THURSDAY, JUNE 14, 1900.

MALAY MAGIC.

Malay Magic; being an Introduction to the Folklore and Popular Religion of the Malay Peninsula. By W. W. Skeat. Pp. xiv + 685, and numerous plates and illustrations. (Macmillan and Co., Ltd., 1900.)

THE object of this interesting and important work is set forth on the title-page with such clearness that the reviewer and reader are spared some trouble in defining it, and it is pleasing to be able to say that the author exhibits the same clearness throughout the hundreds of pages which he has devoted to the discussion of his subject. Speaking broadly, Mr. Skeat's volume is divided into six sections or chapters, which indicate by their length the relative importance of the matters of which they treat, and the well-chosen illustrations do much to enlighten the reader of the work on many points which do not fall naturally under the heading of facts of folklore. Mr. Skeat's book differs greatly from the works on folklore which appear from time to time, for it contains, not only what seems to us to be an exhaustive statement of facts which he has collected and arranged with care and discretion, but a series of deductions made after due consideration of the general principles which have, consciously or unconsciously, guided man in all ages and in all countries in working out theories as to the relations which exist between the animate and inanimate in nature. Many travellers and sojourners in foreign lands and remote islands have written books on the folklore of their inhabitants, but the greater number of them have been characterised by haste, and by a lack of knowledge of the fundamental facts of primitive anthropology. Moreover, it has frequently happened that, although their writers have given their facts correctly, they have not given all that might have been given had their own knowledge of them at first hand been sufficiently good to draw forth from the natives all that might have been extracted from them. Mr. Skeat has given abundant time to his subject, and as he has relied for guidance in difficult matters upon such works as Prof. E. B. Tylor's "Primitive Culture," the non-expert will feel that he is in safe hands. Mr. Skeat's years of residence in the Malay States gave him unwonted facilities for collecting information, and his official position and knowledge of the native dialects enabled him to make the fullest use of his opportunities. Another fact must be remembered. The influence of the West upon the East grows stronger every year, and the systems of the white man and government according to modern Western ideas, which, sooner or later, he invariably succeeds in imposing upon the coloured man, are not favourable to the preservation of native superstitions and beliefs. Little by little they are set aside, and eventually they disappear; thus frequently it happens that information which the student of comparative folklore would consider priceless for his studies is lost for ever. Mr. Skeat has done well in collecting such information in the Malay Peninsula whilst it is still to be obtained, and we can only hope that other officials who have the time and opportunity for collecting anthropological facts may emulate his devotion and industry.

According to Malay views in general, the earth and the sea were formed, each in seven stages, after the light, which was an emanation from the Deity, had become the "world-ocean." The earth was surrounded by a ring of mountains which kept it in its place, and served as the abode for legions of spirits. This mountain is, of course, the old Arab mountain of Kâf, from which, as Yâḳût says, "all other mountains are derived." Certain sages, however, hold other views, and describe how the Kábah, or home of the famous Black Stone at Mekka, the navel of the earth, was made immediately after God made himself manifest by his tokens the sun and moon. Next, the angel Gabriel killed the great serpent Sakátimuna, and the description of the subsequent disposal of her body forcibly recalls the Babylonian account of the fight between Merodach and Tiâmat. In fact, it seems pretty clear that Semitic cosmogonies have been drawn upon by the Malay theologians for several of the above theories. In shape, the earth is oval, and it revolves upon its own axis once every three months. Day and night are caused by the sun, which is a circular body moving round the earth. The sky is made of stone or "bed rock," and the stars are merely holes which let light through from the place of light above. An earthquake is caused by the buffalo which supports the earth on its horns, throwing it from the tip of one horn on to the tip of the other; this buffalo stands on an island in the midst of the nether ocean. The tides are caused by a huge crab moving in and out of his cavern, which is situated at the root of the Pauh Janggi tree. Eclipses are the result of a monster dragon trying to swallow the sun and moon; and indeed any untoward movement in nature is attributed to the movements of beasts of enormous size or dragons.

The appearance of man upon the earth is accounted for in various ways, but it appears that all Malay explanations of his origin are based upon Arabic legends of the creation of man by Allah, who is said to have fashioned him out of earth, air, fire and water. The version of one legend, printed by Mr. Skeat on pp. 19–20, with its mention of Michael, Gabriel and Izrafel, proclaims the source from which it was derived. The body is composed of earth, air, fire and water, and with these elements are connected four essences—the soul or spirit with air, love with fire, concupiscence with earth, and wisdom with water. But the works of Arabic writers on such matters were not the only authorities consulted by the early Malay philosophers, for Greek authors of treatises on the composition of man are often quoted. Passing over the consideration of the sanctity of the body for want of space, we come to the mention of the soul, which is described as a thin, unsubstantial human image or mannikin, which is temporarily absent from the body in sleep, trance and disease; after the death of the body, the soul departs from it for ever. It is usually invisible, but it is supposed to be as big as the thumb, and to resemble the body in shape, proportion and complexion; it is of an impalpable, filmy, shadowy substance, and causes no displacement in the body into which it enters. It possesses all the attributes of the body to which it gives life, and it suffers from all its disabilities; sickness is supposed to be caused by its absence from the body, and the soul may be abducted from it by unlawful means. The human soul is seven-fold, and it seems, at times, as if each was independent, for in certain ceremonies an abode is provided for each. The idea that a man possesses several souls is very old, and in Egyptian religious texts it may be traced back to the period of the earliest dynasties, about six thousand years ago. The number seven is, of course, and always has been, a magical number, and in ceremonies which are intended to do good, as well as those in which the object is to do evil, it plays a prominent part. In Babylonian and Assyrian magical texts we find the seven evil spirits of the deep, and the Mesopotamian underworld possessed seven gates; it must not be forgotten, too, the famous temple of Nebo at Borsippa, which tradition identifies with the Tower of Babel, was built in seven stages.

When we come to discuss Malay gods, we find the subject to be one of some difficulty. In the old religion, which the Malay professed to throw off when he adopted Muhammadanism, his ideas had formulated the existence of a large number of nature powers which closely resemble the Hindu gods found in Brahmanism; and before he adopted these as the objects of his worship, he seems to have peopled heaven and earth with myriads of spirits. To this day, when in trouble, he cries out, not to the Allah preached by Muhammad, nor to the deities which the Brahman religion made known to him, but to the evil spirits which his ancestors worshipped and feared untold centuries ago. It has been the same in all ages and in all countries, and the nations which become "converted" to a new religion in reality only drop the observances connected with their old faiths; and although they may tear down the shrines of old gods and build others to new ones, they do not succeed in uprooting from their minds the beliefs and ideas of which the overthrown shrines were the outward and visible signs. In spite of the teaching of Muhammad and the Brahmans, the Malay still believes that every department of nature is presided over by a "god" who must be propitiated by man, and to be specially honoured and revered are such gods as Batara Guru, Batara Kala, Batara Indra, and Batara Bismu; the greatest of this group is the first. It is interesting to note that native influence has succeeded in introducing into the Malay pantheon a number of gods of the sea, which from certain aspects are identified with older terrestrial gods. Many of the Jinn, or evil spirits of the Arabs, have been identified with old Hindu spirits, and the view held by the Malay on the importance of such beings may be gathered from the fact that it was believed to be possible to buy them from the Shêkh of the Jinn at Mekka, at prices varying from ninety to a hundred dollars each!

More than three-quarters of Mr. Skeat's volume are occupied with a description of the magic rites which the Malay connects with the various departments of nature, and with the life of man. This is not to be wondered at, for it is clear at a glance that there is no event in his life, however trivial and apparently unimportant, which, unless properly protected by magic rites and ceremonies, may give hostile devils and fiends an opportunity for doing undreamed-of mischief to the wretched mortal whom accident or design has left unguarded. We regret that we cannot follow Mr. Skeat through his description of birth-spirits and birth-ceremonies, and through the whole period of a man's life from the cradle to the grave, as sketched by him, for our space is exhausted, and the reader can study for himself the curious Malay customs which concern betrothals, marriages and deaths. Many of them have their counterparts in other countries, but not a few are peculiar to the Malay. As we read of them we cannot help wondering how, if the pious Malay fulfils all his religious obligations, he ever finds time to do anything else. It is improbable in these days that many men are found who are able to carry out all the religious performances enumerated by Mr. Skeat, and it is much to be hoped that the influence of the English will drive many of them out of existence. Meanwhile a good and careful record of Malay sorcery, witchcraft and demonology, which is invaluable for the study of comparative religion and folklore, has been given us by Mr. Skeat, and there is no doubt that he has laid anthropologists and ethnographers and Oriental archæologists under a heavy debt of gratitude.

THE NANSEN NORTH POLAR EXPEDITION.

The Norwegian North Polar Expedition, 1893–96: *Scientific Results.* Edited by Fridtjof Nansen. Vol. i. *The Jurassic Fauna of Cape Flora, Franz Josef Land.* By J. F. Pompeckj. With a geological sketch of Cape Flora and its neighbourhood by Fridtjof Nansen. Pp. 147; with 3 plates. *Fossil Plants from Franz Josef Land.* By A. G. Nathorst. Pp. 26; with 2 plates. *An Account of the Birds.* By R. Collett and F. Nansen. (London: Longmans, Green and Co., 1900.)

THE second chapter of the first volume of the "Scientific Results" of the Nansen North Polar Expedition opens with a geological sketch of Cape Flora and its neighbourhood by the leader of the expedition. It was a wise determination, on the part of those responsible for the publication of the results, to issue the several articles in English. The policy, too frequently followed, of writing important scientific papers in the language of the country where they are published, tends to place serious obstacles in the way of those who endeavour to follow the researches of Continental investigators. It is narrowness of view, rather than true patriotism, that compels authors to publish their results in languages which cannot be read by the great majority of scientific workers.

The geological investigation of Cape Flora, Franz Josef Land, was undertaken by Dr. Reginald Koettlitz, the geologist of the Jackson-Harmsworth Expedition, during the years 1894–97. Dr. Nansen's residence at "Elmwood," as the guest of Mr. Jackson, during a period of rather less than two months, afforded him an opportunity of visiting the most important localities in company with Dr. Koettlitz; the information he collected bears testimony to the good use which was made of this short visit. Nansen has given us a clear account, accompanied by diagrammatic sketches and photographs, of the geology of Cape Flora. This portion of Franz Josef

Land has the character of a plateau with a basaltic cap, 150 metres thick, composed of sheets of lava arranged in regular and almost horizontal terraces, which present a striking resemblance to the familiar basalt sheets in the cliffs of the Western Isles of Scotland.

From the face of the basalt a talus-slope extends to near the shore-line, where it passes into almost horizontal raised beaches, which occur at approximately the same level on both sides of the Cape, and point to a uniform and recent elevation. The volcanic rocks rest on Jurassic sedimentary strata, consisting for the most part of soft shale or clay containing numerous nodules of hard stone. From a "nunatak" protruding through the glacier, about 600 or 700 feet above sea-level, several fossil plants were found in fragments of shale spread over the surface of the rock within two small areas. The important question as to whether the shale was actually *in situ* and represented the remnant of an interbasaltic bed, or whether it had been broken off from a lower stratum and carried up by the intrusion of igneous material, has not been definitely settled. Nansen is of opinion that the plant-bed was *in situ*, and may be looked upon, therefore, as throwing important light on the age of the basaltic sheets; if this view is correct, the basalt must be assigned, on palæobotanical evidence, to an Upper Jurassic or Lower Cretaceous age. Very little is known as to the Jurassic deposits of Northbrook Island beyond Cape Flora; the beds examined at Cape Gertrude have yielded no fossils beyond fragments of wood and lignite. Nansen inclines to the view expressed by Messrs. Newton and Teall,[1] that the beds at Cape Gertrude were deposited under varying conditions and during oscillations of level; while the argillaceous sediments of Cape Flora, which are more uniform in composition, appear to have been laid down in a shallow sea during a period of comparative tranquillity.

The marine Jurassic fossils collected by Nansen from the rocks of Northbrook Island in the Franz Josef Archipelago are described by Dr. J. F. Pompeckj, whose work bears the stamp of thoroughness and accuracy. An account is given of previous literature relating to the Jurassic rocks of Franz Josef Land, special prominence being naturally given to the description by Mr. Newton of the fossils brought to England by the Jackson-Harmsworth Expedition. Some portions of the Cape Flora strata are fairly rich in fossils, but the fragmentary nature of the material renders accurate determination a matter of considerable difficulty, and in many cases the fragments are indeterminable. Dr. Pompeckj has performed his task with ability, and his conclusions have been arrived at as the result of careful sifting of the meagre evidence at his disposal. A glance at the comparative table of the Cape Flora fossils collected by the Jackson-Harmsworth Expedition and by Nansen shows that in several instances Pompeckj's determinations do not agree with those of Newton; considering the fragmentary nature of many of the specimens, it would be strange indeed if there were no discrepancies in the lists of the two palæontologists.

The fauna, as described by Pompeckj, is represented by the following genera:—*Pentacrinus*, *Serpula*, *Lingula*, *Discina*, *Pseudomonotis*, *Pecten*, *Lima*, *Leda*, *Macrodon*, *Amberleya*, *Macrocephalites*, *Cadoceros*, *Quenstedtoceras*, and *Belemnites*. The Ammonites appear to be abundant as compared with other groups, the genus *Cadoceros* being specially prominent as regards both species and the number of specimens.

Of the twenty-six species collected by Nansen, seventeen are new to the region, and five are considered to be new species. As the author points out, his results "differ in no slight degree from those which Newton arrived at from his examination of the Jackson-Harmsworth material." The sedimentary strata of Cape Flora are classed by Pompeckj as Lower Bajocian, Lower, Middle and Upper Callovian.

In the concluding palæo-geographical remarks, attention is drawn to the importance of the Cape Flora fossils as coming from the most northerly development of Jurassic rocks so far investigated. The occurrence of marine Bajocian species demonstrates "the existence of a Bajocian Sea in the north of the Eurasian-Jura continent." The extent of this northern sea cannot be determined, but the Jurassic sediments of Cape Flora afford evidence of deposition in shallow water near the shore-line of an Arctic continent. Neumayr's fascinating theory of climatic zones in the Jurassic period does not receive support from the palæontological results of Pompeckj and Newton; the scanty evidence at present available points to the existence of a decided central European facies in the fauna of Cape Flora, a fact opposed to the conclusions of Neumayr.

The patches of sedimentary rock from which Nansen obtained several fragmentary remains of plants have already been referred to as either portions of strata preserved *in situ*, or conceivably derived from lower strata and carried to a higher level by igneous forces. It is unfortunate that the history of the vegetation which flourished on the site of Franz Josef Land during the Mesozoic period is not represented by more legible records, but we may congratulate Prof. Nathorst on having exercised caution and care in the interpretation of the imperfect documents at his disposal.

Among the genera recognised by Nathorst are the following:—*Cladophlebis* and *Sphenopteris* fragments represent the ferns, small specimens referred to *Podozamites* and *Pterophyllum* may be accepted as evidence of the existence of Cycadean plants: *Ginkgo*, *Czekanowskia*, *Phoenicopsis*, *Feildenia*, *Taxites*, *Abietites*, *Pityanthus* and *Pityostrosbus* demonstrated the occurrence of Ginkgoales and Coniferæ.

The fairly numerous examples of small *Ginkgo* leaves are the most interesting fossils dealt with by Nathorst; they enable us to extend the range of the Mesozoic species of this isolated genus, which is to-day represented by the maiden-hair tree of China and Japan. The leaves named by Nathorst *Ginkgo polaris* bear a close resemblance to *Ginkgo digitata*, a species which played a prominent part in the Jurassic vegetation of several regions; the Franz Josef Land specimens are characterised by the small size of the leaves, and may possibly be regarded as a northern variety of the larger-leaved *Ginkgo digitata* of the Inferior Oolitic rocks of East Yorkshire. As regards

[1] *Quart. Journ. Geol. Soc.* vol. liii. (1897), p. 477; *ibid.* vol. liv. (1898), p. 646.

the question of geological age, we agree with Nathorst's verdict that the plant-bearing beds must be assigned either to an Upper Jurassic or to a Lower Cretaceous horizon. Several of the plants suggest a comparison with Inferior Oolite species from the rich plant-beds of the Yorkshire coast, and it is not improbable that in the fragmentary fossils from Cape Flora we have the remains of a flora but slightly younger than that which has left abundant traces in the Lower Oolite strata of more southern latitudes. While admitting the danger of attempting to assign an exact geological date to the fragmentary and imperfect specimens, there can be no doubt that they must be referred to a period anterior to the Tertiary, and in all probability they are remnants of an Upper Jurassic flora.

While regretting that the fossils from Franz Josef Land are not more numerous and less fragmentary, we may offer a hearty welcome to the two able palæontological memoirs by Dr. Pompeckj and Prof. Nathorst; these authors, in carrying out their difficult tasks with thoroughness and good judgment, have set a standard of efficiency which promises well for the succeeding volumes of the "Scientific Results" of the Nansen Expedition. A. C. S.

As might have been expected, no birds new to science were obtained during the voyage of the *Fram*; nevertheless, some interesting observations were made on the range and distribution of bird-life in the high north, while naturalists have, apparently for the first time, been made fully acquainted with the early plumage of the roseate gull. In the course of the expedition birds were observed in the highest latitudes in which they are definitely known to be able to exist. During the summer of 1895, when the vessel was between 84° and 85° 5′ north lat., in the neighbourhood of Franz Josef Land, ten species were from time to time observed, although none occurred in any numbers. The one found farthest north was the Fulmar petrel, which was seen in lat. 85° 5′; in the last edition of "Yarrell" the extreme range of this bird is given as 82° 30′.

During the summer of 1896, when the *Fram* was north of Spitzbergen, the first herald of returning bird-life was a snow-bunting, which made its appearance on April 25. From the observations made during the same season, it is now evident that to the north of Spitzbergen, between lat. 81° and 83°, the Arctic Ocean is the resort of large numbers of birds, belonging, however, to comparatively few species. Apparently these consist for the most part of immature individuals, in the first plumage, which spend the summer among the open channels in the ice. The little auk and the ivory gull were among those most numerously represented; Sabine's gull having only been seen on a single occasion. Although swimming birds were by far the most numerous in these high latitudes, shore-haunting species were represented by the ringed plover and the grey phalarope, which were seen running about on the ice by the side of the open water.

The fasciculus is illustrated by an artistic plate of the roseate gull in its first plumage, which is mainly brown on the upper-parts, and therefore quite unlike that of the adult. R. L.

THE CYANIDE PROCESS.

The Cyanide Process of Gold Extraction. By James Park. Pp. viii + 127. (London: Griffin and Co., Ltd., 1900.)

THE great success which has attended the introduction of potassium cyanide for the extraction of gold has created a widespread interest in this chemical process, and given rise to several books and papers on the subject from various authors. When we consider that at one large works 500 tons of gold are treated in twenty-four hours, we understand on what a colossal scale the cyanide method is worked. The process, like many others, has grown up from small beginnings, and it is largely owing to Messrs. MacArthur and Forrest that cyanide of potassium is now successfully applied to the treatment of gold ores in different parts of the world.

It is a most significant sign of the times that men who have been practically engaged in an enterprise are willing to communicate the results of their experience to the public at large, and from the manner in which the literature of the subject is growing, every detail requisite for economic working will soon be widely known and utilised. Therefore, one is not inclined to analyse the text too minutely, with the object of finding small flaws, provided the information is broadly reliable and accurate. It was inevitable that electricity should be brought into play in connection with such an important process, and we find Messrs. Siemens and Halske early in the field, with a method of depositing the gold on lead by means of electrolysis. There are two sides to this subject, as to most others, viz. the economic, or practical as it is termed, and the scientific. Now the former seems to be fairly well treated, but what is wanted is much greater attention to be paid to the latter, as it is possible that, with fuller and more intimate knowledge, potassium cyanide may be equally useful in the treatment of other metals besides gold, especially as it is now so largely used in the electro-deposition of gold, silver, copper, brass, &c. The work under notice has passed through three editions in New Zealand, and this is the first English edition. It is intended for the use of students, metallurgists and cyanide operators. Several new illustrations and tables are added, and the information relating to the treatment of slimes and the analysis of solutions has been greatly extended. It is gratifying to learn that wet crushing and cyanide treatment have been followed with as much success in New Zealand as in South Africa, although the ores are of a complex character.

