THURSDAY, DECEMBER 6, 1900.

THE RECENT SPORTING EXPERIENCES OF MR. SELOUS.

Sport and Travel, East and West. By F. C. Selous. Pp. ix. + 311; illustrated. (London: Longmans, Green, and Co., 1900.)

HAVING seen, or shot, practically every species of great game in South and South-east Africa, the indefatigable author of the volume before us has devoted several seasons in the closing decade of the century to hunting-trips in the northern hemisphere. These expeditions included three trips to Asia Minor in search of the wild goat, the Armenian sheep, and the Asiatic red deer, and two to the Rocky Mountains, where wapiti, mule-deer, white-tailed deer, prongbuck and lynx fell to the practised aim of the veteran hunter. Not that Mr. Selous is by any means merely a hunter; he is likewise an observant field-naturalist and an enthusiastic egg-collector, having contributed many years ago an important paper on African antelopes to the *Proceedings* of the Zoological Society, while his recent expeditions to Asia Minor have furnished material for an ornithological paper to the *Ibis*. It is perhaps needless to add that such an experienced hunter may be depended upon not to shoot animals for the mere sake of slaying, and that after obtaining a few fine examples of the species he encountered for the first time to add to his splendid collection at Alpine Lodge, Worplesdon, and occasionally killing an individual or two for the commissariat, Mr. Selous has always been content to stay his hand.

To compare in point of interest his recent experiences with those detailed in his "Hunter's Wanderings in Africa" would perhaps be unjust, if only for the reason that the number of species of game animals to be encountered in the lands he has lately visited falls immeasurably short of those which have their home on the South African veldt. Then, too, we have no such mighty beasts as the white rhinoceros and the African elephant to enthral the reader's interest in the volume. And it must also be remembered that hunting in the "Rockies' has been made familiar to us by the writings of sportsmen like Roosevelt, whereas at the date Mr. Selous gave to the world his unrivalled South African experiences, there had been comparatively little written on the subject of the large game of the interior since the trips of Gordon Cumming, Andersson and Oswell.

Nevertheless, in spite of having the prestige of his earlier *magnum opus* to contend against, it cannot be gainsaid that on the present occasion Mr. Selous has succeeded in producing a volume calculated to attract a large circle of readers, and these, too, not only from among sportsmen and travellers, but from naturalists as well. To the latter, at any rate, the greatest interest of the book is concentrated on the part devoted to shooting in Asia Minor, in which district we have a less full knowledge of the animals than is the case with those of North America. One of the points where the author has been of undoubted service to naturalists is in regard to his description of the seasonal colour-changes of the wild goat; such seasonal changes in the colour of horned game animals having till late years attracted comparatively little attention among zoologists. According to the description given by Mr. Selous, it appears that in the summer coat these goats are of a reddish-brown colour, with the broad dark shoulder-stripe, which becomes so conspicuous in winter, almost entirely wanting, the black beard being at the same time comparatively short. In winter, on the other hand, the old bucks have the general ground-colour nearly white, although the flanks and under-parts are somewhat darker, being of a light sandy-yellow. In marked contrast to these pale tints stands out the broad black shoulder-stripe and dorsal streak, while the beard becomes long and flowing.

It is interesting to note that, in spite of his full acquaintance with all the splendid South African representatives of the antelope tribe, Mr. Selous pronounces the wild goat of the Maimun Dagh to be one of the handsomest and most striking of all game animals, although he is careful to avoid making invidious comparisons. In its native mountains the wild goat is, indeed, one of the most wary of horned animals, and as it is by no means plentiful, its pursuit demands all the patience and resources of the skilled stalker. And the sympathies of all sportsmen will be with Mr. Selous when they read his account how, after many failures and losing one good head, he eventually killed a magnificent old buck, only to discover that it was minus one of its splendid horns. The statement, on p. 27, that the wild goats of the Musa Dagh (on which there is but a single spring of fresh water) frequently descend to the beach and drink sea-water, is certainly very remarkable, for although it is now well known that many species of ruminants can exist for long periods, if not altogether, without drinking, yet this is the first instance that has come under our notice of their resorting to the ocean for water. Although, in the absence of an index, it is a little difficult to be certain that we have not overlooked a passage, the author does not seem to have been successful in "bagging" the Armenian wild sheep, although he obtained several fine examples of the ollin, or Asiatic race of the red deer.

To visit the mountains and prairies of the north-western states of America appears to have been a life-long dream of Mr. Selous—a dream that was never realised till long after the bison had disappeared from the latter, and the numbers of the wapiti had been deplorably reduced in the former. In regard to the skulls of the bison which the author met with so commonly in the Bighorn basin, we are told that many of these still retained the sheaths of the horns and even fragments of skin and hair after an exposure of at least fourteen years. "I should certainly never have believed," he writes, "that even the hardest of bone, let alone horn and skin, could have withstood the ravages of time and exposure so well. In the climate of Africa no organic matter lasts very long when exposed to the weather, and even the skull and leg-bones of an elephant would, I think, crumble to dust and absolutely disappear in less than fifteen years from the date of the animal's death." At the present time, these observations are of considerable interest in connection with the skin of the ground-sloth preserved in a Patagonian cave.

Evidence of the former abundance of the wapiti and the mule-deer in the same district was afforded by the number of bleached antlers which marked the line of the great spring migration, when the wapiti were returning to the mountains from their winter feeding-grounds on the plains. At the present day, these noble deer are unknown on the low-grounds of the Bighorn basin, and the few survivors have to make shift as best they can during the dreary winter months in the mountains, from among the pine forests of which they emerge as seldom as possible.

Mr. Selous was fortunate enough to obtain some very fine heads of wapiti, white-tailed deer and mule-deer, one head of the latter being a remarkably good specimen, and notable on account of the relatively narrow span of the antlers. To one expression which the author is very fond of using—to wit, a "bull" wapiti—we are fain to take exception, the term "stag" being the proper one to employ in this connection. And here we may venture to point out to the author, in connection with a statement on page 166, that naturalists of the present day (whatever may have been the practice with their predecessors) are not in the habit of translating generic terms into English, and that, consequently, there is no objection to the application of the name Antilocapra to the American prongbuck, on the ground that it indicates an animal midway between an antelope and a goat. Such names should be regarded as mere abstract terms without any definite meaning. And, while we are fault-finding, it may be mentioned that there are a few little slips in nomenclature which might advantageously have been avoided. The rough-legged buzzard, for instance, is not an Aquila (p. 140), while Speotyto, and not Speotitis (p. 145), is the proper title for the little American ground-owls. It may be added that it would have been a decided improvement to the book if, instead of making the title the heading of every page, the chapter-headings had been employed for the right-hand pages.

A reviewer is always expected to pick some holes in a book, but it may be candidly stated that the foregoing are all the faults we have to find with the one before us. To those who contemplate a trip to either of the districts visited by Mr. Selous, as well as to those stay-at-home people who prefer to hear of stirring adventures by field and flood when comfortably seated by their own firesides, rather than undergo the inseparable hardships and toils themselves, we can confidently recommend "Sport and Travel" as an attractive and interesting volume, written by one who is at the same time a keen sportsman and an intelligent and thoughtful observer. R. L.

THE COMPARATIVE HISTOLOGY OF VERTEBRATES.

Lehrbuch der vergleichenden mikroskopischen Anatomie der Wirbeltiere. Herausgegeben von Dr. Med. Albert Oppel—Dritter Teil. Pp. x. + 1180. (Jena: Gustav Fischer, 1900.)

PROF. OPPEL has set himself the colossal task of furnishing a succinct account of the comparative histology of vertebrates, and the volume before us is the third instalment towards the attainment of that end. The two former parts, which appeared in 1896 and 1897, dealt respectively with the comparative structure of the stomach and of the gullet and intestines. The present is concerned with the remainder of the alimentary canal, viz., the mouth, including the tongue and salivary glands (but exclusive of the teeth, which are referred to a later publication in which the skeleton will be dealt with) and the large glands whose ducts open into the commencement of the intestine, viz., the pancreas and liver. The extent of the undertaking will be manifest when we mention that the account of these subjects requires nearly 1200 large octavo pages, with 679 illustrations in the text and ten coloured lithographic plates, and that there is a bibliographical list comprising several hundred books and papers, each one of which is referred to in the text, and all of which are given with their full title and references; so that the possession of this alone would render the book of inestimable value to any one working at any part of the subject with which it deals.

As we have pointed out in noticing the parts of Prof. Oppel's work which have already appeared, the author has not attempted to verify all the statements and descriptions which he gives; such verification would indeed be an impossible task when we consider the enormous amount of material which has accumulated upon the subject, even within recent years. Nevertheless, there are several points in the present volume upon which Prof. Oppel has made personal observations, and although these are not published in this book for the first time, their appearance tends to give an air of originality to a work which, in the main, must necessarily be a compilation, however critically the matter which it contains is dealt with; but it will be easily understood that where, as in a work of this character, conciseness must be a main object there cannot be much room for criticism.

A feature of the work is the chronographical order in which the results of investigation upon each subject dealt with are put before the reader, an arrangement which gives a special interest of a historical character to many of the descriptions. This is well exemplified in the chapters dealing with the relation between the structure of glands and their condition of activity, in which, as in many other parts of the book, the author contrives to introduce points of high physiological interest into a work the chief aim of which is no doubt morphological. Where all is excellent it is not easy to particularise; but certain parts are especially dealt with in a masterly manner, as, for example, the structure and relations of the tonsils and similar lymphatic tissues in the mouth and pharynx, the papillæ of the tongue and the distribution of taste buds upon them, the structure of the lingual and salivary glands and pancreas in mammals, including the changes which they undergo during secretion, their secretory capillaries, their nerves and nerve-endings. The account of the pancreas embraces, not only a minute description of the glandular substance proper and of the changes which its cells undergo in different physiological conditions, but also a careful description of the intertubular islands which were first described by Langerhans, and which have recently attracted attention on account of the possibility, which has been expressed by more than one writer, that the influence which that gland exerts upon the carbohydrate metabolism of the body (its entire removal is always followed by severe diabetes) may be dependent upon an internal secretion produced by the cells in question.

The part which is devoted to the liver opens with a comparison of the structure of that with other glands, and is followed by a historical account of the discovery of the bile canaliculi, which furnishes an excellent example of the value of applying the methods of physiology to the elucidation of structure. The treatment of the liver cell alone occupies some forty pages, although this is a subject which, in most text-books of histology, is considered to be sufficiently dealt with in as many lines. Another important part of this section, not merely from a morphological but also from a pathological point of view, is that devoted to the connective tissue of the lobules, which was originally shown by von Fleischl (working with Ludwig) to be so abundant; a fact which has been confirmed and extended by several observers employing modern histological methods. Like its predecessors, this volume is a storehouse of information upon the subjects of which it treats, and must remain for many years an indispensable work of reference, not only to the comparative anatomist and histologist, but also to the physiologist. E. A. S.

OUR BOOK SHELF.

Flies Injurious to Stock. By Eleanor A. Ormerod, LL.D. Pp. 80. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1900.)

MISS ELEANOR A. ORMEROD continues her useful work of popularising the information which has been acquired concerning the life-histories of injurious insects by issuing, in a form accessible to all, an account of the principal dipterous pests which infest stock.

The book does not pretend to be a contribution to science, for Miss Ormerod's own important observations on the "Warble-fly" have been several times previously published, and the rest of the work is mainly compiled from various authors whose papers are duly referred to in footnotes.

The Hippoboscidæ are represented by the "forest-fly" and the so-called "sheep-tick," but most of the book is devoted to an account of the Tabanidæ or "gad-flies" and the Œstridæ or "bot-flies," and the writer tries to make clear the differences in structure and habits between the members of these two families. Much general ignorance exists with regard to the common biting flies, and the brief account of them here given will, we imagine, be particularly welcome. Considering the frequency of their occurrence, remarkably little is known of the early history of some of these insects, but Miss Ormerod is surely in error in stating that that of *Haematopota* is unknown, for the larva has been described and figured by Perris.

The Œstridæ, economically the most important family, naturally come in for the fullest treatment. Errors which have crept into the usual accounts of the "sheep's nostril fly" are corrected. Larvæ, not eggs, are laid in the sheep's nostril, but though they work up into the nasal passages, they never, as is often stated, reach the brain.

A second horse bot-fly which occurs in this country, *Gastrophilus haemorhoidalis*, might have been mentioned, especially as it is more easy of detection and more susceptible of treatment than the common species.

The otherwise excellent account of the "warble-fly" is marred by the incorporation of a large amount of correspondence, the gist of which might have been compressed into a few lines. However appropriate the inclusion of these letters in Miss Ormerod's original papers on the subject, they seem out of place in a *résumé* such as that before us.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Value of Magnetic Observatories.

IN answer to those who consider that the magnetic results obtained at Kew Observatory are of little or no practical value, I would offer the following remarks for their consideration. The railway engine driver may run his 70 miles an hour on rails, certain as to being on the right road, and in like manner the electric tram car driver may keep in the right direction.

The sailor, however, on the trackless ocean, has only his compass to guide him, at best directed by that unstable magnet the earth. But the earth by induction transforms his iron or steel ship into a still less stable magnet, which not only disturbs the compass on board but permanently reduces the value of the earth's directive force on that compass by ·1 or ·2 of that observed on land.

Fortunately, as the knowledge of terrestrial magnetism increased, men of science were gradually enabled to solve the at one time knotty problem of a ship's magnetism, and the seaman can now run his vessel over twenty knots an hour in safety on a dark night. Without a knowledge of terrestrial magnetism, the now universal iron or steel ship would have been almost an impossibility, and the faster ships go the more necessary does that knowledge become, to wit in the navigation of the St. Lawrence and English Channel. The sailor is continually asking for charts of the magnetic declination to be brought up to date; Kew and other magnetic observatories help largely in this direction.

Moreover, a theory of terrestrial magnetism is much wanted which (letting alone other possibilities) would enable us to provide accurate charts of the magnetic elements years in advance, in the same manner that the "Nautical Almanac" is prepared. Hence the importance of Kew as a valuable link in the chain of magnetic observatories, which has already been reduced by the destruction caused by electric tramways.

Blackheath, S.E. ETTRICK W. CREAK.

Huxley's Ancestry.

WITH reference to Lord Avebury's reminiscences of Huxley, and the summary of his views concerning British races, it may be of interest to quote Huxley's account of his own racial characters, as contained in a private letter written ten years ago: "My father was a Warwickshire man; my mother came of Wiltshire people. Except for being somewhat taller than the average of the type, she was a typical example of the 'Iberian' variety—dark, thin, rapid in all her ways, and with the most piercing black eyes I have ever seen in anybody's head. Mentally and physically (except in the matter of the beautiful eyes) I am a piece of my mother, and except for my stature, which used to be 5 feet 10, I should do very well for a "black Celt"—supposed to be the worst variety of that type. My father was fresh-coloured and grey-eyed, though dark-haired, good-humoured, though of a quick temper, a kindly man, rather too easy-going for this wicked world. There is a vein of him in me, but the constituents have never mixed properly. . . . I know of Huxleys in Staffordshire, Worcestershire and Wales, and I incline to think that the Huxleys of Huxley [Cheshire] are responsible for most of us, and that, upon the whole, we are mainly Iberian mongrels, with a good dash of Norman and a little Saxon." This was written for my private information, as bearing on certain inquiries into "genius" and race, but there can be no objection to its publication now.

HAVELOCK ELLIS.

Quartz-Calcite Symmetrical Doublet.

AT the Bradford meeting of the British Association, Section A, I offered to lend this lens for purposes of research to any investigator who would satisfy me as to his qualification for taking the necessary care of it. I am now ready to do so.

Oaklands, Chard, November 26. J. W. GIFFORD.

ON SOLAR CHANGES OF TEMPERATURE AND VARIATIONS IN RAINFALL IN THE REGION SURROUNDING THE INDIAN OCEAN.[1]

II.

Indian Rainfall. S.W. Monsoon, 1877–1886.

It will be clear from what has been stated that our object in studying rainfall was to endeavour to ascertain if the + and – temperature pulses in the sun were echoed by + and – pulses of rainfall. The Indian rainfall was taken first, not only because in the tropics we may expect the phenomena to be the simplest, but because the regularity of the Indian rains had broken down precisely when the widened line observations showed a most remarkable departure from the normal.

It was also important for us to deal with the individual observations as far as possible, because it was of the essence of the inquiry to trace the individual pulses if they were found. Hence the S.W. monsoon was, in the first instance, considered by itself, because although Eliot holds that the winter rains (N.E. monsoon) are due to moisture brought by an upper S.W. current,[2] their incidence is very different and their inclusion might mask the events it was most important to study.

The first investigation undertaken was the study of the rainfall tables published by the Meteorological Department of the Government of India. These were brought together by Blandford down to the year 1886.[3] As the widened line observations were not begun at Kensington till 1879, the discussion was limited in the first instance to the period 1877–1886 inclusive, embracing the following changes in solar temperature, occurring, as will be seen, between two conditions of mean solar temperature:—

Mean	– pulse	Mean	+ pulse	Mean
1876	1877–1880	1881	1882–1886	1886–1887

Bearing in mind that the intensity of the + pulse may in some measure be determined by the solar disturbances, which for the present are registered by spotted area, it is important to point out that the preceding maximum in 1870 was remarkable for obvious indications of great solar activity.[4]

It soon became evident that in many parts of India the + and – conditions of solar temperature were accompanied by + and – pulses producing pressure changes and heavy rains in the Indian Ocean and the surrounding land. These occurred generally in the first year following the mean condition, that is, in 1877–8 and 1882–3, dates approximating to, but followed by, the minimum and maximum periods of sun-spots.

Meldrum, as far back as 1881,[5] referred to "the extreme oscillations of weather changes in different places, at the turning-points of the curves representing the increase and decrease of solar activity."

It was especially in regions such as Malabar and the Konkan when the monsoon strikes the west coast of India, that the sharpness and individuality of these pulses was the most obvious.

One method of study employed has depended upon Chambers's view (*Indian Meteorological Memoirs*, vol. iv. Part 5, p. 271) that the S.W. monsoon depends upon the oscillations of the equatorial belt of low pressure up to 31° N. lat. at the summer solstice. The months of rain-receipt on the upward and downward swing will therefore depend on the latitude, and these months alone have been considered.

We began by taking elevated stations in high and low latitudes.

Leh Lat. 34° N. 11,500 feet	The 1881 pulse (in July) was the heaviest recorded (1·77 inches) save one in 1882; the rainfall was nearly as high. The pulse felt in 1878 was the highest of all.
Murree Lat. 33° N. 6344 feet	The 1881 pulse (Aug.) is high, but is followed by a higher next year. The 1878 pulse (Aug.) is highest of all.
Newera Eliya Lat. 7° N. 6150 feet	Taking the fall in July and Aug. The 1881 pulse occurs in 1882, and is highest. Next comes the pulse in 1878.

