Scientific worthies : [No.] 29, Sir Joseph Lister / [Hermann Tillmanns].

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 7, 1896.

SCIENTIFIC WORTHIES.

XXIX.—SIR JOSEPH LISTER.

I HAVE responded with great pleasure to the honourable request that I should give some sketch, for the readers of NATURE, of Sir Joseph Lister's scientific eminence. As a *confrère* I know him not merely from his prominent scientific renown, but also as a friend, and I too, like other German surgeons, have sought out the founder of modern surgery in his London hospital and, filled with gratitude, have laid my homage at his feet. Lister was many years ago in Leipzig, and I shall never forget the *fête* we then organised in his honour. How we cheered him on that evening, professors and students, old and young! For was it not in Germany first, rather than in England, that his scientific works met with their earliest recognition and general appreciation! Lister was in his day a prophet, and proclaimed a new doctrine for the healing of wounds. And how often prophets fail to find in their own fatherland, especially in the early stages of their activity, the recognition they so well deserve!

Lister's immortal life-work is his antiseptic method of operating and of treating wounds, and it constitutes the greatest advance which surgery has ever made. It is true that operational technique had reached a previously undreamt of development after chloroform and ether had banished pain in 1846 and 1847. But the surgery of those days wanted one thing more—certainty of a successful issue to its operations. Surgeons were still helpless in fighting the ever-present septicæmic infection of wounds, which snatched to the grave so many patients and injured sufferers. Were they but able to circumvent this deadly infection of the bodily fluids, the blood and the lymph, and could they but secure as a rule and not the exception the reactionless healing of wounds without inflammation and suppuration, then would surgery as an art be diverted into new channels, and strive for the goal of final perfection. It was exactly Lister's antiseptic method of operating and treating wounds which first showed the way to the attainment of that healing "by first intention," which had been a subject of discussion for centuries, and of that certain avoidance of traumatic infection of which the general nature was so well known. And now every day we note, with joyful and grateful hearts, and with hitherto unknown feelings of innermost satisfaction, the splendid outcome of this the greatest acquisition of modern surgery. Lister did not create antiseptic surgery suddenly, or without means to his hand, for the path was already smoothed with invaluable scientific facts from the domains of physiology, chemistry, botany, and general experimental pathology. Schulze, Schwann, Helmholtz, Schroeder, Dusch, and, above all, Pasteur had proved that all fermentations and putrefactions are due to organised germs, to those ever-present micro-organisms the schizomycetes or bacteria. This fact had at first received only scant attention, but in Lister's hands its importance for the development of surgery was immense. He began his experiments on the treatment of wounds in the Glasgow Infirmary, somewhere about the year 1864, and characterised his method as "antiseptic," since it was consciously and confidently aimed at the avoidance of all putrefactive changes in the parts affected. In his views as to the nature of traumatic infection, Lister took his stand on the basis of those scientific facts regarding fermentation and putrefaction which, as already stated, had been thoroughly established. He said to himself, "It is not the mere air as such that is antagonistic to the process of healing a wound, but rather those organised germs which are so universally disseminated in the world around us: bacteria are the cause of all inflammation and suppuration, and hence of septicæmia." In this persuasion he directly attacked the problem of how not only to exclude bacteria from entering a wound, but also to destroy by disinfectants those already present, and to stay their further development. Lister selected carbolic acid as a disinfectant. Now it is true that even before his time various antiseptics, and among these carbolic acid, had been employed in bandaging; but to Lister alone is due the unending merit of methodically and confidently working out the detailed technique of antiseptic operating

and bandaging. Like many a new invention, Lister's was also at first incomplete, and was attacked from many sides, partly as to the principles on which it was based, and partly on the grounds of the somewhat complicated manipulations it involved. But, firmly persuaded of the correctness of his theoretical views, he went on steadily developing the details of his antiseptic methods, at first in Glasgow, and later in Edinburgh and London. He endeavoured to prevent the entrance of bacteria by careful disinfection of every object which comes into direct or indirect contact with the wound, more especially of the operational area on the patient, of the hands of the surgeon and his assistants, of the instruments, sponges and absorbents. To the same end he introduced the use of carbolic "spray" during the operation itself and each subsequent change of dressings, and by his ingeniously devised carbolised gauze protected the wounds from further infection. Injuries or wounds already infected were methodically disinfected by 2·5 to 5·0 per cent. solution of carbolic acid. Lister's typical dressing, as it first came into more general use, was applied as follows. A layer of waterproof silk, the "protective," was placed over the wound to shield it from the direct action of the irritant substances (carbolic acid, paraffin) in the antiseptic dressing materials; over this came some eight or more layers of carbolised gauze or muslin, and between the outer two of these a sheet of gutta-percha tissue. The whole was then securely bound round with carbolised gauze so as to effect as far as possible an air-tight enclosure of the wound. This Listerian bandage, as it soon came to be called, was both applied and changed under a continuous carbolic spray.

The results which followed the application of Lister's methods, as used not only for operational but accidental injuries, were at that time—1873 to 1875—simply astounding. We read with the deepest satisfaction the surgical reports of those early days of the more general employment of Lister's antiseptic devices, and find them inspired with proud feelings as of a mighty victory finally won after prolonged and grievous defeats. No such curative results had ever been attained up to that time. In the self-same hospitals in which till then septicæmic infection had kept the upper hand, the best results were henceforth obtained, and the once-dreaded wound-fevers became more and more a rarity. Operations were now successful which had previously been nearly always fatal. The ever-advancing scientific investigations of traumatic septicæmia, more particularly as carried on by Koch and his pupils, and dealing with its origin and nature from the point of view of the deleterious action of bacteria, gave more and more a sound scientific basis for Lister's antiseptic method and removed all doubts as to the correctness of his views. Most convincing proof of the part played by the bacteria was provided by the inoculation of animals with pure cultures of these various organisms; and it was exactly and solely these experiments that proved the all-important fact that in reality all the troubles and dangers which threaten a wound, and hence the life of a patient, are determined by the deadly action of bacteria. This is the fact on which modern surgical methods are based. And in the face of this, people are still found who contest the utility of experiments on animals! It would be well if the opponents of vivisection could correctly picture to themselves the blessings for which the human race has to thank Lister's antiseptic method, and their relation to animal experiment. Did they but realise how many human lives are now saved in comparison with the past, surely they would be compelled to admit the use of vivisection. And, in the future also, scientific medicine imperatively demands experiments on animals for its investigations in the interest of mankind.

When once surgeons had learnt complete mastery of Listerian method, the results they obtained were progressively better. With the help of antiseptic precautions they succeeded in operations on which they would previously have never dared to venture. With these splendid results before their eyes, even those scattered opponents of the system who had at its inception raised their voice against it became silent, for they could no longer blind themselves to the conviction that a new and brilliant era was opening up for surgery.

After Lister's antiseptic method had become the common property of all surgeons, it was progressively improved and simplified, more especially in Germany. One of the most important facts for its further development was the proof that wound infections are chiefly due solely to actual contact with already infected objects, and that any infection by the entry of microbes from the neighbouring air rarely, if ever, occurs. Moreover, it was shown with increasing certainty of proof that under normal conditions the blood, lymph and tissues of healthy animals are free from bacteria. Upon these important facts the conclusion was based that it is unnecessary to disinfect a fresh and uninfected wound, such as a surgical incision, so long as every object which comes into direct or indirect contact with the wound is truly and perfectly sterilised or aseptic in accordance with Listerian requirements. Hence nowadays operations are performed with almost painfully precise sterilisation of every object or instrument employed, as Lister first taught us to do, while at the same time we limit as far as possible the action of irritant antiseptics, such as carbolic acid, and even advantageously use none at all, operating with as little fluid as possible. So far as it may be necessary the fluid now employed is a sterilised solution of common salt, or else sterilised water. In the place, then, of carrying out our operations under the former strictly antiseptic precautions, we now operate aseptically. But the fundamental idea on which Lister's antiseptic method was based has remained unchanged, and will always be the same. We deal with it in internal operations merely in a slightly different way, in so far as we omit the disinfection of wounds with such substances as carbolic acid or corrosive sublimate, regarding their action as unnecessary or even injurious. But all our precautions against traumatic infection are taken with the most minute care. The operational area on the patient is carefully disinfected in accordance with Lister's instructions, and is surrounded with aseptic linen compresses sterilised in steam at 100°–130° C. We employ exact and definite methods to free our hands from microbes, and the instruments are sterilised by boiling in 1 per cent. solution of sodium carbonate. All bandages and the outer garments we wear are made aseptic by prolonged exposure to steam at 100°–130° C. in a specially

constructed apparatus; and so, also, in respect of all else. Steam thus provides us nowadays with non-irritant bandaging materials free from germs with even greater certainty than did their earlier impregnation with antiseptic substances, for bacteria may always be found after the lapse of time in dry bandages which have been dipped in either carbolic acid or corrosive sublimate. Instead of sponges we now use muslin absorbents sterilised by steam, and these, like every other fragment of bandaging material, are burnt after being used but once. In short, the technique of modern surgery is based on Lister's method, and takes for its watchword "asepsis without the use of antiseptics." Antisepsis has given place to asepsis, but the latter is just as surely based on the ground first broken by Lister.

The results of operations carried out under aseptic precautions are magnificent. Surgery now celebrates its greatest triumphs in dealing with the skull and cranial cavity, with the brain, spinal column and spinal canal, with the thoracic and abdominal viscera, with bones and joints, with tendons and nerves. For accidental injuries, or wounds which are already infected, the older antiseptics are still employed, although we know that the complete disinfection of a festering wound is most difficult, nay almost impossible, for we cannot sufficiently reach the microbes lurking in the substance of the tissues. What we chiefly look to in this case is the efficient removal of the purulent secretion from the wound, securing this by free incisions and drainage.

Sir Joseph Lister must indeed experience a glorious feeling of deepest satisfaction when he surveys the labours of his life. His work is accomplished and brought to an incomparable conclusion. He has conquered and attained his object. When we but compare the surgery of thirty years ago, before Lister appeared on the scene, with that of to-day, what a change we see! We can scarcely carry ourselves back in imagination to the pre-antiseptic days of surgery, but each one who has known the older state of things from personal experience, cannot fail to realise with fuller understanding and livelier joy how great a blessing Lister is to suffering humanity. Formerly the healing of injuries or wounds after an operation lay by no means certainly in the hands of the surgeon. In many hospitals the conditions which existed before the advent of Lister were simply incredible. Innumerable victims were snatched away to death by traumatic infections. And how do things stand now? To-day, thanks to Lister, we can heal the most grievous injuries and carry out the most difficult operations without inflammation, suppuration, or fever. We have now a firmly grounded confidence in our surgical art, and our patients, too, trust to the capabilities of modern surgery, for they know that we can heal the wounds we make. The possibility now afforded by Listerian method of preserving and giving back health and life to our patients has led to the growth among the surgeons of every nation of a pride in their professional activities, which finds its expression in the form of active theoretical and practical work. Science and art are international. The doctors of all nations are fighting shoulder to shoulder for the welfare of suffering humanity, and we Germans recognise without a suspicion of jealousy that the sun of modern surgery first rose in the person of Sir Joseph Lister and in England. The word surgery in its origin signifies a handicraft; but that which was thus manual at first has become an art and a science which has, thanks above all to Lister, raised itself with impetuous and surprising speed in the last twenty years to a previously unknown height of development. Modern surgery no longer stops short at the exterior, but has gone even deeper, and now includes within the sphere of its activity every organ of the human body without exception. And for this mankind is indebted in the first place to Sir Joseph Lister. As far as there is an earthly immortality it must be his, for as long as ever surgery is scientifically discussed his name cannot fail to be mentioned.