The arrangement of the contents of the book is admirable. After a brief introduction and a general statement as to the limitations of the subject, the chemistry of the subject is wisely introduced, so that the student is at once brought face to face with the various reactions that occur, and led to see the reason for loss of cyanide, which is sometimes so excessive. Valuable information is given on pp. 10–13 on the action of potassium cyanide on metallic sulphides. A very useful chapter on laboratory experiments will be appreciated by teachers and students of metallurgy, as well as by the chemist and works manager; indeed, a commodious and well-equipped laboratory is one of the most important and necessary parts of a cyanide plant. The control, testing, and analysis of solutions is treated in a fuller manner than is usual with books of this class, and of the three methods given we prefer the silver nitrate test. The tables for the assay of cyanide solutions are a useful addition to this chapter. The appliances for cyanide extraction are briefly described, and although accompanied by several good scale drawings, certain details are omitted which might have been profitably included.

The synopsis of the process for the actual extraction by potassium cyanide is well written, and the conditions for successful treatment, such as strength of cyanide solution, &c., are stated as clearly as one could wish. Chapter vii. deals with the applications of the processes at different works. Leaching and precipitation are succinctly dealt with in Chapters viii. and ix. These are followed by a short description of the Siemens-Halske electrical process, which not only deposits the gold, but gives rise to the production of a number of valuable commercial bye-products, such as lead, copper, litharge and paint. For all those who wish to obtain a sound knowledge of the cyanide process, as conducted at the present time, we heartily commend Park's handbook.

OUR BOOK SHELF.

The Cause and Prevention of Decay in Teeth. By J. Sim Wallace, M.D., B.Sc., L.D.S. Pp. 101. (London: J. and A. Churchill, 1900.)

THIS is a reproduction in book form of a series of articles published in the *Journal* of the British Dental Association.

The subject has been dealt with in the light of the now universally accepted chemico-parasitic theory of dental caries, but the author treats less of exciting or immediate causes than of those remote and predisposing. He attributes the great and increasing prevalence of dental caries among civilised nations to the elimination of the coarser and more fibrous parts of foodstuffs from the diet, and points out that this may act in two ways. Firstly, owing to the absence of mechanically detergent constituents of food, more of the fermentable, acid-producing and germ-sustaining parts of the latter remain in contact with the teeth for some time after meals. Secondly, that the tongue, being less actively employed during the act of chewing and swallowing, fails to attain its full size and exercise its normal important function in modelling the dental arches, so that irregularities arising from crowding and malposition of the teeth serve to intensify their predisposition to caries.

The subject is, on the whole, efficiently dealt with, and the book may be recommended to the medical practitioner or intelligent layman.

It is a pity, however, that the author lays such persistent stress upon what he considers the daring heterodoxy of his opinions, as these are at most modifications of those currently accepted. It is somewhat irritating, too, to find set forth for the instruction of the dentist, and with an air of great originality (as on p. 94), certain points in the operative treatment of caries which are among the very first impressed upon all students in schools of dental surgery.

Surely, too, the accusation of ignorance of the causes of the diseases he attempts to combat, and empiricism in practice, are undeserved by the educated dental surgeon of to-day. HAROLD AUSTEN.

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.*]

Atmospheric Electricity.

IN a letter on this subject in NATURE of March 29, Mr. Aitken criticises the theory which attributes the prevalence of positive electrification in the atmosphere to the superiority in efficiency as nuclei for the condensation of water vapour, of the negative ions over the positive.

That any difference in the degree of supersaturation necessary to make water condense on positively and on negatively charged ions would result under suitable conditions in the production of an electric field was pointed out by Prof. J. J. Thomson (*Phil. Mag.* vol. xlvi. p. 533), and it was suggested by him that this might be a source of atmospheric electricity. Experiments made by the present writer proved that there is such a difference, and that water vapour condenses much more readily on negative than on positive ions; while Elster and Geitel (and independently, Lenard) have recently brought forward evidence based on their own experiments and those of Liuss, tending to show the existence of free ions in the atmosphere.

There remains the question whether the necessary degree of supersaturation can ever occur in the atmosphere. Mr. Aitken contends that there is no such thing as dust-free air in the atmosphere, and that therefore any considerable degree of supersaturation is impossible.

Air practically dust-free does, however, seem to have been met with on Ben Nevis, accompanied by something very like supersaturation (Rankin, *Journ. Scot. Met. Soc.* vol. ix. p. 131). In Mr. Aitken's own papers, too, records of small numbers of dust particles (sometimes considerably less than 100 per c.c.) are not rare; and the lowest values are met with just under the conditions where their occurrence is of most significance. For "most of the low numbers in the tables were observed during rainy weather, and the very low ones in misty rain, when the clouds were at or near the surface of the earth" (Aitken, *Edin. Trans.* xxxvii. p. 664). Again, the purest air met with by Mr. Aitken was that blowing from off the Atlantic Ocean, the mean number of dust particles in a series of 258 observations extending over nearly five years amounting to 338 per c.c.; on one occasion the number was as low as 16 per c.c. (*Edin. Trans.* xxxvii. p. 666). Air coming from such a region can hardly be considered as abnormal. Moreover, such observations are necessarily made in air within a few feet of the ground; at a greater height it is likely to be less contaminated.

Consider a mass of air occupying 1 c.c. and saturated with water-vapour at 10° C., and let it expand till, say, 3×10^{-6} gram. (less than one-third of the total water) has condensed to form 100 drops. Let us suppose the drops to be equal in size and let us calculate the volume and thence the radius of each drop, and from this obtain the rate at which they will fall relatively to the air (assuming the velocity $=\frac{2}{9} g \frac{r^2}{\mu}$, the viscosity μ being taken as $1 \cdot 8 \times 10^{-4}$). We obtain for the radius of each drop the value $1 \cdot 9 \times 10^{-3}$ centim., and for the rate of fall through the air, $v = 4 \cdot 4$ cms. per second.

In a rising current of moisture-laden air containing 100 dust particles per c.c. there is thus no difficulty in seeing how the drops as they ascend may grow large enough to lag behind the air at the rate of 4·4 cms. per second (=160 metres per hour); while the greater part of the moisture in the surrounding air is still retained as vapour. If then the upper surface of the cloud is carried to such a height that the drops reach the size $r = 1 \cdot 9 \times 10^{-3}$ cm., it will there be lagging behind the rising air at the rate named, and a dust-free layer must exist immediately above it, increasing in vertical thickness at the rate of something like 180 metres per hour. Even if 1000 drops were formed in each c.c. of the cloud, the rate of growth of the dust-free layer would, as a similar calculation shows, when the same quantity of water had separated, amount to 34 metres per hour.

A difficulty raised by Mr. Aitken in connection with the removal of dust particles by condensation of water upon them is this: "When a cloud forms in ordinary impure air, only a small proportion of the dust particles become active centres of condensation, whilst many receive no charge of vapour." Instead of being an addition to our difficulties, does not this rather suggest a method by which, even if the air entering the base of a cloud be very impure, it may become freed from its dust? For it follows that even in such air a comparatively small number of drops will be formed in each c.c. when the saturation level is reached. What becomes of the nuclei which do not there form active centres of condensation? If the presence of a few slightly more efficient nuclei has prevented them from coming into play, the same number of actual drops will be at least equally effective in this respect. Will the dust particles then remain free until they are carried up beyond the reach of the drops, and there become active centres of condensation as Mr. Aitken suggests? It seems to me that, after a considerable vertical thickness of cloud has accumulated, this is highly improbable; such a cloud is likely to act as a very efficient air filter. For if even very impure air be kept in a small vessel with wetted walls the dust particles are removed in a comparatively short time—the shorter the smaller the vessel—by coming in contact with the walls. Dust particles in air travelling through a cloud must be very favourably situated for removal by contact with the drops. They are thus not likely to survive as free nuclei long enough to be able to come into play at the upper surface of the cloud, unless the time taken to traverse the cloud has been comparatively short. A cloud, due to an ascending air current containing near its lower surface as many dust particles (7700 per c.c.) as that encountered by Mr. Aitken on one occasion on the Rigi Kulm, even if it receive a continuous supply of equally or more impure air from below, may thus have no dust particles left in its upper portions beyond what are contained in the drops; while the number of drops per c.c. may amount to only a small fraction of the number of dust particles originally present, the size of each being correspondingly greater.

Mr. Aitken refers to the possible re-evaporation of drops due to the tendency of the larger ones to grow at the expense of the smaller. But all drops which have survived the great tendency to evaporate which accompanies the initial stages of their growth will surely continue to grow so long as the rate of expansion remains the same, or even if it be much reduced. The effect of the size of the drops on the vapour pressure necessary to cause water to condense on them is in fact relatively unimportant except in the case of very small drops; if we apply Lord Kelvin's formula to the case of drops even as small as 10^{-4} cm. in radius we find that the vapour pressure exceeds by only about one part in a thousand that over a flat surface of water; the evaporation from the drop of one part in 30,000 of its mass would cool it sufficiently to counterbalance this difference.

With respect to the power of sunshine to manufacture nuclei in air containing various gaseous impurities specified by Mr. Aitken, it may be observed that there is no evidence of such an effect of sunlight in normal atmospheric air, and that all the substances mentioned by Mr. Aitken (ammonia, nitric acid, &c.) being very soluble in water would be dissolved out of the air in passing through a cloud of water drops. It is true that sunshine does appear to produce in pure air nuclei (which however require a fourfold supersaturation to make water condense on them), and that strong ultra-violet light produces large nuclei like dust particles (*Phil. Trans.* 192, p. 403); but these effects have not, so far as I can see, any immediate bearing on the subject of the possibility of supersaturation in the atmosphere.

I do not know of any evidence to show whether the small drops in clouds tend to coalesce to form larger ones or not. Such coalescence would tend to hasten the process of separation of dust-free air from the cloud, by increasing the downward velocity of the drops relatively to the air; but it is unnecessary to assume its occurrence.

We have now seen reason for believing that the drops in the upper portion of a cloud produced in ascending air are likely, before the air around them has lost any very large proportion of its vapour, to have grown large enough to lag behind the ascending air at quite an appreciable rate; and that the air between them is likely to be dust-free. Under these conditions a dust-free layer will be formed above the cloud, and will continually increase in vertical thickness. This layer will be saturated with moisture at its lower edge, above this it will be supersaturated; the amount of supersaturation being greatest near its upper limit, and depending on the vertical distance through which the air has risen since escaping from the cloud. Now to produce in air initially saturated the supersaturation (approximately fourfold) necessary to cause water to condense on negative ions, it is sufficient to let the volume of the air increase adiabatically to 1·25 times its initial value (*Phil. Trans.* A, vol. cxciii. p. 289); an expansion which will result from an ascent of the air through a vertical distance of 2500 metres, if we suppose the air on escaping from the cloud to be at a temperature of 10° C. (at lower temperatures a smaller elevation would suffice). Thus, when the air in the uppermost layers of the supersaturated stratum has reached a height of about 2500 metres above the level at which it escaped from the cloud, a sudden change will result; condensation will there take place on the negative ions. The thickness of the supersaturated stratum (*i.e.* the vertical distance which the upper surface of the cloud has lagged behind the air), when the condensation on the negative ions begins, may vary greatly; it may be very small if the drops are small and the ascent of the air rapid; it may amount to nearly the whole 2500 metres in the case where the drops grow large enough to acquire a velocity relative to the air as great as the upward velocity of the air, so that the upper surface of the cloud has ceased to ascend. Above any cloud in an ascending air current, however numerous and small the drops, we should expect to find a supersaturated layer (possibly of very small vertical thickness), provided its upper surface has risen high enough for all dust particles to have either come into play as condensation nuclei, or to have been removed by coming in contact with drops already formed; provided also that the heating effect of sunshine on the drops at the upper surface of the cloud is not sufficient to counterbalance the cooling effect of the expansion and cause them to evaporate. And if the ascending current continues till a level about 2500 metres higher is reached, we get condensation taking place in the dust-free layer. It is difficult to avoid connecting this process with the sudden appearance of "false cirrus" at the top of a cumulo-nimbus cloud at the commencement of a shower.

We must now consider what will happen to the drops condensing from the supersaturated layer. Mr. Aitken takes the view that if condensation ever did take place on the ions, the drops formed would fall at once as rain, and that a cloud would never result. He remarks that the supersaturated air will be, as it were, in an "explosive" condition, which will cause the extremely rapid growth of any drop that may begin to form, thus preventing condensation on neighbouring ions. There is, however, no obvious reason for supposing the rate of increase of size of a drop in supersaturated air to be of a different order from that of the diminution in size of a similar drop in an unsaturated atmosphere. In neither case is there anything of the nature of an explosion. In the one case evaporation causes the lowering of the temperature of the drop below that of the surrounding air (to the wet-bulb temperature), the evaporation being thereby retarded; in the other case, the condensation on the drop at once raises its temperature above that of the surrounding supersaturated air, the rate of growth being mainly determined by the rate at which the drop can give out to the surrounding air the heat developed in it by the condensation. I do not think we have the data for determining whether the drops will fall at once as rain or remain in suspension till they have travelled into regions where the ascending current is insufficient to support them. In either case, if the drops fall through a supersaturated layer of some thickness, they are likely to reach the ground as negatively charged rain. I see, however, no reason to conclude that negatively charged clouds may not also be produced by condensation on the negative ions.

The foregoing considerations contain a theory of the origin of rain such as I had in view when the paper, criticised by Mr. Aitken, on the difference between the positive and negative ions as condensation nuclei was written (*Phil. Trans.* A, vol. cxciii. p. 289). That rain may sometimes at least have its origin in supersaturated portions of the atmosphere has indeed been held by v. Bezold, Cleveland Abbe, and other meteorologists.

I do not propose to consider what is likely to happen after the rain has begun to fall. It may be pointed out, however, that we are likely then to have a reduction in the supply of dust particles, especially if the rain extends over a considerable area; for the inflowing air is likely to have a considerable proportion of its dust particles carried down by the rain before it has penetrated any great distance into the rain-washed area. In Mr. Aitken's papers may be found references to the apparent dust-removing power of rain.

Mr. Aitken considers that the positive ions would not remain in the atmosphere, because a slightly greater supersaturation than was necessary to cause condensation in the negative ions would bring them down also. It is conceivable that they may sometimes be removed in this way; but if we consider that a greatly increased supersaturation (six-fold instead of four-fold) is necessary, and that the production of ions is continually going on, so that negative ions as well as positive are always present, we can hardly consider it a likely occurrence. What then is the subsequent history of the positive ions after being carried up out of reach of the drops formed on the negative ions? They will, under the action of the electric field produced by this separation, tend to travel downwards relatively to the air with a velocity of the order of one centimetre per second for a field of 100 volts per metre, as the measurements of Rutherford and others have shown. After being carried beyond the region of ascending air-currents, they will travel downwards towards the earth's surface; but long before reaching it they will become attached to cloud particles or to the dust particles of the lower layers of the atmosphere, where the positive charge will accumulate.

It is not claimed that the process described above is the only source of rain or the only source of atmospheric electricity. It should be pointed out, for example, that another way in which rain may possibly acquire a negative charge is by falling through ionised air. For according to Zeleny (*Phil. Mag.* vol. xlvi. p. 135) a body suspended in a current of ionised air becomes negatively charged in virtue of the slightly greater velocity of the negative than of the positive ion under a given force. Elster and Geitel make use of this difference between the positive and negative ions to account for the normal positive electrification of the atmosphere, by the passage of air through the vegetation on the earth's surface. Whether, however, the charged particles, the presence of which near the surface of the earth their experiments seem to prove, are really free ions whose velocity under a given force is that of the ions produced by Röntgen and other rays and not comparatively slow-moving masses (the nuclei called dust particles by Mr. Aitken) to which ions have attached themselves remains as yet undecided. In air charged with dust even to the extent to which clear air near the surface of the ground is shown by Mr. Aitken's observations to be, it is likely, since the rate of ionisation in the atmosphere is certainly slow, that an ion would become attached to some dust particle in a time very short compared with what the average life of an ion would be in dust-free air, where it is determined merely by the rate of recombination of the ions.

In conclusion, it must be confessed that if the rate at which the electric field of the earth is being destroyed by leakage through the air is anything like so great as is given by Elster and Geitel's interpretation of their experiments (*i.e.* of the order of 1 per cent. per minute), no theory which attributes the normal fine weather electricity to the effect of precipitation at a distance is sufficient to explain the facts. C. T. R. WILSON.

Cambridge Laboratory, Cambridge, May 16.

Specimens of "Dromæus ater."

IN reference to Prof. Giglioli's note (*suprà*, page 102), I may perhaps be allowed to remark that Bullock's Museum appears to have contained a specimen of the extinct *Dromaeus ater*. The twelfth edition of the "Companion" to that Museum, published in 1812, has the following entries (page 80):—

"Great Emea, or New Holland Cassowary . . .

"Lesser Emea, not half the size of the above, and a distinct species."

At the dispersal of his collection the sale Catalogue includes both specimens as lots 97 and 98 on the eleventh day of the sale (May 18, 1819), the latter as

"Lesser Emew, a distinct species from the last,"

and my annotated copy of the Catalogue shows that both were bought by the Linnean Society—for 10*l.* 10*s.* and 7*l.* 10*s.* respectively. I have tried to trace the latter specimen, but in vain. It may still exist unrecognised. ALFRED NEWTON.

Magdalene College, Cambridge, June 4.

Effect of Iron upon the Growth of Grass.

SOME years ago NATURE published a short letter of mine from India, noticing the way in which laying out iron (famine) tools on the ground brought on grass upon very dry surfaces. Any one who looks now under the rows of iron chairs, and round the railings, of the band-stand on the east side of the Green Park, will see the same stimulating effect produced. A. T. F.

London, June 4.

SOURCES AND PROPERTIES OF BECQUEREL RAYS.

IN the following article a general account is given of a few of the more striking phenomena connected with Becquerel rays, including some of the recent developments of the subject at the hands of Becquerel, M. and Mme. Curie and others.

Among a large number of papers which have lately been published, dealing with properties of these rays, two are worthy of especial notice, as giving a comprehensive view of the phenomena. For those who propose to study the subject more fully, no better guide can be found than Prof. Elster's report in Eder's *Jahrbuch für Photographie und Reproductionstechnik* for 1900. The footnote references to original papers form a complete bibliography of the literature of the subject existing at the time when the article appeared, and it is surprising that Prof. Elster should have succeeded in summarising so large an amount of matter in eleven very small pages. Dr. B. Walter's article in the *Fortschritte auf dem Gebiete der Röntgenstrahlen* is somewhat less condensed and more popular; the chief phenomena, especially the photographic and fluorescent properties, are dealt with at greater length, and the article is illustrated by a plate of radiographs showing the difference between the actions of Becquerel and Röntgen rays. Already Walter's paper, and, to a less degree, Elster's report, have become out of date on the subject of magnetic deviation, and for this and other later developments no better guide could be found than the well-condensed summaries contained in the current monthly parts of *Science Abstracts*.

The discovery of these rays in 1896 was a natural sequence of the discovery of the Röntgen rays, and was led up to, on the one hand, by the attempts of M. Henry to intensify the action of Röntgen rays by the use of phosphorescent substances; and, on the other hand, by the theory, since abandoned, that the Röntgen rays were themselves the result of phosphorescence of the vacuum tube. Becquerel and other physicists made numerous experiments to test whether phosphorescent substances emitted rays capable of acting on a photographic plate that was enveloped in opaque paper, and it was found that rays which produce actinic action were emitted by the phosphorescent salts of uranium, not only when these salts had been exposed to the action of sunlight or of Röntgen rays, but even after they had been kept in the dark for months, the "radio-activity" showing no perceptible falling off.

The next step was the discovery, by Mme. Curie, that Bohemian pitch-blende—a black, shiny ore of uranium—possessed a higher degree of radio-activity than uranium itself, and this result naturally suggested the view that the ore contained, besides uranium, some other substance to whose presence the increased action was due. By separating the pitch-blende into its constituents, M. and Mme. Curie were led to discover the existence of two sources of radio-activity, one associated with the compounds of bismuth, and the other with those of barium occurring in the ore. Seeing that barium and bismuth obtained from other sources do not emit Becquerel rays, these radiations were attributed to the existence of two new substances, that associated with bismuth being named polonium, a name derived from the Polish nationality of Mme. Curie, while the other substance associated with barium chloride was called radium. The separation of these two substances has led to the production of rays of sufficient intensity to excite fluorescent screens, discharge electrified conductors, and, indeed, to reproduce, with differences, most of the properties of Röntgen rays. A third radio-active substance, produced from the residues of pitch-blende, is recorded by Debierne, who names it actinium. It is precipitated by the principal agents for titanium, and it emits rays which reproduce the same phenomena as the rays emitted by radium and polonium, and are 100,000 times the intensity of ordinary uranium rays. Certain thorium compounds are also radio-active, a property first established in these by G. C. Schmidt and Mme. Curie, and subsequently investigated by R. B. Owens and Rutherford.