It must also be stated that if we take the sun-spot maximum, including the period we have chiefly discussed (1877–1886), as normal, it is found that there are variations in rainfall accompanying the preceding and succeeding maxima of 1870 and 1893. This variation indicates the existence of a higher law, but there has not been time to discuss them thoroughly enough to justify any definite statements about them.

The Rainfall of "Whole India."

The next step was to work on a longer base, and for this purpose Eliot's whole India table of rainfall, 1875–1896 (NATURE, vol. lvi. p. 110), embracing both the S.W. and N.E. monsoons, being at our disposal, was studied.

It was anticipated that such a table, built up of means observed over such a large area and during both monsoons, would more or less conceal the meaning of the separate pulses observed in separate localities; this we found to be the case. But, nevertheless, the table helped us greatly, because it included the summation of results 9 years later than those included in Blandford's masterly memoir. Predominant pulses were found in 1889 and 1893, following those of 1877–8 and 1882–3. So that it enabled us to follow the working of the same law through another sun-spot cycle, the law, that is, of the mean solar temperature being followed by a pulse of rainfall.

Mean sun	Rain pulse
1876	– 1878
1881	+ 1882
1886–7	– 1889
1892	+ 1893

The main feature of this table is the proof of a tremendous excess of rainfall in 1893—by far the greatest excess of all (percentage variation, + 22). This was far greater than the excess in 1882.

The next remarkable excess occurs in 1878 (percentage variation, + 15).

The pulses in the period stand as follows:—

	Percentage variation	Heat pulse		
Min. 1878	+15	–		Years after rise of iron lines.
Max. 1882	+ 6	+	Years after rise of	
Min. 1889	+ 6	–		
Max. 1893	+22	+	unknown lines.	

[1] By Sir Norman Lockyer, K.C.B., F.R.S., and W. J. S. Lockyer, M.A. (Camb.), Ph.D. (Gött.) Paper read before the Royal Society on November 22. Continued from p. 109.

[2] Report, 1877, p. 125.

[3] "Indian Meteorological Memoirs," vol. iii.

[4] "The year 1870 was characterised by an exuberance of solar energy, which is without parallel since the beginning of systematic observations (*i.e.* since 1825). The number of observed groups far exceeds that of any previous year, and it appears also from a cursory comparison with the maximum year's observations, as recorded by Hofrath Schwabe, that the magnitude of the different groups, as well as the average amount of spotted surface during any period of the year, is unprecedented." (*Monthly Notices*, vol xxxi. p. 79, Warren de la Rue, B. Stewart, B. Loewy.)

The table which the authors of this paper give shows that during the year, although observations of the sun were made on 213 days out of the 364, there was no day without spots recorded. In fact, during the whole year no less than 403 new groups of spots were noted, thus showing us that on the average there was more than one new group per diem.

The authors further remark, "A very remarkable feature of the groups observed during the year appears to be their extraordinary lifetime. . . an exceedingly large number of groups completed 3, 4, and even more revolutions before finally collapsing."

[5] "On the Relations of Weather to Mortality, and on the Climatic Effect of Forests."

The variations in the intensities of the pulses of rain at the successive maxima and minima are very remarkable, and suggest the working of a higher law, of which we have other evidence. But, putting this aside for the present, it should be pointed out that even normally we should not expect the same values for the rainfalls in 1882 and 1893, because the amount of spotted area was so different, 1160-millionths of the solar surface being covered with spots in 1883, and 1430 in 1893.

The very considerable variation in the quantity of snowfall on the Himálayas has often been pointed out by the Indian meteorologists. We have, therefore, used the "whole India" curve between 1875 and 1896, to see whether the sun pulses, which we have found to be bound up with the Indian rainfall, are in any way related to the snowfall as might be expected.

The Himálayan snowfall beyond all question follows the same law as the rain, the values occurring at the + and − pulses, as under, being among the highest:—[1]

		inches
−	1867-8 ...	134
+	1871-2 ...	110
−	1877-8 ...	207
+	1882-3 ...	81

From these tables it follows that both in rainfall and snow the quantity is increased in the years of the rise both of the unknown and iron lines.

Other Rainfalls.

Being in presence of pulses of rainfall in India during the south-west monsoon, corresponding with pulses of solar change, it became necessary to attempt to study their origins. We may add that other pulses were traced, especially one in 1875, but the simplest problem was considered alone in the first instance.

The rainfalls at the Mauritius, Cape Town and Batavia were collated to see if the pulses felt in India were traceable in other regions surrounding the Indian Ocean to the south and east.

The Mauritius Rainfall.

The rainfall of Mauritius has been obtained by utilising the results that have been published in the Blue Books[2] issued by the Royal Alfred Observatory since the year 1885. The volume for 1886 gives the yearly total rainfall for every station that was then in use from 1861 up to the year 1885, and these values have been employed; since then the yearly values have been obtained direct from each of the yearly volumes subsequently published, *i.e.* to the end of the year 1898.

It was at first thought that the total Mauritius rainfall could be fairly obtained by employing for the period between 1861 and 1886 the means of several stations as given by Meldrum,[3] and continuing the values from the observations published in the more recent yearly volumes.

It was found, however, that from 1861–1880 the rainfall was obtained from the observations of four stations, while from 1871–1886 the observations from eight stations were employed.

As a study of all the published data showed that more stations might be utilised in determining the total rainfall of Mauritius, it was decided to discuss all the observations afresh, and make use of as many as possible.

To this end the records of twenty-eight stations, situated in six different districts, were chosen, and the total rainfall for each year obtained. It is only natural that the number of rain-gauge stations in the early year of 1860 was not so numerous as that of more recent years; the facts may be stated as follows:—

Years.	Mean yearly rainfall variation from normal	No. stations used.	Years.	Mean yearly rainfall variation from normal.	No. stations used.
	Inches.			Inches.	
1861	+26·6	1	1880	−19·3	23
1862	−10·2	4	1881	− 7·3	25
1863	+ 9·6	6	1882	+16·6	25
1864	−12·2	8	1883	+ 1·8	26
1865	+22·6	10	1884	−12·4	25
1866	−18·2	10	1885	− 9·8	26
1867	− 6·6	11	1886	−35·3	26
1868	+27·1	11	1887	− 4·2	27
1869	− 3·3	12	1888	+22·3	26
1870	− 3·6	12	1889	+18·4	24
1871	−18·9	13	1890	+ 1·2	25
1872	− 7·0	13	1891	+ 1·4	26
1873	+10·3	13	1892	+ 5·1	19
1874	+17·4	17	1893	− 7·4	24
1875	+ 3·0	15	1894	− 0·6	24
1876	− 6·5	17	1895	+10·0	21
1877	+31·4	19	1896	+17·6	22
1878	− 3·8	22	1897	−19·6	24
1879	− 5·2	22	1898	− 2·1	24

With regard to the general rainfall of Mauritius throughout the year, it may be stated that on the average the most rainy months are from December to April, both months inclusive.

The months of November and May are those in which the daily rainfall is increasing and diminishing respectively. Sometimes in July or August there is a slight tendency for a small increase.

The Mauritius Rainfall Curve for the period 1877–1886.

In plotting the Mauritius rainfall curve for the period 1877–1886, it was observed that the curve is of a fairly regular nature, showing alternately an excess and deficiency of rainfall.

The highest and lowest points of the curve will be gathered from the following table:—

Year.	Maximum.	
	Excess.	Deficiency.
1877	31·4	—
1880	—	19·3
1882	16·6	—
1886	—	35·3

Comparing the times of occurrence of the two pulses of rainfall at Mauritius with the times of the crossings of the known and unknown lines, it is found that the Mauritius maximum rainfall of 1877 occurs about a year after the rise of the known lines in 1876. The next Mauritius pulse of rainfall in 1882 follows the succeeding crossing, when the unknown lines are going up, also about a year later.

Comparison of the Mauritius Rainfall with those of Leh, Murree and Newera Eliya for the period 1877–1886.

The most prominent feature of the Mauritius rainfall for this period was the great excess in the years 1877 and 1882.

[1] *I.M.M.*, vol. iii. p. 235.
[2] "Mauritius Meteorological Results."
[3] 1861–1880. Relations of Weather to Mortality, &c., 1881, p. 36. 1871–1886. Annual Report of the Director of the Royal Alfred Observatory for 1886, p. 18.

Both of these pulses have corresponding maxima in the curves for the rainfalls of Leh, Murree and Newera Eliya, the dates of these in all three cases being 1878 and 1882.

The delay of about a year in the effect of the Mauritius pulse being felt in Ceylon and India is exactly what would be expected if the rain at sun-spot minimum comes from the south, as has been surmised.

The fact that the pulses at Mauritius, Ceylon and India in 1882 occur simultaneously is very strong evidence in favour of an origin in the equatorial region itself for the Indian rain at sun-spot maximum. The pulse at maximum in the Indian south-west monsoon may depend to a large extent upon the action of the excess of solar heat on the equatorial waters to the south of India, and not on an abnormal effect on the south-east trade.

We have found that there was a defect of the usual rainfall at Mauritius in 1892–3, and yet the rain supply in India was in excess.

from time to time in the Southern Ocean. In his "Annual Summary" for 1896 he wrote as follows:—

"It has apparently been established in the discussion that the variations of the rainfall in India during the past six years are parallel with, and in part, at least, due to variations in the gradients, and the strength of the winds in the south-east trade regions of the Indian Ocean. The discussion has indicated that there are variations from year to year in the strength of the atmospheric circulation obtaining over the large area of Southern Asia and the Indian Ocean, and that these variations are an important and large factor in determining the periodic variations in the rainfall of the whole area dependent on that circulation, and more especially in India. It has also been indicated that these variations which accompany, and are probably the result in part of abnormal temperature (and hence pressure) conditions in the Indian Ocean and Indian monsoon area may be in part due to conditions in the Antarctic Ocean, which also

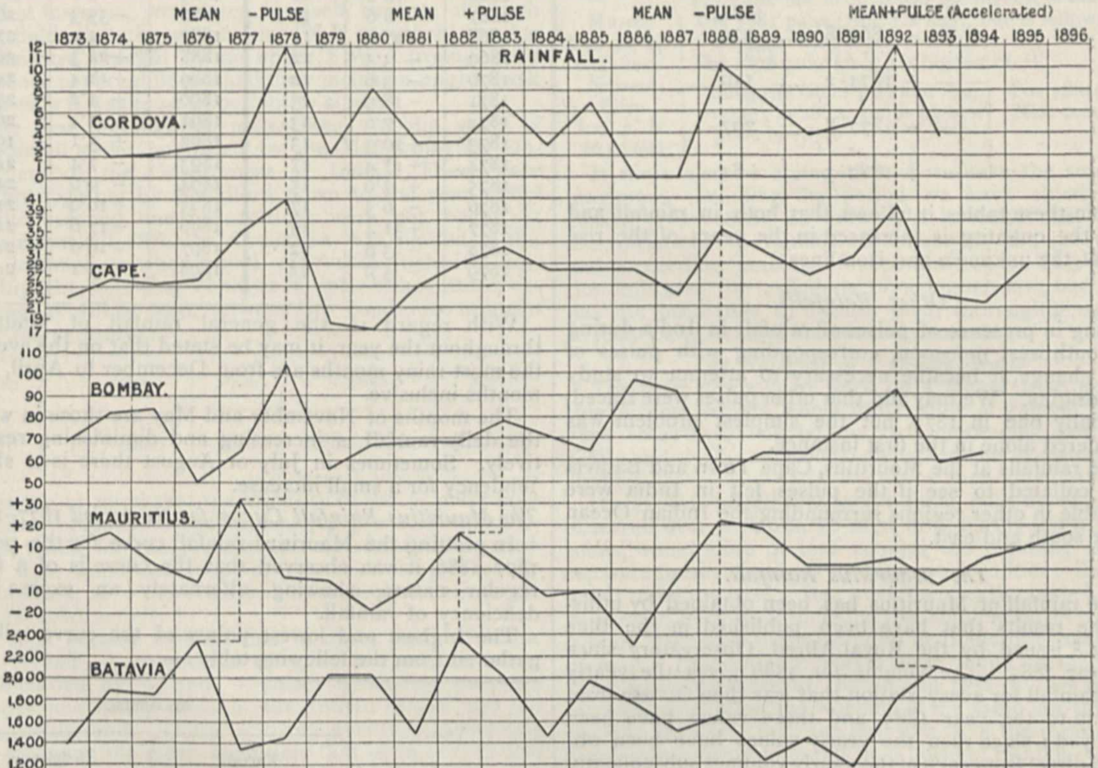

FIG. 1.

RESULT OF THE COMPARISON OF RAINFALL.

The + and – Pulses.

It seems quite certain that we are justified in associating the 1878 pulse of rainfall during the south-west monsoon in India with the rainfall common to Mauritius, Batavia and the Cape at that date; that in all cases the rain has been associated with some special condition connected with the south-east trade in the Indian Ocean.

The rainfall of Cordoba suggests that the same trade wind in the Atlantic Ocean was similarly affected at the same time.

The Cause of the – Pulse.

Mr. Eliot long ago conjectured that the rainfall of India was profoundly modified by events taking place

determine the comparative prevalence or absence of icebergs in the northern portions of the Antarctic Ocean."

We have begun an investigation into the pressure changes which have been recorded in this region, but it will be some time before it is finished. The idea underlying the inquiry is that the reduced solar temperature may modify the pressure so that the high pressure belts south of Mauritius may be broken up and thus allow cyclonic winds from a higher latitude to increase the summer rains as they certainly were increased at the normal minima of 1877 and 1888.

It has been shown that the – pulse is felt in India about a year later than it commences action in the southern oceans; while in some cases the + pulse is felt almost simultaneously in India and at the southern stations.

The Rainfall at the Cape, Batavia and Cordoba for the Period 1877–1886.

Each of the curves illustrating the rainfall for the Cape and Cordoba for this period shows two prominent maxima in the years 1878 and 1883; these correspond nearly with the + and − pulses of solar temperature. Comparing them also with the Bombay and Mauritius curves for the same period, it is found that the pulses indicated at Bombay occur simultaneously with those of 1878 and 1883, but in the case of Mauritius the effect of each of the pulses is felt about a year or so earlier, namely 1877 and 1882 (Fig. 1).

The rainfall curve for Batavia for this period has its most prominent maximum in the year 1882, like that of Mauritius, thus preceding by a year the pulse felt at the Cape, Cordoba and Bombay in 1883.

The Time Conditions of the Pulses.

The various curves which we have drawn for the purposes of study have been compiled from yearly means, generally to be the case. Thus after the mean solar temperature of 1876, the − pulse was felt first at Mauritius, then in India and the Cape. After the mean of 1881, the + pulse was felt first at Mauritius, then in India and the Cape. Cordoba felt both pulses in the same year as India and the Cape.

Subsidiary Pulses.

In a normal sun-spot curve we find a sharp rise, generally taking three or three and a half years, to maximum, and a slow decline to minimum, on which the remaining years of the cycle are spent.

The curve on the upward side rises generally regularly and continuously; on the downward portion the regularity of the curve is very often broken by a "hump" or sudden change of curvature. There has not yet been a complete discussion of the number and character of the prominences associated with the spots during the cycle; we have found, however, that the "hump" in the sunspot curve in 1874 was accompanied by a remarkable increase in the number of eruptive prominences.

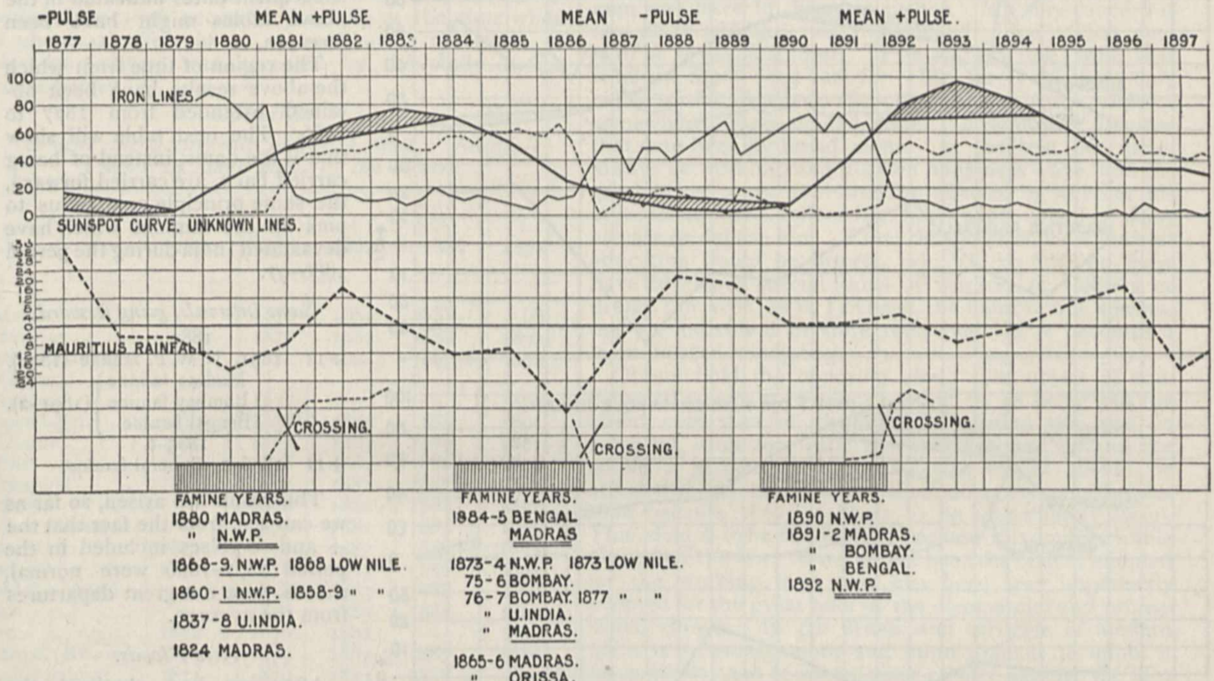

FIG. 2.

and, so far, in these curves the rainfall in months has not been considered. That will have to come later. Hence if the rainfall which most influences the yearly mean occurs in the last three months at one place, and in the first three months of the next year at another, they are shown as being a year apart, whereas they have actually been continuous.

With regard to the travel of the pulses over large areas under the influence of the S.E. trade, it may be gathered from the pressure charts that the + and − conditions of pressure are apt to lie over the centres of land and water areas, and not generally over coast lines. In the case of water surfaces, the effect of a sudden change in the solar radiation on the pressure might be expected to be felt not at the point where the pressure is least or greatest at the time, and of the most general type, but where the equilibrium is most unstable. On the other hand, more time would be required for the new pulse to establish itself where the conditions are more complicated.