H. TILLMANNS.

Sir Joseph Lister is not, as has been often stated, a Scotchman. He was born at Upton, in Essex, which was then a pretty suburban village, though it has long since been completely swallowed up in the metropolis, and here the greater part of his early life was spent. His father, Joseph Jackson Lister, was a man of rare ability, who devoted the intervals of business to scientific pursuits. He was a Fellow of the Royal Society, and is best known for his work on the improvement of the microscope, which is embodied in a paper in the *Philosophical Transactions* for 1831, "On some Properties in Achromatic Object-glasses applicable to the Microscope." Other papers of his appeared in the *Philosophical Transactions*, one of which was written in conjunction with the well-known Dr. Hodgkin, who belonged, like him, to the Society of Friends. They were the first to describe the tendency of the red corpuscles of the blood to arrange themselves in rouleaux.

Sir Joseph Lister was thus early imbued with scientific tastes, and learned by example, if he did not inherit by descent, the habit of accurate observation and relentless logic; in short, that capacity for taking pains which has been in a special manner the characteristic feature of his genius. He was educated at a private Quaker school at Tottenham, which numbered amongst its pupils at about the same time the late Mr. William Edward Forster and Dr. Wilson Fox; and afterwards he became a student at University College, London, from which he graduated B.A. at the University of London in 1847. He then entered upon his medical studies at University College, and here he came under the influence of Sharpey, which possibly had something to do with turning his attention, in the first place, to the study of physiology. His first publications appeared in the year 1853, whilst he was still a student, "On the Muscular Tissue of the Skin" and, "On the Contractile Tissue of the Iris." He began his surgical studies just at the close of the career of Liston, one of the last of the brilliant and rapid operators of the last generation; and he was one of the first house surgeons to Mr.—now Sir John—Erichsen. After a very distinguished career at the hospital and the University, where he graduated M.B. in 1852, he went to Edinburgh, to see the surgical practice there. Here he was closely associated with, and soon became deeply attached to the late Prof. Syme, whose daughter he subsequently married. At first he was Mr. Syme's house surgeon, but before long he was appointed Assistant Surgeon to the Royal Infirmary, and Extra-Academical Lecturer on

Surgery, in which capacity he soon attracted to himself a devoted band of admirers. Whilst in Edinburgh he not only published notes of Mr. Syme's cases, but continued to pursue his physiological and pathological researches. Between 1857 and 1860 several papers appeared on a variety of kindred matters, of which the most important are those dealing with the subject of inflammation and that of coagulation of the blood. In 1857 his paper "On the Early Stages of Inflammation" was read before the Royal Society, preceded by two others, one being "An Inquiry regarding the Parts of the Nervous System which regulate the Contractions of the Arteries," and the other "On the Cutaneous Pigmentary System of the Frog." This work remains up to the present time one of the most important contributions to the subject. Various observations on the coagulation of the blood, a much-debated matter at that time, culminated in the Croonian Lecture of 1862, which excited great interest, upsetting as it did most of the accepted notions, and forming the groundwork of much of our modern teaching on the subject. In 1860 Lister was appointed Regius Professor of Surgery in the University of Glasgow, and it was there, surrounded by the typical surgery of the old *régime*, and shocked by the prevalence and fatality of the so-called hospital diseases, that his work in connection with antiseptic surgery was begun. Those, however, who have studied his various writings will not fail to observe how his physiological observations were the precursors of his pathological studies, and these again, as he traced first the appearances and then the causes of inflammation, led on step by step to the association in his mind of the inflammation occurring in open wounds with the action of micro-organisms introduced from without, and so to the crowning performance by which his name will be principally handed down to posterity. He always acknowledged the influence of Pasteur's work on the evolution of his ideas, as has been pointed out by Prof. Tillmanns.

His writings since that time have been chiefly devoted to one branch or another of the subject of the germ theory of disease. They consist of articles scattered about amongst various periodicals, so that it would be a difficult matter to produce a complete list of them. Some are elaborate investigations into the processes of fermentation and the life-history of certain micro-organisms, most of which were carried out before the introduction of the plan of cultivating these low forms of life upon solid media, and therefore involved far greater difficulties than are met with at the present day; others are treatises on the bearing of bacteriology upon surgical treatment.

The controversy which was raised on the first promulgation of his views was very warm, and it took a strangely long time before their acceptance in this country was by any means general. To many educated under the old system, it seemed hard to appreciate, first that there was anything new in the antiseptic system at all, and secondly that the modifications of the details of the treatment in the course of its evolution, did not imply a recession from the principles upon which it was founded. It was a stumbling-block to some that, as knowledge advanced, and as it became recognised that the atmosphere was not, as it had been at first supposed, charged with innumerable particles bearing the germs of putrefaction—the details of the treatment became simpler. By an unlucky chance, the term "spray-and-gauze-treatment" had by some been substituted for the "antiseptic treatment"; and when our German *confrères* started the watchword "fort mit dem spray," and it was enthusiastically taken up here, it was assumed that Lister had shifted his ground. The assumption was, it need not be said, absolutely without foundation. The earliest antiseptic dressings were much more cumbrous than those mentioned by Prof. Tillmanns. The first attempts consisted in making an antiseptic crust of blood and pure carbolic acid which was protected by a sheet of block tin, then followed the use of carbolic acid and oil, and then that of a layer of putty made with carbolic acid; after this came a plaister made of shellac and carbolic acid, and all these preceded the carbolic acid gauze, whilst the use of the spray was for a long time unknown. Lister was always aiming at simplifying the details of the treatment; none regretted more than he did its complications, and no one rejoiced more than he, when he found that he could give up the use of the spray with a clear conscience. His idea, in fact, has always been to make an external wound behave as much like a subcutaneous injury as possible by the simplest practicable means.

The antiseptic system was fairly launched about 1867, and in the year 1869 Lister was appointed successor to his father-in-law in the chair of Clinical Surgery at Edinburgh; and here he continued the elaboration of his system, lecturing to large and enthusiastic classes, numerically much greater than any which can be met with in London, whilst his clinique acquired a world-wide reputation.

In 1877, on the death of Sir William Ferguson, he was appointed Professor of Clinical Surgery at King's College, London, a position which he held till three years ago.

No reference has hitherto been made to the many improvements and modifications in surgical practice with which the name of Lister is associated; but though they may not be of much interest to the general reader, it would not be right to pass them over altogether.

Long before Esmarch introduced his method of bloodless operation on the limbs, Lister was in the habit of obtaining the same result in a less objectionable way, by simply elevating the limb, which, as he has shown, empties itself not merely mechanically, but by means of an active contraction of the arteries consequent upon the altered position. He also was the inventor of a tourniquet for compressing the abdominal aorta, thus diminishing hæmorrhage in operations in the neighbourhood of the hip-joint. He has introduced several new operations to the profession, notably an amputation which bears his name, and an operation for excision of the wrist, which, although it is now almost superseded, was for a long time looked upon as the orthodox method of treatment. He was the first to undertake osteotomy for the purpose of rectifying deformity of the limbs, and the first to advocate a more complete method of operating on cancer of the breast, than had been practised by his predecessors. Another advance associated with his name is that of treating fractures of the patella and other bones communicating with joints, by means of open incisions and wiring, a procedure which, before the introduction of

antiseptic surgery, would have been obviously unjustifiable.

We have hitherto dwelt chiefly upon his scientific work, but such facts as those just mentioned serve to show how largely he has devoted himself to, and how much he has advanced, the practical side of his profession.

It seems almost unnecessary to refer to a list of his honours, which is a very long one, including that of LL.D. Edinburgh, 1878, Hon. M.D. Dublin, 1879, LL.D. Glasgow, 1879, D.C.L. Oxon, and LL.D. Cambridge, 1880. He is Surgeon-Extraordinary to the Queen, and Knight of the Prussian order, "Pour le Mérite," Knight Commander of the First Class Order of the Danebrog, and honorary member of foreign learned societies without number. He was created a baronet in 1883, and last year succeeded Lord Kelvin as President of the Royal Society. It would be more to the point if one could suitably describe the estimation in which he is held by the civilised world, and the enthusiasm he has always inspired amongst those who have come under his immediate personal influence.

AN EXPEDITION TO RUWENZORI.

A Naturalist in Mid-Africa; being an Account of a Journey to the Mountains of the Moon and Tanganyika. By G. F. E. Scott Elliot, M.A., F.L.S., F.R.G.S. 8vo. Pp. xvi + 413, with 50 illustrations and 4 maps. (London: A. D. Innes and Co., 1896.)

IN 1862 Baron von der Decken discovered on Kilima Njaro a number of plants which are quite different from those of the surrounding country, and are allied to those of the mountains of Abyssinia and the Cameroons, and of the lowlands of the Mediterranean and the Cape. The collections made by the late Joseph Thomson on the lower slopes of the same mountain and on the plateau of Masai-land proved the complex nature of the East African flora, and enabled Sir Joseph Hooker, in a paper which is one of the classics of African literature, to suggest the sources whence its constituents were derived. The interest thus aroused in the geographical affinities of this flora subsequently sent Sir H. H. Johnston and a host of German botanists to undertake detailed work in Kilima Njaro. Still more recently it inspired Mr. Scott Elliot to undertake his adventurous journey to Ruwenzori; for he tells us in his opening page, that the object of his expedition was "to solve the question of botanical areas which on this side of Africa had often puzzled me."

Mr. Scott Elliot left Mombasa in November 1893, and began his march into the interior along the track known as the "Uganda road." His men had been chosen for him by the agents of the British East Africa Company, and the selection does not appear to have been a good one. Mr. Scott Elliott had to dismiss his head man, the terms of whose engagement were at least remarkable; and his opinion of Zanzibari (or "Suahili," as he generally calls them) appears to have been permanently affected by the unsatisfactory character of his men. The narrative takes us rapidly across the country of the Wakamba to that of the Masai, in which the author had the misfortune to lose all his donkeys and their loads. He pressed on to Kavirondo, and thence along the northern shores of the Victoria Nyanza to Uganda. The direct route on to Ruwenzori was unsafe, as Kabbarega the king of Unyoro, was then at war with the British authorities. Anxious to avoid interference from this chief, whom he describes as one of the "ruffians of the sort who always obtain the sympathy of Mr. Labouchere," Mr. Scott Elliot kept southward along the western shore of the Nyanza. Having reached the Kagera River, he followed up this, and crossed Ankole to the southern end of Ruwenzori. This was the main goal of the expedition, and Mr. Scott Elliot spent four months exploring and collecting on the flanks of this snow-capped range. He made several attempts to reach the snow-line, but the nature of the work and illness prevented him. His account of mountaineering in Central Africa is not inviting.