Since this article was in the printer's hands a paper by Sir W. Crookes on the radio-activity of uranium, read before the Royal Society on May 10, has been received. The author records an entire absence of radio-active effects in all the barium minerals in his cabinet from which uranium was absent, while pitch-blende and other minerals containing uranium and thorium excited a photographic plate. Arrangements were then made for working up half a ton of pitch-blende, and the radio-activity of the uranium salts was definitely traced to the presence of a foreign body, which Sir W. Crookes has christened for the time UrX (*i.e.* the unknown quantity in uranium), following a fashion initiated by Röntgen, and which has previously led to the introduction into our vocabulary of such terms as "Xd air" (Italian "aria Xata" or *ixata*). We would suggest the name "Crookesium" as a substitute. Whether uranium-X is or is not identical with radium seems not fully decided, but it appears to be distinct from polonium. It is now proposed to try to separate the radio-active component of thorium.

Le Bon, who claims to have anticipated the Becquerel rays in his "lumière noire," has expressed the opinion that the properties attributed to radium and polonium do not prove the existence of new elements, and may be accounted for by supposing the radio-active substances to be mere allotropic modifications of bismuth and barium. On this view there is no more fundamental difference between the properties of radio-active and ordinary barium than between phosphorescent and ordinary sulphuret of lime. Giesel, of Brunswick, also has adopted the terms "radio-active barium" and "radio-active bismuth" in preference to "radium" and "polonium." In support of the opposite view, Demarçay has proved that radium possesses a characteristic spectrum, and M. and Mme. Curie find that the atomic weight of radio-active barium chloride is greater than that of ordinary chloride, amounting in one specimen to as much as 146 as against 137.

The pitch-blende used in the preparation of these substances is obtained from Joachimsthal, in Bohemia. Under the direction of Giesel, working in co-operation with Profs. Elster and Geitel, the firm of E. de Haën, of List, near Hanover, have undertaken the preparation in small quantities of radio-active barium emitting rays that are unequalled in intensity, and have also placed on the market cheaper by-products which also emit rays of sufficient intensity to visibly excite a fluorescent screen. The solid radio-active compounds of barium increase in activity from the time of solidification, but do not reach their maximum for more than a month. The barium preparations are all luminescent, the chloride and bromide especially so when dry. According to Giesel, the bismuth or polonium preparations lose their radio-activity in a few weeks, and this property is also cited by Elster.

The radio-activity of barium bromide is found by Elster not to be destroyed by continuous heating for twenty-four hours *in vacuo*. After cooling, the strength is much reduced, but is restored after the lapse of a few days to nearly the original intensity.

Becquerel rays resemble Röntgen rays in their power of "ionising" air, a property they possess to such a degree as to discharge all conductors within a considerable distance of the radio-active substance. Their action on electric sparks has been studied by Elster and Geitel. A spark gap 1 cm. wide, consisting of a positive knob and a negative disc, was exposed to the radiations from a barium preparation. The sparks or brushes were converted into a violet glow-discharge, but the former discharge was re-established on interposing a plate of lead. With discs made of semi-conducting card the radium affected the discharge at the distance of over 1 metre. According to Elster, heating a small trace of a radio-active substance in air in a Bunsen flame increases the electric dispersion of the air of the room.

Becquerel finds many bodies acquire the temporary power of discharging conductors under the influence of the rays, thus affording proof that these rays involve a continuous emission of energy. The bodies do not, however, act on a photographic plate, and their activity is lost on heating. This property is not assumed by the double sulphate of uranium and potassium.

There appears at present no prospect of utilising Becquerel rays as a substitute for Röntgen rays in surgery. The difference of behaviour of the two kinds of rays is well shown by two radiographs of the human hand accompanying Dr. Walter's paper. In the one taken with Röntgen rays the outlines of the bones are remarkably clear and sharp; in the other, taken with the rays emitted by Giesel's most powerfully radio-active preparations, a dark, ill-defined shadow of the outline of the hand is seen, but not a trace of the bones is visible. This latter radiograph, which was taken with the relatively short exposure of an hour, shows clearly the shadows of a needle and of a coin that were placed under the middle of the hand, proving that a certain proportion of the rays had actually passed through the hand, but without differentiating the bones from the rest. Experiments undertaken by Walter to account for the hazy outline of the Becquerel radiographs point to the conclusion that the Becquerel rays, when passing through substances of small atomic weight, experience a far greater diffuse scattering than Röntgen rays. Further, the secondary radiations emitted by both light and heavy substances under the influence of the Becquerel rays differ far less from the incident rays in intensity and penetrability than in the case of the secondary rays investigated by Sagnac in connection with Röntgen rays. A further difference lies in the far greater absorption of Becquerel rays by specifically light substances, such as those forming the flesh of the human hand. With the use of a platinocyanide of barium screen, Walter observed the same absence of all traces of bones as with photographic methods, although the shadow of the hand was clearly seen on the screen.

The composite nature of Becquerel rays is suggested by experiments on phosphorescence and selective absorption, as well as on magnetic deviation. Mme. Curie has found that Becquerel rays are more easily absorbed when they have already penetrated an absorbing layer than when they have not. One aluminium disc absorbed a certain proportion of the rays; a second aluminium disc absorbed an even greater proportion of the remainder. According to the note on Mme. Curie's paper in *Science Abstracts*, "this is due to the fact that the less penetrative rays are absorbed in the first absorptive layers," but such a view would more naturally lead one to expect that the proportion of absorbed rays would be less at the second screen than the first, instead of greater; the phenomena can, however, be accounted for by the hypothesis that the first screen transforms the rays into secondary rays of lower penetrating power. The existence of such secondary rays has been supported by Villard, Meyer and Schweideler, Dorn and others. Becquerel has, however, shown that in the case of polonium rays from the Curies' preparations, no secondary rays are emitted by aluminium. The phenomenon of selective absorption has been studied by Becquerel, who exposed various substances to the action of radio-active barium chloride, including hexagonal blende, platinocyanide of barium, diamond, and double sulphate of uranium and potassium. The phosphorescence varied in different cases. When different screens were interposed—namely, aluminium, mica, black paper, glass, ebonite and copper—the absorptions of the radiations which excite phosphorescence in different substances by the same screen were found to be unequal. R. B. Owens has shown that thorium radiations resemble those associated with the derivatives of uranium ore, but possess greater variety. There are indications that they are not confined to so few distinct types, if, indeed, the number of types is limited. Becquerel shows that the absorption of "radium" rays by screens is variable according to the distance of the screens from the source, and that the intensity of the radiation decreases with the distance more rapidly than it would do according to the law of the inverse square; both of these are results of absorption by the air. The view advanced by Le Bon two years ago, that Becquerel rays could not be polarised, has been confirmed by Rutherford.

The magnetic deviation of Becquerel rays has absorbed a large amount of attention during the last few months, and conclusions from recent experiments have in several instances been in contradiction with the inferences from earlier investigations. Thus a survey of the literature of the subject shows that amongst others the following views have been advanced: (1) that Becquerel rays are not deviated; (2) that they are deviated in air but not *in vacuo*; (3) that the deflection gives rise to phenomena which are more marked with polonium than with radium; (4) that both radium and polonium rays are deviated *in vacuo*; (5) that radium rays show marked deviation, but polonium rays show no deviation whatever. The first negative result was obtained by Elster and Geitel; Giesel proved the magnetic deflection of the rays in air, and attributed the previously observed absence of deflections to the experiments having been performed *in vacuo*. Elster, by repeating the experiments with a different arrangement of apparatus, using the same radio-active bismuth and barium as in Giesel's experiments, has discovered the cause of his previous failure, and has established the magnetic deflection of the rays *in vacuo*. Giesel used a strongly radio-active bismuth preparation, and got more marked effects than with his barium compound; Elster, using a similar bismuth preparation and a relatively feeble one of barium, was led to infer that the barium radiations were the most deflected. In these experiments the rays are received on a photographic plate or fluorescent screen; P. Curie, on the other hand, has described an apparatus for comparing the magnetic deviation by means of the electro-dispersion produced by the rays. When not deviated the rays pass out normally between two lead blocks, and traverse the space between the plates of a condenser, causing a current to flow; when deflected the rays are absorbed by the lead blocks, and the current ceases.

Both Curie and Becquerel find that the magnetic deflection varies with different substances. According to Becquerel's paper of December 26, polonium showed no deflection, while radium showed a strong deflection. The absence of deflection in polonium rays has been observed by Mme. Curie, who states that they travel in a straight line. In comparing these results with the different conclusions obtained by Elster, reference must be made to Dorn's hypothesis, according to which it is suggested that the primary rays are not deflected, but are transformed into deviable secondary rays. But in a recent paper Becquerel finds that the Curies' polonium rays are neither deflected by a magnetic field of 10,000 C.G.S. units, nor are they transformed into deviable secondary rays. He has also made experiments to test whether the curvature of radium rays is affected by interposing a screen, as would occur if the transmitted rays were secondary rays moving with lower velocity. No such effect has been as yet observed. The most probable inference at present is that there are two kinds of rays, one deviable and the other not. The Curies find both forms coexist in radium rays; and from Giesel's experiments the deviable rays certainly exist in some preparations of polonium, but were doubtless not present to an appreciable extent in the samples experimented on by the Curies and Becquerel. According to Curie, the rays from radio-active barium carbonate are deflected to a very different extent. Those rays which have the greatest penetrative power are the most easily deflected, and those rays which are not deflected only penetrate air to a distance of 6 or 7 mm. Becquerel finds that magnetically deviable rays are absorbed by different screens up to a certain inferior limit of distance, while they penetrate a screen that is placed sufficiently near the source.

When the magnetic field is uniform and the direction of the rays is perpendicular to the lines of force, they describe circles and return to the starting point; when the rays start in a direction oblique to the lines of force, the paths are helices. These results have been recently verified by Becquerel, and from them it is possible to form a general prediction of the corresponding effects produced in a non-uniform field, such as that produced by a horseshoe magnet, which effects we now proceed to describe.

In Giesel's experiments, the sensitive plate was laid on the poles of the magnet, film downwards, the polonium being placed below and in contact with the film. Between the black patch produced above the substance and the dark zone produced by the deflected rays, a number of dark traces were observed, resembling wavy hair or like the ramifications in Lichtenberg's figures. Becquerel has shown that when the radio-active barium is placed on one pole of an electromagnet and a fluorescent screen on the other, the effect of exciting the magnet is to concentrate and contract the luminous area, a result unaltered by reversing the poles. When the rays pass across the lines of force, they, after proceeding upwards, are bent round and impinge on the plate along a curve, which extends from one pole to the other, bending out of the way of the radiant substance in the centre. When a piece of radium preparation is placed on a plate in a uniform field near a plane normal to the lines of force, the result is an intense impression limited by a spiral whose sense is that of the current which produces the field. This spiral is the trace, deformed by the field, of the line of intersection of the vertical plate and the plate on which the radium rests.

In the *Journal de Physique* for April, Becquerel shows that different radio-active compounds of barium emit rays that are equally deviated, and he establishes the fact that the deviation conforms to laws similar to those which apply to kathodic rays. The phenomenon of dispersion is established, and by interposing strips of paper, aluminium and platinum against the gelatine plate, on which the deflected rays are received, a kind of absorption spectrum is obtained, showing that the most deviable rays are the most readily absorbed under the conditions of the experiment. By calculating an inferior limit to $H\rho$ (the product of the magnetic force and the radius of curvature of the path) for the rays transmitted by various screens, the absorption by different substances is compared, and the results are of the same order of magnitude as for the kathodic rays. These and other facts suggest that part of the radiation is of similar nature to the kathodic rays, where small negatively-charged masses are transported with great velocity, and the Curies' experiments prove the existence of such charges, which, however, are exceedingly feeble. According to this view, the magnetic deviation is given by the formula $vm/e = H\rho$, and in an electrostatic field of intensity F the rays ought to undergo a deviation, $\theta = Fl \div (v^2m/e)$, l being the length of the path. It appeared, at first, that the electrostatic force required to make any such deviation visible would exceed the limit for which disruptive discharge would take place in air, and could only be obtained *in vacuo*. In a footnote, however, Becquerel tells us that he has since observed the electric deviation in air with a field of about 10^{12} C.G.S. units, and has found for certain rays which pass through black paper the values $m/e = 10^7$ and $v = 1{\cdot}6 \times 10^{10}$.

The chemical effects of Becquerel rays have been examined by M. and Mme. Curie and Becquerel; they may be briefly summarised here. The rays from active salts of barium transform oxygen into ozone, a process involving a continuous expenditure of energy. Potassium iodide is coloured blue. Glass in contact with the salts is coloured violet, ultimately becoming nearly black, and the colour penetrates the glass; this phenomenon is analogous to the coloration of fluorspar by kathodic rays. Platinocyanide of barium screens gradually turn yellow, then brown, and finally lose their fluorescence, which, however, is restored by exposure to sunlight. Fluorine continues to phosphoresce for twenty-four hours after being excited, and calcined fluorspar which has lost its phosphorescence regains its luminosity in the presence of radium. Chemical activity is confined to those radio-active preparations which are luminous, but is not always proportional to the luminosity.

According to the Curies' experiments, powerfully radio-active compounds of radium and polonium, when they act on inactive substances, are able to communicate radio-activity to them. This induced radio-activity increases with the time of exposure up to a certain limit. If the inducing substance is 5000 to 50,000 times the activity of uranium, the induced activity may amount to fifty times that of uranium. It is reduced to one-tenth of its amount in an hour after removal, but it may persist for many days, finally disappearing. The emanation of radio-active particles from thorium compounds, investigated by Rutherford, is remarkable. This emanation ionises the gas in its neighbourhood, and it will pass through thin layers of metal, through thicknesses of paper, or through a plug of cotton wool. It is also unaffected by bubbling through hot or cold water, weak or strong sulphuric acid. The emanation retains its radio-active power for some minutes, gradually losing it. The positive ion produced in the gas by the emanation was found to possess the power of inducing radio-activity in all substances on which it fell, this power of giving radiation lasting several days. Whether the emanation be a vapour of thorium is doubtful.

The question as to the amount of energy emitted by the Becquerel rays has already been referred to in NATURE, and need not therefore occupy our space further now. The problem of discovering the seat of this energy would seem of late to have taken another form. At first it was supposed that a difficulty would exist in reconciling the continuous emission of these rays with the principle of conservation of energy; now, however, that the amount of the emitted energy has been estimated, the difficulty is seen to lie in the experimental observation of changes of such inappreciable magnitude as would suffice to generate this energy.

Before 1896 physicists were just beginning to grasp Maxwell's theories, and to realise more clearly the simplification introduced into notions electric and optical by the conception of the ether. The discovery of rays capable of discharging electrified bodies in air has not only shown the fallacy of our preconceived dogmatic notions as to the division of substances into conductors and dielectrics, but has taught us that the properties of the ether are not so simple as we had anticipated. We can only wonder whether Maxwell would have been able to develop his electromagnetic and electro-optic theories had the complications arising from Becquerel and other rays been before him, and the want now makes itself felt of a second Maxwell, who shall co-ordinate the newly-accumulated mass of experimental facts into the form of a connected mathematical theory. G. H. BRYAN.

MODERN MICROSCOPES.[1]

IN spite of the attention which has of late years been paid to the improvements of every detail of microscope construction, it is remarkable how Powell's No. 1 stand has now existed, practically unchanged, for some fifty years. It may therefore be considered a permanent type, and it is one to which the best modern instruments conform more and more. Its most obvious peculiarity, however, a tripod base, has not yet become general. The heavy horseshoe foot is still in all but universal favour on the Continent, although Powell's base is occasionally imitated. Thus the Leitz firm in 1893, and the Hartnack firm in 1898, brought out large model microscopes on a tripod base; Greenough's low-power stereoscopic binocular microscope (1898) is similarly equipped. This last instrument, which is the most recent binocular novelty, is highly esteemed. It is made by Zeiss, is fitted with porro prisms, and, among other advantages, affords views of the *under* as well as the *upper* side of an object.

English makers have lately paid much attention to the perfecting of cheaper stands with some excellent results. In their new model and educational microscope, Messrs. Ross have reintroduced the principle of a reversing and locking foot, which was first invented by Cuff (*circa* 1765). By this means the instrument acquires great stability when used horizontally. The same firm, in their bacteriological microscope, use a tripod stand, of which the hind toe is made to fold forward between the two fixed front toes when not in use, thereby economising space in packing. The stage of this, as well as of Baker's microscopes, is fitted with the Nelson horseshoe perforation. The advantage of this device is that in high-power work, when the objective necessarily works very close to the cover glass, the slide can be tilted with the finger, and the focus gradually attained with far less risk to the object than if the slide rested immovably on the stage.

Messrs. R. and J. Beck's student's microscope and Messrs. W. Watson's "Fram" microscope are other examples of really good, small, cheap microscopes. Economy is obtained, not by sacrificing quality of work, but by simplifying the design. Every step in the direction of reducing the cost of a good instrument is too obviously desirable to require demonstration. Some designs strive after cheapness by using a fine adjustment, and trusting to a push-tube motion for the coarse. But if a microscope is to have only one adjustment, most microscopists will prefer a good coarse to an indifferent fine adjustment. This is the principle of Messrs. Watson's school microscope, which has a coarse adjustment only (diagonal rack and pinion), so good that a $\frac{1}{6}$-inch objective can be accurately focussed with ease. The cost, with eye-piece and objectives, is only three pounds.

The practical difficulty is, of course, that the great amount of wear upon the coarse adjustment affects in time the evenness of the racking, and produces loose action. But an important piece of progress towards obviating this trouble has been made by Mr. E. M. Nelson, who has applied the principle of stepped rackwork (Fig. 1). The two similar racks are placed so that their teeth are slightly out of step, the amount of divergence being regulated by the upper right-hand screw. The two screws in the centre of the pinion regulate the pressure by which the pinion is forced into the rack. The advantage of the arrangement is not only compensation for wear and tear, but rapidity and smoothness of action, for the tube obeys the slightest movement of the milled heads. If experience confirms the favourable opinion with which this novelty has been received, the necessity of a fine adjustment in cheaper stands will disappear.

[1] Fuller accounts of all the instruments referred to will be found in the *Journal* of the Royal Microscopical Society for 1897, 1898, 1899 and 1900.

Another coarse adjustment improvement has been made by Herr Reichert. Its principle is a rack and pinion of specially hardened gun-metal, and a very important feature is the springing with adjusting screws for tightening up. Of these there are three: one being used for regulating the grip on the tube-mount, the others for tightening the pinion; thus the unavoidable wear and tear can be compensated for.

Fine adjustments, owing to the rigorous requirements of high-power photomicrography, have received very great attention.[1] Modern advances may, however, be reduced to some five main types: (1) the direct-acting

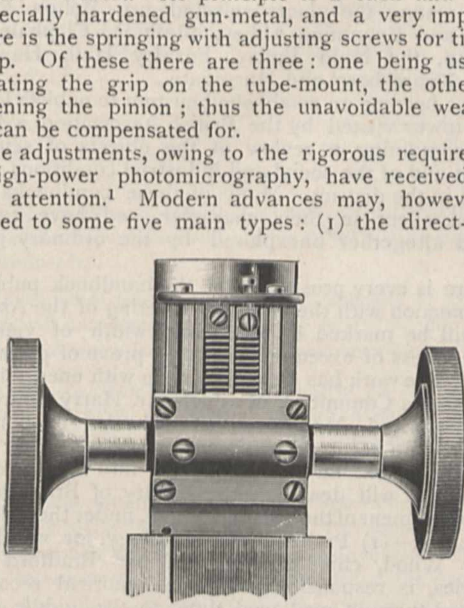

FIG. 1.

screw, (2) the same with lever interposed, (3) the differential screw, (4) Reichert's lever fine acting, (5) Berger's endless screw. The first of these is seen in the Zeiss' microscope (1886), where a left-handed micrometer screw with a hardened steel point presses on a hardened steel plate. In this, one revolution of the milled head causes a movement of 1/101 inch. The second is met with in Messrs. Watson's microscope, where a lever of the first kind with unequal arms is interposed. This arrangement not only greatly reduces the weight bearing on the fine adjustment, but slows the speed down to 1/350 inch for one revolution. This speed is not at all too slow, as any lens possessing a fair optical index is excessively

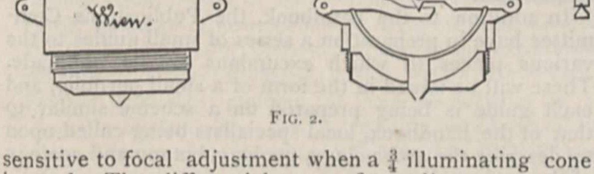

FIG. 2.

sensitive to focal adjustment when a ¾ illuminating cone is used. The differential screw fine adjustment occurs in the microscopes of Messrs. Baker and Messrs. Swift. Its advantage is that fine movements are obtained by the use of coarsely threaded screws, thus reducing the liability to wear and tear. Any degree of slowness may be obtained, but 1/200 inch is adopted by the makers. Herr Reichert's fine adjustment is especially suited to the Continental model, and consists of an ingenious adaptation of a double lever of the second order to the usual direct-acting screw (Fig. 2). It is arranged for a movement of 1/200 inch.

