THURSDAY, OCTOBER 7, 1897.

PRACTICAL ELECTRICITY.

Practical Electricity: a Laboratory and Lecture Course for First Year Students of Electrical Engineering, based on the International Definitions of the Electrical Units. Completely rewritten by W. E. Ayrton, F.R.S. Vol. i. *Current, Pressure, Resistance, Energy, Power, and Cells.* Pp. xviii + 643, with 247 illustrations. (London: Cassell and Co., Ltd., 1896.)

THAT the progress of electricity during the last decade has been great appears in many ways; but none shows this progress more strikingly than a comparison of a new and up-to-date book on practical electricity with the work as it originally appeared ten years ago. Prof. Ayrton's book was well-known to all laboratory students of electricity; it contained in moderate compass a vast amount of detailed information of great value, and it had marched well with the times. But the decision of the author to recast his matter, and to issue the book in an entirely rewritten and rearranged form, was none the less a wise one. He has now freer scope to put things in their newer relations and lights, to introduce new matter, and to emphasise those points and topics which still further increased experience and the trend of applications show ought to be more insisted on, and ought to bulk more largely in a thoroughly modern treatment of the subject.

So far only one volume of the new book has been published, and that deals with current, pressure, resistance, energy, power, and cells. The treatment of these topics, it is needless to say, is fresh and vigorous throughout. The individuality of the author is evident in every page, and however we may differ in opinion from him on such subjects as order of discussion, choice of starting points, and the like, there can be no question that for every position taken up, and every deviation from the ordinary routine of an elementary treatise on electricity, the author is provided with a reason which commands attention and respect.

In the brief review which we here propose to make of this volume, we shall first note some points that have struck us in a general survey of its contents, and then allude more particularly to some matters of detail. First, there is the very large number of clearly drawn and well-chosen cuts with which its pages are illustrated. There are 247 in all, about one to every two pages and a half, and about three out of every four of them have been drawn for the present work. This feature of the book is refreshing as contrasted with what one finds in so many text-books, which seem to be to a large extent written up (?) to a somewhat well-worn set of "process" cuts.

Some of the pictures of instruments are beautiful examples of what such illustrations should be. If a shaded diagram is given, it should be clear, and not, as it often is, a more or less smudged kind of impressionist representation of the instrument. Then, essential parts hidden away behind coils or in tubes should in some way be disclosed, and not left to be imagined from a verbal description. Thus, in the drawings of current-meters, in various parts of the book, the device of showing the coils cut open to display the construction, and to reveal suspensions and suspended coils and needles, is adopted with great effect. Some of the cuts of lines of force, which have evidently been engraved from photographs of the actual arrangements, strike us as the finest we have seen; notably one (Fig. 34) of the lines of force in a plane through the axis produced by a circular coil carrying a current, and two (Figs. 57, 57*a*) of the lines of force of a horse-shoe magnet with curved iron pole-pieces. These last are exceedingly instructive as regards concentration of field and remanent leakage of lines outside the space.

The printing and get-up of the book are all that can be desired. Printed on thin and at the same time opaque paper, it contains 600 pages of text within a bulk not larger than that often given to a book of little more than half the same amount of matter. A clear and well-arranged index has been provided by Miss Ayrton.

Now as to the particular points in the author's treatment, regarding which we would say a word. The book is professedly based on the international definitions of the various units. Hence the discussion of currents begins with the enumeration of the various physical actions of a current, and a decision is come to, the convenience of which is shown in various ways, to regard an unvarying current as proportional to the chemical decomposition it produces in a given time. The unit of current is *defined* as that which passed through a solution of nitrate of silver in water deposits silver at the rate of ·001118 of a gramme per second. Then is given in a very lucid manner much valuable information regarding electrolysis and the quantitative results that have been arrived at in the investigation of the electrolysis of silver and copper, and the electrolytic standardisation of current-measuring instruments.

Now, although the units referred to above have been the subject of international agreement, their adoption is a matter of practical and commercial convenience, and should not be allowed to supersede or put out of sight the direct derivation of the units of current E.M.F., &c., in the absolute C.G.S. system of units. An Order in Council is not a law of the Medes and Persians which cannot be changed; on the contrary, it will have to be altered in any respect in which, under the conditions of future practice, it is found to be too much at variance with later and more accurate determinations of electrical constants, in order to bring it into agreement with the absolute system. The derivation of the absolute unit of current from the magnetic action of a current has a great practical as well as theoretical importance, and constitutes, as it seems to us, the only proper *definition* of unit current. Of course, this definition necessitates, in the first place, a discussion of magnetic effects of currents; but this cannot be avoided, and is, of course, very adequately given later in Prof. Ayrton's treatise. But we prefer that it should come before the electrolytic discussion, as without a familiarity with the specification of the measure of a current by its magnetic action the full force of the results of electrolytic research cannot be quite appreciated. But this procedure adopted, the results of such research connecting currents measured by their magnetic action with their electrolytic effects comes in what seems to us both their natural and their historical place, and the choice of ·001118 gramme of silver, as the quantity deposited by the passage of the quantity of electricity which is to be taken as unity, loses the air of arbitrariness it must at first sight have to many readers of Prof. Ayrton's book.

The order more usually followed in this matter is also, quite as much as the other, in the spirit of the plan of giving in a treatise on electricity initial prominence to the electric current and its effects. We may remark, though not with reference to anything stated by Prof. Ayrton, that in a good deal of the talk about beginning at this point or that in an exposition of electrical matters, it seems to be forgotten that some previous discussion of elementary magnetic, or it may even be electric phenomena, is desirable and even necessary. To quite understand the action of a current on a magnet, it is necessary to know something about magnets and magnetic fields. The truth is that, in a system logically consistent, as the science of electricity to a very great extent is, the point of attack is very much a matter of convenience. It is possible, of course, and it is done in some recent discussions, to begin with Maxwell's or Hertz's equations for electromagnetic action, and work round to electrostatic action as a mere residual effect. Still, in all such exercitations, a great amount of previous knowledge is taken for granted. The teacher has a difficult task in any case, for he soon finds in whatever way the discussion is undertaken, that to know one thing with approximate completeness it is necessary to know everything else. The study is a process of gradual approximation to clear and accurate conceptions, and if this were more recognised, there would be less discouragement of some students, and on the part of others, less cocksureness and contempt of what does not excite their interest, or is only capable of discussion by methods which have the misfortune to meet with their disapprobation.

A very important section of the book before us is that which deals with the power developed in the circuit of a generator, the conditions for the evolution of the maximum power in the working part of the circuit, electrical and commercial efficiency, and the transmission of power. The thorough practical study of all these questions which Prof. Ayrton has made invests this part of the book with a special interest and authority. Nothing could be clearer and better illustrated by graphical exhibition of the results, and by practical examples, than this long chapter. Perhaps a somewhat more explicit warning might have been added with regard to the fallacy which people apparently *will* fall into of confusing the arrangement of maximum power with that of maximum efficiency. Of course the discussion of efficiency ought to be sufficient to guard against error; but we have not seen the last yet of what at one time seemed inveterate, the continual misapplication of the so-called law of Jacobi.

Of the chapter on cells, &c., we will only say that it is in moderate compass a veritable store of information, which would only be found with difficulty, if at all, after much searching of other books, and to ordinary students more or less inaccessible papers.

By completing the book Prof. Ayrton will confer a further great benefit on all students of electricity, technical or otherwise; and we hope the second volume will not be long delayed. A. GRAY.

PRIMITIVE FRENCHMEN.

Formation de la Nation Française. By Gabriel de Mortillet. With 153 engravings and maps in the text. (Paris: F. Alcan, 1897.)

THE account which Prof. de Mortillet gives of the formation of the French nation is based upon archæological data. It is true that he depends on anthropological materials, but these are prehistoric, and therefore archæological. The anthropological investigations on modern Frenchmen by Broca, Topinard, and others have been neglected; even the brilliant researches of Collignon are not referred to. The book thereby loses somewhat in breadth, and the linkage of the past with the present, which the author so firmly appreciates, would have been brought home more forcibly to the general reader if these investigations had been summarised.

The author first shows that the Bible, legends, ancient texts, and even linguistics, are too untrustworthy to determine the origin of any people; reliance must then be placed on anthropology and palethnology, including archæology. The three terms, race, language, and nationality, are discussed clearly and tersely. Race is an anthropological fact and implies common descent, the prolonged action of environment or complete fusion of various primitive elements. Numerous examples, illustrated by maps, are given to show that the distribution of race and language are by no means identical. If Germany claims Alsace because the population speaks German, why does she retain French-speaking Lorraine? Nationality is a sentiment, and is not based on racial but on sociological reasons. The first half of the book deals with historical documents. The ethnic and geographical discrepancies of various classical authors are pointed out; few had any personal acquaintance with the people and places they described, and most of them romanced. Practically all agree in describing the Celts or Gauls and the Germans in the same terms. Tall, fair people, with blue eyes, white skin, very warlike, and readily undertaking great invasions and vast migrations, constructing neither temples nor towns, fighting naked, but very proud of their hair. But below this military aristocracy there were the common people, ignored by the writers, who constituted the patient and laborious democracy fixed to the soil, the true natives of the country, whom anthropology and palethnology have revealed. The Gallo-Germanic race is spread over nearly the whole of Europe, and extends into Africa and Asia, each band transporting its particular name to the different countries that it occupied.

The languages of France are next dealt with. The remarkable agglutinative Basque language is briefly dismissed, as are also the "Celtic" dialects. "The language spoken in Gaul before the Roman conquest is unknown by us." Various early inscriptions and prehistoric carved stones are briefly reviewed; the latter are classified under (1) simple decorative motives; (2) conventional and commemorative carvings; (3) symbolic carvings, very difficult to understand, but apparently not alphabetical. No reference is made to the remarkable painted stones from Mas-d'Azil.

The third section of the book is devoted to palethnology. Tertiary man is discussed. Mortillet admits the occurrence of intentionally worked flints in Tertiary beds, but denies that they were made by man for the theoretical reason that the Quaternary beds are characterised by the appearance of man, and if worked flints occur in undoubted Tertiary strata they cannot have been made by man, but by a precursor of man. He acknowledges *Pithecanthropus erectus* to be such a precursor. The Chellian, Acheulian, Mousterian, Solutrian and Madelenian divisions of the Palæolithic period are described and the typical implements figured. Part of the population of France at the close of the Palæolithic period migrated northwards with the reindeer, and he regards the ancestors of the Eskimo as the most ancient French colonists.

The remaining aborigines were swamped by the first invasion of France, men from Western Asia who brought with them the Neolithic civilisation, the art of polishing stone implements and of making pottery; these brachycephalic immigrants domesticated animals, practised agriculture, cared for their dead, and had religious ideas.

A second Oriental invasion left a very slight physical influence on the population; it merely reinforced the Neolithic brachycephals, but by the introduction of bronze it effected a tremendous industrial revolution.

The discovery of iron came from Africa, but its introduction into Europe was not marked by any racial movement. Mortillet thus epitomises the three imported stages of culture:—

"The polished stone and the civilisation that accompanied it were brought to us by a violent invasion. Bronze by a slow religious infiltration. Iron arrived simply by commerce and industry."

The anthropological documents are lastly put forward as evidence. The author gives a lucid account of the osteology of the prehistoric races. The race of Neanderthal he would erect into a distinct species. The Upper Palæolithic period is characterised by the race of Laugerie; the most important remains of this race were found in Madelenian deposit at Laugerie-Basse and at Chancelade (both in Dordogne). Mortillet argues that this race was a development *in situ* from the older race, and not a foreign invading type. At the commencement of the Neolithic period a third dolichocephalic race is recognisable; this is often called the race of Cro-Magnon, but as this is not very typical, it is better to term it the race of Baumes-Chaudes, the remains of the cave of l'Homme Mort being less pure than the former. The Baumes-Chaudes and the Cro-Magnon were slightly divergent descendants of the older Laugerie race. Mortillet associates the Cro-Magnon sepulture with the similar triple sepulture at Barma-Grande, and suggests that these were the forerunners of the tall fair Gallo-Germanic invaders.

The mass of the French population consists of the dolichocephalic autocthones who have persisted since Palæolithic times, though they have gradually become modified; the Baumes-Chaudes race of this stock amalgamated in Neolithic times with invading brachycephalic peoples. It is this mixture which has formed the mass of the French people, that sedentary population which may be described as the nucleus of the French democracy. Since then there has always been a turbulent, noisy, mobile aristocracy which alone has filled the pages of history.

Prof. de Mortillet has produced a charmingly written and very lucid account of the conclusions at which he has arrived after a life-long study of all the available materials, and though some of his views may be criticised, all his colleagues will congratulate him on the publication of so useful and instructive a work. A. C. H.

OUR BOOK SHELF.

The University Geological Survey of Kansas. Vol. II. By Erasmus Haworth and assistants. Pp. x + 318. (Topeka: The Kansas State Printing Company, 1897.)

WHEN the full and complete geological survey of a State is undertaken by members of a University faculty, it behoves us to be thankful that the University is so alive to its responsibilities as to work in this way for the "increase and dissemination of knowledge among men." Shortly after the Kansas University opened a graduate department in geology and palæontology, the geological survey of the State was undertaken, and the second volume of results is before us. The work is carried out by members of the University faculty, their advanced students, and other individuals. Like the quality of mercy it is twice blessed, for the State gains by the increase of knowledge of its geology, and the information obtained goes to strengthen the geological departments of the University.

The present volume has been prepared principally by the department of physical geology; and it deals chiefly with the stratigraphic properties of the Cretaceous and younger formations of Western Kansas, little attention being given to economic geology. The papers in the volume are as follows:—"Physiography of Western Kansas" and "The Physical Properties of the Tertiary," by Prof. Erasmus Haworth; "The Upper Permian and Lower Cretaceous," by Prof. Charles S. Prosser; "The Upper Cretaceous of Kansas," by Mr. W. N. Logan; "The Kansas Niobrara Cretaceous" and "The Pleistocene of Kansas," by Prof. S. W. Williston; and "The McPherson Equus Beds," by Prof. E. Haworth and Mr. J. W. Beede.

The reports are intended for the citizens of Kansas, and therefore parts of some of them are of an elementary character, the rudimentary principles of the subject being explained where explanation is needed to elucidate the facts and render them easily understood by readers who are not trained geologists. This, however, only makes the reports more interesting to the mass of the people of the State, and it is certainly better to obtain geological knowledge through the medium of reports like those in the volume before us than from text-books which give it second-hand.

Forty-eight plates, reproduced by photographic process, illustrate some of the physiographic features of Kansas, and add to the interest of the various papers.

Set of Twelve Diagrams illustrating the Principles of Mining. Arranged by F. T. Howard, M.A., F.G.S., and E. W. Small, M.A., B.Sc., F.G.S. (London: Chapman and Hall, Limited, 1897.)

ARRANGED in accordance with the syllabus of the Department of Science and Art, this admirable set of diagrams will prove of great value to teachers of evening classes in the principles of mining, for there can be no doubt that hitherto the want of suitable wall diagrams has proved a serious obstacle in the way of efficient instruction in this important subject. The diagrams measure 30 by 40 inches, and the subjects dealt with are: (1) the geology of the British Isles, (2) the occurrence of coal and ore deposits, (3 and 4) boring plant, (5) methods of sinking through watery strata, (6, 7, and 8) methods of supporting excavations and the construction of dams, (9, 10, and 11) methods of working, and (12) pumps and ore dressing. The illustrations have been selected with great care from standard authorities, due acknowledgment of the source being made in each case. The only fault that can be found with the diagrams is, that the authors have covered so wide a field that it has been necessary in some cases for them to crowd together into one diagram too many drawings. The best of the series are the remarkably bold and effective diagrams illustrating methods of working. The least satisfactory are the perspective views of machinery and of timbering. Plans and sections would have been better.

In Northern Spain. By Hans Gadow, M.A., Ph.D., F.R.S. Pp. xvi + 421. With map and eighty-nine illustrations. (London: Adam and Charles Black, 1897.)

THE incidents and impressions of two prolonged journeys through the northern and north-western provinces of Spain are brightly recorded in the volume before us. Personal experiences always have in them the making of an interesting book; and when things are seen with an intellectual eye, and the itinerary refers to places off the beaten track, the narrative is sure to engage attention. The present work, in which the wanderings of Dr. Gadow and his wife are described, possesses both these claims to recognition; moreover, it is well illustrated by camera and pencil. The accounts of the districts traversed, and the notes on the characteristics and customs of the inhabitants, will interest geographers; while archæologists will find a chapter on the Dolmen of Álava, and numerous short descriptions of other interesting antiquities. For students of biological science there are chapters on the fauna and flora of Northern Spain. The former chapter is a valuable analysis of the fauna of the Iberian peninsula.

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 Highest Kite Ascent.

THE general interest in scientific kite-flying leads me to send the following account of a flight here on September 19, when meteorological records were brought down from the greatest height which it is believed a kite has yet attained. The experiment was part of an investigation into the meteorological conditions of the free air now in progress here, and which is aided by a grant from the Hodgkins Fund of the Smithsonian Institution.

A Richard baro-thermo-hygro-graph (described in *La Nature*, 8 Février, 1896), weighing but 3 lbs., was hung 130 feet below two large Hargrave kites, and other kites were attached at intervals to the four miles of steel wire forming the flying-line, the total sustaining surface of the seven Hargrave kites used being something over 200 square feet. At their highest position the two topmost kites were 9386 feet above Blue Hill, or 10,016 feet above sea-level. The altitudes, at short intervals of time, were obtained from angular measurements with a theodolite, and were confirmed by the barometer record of the meteorograph.

This instrument left the ground about noon, and the greatest height was reached soon after four o'clock, the meteorograph remaining more than a mile above the hill during five hours. A little more than two hours were required for the steam-winch to reel in the four miles of wire, and the meteorograph returned to the ground at 6.40 p.m. The wind on the hill blew from the south with a velocity of about twenty-five miles an hour, but veered to the west in the upper air. The chief results, obtained from the automatic records, which are smooth and distinct, are these:—The temperature at the highest point was 38°, while at the ground at the same time it was 63°, giving a decrease of 1° per 375 feet rise, which is less than normal. The relative humidity at the ground was about 60 per cent. of saturation, but rose rapidly with height to about 4000 feet, which is the level of the cumulus clouds. It then fell, but rose again to nearly saturation above 7000 feet, when approaching the level of the alto-cumulus clouds. The humidity fell to less than 20 per cent. at the highest point reached. Throughout the flight the sky was clear.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, September 23.

Outlying Clusters of the Perseïds.

THE clearness of the sky, and the absence of the moon's light at the end of July and in the beginning of August last, were unusually favourable conditions here for watching the progress of the August meteor-shower of Perseïds from the first signs of its appearance up to very near its date of greatest brightness. Having intended to observe the shower in connection with a watch arranged by Mr. Denning to be kept on the Perseïds this year at many places, and an early beginning of the watch having been recommended, in order to note the progressive changes of the radiant-point's position, I had little expectation of being able to contribute much to this inquiry from the usual scarcity of the Perseïd meteors in the shower's early stages.