Hence we should expect the pulses to be felt first in the eastern part of the southern ocean, and this seems

We have already referred, in discussing the Indian rainfall, to a remarkable intensification of the south-west monsoon in 1874–5, the effect of which is especially noticeable in the rainfall of the Konkan and North-West Provinces, and we have come to the conclusion that we must consider all these events as due to a common cause, that is, to a subsidiary solar pulse. We propose to return to this subject in a subsequent communication, after inquiries have been completed relating to 1885–6 and 1896–7.

The Intervals between the Pulses.

There will obviously be intervals between the ending of one pulse and the beginning of the next, unless they either overlap or become continuous.

The + and − pulses, to which our attention has been chiefly directed, are limited in duration; and when they cease the quantity of rain which falls in the Indian area is not sufficient without water storage for the purposes of agriculture; they are followed, therefore, by droughts, and at times subsequently by famines.

Taking the period 1887–89 we have (Fig. 2)

Rain from − pulse	77, 78, 79 (part)
No rain pulse	79 (part), 80 (central year), 81 (part)
Rain from + pulse	81 (part), 82, 83, 84 (part)
No rain pulse	84 (part), 85, 86 (central years), 87 (part)
Rain from − pulse	87 (part), 88, 89

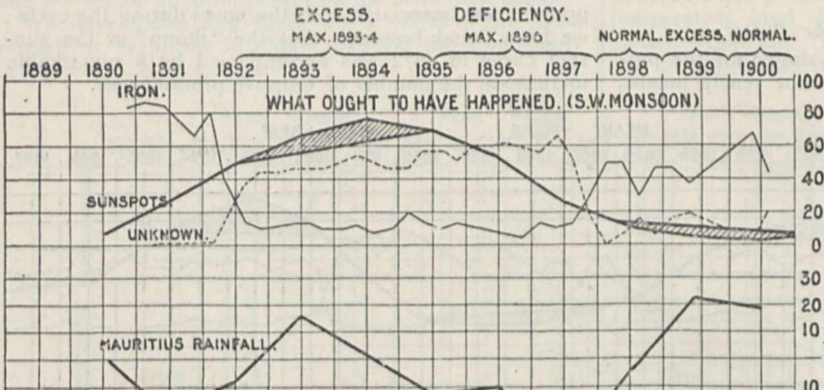

FIG. 3.

The duration of these + and − pulses of rainfall was determined in the first instance by the Mauritius rainfall, which shows both pulses; and later from the Malabar rainfall, which perhaps shows the effect of the south-west monsoon in its greatest purity.

All the Indian famines since 1836 (we have not gone back further) have occurred in these intervals, carried back in time on the assumption of an 11 year cycle.

The following tables show the result for the two intervals:—

The interval between the pulses, taking 1880 *as the central year, on the upward curve.*

1880, Madras famine.
N.W.P. famine.

1880 − 11 = 1869, N.W.P. famine (1868–9).
1869 − 11 = 1858, N.W.P. famine (1860).
1858 − 11 = 1847.
1847 − 11 = 1836, Upper India famine (1837–8). (Great famine).

The interval between the pulses, taking 1885–6 *as the central years, on the descending curve.*

1885–6 {Bengal famine, Madras famine} (1884–5).
1885–6 − 11 = 1874–5, N.W.P. famine (1873–4).
Bombay famine (1875–6).
Bombay famine, Upper India famine (1876–7).
1874–5 − 11 = 1863–4, Madras famine, Orissa famine (1865–6).
1863–4 − 11 = 1852–3, Madras famine (1854).

It is clear from the above table that if as much had been known in 1836 as we know now, the probability of famines at all the subsequent dates indicated in the above tables might have been foreseen.

The region of time from which the above results have been obtained extended from 1877 to 1886. The next table will show that if the dates, instead of being carried back, are carried forward, the same principle enables us to pick up the famines which have devastated India during the period 1886–97.

Same intervals, going forward.

1880.
+11 1891, N.W.P. famine (1890).
Madras famine, Bombay famine, Bengal famine (1891–2).
1885–6
+11 1896–7, General famine.

This result has arisen, so far as we can see, from the fact that the + and − pulses included in the period 1877–1886 were normal, that is, were not great departures from the average.

Nile Floods.

After we had obtained the above results relating to the law followed by the Indian famines, we communicated with the Egyptian authorities with a view of obtaining data for the Nile Valley.

We have since found, however, from a memorandum by Eliot,[1] that Mr. Willcocks, in a paper read at the Meteorological Congress at Chicago, remarked that "famine years in India are generally years of low flood in Egypt."

It remains only for us, therefore, to point out that the highest Niles follow the years of the + and − pulses. Thus:—

1871, one year after + pulse 1870.
1876, two years after subsidiary pulse of 1874.
1879, two years after − pulse 1877.
1883–4, one and two years after + pulse 1882.
1893–4, after + pulse 1892 (India excess rainfall, 1892–3–4).

[1] Forecast of S.W. Monsoon rains of 1900.

The Great Indian Famine of 1899.

When, in a sun-spot cycle, the solar temperature is more than usually increased, the regularity of the above effects is liable to be broken, as the advent of the − pulse is retarded.

This, as we have already pointed out, is precisely what happened after the abnormal + heat pulse of 1892, following close upon the condition of solar mean temperature.

The widened line curves, instead of crossing, according to the few precedents we have, in 1897 or 1898, have not crossed yet—that is, the condition of ordinary solar mean temperature has not even yet been reached.

We have shown that, as a matter of fact, in a normal cycle India is supplied from the southern ocean during the minimum sun-spot period, and that this rain is due to some pressure effect brought about in high southern latitudes by the sun at − temperature.

As the − temperature condition was not reached in 1899, as it would have been in a normal year, the rain failed (Fig. 3).

We may say then that the only abnormal famine recorded since 1836 occurred precisely at the time when an abnormal effect of an unprecedented maximum of solar temperature was revealed by the study of the widened lines.

TABLE

Showing the Occurrence of the + and − Rainfall Pulses in other parts of the World.

	+ 1870	− 1877	+ 1882	− 1886	+ 1892
Batavia ...	—	1876	1882	1888	(?)
Mauritius ...	—	1877	1882	1888	1892
Catherinenburg (Russia)	—	1877	abs.	1887–8	1892
Scotland ...	—	1877	—	—	1892
Copenhagen ...	1872–3	1877	1882	1888	1891
Adelaide ...	1870	1877	1883	1889	1892–3
Tifilis	1870	1878	1881	1886–90	1893
Archangel ...	1872	1878	1881–2	1887–8	1892
Brussels ...	—	1878	1882	1888	1892
Hobart Town ...	—	1878	1882	1887	1893
Malabar [1] ...	1871	1878	1882	1888	1892
Toronto ...	1870	1878	1883	1886	1893
Cordoba (Arg.)	—	1878	1883	1888	1892
Cape	—	1878	1883	1888	1892
Java	1872	1879	1882	—	1893
Barnaul (Russia)	1872	1879	1882–3	1887	1894
St. Petersburg	1871	1879	1883	1888–9	1893
Nile	1871	1879	1883–4	—	1893–5

[1] For comparison.

THE BRADFORD MUNICIPAL TECHNICAL COLLEGE.

PROF RÜCKER recently distributed the prizes at the Technical College at Bradford, which was taken over by the municipality a year ago, and is now controlled by a Committee of the City Council. The following is an abstract of his address:—

It would be trite to dwell at length on the changes which have taken place in the educational standards during the last quarter of a century. Then Mr Forster's Education Bill had only been in operation for five years. Now we have free elementary education, and a large sum has been provided for technical education. Two new Universities have been founded and a third, after fifty years' examining, is at length about to teach. Education is not now regarded as the task of a few dons and professors and schoolmasters. It is a matter which the Cabinet discusses, together with the issues of peace and war, and with the federation of daughter States into a Commonwealth. Nay, and in the great spread of local self-government, when Town Councils decide questions which affect more people than constituted, in the beginning of the century, many an independent German State, education is not forgotten; and here in Bradford you have the whole authority and power of your great municipality brought to bear to form a technical school which will support the industries on which your prosperity depends.

And yet, gentlemen, in the midst of all this eager and fruitful effort how difficult it is to decide what the ideal system of education should be. For in any such system two things must be considered, the welfare of the individuals taught and the welfare of the community of which they are a part; and at first sight these two do not always seem to be identical. Each man, the State may say, has a task to perform, which, if he performs it well, is for the good of the community, and, provided he is a good citizen, I care only about his special task. This man may have to dispense justice. My only concern is that he should be a just and learned judge. That man is to be a manufacturer. If he manufactures well, that is all the State need care for. But surely this view only needs stating clearly to show that there must be a fallacy somewhere. Like the old political economy, it assumes that man lives by bread alone. At the best he cannot always be working, and his own happiness—aye, and the good of the State, too—may be affected by whether his amusements are refined or low, upon whether they elevate or debase him. From this point of view the best educators would be insects, which, like ants or bees, have developed special forms of workers, or soldiers, or drones; or even, as is, I believe, the habit of one species, use an individual to store their food till it becomes a mere bloated honey-bag.

Others hold the opposing view. The object of education, they say, is to educate—that is, to bring out the latent capacities of the mind. Provided this end is achieved, it matters little how this is done; but, on the whole, it is better that the subjects taught should be selected rather because they illustrate general principles than because they are likely to be immediately useful. This ideal is to be condemned because it is impracticable for all but the few. It never has been the system adopted for the working man, and has been very imperfectly adopted for the great bulk of the commercial and professional classes. In the stress and struggle of modern life it is becoming more and more difficult to adopt it for anybody, and common sense revolts against the idea that the utility of the subject taught, or of the method of teaching it, is of secondary importance.

We come, then, to the conclusion that the truth lies somewhere between these two extremes, and that the best education is that which will prepare a man for his walk in life, and will also, as far as may be, keep his mind open to interests and ideas other than those upon which his success as a bread-winner directly depends.

I will not attempt, in the short time at my disposal, to sketch out a general system of education in which these conditions would be fulfilled, and, if I did, I should throughout be conscious that I was only throwing an apple of discord among educational experts.

But, taking scientific and technical education as a whole, I am clear that for the better students, at all events, the study of science should be relieved and aided by the study of modern languages.

Nowadays everything is becoming more cosmopolitan. Science is becoming more international. Only this summer I attended the first meeting of a new association of all the great scientific academies of the world. Again, with the new century will begin the publication of an international catalogue of scientific literature, in which all scientific memoirs and publications will be catalogued.

I quote these instances as they are those which have fallen more immediately under my own observation, but manufacturers can tell a similar tale. The visit of the Iron and Steel Institute and of the Institution of Electrical Engineers to Paris, the visit of the Electrical Engineers to Switzerland, and the travels of the Naval Architects all show that the great professions are becoming more and more international. It is essential that a young man who intends to keep abreast of what is being done abroad should be prepared to read foreign periodicals, and to make the most of any opportunity which may occur of going abroad himself. To do this he must study modern languages. This will be directly useful, and it will also have the great educational advantage that it tends to keep alive an interest in something other than the science or technology to which I am supposing that the attention of the student is chiefly turned.

As matters stand at present, a number of the most intelligent of our youth, after the more elementary parts of their education are completed, devote themselves chiefly to science. Many of the best of them come under my personal observation in the Royal College of Science. Some of them develop such marked scientific ability that they pursue the more theoretical side of their studies, and aim at taking a degree with honours. Their education has often been carried on chiefly by means of State or municipal grants made to the schools or colleges in which they have been educated. In the system of education under which they have been brought up, no effort has been made to induce them to study classics. Yet when they have proved themselves worthy of a high University training in science, they are suddenly stopped in the middle of their career, and told that no further progress towards a degree is possible unless they go back to school again and learn the Latin grammar. I think that the time has come when this should be changed, and a knowledge of modern languages should be allowed to replace Latin.

The hard and fast line of separation which has too often been drawn between the earlier education of those who do and of those who do not propose to go to the University would thus be obliterated. Both should be taught modern languages, both should be taught science, and both would then have acquired a literary and scientific training which could be developed in the further stages of a technical or a University education.

Do not misunderstand me. I am not advocating the abolition of the system of classical education which is predominant in the public schools. But it is too often forgotten that there is another great system of education growing up side by side with that which is based on classics. This system is based on a knowledge of science. The study of classics is introduced into it neither at the beginning as a foundation nor at the end to complete it. It is introduced as a patch in the middle. Of two things one. If Latin is essential, let the State and the municipalities supply funds for it as lavishly as they do for science. If it is not essential, do not insist on introducing it at the most inconvenient moment of the student's career.

But if I would take away something from the burden now laid on beginners, I would also modify the later stages of scientific or technical education.

Up to the present the general training of students of science at the University has ceased with their matriculation. The modicum of Latin which they have then obtained, with a little history and geography, and perhaps some French, is abandoned. The University takes no further note of their progress in these subjects. If I am in favour of ceasing to make Latin compulsory, I also desire that the more advanced students of science or industry should carry on the study of modern languages, which should be regarded as an integral part of a scientific education. Too exclusive attention to one subject would thus be less probable; but nevertheless the student would be directed to what he himself would regard as matter germane to the central interest of his life, for a knowledge of French and German is essential to the proper cultivation of science. These views I have long held, and I am glad to learn that they are very similar to, if not identical with, the views of Lord Rosebery. If the politicians determine on the reform it will become a practical question.

But though anxious that this reform should take place, I am well aware that the matter of immediate, pressing and vital importance for our national welfare is that the knowledge of science should not only be more widely spread among us, but also that the scientific method should be more widely applied to industry.

I have no intention of attempting to read Bradford a lesson on business methods. But you will allow me to congratulate both the scientific and the business worlds on the fact that they are drawing nearer together. A profound knowledge of the secrets of nature may be combined with knowledge of the world, while the business man is often a highly cultivated scholar, and is learning the lesson that he who is quickest to apply new knowledge to old problems is most likely to win and to keep the markets of the world.

Day by day the workshops are growing more and more like scientific laboratories, except that the appliances are on a scale which few laboratories have the means to command. On the other hand, the laboratories are becoming more and more like the homes of scientific industry.

Germany has for some years had a national physical laboratory—the Reichsanstalt—in which scientific questions likely to be useful to industry are investigated. The organisation for which that country is remarkable, and in which we are deficient, was shown by the way in which the scientific exhibits at the Paris Exhibition were dealt with. Those of our scientific instrument makers who sent specimens of their work, each selected and exhibited what seemed to him good. Their exhibits were distinct and separate, and the English exhibit as a whole was a patchwork, with no well-defined scheme or pattern. In Germany the scientific exhibit was supervised by the officials of the Reichsanstalt. Instruments of the same class were exhibited together, whoever their maker might be; and the visitor could see at a glance the best that Germany could produce of each particular type. Assistants were ready to open the cases and to display the wares. Catalogues of the different firms were furnished if the visitor signed a written request, and a central office had been established where orders could be booked. This, of course, was an exceptional piece of work, but the general uses of a national laboratory are permanent; and, owing to the efforts of the British Association and the Royal Society, the Government have lately asked the Royal Society to undertake the management of an institution similar to the Reichsanstalt. The sum granted is very small, as compared with the resources of the German institution, but I do not quarrel with that decision. If the thing is good it will grow, and it is perhaps better not to begin on too large a scale. A year ago we were ready to get to work. Six of the great technical societies are represented on the governing body. Committees have formulated a scheme of work, but grave delay has been occasioned by opposition to the erection of the laboratory at Richmond.

But, gentlemen, putting our difficulties aside, I believe that the foundation of a National Physical Laboratory, and the establishment of a municipal technical school at Bradford are both signs of the growing recognition of the ties between science and industry; and I take it as another sign of the same fact that the heads of this great technical college have asked me, a student of pure science, to distribute your prizes to-night. I should be misusing the opportunity you have given me if I did not assert the conviction, common both to you and me, that it is by means of the scientific study of various industries, study such as you here carry on, and such as will be carried on in the National Physical Laboratory, that trade and science alike will prosper.

The first nuggets in gold-bearing districts are often picked up upon the surface; but mines can only be worked on a large scale by organised industry. As we penetrate deeper into the secrets of nature, as the industrial struggle grows keener, the rough and ready methods of the past will not win either knowledge or wealth.

We cannot afford to dispense with the old virtues. If we become slack and idle, if we devote to sports, innocent and useful in their place, the energy and attention which others are giving, not to the amusements, but to the business of life, we shall be, as we shall deserve to be, beaten. But to the old virtues we must add new methods, and among these none seems to me more praiseworthy than that a great municipality should determine that the lads who embark on the principle industries of the town shall have an opportunity of mastering the scientific principles on which those industries are based, and shall be shown, as they master them, how the principles are to be applied to the business of life.

THE ALLIANCE BETWEEN SCIENCE AND INDUSTRY.

LAST September Prof. Carhardt communicated to the American Institute of Electrical Engineers a very complete account, which has recently been printed in *Science*, of the Reichsanstalt at Berlin. He had worked there as a guest for some months in 1899, and had thus gained an insight into its management and organisation. The details he gives of these are very interesting, and the proof of the value of the work done, and of its consequences to German industry, most striking. The cost of the Institution, we may note, was about 200,000*l.*; the annual expenditure amounts to about 15,000*l.* After mentioning these figures he continues, "A very pertinent inquiry is, what are the results of all this expenditure?" and a careful analysis leads him to the conclusion that, "The results have already justified, in a remarkable manner, all the expenditure of labour and money. The renown in exact scientific measurements formerly possessed by France and England has now largely been transferred to Germany. Formerly scientific workers in the United States looked to England for exact standards, especially in the department of electricity, now they go to Germany." And again, "Germany is rapidly moving toward industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism and the failure to utilise to the fullest extent the lessons taught by science."

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held as usual on St. Andrew's Day, November 30, in the apartments of the Society at Burlington House. The auditors of the treasurer's accounts having read their report, and the secretary having read the list of Fellows elected and deceased since the last anniversary, the president (Lord Lister) proceeded to deliver the anniversary address. After referring to the losses by death sustained by the Society since the previous anniversary, and briefly noticing the work and careers of the deceased Fellows, the president continued his address as follows:—

Through the Malaria Committee the Society has kept in touch with the progress that has been made in unravelling the mystery of the greatest scourge of our tropical colonies, and with the steps that advancing knowledge has suggested for its suppression. The subject has now reached a stage at which it may be not unfitting to refer briefly to what has been accomplished.