[1] For fuller information see "On the Evolution of the Fine Adjustment," by Mr. E. M. Nelson (*Journal* R.M.S. 1899, pp. 366–375).

Herr Berger's (Zeiss) is another great improvement in fine adjustments, and is on an entirely novel plan. The extremity of the micrometer screw comprises a horizontal toothed-wheel, which is actuated by an endless screw, terminating in the usual micrometer knobs. This arrangement permits of any degree of sensitiveness, and is ingeniously packed away in a hollow part of the limb, so that the fine adjustment is both dust-proof and out of risk from any accidental injury. A valuable feature in the contrivance is a device for preventing strain on the fine adjustment from over-winding. This particular microscope is intended for the highest class of work, and possesses another good feature, in that the arm can be made to extend to any length over the stage without increasing the pressure on the fine adjustment. Thus an error in the original design of the Continental model, viz. the shortness of the distance between the limb and the optic axis, is corrected.

In Pillischer's international microscope a serious attempt has been made to reduce the inconveniences inseparable from stage-clips. He secures these to a bar, which, by means of a flange piece, raises or lowers them *simultaneously*, so that their points press on the object slide with any desired degree of pressure.

The use of large slides has led to a corresponding increase in the size of the stage, as well as in improved stage-finders and mechanical movements. There is a marked tendency to make the stages completely rotatory.

Among special stages, that of Herr Kraus (Reichert and Co.) is perhaps the most notable. It is heated by an electric current passed through a coil of platinum immersed in the liquid paraffin with which the stage box is filled. Regulation is accomplished by an ingenious contact thermometer, a device which resembles an ordinary thermometer, except that it is open at the top end. A platinum thread can be set in the tube at any desired temperature, and, when the mercury has risen and has met this thread, an automatic arrangement switches off the supply current. If the platinum and the mercury break contact, the current re-enters. The apparatus is said to be capable of rapidly producing and sustaining a temperature constant to 0·1° C.

In the department of lenses, Messrs. Watson have brought out their holoscopic eye-pieces, in which one lens-mount slides within the other, telescope fashion, thus forming a very convenient arrangement, easily adjustable as an over-corrected or under-corrected ocular as desired. The appropriate graduations are engraved on the tube.

Messrs. Zeiss have issued, at Dr. Hartwig's suggestion, a very useful series of low-power objectives, called "planktonsearchers," which are to be immersed in a trough of water, and so used for exploring it. They are made of Jena glass, and present an image completely plane and free from astigmatism quite close up to the periphery. The microplanar series of objectives by the same firm are used for projecting micro-slides on a screen, and give a wonderfully good ten-feet picture remarkably plane, sharp and well-defined, even to the limits of the field.

Another important set of objectives is Messrs. Leitz' series of achromatics. These are made of Jena glass free from fluorite. They are so well designed and corrected that they give results but very little inferior to the best apochromatics. Their freedom from fluorite renders the risk of atmospheric deterioration insignificant. Moreover, they are sold at so low a price that Messrs. Leitz must be admitted to have outstripped all other opticians in this particular detail.

Mr. H. J. Grayson, of Melbourne, has by an unknown process produced some very fine examples of ruled test-plates, the rulings being executed in various gradations of fineness, as far as 60,000 lines per inch, and 2000 lines per millimetre. The accuracy of the work is remarkable and the mounting in realgar ($\mu = 2.5$) makes the lines stand out with a distinctness and brilliancy hitherto unknown.

The Royal Microscopical Society have, after careful consideration and after full consultation with microscope makers, drawn up a code of standard sizes for eye-pieces and sub-stage fittings. It is to be hoped that this important and useful step towards universality will be generally adopted. ALFRED N. DISNEY.

THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

THE meeting of the British Association, which is to be held in Bradford this year, promises to be an unusually large and important one. Bradford being midway between London and Edinburgh, serves as a common meeting-ground for scientific men from the south of England and from Scotland and Ireland, and it is within easy reach of the Midland and Northern University Colleges. Bradford and Leeds are so close together that for such a purpose as this they are almost one city, and the Bradford Committee, therefore, have the advantage of the Yorkshire College being practically on the spot. The last meeting of the British Association in Bradford was held in 1873, but since that time the city (which, by the way, was then only a town) has practically been re-built, and has grown and developed in a manner resembling the progress of an American rather than that of an English town.

It is, therefore, much better provided now with hotel accommodation and with public buildings suitable for reception and sectional rooms. It is probable that the number of visitors will be far above the average; already some sixty or seventy Fellows of the Royal Society have announced their intention of being present, and professors and eminent lecturers from nearly every University in England, Scotland and Ireland have promised to attend. The Church will be represented by the Bishop of Ripon, the legal profession by the Master of the Rolls and Lord McLaren, and the names of over a score of members of both Houses of Parliament have been sent in.

The meeting will commence on Wednesday, September 5, when the new President, Prof. Sir Wm. Turner, of Edinburgh, will deliver his address in St. George's Hall. On the following evening the Mayor of Bradford will give a conversazione in St. George's Hall, at which it is hoped there will be exhibits illustrating the most recent scientific work. On Friday evening the lecture will be delivered in St. George's Hall by Prof. Gotch, F.R.S., on "Animal Electricity." The lecture to artisans on the Saturday will be given by Prof. Silvanus Thompson, F.R.S., and it is expected that there will be an audience in St. George's Hall of 4000 to 5000 working men. On Monday afternoon the Mayor and Corporation will give a garden-party in Lister Park, and in the evening an address will be given by Prof. W. Stroud on "Range-Finders." The Mayor and Corporation will give another large conversazione on Tuesday evening, and on the Wednesday evening a concert will take place in St. George's Hall with the Permanent Orchestra and the Festival Choral Society, under the conductorship of Mr. Fredk. Cowan. There will also be one or two eminent vocalists.

During the week there will be a textile exhibition at the Technical College, which will illustrate the various processes of the local industries, and the machinery employed can be seen in motion. There will be a reception at the College on Thursday afternoon, September 6, and the smoking concert in honour of the President will also be given at the Technical College, after Prof. Gotch's lecture on Friday.

Excursions to places of interest in the neighbourhood will be made on Saturday, the 8th, and on Thursday, the 13th; among the places selected are Bolton Priory, Ripon and Fountains Abbey, Malham, Clapham and Ingleton, the Nidd Valley, Farnley Hall, Haworth, Ilkley, Knaresboro' and Harrogate.

It has become an established custom to publish locally in the towns visited by the British Association a handbook containing a review of the objects of scientific interest and of the social and industrial conditions which prevail in the district. Many of these handbooks have been excellent in their character, and have covered ground altogether unexplored by the ordinary guide-book.

There is every prospect that the handbook published in connection with the Bradford meeting of the Association will be marked by the same width of view and thoroughness of execution, and may prove of permanent value. The work has been taken up with energy by the Publications Committee, of which Mr. Harry Behrens is chairman, and Mr. Mortimer Wheeler is honorary secretary and editor.

The book will be divided mainly into three sections. The earlier will deal with the history of Bradford and the development of the Bradford trade, under the following sub-heads:—(1) Prehistoric archæology, for which Mr. Butler Wood, chief librarian of the Bradford Free Libraries, is responsible: (2) the historical record of Bradford through mediæval times to the middle of the 18th century, which has been undertaken by Mr. Harry Speight; and (3) the social life and development of Bradford from the middle of the 18th century to the present, which is in the hands of Mr. Halliwell Sutcliffe, the novelist. To this section there will be addenda on the local dialect, the local folklore, and the local place-names, including street-names, which will be written by Mrs. Wm. Wright (of Oxford) and Mr. Butler Wood.

The second section of the volume, of which Mr. John Bacchus is sectional editor, will deal comprehensively with the Bradford industries and institutions. The following are sub-heads:—Introductory notice and description of the staples employed in the Bradford trade; description of the processes in combing, spinning, weaving, dyeing and finishing; merchanting in the textile trade; the iron trade and machinery-making; the stone trade and minor industries; the Chamber of Commerce and the Exchange.

The third part of the book, which is under the sectional editorship of Mr. J. E. Wilson, will deal with the scientific material of the locality, the flora, fauna, geology, meteorology, climate and public health. There will be in addition a number of pages devoted to the topography of the district, for which Mr. J. H. Hastings is responsible.

In addition to the handbook, the Publications Committee have in preparation a series of small guides to the various places to which excursions are to be made. These will be issued in the form of a small portfolio, and each guide is being prepared on a scheme similar to that of the handbook, local specialists being called upon to describe the archæology, geology, botany and zoology of the various districts.

In regard to the accommodation of visitors, it is not anticipated that, in spite of the large influx of strangers, there will be any difficulty in finding comfortable quarters for everybody. Bradford is well provided with hotels, the two largest of which, the Midland and the Great Northern, can put up a great number of guests. All the available accommodation at the Royal Hotel has been secured by the local committee in order to provide for the secretaries of the different sections, who, of recent years, have been in the habit of lodging together. A large amount of private hospitality will be provided by the inhabitants of Bradford, and the Hospitality Committee is also drawing up a list of furnished apartments, which can be had on application. It is important, however, that all persons proposing to attend the meeting should give a long notice of their intention, in order to facilitate the arrangements which the Committee wish to make for their comfort. RAMSDEN BACCHUS.

NOTES.

A CONFERENCE of delegates for the International Catalogue of Scientific Papers was held at the Royal Society on Tuesday and Wednesday.

THE second of the two soirées held annually at the Royal Society will take place on Wednesday next, June 20. This is the soirée to which ladies as well as gentlemen are invited.

MR. C. E. BORCHGREVINK will give an account of his Antarctic work at the meeting of the Royal Geographical Society on Monday, June 25, instead of June 18, as previously announced.

THE annual visitation of the Royal Observatory, Greenwich, will take place on Tuesday, June 26. The visitation has previously been held on the first Saturday in June, and the change of the customary date is due to the absence of the Astronomer Royal, and other astronomers, for the purpose of observing the solar eclipse. This does not, however, explain the change of day.

ON the occasion of the retirement of Sir Frederick Bramwell from the office of honorary secretary of the Royal Institution, the managers of the Institution unanimously resolved "to place on permanent record an expression of their high appreciation of the admirable way in which he has performed the duties of that office and of his signal services to the Institution generally."

THE death is announced of Dr. Julius Althaus, the distinguished physician and neurologist. He was the author of works on "Diseases of the Nervous System," "Failure of Brain Power," "Diseases of the Spinal Cord," "Medical Electricity," "Influenza" and "The Spas of Europe," and was an authority upon the use of electricity in medical practice.

THE next lecture of the Zoological Society of London will be delivered at the Society's Meeting Room, on Thursday, June 21, at 4.30 p.m., by Prof. E. Ray Lankester, F.R.S. The subject will be the gigantic sloths of Patagonia.

AT the last meeting of the Royal Society of Edinburgh, the following were elected as British Honorary Fellows:—Dr. Edward Caird, Master of Balliol College, Oxford; Dr. David Ferrier, professor of neuro-pathology, King's College, London; Dr. G. F. Fitzgerald, professor of natural and experimental philosophy, Trinity College, Dublin; Dr. Andrew Russell Forsyth, Sadlerian professor of pure mathematics in the University of Cambridge; Dr. Archibald Liversidge, professor of chemistry in the University of Sydney; Dr. T. E. Thorpe, principal of the Government Laboratories, London; and, as Foreign Honorary Fellows:—Dr. Arthur Auwers, secretary, Royal Prussian Academy of Sciences; Prof. Wilhelm His, Leipzig; and Prof. Adolf Ritter von Baeyer, Munich.

THE celebration of the centenary of the Royal College of Surgeons of England will commence on July 25 with a conversazione at the College. On Thursday, July 26, a centenary meeting will be held at the University of London, when an address will be delivered by the president, Sir William MacCormac, and honorary fellowships will be conferred. On Friday, July 27, there will be a conversazione at the Mansion House. The Committee have issued invitations to foreign and colonial surgeons, and propose to issue invitations to certain persons of distinction residing in Great Britain and Ireland. A short history of the College, with eight illustrations, has been prepared, and will be presented to guests invited to the centenary celebrations.

THE new clinical laboratories of Westminster Hospital were opened by Lord Lister on Tuesday, in the presence of a distinguished company. The laboratories have been added to the hospital to provide for a more scientific and systematic examination of disease than can be carried out satisfactorily in the wards. A few particulars concerning the work of the hospital were given by Sir J. Wolfe-Barry, K.C.B., and are reported in the *Times*. Westminster Hospital was, he said, one of the oldest hospitals in London, having been founded in 1719. 30,000*l*. had been spent in bringing the hospital up to modern requirements, and in 1899 it was decided to add clinical laboratories and improve the isolation wards and nursing accommodation. In time they hoped to institute an electrical laboratory fitted with the apparatus for the Röntgen rays and micro-photography. To meet these expenses 10,000*l*. was wanted.—Dr. Lazarus-Barlow, in giving a detailed account of the laboratories, said the hospital tried to keep in front of all research and modern improvements, scientific and clinical. The laboratories contained all the most recent apparatus for the clinical work of the hospital.—Lord Lister said it was no less a pleasure than an honour to him to take part in that day's ceremony. The beautiful clinical laboratories they had inspected would give the physicians of the hospital an opportunity of bringing to bear on their cases the most advanced knowledge and the most refined methods of investigation. Many a diagnosis which would otherwise be obscure would be rendered clear in those rooms. He need hardly say that the correct diagnosis was directly proportioned to successful treatment. In respect of what Sir J. Wolfe-Barry had said, he himself felt convinced that those who had worked in the laboratories would not only benefit patients in the hospital, but would also, unfailingly, be able to extend the boundaries of knowledge and promote the now rapid advance of pathological and therapeutic knowledge. The laboratories would also be of service as a powerful means of affording sound practical knowledge to the student.

DURING the early part of the present week a wave of unusual heat has passed over parts of England, accompanied by brilliant sunshine. In the neighbourhood of London, the shade thermometer rose to 89 on Monday, the 11th inst., and thunderstorms occurred over several parts with heavy rainfall, amounting to an inch in the Midland Counties. So high a temperature has not occurred at so early a period of the summer in the neighbourhood of London for more than fifty years. A sharp thunderstorm also visited London about 10 a.m. on Tuesday, and another occurred in the evening; there was also a renewal of severe thunderstorms over a large part of England. The temperature on Wednesday was considerably lower than on the preceding days.

FROM St. Petersburg to Vladivostok by way of the Arctic Ocean is (says the *National Geographic Magazine*) the plan of itinerary of an exploring party that early in June leaves the former city on the steamer *Aurora*. Six men of science and twelve sailors, all experienced in Arctic travel and led by Baron Toll, make up the party. Their special object is the careful exploration of the Arctic regions north of Siberia. After a brief stop at Tromsö, Norway, and at the new Russian port of Catherine Harbour, on the Lapland coast, they will proceed to the Taimur Peninsula, west of the Yenisei River, and there establish their winter headquarters. The neighbouring territory is to be explored during the winter of 1900–1901. On the breaking up of the ice, about August 1901, it is proposed to push on to Sannikoff Land, discovered by Baron Toll in 1886 and as yet unexplored, and later farther northward to Bennett and De Long Islands, following the routes of the *Jeannette* in 1881 and of the *Fram*. The winter of 1901–1902 will be devoted to determining whether this group of islands extends to the Pole. When the water route reopens in 1902 they will resume their voyage to Bering Strait and reach Vladivostok in the autumn of the same year.

THE application of science to the great problem of mechanical traction is revealing the fact that at no distant date the motor car, or automobile, will be regarded a decided success in every respect. Electricity, steam and oil are still fighting for the paramount position of best agent for propulsion, and, on this account, trials and experiments always prove of interest. The *Engineer* (May 25) describes a series of trials for touring vehicles at the Paris Exhibition, and out of thirty-seven cars competing we find that three were driven by steam, and all the remainder propelled by petroleum motors. Among the more recent improvements on the heavier classes are smaller driving wheels; the motor still develops about six horse-power for cars carrying four or six passengers, their lower centre of gravity, owing to their smaller wheels, also proving an advantage when rounding corners at high speed. After exhaustive trials embracing distance, manipulation, grades, &c., medals were awarded to the makers of the following vehicles: the "Peugot" car, the "Delahaye" car, the "De Dietrich" car, and the "Panhard et Levasser" wagonette. All these are driven by petrol motors; for this kind of work, therefore, petrol stands in good stead, and it will be of interest to see whether this agent or steam is adopted for freight vehicles of a much heavier description.

THOUGH the articles upon scientific subjects in popular magazines can often only be called scientific by courtesy, yet we like to think that their presence in increasing numbers indicates a growth of public interest in the progress of science. *Pearson's Magazine* usually contains contributions which are instructive as well as interesting; and the reader who is no longer thrilled by episodes in the lives of freebooters, mysterious knights and similar personages over whom the glamour of the past may be thrown, must find relief by turning to the articles in which imagination is tempered with truth. In the June number of the magazine, we find an account of the destruction of the jack rabbit of the United States, by driving them into a corral, as described and illustrated in NATURE several years ago. M. Flammarion's experiments on the growth of plants under different coloured glasses, also described in these columns, form the subject of another interesting article. Mr. George Griffith concludes his story of imaginary visits to other worlds by means of a machine moved by a force with peculiar properties. If we may venture a criticism of this series of contributions, it is that Mr. Griffith's ideas are too anthropomorphic, and too limited by the present state of knowledge of the objects visited by his interplanetary travellers. Some of the work of the U.S. Fish Commission in pisciculture forms the subject of a short illustrated article; and an interview with Prof. Milne, illustrated by several seismograms, contains much interesting popular information upon earthquake waves. Finally, a number of reproductions of photographs of faces of athletes at the moment of victory are reproduced. The photographs are interesting to students of facial expressions, and a curious point revealed by them is that only in one case of the hundreds of photographs from which the selection was made is a pleasant expression upon the face of the winner.

A NOVEL way of making building land is being carried out not far from New York. The rapidly growing population of this city has made ground scarce on which to build villas and houses for the summer resort of the inhabitants; but the enterprise of the American builder is equal to the emergency, and land is now being literally pumped up from the sea, on which it is intended to erect houses, and to create a new suburb. The site chosen for this venture is the Nassau Beach, on the shore of Jamaica Bay, in Long Island, not far from Brooklyn. The salt marshes bordering on this coast, which for centuries have been overflowed by the tides, and which, of course, while in this condition were utterly unfit for building purposes, are being raised from four to six feet above high water by pumping up the sand, shells and gravel which form the floor of the bay, and delivering this on to the land to be reclaimed. The process adopted to attain this end is as follows:—A powerful suction dredger raises the material from the bed of the bay at the rate of 18,000 cubic yards a day, and with this five times the volume of water, which is sufficient to carry the sand and gravel along the twelve-inch pipes which deliver it on the low land. The water flows off by ditches along a more or less circuitous route back to the bay, the dredged material settling and quickly drying, and forming solid land. The thickness of the material when first deposited averages about eight feet, but there is shrinkage as it dries and consolidates. Ten acres have thus been raised since the pumping began a few months ago. A raised road and promenade two miles long and seventy feet wide, and an electric railway, will connect this new suburb with the railway to Brooklyn and New York.

WE have received the first numbers of the *Boletim Mensal* of the Rio de Janeiro Observatory. The work contains much useful information, chiefly contributed by Sr. L. Cruls, the able director of the Observatory, and it will form a welcome addition to current meteorological literature. As long ago as 1887, Sr. Cruls issued a large number of circulars to all meteorological organisations with the object of collecting data for a climatological dictionary. For want of adequate resources, this valuable compilation has not been published; but we are glad to see that he intends to utilise the bulletin for the publication of some of the principal results. The number for February contains the annual means and extremes for twenty-nine stations in Japan. Another paper worthy of special note is that by Sr. Pereira da Costa on the earliest observations made in Brazil.

