set of thirty-two photographs to illustrate the celebrated Cowthorpe Oak, near Wetherby, Yorkshire. The author concludes that the age of the tree has been greatly over-estimated, his own belief being that 500 years is the extreme limit of its age, from sapling to its present decrepitude and decay.—Dr. George **Henderson** offered some remarks on the possible uses of essential oils in the economy of plant-life. Adverting to the well-known fact that moisture in the air prevents radiation and consequent loss of heat, he suggested that emanations of essential oil from plants might possibly prevent damage by night frost during the period of flowering, basing his suggestion on Prof. Tyndall's researches thirty-two years since, on the presence of infinitesimal quantities of essential oil in the air. Tyndall found such presence increased the absorptive power of the air as regards heat-rays: taking dry air as 1, air saturated with moisture as 72, then traces of essential oil rank as follows:—Rosemary 74, cassia 109, spikenard 355 and aniseed 372. Dr. Henderson brought these remarks before the meeting as an interesting question for botanic investigation, since essential oils are usually regarded as mere waste products.—The Rev. T. R. R. Stebbing, vice-president, having taken the chair, the first paper, on the electric pulsation accompanying automatic movements in *Desmodium gyrans,* by Prof. J. C. **Bose,** was summarised by the president for the author. In this paper Prof. Bose gives the results of his investigation of the question as to whether or not spontaneous movements are accompanied by an electric disturbance comparable to that resulting from external stimulation. Spontaneous movements are not uncommon in the higher plants, but for various reasons there are but few instances suitable for an investigation of this kind. The most striking case is that of *Desmodium gyrans,* the telegraph-plant. The leaf of this plant is trifoliolate, consisting of two small lateral leaflets and a larger terminal leaflet. The lateral leaflets move up and down, like the arms of a semaphore—whence the popular name of the plant—the period of a complete up and down movement, in the plants observed, being about 3½ minutes. Having placed one electrode on the petiolule of a leaflet and the other on the petiole of the leaf, both in connection with a galvanometer, Prof. Bose found that the spontaneous movement is associated with an electrical disturbance of a peculiar kind. There is first a large principal wave of disturbance, followed by a smaller subsidiary wave, the period of the former being about 1 minute, that of the latter about 2½ minutes. This disturbance is the expression of a "current of action" travelling in the plant from the excitable petiolule to the resting petiole.—A paper by Miss A. L. **Embleton,** communicated by Prof. G. B. Howes, was read by Mr. A. D. Michael for the author, on *Cerataphis Lataniae,* a peculiar Aphid. This insect was observed in 1901 on various orchids in the Cambridge University Botanic Garden. The author gives the detailed synonymy of the creature, which is well known to cultivators on the Continent, and proceeds to set out its life-history; in this country it exists in only one form, reproduced parthenogenetically, corresponding to an aleurodiform stage of a migratory Aphis. The author concludes by suggesting that it is one of the migratory Aphides which has been deprived of its usual series of metamorphoses owing to an artificial mode of life.—On specialisation of parasitism in the Erysiphaceæ, by Mr. E. S. **Salmon.** The author began by explaining the term "biologic form" or "species" by instancing two fungi which were not distinguishable morphologically, acting in diverse fashion on the same host-plants. This phenomenon has been known in the Uredineæ for some time, but its discovery in the Erysiphaceæ was more recent.

Royal Microscopical Society, February 18.—Dr. Henry Woodward, F.R.S., president, in the chair.—Dr. Arthur **Rowe** gave a demonstration on the photomicrography of opaque objects as applied to the delineation of the minute structure of chalk fossils. Dr. Rowe said the photomicrography of opaque objects was not so easy as that of transparent objects, for though the broad principles seemed very simple, there were difficulties quite unknown to those who only photographed transparent objects. He used a long camera with powers from 6″ up to 1½″, and had found the incandescent gas light was the best light for the purpose. Success entirely hinged upon obtaining a good contrast of light and shade, and in addition to the difficulties in connection therewith, a great obstacle arose from the inequality of the surfaces of many objects, which rendered focusing troublesome.

EDINBURGH.