The term "malaria" implied the belief that some vitiated state of the atmosphere was the cause of the disease. But the knowledge gained of late years of the parasitic nature of infective disorders pointed clearly to such an origin of the intermittent fevers, as the various manifestations of malaria have been termed. Accordingly diligent and long-continued search was made in the water and the soil of malarious districts in Italy for the suspected living agent, but without success. The discovery was made in 1880 by Laveran, a French army surgeon stationed in Algiers, who observed in the red blood corpuscles of malarious patients what he regarded as adventitious living organisms; not of vegetable nature like the bacteria which constitute the *materies morbi* of so many infective diseases, but a very low form of animal life. In what he believed to be the youngest condition of the organisms, they appeared in the red blood-discs as tiny specks of colourless protoplasm, possessing amœboid movements. These, growing at the expense of the red corpuscles which they inhabited, consumed them more or less completely, at the same time depositing in their own substance a peculiar form of dark brown or black pigment, such as had long been known to form characteristic deposits in the organs of malarious subjects. As they grew they assumed various forms, among which was what Laveran termed the "rosace," a rounded body bearing at its circumference little spherules, while the pigment was accumulated at the centre (*vide* Laveran, Du Paludism, Paris, 1891).

This discovery of Laveran's, at first regarded with the gravest suspicion by pathologists, was the first great step in the etiology of malaria. It supplied the means of distinguishing the disease from its counterfeits, and it explained the wonderful specific efficacy of quinine, till then given only empirically. Quinine is remarkable in the circumstance that it acts with deadly effect upon some microbes, in dilutions which are quite unirritating to the human tissues. It can thus be given in sufficient doses to kill the malaria parasite in the blood without injuring the patient.

Nine years after Laveran's discovery, Golgi, of Pavia, who had been specially studying the "rosace" form of the parasite, and who had become convinced that the spherules at the circumference of the rosace were sporules of the microbe, announced that he had observed differences between the rosaces of the tertian and quartan forms of the fever so great and so constant as to make him satisfied that they were two distinct species of organism. At the same time he had made the extremely important observation that the periods of occurrence of the fever corresponded with the times of maturation of the rosaces. These, all coming to maturity about the same time, shed their sporules into the blood, and this determined the febrile attack. The free sporules then, according to his view, attached themselves severally to other red discs, constituting Laveran's tiny amœbæ, and grew in the red copuscles without causing symptoms till they had produced a fresh crop of sporules ripe for extrusion, the time for this being two days in the tertian and three days in the quartan form. Thus the periodicity of the intermittent fevers and their variety in that respect were alike explained. (*Vide* Laveran, *op. cit.*)

A few months later a third species oi the parasite was recognised, having the peculiarity that some of its individuals, instead of being of rounded form, were of crescentic shape. This species received the title æstivo-autumnal, on account of the season in which it showed itself in Italy. It was not so regular in its periods as the others, and was much more dangerous. The existence of these different species was at first very generally doubted, but it is now universally accepted and is of very great importance. The examination of a drop of blood from the finger of the patient enables the physician to decide, not only whether the disease is malaria, but which of the three types it will follow. The more dangerous crescent form is commonest in the tropics, and hence has been termed by Koch tropical malaria. The quartan has proved the mildest of the three.

The process of sporulation might seem at first sight to explain the whole life-history of the parasites. For their propagation within the human body that process does indeed make ample provision. But the mystery remained—how did they gain entrance into the human system? Though present in abundance in the blood of the malarial patient, they are absent from the excreta. Spontaneous generation having been long since exploded, what could be their mode of origin in the external world? This problem has of late been completely solved.

Among the forms of the parasite observed by Laveran was one which he termed "flagellated," possessing filamentous appendages which exhibited extremely active movements, by virtue of which they were often seen to break off from the parent microbe and swim away. These flagella were regarded by many biologists as products of degeneration resulting from the abnormal influences to which the parasites were exposed in blood outside the body. This Laveran could not believe: indeed, it was the remarkable activity of the flagella that finally satisfied his own mind that what he had discovered were really living parasites: he regarded the flagella as the highest form of development of the microbe. There was another observer who felt equally convinced that the flagella were living elements—our Fellow, Dr. Manson. He, however, went a step further. Seeing that the flagella were never met with in blood when first drawn, but only made their appearance after some little time had elapsed, he conceived that their function must be that of spores for spreading the parasite in the external world, and some suctorial insect seemed to him the probable agency for their diffusion. He had observed several years ago that another parasite of the human blood, a microscopic nematode worm, Filaria, is drawn with the blood into the stomach of a kind of mosquito, and finds in the insect a secondary host, in the tissues of which it passes through a new cycle of development. He became deeply impressed with the idea that a similar series of events might occur with malaria, and he expounded his views fully before the College of Physicians. The notion that mosquitoes might be in some way associated with malaria had occurred to Laveran and to others, but by no one had it been brought home with such logical force as by Manson.

Major Ronald Ross, of the Indian Medical Service, on a visit to this country, became deeply impressed by Manson's arguments, and determined to test his theory on returning to India. Using mosquitoes bred in bottles from the larva, he caused them to bite persons affected with the crescent form of malaria, and afterwards sought in the bodies of the insects for evidence of the development of the parasite within them. For two long years he pursued this search, making about a thousand observations, but to no purpose. So far he had employed two kinds of mosquito common in the district where he was stationed; but in August 1897, having been supplied with some larvæ of a species rare in that locality, and having bred the fully developed insects from them, he induced eight of them to bite a patient with crescents in his blood, and examined their tissues at successive periods. Four of them were killed at once for the investigation of the flagellated bodies. Of the remainder, one examined four days after biting showed, under a high magnifying power, several rounded bodies imbedded in the wall of the stomach, differing from any natural structure of the insect, and containing granules of pigment "identical in appearance to that of the parasite of malaria" (*vide British Medical Journal*, December 18, 1897). The eighth mosquito was killed one day later, and exhibited bodies precisely similar except that they were distinctly larger and more substantial, implying that they had grown in the interval. Thinking that in all probability he had at length found that which he had been so long in search of, and feeling uncertain when he might again obtain the rare species for confirmatory investigation, he at once sent a description of his observations to London, accompanied by his preparations and an independent report upon them by a colleague. Dr. Manson, to whom, among others, they were submitted, was so much struck with the preparations that he had a drawing made of the pigmented bodies in them for publication along with Ross's paper. Though, like Ross, expressing himself with caution, he inclined to his interpretation of the appearances. The paper contained a minute description of the rare mosquito, which seemed to Ross to belong to a "family distinct from the ordinary" kinds.

In the following month he made a similar experiment with another species of mosquito which appeared closely allied to the subject of his last observations. He succeeded, though with some difficulty, in getting two of them to bite a patient with crescents. One of these insects, killed next day, was examined with a negative result; but in the second, killed forty-eight hours after biting, the peculiar pigmented bodies were again seen among the tissues of the stomach. Meanwhile, "some scores" of the species, "unfed or fed on healthy blood, had been examined without finding the cells."

In the same month he observed precisely similar pigmented bodies in a common mosquito which he had seen feeding on a patient affected with the parasite of mild tertian fever. Here he had not the rigorous evidence supplied by insects bred from the larva;[1] and it was quite a new thing to find the pigmented bodies in ordinary mosquitoes. But all the patients on whom his previous observations on the common species had been made had been affected with crescents; and the parasite concerned being in this case a new species, it did not seem unlikely that it might be harboured by the common insects.[2] These new facts removed all doubt from his mind; and he felt that he had the subject in his grasp, and wrote to that effect to Manson. But, to his bitter disappointment, he was at this time despatched to another part of India to study another disease; and thus several precious months were lost.

In February 1898, however, he was told off for the special investigation of malaria, and a laboratory in Calcutta was set apart for his use.[3] Few cases of human malaria being available at that season of the year, he turned his attention to some closely allied forms of disease common in birds. He soon found that one of the ordinary kinds of mosquito, which had invariably given negative results when fed on patients with crescents, developed pigmented bodies among the tissues of the stomach if fed on birds, such as sparrows, containing in their blood the form of bird parasite known as Proteosoma. The birds presented a ready field for experiment; and the kind of mosquito, the grey mosquito as he termed it, was very abundant in Calcutta, so that it was easy for him to hatch from the larva any number that he might require. Discoveries now followed each other in quick succession. He soon announced that the pigmented bodies grew rapidly from day to day, till after about a week they assumed large proportions, projecting like buttons from the outer surface of the stomach, and often showing a curious appearance of radiating striæ. Next we learned that the striæ had been indications of spore formation, and that when the bodies had attained maturity they burst into the general body-cavity, discharging enormous numbers of minute elongated organisms which he termed "germinal rods." Then followed the remarkable observation that the germinal rods soon leave the general body-cavity, and accumulate in the cells of the salivary or poison glands and in the duct leading from them to the proboscis, with which the bites of the insect are inflicted. And, lastly, he completed the cycle of evidence by ascertaining that healthy sparrows could be infected with the Proteosoma by causing mosquitoes to bite them at the appropriate period after biting an infected bird.

Thus was, in truth, established the mosquito theory of malaria. For taking into account the close resemblance of the Proteosoma to the parasites of human malaria, together with the facts ascertained by Ross regarding the infection of the rare mosquitoes with human crescents, we could not doubt that the course of events which he had traced in the sparrow occurred also in man. And the two sets of observations, taken together, clearly established the fact that, as Manson had predicted, different species of malarial parasite may require different kinds of mosquito as their alternative hosts.

At the same time, the presence or absence of the pigmented bodies in the stomach wall afforded a sure means of distinguishing those kinds of mosquitoes which convey malaria to man from those which are incapable of doing so. And it may be added that the multitude of negative results after feeding grey mosquitoes with crescent blood, considering the great prevalence

1 *Vide British Medical Journal* (February 26, 1898). In this second paper Ross did not repeat the description of his method, given in the former article, of using mosquitoes bred in bottles from the larva. But as that had been his practice for more than two years, there can be no reasonable doubt that he continued it with this new species. I have also his personal assurance that such was the case.

2 As the result of further knowledge, there is no doubt that this common mosquito had derived its pigmented bodies, not from the man it was seen biting, but from a bird affected with another species of malarial parasite.

3 It has seemed necessary to refer to these points in detail, as considerable misapprehension has prevailed in some quarters regarding them.

in Indian birds of the parasite with which that species of insect is liable to be infected, afforded pretty conclusive evidence that the mosquito never derives the germs of malaria from the larva and can acquire them only by biting some infected animal.

But although the mosquito theory was thus demonstrated, there remained a link wanting in the chain of biological sequence. The flagella which Manson regarded as spores were destitute of malarial pigment, whereas the smallest corpuscles seen by Ross in the stomach wall invariably possessed it. How was this inconsistency to be explained? What was the relation of the unpigmented flagellum to the pigmented corpuscle? The answer had been already independently supplied.

I was present at a sitting of the Zoological Section of the British Association at the Toronto Meeting in 1897, when Dr. MacCallum, a young pathologist of the Johns Hopkins University at Baltimore, read a paper describing the results of an investigation in which he had long been engaged into another form of malaria parasite, Halteridium, especially common in crows. He told us, and he illustrated his statements with preparations under the microscope, that he had distinguished differences, which he regarded as fundamental, between the spherical bodies seen in the shed blood of a bird affected with that parasite. Though alike in size, some had a more granular protoplasm than the others, which had a more hyaline aspect; and he had observed that the more hyaline ones alone emitted flagella. These, after wriggling themselves free from the parent cell, swam away till they approached some corpuscle of the other, more granular, sort; when the first that reached it plunged into its substance and disappeared, while all others were, by some amazing provision, absolutely refused entrance. Here, then, was witnessed, in an exceedingly low form of animal life, a process of fertilisation identical with that which occurs in an echinus or a fucus. The flagella were neither more nor less than spermatozoa, and the more granular cells were ova. As the result of the fertilisation, the female cell was seen by MacCallum to alter its shape in the shed blood and assume an elongated form to which the term vermiculus was applied. This new creature was possessed of wonderful powers of locomotion, sometimes in its powerful career piercing through the substance of a red corpuscle.[1] Nothing could well be imagined better adapted for penetrating the layer of cells that line the stomach of the mosquito; and as the vermiculus retained its pigment, Ross's pigmented bodies were naturally accounted for.

These observations of MacCallum's might seem at first almost too wonderful for credence; but they have been fully confirmed by others.

It appears to be doubtful whether Halteridium ever produces the "rosace" form, with its attendant sporulation; but there is no doubt that the process of fertilisation seen in that parasite occurs in human malaria. MacCallum himself observed the act of conjugation in the crescentic human form; though he did not see the subsequent development of the vermiculus. Koch made a further step by observing the vermiculus of Proteosoma in blood from the mosquito's stomach.[2] And, finally, our medallist Grassi, who in other ways has made most important contributions to this subject, has, in a recent work (*vide* Grassi, "Studi di uno Zoologo sulla Malaria," Roma, 1900), accompanied by very beautiful illustrations, not only described the presence of vermiculi in abundance in the blood in the stomach of mosquitoes during the first two days after biting patients affected with malaria, but he has traced and figured the pigmented bodies of the smallest size in the tissues of the stomach in the immediately succeeding period, these bodies retaining in some instances the elongated form of the vermiculus after passing through the layer of epithelium that lines the cavity of the organ.

It has thus been abundantly established that the parasites of malaria are present in the patient's blood in two distinct forms, one sporulating asexually in the human system and causing the attacks of fever, the other undergoing sexual development in the body of the mosquito. That both forms are developed from the spores introduced by the mosquito is certain. At what stage they begin to develop their respective peculiarities is not yet quite made out. The crescent form is peculiarly favourable for this inquiry, as it is the crescents only which discharge the sexual function; and they are easily distinguished from the sporulating kind, not only by their shape, but also by their much larger size.

The development of the crescents has been specially studied by the Italian pathologists, Bastianelli and Bignami,[1] who have been able to distinguish the young crescents while still of extremely small dimensions; and they have made the remarkable observation that, while the crescents are as a rule only found in the blood of the finger when they have arrived at maturity, the young forms are to be seen in internal organs, such as the spleen, but above all in the bone marrow, where alone, according to these observers, the youngest recognisable crescents are to be found.

Seeing that, in whatever part of the body they are, the parasites always inhabit the blood, it seems difficult to conceive what can be the cause of their preference, at different stages of their growth, for the blood vessels of different regions and organs. But of this we find parallels in several other cases of blood parasites, the most striking, perhaps, being the astonishing fact that, of two species of Filaria that infest the human blood, one only shows itself in superficial parts at night, and is therefore termed *Filaria nocturna*, while the other has the name *Filaria diurna*, because it only appears by day in the finger blood and retreats into deep parts for the night.

Ross was not an entomologist, and he was unable to learn in India the names of the species of mosquito with which he had been working, till Daniels, one of the explorers sent out by the Malaria Committee, having gone to Calcutta to confirm or otherwise Ross's work, informed him that his rare kinds, which acted as hosts for the human crescents, belonged to the genus Anopheles, and that the common sort which performed the same office for Proteosoma, belonged to another genus, Culex. It has been a matter of great interest to ascertain whether all mosquitoes which act as conveyers of malaria to man are of the genus Anopheles, and the exceedingly common and numerous species of Culex are guiltless in that respect. Very numerous investigations into this question, and especially those conducted by Grassi and his coadjutors, seem to have proved that such is the case, and that, so far as human malaria is concerned, Anopheles alone have to be considered.

Our other two explorers, Messrs. Christophers and Stephens, have made various important contributions to our knowledge of malaria. Thus, having paid special attention to the very dangerous disease which, on account of one of its symptoms, is termed blackwater fever, they have come distinctly to the conclusion that it is not a special disorder but a form of tropical malaria. If this is the case, it is of immense practical importance; for it will follow that any means efficacious for ordinary malaria will prove equally so for the deadly blackwater fever.

Another most important fact which they have ascertained, and which was independently observed by Koch, is that in a native population in a malarious region, while the adults may be perfectly free from the disease, the young children contain the parasites in their blood in an enormously large percentage. Though the disease appears to be much less dangerous to the native children than to new arrivals, implying that they have a degree of congenital immunity, the parasites in the young natives are perfectly efficacious for causing dangerous fever in white people when conveyed to them by mosquitoes. Hence the important practical inference that white people settling in a malarious tropical region should not, as they now commonly do, plant their houses near native settlements, but place them at some considerable distance from them, about a quarter of a mile being apparently sufficient. And Christophers and Stephens in their last communication have gone so far as to express the opinion that the following of this simple rule would go very far indeed towards rendering the malarious tropics healthy to Europeans.

In a communication to this Society, it is the scientific side rather than the practical that is naturally chiefly dwelt on. Yet I should have been glad, had time permitted, to have referred to the various measures of prevention and treatment of malaria which the light of recent knowledge has already suggested, and which have already borne important fruit. I must now content myself with saying that, very various as these measures are, they are all, without exception, based on the mosquito theory.

[1] *Vide* On the Hæmatozoan Infection of Birds, by W. G. MacCallum, M.D., *Journal of Experimental Medicine*, vol. iii. No. 1, 1898.

[2] *Vide* Ueber die Entwickelung der Malaria Parasiten, R. Koch, *Zeitschrift für Hygiene und Infectious Krankheiten*, Band xxxii., 1899. Exceedingly beautiful microphotographs of different kinds of malaria parasites in various stages of development accompany this article.

[1] *Vide* "Sulla Struttura dei Parassiti Malarici," per G. Bastiani ed A. Bignami. Società per gli Studi della Malaria, 1899.

The medals were then presented as follows:—The Copley Medal to Prof. Marcellin Berthelot, For.Mem.R.S., for his brilliant services to chemical science; the Rumford Medal to Prof. Antoine Henri Becquerel, for his discoveries in radiation proceeding from Uranium; a Royal Medal to Major Percy Alexander MacMahon, F.R.S., for the number and range of his contributions to mathematical science; a Royal Medal to Prof. Alfred Newton, F.R.S., for his eminent contributions to the science of ornithology and the geographical distribution of animals; the Davy Medal to Prof. Guglielmo Koerner, for his brilliant investigations on the position theory of the aromatic compounds; and the Darwin Medal to Prof. Ernst Haeckel, for his long-continued and highly important work in zoology, all of which has been inspired by the spirit of Darwinism.

The Society next proceeded to elect the officers and council for the ensuing year. The following is a list of those elected:—

President: Sir William Huggins, K.C.B.; Treasurer: Mr. A. B. Kempe; Secretaries: Sir Michael Foster, K.C.B., Prof. Arthur William Rücker; Foreign Secretary: Dr T. E. Thorpe; other Members of the Council: Prof. H. E. Armstrong, Mr. C. V. Boys, Dr. Horace T. Brown, Mr. W. H. M. Christie, C.B., Prof. E. B. Elliott, Dr. Hans F. Gadow, Prof. W. M. Hicks, Lord Lister, Prof. W. McIntosh, Dr. Ludwig Mond, Prof. A. W. Reinold, Prof. J. Emerson Reynolds, Dr. R. H. Scott, Prof. C. S. Sherrington, Mr. J. J. H. Teall, Sir J. Wolfe Barry, K.C.B.