"It was an awful ascent. Sometimes over deep moss, where jagged root-ends of heather seemed to spring out and stab ankles and knees at every step; sometimes through a dense wood of gnarled and twisted heather-trees, fifteen to twenty feet high, and covered with grey lichens, then down a steep little ravine and dense jungle; and things soon became very hopeless. Everything was shrouded in a cold chilling mist, and first one man and then another became knocked up, until at about 10 a.m. I was left alone. I went on by myself till 2 p.m. The effect of mountain sickness was most trying; I could not walk more than fifty yards without stopping to get breath, and by 2 p.m. I was utterly exhausted, and without food or anything to sleep in. This was at about 12,500 feet."

The level at which the author suffered from mountain sickness was unusually low; but it can be easily explained as due to the effects of malarial fever, which renders men liable to attacks of this malady, at elevations at which they would otherwise be safe.

Two of the men who took part in this excursion never recovered from it, and next time Mr. Scott Elliot tried the ascent, he went alone. He succeeded in reaching the height of 13,000 feet, after a weary struggle with rain, and cold and fever. Climbing over some half-buried boulders, he fell and nearly broke his leg; after this, numbed with cold, and shivering with fever, he crawled back to the point where he had left his blanket-bag, when fireless and foodless in the drenching rain, the night passed as "a sort of horrible dream."

Though Mr. Scott Elliot did not reach the summit of Ruwenzori, he reached the Alpine meadows below the snow-line, and this for his purpose was far more important.

From Ruwenzori he returned to the Kagera River at the point where he had left it, and followed it southward through Karagwe, of Speke's description of which Mr. Scott Elliot speaks most highly. He crossed Urundi to the northern end of Tanganyika; he journeyed down the lake by dhow, marched along the Stevenson road to Lake Nyasa, and then returned home by the Zambesi.

Mr. Scott Elliot's book consists of twenty chapters, which may be divided into two groups. The larger of these is devoted to the narrative of the expedition. This gives a most interesting record of a brilliant piece of pioneer exploration, which was carefully planned, was pluckily carried out in spite of exceptional discouragements, and is described with much charm of style and

many touches of dry humour. This part of the work is of high value, as the notes on the country, the sketches of the life of the people, and the account of the incidents of the march, enable one to form a clear and true idea of the present condition of British East Africa.

The second group of chapters (Nos. x., xi., xii., xviii. and xx.) are devoted to the discussion of general topics. These, taken in order of length, and beginning with the longest, deal with transport, meteorology and climate, outfit, botany and geology. The great length at which transport is treated, and the brevity of the chapter on botany, remind us of the main disappointment of the book. It is entitled "A Naturalist in Mid-Africa"; but, unfortunately, there is in it more about politics than about nature. The author is the only botanical expert who has travelled in British East Africa since Hildebrandt's journey to Ukamba, in 1877, and hence results of the highest importance might be expected from his labours. The chapter on botany is devoted to an attempt to explain the present distribution of the Africa floras. He assumes first, that in Miocene times a sea stretched "across the whole of the desert country which now extends from Beluchistan to the Atlantic, between Morocco and Senegal." But it is practically certain that no such sea has existed since at least Palæozoic times. The second assumption is a use of Körner's thermial constants, to which the author appeals to prohibit the movement of plants along certain directions, and to produce variation by a factor which is almost the same as Romanes' physiological selection. He tells us that in the Victoria Nyanza region, "the rainy season is from October to April. It follows from this that the plants there could not have come from the Congo area, for their climate is a very wet one, and their rainy season is from April to October."

If we are not always converted to Mr. Scott Elliot's theories, we always enjoy his sketches of wild life and of nature. He is seen at his best as an observer. The spirit of the true naturalist comes out in his sketches of life in the woods and on the hillside; and some of his observations, such as on the original limits of the Victoria Nyanza and on the shapes of the valleys of the upper streams of the Nile basin, are of great interest and value. He is always happier when speaking of plants and describing the habits of animals, than when dealing with men. Mr. Scott Elliot takes things sadly, and his quiet humour brings into relief the spirit of sadness that pervades the book. He draws a dismal picture of the conditions of life with a small expedition in Equatorial Africa; and then remarks that on his return people always asked him, "Did you enjoy yourself?" He appears to have been ill-used during his expedition by the officials of both the British East Africa Company and of the German territories. He repeatedly complains that naturalists at home are very inconsiderate of the difficulties of collectors. He grieves that his meteorological notes are of little service, for, as usual, "in the interval between my departure and return, quite new instruments and observations were found to be absolutely essential." In his dedication he describes his book as the "result of a most inconvenient love of botany." In his preface he regrets that he cannot use the map of Ruwenzori prepared from his materials by the Geographical Society, "as several inaccuracies were retained in deference to a more recognised authority than myself." He deplores that "insects are usually collected by travellers, but it is difficult to obtain any information about them in this country." Mr. Scott Elliot's complaint appears to be that the collections of English travellers are not described as thoroughly or as well as those of Germans, and that in consequence there is little inducement to Englishmen to undertake scientific exploration.

There are so few men willing to run the risks and spend their money in this work, that we greatly hope that Mr. Scott Elliot's complaints are not to be taken as proof of a widespread evil. British naturalists have exceptional opportunities for obtaining rich harvests of material from abroad; but owing to the neglect of systematic zoology and botany in our educational centres, the number of trained labourers who can work at them is far too few. The loss to science is no doubt very serious; but as it is impossible for a single collector to collect everything, a traveller can protect himself by devoting his attention to groups in which he knows that his materials will not be wasted.

ANALYTICAL CHEMISTRY.

Analytical Chemistry. By N. Menschutkin. Translated from the third German edition by James Locke. Pp. xii + 512. (London: Macmillan and Co., 1895.)

THERE is, perhaps, hardly any branch of chemistry so overstocked with text-books as that of analysis. In the work before us, however, the subject is presented in such a clear and original manner, that it can hardly fail to become as popular in this country as in Germany, where it has already reached a third edition.

In the preface the author states that although general and analytical chemistry are usually commenced together, yet, in his opinion, the study of the former should always precede that of the latter, the best order of attack being general, analytical, organic, and finally physical chemistry. In view of the difference of opinion in this country as to the best lines to follow in the elementary teaching of chemistry, the following remarks of Prof. Menschutkin are of sufficient interest to quote in full.

"The student cannot rightly turn to analytical chemistry until he has obtained a thorough preparation in the general science; and his knowledge of the latter is measured, not by the number of single and isolated facts with which he is familiar, but by the clearness with which he understands the fundamental chemical phenomena and theories. For these reasons I strongly advise the beginner not to devote himself too quickly to analytical chemistry, and my advice is justified by the character which its study must assume if it is to be of value."

Rather more than half of the book deals with qualitative analysis. The metals are grouped, as usual, according to the properties and modes of formation of their sulphides. Under the heading "General reactions," the corresponding compounds of all the methods of a group are given, and then, as "Special reactions," follow the properties of the chief compounds of each element used in analysis. Especial stress is laid upon the fact that every analytical reaction depends upon definite conditions, which must be known and fulfilled for the suc-

cessful performance of any given separation. The analysis of these conditions is one of the most admirable features of the book, complete explanations being given in all cases where the theory of the reactions is known (as in the separation of nickel and cobalt); conditions found to be necessary by experience, for which no theoretical reason can be given, are definitely stated to be empirical. One point emphasised here, to which no reference is made in our current text-books, has reference to the composition of the metallic sulphides obtained in the wet way. It is pointed out that the anhydrous sulphides as obtained in quantitative analysis differ considerably in their properties (colour, rate of oxidation) from the precipitates obtained in the ordinary course of qualitative work, and these differences of behaviour correspond to differences in composition. Thus the precipitates obtained with hydrogen and ammonium sulphides are in many cases hydrated sulphides (R(SH)(OH) rather than RS). The anhydrous sulphides are occasionally formed in solution, and might give rise to confusion in certain cases. Thus, whilst the ordinary hydrated sulphide of manganese is yellow or flesh-coloured, in presence of an excess of ammonia and ammonium sulphide a green precipitate of anhydrous manganous sulphide is sometimes formed, especially from hot solutions. Again, the black precipitate obtained by treating cupric solutions with hydrogen sulphide is Cu_4S_3, and not CuS, as usually stated, the latter substance, according to Prof. Menschutkin, being unknown.

The analytical properties of the rarer metals are briefly treated in separate chapters. It would have added much to the scientific value of the book if this artificial distinction between ordinary and so-called "rare" metals could have been dispensed with. The present stereotyped mode of treatment is the chief cause of the want of knowledge by the average student of the properties and reactions of metals such as gold, platinum, cerium, uranium, and others that can only be conventionally considered as "rare."

The second half of the book deals with quantitative analysis. The descriptions are concise and the methods well chosen, but are hardly sufficiently detailed for the beginner.

OUR BOOK SHELF.

Grundriss der Krystallographie für Studirende und zum Selbstunterricht. By Gottlob Linck. Pp. vi + 252, 482 figures, and 2 plates. (Jena: Gustav Fischer, 1896.)

THIS book makes no pretence at supplanting such well-known works as those of Groth and Liebisch, but is intended for the less advanced student, and more especially for the chemist, to whom the necessity of some knowledge of crystallography is becoming increasingly felt. Except in one important particular, little attempt is made to break away from old methods of treatment. The thirty-two classes of symmetry are not treated as independent, but crystal symmetry is distributed in the usual way into the six systems, and under each system are described the holohedral, hemihedral and tetartohedral forms. Both the Naumann and the Millerian symbols for the faces are used, but greater prominence is given to the former.

An important innovation, however, is made in the chapter on the optical characters of crystals. Here, we are glad to see, the author has followed the example of Prof. Groth and adopted the purely geometrical treatment involving the use of the "Optical Indicatrix," as devised by Mr. Fletcher.

The book is fairly evenly divided between the two sections dealing respectively with the geometrical and the physical characters of crystals, about a hundred pages being devoted to each. As it is not written for the advanced student, the subject of the calculation and graphic representation of crystals is not touched upon.

The book appears to be well adapted to the purpose for which it is intended. G. T. P.