Royal Society, February 2.—Prof. James Geikie, F.R.S., in the chair.—The meeting was devoted to papers giving some of the preliminary results obtained last season during the bathymetrical survey of the Scottish fresh-water lakes under the direction of Sir John Murray, K.C.B., F.R.S.—Dr. T. N. **Johnston** gave an account of Loch Morar and the neighbouring lochs Beoraid and Nostarie, which drain into it, showing that Loch Morar, with a maximum depth of 1009 feet, is the deepest known British lake. There are seven European lakes known to be deeper, but only three of these exceed it in depth below sea-level. At the time of surveying, the surface of Loch Morar was found to be 30·5 feet above sea-level, and its mean depth is calculated at 284 feet. Loch Beoraid has a maximum depth of 159 feet, and its surface was found to be 170 feet above sea-level. Loch Nostarie, with a maximum depth of 35 feet, is a shallow loch lying in the drift at a height of 89·3 feet above sea-level.—Mr. T. R. H. **Garrett** read a paper on the temperatures in Lochs Morar, Eilt and Dubh (Ailort). The depth of Eilt is 119 feet, and that of Dubh is 153 feet, whilst their heights above sea-level are 96 feet and 103 feet respectively. The temperature in the western portion of Eilt was higher at all depths than in the central, and higher in the central than in the eastern; this was attributed to the north-east winds of the previous week. The temperature in Loch Dubh on July 12, 1902, was 59°·0 at the surface and 43°·5 at the bottom, which is the greatest range observed on any one day in any Scottish loch during last year. This was attributed to the small area of the loch compared with its depth, and to its extremely small drainage area. He placed the limit of penetration of heat due to solar radiation in Loch Morar at 800 feet, and compared this limit with that of 300 to 450 feet in Lake Geneva as given by Forel.—Mr. James **Murray** read a paper on the pelagic life in the lochs, and gave a summary of the biological work done during the season. Most of the Entomostraca and Rotifera, and all the lower forms, were found to be very uniformly distributed. In the Calanidæ two species of Diaptomus, viz. *D. Wierzyskii* and *D. laciniatus*, were shown to be generally distributed in the north. In the large and deep lochs such as Morar and Tay, only a few species of almost cosmopolitan distribution constitute the fauna of the open water. In smaller lochs life is much more abundant. The total absence of Daphnia from Loch Morar and some other lochs might suggest an investigation into the composition of the water and other conditions of these lochs. In regard to the vertical migration of pelagic animals, it was found on one occasion in Loch Treig that the Copepoda were abundant at a depth of from 40 to 90 feet, but scarce nearer the surface. Some curiosities of distribution were given, such as the occurrence of great numbers of the empty cases of Clathrulina in several large lochs, although the animal was never found alive in any loch.

PARIS.