In the evening the Fellows and their friends dined together at the Whitehall Rooms.

NOTES.

DR. E. VON MOJSISOVICS, Vice-director of the Austrian Geological Survey, has obtained permission to retire from the active staff of the service on account of the state of his health. But his scientific labours will suffer no interruption. In particular he will be able to continue, and, it may be expected, bring to an early completion, two important works on which he is engaged —"The Cephalopoda of the Halstatt Limestone," and "The Geology of the Salzkammergut."

PROF. J. PERRY, F.R.S., presided at the annual dinner of the Institution of Electrical Engineers on Monday, and in responding to the toast of the Institution he compared the profession of electrical engineering with a baby, inasmuch as the members were ignorant of its future, though they knew that its life would be affected by the action adopted now. Other speakers were Lord Alverstone, Lord Kelvin, Sir J. Wolfe Barry, Sir G. Kitson, and Sir Courtenay Boyle, who spoke as the representative of a department (the Board of Trade) which has to do with the translation of scientific researches into commercial facts.

MR. I. H. BURKILL, of the Royal Botanic Gardens, Kew, has been appointed assistant to Dr. Watt, and will shortly leave for Calcutta.

WE learn from the *Athenaeum* that an official announcement has been made to the effect that the Viennese Akademie der Wissenschaften intends sending an expedition to Brazil in 1901, which will have for its object the study of the flora of that country. It is to a certain extent a sequel of the expeditions of the early part of this century, which resulted in the publication of that monumental work the "Flora Brasiliens." The botanists accompanying the party are Prof. Dr. Richard von Wettstein, Director of the botanical garden of the University, and Dr. Victor Schiffner of Prague.

IT is announced by the Colonial Office that the Pacific Cable Committee have accepted, on behalf of her Majesty's Government and of the Governments of New South Wales, Victoria, Queensland and New Zealand, the tender of the Telegraph Construction and Maintenance Company for the manufacture and laying of the projected Pacific cable. The amount of the tender is 1,795,000*l.*, and the work is to be completed by the end of 1902. The cable will run from Vancouver to Queensland and New Zealand, *via* Fanning Island, Fiji and Norfolk Island.

A FEW particulars concerning the Antarctic expedition in course of organisation in Sweden, by Dr. Otto Nordenskjöld, are given in the *Times*. For the purpose of his Antarctic expedition Dr. Nordenskjöld has acquired the steam-whaler the *Antarctic*, which was built for whaling in the Greenland seas by a Norwegian firm, and has performed many voyages in Polar waters. She was eventually acquired by Prof. G. Nathorst, the celebrated geologist and Arctic traveller, who has shared in almost every Swedish Polar expedition. Last year, again, the *Antarctic* was employed in the search for Andrée on the east coast of Greenland, when the owner himself was in command of the expedition, but which yielded no result. The vessel will proceed to Gothenburg for her final equipment. Dr. Nordenskjöld estimates the cost of the expedition at only some 10,000*l.* Of this sum one-half has already been contributed by Swedish subscribers, and King Oscar, with his well-known interest in Swedish explorations, has also promised a considerable amount towards this expedition, the first of its kind ever dispatched from Sweden. Should circumstances permit, the Swedish expedition will, of course, co-operate with the British and German. It is hoped that the *Antarctic* will be ready to sail next August.

THE Lincolnshire Naturalists' Union has recently received several valuable additions to its museum. Further space is required for a large collection of fossils and specimens of rock formation recently presented by Mr. Melville. A large case of drawers containing a number of birds' skins from the collection of the late president of the Union (Mr. John Cordeaux) has been presented by Mrs. Cordeaux. A large collection of fossils and specimens of rock formation has been presented by Mr. A. S. Leslie-Melville. The collections would make a good nucleus for a county museum, and the City Council of Lincoln is to be asked to make suitable provision for them.

IT is satisfactory to know that British engineers and manufacturers are seriously examining the causes which have enabled German and American works to successfully compete with their productions. Sir Lowthian Bell dealt with the subject in his address to the Institution of Junior Engineers on November 30. In the course of his remarks he said: "Some correspondents of our newspapers attributed our loss of ground in the race to ignorance of the scientific truths on which success was dependent; but they could not be aware that at Newcastle, Leeds, Nottingham, Sheffield, Edinburgh and Glasgow there were large and well-appointed colleges for teaching the sciences which for the last twenty-five years had been deemed indispensable in Great Britain for a successful career in metallurgy. Moreover, every ironworks of any importance possessed a suitable laboratory as a guide in its daily operations as well as for original research. Comparison between the United States and England involved two conditions—that imposed by nature, and that resulting from ignorance and consequent want of skill; the former was unavoidable, the other susceptible of remedy. Now, taking the Middlesbrough district in this country and Pittsburg and its vicinity in America, it appeared that the final cost of the minerals, mining and carriage included, consumed for each ton of pig iron at Pittsburg and Middlesbrough was almost identical." Though Sir Lowthian Bell's estimate of the alleged advantages of the Pittsburg works may do something to reassure British manufacturers, his remarks as to educational facilities and industrial research are not so convincing. True, we have our University Colleges and Technical Schools, but in how many districts are they considered by the manufacturers to have any real connection with industrial progress? When the business man really believes in such institutions, he does not regard them merely as places where a smattering of useful knowledge can be obtained, but as laboratories where adequate provision has to be made for scientific research. As for the laboratories provided for investigation in ironworks and other manufactories, they are as nothing in comparison with what they ought to be. When they do exist, they are often regarded as failures unless every year the cost of their upkeep is less than the saving they effect. What British manufacturers mostly lack is belief in scientific results and sympathy with the scientific spirit. So long as they are deficient in these qualities, they will be unable to derive the fullest advantage from scientific progress.

MR. FOX BOURNE, on behalf of the committee of the Aborigines Protection Society, has addressed a letter to Mr. Chamberlain with reference to the condition of aborigines of Australia. It is submitted that a comprehensive and uniform native policy should be adopted for the whole of Australia, with harmony and equal efficiency in the measures taken for carrying it out. After referring to the importation of Kanaka and other native labour, the letter recognises that arbitrary interference by her Majesty's Goverment would be inexpedient and impracticable, but urges that the Governor-General and his advisers should be communicated with on this subject, in the hope that they will see their way to take such measures as will ensure to the aborigines adequate protection.

MR. A. B. BASSET asked, in our issue of October 11 (p. 572), for a word to designate a non-singular curve, and suggested that a curve having no double points might be termed an "anautotomic curve." Other correspondents have thought that the idea of curves without double points could be conveyed by the words nonsesecting, (p. 7), unautotomic, and nodeless (p. 58). There is an objection to such hybrid terms as "unautotomic," but Mr. W. R. K. Watson writes to point out that "nodeless" stands on different grounds, because the rule against combining elements derived from different languages does not apply to the terminations. Mr. T. B. Sprague also sends us a letter in which he expresses the view that nodeless is a suitable word. Hence, if anautotomic is objected to on the score of euphony, the balance of opinion appears to be in favour of nodeless.

AT a recent meeting of the West Riding section of the Society of Dyers and Colourists, Messrs. A. Dufton and W. M. Gardner read a paper on their arrangement for the production of an artificial light of the same quality as daylight, and illustrated its practical value. The lamp devised for this purpose was shown at the Bradford meeting of the British Association, and has already been briefly described (vol. lxii. p. 563, October 4).

IN *La Nature* of November 24, M. E. Durand-Gréville gives a good description and illustrations of the so-called Pocky or festoon cloud. It was probably first observed by Lamarck about a century ago, and was subsequently frequently seen in the Orkneys, and referred to in pamphlets entitled "Popular weather prognostics of Scotland," by Sir A. Mitchell in 1863, and by the Rev. Dr. Clouston in 1867. It has the appearance of a *cumulus* cloud reversed, or as it would be seen from a balloon, and it was named by the recent International Cloud Committee *mammato-cumulus*. It was supposed to be formed of drops of water, and its occurrence was in most cases followed by storms either of rain or wind. M. Durand's observations lead him to suppose that it is by no means always composed of water-drops, but that it is often formed of small needles of ice. He proposes that this name should be maintained when it is certain that it is composed of water-drops, but to employ the term *mammato-cirrus*, or Poey's *globo-cirrus*, when it is equally clear that the cloud is ormed of ice-crystals.

A REPORT on the acetylene flame, considered with especial reference to its use in physical laboratories, is given by Mr. Edward L. Nichols in the *Journal* of the Franklin Institute. The report deals with the following points: The falling off in illuminating power when the acetylene is stored for some time, especially over water; the influence of the pressure and mode of production; the characteristics of pure acetylene flames; the temperature of the flame; and the uses of acetylene for the lantern, for the production of high temperatures, and for photometric measurements. A further report on the efficiency of the acetylene flame as a source of light is contributed by the same writer to the *Physical Review* (October).

PROF. KLEIN announces that the publication of Gauss's works, which has been delayed since the appearance of the sixth volume, will be resumed under the editorship of Prof. Brendel, who will have the collaboration of Profs. Fricke, Stäckel, Börsch, Krüger and Wiechert. Volume viii. has already appeared, and contains a miscellaneous collection of hitherto unpublished writings on arithmetic, algebra, analysis, probability and geometry. Volume vii. will contain the *Theoria motus*, as well as a complete collection of Gauss's works on astronomical perturbations; volume viii. will deal with Gauss's geodetic operations and certain physical problems, supplementary to those treated in previous volumes; and volume x. will consist of biographical matter, including extracts from Gauss's correspondence.

A DETAILED account of the system of multiplex telegraphy, which has for its basis the use of alternating currents of different frequencies, is given in the *Journal de Physique* for November by M. E. Mercadier.

IN the *Journal de Physique* for November, M. Raphael Dubois describes in a short note some experiments on the use of photobacteria as sources of illumination. By cultures on a large scale, with liquid nutrient media, the author states that it has been possible to illuminate a room with the brilliancy of moonlight.

A COPY of a very rare botanical pamphlet—the "Orbis Eruditi Judicium de Caroli Linnæi, M.D. Scriptis," dated, Holmiæ, 1741, is offered for sale in a German book circular (*Recensions-exemplar*), at the moderate price of 120 marks. This is the only "apology" ever written by "Linnæus, and the only work published by him anonymously. It is especially directed against his bitter antagonist, J. G. Wallerius, the mineralogist. Pritzel, by whom this work was not mentioned in the first edition of his catalogue, states in the second edition that he saw a copy in the library of de Candolle. Besides this only three other copies appear to be known, two of which were offered for sale at an auction in Stockholm in November, 1888. The pamphlet contains a *résumé* of the most important events in the life of Linnæus, as well as a list of his works to date.

IN his presidential address to the twelfth annual meeting of the Association of Economic Entomologists, held in New York last June, Mr. C. P. Gillette urged the importance of the study of the life-histories of insects injurious to crops, saying that much remains to be learned, even in the case of the commonest and most abundant species. The *Proceedings* of the Association are published as a *Bulletin* (No. 26) by the Entomological Division of the U.S. Department of Agriculture. Among the numerous papers, one of the most interesting deals with the methods adopted for the destruction of the green-pea louse, the illustrations showing the extensive scale on which the operations are conducted. The Association, which is stated to be the only one of its kind in existence, comprises 109 members resident in the United States and 42 foreign members.

WE have rece.ved a copy of the *Communications* of the Millport marine biological station for November. Among the more important contents are a paper by Miss Newbigin on the sabellid worms collectively designated as Polychætes, one by Mr. A. Patience on the Decapod Crustacea of the Largs Channel, and one by Mr. J. Rankin on the Tunicates of the Millport neighbourhood, the latter containing descriptions of three new species. Attention may also be directed to a communication by Dr. J. F. Gemmill regarding the influence of nutrition on sex. The mussel and the limpet, in which the differentiation of sex does not take place till a comparatively advanced stage of life, are taken as examples; and it is shown that the more highly nourished individuals living in low zones do not display any preponderance of females over their less fortunate brethren, who are out of water for a longer period at each tide.

PART ii. of vol. xxix. of the *Morphologisches Jahrbuch* is chiefly taken up by investigations on myology, one of these papers, by Herr H. Engert, dealing with the development of the abdominal muscles of birds, while the second, by Herr H. Klaatsch, treats of the short head of the *biceps cruris* (or *femoris*) and the so-called *gracilissimus* muscle of the thigh in mammals. As its subtitle—ein stammesgeschichtlicher Problem—implies, the latter is really a phylogenetic paper, taking into consideration the relations of man to the other Primates, and of the latter to other mammalian orders. To formulate the author's investigations and conclusions briefly is by no means easy. But it may be mentioned that he identifies the *gracilissimus* (which must not be confused with the *gracilis*) with the short head of the *biceps cruris* of human anatomy, and finds that the lower Old World monkeys possess no representative of this muscle at all. For this muscle, in its different forms, the name *gluteo-cruralis* is proposed. It occurs as a true *gracilissimus* in the lower American monkeys, all Carnivora, and certain Rodents, Marsupials, Edentates and Insectivora. As the main muscle of the upper leg it is found in some Edentates, the Orang, and the majority of the American monkeys, while it forms the short head of the *biceps cruris* in man, Gibbons, the Howlers, the Chimpanzee and the Gorilla. Whether the Old World monkeys have lost the *gracilissimus*, or whether they never possessed that muscle, is left an open question. But it is urged that the less a monkey departs from the primitive type (as represented by the Carnivora), the nearer it approaches man, and in this respect the majority of American monkeys are more man-like than their Old World representatives.

To the *Zeitschrift fur wissenschaftliche Zoologie* (vol. xviii., pt. 3), Herr C. Sihler contributes a paper on muscle-nerves, while in the same issue Herr R. Hesse continues his investigations on the visual organs of the lower animals, dealing in this instance with the eyes of certain molluscs.

MR. THOMAS SHEPPARD has prepared a descriptive catalogue of the specimens in the Mortimer Museum of Archæology and Geology at Driffield. The specimens were gathered together by Mr. J. R. Mortimer during the past forty years, and they comprise relics of Neolithic and later periods which are described, explained and in many cases illustrated in the work before us. Some doubtful Palæolithic and Eolithic flints are mentioned. Mr. Mortimer began collecting at a time when the Yorkshire Wolds formed a region prolific in pre-historic remains. The farm labourers were induced to spend their spare time in searching for them, and many a basketful of specimens was brought to Mr. Mortimer. Now these treasures are rare. Fossils from the chalk were also more readily to be obtained in former years, when the chalk was more extensively quarried, and a fine series of fossils from this and other local strata is exhibited in the museum. The handbook now issued will be of essential service to local workers.

FURTHER illustrations are presented by Mr. W. J. G. Land, in a short article reprinted from the *Botanical Gazette*, of the remarkable process in the fertilisation of flowering plants observed by Nawaschin, Guignard, Miss Sargant, and others. These observations explain the invariable presence of two sperm-nuclei in the pollen-tube by the fact that, while one of them fuses with the oosphere to produce the embryo, the other fuses with one of the polar nuclei of the embryo-sac (or with both when combined into the central nucleus) to produce the endosperm. Mr. Land adds to the Angiosperms in which this process has been observed two genera of Compositæ, *Erigeron* and *Silphium*. He does not accept Guignard's designation of the process "pseudo-fecundation," but regards it as a true process of impregnation. It is interesting, also, to note that in these genera the sperm-nuclei of the pollen-tube have, as in other instances, the coiled form, which indicates their descent from the spermatozoids of vascular cryptogams.

THE *Agricultural Gazette* of New South Wales contains an article by Mr. W. J. Allen on the culture of the olive in Australia. He states that in both South Australia and Victoria this industry has received considerable attention, good crops of fruit being now obtained which yield a good oil. It is evident, however, that if, as Mr. Allen says, the climate of every part of New South Wales is suitable for the growth of the olive, it may in the future become a much more important industry in our Australian colonies than it is at present.

THE December number of the *Journal* of the Chemical Society contains a portrait of the late Prof. Nilson, and the Nilson memorial lecture delivered by Prof. O. Pettersson.

MESSRS. BLACKIE AND SON have published the seventh edition of "An Elementary Text-book of Coal Mining," by Mr. Robert Peel. A chapter has been added on the applications of electricity to various operations in mining.

MR. A. M. BRICE gives a graphic account of the great Charleston earthquake of 1886, in the December number of *Macmillan's Magazine*. In many respects it resembles Mr. McKinley's equally vivid account quoted in Captain Dutton's memoir. The panic of the whites, the childish terror of the negroes, the destruction of the city and many other features are well described. Mr. Brice also gives some interesting examples of the apparently capricious effects of the earthquake, some houses being comparatively unhurt and yet standing in the midst of others completely ruined.

THE *Transactions* of the Rochdale Literary and Scientific Society contain papers on various subjects read before that Society. In vol. vi. (1898–1900), among the articles of general scientific interest are a list of the birds that frequent Hollingworth Lake, by Mr. J. Stott, and a description of Hades Hill Barrow, by Mr. W. H. Sutcliffe. This is a round barrow and contained a broken rude urn, some burnt bones and flint implements and flakes.

IN NATURE (vol. liv. pp. 449–450), an account is given of the sea-waves connected with the Japanese earthquake of June 15, 1896, so far as they affected the eastern coasts of the islands. The propagation of the sea-waves across the Pacific is discussed by Dr. C. Davison in the last number of the *Philosophical Magazine*. Copies of the records of the tide-gauges at Honolulu and Sausalito (San Francisco Bay) are given. The earthquake originated beneath an area near the foot of the western slope of the Tuscarora Deep, and the sea-waves traversed the distances from the epicentre to Honolulu and Sausalito, which are 3591 and 4787 miles, in 7h. 44m. and 10h. 34m. respectively. The path from the epicentre to Sausalito is free from islands, and the mean depth along it is roughly 17,000 feet. If the depth were uniform, that corresponding to the mean velocity with which the waves travelled would be 13,778 feet. The explanation of the discrepancy is given by the same writer in a former paper (*Phil. Mag.* for January 1897), in which it is shown that the formula generally used for determining the mean depth of the ocean is incorrectly applied.

AN interesting account of an old Indian settlement in Kansas is given by Mr. J. A. Udden in the second number of the Augustana Library Publications, Ill. The paper is well illustrated by a number of excellent figures, and it gives an instructive view of the culture of a frontier village, which exhibits a mingling of northern, southern and western features of primitive industry and art.