A theory of its progressive motion had been formed and compared with observations by the late Dr. Kleiber, of St. Petersburg (*Monthly Notices of the Royal Astronomical Society*, vol. lii. 1891–92, p. 341), depending for its application on certain effects and laws of planetary perturbations. Starting from the same, or from a very similar principle of the effects of planetary disturbances on meteor-orbits with that used by Prof. Adams to calculate the motion of the node of the November meteor-system, that without change of shape or of inclination to the plane of the ecliptic, of the long elliptic orbits round the sun, the line of nodes or intersection of the orbit-plane with the ecliptic is carried secularly backwards or forwards slowly round the ecliptic-circle, according as the motion of the meteors in the orbit is direct or retrograde, Dr. Kleiber showed that the meteors' apparent radiant-point on the earth's encountering the stream, would also be carried with the orbit round the pole of the ecliptic at the same rate in longitude, and without any changes in its apparent latitude. If the earth should thus at any point encounter meteors of the shower which have undergone less or greater secular displacements of their nodes than the main meteor-body, so as to furnish slender meteor-streams observable a few days before or after the principal shower-date, since the earth advances round its orbit through nearly one degree of longitude each day, the differences in longitude between these slender streams' and the main stream's radiant-points will evidently be as many degrees, or very nearly as many degrees as the earth takes days to traverse the distances between the outlying meteor-systems and the main one. Tested by this criterion, Dr. Kleiber showed that of forty-nine apparent foci of the Perseïds observed by Mr. Denning, in various years, between July 8 and August 16, forty-six were reducible by applying to all their longitudes the corrections corresponding according to the theory with their dates, to within a circle of only 2° radius round a point at $43°{\cdot}6, +57°{\cdot}1$ assigned by Dr. Kleiber as the cometary radiant-point. This surprisingly close agreement certainly afforded a convincing proof of the adequacy of the perturbation theory to explain the recorded changes of position of the Perseïd meteors' radiant-point; but I had been rather sceptical of obtaining from such scanty materials for observations as the very early traces of the Perseïd comet meteors seem to offer, positions of sufficient accuracy to be capable of furnishing with much reliability such a very satisfactory agreement? In a watch of three hours, however, on the exceedingly fine night of July 22 last, seven Perseïds were recorded here, of which two (like two on the 18th and 20th), were directed nearly from the usual shower-centre at about $43°, +57°$, but the other five diverged so distinctly from about $23°, +49°$ near υ and ϕ, at the point, instead of from near χ and η at the handle of the sword of Perseus, that the displacement of the radiant-point at this early date from its usual position to one in, at least, considerably lower right-ascension and declination, was at once very evident, and I was induced to longer watches, on later nights, by this first indication, than I would have thought likely, otherwise to be very usefully productive.

The following short Table (I.) gives a summary of the

TABLE I.—*Observations of Perseïd and Non-Perseïd Meteors in July and August*, 1897.

Dates of the Watches	State of the Sky	Moon's Phase, and Brightness	Hours of Watches; and their Equivalent Durations in a clear dark sky: Hours From	To	Lengths (about)	Numbers of Meteors seen: From the Perseïd Radiants: φ I	4 II	χ III	η IV	B, C Camelopardi V	Total Numbers of Perseïds	Numbers of Sporadic Meteors
1897			h m.	h. m.	h.							
July 16	Clear	Gibbous; and bright	10 50	11 50	¾	—	—	—	—	—	—	1
,, 18	Rather hazy	,,	11 15	13 0	1¼	—	—	—	1	—	1	—
,, 20	Very clear	Third qr.; faint	12 0	13 0	¾	—	—	—	—	1	1	3
,, 22	,,	,,	10 30	14 0	3	4	1	—	2	—	7	15
,, 23	Slight cloud	Last crescent; faint	12 50	14 0	¾	—	—	—	—	—	—	3
,, 25	,,	,,	11 0 13 30	11 30 14 0	} 2/4	1	—	—	—	—	1	1
,, 26	Cloudy for 1h.	Faint	11 15	13 45	1½	1	—	—	—	2	3	9
,, 27	Cloudy for 15m.	None	11 15	12 15	¾	3	—	—	—	—	3	8
,, 28	Clear	,,	11 10	12 0	¾	—	—	—	—	—	—	2
,, 30	Very clear	,,	10 20	14 0	3½	—	4	2	1	1	8	12
,, 31	Extremely clear	,,	11 15	13 30	2¼	—	2	—	—	1	3	15
August 1	,,	,,	10 30 11 45	11 30 13 0	} 2¼	2	—	—	2	—	4	18
,, 2	,,	,,	10 10	14 15	4	1	10	6	1	2	20	14 (one = 3 × ♀.)
,, 3	,,	,,	12 15	14 15	2	1	3	—	2	1	7	12
,, 4	,,	,,	10 45 13 5	11 45 14 35	} 2½	2	1	2	1	1	7	16
,, 6	Clear	None	11 30	12 30	1	—	—	2	—	4	6	—
,, 8	Cloudy	First qr.; faint	9 5	9 20	¼	—	—	—	1(?)	—	1(?)	1(?), = ♀
,, 8	Clear	None	{ 11 30 13 20	11 45 14 40	} 1½	3	1	4	3	3	14	11
,, 9	Very clear	Gibbous; weak, till 13h.	{ 9 30 11 0	10 30 14 55	¾ 3¼ }	2	1	1	14	10	28 (one = ♀.)	26 (one = 4 × ♀.)
Total Length of clear Watch; and Numbers of Meteors seen				..	33½	20	23	17	27	26	113	167

watches kept until August 9, the five radiant-points of the Perseïds which seemed to be certainly determined being noted as I.–V. in the Table, and being also graphically represented in the accompanying Figure (1), of the 113 or 114 tracks of Perseïds which were noted. In another Table (II.) the hourly numbers are shown of the meteors of these Perseïd showers on the nights of their greatest frequencies, and of sporadic meteors seen on the same nights, using only dark clear hours of the watches from near midnight onwards, to derive the numbers.

The small fireball seen on August 9, at 14h. 18m., lit up the ground with a slight, but sensible illumination, and left a bright streak from 353°, + 5° to 350°, + 1°, which remained visible for three-quarters of a minute. It was not a true Perseïd, but if it was identical with a bright meteor seen at the same hour at Exeter by Mr. Besley, its radiant-point appears to have been near κ and β Persei, at 45°, + 45°. The Venus-like Perseïd which fell at 14h. 43m. on the same night from 88°, + 37° to 98°, + 26°, near Venus, in the East, also left a very dense bright streak, visible for 15 seconds; its apparent course here was straight from η Persei. The equally bright meteor seen in a break between clouds on the previous evening, from 261°, + 26° to 255°, + 10°, at 9h. 10m. (± 3m.), was also true in direction from η Persei, and might be identical with a

TABLE II.

Meteor Showers	Approximate Positions of the Radiants. in R.A.	in Decl.	in Long.	in Lat.	Hourly Numbers (near and after midnight), of the Perseïd and Sporadic Meteors seen on Maximum Dates:— 1897, July 22	27	30	1897, August 2	6	8	9
From the Perseïd Radiants I	23°	+49°	42°	+36°	2	4*	—	—	—	2	—
II	27	+53½	47	+38	—	—	2	4	—	—	—
III	36	+55	54	+37	—	—	1	2	2*	3	—
IV	42	+56	58	+37	< 1	—	—	—	—	2	4
V	51	+57½	64	+37	—	—	—	< 1	4*	2	3
All the Perseïd Meteors ...	—	—	—	—	2–3	4*	3	7	6*	9	8
Sporadic Meteors	—	—	—	—	4–5	5–6*	2–3	3–4	—	7	8

* In short Watches of 1h. only.

meteor of the same appearance seen at 9h. 10m. by Mr. Norman Lattey at Cardiff (*English Mechanic*, vol. lxvi. p. 15. August 20, 1897), if it had left a streak, and had not seemed to move rather more slowly overhead than the swift-flighted Perseïds. The height of its path above the earth would be from 135 to 115 miles if the two meteors really were identical! A more ordinary height of from 81 to 47 miles, was found by Mr. Denning from a second observation of it at Bridgwater, by Mr. Corder, for the non-Perseïd fireball seen here at 13h. 57m. on August 2. This meteor lit up the sky brightly with two concluding flashes, and left a greenish light-streak on the latter portion of its course, visible for 6 seconds. Its radiant-point was found by Mr. Denning, from the double observation, to have been between Aquarius and Aquila, at 312°, ± 0°, on the equator.

Although the watch was not maintained steadily on all fine nights, nor very often for many hours together on the single nights, yet some good views of further frequencies of the Perseïds, with definite centres of radiation, were obtained after the first display from υ, ϕ Persei on July 22, and were pretty successfully recorded. The latter centre remained active until July 27 (when it was again conspicuous), and then ceased, giving place to a second centre between ϕ and χ, near 4 Persei, at about 27°, + 53°; although a few Perseïd meteors still now and then appeared to come from the earlier radiant-point position in some later watches.

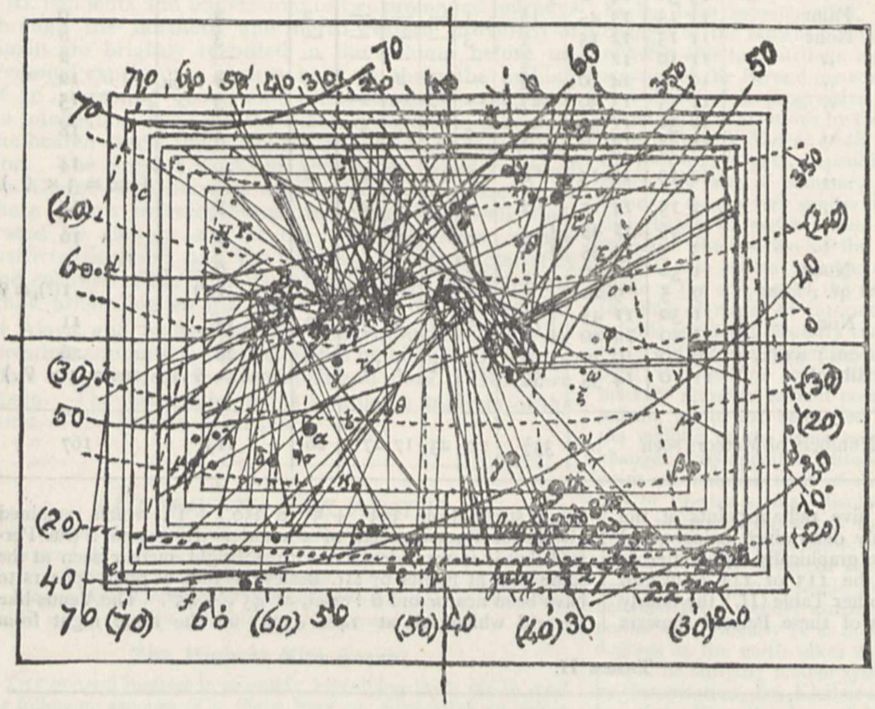


FIG. 1.—Path-lines of Perseïd Meteors belonging to Radiants I. (υ, ϕ); II. (4); III. (χ); and IV. (η, k Persei); and V. (B, C Camelopardi); July 22–August 9, 1897.[1]

The second centre was first well marked on July 30, but it was most active on the beautifully clear night of August 2, with very well-defined radiation from about 30°, + 54°, and with another well-defined and nearly as productive centre near it at 35°, + 56°, whose meteors were afterwards grouped with others (chiefly on August 8) into shower III., at 36°, + 55°. On the two equally fine nights of July 31 and August 1, although sporadic meteors were most plentiful, yet three and four Perseïds only were noted, in watches of 2¼ hours, against 12 Perseïds in the time of watch between the same hours on the later night; and of the twenty Perseïds mapped in 4 hours then, 10 and 6, respectively, proceeded very accurately from the above two companion radiant-points! Like the first shower from ϕ Persei, the immediately succeeding one at 4 Persei ended in its turn on August 3, and produced only three meteors afterwards on later dates!

Clouds prevented observations on August 5 and 7, but an hour's watch on August 6 showed that the usual stream of Perseïds from the well-known radiant-point in Perseus was approaching, as four of the six Perseïds recorded then, diverged very distinctly from close round B, C Camelopardi.

In watches of two, and of four or five hours' duration, until daybreak, on the nights of August 8 and 9, 42 Perseïd and 37 sporadic meteor tracks were mapped at only the very moderate rates, for so near the epochal date, of eight or nine Perseïds per hour in the closing moonless hours of the two nights' watches; the abundance of the Perseïds on the mornings of August 9 and 10, in fact hardly exceeding the rate very perceptibly (of 7 per hour), which had already been noted a week previously at a similar time of watch on the morning of August 3! On the night of August 10 itself, the clouded state of the sky in England, generally deprived observers here of a view of the shower's appearance on its chief annual date; but from a list of 92 meteor-tracks mapped with nearly cloudless sky in 5½ hours on that night, at Le Havre, in France, which I received from a Member of the Astronomical Society of France, M. Libert, who records appearances of shooting-stars and fireballs at that nearly adjacent continental town to English stations, with extreme care and diligence, sporadic meteors seemed still to be greatly outnumbering the Perseïds, as they did here less strongly on the morning of the 10th, in the proportion of nearly two to one, if even allowances most-favourable to the Perseïds are always made in cases where indistinctness of mapping made the radiation doubtful. Substitutions of pointing-stars for the points of first appearance and disappearance, and the abnormal lengths of path thus often noted, which chiefly produced uncertainty in the attempt to assign the meteors their true radiant sources, also prevented any exact positions of the shower's chief centres of divergence on that night from being extracted from the importantly supplied particulars, otherwise, of M. Libert's very valuable and extensive list of path-descriptions.

In point of brightness, however, with seven first-magnitude meteors, and two equal to Sirius or Jupiter, and two compared to Venus, the 25–30 Perseïd shooting-stars described by M. Libert, outshone the 60–65 sporadic meteors, at Le Havre, with their ten of first magnitude and only one each as bright as Sirius and Venus, about as brilliantly as the 28 Perseïds noted here on August 9, with six first-magnitude meteors and one or two each as bright as Sirius and Venus, exceeded the abundance (*pro ratâ*, or doubling the actual numbers here) of bright meteors appearing among the 26 contemporaneously observed non-Perseïd shooting-stars, with three first-magnitude, one Sirius-like, and (possibly) one brighter meteor than Venus, which, however, so nearly came within the range of radiation of the Perseïds that it is also counted in the category above, as possibly a Perseïd fireball.

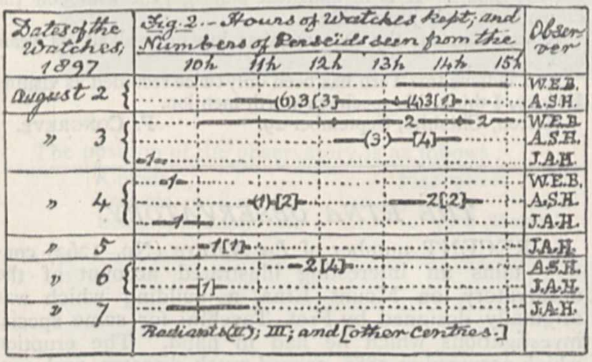
The shower had not yet subsided in numbers or in brightness, it appears, when the strength of the full moon's light had deterred me from looking out for it any longer, on the night of August 11; for in the hour and a half from 10h. 20m. to 11h. 50m. on that night, Mr. J. A. Hardcastle noted at Lymington, in Hants, the paths of ten Perseïds and five sporadic shooting-stars, with two of first magnitude among the former, but none

[1] Circles of Longitude and Latitude are shown by dotted lines (and by figures for every 10°, enclosed in brackets); and circles of Declination by full lines. But to prevent their confusion with path-lines, and their obstructing the view of the path-lines' radiations, the close array of R.A. Meridian-lines is omitted, and the scale of right-ascension is only noted, like the Declination-circles, in plain figures for every 10°, round the border of the Map.

so bright among the latter class of meteors; from which it would appear that the maximum of this year's weak display was probably impending still and not yet arrived at until after daybreak on August 11, when at 1h. 45m. a.m. on that morning, M. Libert ended his long watch of the shower on the night of August 10. With one stray flight from υ, ϕ Persei, six of the ten Perseïd meteors seen by Mr. Hardcastle diverged from η, k Persei, and three from B, C. Camelopardi. A bright streak-leaving Perseïd from the latter radiant-point was also noted, with seven non-Perseïd meteors in one hour, at Lymington, as late as the night of August 19.

A long-continued watch was kept for $5\frac{1}{2}$ hours at Exeter, on August 9, by Mr. W. E. Besley, and the paths of 108 meteors were recorded (*English Mechanic*, vol. lxvi. p. 16, August 20, 1897), among whose projections on a map, he states, a very distinct radiant-point of 71 Perseïds was shown at $43\frac{1}{2}°$, $+ 57°$; extremely near the place, at $43°·6$, $+ 57°·1$ assigned by Dr. Kleiber for the cometary main-stream of the shower. No evidences of a companion-stream at B, C Camelopardi seem to have been noticed among the Perseïd-paths by Mr. Besley; though it seems not impossible, in a case of such near contiguity of two co-operating meteor-streams, if only a few, or scattered tracks from the less productive stream, perhaps, were noted, that some real traces of the weaker and diffuser close-adjoining shower's existence, might easily be overpowered and hidden by the close-crowded group of path-lines round the principal shower's centre.

In a previous, almost equally extensive watch, however, kept on the nights of July 30, and August 2–4, at Westminster in London, of the results of which, in the *English Mechanic* (vol. lxv. p. 601, August 13, 1897), Mr. Besley also gave a most



excellent condensed description, 47 meteors were noted at times almost simultaneous, on August 2 and 3 with my watches here; and together with three non-Perseïd radiant points in Triangulum and Andromeda, and near ζ Persei, a distinct radiant-point which Mr. Besley regarded as that of the "true Perseïds," was obtained from five meteor-paths, four on August 3, and one on August 4, at $32\frac{1}{2}°$, $+ 57\frac{1}{2}°$; only 2° from the place at 35°, + 56°, where on the night of August 2 the radiant-point III. first showed itself distinctly in my watches, accompanied by a closely adjoining and equally distinct and productive shower-centre (the shower II.) at 30°, + 54°. Although my watch and Mr. Besley's were partly contemporaneous on the night of August 2, when six and ten meteors respectively were noted here from the close pair of radiant-points III. and II., yet the five "true Perseïds" mapped by Mr. Besley were not seen among the 16 meteors whose paths he recorded on that night, but among the 27 noted on the following night and one on the night of August 4. These dates of our recorded maxima seem, however, to have been only apparently in disagreement, because, as the above diagram (Fig. 2) of the hours of watching shows, the rate of appearance of the "χ-Perseïds"[1] was at the most only three per hour, and in the times lost in noting observations, either shower might thus easily pass by unnoticed in a watch, for each of us in turn on those two nights, only barely extending to two hours.