Academy of Sciences, March 2.—M. Albert Gaudry in the chair.—The storm of March 2, 1903, by M. **Mascart.** Mention is made of the usefulness of the meteorological station at the Azores. The barometer stood at 7 p.m. at 775 mm. at Horta, in the Azores, whilst in the north of Ireland at the same time it was 725 mm., a gradient of 50 mm. between the two stations, an altogether exceptional value, and which fully explains the violence of the storm.—On the absorption of light (1) by a body naturally heterotropic and on which an intense magnetic field has impressed a strong rotatory power, and (2) by an isotropic body, which such a field renders both birefringent and asymmetric, by M. J. **Boussinesq.**—The preparation and properties of two tetra-alkyl-diamido-diphenylanthrones, by MM. A. **Haller** and A. **Guyot.** The tetramethyl-diamido-diphenylanthrone is obtained in good yield by the condensation of the chloride of anthraquinone with dimethyl-aniline in carbon bisulphide solution in presence of aluminium chloride. The corresponding ethyl compound is obtained in a similar manner, diethyl-aniline being substituted for the dimethyl-aniline. Both compounds react with dilute mineral acids to form colourless salts.—On the generalisation of the Laplace-Abel integral, by M. G. **Mittag-Leffler.**—The discovery of fishes in the Devonian layer of the Pas-du-Calais, by M. J. **Gosselet.** The fossils found were of the genus Pteraspis, which is very common in the Old Red Sandstone in England and Scotland, but which has not been previously found in the Ardennes or in the eastern prolongations.—Remarks by M. C. de **Freycinet** on the experimental teaching of geometry.—Observations on the comet 1902 *b*, made with the 35 cm. equatorial of the Observatory of Lyons, by MM. J. **Guillaume** and G. le **Cadet.** The comet had the aspect of a very feeble nebulosity, which sometimes appeared to show a faint condensation. It was at the limit of visibility with the magnification of 150 employed for the measurements.—Perturbations which do not depend on the elongation, by M. Jean **Mascart.**—On slipping in fluids: a correction of a preceding note, by M. **Hadamard.**—Remarks on the liquidogenic theories of fluids, by M. E. **Mathias.** Of the two views of the phenomena at the critical point, the one regards the saturated state as univariant, the temperature determining the pressure as well as the density of the saturated fluid. This leaves certain facts unexplained, such as the anomalies between the densities of the liquid and saturated vapour in Natterer's tubes, the disappearance of the meniscus below the critical temperature, and the possible heterogeneity of the fluid above the critical point. These phenomena are explained by the theory of De Heen. The author shows that these two theories are not necessarily incompatible.—New researches on electric convection, by MM. H. **Pender** and V. **Cremieu.** The authors, working independently, have previously arrived at contradictory results on the magnetic effect of electric convection, and hence have decided to pursue the subject in collaboration. So far the experiments have given indecisive results, the effects being very irregular.—On the heat of combustion of phosphorus and on the phosphoric anhydrides, by M. H. **Giran.** The heat of combustion of yellow phosphorus has been determined by burning with compressed oxygen in the Mahler bomb, the results being about 3 per cent. higher than those currently accepted. From the heat of solution of the pentoxide obtained, it would appear to consist of the amorphous variety. Metaphosphoric acid is the only product on solution in water.—On some new acetylenic acids, by MM. Ch. **Moureu** and R. **Delange.** By acting upon acetylenes of the general formula $R—C\equiv C—H$ with sodium and then treating these with CO_2, the authors have prepared a number of acetylene acids of the fatty series, the more important physical properties of which are given.—Contribution to the study of the thio-acids of the formula $R—CO—SH$, by MM. V. **Auger** and M. **Billy.** The only method allowing of the production of true thio-acids is that of Kékulé, the saponification of esters with sodium hydrosulphide.—On para-ethyl-benzoic aldehyde, by M. H. **Fournier.** An unsuccessful attempt was made to prepare this aldehyde by the action of hydrogen chloride and carbon monoxide on ethyl-benzene in presence of aluminium chloride. It was obtained by Bouveault's method by the action of ethoxalyl chloride upon ethyl-benzene in presence of aluminium chloride, heating the resulting ester with aniline, and boiling the derivative obtained with dilute sulphuric acid.—A method for estimating glycerol in the blood, by M. Maurice **Nicloux.** After precipitating and separating the albuminoid matters of the blood, the glycerol is distilled in a vacuum at 100° C., and estimated by potassium bichromate and sulphuric acid. A series of test analyses is given, the mean error being about 5 per cent., or approximately that inherent in the bichromate method.—On the structure of the tracheal cell of the gad-fly, and on the origin of the ergastoplasmic formations, by MM. A. **Conte** and C. **Vaney.**—The manometric ear, by M. Pierre **Bonnier**. A criticism of the results of experiments recently published by M. Marage.—The nervous ganglia of the posterior roots belonging to the system of the great sympathetic, by M. N. Alberto **Barbieri.**

—The dinosaurs of Belgium, by M. Louis **Dollo.**—A biological study of parasitism; *Ustilago Maydis*, by M. Julien **Ray.**—On the geology of the Montagne des Français (Madagascar), by M. Paul **Lemoine.**—On subterranean waters and the disappearance of springs, by M. E. A. **Martel.**—On geographical explorations carried out in the Tchad region, by M. **Destenave.**

DIARY OF SOCIETIES.