IN a short essay on Tabu in *l'Anthropologie* (Tome xi., p. 401), M. Salomon Reinach points out that the primitive idea of Tabu is more restricted than mere prohibition. It has three characteristics: (1) no reason is assigned, but reasons are added later; (2) the punishment, whether of death or sickness, results automatically from the infringement. Neither a deity nor man, individual or collective, is credited with avenging power; (3) the danger is not apparent. The power of Tabu has been broken by various religions, who have in their turn at times been sad enemies to human liberty.

NATURALISTS and others interested in bird life will be pleased to learn that arrangements have been made for the speedy resumption of the publication of Mr. W. Eagle Clarke's work on the birds of Yorkshire, which has been partly published in the *Transactions* of the Yorkshire Naturalists' Union, and the continuation of which was interrupted by Mr. Clarke's leaving Yorkshire to settle in Edinburgh. Mr. Thos. H. Nelson, of Redcar, will continue and complete the work. He has now in his possession the original and unpublished observations which Mr. Clarke had at his command when writing the instalments which are already in print, and which include notes, lists and observations from most of the naturalists who have studied and observed Yorkshire birds. In addition to this is the whole of the information amassed by the late Mr. John Cordeaux relating to the birds of the Humber district, and also the notes which Mr. W. Denison Roebuck has extracted from the very voluminous literature of the subject, and Mr. Nelson's own accumulated series of notes on the birds of Cleveland and other districts, the whole forming an ample mass of material for the purpose.

MR. WALTER W. FROGGATT, the Government entomologist of New South Wales, has lately published a series of rather important papers, chiefly as "Miscellaneous Publications" of the Department of Agriculture at Sydney. Among those issued during the present year are No. 358, "Notes on Australian Coccidæ (Scale Insects)"; No. 363, "Plague Locusts"; No. 363, "The Hessian Fly (*Cecidomyia destructor*, Say) and allied Grain Pests"; No. 387, "Insects and Birds"; No. 388, "Insects living in Figs, with some account of Caprification." Other papers by Mr. Froggatt before us are "Miscellaneous Publication," No. 394, "Notes on a Collection of Ticks, determined by Prof. Neumann," from the *Agricultural Gazette* of N. S. Wales; "Scale Insects that produce Lac, with a description of a new Australian Species"; apparently an independently issued pamphlet; and "Australian Psyllidæ," from the *Proceedings* of the Linnean Society of New South Wales, for May. The last paper is illustrated with four plates, and most of the others with one each.

THE question of the possible variability of the valency of carbon has received a considerable amount of attention, especially since the researches of Nef on divalent carbon. In the current number of the *Berichte* there is a somewhat startling extension of this idea by Mr. M. Gomberg. By the action of metals such as silver, zinc and mercury upon triphenyl-chlormethane, $(C_6H_5)_3CCl$, the halogen is removed, and, working in the complete absence of air, the resulting product is not as would be expected hexaphenyl-ethane, but an unsaturated body which readily absorbs oxygen from the air and combines directly with the halogens. The author thinks that the only possible explanation of the observed facts lies in the assumption that the substance is really triphenyl-methyl, $(C_6H_5)_3C$, in which the carbon is trivalent. Further work on this subject will be awaited with interest.

THE additions to the Zoological Society's Gardens during the past week include a Suricate (*Suricata tetradactyla*) from South Africa, presented by Captain J. C. Brinton; a Raven (*Corvus corax*), British, presented by Mr. J. C. Brush; four Ashy-crowned Finch Larks (*Pyrrhulauda grisea*), two Singing Bush Larks (*Mirafra cantillans*), two Slaty-headed Parrakeets (*Palaeornis schisticeps*), a Golden-eyed Fruit Pigeon (*Carpophaga concinna*) from British India, a Burmese Slaty-headed Parrakeet (*Palaeornis finchi*) from Burmah, presented by Mr. E. W. Harper; a Doguera Baboon (*Cynocephalus doguera*, ♂) from Abyssinia, a Salvin's Amazon (*Chrysotis salvini*) from South America, three Alligator Terrapins (*Chelydra serpentina*), two Sculptured Terrapins (*Clemmys insculpta*), three Blue Lizards (*Gerrhonotus caeruleus*), two King Snakes (*Coronella getulus*), a Three-striped Boa (*Lichanura trivigata*), six American Box Tortoises (*Cistudo carolina*) from North America, twenty Climbing Anabas (*Anabas scandens*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

PERTURBATIONS OF EROS PRODUCED BY MARS.—H. N. Russell has recently published the results of an extensive investigation of the perturbations of the major axis of the orbit of Eros by the action of Mars in the *Astronomical Journal* (vol. xxi. No. 484). As the periods of the two planets are nearly equal and their orbits interlock, the disturbing force will in consequence vary greatly in magnitude, and may have any direction whatever. Also, as Eros is sometimes nearer the sun than Mars, and sometimes more remote, the development of the perturbative function proceeding by powers of the ratio of their radii vectores gives rise to a *divergent* series; and as the magnitude of the eccentricities and inclinations makes development in ascending powers of these quantities undesirable, methods based upon mechanical quadrature are preferable.

The present investigation has been by means of Le Verrier's method of interpolation, and its relative merits and disadvantages are discussed. Newcomb's Elements of Mars have been used, those of Eros being original computations published in the *Astronomical Journal* (No. 473).

The numerical results obtained are given in a table, the chief results being:—

(1) The "great inequality," of period about 1000 years, will not affect the place of Eros sensibly during the next dozen years.

(2) The perturbations of moderately long period are much the largest produced by Mars on any planet. They may displace Eros by as much as 90″ in mean longitude; and since at a perihelion-opposition any change in the mean longitude of Eros produces one *ten* times as great in its geocentric longitude, the measurement of this displacement will eventually lead to a valuable determination of the mass of Mars.

CATALOGUE OF ONE HUNDRED NEW DOUBLE STARS.—Prof. W. J. Hussey, of the Lick Observatory, has completed observations of another hundred new pairs in continuation of those in his first catalogue, published in the *Astronomical Journal* (No. 480), and gives the details of the recent measures in No. 485. The work has been done with the 12- and 36-inch equatorials, chiefly with the latter, using generally a power of 1000. An analysis of the distances between the components leads to the following summary:—

Distance.	No. of Pairs.
0″·25 or less	9
0″·26 to 0″·50	16
0″·51 to 1″·00	22
1″·01 to 2″·00	26
2″·01 to 5″·00	27

OSCILLOGRAPHS.

THE phenomena connected with the behaviour of alternating currents present a wide field for experimental inquiry which has, up to the present, been but imperfectly explored. The investigation of the wave-forms of alternating potential differences and currents under various conditions of their actual use is a matter, not only of great theoretical and scientific interest, but also of the highest practical importance, since the shape of the wave-form under given conditions, and the alteration of shape produced by any alteration of conditions, are factors which largely affect the efficiency and economy of working. As examples showing the increased efficiency that may be obtained by choosing a suitable wave-form, we may quote the results obtained by Messrs. Rössler and Wedding, and by Messrs. Barr, Beeton and Taylor. The former experimenters showed,[1] in an investigation on the luminous efficiency of the alternate current arc, that the light per watt when using an alternator giving a flat-topped E.M.F. curve was 44 per cent. higher than when using a machine that gave a peaked curve. Messrs. Barr, Beeton and Taylor, in a research on the efficiency of transformers, found,[2] on the contrary, that a peaked wave-form was the most suitable one to employ. The reactions that take place between alternators running in parallel is another case in which the wave-form is of very great practical importance.

It will be readily understood, therefore, that it is most desirable that we should have some simple method of observing and studying the wave-form of an alternating current or potential difference. Such a method is supplied by the instruments known as oscillographs. Before the invention of these instruments the only means of studying wave-forms was by the exceedingly laborious "point-to-point" method. Suppose that there is a circuit through which is flowing an electric current which is varying periodically at the rate of, say, n, complete cycles per second, and that it is desired to obtain the wave-form of this current. At any particular instant the current will have a certain definite magnitude and direction, and $1/n$th of a second later the current will again have the same magnitude and direction. If, by means of an automatic contact-maker, a galvanometer is brought into circuit at intervals of $1/n$th of a second, there will be given to the galvanometer needle a succession of impulses due, in each case, to the same current, and consequently a steady deflection of the needle will be produced from which the particular instantaneous value of the current can be determined. To obtain, however, the complete wave-form, we must determine the value of the instantaneous current at *every moment* during the cycle, or at a sufficient number of moments to enable a smooth curve to be drawn. Having found one point on the wave-form in the way described, the contact-maker is shifted so as to bring the galvanometer periodically into circuit at some other moment in the cycle, and a second point on the curve is then found. Again the contact-maker is shifted and a third point is obtained, and thus, point by point, the whole curve may be built up.

This method is open to two objections. In the first place, it is only applicable to cases in which the wave-form is undoubtedly steady, all transient effects being obviously unobservable by such a process, and, secondly, it is so lengthy that elaborate researches are practically precluded. As much as four or five hours may, indeed, be spent in obtaining a single curve, and then, even after all this labour, it is more than possible that the conditions will be found to have altered during the experiment, and the curve, in consequence, to be useless. By means of the oscillograph and kindred instruments, however, experiments can now be carried out in a few minutes which occupied days by the old "point-to-point" method, and not only can steady wave-forms be examined, but the most fleeting effects can be studied with equal ease.

An oscillograph may be defined as a galvanometer the deflection of which, at any instant, is practically proportional to the current flowing through it at that instant, in spite of the current varying very rapidly in strength or in direction. For this to be possible it is necessary for the free periodic time of the moving part of the instrument to be very short, less, generally, than 1/30th, of the periodic time of the effect to be observed. The instrument must also be perfectly dead-beat, the moving part taking up instantaneously the deflection proper to the current flowing through the instrument, for if there be any tendency to overshoot the mark it will cause the observed wave-form to be distorted from its true shape. In addition to this, since one is dealing with rapidly varying currents, it is necessary for the self-induction of the instrument to be practically nil, and for all effects due to hysteresis or eddy-currents to be eliminated. The original idea of the oscillograph is due to M. Blondel, who pointed out, in 1893, the principles on which such an instrument should be designed, and all the oscillographs since produced owe their inspiration to M. Blondel's work.

Two other instruments have been invented and developed by which the same end might be attained, namely, the observation or recording of rapidly varying currents or potential differences. These are the Abraham-Carpentier rheograph and the Hess-Braun oscillo-radiograph. With these instruments, since they are not, strictly speaking, oscillographs, we do not propose to deal in detail, but must content ourselves by giving a brief account of the principles on which they are constructed. In the rheograph, instead of making the free periodic time of the instrument excessively small, M. Abraham uses a galvanometer with a period of about 1/10th of a second, and attempts to compensate errors due to the inertia of the moving part by utilising the effects of electromagnetic induction. With this instrument M. Abraham, it is said, has been able to study oscillating discharges having a period of about 1/10,000th of a second; but the adjustment is not an easy matter, and, moreover, has to be made every time the instrument is used. In the Hess-Braun oscillo-radiograph the difficulty of

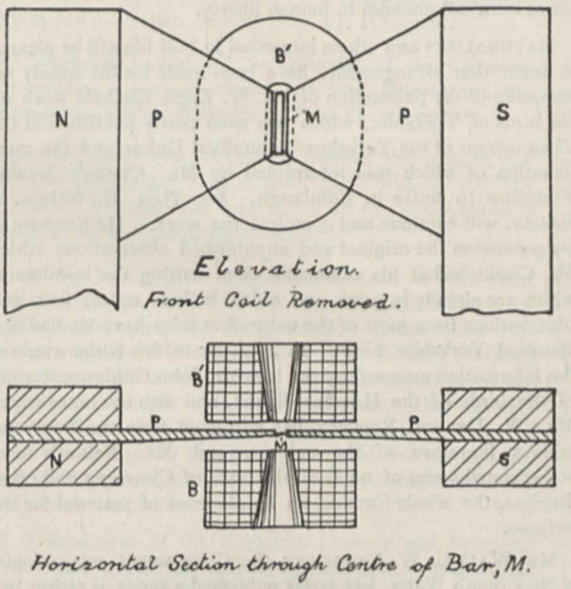

FIG. 1.—M. Blondel's oscillograph.

sufficiently reducing the inertia of the moving part is overcome in a very ingenious manner by using, as the galvanometer "needle," a beam of kathode rays in a vacuum tube. This beam is arranged to produce a bright spot on a fluorescent screen, and the movements of this spot are observed when the beam is deflected by the varying currents passing through two bobbins of wire on either side of the vacuum tube. Unfortunately these bobbins, possessing self-induction, introduce errors. Another difficulty in this apparatus is to obtain good definition, and also sufficient intensity of illumination. On account of the small intensity it is only possible to use this instrument for the study of cyclic phenomena where, as the spot of light can be caused to travel over the same curve again and again, the curve can be observed or photographed.

Neither of these instruments has been brought to the same degree of perfection as the oscillograph, which has been developed into a very perfect instrument by M. Blondel in France and by Mr. Duddell in England. M. Blondel originally suggested three systems on which oscillographs might be constructed, in which the moving part consisted respectively of a small bar of soft iron, a vibrating plate of iron, and a light coil on a bifilar suspension. The instrument which M. Blondel first perfected, and with which his well known researches on the alternate current arc were carried out, was constructed on the first of these systems. The diagram (Fig. 1) shows the chief principles of its construc-

[1] *The Electrician*, 1894, vol. xxxiii.
[2] *Journal* of the Institution of Electrical Engineers, 1896, vol. xxv.

tion. A small bar of soft iron, M, to which is attached a light mirror, is pivoted between the pole-pieces, P.P., of a powerful magnet or electro-magnet. These pole-pieces are laminated and are specially shaped to give as strong a magnetic field in the air gap as possible. On each side of the pole-pieces is a coil of wire, B.B., through which the current to be observed flows. This current produces a field at right angles to that of the field magnet, and so deflects the iron bar through an angle which, if small, is proportional to the current. M. Blondel has produced an instrument of this type having a free periodic time of 1/6000th of a second; and, by replacing the small bar with an iron band stretched between the pole pieces, he has constructed an instrument having much smaller free periodic time than any other type of oscillograph—indeed as small as 1/50,000th of a second—but the sensibility at this high frequency is not very great. At a frequency of about 10,000 vibrations per second, its sensibility is about the same as that of the other types of instrument.

The credit of developing the bifilar oscillograph is due to Mr. Duddell, who, as the result of a long series of investigations

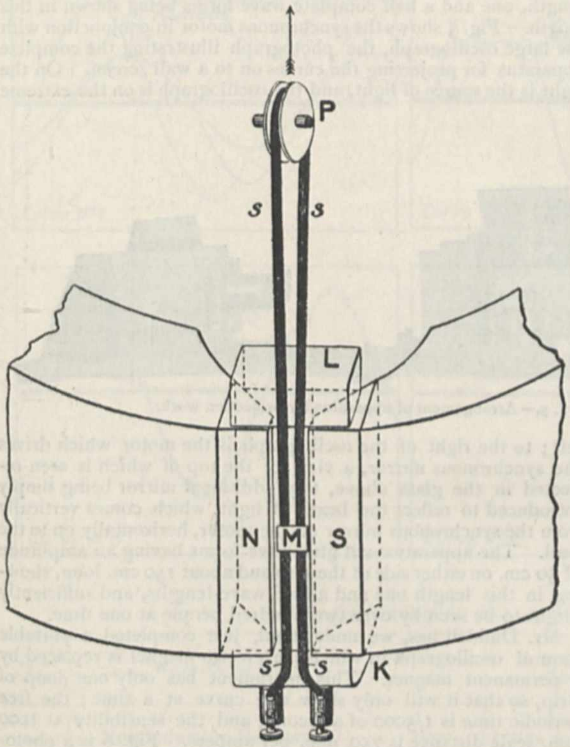

FIG. 2.—Mr. Duddell's oscillograph. (From the *Journal* of the Inst. Elect. Eng., vol. xxviii., 1899, p. 8.)

carried out at the Central Technical College, has produced instruments of this type possessing a high degree of perfection, and by means of their use has brought to light a number of new experimental facts. The principle of Mr. Duddell's oscillograph will be easily understood by reference to Fig. 2. The current to be observed flows up one side and down the other of the continuous strip of phosphor-bronze, *s.s.s.s.* This strip is looped over the pulley, P, which is attached to a small spring balance (see Fig. 3) by means of which the tension on the strip can be regulated. Each arm of the loop passes through the gap between the poles, N.S., of a powerful electro-magnet. The loop carries at its centre a mirror, M, which is made of a small piece of silvered cover-glass cemented to the strips. When a current passes through the loop, one side is moved forward and the other backward, and the mirror is thus deflected through an angle proportional to the current. The phosphor-bronze strips are held in position at the bottom by being clamped between ebonite insulating pieces at K, and at the top by being drawn against the single ebonite piece at L. It will be observed, therefore, that the only part of the strip that takes part in the vibration is that between K and L, and not, as might otherwise be supposed, the whole length from K to the pulley P.

By the use of phosphor-bronze, Mr. Duddell has found it possible to make very light strips having sufficient strength to enable considerable tension to be used, and having, at the same time, good conductivity. He has been able to bring down the free periodic time to 1/10,000th of a second, and, with a free periodic time as low as this, the mirror can easily follow, with extreme accuracy, the vibrations of an electric current alternating at the rate of 300 complete cycles per second, while even if the alternating current has a periodic time as short as 0·001 second, or even less, the record may possess sufficient accuracy for many purposes. The narrow gap through which the strips pass is only just large enough to allow of their free movement, and as the break in the magnetic circuit is consequently very small, the field can be made very intense. This space is filled with damping-oil, which is retained in it by a lens forming a front to the gap, and thus the strips are confined in a narrow oil-bath, in which they have only just room to move, the damping in consequence being very efficient and rendering the instrument accurately dead-beat.