Cyanide Processes. By E. B. Wilson, E.M. Pp. 116 (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

IT is difficult to say with what object this little book has been written, and so it would perhaps be rash to assert that its object has not been attained. It is, at any rate, to be regretted that Mr. Wilson's work ever saw the light, as it is distinctly inferior to each of the half-dozen accounts which have already appeared of the cyanide process for the extraction of gold from its ores, and can only mislead and confuse those who expect to learn something from it. It is evident, from his own statements in the preface and elsewhere, that the author has derived much of his acquaintance with the subject from Patent Office literature, although he also claims to have read extracts from technical journals and other periodicals. He has not touched on mechanical details, but has confined himself to expounding the chemical principles of the process, which he appears to understand very imperfectly. The book is full of mistakes, such, for example, as that "the standard solution of cyanide contains from 0·5 to 1·5 per cent.," and that mercury oxidises quickly in the air at ordinary temperatures. On p. 74 it is stated that "the gold positive dissolves to the cyanide solution negative, with the result that the gold cyanide solution is positive. . . . Whether this electrolyte becomes converted into an electrode by absorbing the gold we are unable to say, but when they become 'cations' the gold is in the metallic state and the potassium cyanide is immediately set free." The book is well supplied with such statements as this. T. K. ROSE.

The Treatment of Phthisis. By Dr. Arthur Ransome, M.A., F.R.S. Pp. viii + 237. (London: Smith, Elder, and Co., 1896.)

MEDICAL men will be grateful for this treatise on the treatment of phthisical patients. The first part of the work comprises a general statement on the etiology pathology of phthisis, and the limits of infection; while the second part deals with the special and medicinal treatment of the malady. The contents are largely confined to descriptions of methods of treatment which have been personally used by the author, and results which have come under his own experience; but they, nevertheless, constitute a broad account of the nature and means of combating phthisis, and one which will give physicians brighter views as to the possibility of cure in the disease.

A Text-book of Applied Mechanics. Vol. I. By Alexander Jamieson, M.I.C.E., Professor of Electric Engineering in the Glasgow and West of Scotland Technical College, &c. Pp. 416. (London: Charles Griffin and Co., 1895.)

THE influence of Rankine is apparent here; the ground covered is much the same as in Rankine's "Applied Mechanics," but the treatment is more elementary, and the illustrative exercises and diagrams of a modern character.

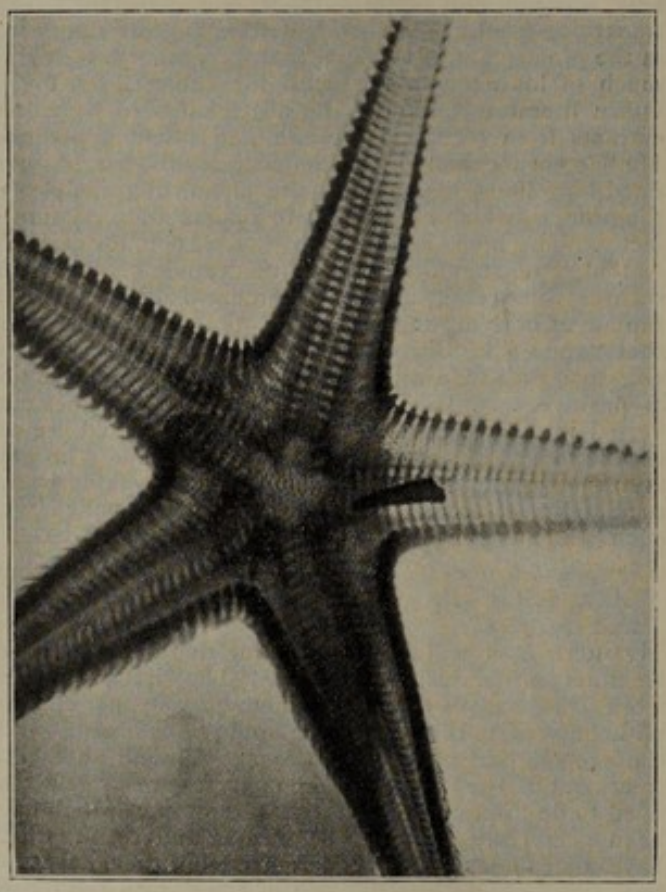
If our writers of elementary school books on Mechanics, all copied from each other and almost exactly alike, could be persuaded to lift their eyes from their own pages and look elsewhere for novelty and reality, they would derive some profit from a treatise such as this. G.

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.*]

A Biological Application of Röntgen Photography.

THE accompanying Röntgen radiograph of *Astrospecten irregularis* was made in the physical department of this college, for a popular lecture on the new photography given by Prof. H. Stroud. It will be seen that not only are the ossicles of the oral surface fairly successfully shown through the thickness of the body and arms, markedly the first of the series of adambulacra, but certain striking and unlooked-for objects appear as well. On dissection the dark conical body to the right proves to be a large piece of the shell of Dentalium lying in one of the cæca of that arm. The oval bodies, one in each of the cæca of the opposite arm, are masses of sand and indigestible material enclosed in the thinned shells of molluscan victims. These are made by the action of the cilia, and form a convenient way of getting rid of the useless matter by way of mouth. The minute anus, indeed,



Astropecten irregularis.

is quite inadequate, and is doubtless used more for fluid than solid evacuation. The madreporite plate and stone canal are seen in the inter-radius below and between the bodies referred to; and the position of the stone canal was in fact the guide in determining their position. The darkish mass in the cæcum to the left of the stone canal consists mainly of broken and whole shells of young Cardia. The stomach was filled with a whole common mussel (*Mytilus edulis*), minus the shell, and this is quite transparent. The paxillæ will be seen to occur as dots all over the body and arms. A block of wood, which was laid over part of the star-fish, has evidently only made a part of the picture lighter.

A radiograph of *Solaster papposus*, with the young Cribella, is enclosed for comparison. Though interesting also in regard to the skeletal parts shown, there is nothing calling for further note here, and they were not dissected.

All three were spirit specimens, and were got at St. Andrews some years ago. ALEXANDER MEEK.

Durham College of Science, Newcastle-on-Tyne, April 25.

Barisal Guns.

IN the correspondence on this subject I have not noticed any reference to the noises said to be heard in the mountains of the peninsula of Sinai. In his "Sinai and Palestine" (ed. 1868, pp. 13–14), the late Dean Stanley refers to "the mysterious noises which have from time to time been heard on the summit of Jebel Musa, in the neighbourhood of Um Shaumer, and in the mountain of Nakus or the Bell, so called from the legend that the sounds proceed from the bells of a convent enclosed within the mountain. In this last instance the sound is supposed to originate in the rush of sound down the mountain side. . . . In the case of Jebel Musa, where it is said that the monks had originally settled on the highest peak, but were by these strange noises driven down to their present seat in the valley, and in the case of Um Shaumer, where it was described to Burckhardt as like the sound of artillery, the precise cause has never been ascertained."

Burckhardt ("Travels in Syria and the Holy Land," 1822, p. 591) refers to these noises and says: "The wind and weather are not believed to have any effect upon the sound."

Failand, April 30. EDW. FRY.

The New Education Bill and Libraries, Museums, and Art Galleries.

REFERRING to the letter by "C." in NATURE for April 23, p. 580, I would urge the importance of his suggestion, but would go further and suggest that all institutions in England and Wales supported out of a rate raised under the Public Libraries Acts or the Museums and Gymnasiums Act, should be put under the management and control of the same local authority as may be appointed for elementary, technical and secondary education.

The management of educational institutions cannot be unified so long as such essentially educational work as that done in public libraries, museums, and art galleries does not come under the purview of the local education authority. There should, of course, be conditions inserted in any Bill having the object suggested to secure the expenditure of the rates received under the special Acts referred to, on the support of libraries, museums, art galleries and gymnasiums.

At present the Public Libraries Acts may be adopted and a rate levied, not one penny of which goes to the support of a library or museum. A certain Lancashire local authority applies the rate for purposes which would have been equally covered by the adoption of the Technical Instruction Acts. On the other hand, some public libraries and museums obtain subsidies out of the funds received by corporations under the Local Taxation (Customs and Excise) Act, though usually on condition that strictly educational books or objects are purchased out of the grants given.

I hope this subject will receive due consideration from such parliamentary advocates of scientific education as Sir John Lubbock and the members who act with him.

In conclusion, may I refer all who are interested in this subject to a paper entitled "The Relationship of the Public Library Committee to other Educational Bodies," published in the *Library* (vol. vii. p. 129), the organ of the Library Association of the United Kingdom. JOHN J. OGLE.

Free Public Library, Museum, and Technical School,
Bootle, April 28.

Magical Growth of Plants.

I NOTICE in NATURE of April 9 that mention is made of the experiments of M. Ragonneau in connection with what is termed the magical growth of plants. At the time when M. Ragonneau's statements were first brought under my notice, I endeavoured as nearly as might be to repeat his experiments. I first used formic acid diluted 1·5000, the strength stated by M. Ragonneau as being that most successfully used by him. The soil was thoroughly dried, and was some which I had carefully prepared for growing Begonia seed. The seeds used were those of the Scotch thistle (*Onopordium Acanthium*), a soft and easily-grown seed. The experiments were carried out in an ordinary greenhouse with temperature ranging from 55° F. to 75° F.; and although I took every precaution to avoid mischance, the seeds have not to

this day shown any signs of life whatever, although seeds from the same packet, planted simultaneously under ordinary circumstances, are now well-grown young plants. After my first failure, I procured pure concentrated formic acid (sp. gr. 1·300) freshly made, and on repeating the experiments with it, other things being the same as in the former experiment, the result was again entirely negative. I then tried various other seeds, first soaking them in water for periods varying from five hours to three days before treating them with the acid, but all with no result. So far as I could judge, the only effect of the acid was to increase the density of the seed and to retard the growth, so much so that some of the seeds (common Lupinus), which under formic acid showed no signs of growth, as soon as they were thoroughly washed and placed under normal conditions began to germinate in the usual way. Since these experiments I have tried many different seeds and many different strengths, but have only so far succeeded in retarding their growth. I also attempted to inject the acid (1·5000) by means of a hypodermic syringe into the substance of growing seeds and bulbs, and in two instances I succeeded in killing a Begonia tuber and an Arum lily, and certainly none of the other plants treated showed the faintest symptom of increased vitality. W. R. M. SEMPLE.

Hendford Park, Yeovil, April 11.

Rooks at Nesting Time.

OPPOSITE my windows are lofty elms on which rooks have established themselves. In one tree there are three nests with sitting birds; a fourth nest, which was built this spring, has never been fully occupied, and a fifth is now in course of construction.

It is in relation to the last two nests that a singular fact is noticeable. A pair of rooks are apparently mated, flying off and returning together, and roosting at night on the same branch.

Both are engaged in building, but on different boughs; both select the same tree, almost the same branch, for twigs, and both return home spray in beak. But while the hen bird flies to the incomplete nest (which she has built up, unaided, from the beginning, and is now three-fourths finished), the cock bird settles on the old nest, at the other side of the tree, and adds an upper story to an already capacious mansion.

How is this binary housekeeping or nest-building to be explained?

There have been further complications in the rookery since I wrote the foregoing a fortnight ago.