READERS of Mr. Fitzpatrick's "Transvaal from Within" will recollect his reference in an appendix to a discussion which took place in President Krüger's Volksraad on the wickedness of firing guns in order to bring down rain. We learn from the *Corriere della Sera* that the practice of firing cannon as a preventive of hail has been adopted lately in Italy with successful results. On May 25, at about 17 o'clock or 5 p.m., three successive storms collected in the neighbourhood of Rogeno (Como), the clouds of which were evidently charged with hail. At a given signal fourteen cannon opened fire on the clouds, with the result that nothing fell except a little sleet, here and there. On the same day a vast amount of damage was done in the vicinity of Alessandria by hailstorms passing over the districts of Rocchetta, Tanaro, Masio, Felizzano and Quattordio about 16 o'clock (4 p.m), the hailstones in some places massing to a depth of 50 cm. In the districts where cannon were adopted for dispersing the hail, the results exceeded all expectations; while in many parts of the district where this precaution was not taken the vineyards were completely destroyed

ACTUARIAL experience is of distinct value in connection with the application of the statistical method to biological problems; therefore it is of interest to learn from the annual report of the Institute of Actuaries that the mortality investigation, which is being conducted jointly by the Institute and the Faculty of Actuaries, has made material progress under the honorary supervision of Mr. T. G. Ackland. The volume containing the unadjusted data of the annuity experience has already been published. It has been decided to include in one volume the unadjusted data relating to endowment assurances and minor classes of assurance (male and female); and the council report that this volume, forming a second of these series, is now completed, and on the eve of publication. The extensive tables comprising the unadjusted data for whole-life assurances (male lives), are in the printer's hands, and will, when ready, form a third volume of the series. These will be followed, so far as the unadjusted data are concerned, by a fourth and final volume, which will contain the experience of whole-life assurances (female lives). The tables to be included in this final volume are finished, and are in course of being copied for the printer.

WE learn from *Science* that the University of Illinois has fallen heir to the Bolter Collection of Insects. The collection numbers approximately fifteen thousand species, represented by about seventy thousand specimens, besides thirty thousand duplicates not in the systematic collection. This collection, accumulated during the last fifty years by the late Andreas Bolter, is remarkable for the excellence of the material and for the exquisite care with which it has been prepared and arranged. It represents all orders of insects and North America in general, and contains also a considerable amount of exotic material. The gift was made by the executors of Mr. Bolter, in accordance with the terms of his will, conditional upon its maintenance as a unit, under the name of the "Bolter Collection of Insects," in a fire-proof building.

IN the *Irish Naturalist* for June, Prof. R. J. Anderson endeavours to account for the circumstance that in certain breeds of domesticated fowls the keel of the breastbone is crooked. It is somewhat curious to find that these crooked keels occur only in pure bred birds, the ordinary barndoor fowls having the keel straight. After consulting with a number of poultry breeders, the author comes to the conclusion that in-and-in breeding, the nature of the perches, the season, early hatching, defective food and cold may all contribute to the production of the abnormal condition.

IN the Christiania *Nyt Magazin for Naturvidenskaberne*, vol. xxxviii. Pt. 1, Dr. G. Guldberg publishes some observations on the body-temperature of the Cetacea, in which he shows how extremely imperfect is our knowledge of this subject. As he remarks, it is a matter of extreme difficulty to obtain the temperature of living Cetaceans, although this has been taken in the case of a white whale and a dolphin, which some years ago were kept in confinement in a pond in the United States. With the larger whales such a mode of procedure is, however, obviously quite impracticable, and we have accordingly to rely on *post-mortem* observations. The layer of blubber by which all Cetaceans are protected from cold renders the *post-mortem* refrigeration of the blood a much slower process than in most mammals, so that such observations have a much higher value than might at first be supposed to be the case. Indeed, the blood-temperature of a specimen of Sibbald's rorqual three days after death still stood at 34° C. The various observations that have been taken have afforded the following results in *individual cases*:—Sperm-whale, 40° C.; Greenland right whale, 38·8° C.; porpoise, 35·6° C., liver of a second individual, 37·8° C.; common rorqual, 35·4° C.; dolphin, 35·6° C. The average blood-temperature of man is 37° C., and that of other mammals 39° C.; while that of birds is 42° C. The record of 40° C. in the case of the sperm-whale seems to indicate that at least some Cetaceans have a relatively high temperature.

PROF. F. E. NIPHER, in a communication to the Academy of Science of St. Louis, has recently described some experiments that he has made in photographic "reversal," one of his aims apparently being to find a useful method of manipulating photographic plates without the need for the exclusion of light from them. The advantage of such a method is obvious when the experiments incur the possibility of light being accidentally produced, as in electrical work. He exposes the plates to light for a few days before use—"to the light of an ordinary room." The other descriptions of exposures are also vague, the time being given, for example, of camera exposures, but with no record of the lens aperture or indication of the character of the light. It is, therefore, not possible to follow the experiments described in other than a qualitative way. Prof. Nipher has taken street views, Röntgen ray photographs, and "electrographs," on plates that have received preliminary exposures, and developed them by the light, for example, of a sixteen candle-power incandescent lamp, at a distance of from about 1 to 5 feet. The exposure on the object was, in one case, about forty times the exposure that would have been required for making an ordinary negative; the over-exposed and pre-exposed plate giving, of course, a positive image. A good deal of work has already been done in this direction, but the uncertainty of the reversal, and the great difficulty of getting rid of mixed results of reversal and non-reversal, have so far prevented any practical use being made of the possibilities of these methods.

SUCH experiments as Prof. Nipher describes are interesting qualitatively, but before any process of the kind can be safely recommended for general use in cases where it might be advantageous, it will be necessary to determine the range of conditions that can be relied on to give simple, that is, unmixed results, and this can never be done by working with such objects and processes as are described in this communication. We would suggest the use of a series of graduated exposures, with a measurement of the opacities produced, and then the ordinary negative image and the reversed image could both be traced. The character of the reversed image could be judged of, and the range of exposures through which its production could be relied upon could be determined. Until some definite information of this kind is available, experiments in reversal will remain more curious than useful. It appears from Prof. Nipher's communication that he is still pursuing the subject, and we hope that he will succeed in placing the method on a firm foundation.

IN a paper in the *Berichte* of the German Chemical Society, Herr G. Kramer and Herr A. Spilker make the suggestion that an important source of petroleum beds may be the oil which is always diffused through the protoplasm of diatoms.

THE Report of the Botanical Exchange Club of the British Isles for 1898 has just been issued under the editorship of Mr. James Groves. The occurrence of *Stachys alpina* in Gloucestershire is regarded as an undoubted addition to the native flora of Great Britain.

WE have received a prospectus of the "Scientific Roll and Magazine of Systematized Notes," to consist of three volumes of about 500 pages each, which will be supplied to subscribers for 10*s*. per volume, at the rate of one volume a year, commencing in September 1900. The first part will be devoted to the literature of the Schizomycetes. The compiler is Mr. A. Ramsay, of 4, Cowper Road, Acton.

THE Annual Report of the Royal Botanic Gardens, Trinidad, for the year 1899, by the superintendent, M. J. H. Hart, gives evidence of work done in the Gardens in connection with the acclimatisation of foreign economical plants, and the study of diseases of fruits and other crops, with the assistance of the Kew establishment. The *Bulletin of Miscellaneous Information*, from the same Gardens for April, contains, in addition to some natural history notes, a continuation of the descriptive list of West India and Guiana ferns.

A SHORT obituary notice of the late Franz Ritter von Hauer appeared in NATURE for April 13, 1899. A full account of the life and labours of this distinguished geologist has now been published by Dr. E. Tietze (*Jahrb. k.k. geol. Reichs.* Wien, Bd. 49). It is accompanied by a portrait, and by a list of geological papers and books dating from 1846 to 1897.

MESSRS. WILLIAMS AND NORGATE have just published a sixth revised edition of "Prehistoric Times as illustrated by Ancient Remains and the Manners and Customs of Modern Savages," by Lord Avebury (Sir John Lubbock). The first edition was published more than thirty-five years ago.

PROF. PRANTL'S "Lehrbuch der Botanik," upon which Prof. Sydney Vines' "Students' Text-book of Botany" is based, has reached an eleventh edition. The new edition has been revised and enlarged by Dr. Ferdinand Pax, professor of botany, and director of the Botanical Gardens, at Breslau. Mr. W. Englemann, Leipzig, is the publisher.

PROF. VIVIAN B. LEWES has in the press an exhaustive work on acetylene gas—a handbook for the student and manufacturer. The book will contain over 250 illustrations, and comprises a history of acetylene, its preparation, properties and chemical reactions, together with a complete list of legal enactments in full concerning its manufacture, patents, and other important data. Messrs. Archibald Constable and Co. are the publishers.

TWO publications of interest to botanists will be issued from the Clarendon Press before long—the first part of the authorised English edition by Prof. J. B. Balfour of Dr. K. Goebel's "Organography of Plants," and Dr. A. Coppen Jones's translation of Prof. Alfred Fischer's "Structure and Functions of Bacteria." The former brings within reach of English students the only book of recent years upon its special subject; the latter is the only work on bacteriology of similar scope and mode of treatment that has appeared in England since Dr. A. de Bary's "Lectures on Bacteria," a second edition of which appeared in 1887. This translation of Prof. Fischer's "Vorlesungen über Bakterien" should be welcome in pathological laboratories.

THE Orient Company announce that the cruise to Norway, Spitsbergen and Iceland will be repeated this summer. Their steamship *Cuzco*, 3912 tons register, is appointed to leave London on July 3, and to arrive back on August 4. After visiting some of the most interesting Norwegian fiords, the *Cuzco* will proceed to Spitsbergen, thus affording an opportunity of viewing the midnight sun, as for five days and nights after the ship leaves the North Cape the sun will be continuously above the horizon. Thereafter the *Cuzco* will proceed to Iceland, and her contemplated stay there of three days will enable passengers to see some of the most interesting sights in this remote island. The Faroe Islands will also be visited on the way back to London, *viâ* Leith.

THE purification of mercury is frequently necessary in physical and physico-chemical work, the process generally relied upon being distillation *in vacuo*. The apparatus in general use for this purpose, although convenient, has the disadvantage of being somewhat fragile, and requires large quantities of mercury. Some doubts, moreover, have been thrown on the efficacy of distillation as a purifying process, as Victor Meyer, in 1887, showed that traces of foreign metals passed over even after repeated redistillations. According to G. A. Hulett (*Zeitschrift für physikalische Chemie*, xxxiii. p. 611), these traces of foreign metals are carried over mechanically during the bumping of the boiling mercury; and if measures are taken to prevent this bumping, perfectly pure mercury can be obtained in one distillation. Instead of the complicated apparatus of Weinhold, or its various modifications, a slight modification of the arrangement of two distilling flasks, with a capillary tube for admitting air, as commonly employed in organic work, was found to work perfectly.

PROF. RICHARDS, of Harvard, continuing his valuable redetermination of atomic weights, has lately published, in conjunction with Mr. G. P. Baxter, a preliminary paper on the atomic weight of iron. He points out that the value Fe = 56, which is now used, is practically based on work of fifty years since—being Wackenroder's corrected value of Berzelius' result, which was based upon the conversion of metallic iron into ferric oxide. In their preliminary determinations, Messrs. Richards and Baxter have reduced ferric oxide to the metal. The ferric oxide was prepared in the first case from ferric hydrate, which itself was prepared with elaborate precautions from very pure iron ribbon. The mean of two closely agreeing determinations gave Fe = 55·900. In the second case, ferric oxide was prepared with equal care from ferric nitrate. The mean value of five determinations gave Fe = 55·883. Further determinations are promised, but meanwhile the higher value of the older number (Fe = 56) is explained as probably due to one or more of the following causes:—The possible presence of magnetic oxide in the ferric oxide; the possibility of incomplete reduction during the analysis of the substance; the possible presence of alkaline, siliceous or other non-reducible material. At the present stage of the work 55·88 may be taken as the most probable value.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*) from British Central Africa, presented by Mr. C. H. Ambruster; a Barbary Ape (*Macacus inuus*) from Algeria, presented by Mr. R. S. Allen; a Large Red Flying Squirrel (*Pteromys inornatus*) from Northern India, presented by Mr. A. Dudley Yorke; three Goshawks (*Astur palumbarius*), European, presented by Mr. John Simonds; a Little Egret (*Ardea garzetta*) from North-west Africa, presented by Mr. J. H. Yates; an Allen's Porphyrio (*Hydrornia alleni*), captured at sea, presented by Miss Wallace; a West African Python (*Python sebae*) from West Africa, presented by Francis E. Colenso; a Green Lizard (*Lacerta viridis*), European, presented by Miss Mabel A. Heaton; a Common Snake (*Tropidonotus natrix*), British; two Mocassin Snakes (*Tropidonotus fasciatus*) from North America, presented by Mr. W. H. St. Quintin; a Lion (*Felis leo*, ♂) from Kattiwar; a Nylghaie (*Boselaphus tragocamelus*, ♂), two Four-horned Antelopes (*Tetraceros quadricornis*), three Indian Gazelles (*Gazella bennetti*) from India; four Bearded Lizards (*Amphilolurus barbatus*), two Stump-tailed Skinks (*Trachysaurus rugosus*) from Australia, five American Box Tortoises (*Cistudo carolina*), six Stink-pot Mud Terrapins (*Cinosternum odoratum*) from North America, deposited; a Rocky Mountain Goat (*Haploceros montana*, ♂) from British Colombia, two Cunning Bassaris (*Bassaris astuta*) from Mexico, five Gentoo Penguins (*Pygosceles taeniatus*) from the Falkland Islands, a Three-toed Sloth (*Bradypus tridactylus*) from British Guiana, purchased; two Japanese Deer (*Cervus sika*), a Burchell's Zebra (*Equus burchelli*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ROTATION PERIOD OF VENUS.—In the *Astronomische Nachrichten* (Bd. 152, No. 3641), Prof. A. Belopolsky gives the detailed measurements of the photographs of the spectrum of Venus taken during the recent favourable disposition, from which he has been enabled to confirm the short rotation period of the planet.

The spectrograms have been made with the 30-inch refractor at the Observatory of Pulkowa, using two different spectrographs, one of which was provided with two simple prisms, the other having three compound prisms. The spectra being obtained, the inclination of the spectral lines and the difference of wave-length of the light coming from the two opposite equatorial limbs of the planet is measured, and after corrections being applied for the inclination of the planet's equator to the line of sight, the resulting displacement indicates the equatorial velocity. As the light from the planet is reflected sunlight, the value measured is, of course, double the actual velocity.

The complete measures from fourteen plates taken with the two-prism spectrograph, and from five obtained with the instrument furnished with three compound prisms, are given. The values adopted are the means of measurements of from six to sixteen spectrum lines on each plate.

The photographs were obtained on the evenings of March 25, 30; April 4, 6, 7, 8, 10, 11, 20, 28; May 4, 5, 13, with exposures varying from 7m. to 60m. The angular diameter of the planet varied from 8"·6 to 11"·0. With the 30-inch refractor, of about 40 feet focal length, the linear diameter at the principal focus was 1·2 mm., and this was further reduced by the relative foci of collimator and camera objectives to 0·8 mm. on the photographic plate.

From the difficulty of the determination it is to be expected that the several means should vary for the different plates; but the extreme values given still prove the short rotation period. Taking the diameter of Venus to be 12,700 km., the values of the equatorial velocity (v) are as follows, the corresponding time of rotation (T) being placed under each:—

$v=$	0·7	0·5	0·462	0·45	0·3 km. per sec.
T=	15·9	22·1	24·0	24·6	37·0 hours.

The author expresses the hope that the astronomers having the control of the large telescopes at the Potsdam, Lick and Yerkes Observatories will repeat his observations for confirmation or revision.

NEW VARIABLE IN AURIGA.—Dr. T. D. Anderson, of Edinburgh, announces in the *Astronomische Nachrichten* (Bd. 152 No. 3642), the detection of a new variable star in Auriga. It is not charted in the B.D., and has the following position:—

$$\left.\begin{array}{l}\text{R.A.} = 6\text{h } 0·9\text{m.}\\ \text{Decl.} = +50^\circ\ 14'\end{array}\right\}(1855·0)$$

The changes in brightness during April and May 1900 were from 8·3 to 8·8 magnitude.

PHOTOGRAPHIC OBSERVATIONS OF SATELLITE OF NEPTUNE.—In the *Astronomische Nachrichten* (Bd. 152 No. 3642), M. S. Kostinsky gives the particulars relating to a series of determinations of the satellite of Neptune, obtained from measures of photographs taken with a telescope of 13 inches aperture at Pulkowa. Many of the difficulties encountered in the photographic delineation of two neighbouring objects of very different brightness have been previously discussed by the author (*Bull. de l'Acad. Impér. des Sc. St. Pétersbourg*, vol. vii. November 1897). In the present case of Neptune the problem is rendered slightly less difficult by the feeble brightness of the planet and the slow movement of the satellite.

The photographs described were obtained during the period 1899 February 4–March 25, the plates having exposures varying from 20m. to 60m. A table giving the corresponding calculated and observed values shows the method to be very accurate.

SOME NOTES ON THE LATE PROF. PIAZZI SMYTH'S WORK IN SPECTROSCOPY.

LAMENTING, as we must do, that time has stolen from us a mighty Ajax in the field of science, a sturdy, patient Atlas who through more than half of this fast waning century robustly upheld on his strong shoulders the growing spires and architraves of science's ever-increasing edifice, it is with keenest sorrow that the writer of these notes turns over the ample pages, rich to profusion in details and superb in colour, of the monumental works of spectroscopy left to us by the late Prof. C. Piazzi Smyth, with the nearly hopeless intention of endeavouring to give a short account of some of his most conspicuously important contributions to that branch of science. The late Prof. Smyth was, indeed, no *dilettante* in the intricate and difficult but fertile and alluring byways of science to which his leisure moments were devoted; and he was far from conceitedly or affectedly pedantic in the grasp of science which he brought to bear upon his philosophical investigations. Although these embraced a range of astronomical and meteorological subjects which would singly engage all the energies of most men, and their whole lifetimes to study with success, yet his mastery of the state of science in the questions which he set himself to solve or to explore, was acquired with so much inventive skill, unsparing pains and ardour, as always to make the character of the work which he accomplished in them permanent and thorough. Well accustomed as he was from his youth, and trained from boyhood,[1] to delicate telescopic, angular and micrometrical measurements by eye and hand, he further possessed a gift of great artistic skill in committing to paper, canvas, and even to frescoes, beautiful drawings, photographs and coloured paintings of the scenes of travel which he witnessed, and of sights which clouds, the heavens, or his laboratory experiments disclosed to him. This accomplishment, well illustrated, long ago, by his publication in the Edinburgh *Philosophical Transactions* (vol. xx. pt. iii.) of a scene of darkness on the coast of Norway, near Bergen, during the Total Solar Eclipse of July 1851, contributed again in colours from his original, carefully kept paintings of the scene, together with a similar view of the Zodiacal Light as seen at Palermo in April 1872, to a new illustrated work on astronomy published by Messrs. Cassell and Co. in 1894, led him to leave to others the study of the actinic spectrum-regions with the aid of photography, and to restrict his spectrum-measurements entirely to all that could be seen and measured by the eye alone, of the solar spectrum, or of the characteristic features of gaseous bright-line spectra, in the whole visible portion of the spectrum only.