Already the Cambridge Scientific Instrument Co. have constructed many specimens of two types of this form of oscillograph,

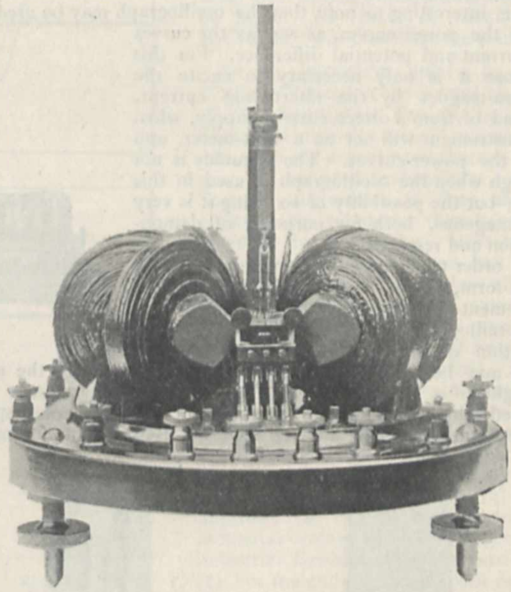

FIG. 3.—Mr. Duddell's oscillograph. High frequency pattern.

a large one for projection work and a high frequency instrument for more accurate research work. The general design in both types is the same, the chief difference lying in the high frequency pattern having its moving parts smaller and lighter, by which means the periodic time of 1/10,000th second has been obtained, whereas the free periodic time of the projection instrument is 1/2000th of a second. The instrument is made with two loops fixed side by side in the gap so that one may be used to give the wave-form of the current while the other is used to give the wave-form of the potential difference, the two curves being thus obtained simultaneously. There is a third fixed mirror between the two vibrating mirrors which is used to give a zero line. Small tangent screws enable the positions of the moving mirrors to be adjusted to zero. From Fig. 3, which is a photograph of the double instrument, a good idea of its general appearance and construction may be obtained. The light band between the poles of the magnet shows the position of the mirrors, but the illustration is on too small a scale for the mirrors themselves to be distinctly visible. This is not surprising when one considers that their actual size is only 1·0 mm. high by 0·3 mm. wide by about 0·1 mm. thick. The strips are connected through the four small upright fuses with the terminals on the front of the base of the instrument. The normal working current in the strips is 0·10 amp., and the sensibility at a scale distance of 1000 mm. is nearly 600 mm. per ampere. The other terminals which are seen make connection with the magnet, on which there are four pairs of coils the ends of which are brought out to separate terminals so that the coils may be connected up

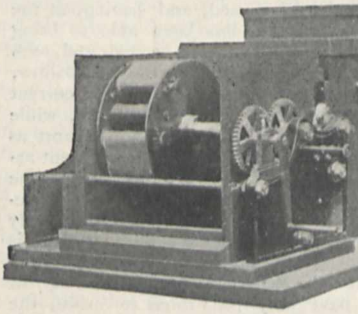

FIG. 4.—Photographic recording arrangement.

in series or parallel to suit the voltage obtainable. The magnet is wound so that the coils may be connected in series direct across 100 volt mains.

It is interesting to note that the oscillograph may be used to show the power curves, as well as the curves of current and potential difference. For this purpose it is only necessary to excite the electro-magnet by the alternating current, instead of from a direct current supply, when the instrument will act as a watt-meter, and give the power-curves. The accuracy is not so high when the oscillograph is used in this way; but the possibility of so using it is very advantageous, both for purposes of demonstration and research.

In order to observe the actual shape of the wave-form, it is necessary to introduce a movement of the beam of light reflected from the oscillograph mirror at right angles to the direction of vibration it already possesses. This may be done by observing the movements of the spot of light in a rotating mirror, or, if permanent records are desired, by receiving the spot on a moving photographic plate or film. This method may be used for observing or

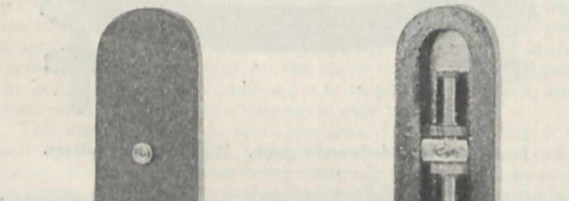

FIG. 6.—Mr. Duddell's portable pattern oscillograph.

recording any variations in current, whether they be periodic or not. In Fig. 4 is shown a photograph of the recording arrangement. The oscillograph is in the back part of the box, and in the front part may be seen the recording drum, which carries Kodak daylight changing spools. There is a shutter between the oscillograph and the film which enables any length of film up to 40 cm. to be used at each experiment, and this shutter carries a contact maker which can be used to start any non-periodic phenomena it may be desired to record. For the cases in which it is only periodic changes which have to be studied, Mr. Duddell has devised a very convenient arrangement in which the rotating mirror is replaced by one which is vibrated in synchronism with the waves of potential difference or current under observation. The mirror is vibrated by a small synchronous motor, and the spot of light is reflected from it on to a transparent screen above it; as the mirror moves with a uniformly increasing displacement the wave form is drawn on this screen, and when arrived at the full extent of its motion, the mirror is pressed back suddenly to its initial position, the beam of light being interrupted during this return journey by a shutter attached to the motor shaft. The mirror then starts on a fresh swing, and draws a second wave-form on the top of the first, the successive curves appearing, by persistence of vision, on the screen as a single bright line, which may be either traced, or photographed on sensitive paper. The size of the curves is about 3 cm. amplitude on each side of the zero and about 8 cm. in length, one and a half complete wave-forms being shown in this length. Fig 5 shows the synchronous motor in conjunction with the large oscillograph, the photograph illustrating the complete apparatus for projecting the curves on to a wall screen. On the right is the source of light, and the oscillograph is on the extreme

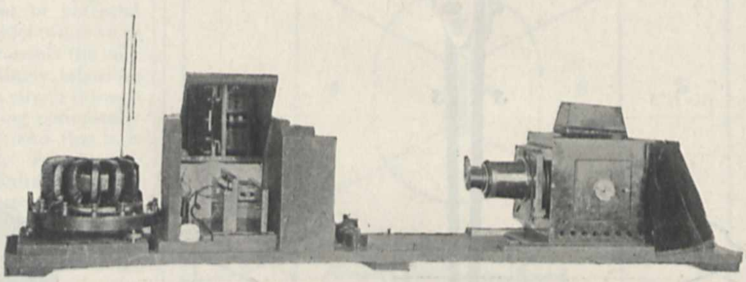

FIG. 5.—Arrangement of apparatus for projection work.

left; to the right of the oscillograph is the motor which drives the synchronous mirror, a view of the top of which is seen reflected in the glass above, this additional mirror being simply introduced to reflect the beam of light, which comes vertically from the synchronous mirror on the motor, horizontally on to the wall. The apparatus will give wave-forms having an amplitude of 50 cm. on either side of the zero and about 150 cm. long, showing in this length one and a half wave-lengths, and sufficiently bright to be seen by over two hundred people at one time.

Mr. Duddell has, we understand, just completed a portable form of oscillograph in which the electro-magnet is replaced by a permanent magnet. This instrument has only one loop of strip, so that it will only show one curve at a time; the free periodic time is 1/5000 of a second, and the sensibility at 1000 mm. scale distance is 750 mm. per ampere. Fig. 6 is a photograph of this small oscillograph, and shows the instrument with and without the front which protects all the working parts. The whole apparatus for observing wave-forms—oscillograph, source of light and rotating mirror—is fitted up ready for use in a small and easily portable box, and should prove of great value to central station engineers and others who employ alternating currents.

In Fig. 7 are shown some examples of curves of current and potential difference obtained by means of the oscillograph. These curves were photographed on to a falling plate, and are here reproduced half full size. Curve 1 shows the wave-forms of the P.D. between the terminals of a dynamo sending a current through an inductive and non-inductive resistance in series, and of the P.D. between the terminals of the non-inductive part, as well as the wave-form of the current flowing in the circuit. It will be seen that the self-induction has caused the current curve to be out of phase with the dynamo P.D., but there is no distortion of the shape. Curve 2 shows the characteristic wave-forms of the current and P.D. of an alternating current arc, burning between solid carbons. The P.D. has a high peak at the beginning, and the current curve lies flat along the zero line at the beginning and end of each half-wave. Curve 3 is for an arc burning between carbon and zinc; these waves are particularly interesting, as it would be practically impossible to obtain them by the "point-to-point" method, since arcs between carbon and metals burn very unsteadily. The arc, it will be seen, only burns for half a period; when the metal is positive (upper curves) the current is able to flow, and the P.D. and current curves have the shape characteristic of the same curves for the carbon arc, only somewhat accentuated; for the other half period, when the metal is negative no current flows at all, and the current curve is flat along the zero line, the P.D. curve being, in consequence, that given by the dynamo on open circuit. The three curves are for a frequency of 100 periods per second. Curve 4 shows the P.D. and current through the primary of an induction coil in which the contact-maker was driven by a motor, no condenser being used. The steady growth of the current and its rapid fall at break can be clearly observed in the current curve. From the P.D. curve it will be seen that the P.D. at the start is high, since, until the current begins to flow, the P.D. between

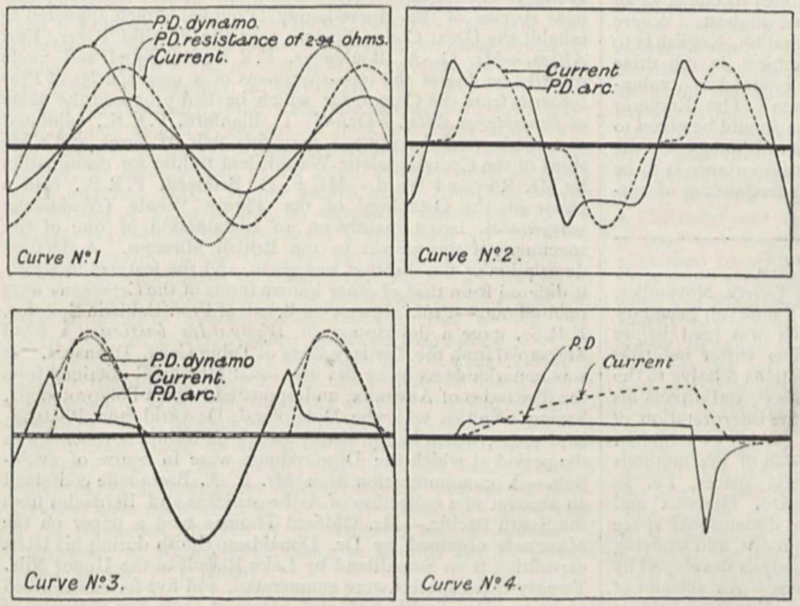

FIG. 7.

Data for Curves in Fig. 7.

No. of Curve.	Wave Forms for.	Periods per second.	Scale of P.D. Curve.	Scale of Current Curve.
1	Non-inductive Resistance.	100	1 mm. = 10 volts.	1 mm. = 2 amps.
2	Solid Carbon Arc.	100	1 mm. = 6 volts.	1 mm. = 2 amps.
3	Zinc-Carbon Arc.	100	1 mm. = 10 volts.	1 mm. = 2 amps.
4	Primary of an Induction Coil.	60 breaks	1 mm. = 2 volts.	1 mm. = 1 amp.

the terminals of the coil is equal to the E.M.F. of the cells. As the current rises, the P.D. between the terminals of the coil falls, due to the drop in volts in the circuit outside the coil; finally the break occurs and there is a large kick of the P.D. in the opposite direction to that applied.

From what has been said some idea will be gathered of the great value of the instrument that has been put into our hands by the invention of the oscillograph. To the scientific investigator it opens wide fields for experimental research, and it will enable the engineer to know more about the currents and E.M.F.'s with which he works. In addition, the projection oscillograph should prove invaluable for lecture and demonstration purposes, for even the simplest problems of alternate current working are by no means easy of comprehension by the average electrical student, who approaches them with only a bowing acquaintance with differential calculus and Fourier's theorem. The remarkable clearness with which their working can be demonstrated on the screen by the oscillograph will go a long way to give students a clear idea of their properties.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. T. Loveday, of Magdalen College, has been elected John Locke Scholar for the ensuing year.

Mr. G. C. Bourne has been re appointed a delegate for the extension of University teaching.

The electors to the Wykeham Professorship of Physics have appointed Mr. J. S. Townsend, Fellow of Trinity College, Cambridge, and Demonstrator in the Cavendish Laboratory.

CAMBRIDGE.—The Clerk Maxwell Scholarship in physics is vacant through the election of Mr. J. S. Townsend to a professorship at Oxford. Candidates are to apply to Prof. J. J. Thomson by December 18.

The British Westinghouse Electric Company have presented to the Engineering Laboratory a valuable dynamo and other apparatus illustrating the generation and use of polyphase currents.

AN opportunity for seeing the Northampton Institute, Clerkenwell, and examining some of the work done in the laboratories, will be afforded to-morrow evening (December 7), when the annual prize distribution and members' and students' conversazione will be held. Sir John A. Cockburn, K.C.M.G., will distribute the prizes.

IN an important article by Dr. William Wallace in the current number of the *Fortnightly Review*, on "the Scottish University crisis," attention is drawn to the urgent need there is for a greatly increased expenditure upon Scottish universities if they are to maintain the reputation they have enjoyed in times gone by. It is urged that a lump sum of not less than 1,500,000*l.* is required to place all the Scottish universities in such a position that their degrees should be regarded as of equal value with those of England, Germany, or even America. Such money is regarded as imperatively necessary for the following main purposes: (1) The conversion of the present skeleton faculties into real teaching organisations; (2) For laboratory and other scientific equipment; (3) For libraries; (4) For the endowment of industrial universities or of genuine industrial faculties in the universities; (5) For the endowment of poor undergraduates; (6) For the endowment of post-graduate research.

DR. OLIVER LODGE made some novel suggestions as to the time, place and purpose of University examinations, in his address to the students of the University of Birmingham on November 28. His proposals amount essentially to this—that examinations should not immediately follow teaching, and that a vacation interval should intervene for private study and revision, quiet thought, assimilation and digestion. Students should not be taken straight from a lecture-room into an examination-room, so that they might tell the examiner what the professor had said before they had time to forget it. So he wished to urge that a long vacation should be left between instruction and examination; that the examinations be held in September instead of at the end of June. If no interval for rumination was afforded during student days, if the unrooted ideas were pulled up for inspection by the examiner at the end of each session, and the student turned loose in the holidays, empty, swept and only partially garnished, for a period of complete idleness before another filling-in process began, then the last state of that man was liable to be little better than the first. The principle underlying Dr. Lodge's proposals is sound enough, but there are difficulties and objections in the application. What, for instance, is to prevent the student who wishes to obtain a good place in the examination at the commencement of the session from devoting his holidays to study when he ought to be gaining physical strength and enjoying mental relaxation?

THE Emperor of Germany has given his consent to further reforms in the educational systems of the higher schools of Prussia, and a summary of the edict is given in the *Times*. The general education received in the three kinds of schools, the Gymnasium, the Realgymnasium and the Oberrealschule, is to be regarded as of the same value, and as only requiring to be supplemented in so far as for several branches of study and for several professions special preliminary knowledge is necessary which is not included in the curriculum of all three institutions. In accordance with this consideration, the desirability of extending the privileges of the Realgymnasien and the Oberrealschulen is to be kept in view. By this means it is hoped to raise these schools in public estimation, and to render an acquaintance with modern subjects more general. In view of the great importance of a knowledge of English, his Majesty lays stress upon the necessity of giving more attention to that subject in the Gymnasium. English is to be taught as an alternative subject to Greek in all the classes of those schools, except the three highest. Where the local conditions are favourable to the alteration, English is to take the place of French as a compulsory subject in the three highest classes. French, however, is to be retained as a voluntary subject wherever this change is made. The Emperor further regards it as advisable that more time should be given to geography in the higher Realschulen than has hitherto been the case. In the teaching of modern languages importance is to be attached to fluency in speaking and to the understanding of current authors.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, November.—The only paper in the present number is a note on geometry of four dimensions, by Prof. Lovett, which was read before this society on April 28 of this year. The writer indicates nine well-defined "trends" which the speculations relative to the geometry of *n*-dimensional space have followed, and directs his work to following up two out of these, viz., the interpretation of this geometry in the light of the theory of groups as exhibited by Lie, Klein and Poincaré and the extension of the methods of ordinary differential geometry to general spaces, *i.e.* as worked out by Christoffel, Beltrami, Cesàro, Darboux and others. This he does by constructing four dimensional space by the method of Lie's theory of continuous groups, and studying curves of triple curvature by the intrinsic analysis developed by Cesàro in his Lezioni di geometria intrinseca.—An account of the proceedings at the recent International Congress held at Paris is furnished by Miss C. A. Scott, in which she abstracts the addresses by Prof. Cantor, sur l'historiographie des mathématiques, and Prof. Volterra, trois analystes italiens, Betti, Brioschi, Casorati. Several of the papers communicated are lightly but clearly handled, and M. Poincaré's presidential address, du rôle de l'institution et de la logique en mathématiques, is concisely analysed. She plainly speaks her mind on many points of detail.—Dr. G. A. Miller gives an account of the 49th Annual Meeting of the American Association for the Advancement of Science so far as it relates to the work of the society. The meeting was held at Columbia University, June 23—30, and from the point of view of scientific work it is said to have been one of the most successful that has been held by the association. About twenty papers were read in section A., some of which are given in brief abstract.—In the "notes" additional particulars (to those given in the October number) are given of the mathematical courses to be followed in the coming winter at British and Continental colleges.—Personal details as to deaths and new appointments, with the usual "new publications," close the number.

IN a paper on new and critical British Algæ, in the *Journal of Botany* for October, Mr. E. A. L. Batters describes no less than three new genera of sea-weeds:—Neevea, belonging to the Bangiaceæ, represented by *N. repens*, endozoic on *Flustra foliacea* at Deal; Rhodophysema (Florideæ), founded on *R. Georgii*, growing on *Zostera marina* off the Scilly Islands; and Erythrodermis (Florideæ), represented by *E. Alleni*, dredged up from 4—6 fathom water at Plymouth.—In the number for November Mr. Pearson describes and figures a new liverwort, *Lejeunea Macvicari*, from Inverness-shire; and Mr. E. S. Salmon a new parasitic fungus belonging to the Erysipheæ, *Uncinula septata*, from Japan.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 15.—"Data for the Problem of Evolution in Man. VI.—A First Study of the Correlation of the Human Skull," by Alice Lee, D.Sc., with some assistance from Karl Pearson, F.R.S., University College, London.

November 22.—"On the Restoration of Co-ordinated Movements after Nerve Crossing, with Interchange of Function of the Cerebral Cortical Centres." By Robert Kennedy, M.A., D.Sc., M.D.