In short watches on August 3, 4, and 5, at Lymington, three meteors proceeding from the "χ-Persei" position were mapped by Mr. J. A. Hardcastle, and a second Perseïd on the latter date from between υ and ϕ Persei. The first two path-lines' directions backwards, passing on either side of χ to a point of intersection at 33°, + 54° (about 3° south of χ), and that of the third within 1° east of or preceding χ Persei, through 32°, + 57°. One "ϕ-Perseïd" and four sporadic meteors were also mapped at Lymington in a short watch on August 6, and nine sporadic meteors, but no shooting-star from Perseus, on August 7!

There seems to be clear evidence in all these observations that pretty conspicuous appearances are observable in July and August, of well-marked brief *battues* of Perseïd shooting-stars, which follow each other in a regular order up to the chief annual display, from about three weeks before it; and additional observations of these feeble meteor-currents will be very useful to determine the exact durations, radiant-point positions and relative intensities as well as variations of intensities in future years, of these weak supplementary streams apparently derived by thinning out of the main current's ring-like, lengthened cluster, on the ring's preceding side.

In the Perseïd meteor-swarm's original progressive lengthening by dissimilar times of revolution and orbit-sizes among its individual meteors, until the slower- and faster-moving stream-ends overlapped each other along the orbit in several repeated circuits, the slightly different-sized orbits must be a little differently affected and impressed with node-line motions by planetary disturbing actions, and they must thus have gradually become very slightly separated from each other. But in the case of any local knot or condensation which the original meteor-cloud may have contained, from the very approximately equal revolution-times and orbit-sizes with which the meteorites in such a small cometary knot or parcel would all set out together from the scene of initial disturbance which first deflected the Tuttle's comet meteor-cluster of Perseïds into its present long-elliptic orbit, the densities and contracted limits of such small groups at intervals along the winding convolutions of the lengthy coil, would naturally still be retained, though less compactly, compared to poorer intervals between them; and weaker annual showers flanking the main one at some constant distances in time and longitude before or after it may thus be expected to be visible, like the present short series of them, or like the larger train of attendant Perseïd-showers which Mr. Denning has recorded, all verifying Dr. Kleiber's view of their origin so exactly by their radiant-point positions.

But the mean rate of motion in longitude of my few observed shower-centres, although also in very distinctly good and notable agreement with the theory, appears to have been a little over-rapid, or about 22° in eighteen days, instead of a little less than 1° *per diem*; and long-maintained activities of the grander central and of the laterally cast-off poorer meteor-streams seemed also in my watches to be as clearly evident and nearly as prominent a property of their radiations as the advance in longitude, both by often noted derivations of single and sparse meteors from them on very different dates from those of the showers' maximum abundances, and more especially by maxima of some of the showers having been noted simultaneously (as those of the showers II. and III. together on August 2, and of showers III., IV., and V. together on August 8 and 9), instead of, as the theory postulates, and as the showers I. and II. exemplified much more distinctly and it may quite possibly be shown hereafter by further better observations, more truly and correctly, with an interval of some few days between them in succession.

The mode of the figure's construction which shows the radiant-point directions of the 114 Perseïd paths recorded, requires a little explanation. As my view of the sky was chiefly overhead (embracing the north pole of the ecliptic the more readily to detect any changes in longitude of the radiant-point's position), the observed meteor-paths from Perseus nearly all shot upwards, and would confuse each other by cross-intersections if it were attempted to represent all the four or five radiant-points together by their means, on a single map. But as only depictions of the path-directions traced back to the several radiant-points, and not of the paths themselves were needed for the figure, these direction-lines only are represented

[1] The star χ, and the conspicuous star-cluster in Perseus in which it appears to the naked eye to be involved, are situated at about $32\frac{1}{2}°$, $+ 56\frac{3}{4}°$, within 1° of the place assigned by Mr. Besley to the Perseïd radiant-point on August 3–4, and only 2° or 3° from the places which were here obtained for Radiant III., at 35°, + 56°, on August 2, and 36°, + 55° for July 30–August 8. The star's name may thus be used conveniently, for shortness, as is done above and at a few former places in this *résumé*, to distinguish this radiant-point III. from the earlier Radiant II. near 4 Persei from July 30 to August 4, which seemed to precede it there quite distinctly and in good agreement with the theory, both in R.A. position and in time.

in their true positions of passing near the several radiant-centres, but directed upwards and downwards alternately, for each radiant-point in turn, so as not very sensibly to confuse each other. The lines are also drawn of such lengths as to show by ending at different border-lines of the diagram, at what date, or approximate date (for the few Perseïds' paths noted on July 20, 23, 25-6, 28, and 31, and on August 4 and 6 are referred to the nearest special dates, by their line-lengths, only) in July or August any path-line was observed. In this way the progress of the radiation is either visible in its main outline at a glance, or any special peculiarities and features of it may be studied closely in detail.

It may thus be noted easily that although not dying out for some days longer, the activity of shower I. was chiefly confined to the first week (up to July 27) of the watch; while the meteors of shower II., first appearing only on July 30, continued, with a maximum on August 2, to show themselves brightly up to August 3; and that little was to be seen of the main stream of η-Perseïds (shower IV.) until August 2-3, when it was still inconspicuous, but when a precursor limb of it, the intermediate shower III., was about as active beside shower II. as it again became afterwards on August 8, but more feebly on August 9, beside the plentiful displays then going on, of the showers IV. and V. from η Persei and B, C Camelopardi.

The offshoot as it seemed of the main shower's radiation, at the latter place, showed like the main stream itself, but slight signs of its existence, either in July or later, until August 6, when four of six meteors (all Perseïds), seen in an hour, diverged very distinctly from a point thus first well indicated near B, C Camelopardi. On the nights of August 8 and 9 it appeared to form an almost equally intense companion-shower to the η-Perseïds; and as it seems to conform well in its position to the straight onward line of motion of the other Perseïd centre-points, and to add apparently another link-step to the regular earlier stages of a chain-like progression, it might have been expected, had the nights of the 10th and 11th of August not been such unfavourable ones for noting any further changes in these loci of divergence, that with the expiration of the η-Perseïd shower IV., the accompanying stream V. from B, C Camelopardi, would perhaps survive it, or else would on some later night reappear with a new and naturally much weaker maximum agreeing with its theoretically proper apparition-date.

Some future years' clear skies, it may be hoped will allow the after-showers of Perseïds, already very clearly and distinctly traced by Mr. Denning, to be seen and noted in not less splendid weather than that which so well and continuously displayed the phases of the preceding showers' appearances in the present year.

Several exceptionally bright meteors, and some smaller ones presenting specially remarkable features of appearance, were noted in my watch, which, together with the real paths obtained from corresponding observations at other places of some of the shooting-stars and fireballs of its list, would furnish me with a sufficient abundance of interesting notes to fill another letter. But the subject of the latter meteors will be discussed more satisfactorily and completely in a general review of the collected observations which Mr. Denning and Mr. Corder are conducting; and satisfactory descriptions of the former meteors would involve more searches among known radiant-points, with full deductions of their radiant-centres for the 167 sporadic meteors of my list, than I have yet attempted, to summarise correctly the points of leading and rather novel interest which were presented by the radiations of some of the more particularly striking meteors. I must forego, therefore, a review of features of interest, and of real path conclusions which some of the individual meteors offered very attractively for description, although I felt at first much prompted to describe them; in order to place their discussion in the hands of those much better and more surely able than myself to judge of their importance, who in combination with Mr. Denning undertook the arduous task of collecting and the necessarily much slower and more dilatory task of abstracting and collating all these numerous descriptions. A. S. HERSCHEL.

Observatory House, Slough, September 21.

A Colony of Highly Phosphorescent Earth-Worms.

IN the sheltered westward corner of a small grass-plat in this city there is a colony of highly phosphorescent earth-worms. The annelid is round, pellucid, slender, of a faint yellowish tint, is about two inches long, and is not flattened behind. I have been unable to distinguish segmentation. The worm is entirely luminous. The phosphorescence has precisely the bright greenish colour of the light emitted by the glow-worm. The light is under control. When in glow its secretion is luminous, as is seen in its trail and in the phosphorescence imparted to the hands when handled. It is said by the owner of the grass-plat that the casts are luminous. This is a point I have had no opportunity of observing.

At night the slightest irritation suffices for lighting-up. I captured one in a small clod of turf, to transplant in my grass-plat. The very slightest pressure of the clod, which I should have thought inappreciable, brought on a manifestation of light. On nights when not on the crawl and not otherwise visible, a favourite expedient is to stamp on the ground to get them to come to the surface. The worms in response at once rise to the surface and light up, as though it were possible for them to show fight, instead of, like other worms, scampering away.

The spot colonised is far from humid, but the worms are more active in wet than in dry weather. The worm is new to this place, and, as far as my researches go, it has not been observed westward in Wales. It seems to me to be an instance of *Lumbricus phosphoreus*, but it hardly agrees with the published description of that organism. I want to avoid depleting the colony, or putting any of the inmates to torture, but I could at least furnish a specimen. J. LLOYD-BOZWARD.

Worcester, September 27

Appearance of a Noddy in Cheshire.

THE other day, when looking through a collection of stuffed birds, I saw and obtained a specimen of the Noddy Tern (*Sterna stolida*, Linn.). It is in immature plumage, the white on the crown being only just visible.

It was shot on the Dee marshes in winter about six years ago.

As I believe this Tern has been only twice recorded as visiting Europe, I think this specimen worth mention.

Neston, Cheshire, September 29. F. CONGREVE.

THE ETNA OBSERVATORY.

A RECENT number of *La Nature* (No. 1262) contains an interesting illustrated account of the observatory on Mount Etna, a building which was originally designed by Prof. Tacchini for some special investigations which he had in hand. The eruption which occurred in 1886 caused much disaster, and considerably affected the building which was not restored till the year 1891. In the observatory at the present time there is an equatorial of 5·5 metres focal length, besides various meteorological and seismographical instruments. Observations are made regularly, except in the winter months. This year a very important addition will be made by the setting up of telegraph and telephone wires as far as Nicolosi, thus rendering it possible to regulate the work.

The ascent from Catania, which town lies at a distance of about 30 kilometres in a southerly direction, is made by coach as far as Nicolosi (700 metres). One proceeds then by mule as far as Casa del Bosco (1440 m.), and to the Alpine meteorological station (1890 m.); this latter place being half-way between Nicolosi and the observatory. The rest of the way is made by foot over the snow; the path, which is very rough, can be ascended by mule in the summer, but it is impossible in the winter, owing to the great accumulation of snow. The observatory is sometimes buried in the snow to a depth of two to five metres, admission being then only possible through the first-floor windows.

The disadvantages of Mount Etna as an observing station are therefore due more to the snow than to volcanic disturbances. Long periods elapse between the volcanic outbreaks, during which time the surface near the central crater and the observatory is quiet, so that even the most sensitive seismograph may be used.

When the outbreaks do occur they are usually very severe, and streams of lava pour down the sides of the mountain, devastating forests, vineyards and fields. Huge boulders, sometimes a cubic yard in volume, are also thrown up.

	Mean temperature.
Winter	−6°·6
Spring	−1°·5
Summer	+7°·3
Autumn	+2°·7
The year	+0°·4

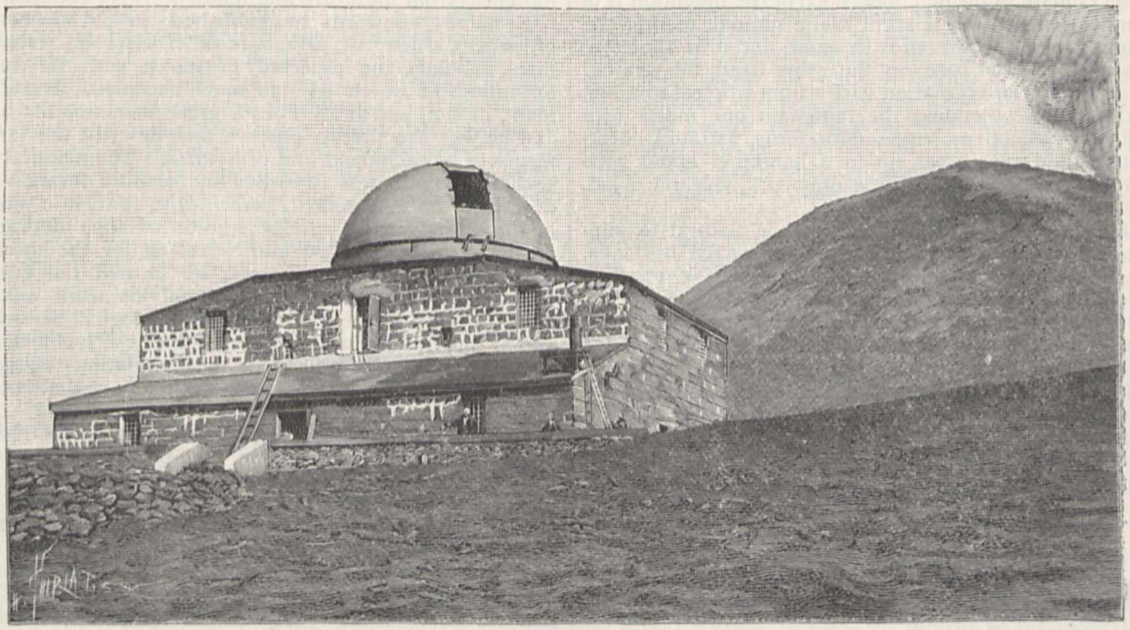


FIG. 1.—The Etna Observatory.

The position of the observatory is as follows:

Altitude	2942 metres.
Latitude	37° 44′·3
Longitude (East)	2° 33′·8 (Rome).

The temperature at the summit ought to be 2°·2 lower than that at the observatory, but observations have shown that it is 0°·6 greater, owing doubtless to the heat of the crater.

FIG. 2.—Showing the front of the Observatory near the summit of the mountain.

It is situated one kilometre from the central crater, and on the southern side (Figs. 1 and 2). Meteorological observations made since 1892 have given the following mean results :—

Thunderstorms on Mount Etna are not common, and occur chiefly in the autumn. There is no lightning conductor fixed on the observatory, and up to the present time the latter has never been struck, although the large metallic dome is not in any way connected metallically with the ground. The rareness of thunderstorms is accounted for by the presence of the central crater, the smoke and hot vapour of which act as a lightning conductor on a large scale.

The climate in the neighbourhood of the mountain is of a very varied nature. Except in the summer months the summit is always covered with snow, and it is therefore very cold. At the base, on the other hand, the weather is warm, and the vegetation varies from tropical to arctic species. On ascending the mountain one meets with cacti, oranges, olives, vines, corn, ferns, astragal, chestnut trees and pine trees, up to a height of about 2000 metres. At a higher altitude only rock, volcanic sand, and snow are found.

After an outbreak of the volcano it is natural to suppose that the snow is generally melted by the hot lava. It is of interest, however, to note that a layer of volcanic cinders has been known to protect the snow from lava at a temperature of about 1000°, so that when covered by it the snow was but slightly melted, and the lava formed a black covering in contrast to this white background.

The view from the summit of Mount Etna is described as most magnificent, extending nearly 200 kilometres in all directions. This is due to the fact that the air at this height is reduced to a third of its density, and is of extreme transparency.

FRITZ MÜLLER.

THE death of Dr. Fritz Müller, which took place on May 21 at Blumenau, in South Brazil, has inflicted upon science a loss, the importance of which needs no pointing out. Although the greater part of his life was passed at a distance from the centres of scientific thought, and his natural modesty and self-effacement left him indifferent to his own fame, it has long been recognised that the qualities of observation and interpretation which drew from Darwin the title of "the prince of observers," have earned him a position as one of the greatest and most original naturalists of the century.

Johann Friedrich Theodor Müller was born on March 31, 1822, at Windisch-Holzhausen, in Thuringia, where his father was pastor. After receiving his schooling at Erfurt, he began the study of pharmacy, but shortly afterwards went to Berlin as a pupil of his distinguished namesake, Johannes Müller, the zoologist. As soon as he had taken his doctor's degree, for which he wrote a thesis on the leeches of the neighbourhood of Berlin, he settled at Erfurt as a teacher of science. The occupation, however, proved uncongenial, and he again changed his studies, and turned to medicine, with a view to becoming a ship's surgeon, and thus gaining opportunities for travel and for zoological work in foreign countries. During this early period he began gradually to make a name for himself in science by the occasional publication of various morphological and descriptive papers on leeches and crustacea.

In 1852 the liberal character of his political views brought about a crisis which led to his leaving Germany and betaking himself to Blumenau, on the river Itajahy, just outside the limits of the tropics, where, his education and tastes notwithstanding, he settled down to the occupation of a farmer. Henceforward Brazil was his home, and to this fact and the freedom it brought from the limits set to observation by travel and temporary residence is largely due his distinctive position among naturalists. Under less favourable conditions much of his work, particularly on morphological subjects and on matters involving experiment such as the hybridisation of plants, must have been impracticable. Nevertheless, his expatriation put an end to research for some years, until an appointment as teacher of mathematics at the gymnasium of Desterro, on the island of Sta. Catharina, gave him the wished-for opportunity, and he began assiduously to study the invertebrates of the Brazilian coast, and to overcome the difficulties which the absence of a properly-equipped zoological station and his remoteness from literature and fellow-workers entailed.

From 1857 onwards he published a rapid succession of papers, chiefly in *Wiegmann's Archiv*, on cœlenterates, annelids, and especially crustacea, with the transformations of which he was much occupied. Development, in fact, had at all times a great attraction for him, and he was the first to observe and describe the larval stages of a brachiopod and of *Squilla*. The material for several memoirs was furnished by parasitic forms. He described an anemone, *Philomedusa*, parasitic on a medusa, and made careful studies of such degraded crustacea as *Entoniscus* and *Sacculina*, for the latter of which, together with its allies, he formed the family Rhizocephalidæ. During this period his work was almost entirely concerned with morphological subjects, and it was not until the "Origin of Species" had brought a new interest and significance to the relations between structure and bionomics that he devoted close attention to field observation.

He must have become acquainted with the "Origin" very soon after its publication, and probably received a copy of it from his younger brother and devoted correspondent, Hermann Müller of Lippstadt. His initial attitude towards the book appears to have been critical rather than receptive, for he admits that it was an observation of his own which gave him the first decided impulse in its favour. But he was not long in finding that he could unreservedly accept its principles and devote his energies to their support; and the theory of natural selection gave a definite direction to the whole of his subsequent work.

The observation which determined his adherence to the theory of evolution was the discovery of the nauplius-larva of *Penæus*, a genus of prawns. Important as it is from its bearing on the phylogeny of the crustacea, in which malacostracous nauplius was previously unknown, and its influence on Müller himself, it has not even yet been fully confirmed. Müller succeeded in breeding the protozoæa-stage from his nauplius, but had to build up the further steps in the development from a series of captured examples. Here was room for error, and his account consequently met with a criticism which induced him, in spite of an expressed dislike to going twice over the same ground, to return to the defence of his observations in 1878. Four years later Prof. W. K. Brooks succeeded in rearing *Penæus* from a protozoæa, "identical with that developed by Fritz Müller," but the assumption involved in this statement was such as to prevent the matter from being regarded as settled, and Müller's account, though presumptively correct, is still accepted with reserve by some carcinologists.