In his keen perception of all the grand sublimities of law and order by which Nature's works are everywhere controlled and guided and sustained, and in the constant intentness of his mind to seek out these nature's workings, and to promulgate lucidly and clearly his own perceptions and interpretations of them, Kirchhoff's great discovery, in 1859, that the chemical constitution of the sun could be read in its light's prismatic spectrum, constrained him like a spell, as it quickly did many other physicists, to devote much of his leisure time and abilities to spectro-chemical researches. New striking truths were taught in 1860–61 by Sir William Huggins' not less surprising discovery from observations of their spectra, of the gaseous conditions of certain nebulæ, and by Sir David Brewster's and Dr. J. H. Gladstone's majestically mapped separation from the really solar dark lines in the sun's spectrum, of its low-sun, or terrestrial atmospheric lines, soon afterwards distinguished by Secchi, Ångström and the first detector of the "rain-band" near solar D, in America, Dr. J. P. Cooke, and especially by Dr. Janssen's observations among the high Alps of Switzerland and experiments with a long steam-tube in Paris, in 1866–7, into "aqueous-vapour" and "dry-air" telluric lines. Kirchhoff's and Hofmann's first chemical investigation of the solar spectrum was rapidly extended in the years from 1859 to 1868, with tables of metallic and other elementary line-spectra by Huggins and Miller, Mascart, Plücker, Ditscheiner, Van der Willigen, Thalen, Lockyer and others, into a wonderfully novel panorama field of spectrum-analysis, chiefly applicable at first to celestial chemistry and physics, but in such skilled hands as those of Bunsen, Crookes, Reich and Richter, and later of Lecoq de Boisbaudran and other able chemists, to the discovery also of new terrestrial elements. The appearance at Upsala, in 1868, of Ångström and Thalen's classically accurate and chemically expounded "Normal Solar Spectrum" map, with its line-places in a natural diffraction-spectrum order of wave-length progression reckoned in "tenth-metres," or $(10)^{10}$th parts of a metre as scale-units of wave-length,[2] and the detection with spectroscopes in the total solar eclipse of the same year in India, of the hydrogen-flame nature of the sun's red prominences, seen in full sunshine there by Dr. Janssen and almost simultaneously also by Sir J. N. Lockyer in England, afforded to the new

[1] Under Sir Thomas Maclear's care, in 1836, at the age of seventeen; at the famous Observatory at the Cape of Good Hope, where, during the last three years, the presence of oxygen was discovered by its line-spectrum in certain southern stars by the indefatigable English amateur astronomer, Mr. F. Maclean; and where both that discovery and another by Sir J. N. Lockyer of the presence of silicium in the same stars, have been confirmed, and made independently by its energetic Director, Sir David Gill, with a noble spectrophotographic 24-inch refracting telescope presented to the Observatory under his own directions and liberal care for its completeness by the same munificent explorer of stellar spectra in the northern and the southern heavens, Mr. Frank Maclean.

[2] It has now become a common usage in spectroscopy, microscopy and molecular physics, to reckon such small quantities as light wave-lengths in a tenfold larger unit than the Ångström one, denoting it by "$\mu\mu$," the thousandth part of "μ," the thousandth part of a millimetre, "mm."

study of spectroscopy at once a sound philosophic basis for spectrum-definitions, and a new territory of interesting astronomical investigations in the sun's glowing atmosphere, upon which it was not remiss or slow to grow up in strength and stature, expanding itself largely in new observational, practical and theoretical directions, in the next following interval of ten or fifteen years.

From the graphic mementos which he kept, as we have seen, of the total solar eclipse of 1851, and from his successful attempts, described in 1858 in his well-known and most attractively illustrated volume on Teneriffe, to prove by visits (in that year, and again in 1868) to the Island and Peak of Teneriffe, the practical benefit to be obtained in astronomical observations, of avoiding in great part the atmosphere's absorbing action on the light of stars and planets by establishing observatories on mountain heights, it cannot be doubted that these discoveries with spectroscopes concerning the bright, ruddy light-flakes seen round the sun, or round the moon's disc when the sun is totally eclipsed, and regarding the particular rays of the sun's light which undergo absorption in the earth's atmosphere, would, as important contributions to our extremely circumscribed knowledge of the materials and physical conditions of planetary and stellar atmospheres, greatly impress and interest him.

In the preface of his "Spectre Normale du Soleil," Ångström pointed out that the spectrum of the aurora, as he had frequently observed it in the winter months of 1867-8, consisted almost entirely, as Dr. O. Struve at Pulkova, on hearing from Prof. Ångström of this discovery also confirmed it in May 1868, and as Prof. Ångström had previously found to be the case with the spectrum of very bright appearances of the zodiacal light at Upsala in March 1867, of a nearly solitary bright yellow line. Many exact corroborations of this line's conspicuousness, and detections of several less constant bright and faint auroral lines were thereupon made by observers of a series of fine red auroras which at the time of the marked maximum of sunspot frequency in 1870 appeared during the years from 1869 to 1871. A paper recommending Prof. Swan's well-known blue gas-flame, or blow-pipe flame spectrum with its five well-determined line or band-edge positions as a most suitable one for reference in mapping auroral spectra, was sent in 1870 by the late Prof. Piazzi Smyth to the Royal Astronomical Society in London; but owing to his describing the flame-spectrum as Prof. Swan had done in 1856, and as did also Ångström in the introduction to his "Solar Spectrum Atlas" in 1868, as the spectrum of hydrocarbons, or of acetylene, it remained unpublished on account of the doubtfully correct chemical apellation given in the paper to this important set of spectrum-bands. Yet the same chemical origin, describing it as probably that of acetylene, was attributed to this spectrum both by Profs. Liveing and Dewar at Cambridge, and by Ångström and Thalen in their "Spectres des Metalloïdes" at Upsala, in 1875; and Prof. Smyth never felt induced to resign the view which he held in such good company, by the contrary opinion steadfastly maintained by many not less skilled and experienced and at least as chemically well versed spectroscopists, that the blue candle-flame's spectrum of delicately fluted bands was not really due to any chemical compound of carbon with other elements, but to carbon itself in one of the modes of molecular aggregation into which, like the materials of some other metalloids at least, the substance of carbon in its volatilised state is liable, by temperature or by some sufficient chemical or electrical powers of dissociation to be broken up.

Another very similar band-spectrum to the Bunsen-flame one, agreeing in the positions of its two brightest (citron and green) band-edges pretty closely with two corresponding bright band-edges of the latter spectrum, but differing from it throughout in its more numerous remaining bands' positions, and with all its bands evenly shaded, instead of (as in the other spectrum) both fluted and shaded off towards the blue direction, only too often seen mingling with the latter spectrum to some extent in nearly all electrically excited vacuum-tubes, can be very readily produced in its natural purity with ordinary induction-sparks in carbon oxide or di-oxide vacuum-tubes; and it was described on that account, in their "Spectres des Metalloïdes" in 1875, by Ångström and Thalen, and after some hesitation about its possible chemical nature in his first paper on "Gaseous Spectra in Vacuum-tubes under Small Dispersion" in 1880,[1] it was afterwards regarded also by the late Prof. Piazzi Smyth as belonging to carbonic oxide. Appearing as these two spectra do almost ubiquitously as impurities in ordinary gas-vacuum-tubes, their precise discrimination from each other, and the resolution of their many hazy bands into as many ranks of scores upon scores of accurately measured linelets, was a work of exact spectrometry in which the great light-intensities of his vacuum-tubes and the powerful train of prisms finally used by Prof. Smyth for the maps of gaseous spectra which he constructed in 1884,[1] accomplished some of the most wonderfully perfect and beautiful achievements. The much debated experimental evidence as to the chemical origins of these two spectra, moreover, prepared the way for some most embracing views of the modes of production of stellar and celestial spectra, which, besides providing astronomers with the means of classifying stars and the lesser lights of nebulæ and comets methodically, also afforded chemists an imposing outline of problems for consideration, of apparently successive stages of subdivision of the elementary forms of matter from dense into light-atomed elements.

In Sir J. N. Lockyer's hands the condensed spark of a Leyden-jar introduced into the vacuum-tube circuit (which Prof. Smyth never used, having decided to confine himself to weak-spark or low temperature excitations only in his spectrum-measures), supplied a method of transition from the oxy-carbon spectrum in carbon-oxide and dioxide vacuum-tubes, directly to the hydrocarbon or blue gas-flame one,[2] showing that only a rise of temperature was needed, from that of the nearly continuous induction-spark or simple brush-discharge in rarefied gas-tubes, to the vastly hotter disruptive spark (instantly volatilising gold-leaf or thin metallic wires), of a Leyden-jar and air-gap in the outer circuit, to furnish a new spectrum, not, we must conclude, by any chemical change of substance, but by disgregation, it seemed evident, of cool and dense into hot light molecules of pure carbon, which could thus be made at pleasure to give either of these two spectra in succession. The flame, and tube spectra, or the hydrocarbon and carbonic oxide ones are therefore now usually referred to, by Sir J. N. Lockyer, as the "hot carbon" and the "cool carbon" spectrum, respectively.[3] But all the best means that can be used to obtain, on the one hand, an evenly ascending scale of temperature and uniform intensities of action of discharges of the electric arc and spark (the only sufficient known means which can be used to reach the high temperatures demanded), and on the other hand the requisite chemical purity of the substances submitted to spectroscopic examination, are so very liable to unsuspected failures from the many lurking sources of deception which most insidiously waylay and falsify the observations and conclusions, that although, on both sides, these sources of error have been unremittingly sought out and often most startlingly disclosed and very skilfully eliminated, it is difficult to say yet whether the distinctive attributes in which the substances which give the different banded carbon spectra really differ fundamentally from each other, are either, as was at first supposed, simply chemical, or else, according to a subsequent suggestion, attributing to pure carbon spectroscopic properties which are at least not at variance with those of oxygen, hydrogen, sulphur, selenium and phosphorus, of an entirely structural kind; that is to say, gaseously allotropic, or molecularly disgregational under the action of increasing temperature. New discoveries and fresh discussions of these bands must doubtless be awaited before we can be definitely sure to what extent the views expressed by different observers as to the chemically compound or elementary dissociated natures of the material sources of special series of shaded or fluted bands seen in banded carbon spectra can be fully trusted.

Besides the two chief ranks already mentioned, there is another

[1] Edinburgh *Philosophical Transactions*, vol. xxx. (1883), pp. 99, 104. In a letter to NATURE (vol. xx. p. 75), in May 1879, on "End-on Vacuum-tubes brought to bear on the Carbon and Carbohydrogen question," the late Prof. Piazzi Smyth also adopted at first without reserve the view of this spectrum that it is produced by carbon simply.

[1] "Micrometrical Measures of Gaseous Spectra under high Dispersion," Edinburgh *Philosophical Transactions*, vol. xxxii. Pt. 3 (1886). The end-on vacuum-tubes used in these measures and in those of the earlier paper, were devised by the late Prof. Smyth himself, as described in a paper, "End-on Vacuum-tubes in Private Spectroscopy," read before the Royal Scottish Society of Arts in 1879. The eminent spectroscopist of Ghent, in Belgium, Dr. van Monckhoven, had, however, invented and used such tubes a few years earlier. An ingenious arrangement of electrodes which he applied to them in 1882 (one electrode at the foot, and one at the summit of each upright leg), for passing two discharges of different strengths, either simultaneously or alternately through the connecting capillary tube, in a research on the effects of temperature and pressure in widening gas-spectrum lines, was described in an interesting paper by Dr. van Monckhoven, in *Comptes rendus*, vol. xcv. (*2me semestre*, 1882).

[2] "Carbon and Carbon-compounds," by Prof. A. S. Herschel, NATURE, vol. xxii. p. 320, August, 1880.

[3] "Researches on the Spectra of Meteorites." *Proceedings* of the Royal Society, vol. xliii. pp. 118, 133, Map 3, November, 1887.

group of two carbon-bands, usually accompanied by a preceding one close-following the gas-flame spectrum's blue beam, near the Fraunhofer rays *h*, H, at the violet confines of the visible spectrum. All three are seen brightly in the spectrum of the electric arc between carbon poles, where the furthest member of this blue, violet, and ultra-violet array produces a just ocularly visible *pharos*-like mass of grey-looking light slightly beyond the spectrum-place of the furthest visible pair of dark lines H, K, of the solar spectrum. This strong outlying pair and its near preceding blue band were referred by Profs. Liveing and Dewar,[1] and also, when he found the two chief bands bright by themselves in his spectrum photographs of the Comet 1881, III., by Sir William Huggins,[2] to cyanogen. But the same strong pair's violet, or first colonnade, between G and *h*, when he first traced it beautifully distinct and bright with the ordinary coil-spark in an end-on marsh-gas vacuum-tube,[3] was coupled on by Prof. Piazzi Smyth, in his "Measures of Gaseous Spectra with High Dispersion," 1884, as it was also grouped by Dr. W. M. Watts in his "Index of Spectra," 1872 (and where Sir J. N. Lockyer classed all these three flutings provisionally together,[4] from a careful survey made in 1880[5] of their deportments, in an unstable-systemed extension, "B," of the "hot carbon's" ordinary set of flutings, "A"), as a sixth or extra fluted-band transcending in refrangibility all the five commonly seen ones of the "hydrocarbon," or blue gas-flame series.

Six of the seven main lines of the blue band of this set were marked as measured lines distinctly, by Prof. Piazzi Smyth, in a hazy glow of light immediately following the fourth, or blue band of his "High Dispersion Spectrum" Paper's full-length map of the "hydrocarbon" spectrum, but as considerably weaker lines than those of the violet or "marsh-gas" band. As the blue band, however, is in fact the weakest one of a group of bands which only the exceedingly hot flame of cyanogen, or the intense heat of the electric arc, or jar-spark usually produces, its exact indication there, precisely in its natural inferiority of strength to the violet array, and with only one line missing of its seven, at the beginning of the hazy glow, is a speaking testimony to the faithful accuracy of the late Prof. Piazzi Smyth's spectrum records, as well as to the watchful care with which all the spectra which he mapped were guarded against contaminating admixtures of interloping gas-spectra; since with the modest 2–3 inch sparks which he was content to use, of a simple induction coil, nothing but the lamp-like brightness of the Salleron and Casella end-on tubes examined, and the chemical purity of the contents of those used in taking final spectrum measures, could have been expected to show the weakest of the three "cyanogen" bands so equally free from other spectrum-glares, and almost as sharply well-defined in position, as its bright violet companion tier of "marsh-gas" lines was seen and measured.

The fifth (faint violet) band—or the latter part of it—seen under high dispersion to contain only hazy linelets, with no strong lines or sharp-edged flutings, is the only visible light-beam in the Bunsen-flame spectrum which Sir J. N. Lockyer seems willing to admit,[6] can be described correctly as a "hydrocarbon" band; and in his splendid series of discriminations of celestial spectra, that brightest portion of the Bunsen flame's violet band forms the whole system of spectroscopic bands which in those analyses of celestial spectra is usually indicated as characteristically denoting hydrocarbon radiation. Two small bands, or fluted line-groups, however, sometimes occur also in this unstable violet, or "Carbon-B" region, of which one is classed by Sir J. N. Lockyer together with the *pharos*-like band beyond H, K, as an invariable accompaniment (much more refrangible than the four "Carbon-A" bands) of the "hot-carbon" spectrum. This small three-lined band falls exactly in place and width on the Bunsen-flame spectrum's fifth, or violet band's preceding zone of weak hazy light, as the late Prof. Piazzi Smyth, in his full-length map and micrometric measures of that spectrum pictured it, surrounding the place of the violet line $H\gamma$ almost as closely as its bright following "hydrocarbon" light-zone surrounds the dark solar line G's position, with a curiously prominent solitary bright line in the dark partition space between them. A fairly satisfactory explanation of this fifth band's construction might thus, with no material need of any reconciling adjustment to the "Carbon-B" band's line-places, be extracted from the Edinburgh spectrum record, by supposing the first and second portions of its divided light-field to belong really to different radiant sources, and to be due, independently of each other, respectively to "hot carbon" and to "hydrocarbon gas's" incandescence. But the near agreement in position between the flame-band's feeble front-domain of shapeless light-haze, and the "hot carbon's" small three-ribbed fluting lacks far too much from being well affirmed by exact co-ordinations to be any certain evidence of a real spectroscopic or physical connection; and the weak preceding portion of the violet flame-band has thus been very appropriately consorted by Sir J. N. Lockyer with the following bright portion of this violet haze-band, as belonging both together to the hydrocarbon spectrum.[1] Another small violet-region band was traced by Sir W. Huggins in the spectrum of the Comet 1881, III., where it lay between the violet and the ultra-violet "cyanogen" bands, a little beyond *h* towards the line H of the solar spectrum.

Among this "Carbon-B" *suite* of bands, suspected by Sir J. N. Lockyer at an early stage of his spectroscopic observations of the sun, in 1874, to have counterparts in the dark lines of the solar spectrum, the strong *pharos*-like ultra-violet fluting's delicate train of bright lines and linelets was at length photographically proved by Sir J. N. Lockyer, in 1878,[2] to coincide precisely with a close-packed orderly array of faint, exceedingly fine dark lines at the same place in the solar spectrum; and the same coincidence of about thirty serrations of this band in ten Ångström's wave-length units, with as many exactly corresponding ripplings of light and darkness at the ultra-violet confines of the sun's visible spectrum was again very abundantly well proved by Profs. Trowbridge and Hutchins at Hartford, U.S., in 1887.[3] It was also pointed out by Profs. Liveing and Dewar at the close of the second of their above-quoted papers, in 1880, on the "Spectra of Compounds of Carbon with Hydrogen and Nitrogen," that a fluted ultra-violet band in the spectrum of the cyanogen-flame, of which they photographed many in an ultra-violet region extending far beyond this grey one's position, exactly coincided in spectrum-place with the remarkably fluted ultra-violet dark band P, in the solar spectrum. After Sir W. Huggins and Padre Secchi had independently detected the "hydrocarbon's" or low gas-flame's bands in the spectrum of Winnecke's Comet, in 1868, and some ten or twelve comets in as many following years were found to show the same bands in their spectra,[4] together with occasional traces of the oxy-carbon or "cool-carbon" spectrum, a far wider range of the "hot" and "cool carbon" bands was presently discovered for them by Sir J. N. Lockyer among the spectra of celestial bodies, and in his "Researches on the Spectra of Meteorites," in 1887,[5] and in the Bakerian Lecture to the Royal Society on a "Suggested Classification of the various Species of Heavenly Bodies,"[6] the low gas-flame's or hot carbon spectrum's bands were clearly shown to exhibit themselves, with rarer excrudescences of cool carbon bands, not only in comets, but alike in sun-like and fluted, and bright-line and temporary stars, and even in nebulæ, the aurora, and sometimes in lightning-flashes, as a sort of torch-light glow of colliding meteorites, condensed meteoritic swarms, and electrically gasified and illumined meteoritic dust, throughout the universe.

It surely needed then only the recent discovery by Prof. G. E. Hale and his coadjutors, Mr. W. S. Adams and Prof. Frost, in

[1] "On the Spectra of the Compounds of Carbon with Hydrogen and Nitrogen." Two Papers, Nos. i., ii. *Proceedings* of the Royal Society, vol. xxx. p. 152 and 494, February–June, 1880.

[2] *Proceedings* of the Royal Society, vol. xxxiii. p. 1, November 1881.

[3] It was also seen by Dr. W. M. Watts ("On the Spectrum of Carbon," NATURE, vol. xxiii. p. 197, December, 1880), "very bright" in a pure Marsh-gas vacuum-tube; and in a methyl vacuum-tube by Dr. Plücker.

[4] The Bakerian Lecture, "Suggestions on the Classification of the various Species of Heavenly Bodies,"—"Radiation Flutings": *Proceedings* of the Royal Society, vol. xliv. p. 53, April, 1888; and "Appendix to the Bakerian Lecture," Section vi. "General Statement with regard to Carbon," *Proceedings* of the Royal Society, vol. xlv. p. 186, November, 1888.

[5] "Further Note on the Spectrum of Carbon," *Proceedings* of the Royal Society, vol. xxx. p. 461, May, 1880.

[6] "Researches on the Spectra of Meteorites," *Proceedings* of the Royal Society, vol. xliii. p. 118; November, 1887.

[1] The Bakerian Lecture:—"Radiation Flutings," *Proceedings* of the Royal Society, vol. xliv. p. 53, April 1888.

[2] "Note on the existence of Carbon in the Coronal Atmosphere of the Sun," *Proceedings* of the Royal Society, vol. xxvii. p. 308, April, 1878.

[3] "On the Spectrum of Carbon compared with that of the Sun," *Proceedings* of the American Academy of Arts and Sciences, vol. xxiii. p. 10, 1887–8; and *American Journal of Science*, Series 3, vol. xxxiv. p. 345, 1888; NATURE, vol. xxxvii. p. 114, December, 1887.

[4] "The Meteoritic Hypothesis," by Sir J. N. Lockyer (Macmillan and Co., 1890), p. 176:—Table of Carbon-Spectrum Comets.

[5] *Proceedings* of the Royal Society, vol. xliii. pp. 117–156, November, 1887.

[6] *Proceedings* of the Royal Society, vol. xliv. pp. 1–93, April, 1888; and ("Appendix to the Bakerian Lecture") vol. xlv. pp. 157–262, November, 1888.

America,[1] with the giant telescope of the Yerkes Observatory's enormous power, that the green and citron hydrocarbon's chief band-lines can be observed dark on the photosphere at the sun's edge, and close by, bright in the chromosphere to a height from the sun's edge which they estimated not to exceed 1″ of arc, or about 500 miles, to completely ratify the foregoing views that those low gas-flame's fluted bands are produced by carbon vapour at an exceedingly high temperature; and fully to justify the first observers in England and America of the presence of carbon in the sun, in the opinion which they independently expressed, that the temperature of the glowing region of the sun's atmosphere where this carbon vapour is produced and made to incandesce, must certainly approach nearly to, and at the same time not much exceed, that of the electric arc.