Zoological Society, November 20.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. Sclater stated that during a recent short stay at Gibraltar he had visited the haunts of the Barbary Ape (*Macacus innuus*), at the top of the Rock, and had ascertained that the herd of these animals was in a flourishing condition, and had considerably increased during the last few years.—An extract was read from a letter from Sir Harry Johnston, K.C.B., containing indications of a supposed new species of the Horse-family (Equidæ) which appeared to inhabit the Great Congo Forest, near the Semliki River, East Africa.—Mr. G. A. Boulenger, F.R.S., exhibited and made remarks on one of the type-specimens of a new species of Protopterus from the Congo, for which he had proposed the name of *Protopterus dolloi*.—Dr. W. T. Blanford, F.R.S., exhibited and made remarks upon a very fine pair of horns and some skins of the Central-Asiatic Wapiti, lent to him for examination by Mr. Rowland Ward.—Mr. F. E. Beddard, F.R.S., read a paper on the Osteology of the Pigmy Whale (*Neobalaena marginata*), based mainly on an examination of one of the specimens of this animal in the British Museum. A detailed description of the skeleton was given, and the features in which it differed from that of other known forms of the Cetaceans were pointed out.—Prof. Howes, on behalf of Prof. Baldwin Spencer, F.R.S., gave a description of *Wynyardia bassiana*, a fossil Marsupial from the Tertiary Beds of Table Cape, Tasmania. It was remarkable as being the first fossil Marsupial obtained from the Tertiaries of Australia, and appeared to be a Polyprotodont, having affinities with the Didelphyid, Dasyurid, and Phalangistid series, which had probably struck off from the rootstock at the period at which the Diprotodonts were in course of evolution.—A communication from Mr. L. A. Borradaile contained an account of a collection of Arthrostracans and Barnacles from the South Pacific.—Mr. Oldfield Thomas read a paper on the Mammals obtained by Dr. Donaldson Smith during his latest expedition from Somaliland by Lake Rudolf to the Upper Nile. Twenty-three species were enumerated, and five forms described as new. Dr. Smith had also obtained some fine examples of the true Bohor of Rüppell (*Cervicapra bohor*) and of the Bushbuck described by Heuglin as *Tragelaphus bor*, which proved to be a tenable sub-species of *T. scriptus*.—Mr. W. L. Distant read a paper on the Rhynchota belonging to the family Pentatomidæ in the Hope Collection at Oxford. It constituted a revision of the catalogue of the Hope Collection written by the late Prof. Westwood in 1837. All the specimens had been examined by the author, and the species relegated to modern genera and much synonymy removed, while several new genera were described in the paper.—A communication was read from Mr. R. C. Punnett, containing an account of the Nemerteans collected by Prof. Haddon in Torres Straits. They comprised examples of seven species, four of which had been previously described, whilst the remaining three were new.

Royal Meteorological Society, November 21.—Dr. C. Theodore Williams, President, in the chair.—A communication was read from the International Meteorological Committee inviting observations of the form, amount and direction of the clouds on the first Thursday of each month during 1901, as well as on the preceding and following days. These observations are to be made in connection with the balloon ascents which will be carried out under the direction of the Aërostation Committee.—Mr. R. H. Curtis exhibited an improved mounting for the lens and bowl of the Campbell-Stokes sunshine recorder, by means of which the glass ball can be quickly and accurately placed centrally in the bowl, where it is secured by clamping screws.—Mr. W. H. Dines read a brief paper on the weekly death-rate and temperature curves, 1890-99. He exhibited diagrams showing the death rate of the thirty-three great towns of England, and also curves of the temperature at Greenwich. The author is of opinion that, from the health point of view, the English climate is one of the best in the world, and this is proved by the relatively low rate shown in these curves. A pleasanter climate may well be found, but the majority of health resorts to which Englishmen resort in the winter have a higher death rate than London has at the same season, and a far higher rate than any of the country districts of the British Isles.—Mr. H. Mellish also read a paper on the seasonal rainfall of the British Islands. After referring to what had already been written on the subject by others, he proceeded to discuss the data contained in the "Tables of Rainfall, 1866-90," published by the Meteorological Council. He concluded by saying that, as regards the relation between the amount which falls in the wettest and the driest month at any station, it seems to be generally the case that the range is larger for wet stations than for dry ones.

Entomological Society, November 21.—Mr. G. H. Verrall, President, in the chair.—Mr. H. W. Andrews exhibited *Atherix crassipes*, Mg., a Dipteron new to the British list, taken near Ticehurst, Sussex. Mr. Verrall remarked that it was a distinct species, and, like *Leptis*, affected the leaves of alder.—Colonel Yerbury exhibited *Anthrax paniscus* and *Tabanus bromius*, bred from a lepidopterous pupa found in sand at St. Helen's, Isle of Wight, and a new species of Cordylura, taken at Aviemore in July 1899 and June 1900.—Mr. L. B Prout exhibited three male specimens of *Proutia betulina*, Z , and two of *P. eppingella*, Tutt, bred from larvæ taken this season in Epping Forest. He remarked that both species occurred in the same part of the forest, and the larvæ appeared to be attached chiefly to old hawthorns. Excepting in the smaller size of *P. eppingella*, no superficial difference was observable between the two species. The specimens of *P. betulina*, however, emerged about ten days earlier.—Dr. Chapman exhibited some specimens of considerable interest in relation to the question of correspondence or otherwise of the pupal and imaginal wings of *Aporia crataegi*, showing that at this particular stage the imaginal wings presented the markings of the pupal wing, a set of markings which are in a way the reverse of those of the mature imago. He also exhibited specimens of the wings at a later stage, showing the true imaginal markings developed. With regard to these effects, Dr. Chapman explained them to some extent as analogous to photographic effects. It was quite possible, he thought, that light and heat caused a differential effect through the different coloured areas of the pupa.—Papers were communicated on contributions to a knowledge of the Rhyncota, by Mr. W. L. Distant, and an account of a collection of Rhopalocera made at Zomba, British Central Africa, by Mr. P. T. Lathy.

MANCHESTER.

Literary and Philosophical Society, November 27.—Mr. J. J. Ashworth, Treasurer, in the chair.—Dr. Wilson mentioned a peculiarity to which his attention had been called in reference to the bursting of gauge glasses on the engines in the laboratory at the Owens College. It appears that an interval of perceptible length occurs between the first appearance of a longitudinal crack in the glass, from which the steam issues, and the actual burst. The interval was sufficiently long on one occasion to allow the fireman to shut off the steam before the tube collapsed. If the interval be found to occur generally, it is of obvious importance.

DUBLIN.

Royal Dublin Society, November 21.—Prof. G. F. FitzGerald, F.R.S., in the chair.—Prof. J. Emerson Reynolds, F.R.S., presented notes on some recent advances in chemical science illustrated at the Paris Exhibition.—Mr. J. R. Wigham described a method of burning petroleum under pressure for lighthouses and other places where an extremely powerful light is required, and exhibited a working model of the apparatus.—Prof. J. Emerson Reynolds exhibited a series of photographic slides showing various parts of the Paris Exhibition.—Dr. W. E. Adeney exhibited and described the Michelson Echelon spectroscope.—Mr. R. M. Barrington showed a collection of the wings of birds killed by striking Irish lighthouses in their flight.

PARIS.

Academy of Sciences, November 26.—M. Maurice Lévy in the chair.—Action of the earth's magnetic field upon the behaviour of a magnetised chronometer, by M. A. Cornu. As the result of the experiments cited, the conclusion is drawn that it is possible to correct the action of a magnetic field upon a magnetised chronometer, either by a correction formula or by the use of compensators.—On the existence of the nitrides of neodymium and praseodymium, by M. H. Moissan. A claim for priority against M. Matignon.—M. Haller was elected a member of the section of chemistry in the place of M. Ed. Grimaux.—On the definition of certain surface integrals, by M. H. Lebesgue. On fundamental functions and the problem of Dirichlet, by M. W. Stekloff.—On orthogonal systems admitting a continuous transformation group of Combescure, by M. Maurice Fouché.—Solution of a problem of elastic equilibrium, by M. Ivar Fredholm.—On the study of distant storms by means of the telephone, by M. Th. Tommasina. By the use of a coherer and a telephone each change of sign of atmospheric electricity shown on the electro-radiograph of M. Boggio Lera is shown to be accompanied by a sound in the telephone, giving rise to the illusion that the storm is quite close. The apparatus may possibly be of use at sea.—Actinometric measurements at Pamir, by M. B. W. Stankewitch. Observations were made at the passes of Taldik (3590 metres), Kisil Art (4220 metres), and Ak Baital (4650 metres).—On the magnetisation of electrolytic deposits of iron obtained in a magnetic field, by M. Ch. Maurain. Two curves are given, one showing the ordinary magnetisation curve of a deposit obtained as little magnetised as possible, the other the intensities of magnetisation of deposits obtained in constant fields up to 800 C.G.S. units.—Apparatus for localising despatches in wireless telegraphy, by M. Paul Jégou.—Cryoscopic researches, by M. Paul Chroustchoff. The measurements were made with a Callendar and Griffiths electrical thermometer, reading to 0°·0001 C. Experimental results are given for salt, sugar, potassium bromide and sulphate.—New method of estimating arsenic, by M. O. Ducru. In a solution containing ammoniacal salts, and slightly alkaline with ammonia, arsenic acid is completely precipitated by cobalt salts. The precipitate may be treated in one of three ways, dried at 100°, ignited at a low red heat, or the cobalt determined electrolytically, of which the first and third appear to give the best results.—On a general method of separation for the metals of the platinum group, by M. E. Leidié. Metals other than those belonging to the platinum group are eliminated, and the remaining metals transformed into double nitrites. Soda is added to the liquid, and the osmium and ruthenium distilled off in a current of chlorine. The iridium and rhodium are precipitated as double nitrites with ammonium nitrite, and the residual palladium and platinum separated in the usual way.—Direct combination of hydrogen with the metals of the rare earths, by M. Camille Matignon. Neodymium, praseodymium and samarium combine rapidly and completely with hydrogen, the hydrides being dissociable.—On some chlorobromides of thallium, by M. V. Thomas. A description of the method of preparation and properties of the chlorobromide, $TlCl_2Br_4$.—On the selenide of cadmium, by M. Fonzes-Diacon. Crystallised cadmium selenide, CdSe, is rhombohedral, and isomorphous with zinc selenide obtained under similar conditions.—Examination of mineral waters for metals present in minute proportions, by M. F. Garrigou.—On the nitration of di-substituted derivatives of benzene, by M. Ch. Cloez.—Action of nitric acid upon tribromoguaiacol, by M. H. Cousin. Nitric acid gives a quinone, which is the result of a simultaneous condensation and oxidation.—On the presence of seminase in seeds containing horny albumen, by MM. Em. Bourquelot and H. Hérissey. Experiments were made on the seeds of lucerne (*Medicago sativa*) and indigo (*Indigofera tinctoria*). These contain, before germination, a small proportion of a soluble ferment, seminase, capable of liquefying their horny albumen and transforming it into assimilable sugars, these sugars forming the first nutriment of the embryo at the commencement of its development.—Osmotic communication in the normal marine invertebrate, between the internal and external media of the animal, by M. R. Quinton.—The adipose body of the Muscides during histolysis, by M. F. Henneguy.—Experiments on telegony, by Mlle. Barthelet.—On polymorphism of stems in a single species, by M. Marcel Dubard. The Miocene basalts in the neighbourhood of Clermont, by M. J. Giraud.—The effects of working certain groups of muscles, upon others which do no work, by Mlle. I. Ioteyko. A discussion of the previous note of MM. Kronecker and Cutter upon the same subject.—Seasonal variations of temperature at different heights in the atmospheres, by M. Léon Teisserenc de Bort.

New South Wales.

Royal Society, September 5.—The President, Prof. Liversidge, F.R.S., in the chair.—The language, weapons and manufactures of the aborigines of Port Stephens, New South Wales, with two plates, by W. J. Enright.—The past droughts and recent flood at Lake George, by H. C. Russell, C.M.G., F.R.S. It was shown that at the end of 1874 Lake George was at its maximum depth during the past seventy years, the depth then being 24 ft.; from that date the water gradually decreased, rising sometimes during heavy rains, and on February 25, 1877, the water was only 10 ft. 9 in. deep. At this time the author put up an automatic gauge, which recorded every change until it became too low for the machine to work, and exact measures were then carried on by hand. Meantime the level varied with the seasons, until in 1890, a very wet year, the lake was 12 ft. 11 in. deep; and after this the lake level fell faster than ever recorded before, and on March 28, 1900, the depth was only 0 ft. 10 in., a fall of 12 ft. 1 in. in six years. During 1895 the evaporation was most rapid, the hot and windy weather carried the water away, not only by evaporation but also as spray into the forest, and the total loss of water in that year was 5 ft. 4 in.—Note on an obsidian "bomb," by R. T. Baker. The specimen described in this note is not quite perfect—a portion having been broken off when it was discovered. It has a form quite unusual to those previously recorded from Eastern Australia, but resembles those from Western Australia and the interior of the continent. It is not unlike one found in Tasmania in 1897. It is sub-globose in shape, the surface being much indented with air pores and globulites; it has a very dark green or almost black, glassy appearance, and measures 1 in. in diameter, and ⅝ in. in thickness, and has a specific gravity of 2·456 at 15° C. It was found at O'Connell, near Bathurst, by Messrs. A. Walkes and Lester, some feet below the surface, whilst sinking for gold.

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part 2 for 1900, contains the following memoirs communicated to the Society:—

April 9.—W. Voigt: On the present state of our knowledge of the elasticity of crystals (report for the Paris International Congress of Physics).

February 3.—E. Landau: The function $\varphi(n)$ in the theory of numbers, and its relation to Goldbach's theorem.

May 19.—H. Winkler: On the segmentation of unfertilised ova under the influence of sperm-extractives.—G. Mittag-Leffler: On the generalisation of Taylor's theorem.

June 30.—E. Ehlers: Magellanic annelids, collected by the Swedish Expedition to the Straits of Magellan.—J. Orth: Researches at the Göttingen Pathological Institute (Report vii.).

DIARY OF SOCIETIES.

THURSDAY, December 6.

Royal Society, at 4.30.—The Histology of the Cell Wall, with Special Reference to the Mode of Connection of Cells. Part I. The Distribution and Character of "Connecting Threads" in the Tissues of *Pinus sylvestris* and other Allied Species: W. Gardiner, F.R.S., and A. W. Hill.—On the "Blaze Currents" of the Frog's Eye-ball: Dr. Waller, F.R.S.—On a Bacterial Disease of the Turnip (*Brassica napus*): Prof. M. G. Potter.—The Micro-organism of Distemper in the Dog, and the Production of a Distemper Vaccine: Dr. S. M. Copeman.—On the Tempering of Iron Hardened by Overstrain: J. Muir.

Chemical Society, at 8.—Ballot for the Election of Fellows.—Santalenic Acid: A. C. Chapman.—Ammonium Bromide and the Atomic Weight of Nitrogen: A. Scott, F. R.S.—Interaction between Urethanes and Primary Benzenoid Amines: Dr. A. E. Dixon.—The Decomposition of Chlorates. Part III. Calcium Chlorate and Silver Chlorate: W. H. Sodeau.—Nitride of Iron: Gilbert J. Fowler.—The Heat of Formation and Constitution of Iron Nitride: Gilbert J. Fowler and Philip J. Hartog.—Relationships of Oxalacetic Acid: H. J. H. Fenton, F.R.S., and H. O. Jones.

Röntgen Society, at 8.—Exhibition and Description of a Stereoscopic Fluoroscope and a New Rotary Mercury Break: J. Mackenzie Davidson.

Linnean Society, at 8.—On some New Foraminifera from Funafuti: C. Chapman.—On British Thrifts: G. Claridge Druce.

Institution of Electrical Engineers, at 8.—Continuation of Discussion on Mr. Langdon's paper.

FRIDAY, December 7.

Institution of Civil Engineers, at 8.—Dock Gates: F. K. Peach.

Geologists' Association, at 8.—The Zones of the White Chalk of the English Coast. II. Dorsetshire: Dr. A. W. Rowe.

MONDAY, December 10.

Royal Geographical Society, at 8.30.—Expedition to the Barotse Country and through Africa to the Nile: Major St. Hill Gibbons.

Society of Arts, at 8.—Electric Oscillations and Electric Waves: Prof. J. A. Fleming, F.R S.

TUESDAY, December 11.

Institution of Civil Engineers, at 8.—The Signalling on the Waterloo and City Railway; and Note on the Signalling of Outlying Siding Connections: A. W. Szlumper.—Signalling on the Liverpool Overhead Railway: S. B. Cottrell.

WEDNESDAY, December 12.

Society of Arts, at 8.—The Treatment of London Sewage: Prof. Frank Clowes.

THURSDAY, December 13.

Royal Society, at 4.30.—*Probable* papers: On the Spectrum of the More Volatile Gases of Atmospheric Air, which are not Condensed at the Temperature of Liquid Hydrogen. Preliminary Notice: Prof. Liveing, F.R.S., and Prof. Dewar, F.R.S.—Additional Notes on Boulders and other Rock Specimens from the Newlands Diamond Mines, Griqualand West: Prof. Bonney, F.R.S.—The Distribution of Vertebrate Animals in India, Ceylon and Burma: Dr. W. T. Blanford, F.R.S.—Elastic Solids at Rest or in Motion in a Liquid: Dr. C. Chree, F.R.S.

Mathematical Society, at 5.30.—The Syzygetic Theory of Orthogonal Bivariants: Prof. Elliott, F.R.S.—On Discriminants and Envelopes of Surfaces: R. W. Hudson.—Note on the Inflexions of Curves with Double Points: H. W. Richmond.—On some Properties of Groups of Odd Order, ii.: Prof. Burnside, F.R.S.

Institution of Electrical Engineers, at 8.—Possible continuation of Discussion on Mr. Langdon's paper.—*Time permitting*: Rapid Variations in the Current through the Direct Current Arc: W. Duddell.

Chemical Society, at 8.30.—Rammelsberg Memorial Lecture: Prof. H. A. Miers, F.R.S.

FRIDAY, December 14.

Physical Society (Royal College of Science), at 5.—(1) Electric Inertia; (2) The Effect of Inertia on Electric Currents in a Rotating sphere: Prof. A. Schuster, F.R.S.—Exhibition and Description of a Quartz-Thread Gravity-Balance: Prof. R. Threlfall, F.R.S.—On the Theory of Magnetic Disturbances by Earth Currents: Prof. A. W. Rücker, F.R.S. Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents: Dr. R. T. Glazebrook, F.R.S.—The New Physical Laboratories of the Royal College of Science: Prof. A. W. Rücker, F.R.S.—Exhibition of a Set of Half-Seconds Pendulums: W. Watson.

Royal Astronomical Society, at 8.

Malacological Society, at 8.

Institution of Mechanical Engineers, at 8.—Power-Gas and Large Gas-Engines for Central Stations: H. A. Humphrey.

SATURDAY, December 15.

Essex Field Club (Essex Museum of Natural History, Stratford), at 6.30.—Notes on the Mollusc *Paludestrina jenkensi*, Smith, in Essex and elsewhere: A. S. Kennard and B. B. Woodward.—Aquatic Autocrats and Fairies (Lecture): Fred. Enock.

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