The philosophic bent of his mind soon led Müller to recognise the possibility of testing the principles of evolution by applying them towards the building-up of the phylogeny of some group of animals, and ascertaining how far the theoretical results obtained were reconcilable with the observed facts of development. The idea was put into practice for the crustacea in a little book published in 1865, the well-known "Für Darwin," which had a great success in spite of its technical character and limited scope. This success was probably due not merely to the value of its accounts of crustacean development, which embody the main results of Müller's own researches, and the then novel support which the deductive argument brought to evolution, but also to the brilliant simplicity of a title which disclosed nothing beyond the fact of his advocacy and would have served even better to cover the whole of his subsequent writings. At that time the principle of evolution itself was at stake, and the book is essentially an argument for it, rather than for natural selection, in support of which as distinct from other suggested agencies it advances comparatively little.

Its publication naturally aroused Darwin's interest; he quoted freely from it in the later editions of the "Origin," and arranged for its appearance in an English translation. This was made by Mr. W. S. Dallas, and published in 1869 under the somewhat less forcible title of "Facts and Arguments for Darwin." It materially increased the reputation which Müller had gained in this country during the preceding twelve years by the appearance in the "Annals and Magazine of Natural History" of translations or abstracts of his chief papers, also from the pen of Mr. Dallas.

The most important result, however, of "Für Darwin" was that it led Darwin to address to Fritz Müller in August 1865, the first of the long series of letters which passed between the two naturalists. Mr. Francis Darwin has put on record his recollection of the pleasure which his father took in this correspondence, and his impression that of all unseen friends Müller was the one for whom his father had the strongest regard. Closely in touch with nature as Müller was, his was exactly the adherence which was most welcome to Darwin, who so directly recognised the affinity in character and mental outlook between himself and his correspondent that, in asking for Müller's opinion on pangenesis, he wrote: "I value your opinion more than that of almost any one. . . I feel sure that our minds are somewhat alike."

Some of the letters written by Müller were sent for publication to NATURE; from these as well as from the references in Darwin's published correspondence and books, particularly "The Forms of Flowers" and "Cross and Self-Fertilisation of Plants," some idea can be formed of the abundance of new and interesting observations on all sorts of subjects, largely botanical, which Müller made and communicated. These letters, which drew from Darwin the exclamation: "Heaven knows whether I shall ever live to make use of half the valuable facts which you have communicated to me," show, even better than his papers, Müller's insight into and sympathy with Darwin's work, and his consequent tendency to be always on the look-out for any peculiarity of structure or habits that could be interpreted by natural selection.

Thus, when in the controversy as to the existence of the insect required, *ex hypothesi*, to reach the nectary of *Angræcum*, it was contended that no existing moth possessed a proboscis of the necessary length—about eleven inches—Müller entirely disposed of the contention by forwarding the proboscis belonging to an undetermined Brazilian *Sphinx*, of the length required, to his brother, who described and figured it in these columns.

In 1867 the increasing influence of the Jesuits compelled Müller to leave Desterro, and he returned to the occupation of a farmer, a change which brought his work on marine zoology to an end. At this time he was appointed naturalist to the Brazilian Government, and somewhat modified the range of his studies, occupying himself with entomology and botany, and applying a more systematic attention to bionomics and field observation. Although often looked upon as mainly an entomologist, he published nothing on insects during the first thirty years of his career. In 1873, however, he began a series of papers on Termites in the *Jenaische Zeitschrift;* these contain some of his most brilliant conceptions in the theories put forward as to the existence and function of the supplementary reproductive forms and the uselessness of the true imagos, as well as in the comparison of the two kinds with cleistogamic and perfect flowers. Although the facts at his disposal were insufficient to enable him to confirm his theories, they formed the foundation on which Prof. Grassi has since successfully built, and which he has appropriately acknowledged by the dedication of his monograph to his predecessor.

Fritz Müller's most familiar entomological work is certainly that on mimicry. The original theory of Bates failed to suggest any explanation of the most striking class of resemblances found among butterflies, those subsisting between pairs or among groups of what are regarded as protected forms, and was open to criticism on several points for want of evidence. Bates, it must be recollected, did not elaborate it on the Amazons, but after his return to England, when all opportunity of specially directed observation had ceased for him. Müller first dealt with the possibility of the origin by gradual stages of a mimetic from a non-mimetic pattern, a point left so little treated as to have invited scepticism; but his work, though sound in principle, suffered from a want of familiarity with the range of form in the genera discussed, which only the resources of a museum could remedy, and the idea has been recently worked out more exhaustively by Dr. Dixey.

In 1879 Müller published in "Kosmos," to which he had been a regular contributor from the first, the well-known hypothesis framed to supplement that of Bates, and based on the assumption that a bird learns to recognise and avoid an unpalatable species of butterfly as the outcome of a series of experiments. The toll thus taken must stand in relation to the number of birds and not of butterflies, and would therefore be distributed over two or more species of the latter by their acquisition of a common appearance, a fraction only of the loss falling on each component of such a group.

The "Müllerian theory," though destined to perpetuate its author's name, is scarcely typical of his work in so far as it is an ingenious speculation, not dependent on direct observation, but one which could have been evolved by a naturalist who had never seen a living example of the insects it deals with. Still, it remains the first and only serious attempt to bring an intractable class of facts within the scope of natural selection, and, even if it should be ultimately superseded, it will have immensely advanced the study of these wonderful resemblances.

The paper containing Müller's article was sent by Darwin to Prof. Meldola, then Secretary of the Entomological Society of London, who recognised its importance, and at once published a translation. The theory, however, met with much opposition, including that of Bates himself, then somewhat past the reception of new ideas, but to its author's great gratification it found a warm supporter in Dr. Wallace, whose adhesion involved the abandonment of an earlier view that these resemblances were due to unknown local conditions. Three years later this view was strenuously combated by Müller in an important but untranslated, and therefore less familiar, article. To accept its main argument, that these likenesses result from some process of visual selection—and it has never been seriously answered—does not compel belief in a destructive process. Though Müller suggests no alternative in his paper, he appears to have held and privately put forward the idea that another factor, that of direct selection or segregation on the part of the insects themselves, might play some part. He paid a large amount of attention to the scent-tufts, odours and other means of recognition in butterflies, and at a somewhat earlier period had so far expressed his views that we find Darwin writing to him in 1871 ("Life and Letters of Charles Darwin," iii. p. 151): "Would you object to my giving some such sentence as follows: 'F. Müller suspects that sexual selection may have come into play, in aid of protective imitation, in a very peculiar manner, which will appear extremely improbable to those who do not fully believe in sexual selection. It is that the appreciation of certain colour is developed in those species which frequently behold other species thus ornamented.'" Granted that this was a somewhat fanciful speculation, it is at least significant that it should have presented no improbability to the mind of an observer before whom the insects concerned were constantly present as a living reality.

The work on mimicry was brought to a close with the account, published in 1883, of the torn wings collected from specimens of an inedible butterfly, *Acræa thalia*, in order to show that a protected insect was not immune from tentative attacks on the part of birds. Still, even if the evidence thereon be regarded as conclusive, it scarcely indicates the difference in amount between the attacks made on protected and unprotected species respectively, which must exist under Müller's hypothesis. And in view of the doubts which have been expressed by competent observers as to the prevalence of butterfly-destruction on the part of birds, the subject calls for further and more exhaustive investigation. Since Müller's work, little progress has been made on the study of mimicry by observations on the living forms.

Amongst the many other entomological subjects investigated by him are cases of dimorphism in fig-insects and in gnats, in a species of which he found two kinds of females, one large-eyed and honey-sucking, the other small-eyed and blood-sucking; the case-making of Phryganeidæ and the development, in some cases very remarkable, of several species of aquatic insects. As recently as 1895 he published in the *Transactions* of the Entomological Society of London a paper on the metamorphoses of an aquatic fly, the material for which, however, had been worked out some fourteen years previously, when the drawings were made. These are, perhaps, the best published examples of his skill as a draughtsman.

In botany Müller's work, like that of his brother, the author of "Die Befruchtung der Blumen," deals mainly with the fertilisation of plants, and includes a number of important observations on heterostylism, hybridisation and self-sterility, many of which are recorded in Darwin's "Animals and Plants under Domestication" and "Cross and Self-fertilisation of Plants." The experimental results obtained, *e.g.* in the fertilisation of orchids, are of great interest; in a series of cases he was able to establish a progressive gradation in self-sterility from species in which the flower was sterile to its own pollen but not to that taken from other flowers on the same plant, up to those in which entire fertility was only to be obtained by crossing, the pollen of a different species being prepotent. Most remarkable of all, in certain species the pollen of a flower was found actually to have a destructive effect upon its own stigma.

His later years were mainly given over to botanical studies, but the period was clouded with a succession of misfortunes which he bore courageously, not losing his interest in research, although his activity was diminished. For him science meant the advancement of knowledge, and he looked for no practical benefits for himself from it. Assuredly they did not come unsought. As far back as 1880 he suffered gravely from the destruction of his property by a flood, a loss which drew from Darwin a touching expression of sympathy and a desire to aid. At a later period the Brazilian Government, with singular illiberality, deprived him of his post without pensioning him, and left him in straitened circumstances; and as recently as 1894 he was imprisoned by rebels and tried by court-martial. In the same year the death of his wife took place, but the bereavement, heavy as it was, did not affect him so deeply as did the loss of a beloved daughter, herself an excellent observer, who, at eleven years of age, discovered the circumnutation of *Linum*. She died at Berlin, and the blow deprived her father for a long time of all desire for work. But his indomitable enthusiasm overcame even this trouble, and his researches were carried on up to the last year of his life.

To call Müller by Darwin's happily-bestowed title is to recognise not merely the energy, perseverance and capacity for observation which he brought to his work, but also the discrimination which led him to the choice of subjects for study and the closely-reasoned and philosophic interpretation of his results. If his name is not associated with any marked advance in thought, except on one or two special questions connected with natural selection, it is because he found his intellectual faith in the theory which he set himself to developing and strengthening. He was content, in fact, to assist in the building of the structure of which another was architect, and in this task his services have been great. It may be questioned whether any other naturalist, save Darwin himself, has given the world so large and original a mass of observations of the kind by which natural selection has been most strongly supported.

To take a just and comprehensive survey of his labours is by no means easy. His papers are scattered through many journals, and a full bibliography of them is as yet wanting; even the list, down to 1883, given in the "Royal Society Catalogue of Scientific Papers" is incomplete, omitting as it does all his contributions to "Kosmos." Moreover, they cover a wider range than most naturalists take for their province, and yet are far from containing the whole of his results. Not a few of his notes have been made public by the friends to whom he communicated them with characteristic generosity; others still lie buried in his letters and memoranda. And a reference to such papers as those on mimicry makes it plain that but a part of his published observations have found their way into common scientific knowledge, and many still wait to be incorporated into the fabric of biology.

More than five-and-twenty years have passed since Darwin wrote to Müller: "I earnestly hope that you will keep notes of all your letters, and that some day you will publish a book, 'Notes of a Naturalist in S. Brazil,' or some such title." But the idea did not attract, and the wish, though echoed by many friends, was destined to remain unfulfilled. One can therefore but express the hope that, now that his labours are ended, such a record of them may be given to the world as shall form a worthy memorial of so earnest and single-minded a lover of nature.

W. F. H. B.

NOTES.

We invite attention to the change of address of the publishers of Nature, announced in our advertisement columns. After Saturday next, October 9, all communications for the editor of Nature should be sent to St. Martin's Street, London, W.C.

We regret to announce that Dr. Charles Smart Roy, F.R.S., of Trinity College, Professor of Pathology in the University of Cambridge, died on Monday night, at the age of forty-three years.

The Accademia dei Lincei have just elected Prof. G. H. Darwin, F.R.S., and the Right Hon. G. J. Goschen, M.P., F.R.S., foreign members of the Academy.

It is stated in the *Athenæum* that the well-known Dr. Adolf Harnack is engaged on a "History of the Prussian Academy of Sciences," which is to appear in the year 1900, the two hundredth anniversary of its foundation.

The annual address of the President of the Royal Photographic Society will be delivered at the meeting of the Society on Tuesday next, October 12. The presentation of the medals will take place on the same evening.

The *Geological Magazine* makes the following announcement with reference to the forest-bed of the Norfolk coast:—This interesting deposit, so rich in organic remains, has been care-fully worked for more than twenty years by Mr. A. C. Savin, of Cromer, who during that period had accumulated about 1900 specimens of Vertebrata, many of which had been described and figured by Mr. E. T. Newton, F.R.S., Prof. Leith Adams, Prof. Lankester, F.R.S., and others. Mr. Savin's collection has just been acquired by the British Museum (Natural History), where it will be preserved for all time, and form a most unique and valuable addition to our National Museum, as well as add greatly to our knowledge of the fauna of this old Pliocene land-surface.

THE *Forres, Elgin, and Nairn Gazette* contains a paragraph to the effect that within the last few weeks, by the kindness of Lady Prestwich and the Trustees of the British Museum, an interesting and instructive series of fossils, ranging through the whole scale of the fossiliferous rocks and consisting of 833 specimens, has been presented to the Falconer Museum at Forres. This valuable collection has been systematically arranged by Mr. Bullen Newton, of the British Museum, and it forms an addition of great educational value to the contents of the Falconer Museum. The thanks of the Trustees and Managers of the Falconer Museum are due to the authorities of the British Museum for their generosity, but especially to Lady Prestwich, to whose interest in the Museum, which was erected by funds bequeathed for the purpose by her uncles, they are mainly indebted for this valuable gift.

THE death is announced of the Rev. Andrew Matthews, distinguished for his work on micro-coleoptera. We learn from the *Entomologist* that in 1872 Mr. Matthews published the first volume of "Trichopterygia illustrata et descripta," with thirty-one plates drawn by himself; and in his eightieth year he completed a second volume, also illustrated by his own hand: this is now with the publisher. Among his other works are papers on the genera *Hydroscapha*, *Amblyopinus*, *Myllæna*; and synopses of the Trichopterygidæ of Europe and North America. He also described the species of his particular group of Coleoptera in "Biologia Centrali Americana."

THE North German Lloyd Steamer, *Kaiser Wilhelm der Grosse*, which has recently made the record passage for speed on her maiden voyage from Southampton to New York in 5 days 22 hours, or an average of 21·39 knots, is the largest passenger steamer afloat. Her dimensions, however, will be exceeded by the *Oceanic*, now building for the White Star Company by Messrs. Harland and Wolff at Belfast, and which is expected to be ready for launching at the beginning of next year. The length of this vessel will be 704 feet, or 25 feet longer than the ill-fated *Great Eastern*, and 55 feet longer than the *Kaiser Wilhelm*. Her gross tonnage will be 17,000 and she is to be adapted for use as an armed cruiser, her coal-carrying capacity when so used being, at a speed of 12 knots, sufficient for 23,400 miles, or practically for a voyage round the world. The speed, when in use for passenger traffic to and from New York, is, as at present designed, to give an average of 21 knots.

AN international conference of leather trades chemists, held on Tuesday and Wednesday, September 28 and 29, at Herold's Institute, Bermondsey (Leathersellers' Company's Tanning School), and at which Great Britain, the United States of America, Austria, Denmark, France, Germany, Norway and Sweden were the countries represented, concluded its proceedings on the 30th ult., by a joint meeting of the leather trade and its allies at Leathersellers' Hall, kindly lent by the Worshipful Company of Leathersellers. The object of the conference was chiefly to arrive at uniformity in the matter of tanning analyses, and to formally establish an International Association of Leather Trades Chemists. The conference was opened by Mr. C. T. Millis, Principal of Herold's Institute, and representing the Governors of the Borough Polytechnic, of which the Institute is a branch; the chair being afterwards taken by Dr. Perkin, F.R.S. The Right Hon. W. L. Jackson presided at the Leathersellers' Hall meeting. As the first president of the International Association, the conference elected Mr. Alfred Seymour-Jones; as honorary secretaries, Prof. H. R. Procter (Yorkshire College, Leeds) and Dr. J. Gordon Parker (Herold's Institute, London).

THE *Times* prints the following dispatches, received from its correspondent at Melbourne: October 3: "The scientific expedition which was despatched to the Ellice Islands by the Sydney Geographical Society, under Prof. David, has confirmed Darwin's theory of the formation of coral islands. Prof. David reports from Samoa that the expedition has been a decided success. The diamond drill went down 557 feet in the coral without reaching the bottom." October 4: "With reference to the borings on the Ellice Islands to obtain information as to the formation of coral islands, Prof. David states that the results to 487 feet were inconclusive. Beyond that, they strongly favour Darwin's theory, though a final judgment depends upon microscopic examination of the drill cores. The borings are being continued." Miss E. Walker contributed 500*l.* towards the expenses of this expedition, and the Royal Society 100*l.* directly, and probably another 100*l.* through its coral-boring committee. The expedition was under the auspices of the Royal Geographical Society of Australasia, and was directed by Prof. T. W. E. David, of Sydney. In view of the difficulties previously met with at Funafuti, a special boring plant was provided weighing over 25 tons, and capable of boring to a depth of 1000 feet. It is understood that the core obtained will be forwarded first to the Royal Society of London, which will return one-half to the Royal Geographical Society of Australasia.

THE Beavers exhibited in the Zoological Gardens are mostly of the American species (*Castor canadensis*), though specimens of the European form (*C. fiber*) have been occasionally obtained from the Lower Rhone, and Beavers are still to be met with in some districts on the Elbe and on the Danube. An excellent memoir lately issued by Prof. Collett, of Christiania ("Bæveren i Norge"), gives us an account of the Beavers still remaining in Norway, where it had formerly a very extended distribution. Prof. Collett thinks that in all probability the Beaver will last in Norway in a state of nature "well into the next century," provided a small amount of care is taken to protect it. The number of individuals existing in Norway at present he estimates as about 100. In 1880 Mr. Cocks considered that there were only about 60, so that there may have been a slight increase in recent years.

UNDER the name *Hylobates henrici*, M. E. de Pousargues describes a new species of Gibbon from the interior of Tonquin. It is based on a skin presented to the Muséum d'Histoire naturelle of Paris by Prince Henry of Orleans, which was obtained by the Prince in 1892 at Lai-Chan, a little to the north of the Black River of Tonquin, and not far from the frontier of the Chinese province of Yunan.

MR. H. SAVAGE LANDOR, who left England in March last, commissioned by Mr. Harmsworth, the proprietor of the *Daily Mail*, to endeavour to enter the sacred city of Lhassa, in Tibet, has not been successful in his undertaking. News has just been received that a few days after crossing the frontier of Tibet, disguised as a Chinese pilgrim, all except two of Mr. Landor's men abandoned him. In spite of this, Mr. Landor continued on his journey, but eventually he lost all his provisions, and by an act of treachery was made a prisoner by the Tibetans. He was sentenced to be beheaded, but at the last moment the Grand

Lama stopped the executioner, and commuted the sentence of decapitation to the torture of the stretching log—a kind of rack upon which Mr. Landor was chained for eight days—after which he was released. Mr. Landor has now returned to India, suffering from the effects of the torture to which he was subjected, and which he half anticipated before he set out upon his hazardous journey.