THURSDAY, MARCH 12.

ROYAL SOCIETY, at 4.30.—On the Histology of *Uredo dispersa*, Erikks., and the "*Mycoplasm*" Hypothesis: Prof. Marshall Ward, F.R.S.—The Statolith Theory of Geotropism: F. Darwin, F.R.S.—A Study of a Unicellular Green Alga, occurring in Polluted Water, with Especial Reference to its Nitrogenous Metabolism: Miss H. Chick.—A Comparative Study of the Grey and White Matter of the Motor Cell Groups and of the Spinal Accessory Nerve in the Spinal Cord of the Porpoise (*Phocaena communis*): Dr. D. Hepburn and Dr. D. Waterston.—The Oestrous Cycle and the Formation of the Corpus Luteum in the Sheep: F. H. A. Marshall.—On the Culture of the Nitroso-bacterium: H. S. Fremlin.—Upon the Immunising Effects of the Intracellular Contents of the Typhoid Bacillus as Obtained by the Disintegration of the Organism at the Temperature of Liquid Air: Dr. A. Macfadyen.

ROYAL INSTITUTION, at 5.—Insect Contrivances: Prof. L. C. Miall, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Distribution Losses in Electric Supply Systems: A. D. Constable and E. Fawssett.—A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms (abstract): M. B. Field.

SOCIETY OF ARTS, at 4.30.—The Currency Policy of India: J. Barr Robertson.

MATHEMATICAL SOCIETY, at 5.30.—On the Convergence of Certain Multiple Series: G. H. Hardy.—On the Representation of a Group of Finite Order as an Irreducible Group of Linear Substitutions and the Direct Establishment of the Relations between the Group-Characteristics: Prof. W. Burnside.—Approximate Calculation of the Periods of Vibration of a Circular Plate: Prof. H. Lamb.—Mathematical Notes: Dr. H. F. Baker.—Note on a Point in Hilbert's Grundlagen der Geometrie: E. T. Dixon.—On Surfaces which have Assigned Families of Curves as their Lines of Curvature: Prof. A. R. Forsyth.—Extension of Two Theorems on Covariants: J. H. Grace.—On Certain Sequences for Determining the *n*th Root of a Rational Number: S. M. Jacob.

FRIDAY, MARCH 13.

ROYAL INSTITUTION, at 9.—Character Reading from External Signs: Prof. Karl Pearson, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Interpretation of Milne Seismograms: Dr. Farr.—A Potentiometer for Thermocouple Measurements: Dr. R. A. Lehfeldt.—A Direct-Reading Potentiometer for Thermoelectric Work: Dr. J. A. Harker.—The Measurement of Small Resistances: A. Campbell.—A Resistance Comparator: Dr. R. A. Lehfeldt.

MALACOLOGICAL SOCIETY, at 8.—Further Description of the Animal of *Damayantia carinata*, Collinge: Lieut.-Col. H. H. Godwin-Austen, F.R.S.—Note on the Generic Name Buliminus: B. B. Woodward.—Notes on Pleistocene Non-marine Mollusca from Portland Bill; and on Holocene Non-marine Mollusca from Wilts, Dorset, Cambridgeshire and Folkestone: R. Ashington Bullen.—On the Occurrence of *Neritina Grateloupiana*, Fér., in the Pleistocene at Swanscomb: A. S. Kennard and B. B. Woodward.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Reconstruction of Midland Railway Bridge No. 27, over the River Trent: A. R. Langton.

ROYAL ASTRONOMICAL SOCIETY, at 5.—On the Desirability of a Re-investigation of Problems growing out of the Mean Motion of the Moon: Prof S Newcomb.—A Proposed Southern Belt of Latitude Stations: Prof. S. C. Chandler.—On three of Sir W. Herschel's Observed Nebulous Regions in Orion: Prof. Max Wolf.—On the Period and Light Curve of 7514 *UY* Cygni: A. Stanley Williams.—On the Nebula *h* 2302 Cassiopeiæ; the Region surrounding H II. 457 Eridani and H III. 558 Aquarii: Dr. Isaac Roberts.—A Series of Photographs of Nebulæ, &c., taken by Mr. Ritchey at the Yerkes Observatory will be Exhibited.