Then the situation was that a couple of rooks (apparently paired) were working together in collecting twigs; but while the hen bird carried hers to a new nest on the north side of an elm, the cock took his to an old nest on the south side.

Still they roosted and flew together, and behaved as engaged rooks should do, the cock now and then bringing a twig or two to the hen's nest, but chiefly working on his own.

In a few days the cock brought home another mate, and both birds set to work at the old nest. Although, for a day or two, appearances were still preserved, the original hen at last resented this trifling with her affections; she pecked at and drove off the cock, stole lining from his nest, and has since lived a life solitary and misanthropic. I see no sign of a new mate, but the hen sits by or on her own nest, and routs all new-comers who approach it.

On the same tree I have seen a singular case of wholesale burglary in which the sufferers are the new occupants of the old nest I have referred to, and the burglars a new pair of rooks. For a week they strove and failed to build a nest in an honest way, *i.e.* by breaking twigs from other trees; but they made no progress, the wind repeatedly blowing away the foundation during their absence in quest of materials.

One night, however, the wind dropped. The pair got up very early next morning, fell on the old nest (the tenants having gone off to feed), and by nine o'clock had three parts finished a new nest, on the north-west side, built entirely out of plunder from the old nest. To this they have since added a clumsy top story made of new materials.

One other curious fact, and I will take up no more of your space. On another elm a stray hen had persisted in thrusting her unwelcome attentions on an established pair now feeding their squabs. She had been there some days, and apparently was at last tolerated. One night, however, as many as ten desperate battles took place; the combatants falling, still locked in combat, from the topmost bough almost to the ground, and as often returning to the fray at the nest-side. This morning Aunt Caroline is *non est*, but I expect she will turn up again before long. Meanwhile, due perhaps to the extra food the young birds got by the exertions of the aunt, they are the largest and strongest in the rookery. F. E. BAINES.

Leamington, April 28.

An Auroral Display on May 2.

ON the evening of Saturday, May 2, at Filey (Yorkshire) I observed faint indications of an auroral display as early as 10 o'clock. On going out of the house at 11.10, five streaks of light were seen in the north, and a small cloud of light appeared on the horizon, which quickly rose and formed a perfect bow of light of great length and some 10° above the horizon at its highest point; by 11.15 all the streaks had disappeared. At 11.30, rapid beams of light were seen following the curve of the bow from west to east, each succeeded by straight arrow-like flashes above the bow in the opposite direction; 11.36, streaks again appeared on the eastern side; 11.39, the bow threw off clouds of light radially, first on the western, then on the eastern side; 11.42, the phenomena observed at 11.30 again set in on the western side; 11.49, the bow became very sharp towards the west and threw out streaks of light, while towards the east it became broken and flickering; 11.55, streamers appeared on the eastern side, and the bow became contracted on this side and smaller, striking the horizon at a higher angle; 11.58, the bow thickened and threw off radial clouds again; 12.1, a fine streamer appeared on the extreme eastern side; 12.3, the bow became very irregular, and for the first time the streamers appeared to start below the bow, three very sharp ones forming towards the east; 12.7, a second bow formed below the original one; 12.9, the bow broke up entirely towards the east into fine streamers, radial clouds of light being thrown off in the west; 12.20, bow became very indistinct in the west, and streamers gave place to clouds of light in the east; 12.22, streamers reappeared in the east; 12.25, arc of the bow reformed; 12.27, bow narrowed down and broke into two bows; 12.30, bow became irregular and sank down towards the horizon; 12.37, bow disappeared and faint streamers formed. After this a gradual fading set in, but the light was still visible though feeble at 1 a.m. The atmosphere had been exceptionally clear all through the day. A. E. M.

Felsted School, Essex.

Daylight Meteor, April 12.

THE meteor referred to in NATURE of April 23 (p. 581), was seen by me in Glasgow, low down on the S.E. horizon, at 8.5 p.m. The position of its visible path was carefully noted at the time in relation to a church spire, which it just seemed to touch. On April 27, at 10.30 p.m. the centre of the full moon was 2° above this point, its declination was therefore 22° 13′ S., and its R.A. on April 12 at 8.5 p.m. was 10h. 39m. On account of some intervening shrubs the meteor's path was only visible over a distance of 10°, but the declination seemed to remain unchanged. C. E. STROMEYER.

Glasgow, May 2.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following are the names and qualifications of the fifteen candidates recommended by the Council of the Royal Society for election this year:—

SIR GEORGE SYDENHAM CLARKE,

Major, R.E., K.C.M.G., Secretary to the Colonial Defence Committee and Associate Member of the Ordnance Committee. Late Secretary to the Royal Commission on Administration of the Naval and Military Services. Examiner to the Science and Art Department and the Military Education Department. Formerly (from 1871 to 1880) Instructor in Geometrical Drawing in the Royal Engineering College, Cooper's Hill. Joint Author of paper "On some Figures Exhibiting the Motion of Vibrating Bodies, and on a New Method for Determining the Speed of Machines" (*Proc. Roy. Soc.*, vol. xxvi., pp. 157–163), and of a paper "On the Determination of the Rate of Vibration of Tuning Forks" (*Phil. Trans.*, 1880, pp. 1–14). Author of

"Practical Geometry and Engineering Drawing" (1875); "Principles of Graphic Statics" (1879); "Perspective Explained and Illustrated" (1884); "Plevna: a Study of the Operations of 1877" (1880); "Official Report on the Effects of the Bombardment of Alexandria" (1882); "Fortification: Past, Present, and Future" (1890); and of a large number of papers on naval and military subjects.

J. NORMAN COLLIE,

Ph.D., Assistant Professor of Chemistry, University College, London. Distinguished as a worker in Organic Chemistry. Author of numerous papers published during the period from 1881 to the present time in the *Proceedings* and *Transactions* of the Royal Society of Edinburgh, *Liebig's Annalen*, the *Berichte* of the German Chemical Society, and the *Transactions* of the Chemical Society. His earlier papers relate chiefly to the study of phosphonium and phosphine derivatives and allied ammonium compounds, their behaviour when decomposed by heat having been thoroughly studied by him. Of late years he has made important contributions to our knowledge of dehydracetic acid, having described a number of very remarkable "condensations," whereby it is converted into pyridine, orcinol and naphthalene derivatives.

ARTHUR MATTHEW WELD DOWNING,

M.A., D.Sc., Vice-President of the Royal Astronomical Society. President of the British Astronomical Association. Superintendent of the *Nautical Almanac*. Author of the following papers, among many others, which have appeared in the *Monthly Notices* of the Royal Astronomical Society:—"Proper Motions of Certain Stars in the Greenwich Seven Year Catalogue for 1864" (vol. xxxviii., p. 514); "On the N.P.D.'s of the Greenwich Seven Year Catalogue for 1860" (vol. xl., p. 85); "The Greenwich Standard Right Ascensions" (vol. xl., p. 162); "The Possible Ten-month Period of Variation in Latitude" (vol. xl., p. 430); "On the N.P.D.'s of the Cape Catalogue for 1880, and on the Greenwich and Cape Mean Systems of North Polar Distances" (vol. xlii., p. 20); "Discussion of the Observations of γ Draconis, made with the Greenwich Reflex Zenith Tube, during the years 1857-75" (vol. xlii., p. 326); "On the relative Motion of the Components of p Eridani" (vol. xliii., p. 263); "On the Orbit of γ Coronæ Australis" (vol. xliii., p. 368); "On the Periodic Time of α Centauri" (vol. xlv., p. 151); "A Comparison of the Star Places of the Argentine General Catalogue for 1875 with those of the Cape Catalogue, 1880" (vol. xlvii., p. 446); "Positions for 1750 and Proper Motions of 154 Stars, S. of $-29°$ dec., from a revision of Powalky's Reduction of the Star Places of Lacaille's Astronomiæ Fundamenta" (vol. xlviii., p. 322); "Discussion of Washington Observations of the Sun, 1875-83" (vol. xlix., p. 431); "Corrections to the Orbit of Juno" (vol. l., p. 487); "The Orbit of Flora, with corrections to Brünnow's Tafeln der Flora" (vol. lii., p. 585).

FRANCIS ELGAR,

LL.D., F.R.S.E., Naval Architect and Engineer, Professor of Naval Architecture and Marine Engineering in the University of Glasgow, and Director of Her Majesty's Dockyards. Prof. Elgar has advanced the science of naval architecture by original investigations, notably in the departments of stability and of the structural strength of ships. These are described in papers communicated to the Royal Society, one of which is printed *in extenso* in *Roy. Soc. Proc.* No. 232, 1884. An abstract of the other was read before the Society on January 14, 1886. The first describes an important and novel principle which determines the variation of stability with draught of water, and the second greatly advances the investigation of the straining actions upon ships at sea. Prof. Elgar is distinguished for his acquaintance with the theory and practice of Naval Architecture, and was unanimously elected on that account by the Court of Glasgow University to the "John Elder" Chair of Naval Architectural and Marine Engineering. He is eminently distinguished as a Naval Architect and Engineer, being a Fellow of the late Royal Society of Naval Architecture and Marine Engineering, and Member of Council of the Institution of Naval Architects, Member of Council of the Institute of Engineers and Shipbuilders in Scotland, and Member of the Institution of Civil Engineers. He was appointed in January 1884 by the Council of the Institution of Naval Architects to sit as their representative upon the Committee formed by the President of the Board of Trade to frame rules for regulating the load lines of ships.

Supplementary Certificate.—Is now a representative of the Institution of Naval Architects upon the Technical Committee of Lloyd's Register of British and Foreign Shipping. Was Vice-President of the International Jury in the class of *Matériel de Navigation et Sauvetage*, in the Paris Exhibition, 1889. Is the Consulting Naval Architect for the Cunard Steamers *Campania* and *Lucania*, which are the most powerful and, with the exception of the *Great Eastern*, the largest ships ever built.

ANDREW GRAY,

M.A. (Glasgow), F.R.S.E, Professor of Physics, University College of North Wales. Examiner in Mathematics for degrees in the University of Glasgow. For five years Private Assistant and Secretary to Sir W. Thomson (Lord Kelvin); for four years Official Assistant to the Professor of Natural Philosophy in the University of Glasgow; and for the last nine years in his present post. Distinguished for his acquaintance with theoretical and experimental physics. Author of the following scientific works and papers:—"Absolute Measurements in Electricity and Magnetism" (1889); "Theory and Practice of Absolute Measurements in Electricity and Magnetism" (vol. i., 1888; vol. ii., in two parts, 1893); "A Treatise on Magnetism and Electricity," shortly to be published; "On the Determination in Absolute Units of the Intensity of Powerful Magnetic Fields" (*Phil. Mag.*, 1883); "On the Dynamical Theory of Electro-magnetic Action" (*ibid.*, 1890); "On the Calculation of the Induction Coefficients of Coils" (*ibid.*, 1892); "On a New Reflecting Galvanometer of great sensibility, and on New Forms of Astatic Galvanometers," jointly with T. Gray (*Proc. Roy. Soc.*, 1884); "On the Relation between the Electrical Qualities and the Chemical Composition of Glass and Allied Substances," Part I., jointly with T. Gray and J. J. Dobbie (*Proc. Roy. Soc.*, 1884) "On the Electro-magnetic Theory of the Rotation of the Plane of Polarised Light" (*Rept. Brit. Assoc.*, 1891).