A CURIOUS illustration of the power of light matter to perforate more substantial substances when driven at a high velocity is stated by the *Engineer* to have occurred in the Royal Arsenal a few days ago. In the course of experiments on firing gas in mines, conducted by Captain Cooper Key, R.A., under the Home Office, a special gun is employed to do duty for a bore-hole with a charge of high explosive, and pressed cylinders of raw dry clay 3 in. long and 1⅝ in. in diameter are used to represent tamping. These "shots" are made to act in various mixtures of air, coal-dust, gas, &c., and to stop the course of plug, &c., eventually, a cast-iron target plate, 1 in. thick, was placed 25 ft. in front, at an angle of 45°, in order to break up everything into dust and throw it upwards. After three or four shots with this arrangement the clay plug, weighing 7½ ozs., perforated the inch iron plate, and the hole thus made has been steadily extended since. The familiar tallow candle passing through a door must hide its head before a 7½-oz. plug of clay perforating an iron plate an inch thick at an angle of 45°. Doubtless the velocity must be tremendous. It is pointed out that the velocity for a hard cylinder of this weight and size to cut through an inch of wrought iron at 45° would be over 1800 foot-seconds. With cast-iron and clay and the three or four repeated blows, everything is so greatly altered that there is little more to be said than that the effect is remarkable and unexpected.

AN important contribution to the controversy respecting the great Alpine double-fold has been issued by Dr. Rothpletz of Munich, in the last number of the *Zeit. deut. geol. Gesell.* (vol. xlix. pp. 1–17). In this paper Rothpletz examines in detail the evidence which led the orthodox school of Swiss geologists to the belief that the Glärnisch massif has been formed by a double fold. It is well known from Heim's great work, the "Mechanismus der Gebirgsbildung," that the summit of the Glärnisch consists of Lower Cretaceous rocks, which rest on deposits belonging to a later part of the same system. Baltzer accordingly explained this inversion by a complex series of folds and double folds. Rothpletz, however, by a magnificent piece of detailed field-work, has shown that the arrangement can be more easily explained as a case of over-thrust faulting. The Glärnisch, it may be added, stands on the western border of the mountain group, whose complicated structure Heim's double-fold of Glarus was invoked to explain.

A SYNOPSIS of a report on an experimental boring for petroleum, carried out by Mr. W. A. Fraser at Athabasca Landing, Alberta district, is given by Dr. G. M. Dawson in the Annual Report (vol. viii.) recently issued by the Geological Survey of Canada. Where the basal sandstone of the Cretaceous formation comes to the surface, about 130 miles north of the place of the boring on the Athabasca River, it is charged with bituminous matter, and from the observed dip of the Cretaceous rocks it was hoped that these "tar sands" would be found at a depth of from 1200 to 1500 feet. This estimate has proved to be a little under the mark, but the work that has been done indicates that the top of the tar sands should be reached at about 1800 feet. When Dr. Dawson visited the boring, a depth of 1731 feet had been reached, and it was proposed to continue down to 2000 feet, so as not only to pass through the tar sands, but also to penetrate, for some distance, the rocks—presumably limestones of Devonian age—underlying them. It is pointed out that there can be no reasonable doubt that an important oil-field exists in northern Alberta and Athabasca, and the facts gained by the experimental boring of the Canadian Geological Survey has rendered it possible to estimate very closely the depth at which the tar sands may be looked for along the Athabasca Valley for a distance of about 150 miles. The development of deposits of petroleum in this region is of such great importance that Dr. Dawson should not lack support in the plan he advocates of sinking several experimental wells simultaneously in different parts of the great area, which the geological conditions show to be favourable to the occurrence of petroleum in quantities of commercial value.

THE Explosives Department of the Home Office has (says the *Times*) recently had under consideration the question of the restrictions to be applied to the manufacture and keeping of acetylene gas, and has conducted various experiments with the object of gaining information on this matter. The results show conclusively that acetylene gas *per se*, when under a pressure of something less than two atmospheres, is violently explosive; whereas at a pressure less than one a half atmospheres it appears to be reasonably free from liability to explosion, provided it is not admixed with oxygen or atmospheric air. For commercial and practical purposes it is considered sufficient to allow a pressure of 20 inches of water above that of the atmosphere (*i.e.* roughly about one and one-twentieth atmospheres), and it is accordingly proposed to draw the safety line at this point, and to declare acetylene when subject to a higher pressure to be an "explosive" within the meaning of the Explosives Act, 1875. In France and Germany, the authorities have fixed the limit of danger at one and a half and one and one-tenth atmospheres respectively, and have imposed prohibitions or restrictions on the keeping or manufacture of the gas when it is at a higher pressure.

DR. AL. BLUDAU publishes in *Petermann's Mittheilungen* (viii. 1897) a second instalment of his work on the measurement of the great drainage basins of the world. Dealing this time with Africa, he discusses in detail some of the divisions offering special difficulty in definition, and finds that of the total area of 29·3 millions of square kilometres, 36 per cent. drain to the Atlantic, 15 per cent. to the Mediterranean, and 18 per cent. to the Indian Ocean, while the neutral regions form the remaining 31 per cent., the Sahara alone occupying six and three-quarter millions of square kilometres.

A BRIEF preliminary report by the surviving officers of the second Bòttego Expedition in Somaliland, Lieuts. Vannutelli and Citerni, with a route map, is contained in a recent bulletin of the Italian Geographical Society. The expedition started from Brava in October 1895, and reached the north end of Lake Rudolf in August 1896, whence Dr. Sacchi set out in the November following, intending to return southwards with the zoological and ethnographical collections; his fate seems still very uncertain. The main body of the expedition left the camp on Lake Rudolf about the same time, and skirted the Ethiopian highlands, travelling in a north-westerly direction; but owing to the unhealthy climate Captain Bòttego was compelled to make for the mountains, where he had dealings with the chief of Lega and Sajo, who, however, proved treacherous, and in the fight which ensued Captain Bòttego lost his life. The survivors were kept prisoners for a time, but were ultimately sent to Adis Abeba by the Emperor Menelik.

IN the *Bollettino della Società geografica Italiana*, Signor G. Roncagli discusses the tides of the Straits of Magellan between Cape de las Virgines and Punta Arenas, the special question being the retardation of the tidal stream by some three hours in mid-channel, compared with the shore on either side, first pointed out by King and Fitzroy. He suggests as an explanation of the phenomenon, that on account of the peculiar shape of the channel a gravity current is superposed on the normal tidal stream, in such a manner that while at the sides the tide presents the ordinary phases, in the centre the gravitational movement is first against the tidal movement, then in equilibrium with it, giving slack water for a longer or shorter period, and finally in the same direction with it.

AN account of the quantity and value of the minerals obtained from mines, quarries, brine-works, &c., in the United Kingdom, during the year 1896, is given in a Blue Book just issued by the Home Office. Many facts of interest are contained in the report, in addition to the statistical information; but the limitations of space will only permit us to refer to a few of them. In 1896 the total output of coal was 195,361,260 tons; of this amount, 9309 tons were obtained from open quarries. The seams worked in England vary from eleven or twelve inches to thirty feet in thickness, and in Scotland seams of cannel coal only six inches in thickness are being worked. The only mine worked for cobalt and nickel ore is in Flintshire; and, after being idle for several years, it has lately been re-opened. The mine affords an instance of the occurrence of the mineral asbolane with red clay in irregular cavities in the carboniferous limestone. Copper mining is rapidly decreasing in importance in Britain, only 9168 tons having been produced in 1896, whereas the output in 1863 was 210,000 tons. Flint-mining still survives at Brandon, in Suffolk; the produce of a few shallow mines worked in a most primitive fashion suffices to supply the gradually diminishing demand for gun flints, which are exported to savage countries. Referring to gold ore, the report points out that, compared with the yield of the colonies and many countries, the amount of gold obtained in Britain is insignificant; nevertheless, mineral veins in North Wales have from time to time furnished considerable quantities of rich auriferous quartz. In 1896 the five mines in Merionethshire produced 2765 tons of ore, from which 1352½ ounces of gold, having a value of 5035*l*. were obtained. This, however, is a much lower output than that of the previous year. The principal iron-producing districts at the present time are Cleveland or North Yorkshire, yielding over five million tons annually, and Cumberland and North Lancashire, with an output of over two million tons. The Cleveland ore is an earthy carbonate containing about 30 per cent. of metal, while the red hæmatite of the two other counties yields 50 to 60 per cent. The total quantity of iron ore obtained from our mines and quarries last year was twelve and a half million tons. Appended to the report are tables showing the production of minerals in the British Colonies and Dependencies.

THE Weekly Weather Reports issued by the Meteorological Office show that for the nine months ending with September the rainfall had reached or exceeded the average in all districts of the United Kingdom, except in Scotland. The greatest excess has occurred in the south-west of England, where it amounts to six inches, and in Ireland. During the severe thunderstorm which occurred over the southern and eastern parts of England at the close of the month, amounts exceeding an inch were recorded at many places, the fall in the metropolis (1·03 inch) being the greatest in twenty-four hours since the beginning of the year; about one and a half inches fell at Cambridge, being about three parts of the mean for the month, and over two inches at Hillington (Norfolk). The greatest deficiency (2·7 inch) is in the north of Scotland, notwithstanding that more than an inch fell at some places in the twenty-four hours ending on the morning of September 30, during which period the heavy storms occurred in the south of England.

WE have received from Prof. A. Klossovsky a copy of the *Annales* of the Odessa Observatory, for the year 1896. One of the most serious operations during the year has been the erection of magnetic variation instruments in an underground room of the observatory. In this work the valuable assistance of Dr. Leyst, of the Pavlovsk Observatory, has been obtained. In addition to the usual meteorological and magnetic observations, a special study has been made of the movement and height of the clouds during the year, in accordance with the scheme of the International Meteorological Committee. Some interesting experiments have also been made upon the ascending and descending currents of the atmosphere by means of an anemometer turning in a vertical direction. The results show that in the diurnal period the ascending currents are more frequent than the descending, the hours being in the proportion of 8 : 1. The maximum motion occurs at 1h. p.m., and the minimum at 4h. a.m. The regular staff of the observatory, two in number, is absurdly small for the amount of good work done; the publication of the results is due to the liberality of the Municipality of Odessa.

THE South Saxons have been investigated by Mr. R. J. Horton-Smith (*Journ. Anth. Inst.* xxvi. p. 81). His studies are based on a collection of fourteen skulls, excavated by Mr. C. H. Read at Goring in Sussex, the associated ornaments proving them to be of early Saxon age. This collection was supplemented by a study of West Saxon, East Anglian, and other British skulls in the Cambridge Museum. Mr. Horton-Smith arrives at the following conclusions:—The South Saxons in Britain were not an absolutely pure race, but had a little British blood in them. The Wessex Saxons were still less pure, owing to their more frequent intermarriage with the British population. Dr. Beddoe's researches are confirmed that the pre-Saxon population predominates in the upper valley of the Bristol Avon; but the population of the Cirencester district is chiefly Saxon, though containing a slightly larger admixture of British blood than is the case in East and South Wessex. The East Anglians have a form of skull slightly different from that of the South Saxons. It is rather broader, less flattened, the orbits are higher, the face relatively longer, and the cranial capacity larger. Mr. Park-Harrison believed that the projecting (prosopic) nose of the modern English was derived from the Angles, and not from the Saxons. According to Mr. Horton-Smith's observations the reverse is the case.

A BACTERIAL disease of the common "squash-bug," *Anasa tristis*, has been studied by Mr. B. M. Duggan at the Illinois State Laboratory. It is readily communicated to "chinch-bugs," and is the first genuine bacterial disease of hemipterous insects known. The parasite has been named *Bacillus entomotoxicon*. A disease which attacks the capsules of the cotton-plant in Alabama has also been worked out in the Agricultural Experiment Station at Auburn, Ala., by Mr. J. M. Stedman, and is referred to a hitherto undescribed microbe, which he names *Bacillus gossypinus*.

WE have received a copy of "Botanical Observations on the Azores," by William Trelease (from the eighth annual report of the Missouri Botanical Garden). The observations were made and specimens collected in order to obtain information as to the endemic and naturalised flora of the Azores group. Very few of the species described are, however, endemic, most of the existing species having evidently been introduced by drift, migratory birds, &c., and by human agency since the discovery of the islands. Mr. Trelease remarks: "Though it might, perhaps, be expected, no differentiation has yet been shown comparable with that seen in the plants of different islands of the Galapagos group in the Pacific, where specific or varietal differentiation is strongly marked, but where communication between the several islands is far more restricted than in the Azores."

To the list of forthcoming scientific books, given in last week's NATURE, we are now able to add the following:—The Cotton Press announces:—"Synopsis of Diseases and their Treatment," by Bornal, and "Notes Introductory to the Study of the Animal Alkaloids for Students," by Dr. A. M. Brown. Messrs. Sampson Low and Co., Ltd., promise:—"The Wild Flower Journal," by Mrs. Arthur Bell; "The Manufacture of Leather," by Charles T. Davis, new and revised edition, illustrated; "How to treat Accidents and Illnesses," by H. Morten, new edition, illustrated; "A Treatise on Paper-Making," by Carl Hofmann, new edition in parts, illustrated. Among Mr. Murray's announcements we notice:—"A Flower Hunter in Queensland," by Mrs. Rowan, illustrated. In Messrs. Nelson and Sons' list we find:—"Rambles among the Wild Flowers," by Dr. M. C. Cooke, illustrated. Mr. J. C. Nimmo announces:—"British Game Birds and Wild Fowl," by Dr. B. R. Morris, revised and brought up to date by W. B. Tegetmeier, 2 vols., illustrated. Messrs. George Philip and Son's announcements include:—"Life Size Anatomical Model of the Human Body, for Class Use"; "Model of a Locomotive Steam Engine, with an historical sketch and brief description of the working parts for the use of general readers and elementary students," by H. H. P. Powles; "Indian Frontier, a map of the North Western Frontier of India, with insets (1) showing the overland route to India, (2) a military map of the Indian Empire" (scale: 55 miles to 1 inch; size: 22 × 30 inches); "Klondike Gold Fields, a map of British Columbia showing the Klondike, Cariboo, Kootenay and other Gold Fields, with inset map of West Canada showing the route to the new Gold Fields" (scale: 47 miles to 1 inch; size: 22 × 30 inches); "Philips' Revolving Planisphere and Perpetual Calendar" (special edition for desk use); Messrs. G. P. Putnam's Sons give notice of:—"Religions of Primitive Peoples," by Dr. D. G. Brinton, and "The Liver of Dyspeptics," by Dr. Émile Boix. Messrs. Rivington and Co. promise:—Handbooks of Practical Science, in three books, to be published separately: No. 1, "Physical Measurements"; No. 2, "Chemical Experiments"; No. 3, "Experimental Mechanics," by G. H. Wyatt; and a New Edition of "Elementary Non-Metallic Chemistry," by S. R. Trotman. Messrs. Smith, Elder, and Co.'s list contains:—"Reference Book of Practical Therapeutics," by various authors, edited by Dr. F. P. Foster, 2 vols; "A Practical Treatise on Traumatic Separation of the Epiphyses, including the Anatomy of the Ephiphyses, the Pathological Anatomy, Symptoms, Treatment, and Results of Traumatic Separations"; "Spinal Caries," by Noble Smith, new edition, illustrated. The list of the University Correspondence College Press includes:—"A Manual of Psychology," by G. F. Stout; "The Tutorial Algebra," by W. Briggs, and Prof. G. H. Bryan, F.R.S.; Part i. Elementary Course; Part ii. Advanced Course; "Advanced Mechanics," by W. Briggs, and Prof. G. H. Bryan, F.R.S.; Part i. Dynamics, Science and Art; "Elementary Text-book of Mechanics," second edition, by W. Briggs, and Prof. G. H. Bryan, F.R.S.; "Properties of Matter," by E. Catchpool; "First Stage Magnetism and Electricity," by Dr. R. H. Jude; "An Elementary Text-book of Sound," by John Don; "The Tutorial Chemistry," by Dr. G. H. Bailey, Part ii. Metals.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, a Toque Monkey (*Macacus pileatus*) from Ceylon, a Sooty Mangabey (*Cercocebus fuliginosus*), a White-crowned Mangabey (*Cercocebus æthiops*) from West Africa, presented by Mr. W. S. Gilbert; a White-fronted Lemur (*Lemur albifrons*) from Madagascar, presented by Mr. George F. Gardner; a Rufous Rat Kangaroo (*Æpyprymnus rufescens*) from New South Wales, presented by Dr. J. S. Williams; a Greater Black-backed Gull (*Larus marinus*), four Lesser Black-backed Gulls (*Larus fuscus*), British, presented by Mr. W. J. Simpson Ladell; four Rollers (*Coracias garrulus*), twenty Marbled Ducks (*Marmaronetta angustirostris*), two Pochards (*Fuligula ferina*), six Black-bellied Sand Grouse (*Pterocles arenarius*), two Pintail Sand Grouse (*Pterocles alchata*), three Stone Curlews (*Ædicnemus*) *scolopax*), twelve Pratincoles (*Gareola pratincola*), nine Great Bustards (*Otis tarda*), four Little Bustards (*Otis tetrax*), two Slender Gulls (*Larus gelastes*) from Spain, two Serrated Terrapins (*Chrysemys scripta*) from North America, four Reeve's Terrapins (*Damonia reevesi*) from China, an Amboina Box Terrapin (*Cyclemmys amboinensis*) from the East Indies, a Bell's Cinixys (*Cinixys belliana*), two —— Sternotheres (*Sternothærus adansoni*) from West Africa, a Lesueur's Gecko (*Ædura lesueuri*), a White's Skink (*Egernia whitii*), two Cunningham's Skinks (*Egernia cunninghami*), two Lesueur's Skinks (*Lygosoma lesueuri*), a —— Skink (*Lygosoma mustelinum*), thirty-one —— Skinks (*Lygosoma decresiense*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

NEW DIVISIONS IN THE RINGS OF SATURN.—Prof. J. M. Schaeberle announces (*Astronomical Journal*, No. 411) that during the present opposition of Saturn he has detected a partial division in the B- or middle-ring of Saturn not previously seen by him. The new division is said to be 0″·7 from the inner edge of the B-ring, and the width about the same as that of the Cassini division. The fact that the new division is not conspicuous, like Cassini's, suggests to Prof. Schaeberle that the separation is not yet complete, and that the interval which he has detected contains matter which reflects light to such an extent that unless the conditions of seeing are very good it is indistinguishable from the general appearance of the B-ring. He has not been able to see the division between the middle-ring and the crape-ring, announced by Herr Brenner. Writing to the *Observatory*, Herr Brenner says:—"On August 27 I discovered two new divisions in the rings of Saturn; the one between the Manora division and the inner edge of the crape-ring is identical with the Struve division, discovered in 1850, and seen again in 1887 by Struvaert. The other division, between those of Encke and Cassini, is quite new, and was never before seen. Nevertheless it was more conspicuous than the Encke division and more extended too." In connection with these announcements it may be worth referring to a paper by Captain H. Kater, in the *Memoirs* of the Royal Astronomical Society (vol. iv. p. 383, 1831). Enough divisions in the outer ring are there described and figured to furnish astronomers with material for contemplation for some time to come.