Carbon substance furnishes yet another known form of gaseous spectrum, which consists only of a few sharp bright lines, quite free from bands of shaded light, or flutings; and this linear form of its spectrum may be pretty certainly ascribed to carbon vapour in its simplest molecular, perhaps even monatomic, state of aggregation, since it is only obtained by heating carbon in a condensed electric spark to the highest possible artificial temperatures. No indications, however, of carbon's occurrence at this exceedingly high temperature in any celestial spectra, appear as yet to have been met with. Although no gaseous spectra produced at such high temperatures as those of the condensed electric spark were spectroscopically measured by the late Prof. Piazzi Smyth, yet a depiction of this carbon spectrum as it was first seen in the Leyden-jar spark between carbon poles by Ångström in 1863, and as it was represented by Ångström and Thalen in their "Spectres des Metalloïdes" in 1875, is given with the line-spectra of common air, hydrogen, nitrogen and oxygen and of vapour of mercury, by different authors, in the Plate of full-length spectra of his "High Dispersion Spectrum" Paper of 1884, by the late Prof. Smyth, to compare with his own measurements of low temperature spectra of the same elementary gases or their compounds. The map of the carbon line-spectrum given by Ångström and Thalen shows a spectrum-field extremely bare of lines, but terminated, at its two ends, by two very bright ones, a red, closely double line almost coincident with Fraunhofer's C, or $H\alpha$, and a violet one close-following G and the violet hydrogen line $H\gamma$, and like the hydrogen-lines appearing to be easily widened into a diffuse, broad line by taking the spark in gases at increasing pressures.[2]

A faint single line near E, and two groups of three and four moderately bright, pretty close-packed lines near the beginnings of the two brightest (green and citron) flutings of the Bunsen-flame, or "hot-carbon" band-series, are all the remaining visible portions of this spectrum figured, as they had excellently observed and studied it, by Profs. Ångström and Thalen. But the latter two isolated line-groups appear to fit on remarkably well to the view already apparently borne out and substantiated by what precedes, that with rising temperatures and increasing disgregation of carbon-vapour molecules, the interval between the beginnings of the green and citron flutings becomes wider in passing from the "cool" to the "hot" carbon-band series. For while those band-beginnings are respectively at $\lambda = 519{\cdot}70$ and $560{\cdot}75$ (distance $= 41{\cdot}05\mu\mu$) in the cool, or oxy-carbon set, and at $\lambda = 516{\cdot}40$ and $563{\cdot}34$ (distance $= 46{\cdot}94\mu\mu$) in the hot, or hydrocarbon set of bands, the front-lines of the "Excelsior" Carbon-spectrum's (as the late Prof. Piazzi Smyth poetically termed it), or still hotter and more broken-up carbon-vapour molecules' two small solitary line-groups, are at $\lambda = 515{\cdot}05$ and $569{\cdot}41$, in Ångström and Thalen's Table of these carbon lines; both shifted again slightly in position in the same left and right directions as before, and with the interval between them again increased a little, now, from its last measures, $41{\cdot}05$ and $46{\cdot}94$, to $54{\cdot}36\mu\mu$.

But a most industrious explorer, and a describer and recorder unsurpassed in the skill of his depictions of the surprising beauties of all this rich domain of matter's spectroscopic radiations, we must again here grieve to note, has passed away. Besides his already-mentioned extremely perfect measurements of "gaseous spectra," the late Prof. Smyth's published spectrum-maps and spectroscopic writings comprised long descriptions too of not less than five full series of measurements with high dispersion, in southern skies, and with great magnifying powers, of the dark lines of the solar spectrum.[1] These graphic solar-spectrum maps and those of the "gas-spectra," and separate papers treating also of the oxygen-gas spectrum singly, and of the dark line group "*b*" in the solar spectrum by itself,[2] together form a lasting store of precious materials for spectroscopic study too variously instructive and often suggestive of interesting theoretical deductions from their well-recorded details, to be here dealt with shortly and concisely. It is with a sense of doing only very partial justice to the exceedingly high merit and scientific value of those other important spectrum records and researches, that as much space as could be accorded to these short notes has been devoted here to pourtraying only the increasing cosmical significance and the widely-spreading applications in spectroscopic astronomy, of his valuable investigations of the ordinary forms of carbon spectra. In his effectual unravelling of the mazy linelet systems of those familiar spectra's bands, a plain and simple law of sequence in the linelets' spectrum-places was disclosed, which some years later also proved the proper clue to elicit order from the complex-looking linelet structures of the dark absorption-bands, "A" and "B" (both due to oxygen in our terrestrial atmosphere), at the red end of the solar spectrum. Although those shaded groups' constructions were only perfectly made known at last in 1893, by Mr. G. Higgs, of Liverpool,[3] from the beautiful figures of them given in his then published "Photographic Studies of the Solar Spectrum," yet the drawings of those bands in Prof. Smyth's Madeira and Winchester Solar Spectrum Plates in 1881 and 1884, only second to Mr. Higgs' photographs in their clear discriminations and accurate positions of the bands' details, would have certainly afforded ripe enough materials to establish at least the major portions of their simple featured laws of linelet sequence by themselves, if they had been searchingly examined, and carefully enough discussed and studied for the purpose.

Further examples of the same simple law of linelet intervals in such "shaded" bands (where each distinguishable *suite* or tier of linelets exhibits simply a fixed and uniform excess or growth of interval—of each *suite's* own amount or proper measure—in every pair of adjoining lines, over that of its immediately preceding line-pair, as the rank of lines advances from the brighter to the dimmer region of the shading) occur, moreover, not only in the brightest, green, but also in the citron and the blue band-figures, very plainly, of Prof. Smyth's full-plate "high dispersion" maps of those three most notable light-ridges in the "carbon oxide" (or "cool carbon") spectrum. Another interesting indication of line-systems also can be traced in his full-length mapped array of the four then known low temperature lines of oxygen, three of which he discovered to be finely triple, and to which he contributed three more just similarly triple lines. Two Balmer's series of three lines each can be pretty certainly distinguished in this strikingly peculiar group of six mapped triplets, converging approximately to a nearly common progression-head, or series-limit, at about $\lambda = 430\ \mu\mu$. Possibly these two line-sequences which his much extended range and finely multiplied line-features of the ordinary tube-spectrum of oxygen appear to show, may have been already recognised and fittingly comprised by Messrs. Kaiser and Runge among the many such line-series which they have found indications of in the spectrum-field of oxygen. But these and many more such philosophical results may be looked for to be richly gleaned and brought to light by coming years' discussions of the minute and copious information which with Mr. T. Heath's skilful assistance in their draughtsmanship and computations, is lucidly unfolded in Prof. Smyth's noble works of well resolved and accurately measured ranks of lines both in the solar and in gaseous spectra. In those several sound and stalwart *opera*

[1] *Bulletins* of the Yerkes Observatory, No. 12, 1899.

[2] This widening of the carbon violet line to a "broad band" at $\lambda = 4272$ (Ångström, 4266·0) is very distinctly recorded in Dr. W. M. Watts' "Index of Spectra," 1872, "Carbon-Spectrum, No. IV."; where the groups and single lines, α, β (*plus* the two next lines), γ, and ι, compose together Ångström and Thalen's line-spectrum of pure carbon. With four or five exceptions, all the many lines contained in the several other line-groups besides these, in the same Carbon-Spectrum Table, can, however, be readily identified with lines of the oxygen line-spectrum mapped by Ångström and Thalen on the same Spectrum-Plate ("Spectres des Metalloïdes," Upsala *Nova Acta*, vol. ix. 1875) with their line-spectrum of carbon, and also with lines in Dr. Schuster's map (*Philosophical Transactions* of the Royal Society, 1879) of the line-spectrum of oxygen.

[1] At Lisbon, in 1877–78, with glass prisms (the whole visible solar spectrum), Edinburgh *Philosophical Transactions*, vol. xxix. 1880; in Madeira, in 1881, with a Rutherford's diffraction grating (21 special "subjects," or small regions of the solar spectrum); "Madeira Spectroscopic," Edinburgh, 1882; and at Winchester, in 1884, with a Rowland's diffraction grating (the whole visible spectrum, mapped *thrice*), Edinburgh *Philosophical Transactions*, vol. xxxii. 1886.

[2] Edinburgh *Philosophical Transactions*, vols. xxx. Part 1, and xxxii. Part 1.

[3] *Proceedings* of the Royal Society, vol. liv. p. 200, October 1893.

magna of spectroscopic explorations, we may surely feel convinced that after-times will neither fail to be gratified with results of scientific consequence, nor find it easily possible to overlook the great accessions made by the late Prof. Piazzi Smyth to spectroscopic science, by his boldly-planned recourses to, and ingeniously contrived employments of, great optical power and very high dispersions. A. S. HERSCHEL.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At a meeting of the Junior Scientific Club, held on Friday, May 18, Dr. Mann gave a *résumé* of the history of the nerve cell from Malpighi's and Leeuwenhoek's time up to the present. He showed the advance due to the introduction of new methods, viz. chromic acid by Hannover, Golgi's and Ehrlich's methods, and the Picro-corrosive sublimate method of the author. Ehrenburg in 1833 discovered the nerve-cell, Beale in 1863 the nerve-fibril, Flamming and Nissl the basophil substance of the cell, which, as Mann was the first to show, becomes used up during functional activity. Hohngren's observations on material fixed by Mann's methods had demonstrated the universal occurrence of intracellular lymph channels in nerve-cells. Finally it was suggested that the basophil substance (Nissl's bodies) should rather be regarded as the homologues of Zymogen granules than as reserve material in the strict sense of the word.—Mr. A. D. Darbishire (Balliol) showed a number of living crustaceæ by microscopic projection on to a transparent screen.

CAMBRIDGE.—The honorary degrees in law, science, and letters, were conferred in presence of a large and brilliant assemblage on June 12. Prof. Langley was unable to arrive from America in time to be present, but the American Ambassador, Lord Rosse, Sir Benjamin Baker, Sir Walter Buller and Prof. Poincaré attended, and received a cordial welcome. The following are the speeches delivered by the Public Orator, Dr. Sandys, in presenting to the Vice-Chancellor the under-mentioned recipients of honorary degrees for distinction in science:—

THE RIGHT HON. THE EARL OF ROSSE, LL.D.

Assurgit proximus Universitatis Dubliniensis Cancellarius, cuius pater munere eodem ornatus atque etiam Regiae Societati praepositus, Hiberniâ in mediâ instrumentum ingens stellis observandis olim construxit; cuius de fratre autem, navis cellerimae inventore sollertissimo, omnibus notum est "quo turbine torqueat" undas. Ipse famam inter peritos adeptus est, non modo de lunae calore subtilius inquirendo, sed etiam stellarum nebulis remotissimis (ut Aristophanis a Nubibus aliquantulum mutuemur) ὄμματι τηλεσκόπῳ observandis. Habetis exemplar domus praeclarae scientiarum amore conspicuae, cuius caput dignitatis Academicae heres dignissimus exstitit. Qui abhinc annos octo Universitatis suae inter ferias saeculares tot honores in alios contulit, hodie fortasse nobis ignoscet, quod honos ipsi olim debitus praecepto illi Horatiano nimium paruisse visus est:—"nonum prematur in annum."

SIR BENJAMIN BAKER, SC.D.

Quantum miratus esset historiarum scriptor, Gaius Cornelius Tacitus, si providere potuisset fore aliquando, ut Caledoniae fretum, Bodotriae nomine sibi notum, duobus deinceps pontibus immensis iungeretur! Quantum miratus esset historiae pater ipse, Herodotus, si audivisset fore aliquando, ut vir quidam, ab insulis Britannicis sibi prorsus ignotis oriundus, fluminis Nili aquas redundantes duplici mole et aggere magno coerceret et Aegypti regioni immensae irrigandae conservaret! Operis utriusque magni conditorem magnum hodie praesentem contemplamur, qui non pacis tantum triumphis contentus, velut alter Archimedes, etiam Martis tormentorum inventor et machinator admirabilis exstitit. Atqui ne Martis quidem inter opera pacis causam revera deseruit; etenim scriptoris antiqui de re militari monitum non ignotum est:—"qui desiderat pacem, praeparet bellum."

SIR WALTER LAWRY BULLER, SC.D.

Coloniae nostrae remotissimae, Novae Zealandiae, inter decora conspicua numeratus, adest hodie vir regionis illius indigenarum linguae imprimis peritus, cui, propter merita eius egregia, gratiae saepenumero publice sunt actae. Adest vir qui etiam regionis illius avibus summâ curâ describendis atque arte eximiâ depingendis opus magnum dedicavit. Quantum autem liberalitati eius etiam nostra Academia debeat, Musei nostri parietes, avium et animalium aut prorsus aut prope extinctorum exemplis ornati, satis clare loquuntur. Ergo quem ipsa Regina, quem et Gallia et Germania et Italia honoribus cumulaverunt, eundem etiam nosmet ipsi, tot munerum non immemores, laudis nostrae diademate decoramus.

M. HENRI POINCARÉ, SC.D.

Sequitur scientiarum Academiae Gallicae socius illustris, scientiae mechanicae caelestis inter Parisienses professor insignis, societatis Regiae Londinensis inter socios exteros olim numeratus, astronomorum denique a societate Regia numismate aureo nuper donatus. Quantam laudem meritae sunt investigationes illae subtilissimae, de aestuum maritimorum natura universa, de molium liquidarum sese rotantium aequilibrio, de planetarum denique et satellitum cursu vario, ad exitum felicem ab hoc viro perductae! Studiorum mathematicorum in utrâque provinciâ, et analyticâ et physicâ, propter scientiae suae prope infinitam varietatem inter principes numeratus, quam egregie nuper ostendit quantum provinciae illae vicinae invicem inter sese deberent! Quam pulchre studiorum suorum voluptatem cum artis musicae et artis pingendi voluptate comparavit! Quam ingenue mathematicam physicam confitetur novam quandam linguam desiderare; linguam cotidianam nimis exilem, nimis ambiguam esse, quam ut aliquid tam delicatum, tam subtile, tam varium, possit exprimere. Et nos idem hodie libenter confitemur: viro tali pro meritis eius tam variis laudando lingua nostra vix sufficit. "Conamur tenues grandia."

THE Knightsbridge Professorship, vacant by the resignation of Dr. Sidgwick, will be filled up on Saturday, June 30. Candidates are required to send their names to the Vice-Chancellor by June 25.

Mr. G. F. C. Searle has been appointed a university lecturer in experimental physics; and Dr. G. H. F. Nuttall, university lecturer in bacteriology and preventive medicine.

The first award of the Raymond Horton-Smith Prize has been made to Mr. A. B. Green, for his M.D. thesis on amyloid disease.

Mr. W. A. Macfarlane-Grieve, M.A., Oxford and Cambridge, of Impington Park, has offered to the University a farm of about 145 acres near Cambridge, free of rent till Michaelmas 1909, for the purposes of the Department of Agriculture. This handsome offer has been gratefully accepted on behalf of the Board of Agricultural Studies, to whom the management of the experimental farm is assigned.

The *University Reporter* for June 12 contains an interesting report on Mr. W. W. Skeat's exploring expedition to the Malay provinces of Lower Siam.

The Right Hon. A. J. Balfour, M.P., will deliver the inaugural address to the students of the Vacation Courses, arranged by the University Extension Syndicate, at 12 noon on Thursday, August 2.

The Arnold Gerstenberg Studentship in moral philosophy for graduates in natural science has been awarded to Mr. T. J. Jehu, of St. John's College, who holds a Heriot Fellowship in geology from the University of Edinburgh.

The Mathematical Tripos list is unusually short this year. The sixteen wranglers are headed by Mr. J. E. Wright of Trinity, Mr. A. C. W. Aldis of Trinity Hall being second wrangler. An Indian student, Mr. Balak Ram of St. John's is fourth; and Miss W. M. Hudson of Newnham College, sister of the senior wrangler of 1898, is bracketed eighth wrangler. Miss E. Greene, also of Newnham, is equal to tenth. St. John's claims five of the wranglers, Trinity four, Clare two.

In Part II., the bracketed senior wranglers of last year, Mr. Birtwistle of Pembroke, and Mr. Paranjpye of St. John's, are placed with two others in the first division of the first class.

MR. CHAMBERLAIN, Chancellor of Birmingham University, has received a letter from Mr. W. H. Foster, Apley Park, Bridgnorth, offering a donation of 2000*l.* towards the endowment fund.

MR. J. G. CLARK, whose death is announced from Worcester, Massachusetts, was a generous promoter of the interests of education in the United States. By his efforts the Clark University at Worcester, Mass., was founded "to increase human knowledge and transmit the perfect culture of one generation to the ablest youth of the next; to afford the highest education and opportunity for research." He gave a close study to the subject of the higher education, and was anxious to include in his proposed University the best features to be found in institutions in America and elsewhere. At the foundation of the University in 1889, Mr. Clark gave it an endowment of one million dollars, to which he added a like amount later on. By his death, the institution receives his magnificent library of rare and costly books. Clark University is perhaps unique among the educational institutions of the United States. It is devoted entirely to post-graduate studies, and recently celebrated its tenth anniversary.

As announced last week, a series of festivities began at Cracow, on June 7, in commemoration of the 500th anniversary of the foundation of Cracow University. A Reuter correspondent states that a large number of men of science, including representatives of most of the European universities and colleges, attended the celebration. The Austrian and foreign investigators went in procession on Thursday morning to the Church of St. Mary, where a Papal Brief in reference to the celebration was read. The graves of the founders of the University were visited and wreaths deposited upon them. At the special commemorative meeting subsequently held, speeches in Latin were delivered by Prof. Tarnowski, the rector, and Dr. von Hartel. An illuminated address was presented by a deputation from Oxford University. The proceedings terminated with the distribution of the diplomas of honour to those upon whom the honorary degree of doctor has been conferred.