SATURDAY, MARCH 14.

ROYAL INSTITUTION, at 3.—Light: Its Origin and Nature: Lord Rayleigh.

MONDAY, MARCH 16.

SOCIETY OF ARTS, at 8.—Hertzian Wave Telegraphy in Theory and Practice: Prof. J. A. Fleming, F.R.S.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Standardisation of Analytical Methods: H. Droop Richmond.—The Standardisation of Commercial Methods of Analysis, especially those applied to Brewing Materials: Arthur R. Ling.

TUESDAY, MARCH 17.

ROYAL INSTITUTION, at 5.—Great Problems in Astronomy: Sir Robert Ball.

ZOOLOGICAL SOCIETY, at 8.30.—Observations and Experiments on Japanese Long-Tailed Fowls: J. T. Cunningham.—On some Nudibranchs from East Africa and Zanzibar. No. II.: Sir Charles Eliot, K.C.M.G.—Contributions to the Osteology of Birds. Part VI. *Cuculiformes*: W. P. Pycraft.

SOCIETY OF ARTS, at 4.30.—Artistic Fans: Miss Hannah Falcke.

ROYAL STATISTICAL SOCIETY, at 5.—Statistics of Italy: Bolton King.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*:—Recent Irrigation in the Punjab: S. Preston.—The Irrigation Weir across the Bhadar River, Kathiawar: J. J. B. Benson.—*Paper to be read, time permitting*:—The Protection Works of the Kaiser-i-Hind Bridge over the River Sutlej, near Ferozepur: Amyas Morse.

WEDNESDAY, MARCH 18.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Helmholtz Theory of the Microscope: J. W. Gordon.

SOCIETY OF ARTS, at 8.—New Aspects of Life Assurance: William Schooling.

CHEMICAL SOCIETY, at 5.30.—(1) Essential Oil of Hops: (2) On a Compound of Dextrose with Hydroxide of Aluminium: A. C. Chapman.—Action of Phosphorus Haloids on Dihydroresorcins. Part II. Dihydroresorcin: A. W. Crossley, and P. Haas.—On the Constitution of Cotarnine: J. J. Dobbie, A. Lauder, and C. K. Tinkler.—Decomposition of Mercurous Nitrite by Heat: P. C. Ray and J. N. Seh.

ENTOMOLOGICAL SOCIETY, at 8.—An Entomological Excursion to Bejar, Central Spain: G. C. Champion.—On Lepidoptera from the White Nile collected by Mr. W. L. S. Loat, with further Notes on Seasonal Dimorphism in Butterflies: Dr. Frederick A. Dixey.—*Hymenoptera aculeata* collected by the Rev. A. E. Eaton, in Madeira and Tenerife, in the Spring of 1902: E. Saunders, F.R.S.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Passage of Sound through the Atmosphere: C. V. Boys, F.R.S.

THURSDAY, MARCH 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—On the Formation of Barrier Reefs and of the Different Types of Atolls: Prof. A. Agassiz, For. Mem. R.S.—On Central American Earthquakes, particularly the Earthquake of 1838: Admiral Sir John Dalrymple Hay, Bart, F.R.S.—On the Electrons of Radium: Sir William Crookes, F.R.S.

LINNEAN SOCIETY, at 8.—On *Poa laxa* and *Poa stricta*, of our British Floras: G. Claridge Druce.—The Botany of the Ceylon Patanas. Part II. Anatomy of the Leaves: John Parkin and H. H. W. Pearson.

FRIDAY, MARCH 20.

ROYAL INSTITUTION, at 9.—The Paths of Volition: Prof. E. A. Schäfer, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Prevention of Diphtheria Outbreaks in Hospitals for Children: Dr. Louis Parkes.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—A Premium System applied to Engineering Workshops: James Rowan.

SATURDAY, MARCH 21.

ROYAL INSTITUTION, at 3.—Light: Its Origin and Nature: Lord Rayleigh.

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