A NEW METEOR PHOTOGRAPH.—We are glad that increased attention is being given to the photography of meteors. Prof. E. E. Barnard states (*Astronomical Journal*, No. 412) that he exposed photographic plates in two cameras on the mornings of August 10, 11 and 12, with the object of securing meteor trails. Only one meteor trail was secured, but this was a very fine one, the full length of the path, about 8°, being recorded upon the plates. The trail commences at R.A. 2h. 59m., Decl. + 23°·7, and ends in R.A. 2h. 59m., Decl. + 32°·0. The meteor must have been a very bright one, as the trail, which is perfectly straight, is strong and clear. Near the southern end of its path the meteor appears to have exploded, as there is a distinct enlargement of the trail at that point. The path continues a little beyond this in the same direction but fainter, and there is evidence of a second minor explosion about 1° from the first. It may be remembered that in the case of Mr. Butler's meteor photograph, reproduced in NATURE two years ago (vol. liii. p. 131) the meteor underwent a change of direction after it exploded.

Prof. Barnard has sent to the Royal Astronomical Society a copy of the photograph obtained with each camera.

THE ALLEGED FORMER REDNESS OF SIRIUS.—This subject is discussed at length by Dr. H. Samter in the September number of *Himmel und Erde*, and answered in the negative sense so far as human records are concerned. Besides some ambiguous references of Ptolemy and Aratus to the colour of the star, there is Horace's reference to *rubra canicula* or red dog-star, and Pliny's description of the colour as redder than Mars. But the *canicula* may just as likely be Procyon, and the redness may have been due to its low altitude at the time of its first appearance in the sky after sunset. Hyginus and Germanicus Cæsar use the word *candidus*, that is, bright or shining white, in referring to the colour of the star. It is at least strange that Mars should have been so constantly, and Sirius so sparingly, referred to as red, and that not Sirius, but Alpha Scorpii should have been referred to as Anti-Mars (Antares). On the whole, Dr. Samter thinks the evidence is in favour of a very nearly white colour, as at present. The real explanation of the matter probably lies in the fact, pointed out some time ago in these columns, that the ancients observed Sirius at the heliacal rising, when it necessarily appeared red.

THE NEW GOVERNMENT LABORATORIES.

THE new Government Laboratory is built on a rectangular plot of land, 120 feet long by 65 feet wide, in Clement's Inn Passage, adjacent to King's College Hospital.

The exterior of the building is faced with red bricks with bands, corners and windows of Portland stone, and consists of four floors surrounded by an area whose retaining wall is faced with white glazed bricks. Central corridors run from end to end of the building on the basement and ground floors; a staircase at each end and a hydraulic lift give access to the various floors. The main entrance faces the gateway leading into Clement's Inn, and at the opposite end are two entrances for service purposes.

The architectural treatment of the first and second floors differs wholly from that of the ground-floor and basement: the entire central portion of the building forms one large room, 49 feet long by 43 feet wide, lighted by eight lofty mullioned windows and a flat-roofed dormer lantern, the open roof being carried on light iron principals. The floor of this room is about five feet above the ceiling level of the ground-floor rooms, and the space thus gained is utilised in raising the height of the principal rooms on the ground-floor, and as a duct, seven feet wide, below the floor of the central room, for holding the heating appliances, and water, gas and drainage pipes. The remainder of the building is divided into two sections by this room: each section consists of two floors with flat asphalted roofs, one roof carrying the water cisterns, and the other affording space for operations which it is desirable should be performed in the open air, a spiral iron staircase affording the necessary access.

The ground-floor corridor has a mosaic pavement, and with the exception of a few rooms in the basement, which, as well as the other corridors, are "granolithic," all the rooms have pitch-pine parqueterie flooring. The interior walls of all the laboratories, store rooms, and corridors, are faced with white glazed brick relieved by an ornamental dado of coloured glazed bricks; the only rooms with plastered walls being those intended for office purposes.

The basement floor contains a boiler house, engineer's workshop, store rooms, a mechanical laboratory, and laboratories for bacteriological work, water analysis, standardising scientific instruments, and verifying the hydrometers and saccharometers used in the Revenue Service. The mains for gas, water, and steam are carried along the corridor immediately below the ceiling, and are supported on light iron girders, every pipe being in view throughout its entire length. Underneath the corridor floor is the main ventilation shaft, a long chamber seven feet square, with which the several ventilating shafts and fume flues are connected. A powerful fan, worked by a silent one-horse engine, keeps up the air circulation and discharges the foul air into an upcast shaft surrounding the boiler furnace flue. A "return clean water main" also runs under this corridor floor, and after picking up branch mains from all the working laboratories, ends in a concrete tank of 7000 gallons capacity. Stores for house and steam coal, and a room for refrigerating machinery, have been constructed outside the main building, the former under the street pavement and the latter also partly in the area, which is here roofed in with Hayward's lights.

The main entrance leads into the ground floor, which contains on the left a waiting-room, the principal's private office, the reference library, and the research laboratory (a room 34 × 17 feet); on the right are the Crown contracts laboratories, a suite of three rooms having a total length of 69 feet by 17 feet, the private office of the deputy principal, and the reference sample laboratory, which is 28 feet long by 20 feet wide.

The chief feature of the first floor is the main laboratory, the central room already mentioned, adjoining which is a dark room for polarimetric work and a refrigerated room for storing samples. A short corridor leading to the main staircase gives access to two rooms for the superintending analysts and to the two tobacco laboratories.

The second floors contain photographic rooms, typewriter's office, museum, and four laboratories.

The building is lighted throughout by electricity obtained from the Strand Corporation, whose continuous 100-volt current is also employed for working various motors.

Rooms intended for offices have open fireplaces fitted with Teale's slow combustion stoves; the remaining rooms are heated by passing steam through iron radiators. In the main laboratory the radiators are below the floor in the central duct, and are connected with the external atmosphere by air channels covered with slate slabs, and the warm air enters the room through iron gratings which cover the duct. To prevent down draught a copper steam pipe runs all round the base of the dormer lantern; in all the other laboratories the radiators are on the slate slabs covering the air channels, usually in the centre of the room.

For ventilation, four large air shafts run from the upper corners of the main laboratory down to the basement, where they connect with the main shaft already mentioned, and in every room through which they pass there is an opening controlled by a "hit and miss" grating. The mouthpieces at the back of all the evaporation and draught closets are contained by downward flues into the same main shaft.

The water supply is from the New River Company's high-pressure main, branches from which run throughout the building direct to the various tables for working filter-pumps, turbines, and similar contrivances. For other purposes the water is stored in three cisterns on the roof, having a total capacity of 7000 gallons, from which it is distributed for boiler feed and ordinary laboratory work. To economise water, all the working tables are provided with special drainage outlets, which are connected by a system of iron pipes to the "return clean water main." The water discharged through this main into the concrete tank is pumped up into the service cisterns on the roof; the only water run to the drains is that used for cleansing purposes.

For ice making and refrigerating, one of Messrs. J. and E. Hall's carbonic anhydride refrigerating machines is employed, in which "brine" is cooled by the evaporation of liquid carbonic anhydride in copper coils surrounded by the brine, the cooled brine being used for making ice, cooling water, and for maintaining a low temperature in the sample store adjoining the main laboratory. This store is an insulated chamber with hollow walls, made of steel plates placed immediately in front of the insulation, through which the cooled brine circulates. The main laboratory has been specially designed for the evaluation of spirituous liquors, in connection with which a great desideratum is a supply of water fairly uniform in temperature all the year round. In the summer months the temperature of the ordinary water is lowered by passing it from the cisterns on the roof down to the refrigerating machine-room, where it runs through a cooler fitted with coils through which cold brine circulates. From the cooler the water is pumped by a centrifugal pump up to a special insulated cistern holding 1000 gallons, from which all the tables in the main laboratory are served.

The working tables have mahogany tops $1\frac{1}{2}$ inches thick, with fronts and ends of varnished Riga wainscot. In all rooms, except the main laboratory, the tables are placed against the outer walls immediately underneath the windows; they stand on a 3-inch plinth, which is protected by a recessed toe space and by making the table-top overhang 3 inches. They are uniformly 37 inches from floor to top of table, with a row of cupboards above the plinth topped by a single row of drawers. A space between the removable backs of the cupboards and the walls serves for carrying the water-pipes and draining troughs.

A white ware sink ($12 \times 9 \times 4\frac{1}{2}$ inches) is provided for each pair of workers, and behind it is a water standard fitted with Kelvin tap delivering into the sink, and side pipes with lever cocks for condensed water. The outlet of the sink connects through a wooden pipe with a V-shaped wooden trough lined with lead and pitched, which, after picking up from all the sinks in the table, discharges into a galvanised iron funnel, also coated with pitch; a continuing pipe conveys the dirty water into drains outside the building.

Fischer's brass filter pumps with vacuum gauge attached are fixed to the tables, and the water passing through them is conveyed by a system of pipes into the clean water return-main, as is also the water drawn from the side tubes of the water standard.

Sets of shelves for reagent bottles, consisting of three plates of glass supported on gun-metal brackets, are fixed on the walls at the back or ends of the tables.

In the main laboratory there are eight tables arranged in two rows, four tables being on each side of a wide central gangway, with a clear space of five feet between each table. The tops are twelve feet long by five wide, and each table affords working space for four operators; a white ware sink (20 × 9 × 4½ inches) is placed at each end of the table, and the standards delivering water into the sinks serve as pillars carrying a shelf nine feet long by one foot wide, which runs down the centre of the table between the two sinks at a height of one foot above the table top. Along the under surface the wires for the electric light are carried, and a plug is fixed on each side for motor attachments.

The two water standards are connected by a water pipe running underneath the shelf, and from this pipe four branches are taken on each side for supplying water to the still condensers. This water comes from the cooled water cistern, and after doing its work is passed through nozzles fixed on the table top into a pipe running underneath along the middle of the table, which finally connects with the return clean water main.

The tables stand on a plinth with recessed toe space, the top overhangs three inches all round; the cupboards and drawers are similar to those already described. Between the backs of the opposite cupboards is a space similar to that between the backs of the cupboards and the walls in the other laboratories, and this space is utilised for holding the water pipes and draining trough. The gas supply pipes are carried along the fronts of the tables in all the laboratories immediately below the overhanging portion, with off-takes leading to nozzles fixed on the top of the tables at the back. These off-takes are copper tubes which pass through the framing of the drawers, the contro. cocks being in front of the table.

All the principal laboratories are provided with evaporation closets, steam sand trays, steam drying ovens, distilled water apparatus, and cabinets for holding and using standard volumetric solutions.

The evaporation closets are very similar in character to those already in use at the Yorkshire College and elsewhere. They consist of a slate slab placed in front of a flue mouthpiece; a copper conical vessel is bolted to the under surface of the slab, which is perforated with a large bevelled hole in which is fitted a white stoneware collar. This collar, together with the copper portion, forms a hollow inverted cone, passing through the slate with a base 12 inches in diameter, on which is placed a thin steel plate coated on both sides with a rubber composition called "woodite," and perforated with holes of various sizes for holding basins, capsules and similar vessels. The upper portion is enclosed in a glass case resting on the slate slab, the front being a glass door sliding up and down by means of a counterbalancing weight working over pulleys. The roof is a plate of glass sloping down from front to back, with its back edge placed just above the top of the mouthpiece. A valve placed underneath the slab admits steam into the copper under portion of the cone, and any accumulation of condensed water flows away by a pipe fixed at a level slightly lower than the steam inlet. This pipe connects with a cubical cistern of brass with plate-glass front, arranged to act as a constant level apparatus in the event of steam not being available, in which case the bath is heated by a safety Bunsen burner placed immediately below the inverted copper apex.

The drying ovens, steam sand trays, and distilled water apparatus are all constructed as constituent parts of one appliance, through which steam from a single inlet circulates. The sand tray is a shallow copper vessel 30 × 12 inches; below it is a copper jacket lined with tin, through which the steam passes. It is well insulated and lagged round the sides and bottom, and forms the top of an enclosed oak cabinet fitted with wooden rails for holding dusters and towels, which are dried by the waste heat. Reduced steam first passes through a steam trap which automatically discharges the accumulation of condensed water, the outlet from the sand tray being so arranged that there is always available a supply of hot distilled water which can be drawn off as required through a Kelvin bib cock placed immediately over the cabinet doors.

From the sand tray the steam passes into the drying oven, which is fixed on the wall immediately above the sand tray. This oven is a stout copper-jacketed vessel insulated and lagged, the doors being fitted with plate-glass panels. Air for ventilation is admitted at the bottom and passes through a copper coil in the steam jacket, so that on entering the bath it is heated up to the temperature of the steam, and escapes through a similar opening at the top.

From the top of the oven a copper pipe leads the excess steam into the distilled water apparatus. This is an iron cylinder supported on brackets, and contains a block-tin worm, the upper end of which is connected with the pipe from the oven. The lower end delivers distilled water into a large earthenware jar standing on a wooden pedestal. A glass cock passes through a tubulure at the bottom of the jar in front, and through a similar tubulure on the right-hand side of the jar is fitted a glass water gauge, which also serves as an automatic overflow by being bent over into a funnel placed behind the jar; this funnel also receives water from the cylinder containing the block-tin worm, and by suitable connections delivers the water into the tank under the basement.

The appliance for holding the standard solutions is a shallow cabinet of Riga wainscot fixed against the walls, with polished plate-glass top and four doors; the panels of the upper doors are of glass, and the plinth is protected by a countersunk band of brass. The bottles containing the standard solutions stand on a shelf immediately behind the glass doors, and are fitted with two-holed rubber stoppers, through which pass a soda-lime guard tube, and a glass tube dipping down to the bottom of the bottle. This glass tube is connected, by india-rubber tubing which passes through a bevelled hole in the plate-glass top, with the stoppered side tube of a burette. Each burette is held in position by a pair of small clips fixed on two parallel brass bars, the bars being supported between a pair of brackets fixed to the ends of the cabinet on the plate-glass top. These clips ensure a perfectly rigid perpendicular position, and at the same time allow the burette to be easily raised or lowered. The burettes are filled with the standard solutions by suction through the top end of the burette, which is fitted with guard-tube continued by a depending piece of india-rubber to a glass mouthpiece.

The tobacco laboratory is provided also with special drying ovens and furnaces for incinerating vegetable substances. The drying ovens, three in number, are placed on the wall one above the other, and steam for heating them is generated in a special boiler standing close by, the condensed water flows back into the boiler, which is also connected with an independent water supply, having a valve and ball-cock for keeping constant level.

The carbonising and muffle furnaces are arranged in two chambers of white glazed bricks, supported on arches which spring from a large York flagstone; apertures in the roof communicating with a flue for carrying off the fumes and heated air. For carbonising the tobacco a special furnace has been designed. From the gas main in front of the chamber five branch pipes connect with long rectangular tubes. On each tube are screwed eight brass boxes, with a lever gas-cock between each box and the tube. Near each corner of the box a small Bunsen burner is fixed, and by this means a small flame plays uniformly over the under surface of the platinum dishes, which are supported on a light wrought-iron nickel-plated grid. The furnace is capable of holding forty dishes at one time. The front of the chamber, in which the furnace stands, is closed by a counterpoised glass door sliding up and down.

The incineration of the samples is completed in three muffle furnaces, of special design, heated by gas.

The whole of the work in connection with the building and fittings has been carried out under the immediate supervision of H.M. Office of Works, from designs supplied by Dr. Thorpe, and the manner in which the work has been executed reflects the highest credit on that department.

J. WOODWARD.

ZOOLOGY AT THE BRITISH ASSOCIATION.

BY arrangement between the Organising Committees, the presidents of the four biological sections gave their addresses at different hours, so as to make it possible for members to attend two or more. The address in Section D was given at 11.30 on Thursday, and followed Prof. Foster's address to the Physiological Section. After the address in Section D, some of the Reports of Committees were taken, and that of the Naples Zoological Station was most appropriately followed by a short statement, made by Dr. Anton Dohrn himself, as to the Naples Marine Station and its work. Dr. Dohrn dwelt chiefly upon his plans for the development of the station, how far they had been realised, and what still remained to be done. Prof. Ramsay Wright followed with a paper on a proposed lacustrine biological station, in which he gave a preliminary account of the microscopic fauna of the lakes of Ontario, pointed out the bearing of such observations upon problems of pisciculture, and the need of a biological station for the further study of the animals and plants in the great lakes. As a result of this paper, and of the discussion on the subject in Section D, towards the end of the meeting a deputation of biologists, consisting of Lord Lister, Prof. Ramsay Wright, Prof. Miall, Prof. Herdman, Prof. Poulton, Mr. Hoyle, Prof. Prince, and others, were received by the Hon. Mr. Hardie, Premier of Ontario, the Hon. Dr. Ross, Minister of Education, the Treasurer, and other members of the Cabinet, and spoke in favour of the establishment of a fresh-water station by the Government on one of the numerous lakes in the Algonquin National Park. The proposal was very favourably received by the members of the Government present, and the Committee of Section D appointed a Committee, with a grant of 75*l*. for the purpose of assisting in the promotion of the scheme. It may confidently be expected then that as the result of this action in Section D a biological institution of both scientific and practical importance will be permanently established in the province of Ontario.

None of the other reports of committees call for special attention, and the only remaining paper taken on Thursday was Prof. Minot's on the origin of vertebrata. This gave rise to considerable discussion, in which Dr. Dohrn, Prof. Osborn, Dr. Gaskell, Prof. T. Gill, and others took part.

Friday, August 20.—The Section opened at 10.30 with an interesting description by Prof. Osborn, of the restoration of *Phenacodus primævus* and of the skeletons and restorations of Tertiary mammalia in the American Museum of Natural History at New York. Prof. Osborn illustrated his remarks by a remarkably fine series of large photographs of the actual fossils and of their artistic restorations executed in water colours by Mr. Charles Knight. Prof. Osborn has had the famous skeleton of *Phenacodus*, originally described by Cope, entirely remounted, with the result that he finds it to be as digitigrade as the tapir, with the hind limbs more powerful than the fore, the tail of great size and the head extremely small. Prof. Herdman then gave an address upon oysters and the oyster question, illustrated by lantern slides, in which he dealt with oyster culture, the connection between oysters and disease, the presence of copper in some oysters, and the nature of the various kinds of greenness which occur in certain oysters. Prof. H. F. Osborn then gave a paper on the origin of mammalia, in which he discussed the evidence as to primitive lines of descent afforded by American Tertiary mammals. He showed that probably none of the forms up to now made known, ought to be regarded as the original stock of the mammalia. The rest of the papers taken on that forenoon dealt with detailed questions of fishes and fisheries, and were:—Prof. Prince's description of specimens of sea trout, capelin, and sturgeon from Hudson Bay, and the Esocidæ of Canada with description of a new species of pike found in Ontario, Dr. P. Cox's recent additions to the fish fauna of New Brunswick, and Dr. Carl Eigenmann's interesting exhibition of the blind fishes of America in a living state.