GEORGE JENNINGS HINDE,

Ph.D. (Munich), F.G.S. Studied at University College, Toronto, Canada (1874-75); afterwards (1879-80) studied, under Dr. Karl Zittel, in the University of Munich, where he graduated. Author of numerous papers on Geology and Palæontology, viz.:—"The Glacial and Interglacial Strata of Scarboro' Heights and other localities near Toronto, Ontario" (*Canad. Journ.*, 1877, pp. 28, one plate); "On Conodonts from the Cambro-Silurian and Devonian of Canada and the United States" (*Quart. Journ. Geol. Soc.*, vol. xxxv., pp. 351-369, pl. xv.-xviii., 1879); "On Annelid Jaws from the Cambro-Silurian and Devonian of Canada and the Lower Carboniferous of Scotland (*op. cit.*, vol. xxxv., pp. 370-389, pl. xviii.-xx., 1879); "On a New Genus of Favosite Coral from the Upper Silurian, Manitoulin Island, Lake Huron" (*Geol. Mag.*, 1879, pp. 244-246); "Fossil Sponge Spicules from the Upper Chalk, Horstead, Norfolk" (*Inaug. Dissert.*, Munich, 1880, 8vo, pp. 84, 5 plates); "On Annelid Jaws from Wenlock and Ludlow formations of the West of England" (*Quart. Journ. Geol. Soc.*, vol. xxxvi., pp. 368-378, pl. xiv., 1880); "Notes on Fossil *Calcispongiæ* with Descriptions of New Species" (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. x., pp. 185-205, pl. x.-xii., 1882); "On Annelid Remains from the Silurian Strata of the Island of Gotland" (*Bihang till K. Svenska Vet. Akad. Handl.*, Bd. vii. No. 5, pp. 28, 3 plates, 8vo, Stockh., 1882); "Catalogue of the Fossil Sponges in the British Museum (Nat. Hist.) with Descriptions of New and little-known Species" (4to. pp. 248, 38 plates, 1883); "On some Fossil *Calcispongiæ* from the Well-boring at Richmond, Surrey" (*Quart. Journ. Geol. Soc.*, vol. xl., pp. 778-783, 1 plate, 1884); "On the Structure and Affinities of the *Receptaculitidæ*," &c. (*op. cit.*, vol. xl., pp. 795-849, pl. xxxvi.-xxxvii., 1884); "On a New Species of Crinoid with Articulating Spines" (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. xv., pp. 157-173, pl. vi., 1885); "On Beds of Sponge Remains in the Lower and Upper Greensands of the South of England" (*Phil. Trans.*, 1885, vol. clxxvi., p. 51, pl. xl.-xlv.)

Supplementary Certificate.—"A Monograph of the British Fossil Sponges" (Palæontographical Soc., Part I., 1887, pp. 1-92, pl. i.-viii.; Part II., 1888, pp. 93-188, pl. ix.; Part III., 1893, pp. 189-254, pl. x.-xix.); "On the Cherts and Siliceous Schists of the Permo-Carboniferous of Spitzbergen" (*Geol. Mag.*, 1888, pp. 241-251, 1 pl.); "On some New species of *Uruguaya* (Carter), with Remarks on the Genus" (*Ann. and Mag. Nat. Hist.*, ser. 6, vol. ii., 1888, pp. 1-12, 1 pl.); "On a True

Deuconid Calcisponge from the Middle Lias of Northamptonshire" (*ibid.*, vol. iv., 1889, pp. 325–358, 1 pl.); "On Archæocyathus, Billings, and on other Genera allied to it, from Cambrian Strata, &c." (*Quart. Journ. Geol. Soc.*, vol. xlv., 1889, pp. 125–148, 1 pl.); "Notes on Radiolaria from the Lower Palæozoic Rocks of the South of Scotland" (*Ann. and Mag. Nat. Hist.*, ser. 6, vol. vi., 1890, pp. 40–59, 2 pl.); "On the Sponge Remains in the Tertiary Strata, near Oamaru, New Zealand" (in conjunction with Mr. W. M. Holmes), (*Linn. Soc. Journ. Zool.*, vol. xxiv., 1891, pp. 177–262, with 9 pl.); "Note on a Radiolarian Rock from Fanny Bay, Port Darwin, Australia" (*Quart. Journ. Geol. Soc.*, vol. xlix., 1893, pp. 221–226, 1 pl.). Has paid special attention to the microscopic structure of Siliceous Deposits and Cherts, and has demonstrated the existence of Sponges, Radiolaria, and other organisms in them, and as largely composing such deposits, of all ages, and from the most distant parts of the world.

HENRY ALEXANDER MIERS,

M.A. (Oxon), F.G.S., F.C.S., Assistant in the Department of Minerals, British Museum (Nat. Hist.). Has improved the Adams instrument for the measurement of optic axal angles; devised a form of goniometer for measuring the angles of growing crystals; and a stage-goniometer for use with the microscope. Distinguished as a mineralogist and crystallographer, and author of important investigations in crystallography and mineralogy, 1882–94, as under:—"Cerussit von La Croix" (*Zeitsch. für Krystall.*, vi.); "The Crystalline Form of Meneghinite" (*Mineral. Mag.*, v.); "Hemihedrism of Cuprite" (*Phil. Mag.*, xviii.); "Monagite from Cornwall and Connellite" (*Mineral. Mag.*, vi.); "Crystallography of Bromostrychnine" (*Journ. Chem. Soc.*, xlvii.); "Crystallography of Tricupric Sulphate" (*ibid.*); "Orthoclase from Kilima-n-jaro and Adrelavia, Switzerland" (*Mineral. Mag.*, vii.); "New Cornish Mineral" (*Mineral. Mag.*, vii.); "Zonenformal für Orthogonate Systeme" *Zeitsch. für Krystall.*, xii.); "Crystals for Baric Slag" (*Journ. Chem. Soc.*, li.); "Use of Gnomonic Projection" (*Mineral. Mag.*, vii.); "Calcites, Egremont, Cumberland" (*ibid.*, viii.); "Pyrargyrite and Proustite" (*ibid.*, viii.); "Mineralogical Notes—Polybasite, Aikinite, Quartz, Cuprite, and Locality of Turnerite" (*ibid.*); "Stephanite and Kaolinite" (*ibid.*, ix.); "Sanguinite (new mineral), Krennerite" (*ibid.*); "Ullmannite Tetartohedrism" (*ibid.*); "Student's Goniometer" (*ibid.*); "Orpiment" (*ibid.*, x.); "Cornwall Danalite" (with G. T. Prior, *ibid.*); (with W. J. Pope) "Mittheil. aus dem Krystall Laboratorium des City and Guilds of London Inst." (*Zeitsch. für Krystall.*, xx.); "Spangolite from Cornwall (*Neues Jahresbr. für Min.*, ii.); "Quartz from North Carolina" (*Amer. Journ. Sci.*, xlvi.); "Xanthocanite," &c. (*Mineral. Mag.*, x.); "Spangolite" (*ibid.*, x.); "On a New Method of Measuring Crystals," &c. (*Rept. Brit. Assoc.*, NATURE, l.).

FREDERICK WALKER MOTT,

M.D. (Lond.), F.R.C.P. Lecturer on Physiology, Charing Cross Hospital. Distinguished as a physiologist. The following are his most important published papers:—"Bacteria, or their Antecedents, in Healthy Tissues" (with Prof. Horsley—*Journ. of Physiol.*, 1883); "Myxofibroma of Spinal Cord" (*Brain*, 1888); "Cardio-vascular Nutrition and its relation to Sudden Death" (*Practitioner*, 1888); "Pathology of Pernicious Anæmia" (*ibid.*, 1890); "Clarke's Column in Man, Monkey, and Dog" (*Journ. of Anat. and Physiol.*, 1887); "On Eye Movements produced by Cortical Faradisation of the Monkey's Brain" (with Prof. Schäfer—*Brain*, 1890, and Internat. Med. Congress, Berlin); "On Movements resulting from Excitation of the Corpus Callosum in Monkeys" (with Prof. Schäfer—*Brain*, 1891); "Complete Sclerosis of Golt's Column" (*Internat. Journ. of Med. Sci.*, 1891); "The Results of Hemisection of the Spinal Cord in Monkeys" (*Phil. Trans.*, 1892).

Supplementary Certificate.—Physiologist and Neurologist. Secretary of the Neurological Society. Pathologist to the London County Council Asylums. Has published the following papers recently:—"The Bipolar Cells of the Spinal Cord and their Connections" (*Brain*, 1891); "Ascending Degenerations of the Spinal Cord" (*ibid.*, 1892); Article on "Pernicious Anæmia" ("Quain's Dict. of Med.," 2nd edit.); "A Case of Multiple Infective Neuritis" (*Clin. Soc. Trans.*); "A Case of Amystrophic Lateral Sclerosis with Degeneration of the Motor Path from the Cortex to the Periphery" (*Brain*, 1895); "Experimental Enquiry upon the Afferent Tracts of the Central Nervous System" (*ibid.*, 1895); "The Sensori-Motor Functions of the Central Convolutions of the Cerebral Cortex" (*Journ. Physiol.*, 1894); "Experiments upon the Influence of Sensory Nerve upon Movement and Nutrition of the Limbs" (Preliminary Communication, with Prof. Sherrington, F.R.S.) (*Proc. Roy. Soc.*, vol. lvii.).

JOHN MURRAY,

Ph.D. (Jena)., LL.D. (Edin.), D.Sc. (Camb.). One of the Naturalists on board the *Challenger*, 1872–76. First Assistant on the *Challenger* Editorial Staff, 1876–82. Editor and Director of the *Challenger* publications, 1882–95. Editor of the Reports on the Scientific Results of H.M.S. *Challenger*; joint Author of the Narrative of the Cruise of the *Challenger*, and of the Report on Deep-Sea Deposits; Author of a Summary of the Scientific Results of the *Challenger* Expedition; Author of numerous Papers dealing with Oceanography, Physical Geography, and Marine Biology.

KARL PEARSON,

M.A., LL.B., late Fellow of King's College, Cambridge. Professor of Mathematics and Mechanics at University College, London. Editor and joint Author of vol. i. of Todhunter's "History of Elasticity." Author of the following papers on Elasticity:—"On the Distortion of a Solid Elastic Sphere" (*Quart. Journ. Math.*, vol. xvi.); "On Twists in an Infinite Elastic Medium" (*Mess. of Math.*, vol. xiii.); "On the Flexure of Heavy Beams" (*Quart. Journ. Math.*, vol. xxiv.); "On the Generalised Equations of Elasticity, and their Application to the Wave Theory of Light" (*Proc. Lond. Math. Soc.*, vol. xx.); "On Energy in an Elastic Solid" (*Mess. of Math.*, 1889); "On Wöhler's Experiments on Alternating Stress" (*ibid.*, 1890): also "Contributions to the Mathematical Theory of Evolution" (*Phil. Trans.*, 1894).