THE new Directory of the Board of Education, South Kensington, containing regulations for establishing and conducting science and art schools and classes, has just been published. Many of the regulations have been modified, more particularly those referring to administrative matters and practical work. The syllabus of practical mathematics has been revised, but the subjects remain much the same as were prescribed in last year's syllabus. A syllabus of an advanced stage of practical mathematics has been added. The syllabus of mineralogy has been slightly modified and recast. The laboratories in a School of Science are to be available for preparation work by students of the school beyond the school hours of the time-table. Courses of work for Schools of Science in rural districts have been added. The obligatory subjects of the elementary course for men are:—(1) mathematics; (2) chemistry (with practical work); (3) physiography (Section I.) or elementary physics (with practical work); (4) biology (Section I.) or elementary botany (practical work may be in the field or garden); (5) drawing, practical geometry, or practical mathematics. Manual instruction in its application to workshop and garden must also form part of the course, which is intended to cover two years. The elementary course for women in Schools of Science differs slightly from the foregoing. Physics and chemistry are optional for the second year, and hygiene may be taken instead of botany. Practical mathematics is not included. Separate advanced courses of work are prescribed for men and women who have passed through the elementary courses. Managers of schools are now allowed the option of having the grant for practical chemistry in the advanced course assessed by the inspector or on the results of examination in the advanced stage. The announcement made last year that examinations in the elementary stages of science and art subjects will only be held upon special application, in which case a fee for each paper asked for will be charged, is ratified. This probably means the abolition of examination in the elementary stages; for apparently nothing can be gained by arranging for the examination of candidates.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 8.—Dr. J. H. Gladstone, F.R.S., Vice-President, in the chair.—A paper on the magnetic properties of alloys of iron and aluminium (Part ii.), by S. W. Richardson and L. Lownds, was read by Dr. Richardson. Experiments have been made to ascertain in what way the hysteresis loss between given limits of the field strength is connected with the temperature for an alloy containing 3·64 per cent. of aluminium. The experiments show that the hysteresis loss attains a maximum value at a temperature considerably higher than the temperature of maximum induction. The changes produced in the magnetic properties of the alloy by heating and subsequent cooling have also been investigated. The properties depend largely on the previous history of the specimen, but there does not appear to be any essential difference between the behaviour of the alloy during heating and cooling (except near the temperature of minimum permeability). Experiments have also been conducted on the abrupt change in the permeability that takes place at a temperature of about 650° C. The conclusions arrived at are as follows:—(1) The hysteresis loss at first diminishes as the temperature rises. It then increases and reaches a maximum at about 550° C. On further heating it falls off rapidly, and is negligible at 700° C. (2) The magnetic properties of the specimen depend largely on its previous history. (3) There is no essential difference between the behaviour during heating and cooling except near the temperature of minimum permeability. (4) An abrupt increase in the permeability takes place at about 650° C. during heating, followed by an equally abrupt diminution on further heating. (5) This abrupt change is more marked with falling than with rising temperatures. (6) Continued heating and cooling diminish the permeability. (7) The curve connecting temperature of minimum permeability and percentage of aluminium is a straight line. (8) The microscopic examination of the specimens shows the presence of crystals. Prof. S. P. Thompson asked if the specimens had been kept for any length of time at a high temperature, because crystals changed and grew in metals at temperatures even far below their melting points. Prof. Reinold asked if any specimens had been examined where the crystalline structure had not been observed. Mr. Blakesley asked if any explanation of the orientation of the crystals could be given. The chairmain said it was difficult to know exactly what substances were being dealt with. They might be pure alloys or mixtures of two or three alloys with iron or aluminium. Dr. Richardson in reply said the crystals might be dissolved in nitric acid and analysed, but at present he did not know their composition.—Mr. W. Campbell then read a note on crystallisation produced in solid metal by pressure. In the preparation of sections of tin, particles cling to the file and, if allowed to remain, tend to tear the surface of the metal. The effect is not immediately noticeable, but on etching the polished surface there appear, besides the usual structure of the tin, lines of much smaller crystals with irregular boundaries but possessing different orientation. The effect is only superficial because it can be removed by polishing. The same behaviour is noticed in some alloys, and it would thus appear that the pressure of a file is sufficient to cause a metal or an alloy to rearrange itself. Prof. S. P. Thompson suggested that the effect might be due to local heating caused by tearing rather than to pressure. Mr. Campbell said that the effect was not due to the heating of the file, because if the file were kept perfectly clean no crystals formed. Prof. S. P. Thompson asked if scratching the surface with a diamond produced crystallisation. The author said he had tried with a sharp knife without success, but cutting with a blunt chisel produced crystallisation along the chisel mark.—A paper on the viscosities of mixtures of liquids and solutions was read by Dr. C. H. Lees. Three formulæ have been suggested for expressing the viscosity of a mixture in terms of the percentages and viscosities of its constituent parts. The first of these represents the viscosity as being the sum of a number of terms, each one of which is the product of the percentage of any constituent and its viscosity. The second formula represents the logarithm of the viscosity in a similar manner, and the third one the reciprocal. None of these formulæ represent the viscosity of a mixture with closeness. The author suggests a formula in which the mth power of the reciprocal of the viscosity of a mixture is equal to the sum of a number of terms, each one of which is the product of the percentage of any constituent, and the mth power of the reciprocal of the viscosity of that constituent. This formula gives satisfactory agreement, and, moreover, leads to Slotte's formula for the variation of viscosity with temperature.—The secretary read a note from Prof. Wood on an application of the method of striæ to the illumination of objects under the microscope. The object chosen was powdered glass immersed in cedar oil of the same refractive index. The glass particles were almost invisible under ordinary conditions of illumination. The illuminating system was then arranged as follows:—A screen, bounded by a straight edge, was placed in front of an incandescent gas lamp, so as to cut off half of the mantle, and give a source of light bounded by one perfectly straight edge. A small lens of very short focus was placed below the stage as close as possible to the object. The lamp was at a distance of six feet, and the light reflected from the mirror was brought to a focus by this lens, passing through the object on its way. An image of the lamp was formed in space and viewed by the microscope. A little strip of thin brass, with a carefully cut straight edge, was fastened to the stand carrying the bull's eye condenser, and moved into position between the objective and object so as to cut off the flame-image with the exception of a narrow thread of light along the straight edge. The brass screen must be in the plane of the flame-image, with its edge parallel to the straight edge of the flame. The brass was then advanced over the flame until nearly all the light was cut off. Upon lowering the microscope until the object was in focus, and carefully advancing the brass strip until practically all the flame-image was cut off, it was found that the glass particles suddenly appeared with great sharpness, showing as distinctly as if in air. Two photographs of glass in oil were shown, one taken with ordinary illumination, and the other by the Schlieren-Methode.

Geological Society, May 23.—J. J. H. Teall, F.R.S., President, in the chair. — The igneous rocks of the coast of County Waterford, by F. R. Cowper Reed. The first part of this paper is devoted to a discussion of the field-evidence, as shown by the coast-sections from Newtown Head to Stradbally. The igneous rocks there exposed are divided into the following five categories:—(*a*) The felsitic rocks; (*b*) necks of non-volcanic materials; (*c*) the basic sills and vents; (*d*) intrusions of dolerite; (*e*) intrusions of trachyte, andesite, &c.; (*f*) intrusions of other types. In regard to the age of the rocks, there appear to have been two main periods of volcanic activity: the first, in Ordovician times, was marked solely by outpourings of a felsitic nature; the second, post-Ordovician but pre-Upper-Old-Red-Sandstone, was characterised by a succession of several distinct types of igneous rocks. The relative age of some of the peculiar types of intrusive rocks is indicated in the paper in those cases in which it can be determined. That those rocks which are later in date than the folding of the Ordovician are older than the Upper Old Red Sandstone is shown (1) by the unconformity of the Upper Old Red Sandstone; (2) by the fact that the latter rock does not contain any interbedded igneous rocks; and (3) by the absence of felsitic or other intrusive rocks from the Old Red Sandstone of the district. The second part of the paper is devoted to petrological notes on the different rock-types.—On a new type of rock from Kentallen and elsewhere, and its relation to other igneous rocks in Argyllshire, by J. B. Hill, R.N., and H. Kynaston. [Communicated by permission of the Director-General of H.M. Geological Survey.] A rock originally described by Mr. Teall from Kentallen is used by the authors as a type round which they group a peculiar series of basic rocks discovered in several localities. The rocks consist essentially of olivine and augite with smaller amounts of orthoclase, plagioclase and biotite, while apatite and magnetite are accessory. The peculiar feature of the rocks is the association of alkali-felspar with olivine and augite, and the group is related to the shonkinite of Montana and the olivine-monzonite of Scandinavia.

Anthropological Institute, May 29.—The President in the chair.—Prof. Oscar Montelius, of Stockholm, made a communication on the earliest communications between Italy and Scandinavia. Beginning with the evidence derived from the discovery, in Denmark and Central Europe, of bronze bowls and other objects of Roman date, coming from the workshops in Italy, as similar to examples found at Pompeii and elsewhere, he traced the active and copious intercourse thus demonstrated, step by step backwards in time through the period of early Greek commerce at the beginning of the Iron Age in the Mediterranean, into the later and earlier Bronze Age; and illustrated his conclusions by a variety of classes of objects, which though originally of Italian origin and manufacture are found widely distributed in Central Europe, in Denmark and in Sweden; and can be shown by numerous examples to have been imitated by the bronze working industry of these northern areas. Among these objects, he regarded the attenuate sword-hilts and the bucket-like *situloe* as demonstrating this intercourse for the early centuries of the first millennium B.C.; the transversely-grooved sword-hilts, and the simple bow-fibula as proving the same for the later half of the second millennium, corresponding with the Mycenæan Age in the Mediterranean; the triangular dagger-shaped blades, and the imitations of open spiral torques and bracelets, as representing the earlier half of the same; and the rude hour-glass shaped types of cups and vessels as carrying the same argument back beyond the date 2000 B.C.—The paper was followed by a discussion.

PARIS.

Academy of Sciences, June 5.—M. Maurice Lévy in the chair.—The eclipse of the sun of May 28, 1900, at Paris, by M. Lœwy. The observations were interfered with by the state of the sky.—Total eclipse of May 28, by M. J. Janssen. An account of the work done in Spain by observers from the Observatory of Paris.—On the calorific equilibrium of a closed surface radiating outwardly, by M. Emile Picard.—Observation of the solar eclipse of May 28 at Marseilles and Algiers, by M. Stéphan. As the atmospheric conditions were extremely favourable at these two stations, good observations of the times of contact, and of the corona and solar protuberances, were taken.—Observations of the partial eclipse of the sun of May 28 at the Observatory of Bordeaux, by M. G. Rayet.—Observations of the planet (FG) (Wolf-Schwassmann, May 22), made with the large equatorial of the Observatory of Bordeaux, by MM. G. Rayet and Féraud.—On the curve of rifling in fire-arms, by M. Vallier.—The formation of the coal-measures, by M. Grand'Eury. In contrasting the two theories current for explaining the formation of coal deposits, the drift theory and the peat bog theory, the author cites instances in which, from his own observations, both influences must have been at work simultaneously.—The total eclipse of the sun of May 28 observed at Hellin, in Spain, by M. Hamy. The observations, which were entirely successful, include seven photographs of the corona. The characteristic green line of the corona, although falling within the sensitive region of the orthochromatic plates employed, gave no trace of impression in the spectrum photographs.—The total eclipse of the sun of May 28. Observations made at the Observatory of Algiers, by M. Ch. Trépied. The plan of operations included observations of the four contacts, visual study of the corona, photography of the partial eclipse, photography of the corona and of the spectrum of bright lines in the chromosphere, the photography of the spectrum of the corona, and thermo-actinometric observations. Under the very favourable atmospheric conditions, all the results were good, the only failure being in the attempt to photograph the spectrum of the corona.—On the solar eclipse of May 28, by MM. Meslin, Bourget and Lebeuf. Results of observations made at Elche. The photograph of the spectrum of the corona, obtained with a Rowland concave grating, shows circles corresponding to the lines H, K and G.—Observations of the eclipse of the sun of May 28, by M. de La Baume Pluvinel. Nine photographs of the corona were taken, but the instrument set apart for the special study of the coronal line gave no result.—On the proportion of polarised light in the solar corona, by M. J. J. Landerer. The proportion found was 0·52.—The eclipse of the sun of May 28 observed at Besançon, by M. Gruey.—The partial eclipse of the sun of May 28, at the Observatory of Lyons, by M. Ch. André. The scheme of operations included the comparison of the time of direct observation of contact with that made by projection upon a white screen, and the examination of the dark line noted in the eclipse of 1882.—The solar eclipse of May 28, observed from a balloon, by Mdlle. D. Klumpke.—On the theory of the moon, by M. H. Andoyer.—On the congruences of circles and spheres which are multicyclic, by M. C. Guichard.—On divergent series, a correction of an earlier note, by M. Le Roy.—On the decomposition of continued finite groups, by M. Edmond Maillet.—On the integration of the equation $\Delta u = fu$, by M. J. W. Lindeberg.—On the electrical state of a Hertz resonator in activity, by M. Albert Turpain.—Researches on the existence of a magnetic field produced by the movement of an electrified body, by M. V. Crémieu. According to Maxwell, a charged electrified body in motion should produce magnetic effects, the magnitude of which can be calculated from the charge and velocity of the moving body, and experiments by Rowland in 1876, and Rowland and Hutchinson in 1889, gave results in agreement with Maxwell's views. Lippmann, applying the principle of the conservation of energy to Rowland's experiment, shows that magnetic variations ought to produce a movement in electrified bodies situated within the field, but experiments by the author would appear to show that such an effect is not produced. A repetition of Rowland's original experiments, under conditions more favourable to accuracy, also leads the author to conclude that the motion of an electrified body produces no magnetic effect.—Measurement of the quantity of electricity and of electrical energy distributed by continuous currents, by MM. A. and V. Guillet.—On a mode of decomposition of some metallic chlorides, by M. Œchsner de Coninck. Gold can be completely removed from solutions of auric chloride by filtering through animal charcoal; solutions of the perchlorides of platinum and iron are also decomposed on filtration through animal charcoal. No such decomposition could be observed with the chlorides of nickel, cobalt, manganese, zinc, copper and magnesium.—On the conditions of stability of rotatory power, by M. J. A. Le Bel. It is found that at temperatures of 100° or thereabouts, many optically active bodies tend to lose their rotatory power by racemisation; on the other hand, if the asymmetric radicals grouped round a central atom are increased in volume, the stability is increased.—On the dihydroxylates, by M. de Forcrand.—Addition of hydrogen to acetylene in presence of copper, by MM. Paul Sabatier and J. B. Senderens. A mixture of hydrogen and acetylene passed over reduced copper at a temperature of 130°—200°, reacts readily, forming ethane, ethylene and other hydrocarbons, no acetylene remaining unchanged if the hydrogen is in excess.—On the copper and mercury organo-metallic compounds of diphenylcarbazone.—On acidimetry, by M. A. Astruc. A study of the behaviour of isethionic, sulphanilic, meconic and mellic acids with indicators.—On a new species of subterranean Isopod, *Caecosphaeroma Faucheri*, by MM. Adrien Dollfus and Armand Viré.—Gregarinæ and intestinal epithelium, by MM. L. Léger and O. Duboscq.—On the animal fossils collected by M. Villiaume in the carboniferous strata near Nossi-Bé, by M. H. Douville. The whole of the carboniferous strata in the region of Nossi-Bé belongs to the Upper Lias, and is to be classified with the carboniferous strata of the same age in the north of Persia.—On the vegetable fossils collected by M. Villiaume in the carboniferous beds in the north-west of Madagascar, by M. R. Zeiller. The conclusions drawn are in harmony with those drawn by M. Douville in the previous paper from a study of the animal fossils.—The volcano of Gravenoire and the mineral springs of Royat, by M. P. Glangeaud.

DIARY OF SOCIETIES.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.—Election of Fellows.——At 4.30.—Some New Observations on the Static Diffusion of Gases and Liquids, and their Significance in certain Natural Processes occurring in Plants: H. T. Brown, F.R.S., and F. Escombe.—The Electrical Effects of Light upon Green Leaves (Preliminary Communication): Dr. A. D Waller, F.R.S.—The Nature and Origin of the Poison of Egyptian Lotus (*Lotus Arabicus*): W. R. Dunstan, F.R.S., and T. A. Henry.—The Exact Histological Localisation of the Visual Area of the Human Cerebral Cortex: Dr. J. S. Bolton.—Data for the Problem of Evolution in Man. V. On the Correlation between Duration of Life and the Number of Offspring: Miss M. Beeton, G. U. Yule, and Prof. K. Pearson, F.R.S.—The Diffusion of Ions produced in Air by the Action of a Radio-active Substance, Ultra-violet Light and Point Discharges: J. S. Townsend.—On an Artificial Retina and on a Theory of Vision, Part I.: Prof. J. C. Bose.

MATHEMATICAL SOCIETY, at 5.30.—Some Multiform Solutions of the Partial Differential Equations of Physical Mathematics and their Applications, Part ii.: H. S. Carslaw.—Some Quadrature Formulæ: W. F. Sheppard.—Notes on Concomitants of Binary Quantics: Prof. Elliott, F.R.S.—Extensions of the Riemann-Roch Theorem in Plane Geometry: Dr. Macaulay.—On the Invariants of a certain Differential Expression connected with the Theory of Geodesics: J. E. Campbell.—On the Constants which occur in the Differentiation of Theta Functions: Rev. M. M. U. Wilkinson.—On the Transitive Groups of Degree n and Class $n-1$: Prof. W. Burnside, F.R.S.—The Invariant Syzygies of Lowest Order for any Number of Quartics: A. Young.—Further Notes on Bilinear Forms: T. J. I'A. Bromwich.

MONDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Country between Lake Rudolf and the Nile Valley: Captain M. S. Wellby.

TUESDAY, JUNE 19.

ZOOLOGICAL SOCIETY, at 8.30.—On the Significance of the Hair-slope in certain Mammals: Dr. Walter Kidd.—On the Anatomy of *Bassaricyon alleni*: F. E. Beddard, F.R.S.—Observations on the Habits and Natural Surroundings of Insects and other Animals, made during the "Skeat" Expedition to the Siamese Malay States: Nelson Annandale.

ROYAL STATISTICAL SOCIETY, at 5.—The Defence Expenditure of the Empire: The Right Hon. Sir Charles W. Dilke, Bart.

MINERALOGICAL SOCIETY, at 8.—On Conchite, a New Variety of Calcium Carbonate: Miss Agnes Kelly.—On the General Determination of the Three Principal Indices of Refraction from Observations made in any Arbitrary Zone: G. F. Herbert Smith.—On Monazite from Tintagel: H. L. Bowman.—On the Oxidation of Pyrites by Underground Water: Dr. J. W. Evans.—Petrological Notes: G. T. Prior.—A Quantitative Determination of the Action of Hydrochloric Acid and Soda Solution on the Enstatite and Felspar of the Mount Zomba Meteorite: L. Fletcher, F.R.S.

WEDNESDAY, JUNE 20.

GEOLOGICAL SOCIETY, at 8.—On the Skeleton of a Theriodont Reptile from the Baviaans River (Cape Colony): Prof. H. G. Seeley, F.R.S.—On Radiolaria from the Upper Chalk at Coulsdon (Surrey): W. Murton Holmes.—Fossils in the Oxford University Museum. IV. Notes on some Undescribed Trilobites: H. H. Thomas.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Rainfall in the West and East of England in Relation to Altitude above Sea-level: William Marriott.—Description of Halliwell's Self-recording Rain Gauge: Joseph Baxendell.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Demonstration on the Structure of some Palæozoic Plants, with Sections of the Plants shown by the Lantern: W. Carruthers, F.R.S.

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On some Scandinavian Crustacea: Dr. A. G. Ohlin.—The Subterranean Amphipoda of the British Islands: Chas. Chilton.—On certain Glands of Australian Earthworms: Miss Sweet.—Notes on Najas: Dr. A. B. Rendle.

ZOOLOGICAL SOCIETY, at 4.30.—The Gigantic Sloths of Patagonia: Prof. E. Ray Lankester, F.R.S.

ANATOMICAL SOCIETY (Owens College, Manchester), at 10.30.—Lantern Demonstration on the Comparative Anatomy and Histology of the True Cæcal Apex—the Appendix Vermiformis: Dr. R. J. Berry.—Lantern Demonstration of some Surface Markings of the Calvaria, and their Significance: Prof. Dixon.—Lantern Demonstration of Microphotographs of the Maturation Stages in the Ovum of Echinus: Dr. T. H. Bryce.—Some Points in the Anatomy of the Digestive System: Prof. Birmingham.—(*a*) Two Cases of Absent Vermiform Appendix; (*b*) A Specimen showing Direct Continuity between the Long External Lateral Ligament of the Knee-joint and the Peroneus Longus Muscle; (*c*) A Supernumerary Bone in the Carpus connected with the Trapezium: Prof. Fawcett.—A Note on the Genital Apparatus of the Jerboa: Dr. Armour.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—Notes on the Chemistry of Chlorophyll: Dr. L. Marchlewski and C. A. Schunck.—Researches on Morphine, I.: Dr. S. B. Schryver and F. H. Lees.—A New Series of Pentamethylene Derivatives, I.: Prof. W. H. Perkin, jun., F.R.S., Dr. J. F. Thorpe, and C. W. Walker.—Experiments on the Synthesis of Camphoric Acid. III. The Action of Sodium and Methyl Iodide on Ethyl-dimethyl-butanetricarboxylate: Prof. W. H. Perkin, jun., F.R.S., and Dr. J. F. Thorpe.—On the Oxime of Mesoxamide and some Allied Compounds: Miss M. A. Whiteley.—The Oxyphenoxy- and Phenyleneoxy-acetic Acids: W. Carter and Dr. W. T. Lawrence.—(1) The Condensation of Ethyl α-Bromo-isobutyrate with Ethyl Malonates and Ethyl Cyanacetates: α-Methyl-α′-isobutylglutaric Acid; (2) Methylisoamylsuccinic Acid, II.: Dr. W. T. Lawrence.

FRIDAY, JUNE 22.

PHYSICAL SOCIETY, at 5.—Notes on Gas Thermometry: Dr. P. Chappuis.—A Comparison of Impure Platinum Thermometers: H. M. Tory.—On the Law of Cailletet and Mathias and the Critical Density: Prof. J. Young, F.R.S.

ANATOMICAL SOCIETY (Owens College, Manchester), at 10.30.—Note on the Configuration of the Heart in a Man and some other Mammalian Groups: Dr. C. J. Patten.—On the Arrangement of the Pelvic Fasciæ and their Relationship to the Levator Ani: Dr. Peter Thompson.—(*a*) A Preliminary Note on the Development of the Sternum; (*b*) Specimens of Diaphragmatic Hernia and of a Left Inferior Vena Cava: Prof. Paterson.—Preparations and Lantern Slides illustrating: (*a*) The Anatomy of the Subclavian and Axillary Arteries; (*b*) The Position and Relations of the Eustachian Tubes: (*c*) Stereoscopic Views of Anatomical Preparations: Dr. Arthur Robinson.—A Series of Microscopical Preparations illustrating the Development of the Posterior End of the Aorta: Prof. Young and Dr. Arthur Robinson.—Demonstration of a Series of Preparations of the Posterior End of the Adult Aorta: Prof. Young.

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