The Section opened in the afternoon with a paper by Prof. E. B. Poulton, illustrated by the lantern, upon "theories of mimicry as illustrated by African butterflies." He showed how various distinct forms with offensive characteristics and warning colours tend to converge in appearance, so as to share the responsibility of keeping up their character and spread the inevitable loss over a greater number. This was made known by Bates and F. Müller for South American forms, and by Moore for Indian, and now Poulton completes the case by evidence derived from African butterflies. There were two papers by Mr. A. Halkett, the one on *Branchipus stagnalis*, and the other on large specimens of Unionidæ from Lake Huron.

Two papers were given on the surface plankton of the Atlantic, one on this afternoon by Mr. W. Garstang, the other on Tuesday morning by Prof. Herdman. Mr. Garstang had collected his material on board the steamer *Laurentian* by tying a fine net over the bath tap and running the water through it occasionally during the day; Prof. Herdman had worked on the steamer *Parisian* by using four silk nets of different degrees of fineness over pipes through which the sea-water ran continuously day and night during the voyage from Liverpool to Quebec. These nets were emptied morning and evening. Mr. Garstang's method gave gatherings taken intermittently during the day, while Prof. Herdman's gave each day and each night as a continuous gathering. The results differed a little, showing that both these plans should be adopted in future observations. One point brought out by these papers was the efficient and inexpensive character of this method of collecting plankton. To obtain any number of samples of the surface organisms of the great oceans, collected either periodically or continuously, little or no expense need be incurred beyond the naturalist's passage. It is not even necessary that the naturalist should make the voyage himself. The methods of collection and preservation are so simple that they can be carried out by one of the officers on board. This method, which was first introduced by Dr. John Murray, will probably be largely employed by biologists in the future.

On Saturday the Section did not sit, as a natural history excursion had been arranged in conjunction with Section K.

Monday, August 23.—Prof. Poulton gave a paper on mimicry as evidence of the truth of natural selection, illustrated with the lantern. He described cases where very different butterflies and moths had converged in their characters, to a dark-coloured type of insect having certain clear spots upon the wings. These clear spots have been acquired independently in the different cases by entirely distinct methods—by loss of scales, by the conversion of scales into hairs, and in other ways. He also cited cases of various insects which mimicked ants, and which had acquired the resemblance by quite distinct methods.

Other papers taken this morning were:—Dr. L. O. Howard on economic entomology in America; Mr. J. F. Whiteaves on New Sepiadæ from the Lower Cretaceous of the South Saskatchewan; Prof. F. Y. Edgeworth on the statistics of bees: an inquiry into the time occupied by the successive journeys of workers; and by Prof. J. H. Panton on the appearance of the army-worm in Ontario during the summer of 1896.

In the afternoon Prof. Miall gave an account, with lantern illustrations, of a supposed new insect structure—a cellular organ found in connection with the heart and of doubtful function; Mr. W. Garstang had a paper on recapitulation in development, as illustrated by the life-history of the masked crab (*Corystes*); and Prof. G. Gilson gave a detailed description of the musculo-glandular cells in Annelids. Prof. Gilson's chief results are: (1) That the subepidermic part of the body-wall of *Polygordius*, *Owenia*, and many other Annelids consists of only one layer of mesodermic cells. These are much elongated and divide into an outer part, which becomes differentiated into muscular substance, and an inner one containing all the nuclei, and which has been erroneously regarded as cœlomic endothelium. The cœlom has no proper membrane on its parietal surface; and the myotomic sacs remain monodermic on their outer face. (2) That in *Owenia* the elements which constitute the monodermic outer wall of the cœlom, are musculo-glandular cells which may be classified with the neuromuscular cells of Cœlenterates. The author shows that the use of the secretion formed by the inner glandular processes of the cells is to produce a plasma in which the genital products float and are carried away.

The Section then adjourned to a natural history excursion at Ashbridge Bay, in conjunction with Section K.

Tuesday, August 24.—First came Prof. Herdman's paper "on the plankton collected continuously during a traverse of the Atlantic" (see above), and then a series of papers on vertebrate morphology; Prof. Theodore Gill on the determinants for the major classification of fish-like vertebrates, and on the derivation of the pectoral member in terrestrial vertebrates; Dr. W. H. Gaskell on the morphological significance of the comparative study of cardiac nerves, and Dr. Elliot Smith's observations upon the morphology of the cerebral commissures in the vertebrata.

The remaining papers before the Section were :—Prof. J. P. McMurrich on some points in the symmetry of Actinians; Prof. Lloyd Morgan on the natural history of instinct; Mr. W. G. McCallum on the hæmatozoon infections of birds; Mr. J. Stafford on the post-embryonic development of *Aspidogaster conchicola*, and Mr. G. P. Hughes on the antlers of the red deer, and on the evolution of the domestic races of cattle. Prof. Lloyd Morgan, in his paper on "instinct," replied to certain criticisms of the biological treatment of instinctive activities as relatively definite organic responses. Mr. Rutgers Marshall had argued that the "instinct of self-preservation," the "play instinct," and so forth, could not be regarded as in any sense definite. Prof. Morgan contended that these are group-terms under which a number of responses, each in itself relatively definite, are roughly classified. If we speak of "mimicking instincts" the group is so varied as to be quite indefinite as organic response. But when we study the particular cases which fall within the group, we find that each example shows an activity of a relatively definite kind.

The Section did not meet on Wednesday, as another natural history excursion was planned for that day in conjunction with Section K. It seemed desirable, to the biologists, on an occasion when the meeting was held out of Britain, that every opportunity should be taken of studying the more or less novel fauna and flora. This field work has been continued by some naturalists on the excursions which concluded the meeting. Thus Prof. Miall and Prof. Ramsay Wright have gone to examine the Algonquin Lakes; Prof. Herdman has been dredging and tow-netting in Puget Sound on the Pacific coast; while Profs. Bower and Marshall Ward have been collecting plants; and Prof. Poulton insects at many points along the line from Toronto to Vancouver.

PHYSICS AND CHEMISTRY IN RELATION TO MEDICINE.

THE advances of medical science due to the adoption of the methods and results of physics and chemistry have recently been generously acknowledged by several foremost members of the medical profession, in addresses delivered before congresses, and at the opening ceremonies of various medical schools on October 1. From the reports of a number of these addresses, the subjoined expressions of opinion have been collated. It is gratifying to be able to put on record these authoritative views as to the assistance which the physical sciences have given to medical progress.

Medical Progress due to Physical and Chemical Methods.[1]

All recent progress in medicine has depended on research and discovery carried on by physical and chemical methods. The mechanical principles that were first applied in anatomy, the mother science of medicine, to the explanation of the construction and movements of bones and muscles have been carried by the physiologist into every organ of the body and into the arcana of the tissues, and have been shown to be essential to the understanding of the changes that take place in them during the performance of their functions. And at the same time the aid of chemistry and electricity has been invoked to drive back step by step, and if possible to banish altogether, that vitalism which was at one time all but supreme in the domain of animal physiology. And now, not content with this corporeal conquests, the physiologist is pushing his mechanical methods into the realm of psychology, and is seeking by means of them to investigate the data of consciousness. Having by electrical stimulation and other experimental procedures localised sensory and motor centres in the brain, having shown that there is a definite order of development in the nerve tracts, and having disentangled to a large extent the paths of nervous impulses of various kinds, their halting points and goals in nerve cells, he is now eager to catch ideas on the wing and to examine them in the usual manner. Helmholtz, in his great works on vision and hearing, was the first to show how physics mount into physiology and psychology, and after him Weber, Fechner, Lotze, and Wundt have step by step pushed forward the parallels of the material accompaniments of thoughts and feelings. And quite recently a movement has sprung up in Germany to advance still further mechanical explanation of the facts of mental life, and to bring psychology, which has always been scientific in as far as it has observed and classified and analysed phenomena, into line with the exact sciences of external nature. Experimental psychology has been inaugurated, and research laboratories, in which the physical and vital changes that are associated with mental processes are to be measured and tested, have been established. Originating in Leipzig, experimental psychology has taken root in several other centres on the continent, has spread to America, where it has been eagerly adopted, and has at last made its way into England. The University of Cambridge has voted a sum of money to be devoted to investigations in connection with it, and a few months ago a meeting was held in London to promote the establishment of a laboratory for its study in University College. The names of those who attended that meeting are a sufficient guarantee that the project which it approved will be successfully carried out. I have little doubt that suitable arrangements will be made for instruction in the new methods of psycho-physical research in University College, and that in course of time other schools and colleges—Mason College amongst them—will follow its example and afford facilities for studies in anthropometric psychology. I have little doubt, too, that such studies will be fruitful of useful results, by widening the scientific basis of psychology and supplying us with standards by which to gauge the speed and duration of certain neural operations, the variations in these in different individuals, and the depth of certain mental defects. But at the same time I am disposed to think that exaggerated notions are entertained as to what experimental psychology can actually accomplish. Its field is, after all, a narrow one. It can never supplant self-observation and introspection as means of mental analysis, and must indeed always to a large extent lean on these. It is practically restricted to the measurement of sensations and movements and the gaps between them, or the simplest mental processes; and hitherto it has, it must be admitted, been somewhat ambiguous and indefinite in its declarations. For my own part I look with more sanguine expectations of light on the obscure problems of mind to comparative, ethnical, developmental, and pathological psychology—which may all, of course, be investigated by experimental methods—than to the new experimental psychology strictly so-called.

We all gratefully acknowledge the immense debt we owe to experimental physiology with its exact mechanical methods. It has dispelled myths and errors, supplied us with a body of precise and well-organised knowledge, and revolutionised our treatment of disease; and it promises in the future not only to augment our healing power, but to afford trustworthy guidance in education and in the regulation of some social relations. As it stands to-day physiology, it seems to me, offers a liberal culture to all who study it. An independent science itself, but in touch with all other sciences, it brings into exercise observation, judgment and memory, while it passes in review questions of surpassing interest to every human being, and thus confers an admirable intellectual discipline while storing the mind with information that must prove useful in the conduct of life.

Scientific Method in Medicine.[1]

Various spheres of activity have exercised their influences in bringing medical science to its present position.

We must, in the first place, ascribe the greatest importance to the study of anatomy. Gradually our knowledge of every detail of naked-eye anatomy has been gained, and at the present time every one practising medicine must have a competent knowledge on the subject gained by dissection. The same systematic study has extended to comparative anatomy, and great, for its time, as was the knowledge of Aristotle, it has undergone an entire revolution by the application of scientific methods to increased data of information by such workers as Cuvier, Darwin and Owen. It is now taught as a branch of medical education. Physiology could have no scientific basis until anatomy was fairly advanced. The facts on which it was at first based were founded on medical observations, but in the seventeenth century direct investigations and observations were commenced by Haller, Hunter, Spallanzani and Hewson. It has since been prosecuted with the greatest zeal and success, and the position of physiology

1 Extracted from an address on "Ethics and Individualism in Medicine," delivered at the opening of the winter session of the Queen's Faculty of Medicine, at Mason College, Birmingham, on October 1, by Sir James Crichton-Browne, F.R.S.

1 "The Influences that have determined the Progress of Medicine during the preceding Two and a half Centuries." Abridged from an address delivered at the opening of the Section of Medicine, at the annual meeting of the British Medical Association at Montreal, September 1897, by Dr. Stephen Mackenzie.

at the present time is that of a science, explaining the action and interaction of the organs and tissues, and the forces of the body, which is the true foundation of scientific medical knowledge—the Institutes of Medicine. The rise of physics and chemistry in the seventeenth and eighteenth centuries contributed greatly to the progress of medicine by increasing our powers of "searching out the secrets of nature" by methods and instruments of precision.

Of any one influence that has helped the advance of scientific study and the progress of medicine probably the increasing perfection of the microscope has been the greatest. With each new development of this instrument a greater range has been given to our researches, and with the assistance of chemistry it is continuing to reveal to us fresh facts that have created new branches of science.

Starting from the observations of Bichat on the minute anatomy of the tissues in 1801, the microscope has enabled us to understand the details of structure which were essential to complete anatomy. Until the microscope was capable of practical use the capillaries could not have been discovered by Malpighi, nor the composition of the blood understood; the mechanism of renal secretion could not be worked out until the minute structure of the kidney was known; the functions of glands, the process of digestion and secretion could not be understood until the histological details of the parts concerned were ascertained; the mechanism of light and hearing, of taste and smell were not revealed until the ultimate details of the structures involved had been investigated; the marvellous complexity of the nervous system, whether in the delicate though comparatively coarse structure of the nerves, the higher intricacy of the spinal cord, and the marvellous details of the arrangement of ganglionic cells and communicating fibres of the cerebral tissue, which by improved methods of preparation and staining are being revealed to us at the present time, could not have been worked out without its aid. Just as anatomy had to reach a certain stage before physiology and morbid anatomy became possible, so normal histology had to advance before pathological histology could come into existence; and as knowledge advances from the special to the general, special pathological histology had to reach to a very high point before we could reach that knowledge of general pathology on which our conceptions of the nature of disease are at present based.

The microscope again has introduced us to a new world, revealing minute organisms that play a great part in the plan of nature, and which are largely concerned in the production of disease. It has led to a new department of science, bacteriology, which has taught us how bacteria enter the body, how they increase and multiply therein, and how the tissue reacts for for self-protection. Chemistry has shown how the poisons formed by such organisms act in the body, and supplied us with means—as yet only in their infancy—for counteracting their effects or guarding against their exclusion and by protective inoculation. The microscope has further furnished us with evidence of parasitism other than bacteria in the blood, in the muscles, in the skin and hair, and on the mucous membranes. By its aid we are able to diagnose and watch the course of several primary diseases of the blood. It has enabled us to differentiate the various new growths that develop in our bodies. So much does the microscope constitute a necessary means of research that it would be impossible to perform our daily medical duties conscientiously without its aid.

The thermometer, again, has been of invaluable aid in the study of disease, allowing of our measuring and recording the degree of fever, and of watching its progress with such a degree of accuracy as to furnish us with evidence of the greatest value in the diagnosis, prognosis, and treatment of disease.

Electricity, by the laborious and complete investigations of Du Bois-Reymond, has revealed to us the mode of action of nerve and muscle that would have been impossible to obtain in any other way. Though the hopes at first entertained of its value in the treatment of disease have not been altogether fulfilled, it is still of much service in this respect, and perhaps still more valuable as an aid in diagnosis.

The ophthalmoscope, introduced by Helmholtz, has enabled us to understand diseases of the interior of the eye, which, without its assistance, was impossible. It has admitted of the exact examination of refraction, and has revealed changes in the termination of the optic nerve, in the retina and choroid, not only valuable in themselves, but so important in the light they throw on pathological changes occurring in the nervous system, and in the body generally, that the use of this instrument has become a necessity of practical medicine.

The laryngoscope perfected by Czermak has given a precision to the diagnosis and treatment of diseases of the throat not otherwise attainable, and which has important bearings on general medicine, by the recognition of paralyses of the muscles that move the vocal cords in aneurism and in disease of the central nervous system.

The sphygmograph, the cardiograph, the arteriometer, and, the latest invention of this class, the sphygmometer, have enabled us to ascertain the exact condition of the circulatory system, of the greatest service not only in studying the problems of normal and abnormal physiology, but in the recognition of disease and its tendencies, and in the influence of remedies.

All the branches of scientific knowledge we have been considering—anatomy and physiology, chemistry and physics, morbid anatomy and pathology, therapeutics and preventive medicine—have helped us to the knowledge we at present possess. But they have rendered a further aid to medicine than the mere knowledge they enabled us to acquire. Themselves scientific studies utilising methods and instruments of precision, they have influenced our whole mode of thought, and made us exact and precise in our observations and investigations of disease. We may paraphrase an expression of Burdon Sanderson's: "The history of modern medicine is largely the history of scientific method." So when we are taunted with the assertion that medicine is not a science, we can reply that medicine utilises the knowledge gained in every branch of science, and is scientific in its method of research into the nature and treatment of disease. If its results are not so exact as in some other branches of knowledge, this is not due to any want of scientific method and care in its investigations, but to the very complicated phenomena with which it has to deal, whilst the investigator has not the same unfettered freedom of dealing with his subject that the investigator into chemistry or physics has. By a continuance of the same methods and exact research, we cannot for a moment doubt that the progress that has been so manifest in the past will be exceeded in the future.

The Influence of Chemistry upon Medicinal Treatment.[1]

We must recognise that until the most recent times all remedies were borrowed from the purest empiricism. Unprejudiced physicians, armed with the weapons of scientific criticism, disentangled popular observations from superstitious and mystical ideas, and put to actual clinical test measures vaunted by their conservative colleagues, in order to ascertain whether in reality any use could be made of them. In consequence of the early state of scientific knowledge their judgment had necessarily to be based entirely on the results of practical experience without any experimental assistance. In this connection the history of digitalis is most instructive. Withering finds an old family recipe for dropsy; he does not keep to himself the results obtained with it, he finds the remedy of actual value, and in 1785 publishes it, with the results of his own cases, and so introduces it into practice.

It is extremely interesting that even the action of many of the chemical elements has been made use of in the form of the simplest house remedies. The ashes of the ordinary marine sponge have, for example, been much employed on account of their curative properties. When, however, chemical analysis found that they only contained soda, this valuable remedy, which had also found its way into medical practice, was for some decades laid aside. For in that period of chemical knowledge the mistake began of relying too much upon analytical results and of disregarding the strong evidence of clinical experience, because analysis did not necessarily detect powerful substances to explain the action of remedies. Owing, however, to the valuable discovery of Courtois, the soap-boiler, who separated iodine from the soda-lye of his factory, it was easy to demonstrate this element in sea sponges as well, and it had in consequence to be admitted that the results recorded with them were neither due to error nor to suggestion. And how noteworthy is it that in opotherapy also iodine was first discovered long after its value

[1] Abridged from an address on the Aims of Modern Medicinal Treatment, delivered at the Fifteenth Congress of Clinical Medicine at Berlin by Prof. Dr. Oscar Liebreich.

had been shown by therapeutic observations, made in ignorance of the fact that an iodine-containing organic body was present in the thyroid. Similar considerations apply equally to preparations of arsenic and mercury. It could not but happen that the philosophic point of view ascribed to all these remedies certain qualities which did not in reality reside in them. It is admitted, however, that the idea that as a matter of fact the chemical properties of a substance were of significance in regard to its action was known to Paracelsus. If, therefore, the fanaticism for this idea far overshot the mark, still the results then and afterwards obtained, and, indeed, the whole work of the iatrochemical school was not without therapeutic value.