THOMAS ROSCOE REDE STEBBING,

M.A. (Oxon.), B.A. (Lond.). Clerk in Holy Orders. Late Fellow and Tutor of Worcester College. Author of Report on the Amphipoda collected by H.M.S. *Challenger*, a task which has occupied him almost exclusively for six years. It forms three large volumes (vol. xxix. of the Report), and consists of 1774 pages, and 212 plates, with a map, 4to, 1888. (The figures were all drawn by the author.) Also author of the following:—"Note on *Calceola sandalina*, Lmk." (*Geol. Mag.*, vol. x., pp. 57–61, pl. v., 1873); "A New Species of Sessile-eyed Crustaceans" (*Ann. and Mag. Nat. Hist.*, ser. 4, vol. xvii., pp. 73–80, pl. iv.–v., 1876); "Amphipodous Crustaceans (*Hyale, Aronyx, &c.*)" (*ibid.*, pp. 337–346, pl. xviii.–xix., 1876); "Some New and little-known Amphipodous Crustaceans" (*ibid.*, vol. xviii., pp. 443–449, pls. xix.–xx., 1876); "On Sessile-eyed Crustaceans" (*ibid.*, ser. 5, vol. i., pp. 31–37, pl. v., 1878); "On Species of Amphipodous Crustaceans" (*ibid.*, vol. ii., pp. 464–370, pl. xv., 1878); "The Sessile-eyed Crustaceans of Devonshire" (*Trans. Devon. Assoc.*, vol. xi., pp. 516–524, 1879); "On *Gastrosaccus spinifer*" (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. vi., pp. 114–118, pl. iii., and p. 328, 1880); "A New English Amphipodous Crustacean" (*ibid.*, vol. xv., pp. 58–62, pl. ii., 1885); "On the Crustacea Isopoda of the *Lightning*, *Porcupine*, and *Valorous* Expeditions" (joint paper with the Rev. A. M. Norman, *Trans. Zool. Soc.*, 1886, vol. xii., pp. 77–142, pls. xvi.–xxvii.); "Exotic Amphipoda from Singapore and New Zealand" (*ibid.*, vol. xii., pp. 199–220, pls. xxxviii.–ix.); Address as President of Devonshire Assoc. (*Trans. Devon. Assoc.*, 1884).

Supplementary Certificate.—Author of "The Naturalist of Cumbræ; being the Life of David Robertson, F.L.S., F.G.S., by his Friend" (1891)" "The right Generic Names of some Amphipoda" (*Ann. and Mag. Nat. Hist.*, 1890); "Sessile-eyed Crustaceans" (*ibid.*, pl. xv.–xvi., 1891); "On the genus *Urothæ* and a new genus *Urothoides*" (*Trans. Zool. Soc.*, pl. i.–iv., 1891); "A History of Crustacea" and "Recent Malacostraceæ" (1893); "A New Pedunculated Cirripede" (*Ann. and Mag. Nat. Hist.*, pl. xv., 1894); "The Amphipoda collected during the Voyages of the *Willem Barents* in the Arctic Seas in the Years 1880–84" (*Soc. Nat. Art. Mag.*, Amsterdam, 1894, pl. i.–vii.); "On the Amphipoda of the *Buccaneer*" (*Zool. Soc. Trans.*, 1895, pls. i.–iv.); "Notes on Crustacea"

(*Ann. and Mag. Nat. Hist.*, pl. ii., 1895); "On Four New British Amphipoda (Stebbing and Robertson, *Zool. Soc. Trans.*, vol. xiii., pl. v.-vi., 1891).

CHARLES STEWART,

M.R.C.S., President of the Linnean Society. Conservator of the Museum of the Royal College of Surgeons, and Hunterian Professor of Human and Comparative Anatomy. Late lecturer on Comparative Anatomy, and joint lecturer on Physiology at St. Thomas's Hospital. Distinguished as a Biologist. Author of the following papers:—"On the Structure and Cause of Colour in the Nacreous Layer of Shells" (*Devon. Assoc. Trans.*, 1864); "On the Spicula of the Regular Echinoidea" (*Trans. Linn. Soc.*, 1865); "On a New Sponge, *Tethyopsis columnifer*" (*Quart. Journ. Micros. Sci.*, 1870); "On the Minute Structure of certain Hard Parts of the genus Cidaris" (*ibid.*, 1871): "Note on the Scalp of a Negro" (*Monthly Micros. Journ.*, 1873); "Note on the Calcareous Parts of the Sucking Feet of an Echinus, *Podophora atrata*" (*ibid.*, 1873); "Notes on *Bucephalus polymorphus*" (*ibid.*, 1875); "On the Lachrymal Gland of the Common Turtle (*ibid.*, 1877); "On a New Coral, *Stylaster stellulatus*, and Note on *Tubipora musica*" (*ibid.*, 1878); Note on an Abnormal *Amblypneustes griseus*" (*Journ. Linn. Soc.*, 1880); "On certain Organs of the Cidaridæ" (*Linn. Soc. Trans.*, 1877); "On Some Structural Features of *Echinostrephus molare*, *Parasalenia gratiosa*, and *Stomopneustes variolaris*" (*Journ. Roy. Micros. Soc.*, 1880); "On a Supposed New Boring Annelid" (*ibid.*, 1881); "On a Hermaphrodite Trout, *Salmo fario*" (*Journ. Linn. Soc.*, 1891); "On a Hermaphrodite Mackerel, *Scomber scomber*" (*ibid.*, 1891); "On Some Points in the Anatomy of *Heloderma*" (*Proc. Zool. Soc.*, 1891); "On a Specimen of the True Teeth of *Ornithorhynchus*" (*Quart. Journ. Micros. Sci.*, 1891).

Supplementary Certificate.—Fullerian Professor of Physiology in the Royal Institution.

WILLIAM E. WILSON,

A gentleman who has devoted himself to astronomical research. In December 1870, he was engaged on the Total Solar Eclipse Expedition to Oran. In 1872 he built an astronomical observatory at Daramona and equipped it with a 12″ reflector by Grubb. In 1881 he built a new observatory and equipped it with a 24″ reflector by Grubb. In 1891 this was remounted and provided with electric control for stellar photography. Author of "A Method of recording the Transits of Stars by Photography" (Roy. Astron. Soc., 1889); "A New Photographic Photometer for Determining the Magnitudes" (*ibid.*, 1892); "On the Radiation of Heat from Sun Spots" (*Proc. Roy. Soc.*, vol. lv.); "The Absorption of Heat in the Solar Atmosphere" (*Proc. Roy. Irish Acad.*, 1892), in conjunction with Prof. Rambaut; "Experimental Investigations on the Effective Radiation from the Sun" (*Phil. Trans.*, 1894), in conjunction with Mr. P. L. Gray; "On the Temperature of the Carbons in the Electric Arc" (*Proc. Roy. Soc.*, 1892), in conjunction with Mr. P. L. Gray.

Supplementary Certificate.—In addition to the qualifications already set forth the following may be mentioned:—(1) Mr. Wilson has undertaken to carry out Experiments on Solar Radiation for the Committee of the British Association; (2) he has written a paper entitled "The Thermal Radiation from Sun Spots" (*Monthly Notices R.A.S.*, vol. lv., No. 8); (3) he has also written on "The Effect of Pressure of the surrounding Gas on the Temperature of the Crater of the Electric Arc" (*Proc. Roy. Soc.*, vol. lviii.).

HORACE BOLINGBROKE WOODWARD,

F.G.S., Geologist on the Geological Survey of England and Wales. Hon. Mem. Norfolk Nat. Soc. and Yorksh. Phil. Soc. Awarded the Murchison Fund by the Council of the Geological Society in 1885. On the staff of the Geological Survey since 1867, and author of the following memoirs:—"Geology of East Somerset and Bristol Coalfields" (1876); "Geology of the Country around Norwich" (1881); "Geology of the Country around Fakenham, &c." (1884); and of parts of five other memoirs; also of parts of sixteen sheets of the map, and of nine sheets of sections. Author of "The Geology of England and Wales" (1876 and 1887); of two papers in *Quart. Journ. Geol. Soc.* (1876, 1886); nine papers, &c., in *Proc. Geol. Assoc.* (1875-1889); of two Presidential Addresses to the Norwich Geol. Soc. (1879, 1880); of eleven other papers published by Norfolk and Somersetshire Societies (1874-1887); of nine papers in the *Geological Magazine*; of Reports on Coast Erosion (Brit. Assoc., 1885, 1889); and of Reports on Pliocene and Post Pliocene Beds to the British Sub-Committee of the International Geological Congress (1882, 1888),

Supplementary Certificate.—Since the above certificate was sent in, Mr. Woodward has been President of the Geologists' Association and of the Norfolk Naturalists' Society. He has also published various papers and memoirs, including the following:—"Formation of Landscape Marble" (*Geol. Mag.*, 1892); "Geological Zones" (*Proc. Geol. Assoc.*, 1892); "Oolitic Iron Ore in Raasay" (*Geol. Mag.*, 1893); "Memoir on the Lias of England" (Geological Survey, 1893).