The science of experimental pharmacology, which has arisen in our time, might well have contented itself with undertaking to put to the test the therapeutic material already to hand, and to contribute to the elucidation of its mode of action in order to be able to lay down more precisely the limits of its action, and so to lend a helping hand to clinical observation. It could easily have foregone the further empiricism of collecting new materials. But from the moment in which scientific remedies were brought into the domain of therapeutics, its horizon widened. It became necessary to take up and to seek to realise the idea of freeing the mind from empiricism, and of finding the leading principles by which the material of the healing art might be increased in a scientific manner. With the beginning of the attempt to establish this undertaking pharmacodynamics could no longer be satisfied to use merely the results of simple experiments upon living animals, but must needs also, with scrupulous attention to pathological principles, regard as its most important factor the representation of the conditions in health and disease as the basis of experimental inquiry.

In so far as concerns the search after new materials for remedies, one may correctly rely upon the principles of the iatrochemical school. Only those ideas must be excluded which, owing to deficient anatomical knowledge, rank as belonging to humoral pathology in the most rabid sense of the term. The investigators of those days stood also in the shadow of an alchemical environment, but had always before their eyes the endeavour to form an idea as to the nature of matter. For us, modern chemical ideas have created a new world. We know now that the smallest part of a chemical component—let us say, for example, a piece of sugar—is characterised by a special arrangement of the atoms of various elements, and that each change in their relative positions leads to the formation of a substance with new physical properties. The development of chemical research in this direction points to the discovery of innumerable new substances. One single reaction can yield several millions of these, and he who knows how to use the pencil aright can readily, by the construction of their formulæ on the paper, convince himself that the vast number of hitherto isolated organic substances forms but a minute part of those which can be assumed with safety to be capable of existence. This simple observation teaches us that we are no longer travelling along the route by which digitalis and the other old remedies of the healing art were made known to us.

It is very noteworthy that a long period elapsed before attention was paid to these powerful therapeutic adjuvants. It may be acknowledged with great thankfulness that this attention has been directed not only from the medical but also from the chemical side. In this connection, A. W. v. Hofmann correctly points out that after the discovery of so many organic substances some were soon brought into use for the sake of their external properties, while their internal applicability was never troubled about. Thus chloral hydrate was discovered in 1832, but its properties were first recognised through my pharmacodynamical researches in 1869. When new alkaloids were discovered, the task which lay before the chemist was to test their action upon the organism itself on the chance that it might fit in with a similarity in chemical constitution between their new substances and alkaloids. On account, however, of defective application of methods which lay out of their own beaten track, many chemists overlooked the true affinities of these bodies. In support of this may be adduced an example which has hitherto been scarcely ever quoted. Cocaine was discovered in Wöhler's laboratory. Its chemical similarity to atropine led to a chemical investigation of its topical action on the eye, and while it was noted that no dilatation of the pupil occurred, its remarkable property as a local anæsthetic was overlooked. Even the chemists found soon enough the exceptional loss of sensibility which cocaine causes when applied to the tongue; but it was Koller's medical observations and the clinical observations following which first indicated the correct position of cocaine as a drug.

The first ideas in testing the materials provided by chemistry in such enormous quantities must naturally be directed towards establishing a connection between their chemical constitution and their action. And from this line of thought many considerations naturally result. Before everything, it compels the speedy observation that the chemical division into groups such as alcohols, aldehydes, ketones, &c., has no bearing upon therapeutical action. Nevertheless, that a connection exists between the actions of certain chemical groups is not to be denied. It has been proved that the great group of bodies allied to antipyrin ("pyrazolones") exhibit similar therapeutic properties in a given direction. But we must always keep in mind that when we wish to speak of the connection between constitution and action, we must recognise that the effect of medicinal action upon the animal and human frame forms a complex whole, and cannot be mapped out with mathematical clearness. Bodies which lower the temperature produce an effect which is compounded of various different factors. The same is true of the lowering of blood pressure: thus one cannot scientifically represent that the chemical constitution of a given substance will be in relation to its influence on a complicated diseased condition such as migraine, or perhaps on the killing of the itch parasite, the destruction of which can be accomplished by the most varied toxic agencies. This imperfection of the new method must be admitted, but from its incompleteness no one can deduce that it is useless. On the contrary, its perfection promises to bring forward new and unexpected results.

But it must also be admitted that if the knowledge of the chemical material be made the basis of research and merely taken by way of comparison in relation to the remedies already guaranteed by experience, this alone already affords sufficient ground for rendering a portion of the chemicals available in treatment. In this connection I may recall, for example, the fact that working from the chemical constitution of cocaine bodies, such as eucaine were obtained which are not, it is true, identical in action with cocaine, but are able to replace it in many cases without exhibiting its toxic action. Thus in the search for new remedies it is no longer indicated that we should wait for chance results, as was formerly the case; we are, on the other hand, directed by scientific principles. Results crowned with success may be obtained through the most varied combinations which only those ignorant of the scientific method could describe as a "happy chance."

The Pursuit of Natural Knowledge.[1]

After referring to the history of University education in England, and congratulating Sheffield on the union of Firth College and the Medical School to form the new University College, and on its approaching admission as a constituent of the Victoria University, Dr. Pye-Smith said enough probably had been done for the present in constructing the framework for higher education in England. Accumulated endowments were still needful and the working out of the federal type of university. If he might offer advice drawn from the chequered and still uncertain fortunes in London he would say—trust to local wealth and public spirit and avoid Government grants as much as possible. Beware of the utilitarian spirit; let adequate provision, personal and material, be made first for literary and scientific research, secondly for education, and thirdly for technical instruction. The reversed order was the easier, but in the long run he ventured to think the less fruitful. While the moderating influence of statesmen and men of business and the interest and support of past students and graduates would find a valuable place in the constitution, let the chief responsibility rest upon those actually engaged in teaching and research.

Dr. Pye-Smith then went on to speak of the two senses of the word knowledge, both of them the objects of attainment by students of a university. The desire for knowledge how to do something is historically the earlier and is shared to some extent by the lower animals. Its end was: subjectively, the partly physical, partly intellectual pleasure of exercising the

1 Abstract of part of an address delivered at the University College Sheffield, by Dr. Pye-Smith, F.R.S.

muscles and brain; objectively, the attainment of some useful object. Such knowledge was called skill or art, and the man who attained it was a skilled workman, an artisan, an artist, a master of his craft. The continuity of this kind of knowledge depended on tradition, and its improvement was by invention. Its acquirement was called technical education; its results were seen in the products of agriculture which feed us, in the ships and railroads which carry us round the globe, in the triumphs of steam and electricity, of preventive medicine and antiseptic surgery, in the matchless steel, the wondrous armour-plates, and all the vast output of the skilful industry of Sheffield. But there was another kind of knowledge—the desire for which came later in human history—the knowledge of what things mean, of how they consist, of why one event follows another. This knowledge was not active, but contemplative, not practical, but theoretical, not technical, but scientific. Its end was purely intellectual; subjectively, the pleasure of exerting the mental powers; objectively, the truth about things. We call this knowledge science; that is, not only acquaintance with the objects around us, or natural history (descriptive botany, zoology, mineralogy, geology, astronomy, and anatomy), but also some insight into their constitution and growth, into the laws of their origin, their actions, their decay and metamorphoses. This was called natural philosophy. Its improvement depended, not on invention of tools and methods, but on discovery of facts and their relations. It was only indirectly useful, and the pleasure it gave was in proportion to the intelligence of the man who felt it: "*Felix qui potuit rerum cognoscere causas.*" The abstract sciences seem to have arisen out of the needs of useful arts—geometry out of measuring the rising of the Nile, arithmetic out of counting the hosts of a Persian despot or the gains of an Indian money-lender, trigonometry out of setting landmarks, chemistry out of the alchemist's search after gold, botany out of materia medica, and anatomy out of surgery. Amply has the debt been repaid. At the present time all the progress in useful arts was called "scientific," and rightly so, for all depended upon natural science. Agriculture rested on the basis of organic chemistry, geology, and botany, navigation on astronomy, the working of metals on physics and chemistry, engineering on mathematics, medicine on physiology, and if ever the art of governing mankind was to be more than empirical, it would rest on profound knowledge of palæontology and neuro-physiology.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—On October 1, the first day of the Michaelmas term, Dr. Alex Hill, Master of Downing, was formally admitted to the office of Vice-Chancellor. The retiring Vice-Chancellor delivered an address to the Senate, in which he reviewed the events of the past academical year. The emphatic rejection of the proposals in reference to degrees for women rendered it probable that some years must elapse before the University would grant any further rights or privileges to women students. The statement published last term by the Chancellor, as to the pressing financial needs of the University, had already led to one munificent gift of 2000*l.*, and it was hoped that this would be followed by others. Valuable donations to the museums and laboratories were acknowledged. Among new appointments were included the Professorship of Mental Philosophy, the Gilbey Lectureship in Agriculture, the Lectureship in the Hausa Language, and the Lectureship in Physiological Psychology.

The death of Prof. C. S. Roy, F.R.S., who has filled the chair of Pathology since 1884, took place on October 4. The late professor has been incapacitated by serious illness for over a year, but his death was somewhat sudden. The department has been superintended during his prolonged absence by Dr. Kanthack, of St. John's College, the deputy-professor.

IT is stated in *Science* that the plans are well formulated for the proposed new physical laboratory of Dartmouth College, New Hampshire, the result of the 75,000 dollars bequest of the late Mr. Charles T. Wilder. The committee has set apart 50,000 dollars for its erection and 20,000 dollars for maintenance. Additional grants have been made for an observatory, the foundations for which will be laid at once.

PROF. G. B. HOWES presided at the annual meeting for the distribution of the prizes gained by the students of the Westminster Hospital Medical School, on Thursday last. Reference was made in the report, read by the Dean of the College, to the resignation by Dr. Dupré of the post of lecturer on chemistry after thirty-three years' service, and it was stated that he had been succeeded by Dr. Wilson Hake. The entrance natural science scholarship, value 60*l.*, was awarded to Mr. E. C. Whitehead, and the entrance scholarship of 40*l.* to Mr. F. D. Martyn.

MR. R. C. CHRISTIE has given to Owens College, Manchester, the whole of his share of the estate of the late Sir Joseph Whitworth, as residuary legatee. It is estimated that the value of the gift is 50,000*l.* Mr. Christie has expressed the desire that the sum should be devoted to the erection of such buildings as the governors should think fit in connection with the college, only stipulating that the name of Sir Joseph Whitworth may be associated with the new buildings, and that they may be accepted and treated as a further gift from him to the college. It is also announced that two friends of the college have given sums respectively of 20,000*l.* for the erection of a physical laboratory and 5000*l.* for the maintenance of it; also that Mr. Edward Holt, of Manchester, has sent a cheque for 1500*l.* towards the erection of a museum at the college. Mr. Christie's fund will probably be devoted first of all to the erection of a hall for ceremonial and other large gatherings at the college.

MANY of the syllabuses of the subjects in which examinations are held by the Department of Science and Art have been modified. As already announced, the examinations in the honours stage of most of the science subjects will in future be divided into two grades: Part I. of a more advanced character than the advanced stage; and Part II. dealing with the highest branches of the subject. The honours portions of the syllabuses of most of the subjects have been re-written in consequence of this new regulation. The syllabuses of naval architecture, applied mechanics, and general biology (Section I.) have been entirely re-written. Prof. J. Perry is now an examiner with Mr. W. H. Greenwood in applied mechanics, and the new syllabus of the subject gives unmistakable evidence that he has had much to do with its composition. Prof. Perry has also been appointed an examiner in steam; and Dr. Fream has been appointed an examiner in agriculture. Prof. L. C. Miall's new syllabus of an introductory course of biology should be seen by all who are interested in the teaching of the subject.

THE new Directory of the Department of Science and Art has just been published. Many modifications have been made, both in the regulations for conducting science and art schools and classes, and in the syllabuses of the subjects recognised by the Department. We can only refer to a few of the changes. It is announced for the first time that recognition may be refused to any class which the Department considers to be unnecessary, or to compete unduly with a neighbouring school. This regulation will probably be the means of reducing the undesirable competition which often exists between science classes near one another. Schools may now be managed by a public company, provided that the articles of association specify 5 per cent. per annum as the maximum dividend. Counties and county boroughs which possess an organisation for the promotion of secondary education may elect to be responsible to the Department for the science and art instruction within its area. In such case grants will in general only be made to the managers of new schools and classes if they are acting in unison with the local authority.

A LARGE building, in which the art and technical schools of Leicester will be incorporated, was opened by the Bishop of London on Tuesday. The cost of the new buildings and site is just under 40,000*l.* The site extends to nearly three-quarters of an acre, and the main frontage is 220 feet, with an elevation of four stories. Two of the floors are devoted to technical instruction in hosiery and boot and shoe manufacture, with a full complement of all kinds of old and new machinery showing the development of the processes of manufacture, engineering, plumbing, dyeing, painting, &c. The two upper floors will be occupied by the school of arts. A portion of the roof of the building is flat, and on this a conservatory has been erected for studies of plant-life. At the opening ceremony Sir Thomas Wright, chairman of the committee, stated that the whole of the funds for the new building would be provided out of the excise duties, or what was commonly called "beer money." This contribution from the Exchequer would be sufficient to pay the interest on the outlay, provide a sinking fund, and leave a balance of 1250*l.* per annum towards the annual expenditure.

IN an introductory address delivered at the Yorkshire College, Leeds, on Friday last, Mr. T. R. Jessop described the magnificent provision made for the study and practice of medicine and surgery in some of the cities in Russia. He said that he found several of the Russian hospitals and cliniques far in advance of our own. Of the recently completed Moscow cliniques it was difficult to speak in adequate terms. Built at a cost of about half a million pounds sterling, half of which was contributed by a few wealthy ladies, whilst the remainder, as well as an endowment of 43,000*l* yearly, was guaranteed jointly by the Imperial Government and the municipality, they consisted of a dozen or more separate detached handsome buildings, erected on an open estate of from forty to fifty acres, situated about a mile and a half outside the busy city. Each building was a complete hospital, with its own lecture room, laboratory, professor's room, &c., and in those requiring it there was provided a suite of operating rooms which might well serve as models for any hospital. Each building was adapted for a special purpose, for dealing, namely, with surgical or medical cases, children's diseases, ophthalmic, contagious, nervous, nasal, and aural affections, and so on. And all this had been done for the sole purpose of educating medical students, and providing the country with competent medical men.

THE following entrance scholarships have been awarded in medical schools:—*Guy's Hospital Medical School:* Scholarship for University students (anatomy and physiology), of the value of 50*l.*, to Mr. A. H. Davies, Caius College, Cambridge. Open scholarships in science—First scholarship, of the value of 150*l.*, to Mr. A. E. H. Parkes, Guy's Hospital Medical School; second scholarship, of the value of 60*l.*, to Mr. W. H. Harwood-Yarred, Dulwich College. *St. Mary's Hospital Medical School:* Science scholarships.—144*l.*, Mr. M. F. Kelly; 78*l.* 15*s.*, Mr. J. B. Albury; 78*l.* 15*s.*, Mr. D. E. Finlay; 52*l.* 10*s.*, Mr. J. H. Wells; exhibition of 26*l.* 5*s.*, Mr. H. R. Kidner and Mr. M. T. Williams. University Scholarships.—57*l.* 15*s.*, Mr. F. C. Eve; 57*l.* 15*s.*, Mr. C. Killick; exhibition of 26*l.* 5*s.*, Mr. A. Whitmore. *St. Thomas's Hospital Medical School:* First entrance scholarship in natural science (150*l.*) to Mr. W. H. Harwood-Yarred, and the second, of the value of 60*l.*, to Mr. Francis H. Whitehead. The University Scholarship, of the value of 50*l.*, to Mr. Frank Cecil Eve, of Emmanuel College, Cambridge. *Charing-cross Hospital Medical School:*—Livingstone Scholarship (100 guineas), to Mr. S. A. Boyd; Huxley Scholarship (55 guineas), to Mr. W. J. O'Brien; Universities' Scholarship (60 guineas), to Mr. W. G. Rogers. Entrance scholarships have also been awarded to Mr. E. Bayley (60 guineas), Mr. C. L. Lakin (40 guineas), and Mr. G. S. Welham (30 guineas). *London Hospital Medical College.*—Price Science Scholarship (120*l.*), Mr. J. Jones; Price Anatomy and Physiology Scholarship (60*l.*), open only to competitors from Oxford or Cambridge, Mr. C. Warren (Oxon.); science scholarship (60*l.*), Mr. R. T. Dolbey; science scholarship (35*l.*), Mr. M. T. Williams.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, September.—Climatological records for the British Empire in 1896. A table is given showing the chief climatological elements at eighteen stations in various parts of the globe, and is accompanied by interesting remarks upon the results. The highest shade temperature, $111^{\circ}\cdot 2$, occurred, as is most frequently the case, at Adelaide, in January. A temperature of $104^{\circ}\cdot 8$ was recorded at Malta, in August, which appears to be unprecedented. No station has ever approached Winnipeg in respect of minimum shade temperature, and the daily and yearly range, but the values for 1896 call for no special remark. The least daily and yearly range were recorded at Grenada; the values appear to be normal, and are very similar to those obtained at Barbados in former years. The highest mean temperature always occurs at Ceylon; in 1896 it was $81^{\circ}\cdot 5$, but the average for fifteen years at Bombay is less than a degree below that for Ceylon. The driest station, viz. that recording the lowest relative humidity, has for many years been Adelaide, while Esquimalt is the dampest. The highest temperature in the sun, 177°, was recorded at Trinidad, and the lowest temperature on grass was $-23^{\circ}\cdot 5$ at Toronto; the radiation temperature is not registered at Winnipeg. The greatest rainfall, 101·06 inches, occurred at Colombo, and the least, 15·17 inches, at Adelaide, this value being much below the average. The fall at Mauritius, 68·17 inches, is the greatest since 1877. The greatest amount of cloud was recorded at Esquimalt, which slightly exceeds that of London; the clearest sky was observed at Grenada, where the average amount was 3·6, the scale being 0 to 10.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 27.—M. A. Chatin in the chair.—On the hypocycloid with three inflections, by M. Paul Serret. A continuation of a preceding paper.—On the stability of the phosphorescent sulphides of strontium, by M. J. R. Moureto. Specimens of phosphorescent strontium sulphide, prepared by five different methods, and exposed to air and sunlight at a temperature of 45° C., undergo a decomposition with production of hydrogen sulphide, and a sulphate.—On parastannyl chloride, by M. R. Engel. Metastannic acid, if washed with boiling water before drying in a vacuum, contains two molecules of water less than the acid prepared with cold water. This gives with hydrochloric acid an insoluble metastannic chloride, $Sn_5O_9Cl_2.2H_2O$, which differs from the chloride previously known by two molecules of water. From this a new stannic acid is obtained, to which the name of parastannic acid is given.—On some double chlorides formed by cinchonamine, by MM. Léon Boutroux and P. Genvresse. The alkaloid forms double chlorides with cadmium, zinc, and copper chlorides, the analyses and crystallographic characters of which are given.—On the improvement of humous earths, by M. J. Dumont. The application of potash manures, with a small proportion of lime salts, or of phosphatic slag, is recommended.

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