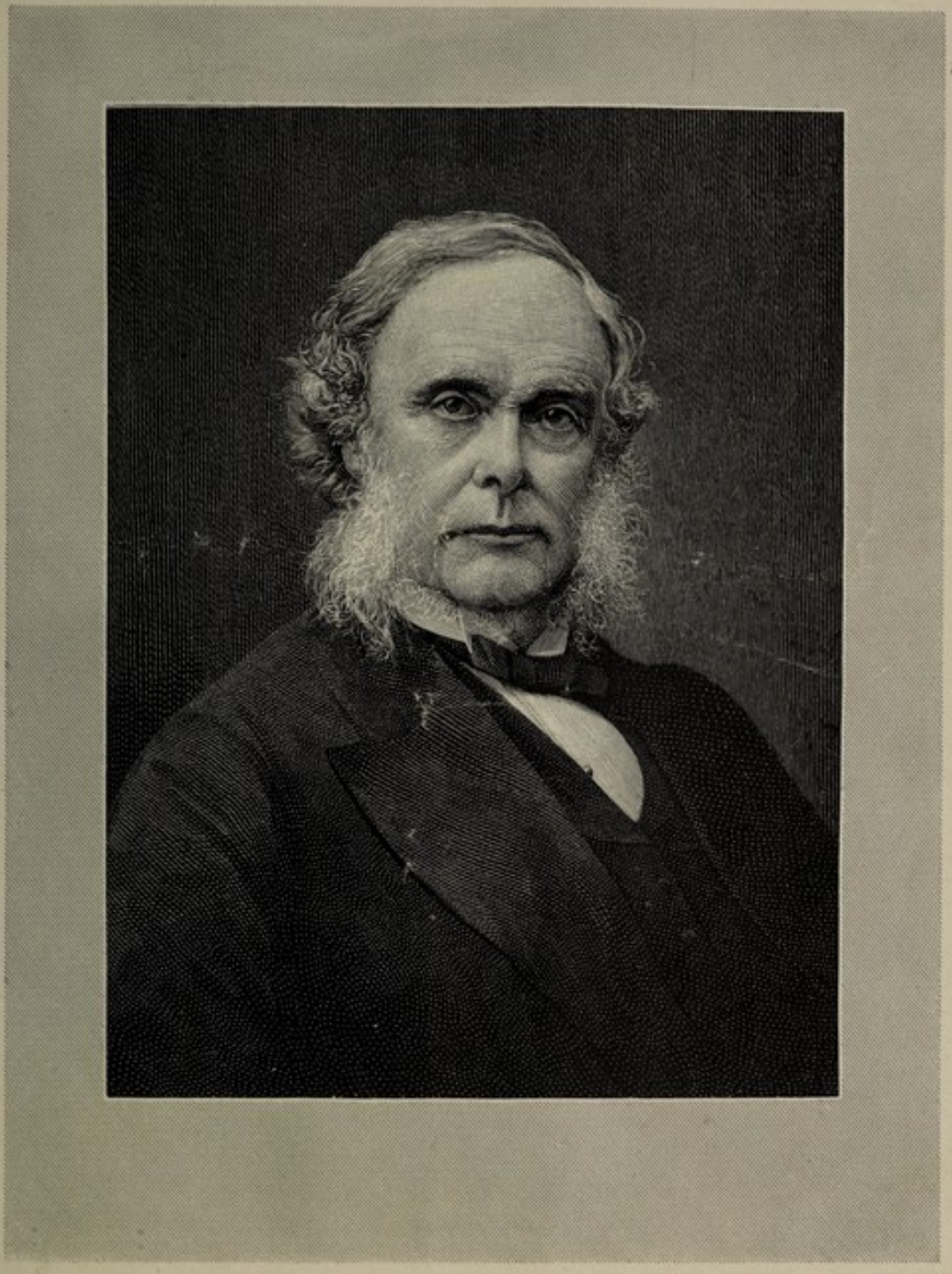
WILLIAM PALMER WYNNE,

D.Sc. (Lond.), Assistant Professor of Chemistry in the Royal College of Science, South Kensington. Distinguished for his zeal and ability as an organic chemist. Author of "Action o. Sulphuryl Chloride on Acetorthotoluidide and Acetoparatoluidide, Mono-, Di-, and Tri-chlorotoluenesulphonic Acids," and "Note on the Constitution of Nevile and Winther's Orthotoluidenesulphonic Acid and of the Sulphonic Acids of Orthochlorotoluene and Orthobromotoluene" (*Trans. Chem. Soc.*, 1892). Joint Author with Prof. Japp of "Action of Aldehydes and Ammonia on Benzil" (*Trans. Chem. Soc.*, 1886). Joint Author with Prof. Armstrong of twenty-four papers in the *Proc. Chem. Soc.* from 1886-93 on Naphthalene and its Derivatives.

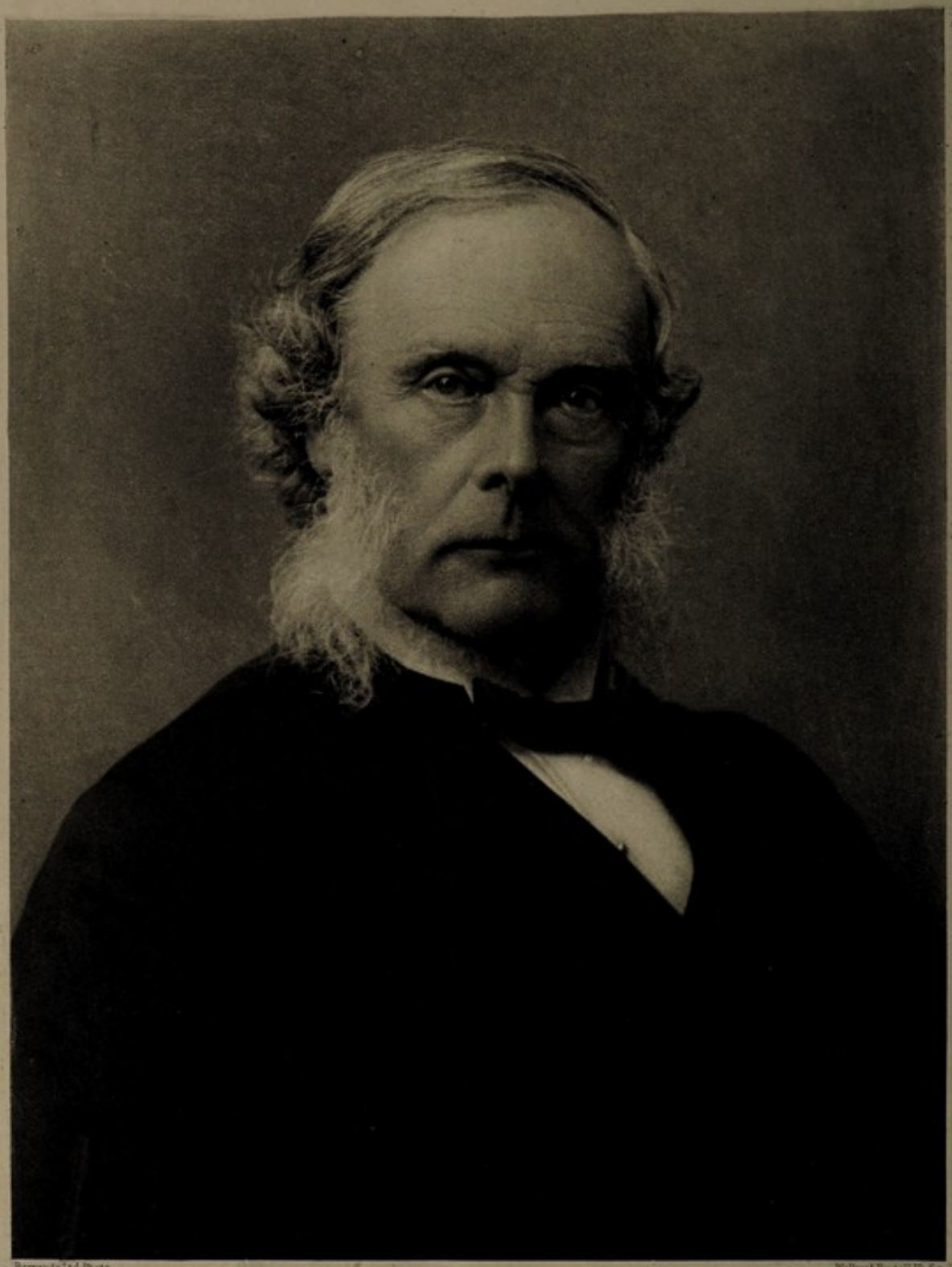
Supplementary Certificate.—Has submitted to the Chemical Society since 1893 papers on the Disulphonic Acids of Toluene and of Ortho- and Para-chlorotoluene (in conjunction with Mr. James Bruce); on the Six Dichlorotoluenes and their Sulphonic Acids (in conjunction with Mr. Alfred Greeves); and eleven communications on Naphthalene Derivatives (in conjunction with Dr. Armstrong). In their communications on Naphthalene (thirty-nine in all) made to the Chemical Society during the past ten years, Drs. Armstrong and Wynne have revised practically the whole of the Chemistry of Naphthalene in so far as relates to the formation of its Chlorinated and Sulphonated Derivatives, and, besides describing many new Derivatives, have placed beyond question the structure of the ten Di- and fourteen Tri-Chloronaphthalenes to which respectively all other Di- and Tri-Derivatives may be referred.

ON LIPPMANN'S COLOUR PHOTOGRAPHY WITH OBLIQUELY INCIDENT LIGHT.

IN the discussion which followed Prof. Lippmann's splendidly interesting communication to the Royal Society (April 23), on colour photography, I suggested the possibility of applying his method to the Röntgen X-light; but at the same time remarked that it might be found impracticable on account of the smallness of the specular reflection of the X-light from polished surfaces, unless at obliquities little short of 90°. Lord Blythswood's experiments, communicated to the Royal Society on March 19, seemed to prove decisively something of true specular reflection of X-light, incident on a plane mirror of speculum metal at 45°. Experiments, which he has since made by means of a concave mirror of speculum metal, have demonstrated beyond all doubt that there is regular reflection at nearly normal incidence; but they have also proved that the amount of regularly reflected light is exceedingly small in proportion to diffuse light caused to emanate from the mirror, by the incidence of X-light upon it. Experiments by Joly, of Dublin, have, I believe, proved somewhat abundant specular reflection of the X-light, at incidences little short of 90°, on surfaces of bodies transparent to ordinary light. And the extremely small refractivity of the photographic gelatine film for X-light, will allow incidences little short of 90° upon the metal mirror, to be used instead of the normal incidences which Prof. Lippmann has hitherto used. But for very oblique incidences the mercury mirror, with its surface fitted to



JOSEPH LISTER.



Bassano Ltd. Photo. Walker & Boutall Ph. Sc.

Joseph Lister

the not rigorously plane surface of the photographic film, would be unsuitable; and the plan, which Lord Rayleigh described in the discussion, of forming the film on a solid metallic mirror, might be substituted for it.

All things considered, it seems not improbable that Lippmann's process may be applied successfully to X-rays at nearly grazing incidences on metallic mirrors, and possibly even on non-metallic mirrors.

Suppose now, for instance, the directions of the incident and reflected rays to be inclined to the mirror at angles of ·1 of a radian (5°·7). The distance between the planes of stratification in the photograph would be ten times that which would be produced by the same light at normal incidence. Thus if, for example, the wave-length of the particular X-light used is 5×10^{-6} cms. (or one-tenth of that of green light), the photograph would show tints of from green to violet when viewed normally, or at less or more oblique angles, by Lippmann's ordinary arrangements.

It is quite possible, however, that when we know something of the composition of Röntgen light, we may find such great differences of wave-lengths [1] in it, and so much difficulty to obtain approximately homogeneous X-light by sifting through metal plates (as we sift ordinary visible light by coloured glasses), or by other means if other means can be found, that the experiment which I have suggested may fail on account of want of homogeneousness of the incident light.

But here, suggested to me by thinking of oblique incidence for the photographic light, is an illustrative experiment which (with variations of detail to facilitate realisation) cannot fail if Prof. Lippmann will think it worth while to try it. Place a point source of homogeneous violet light (wave-length 4×10^{-5} cms.) so near to the centre of the mirror and sensitive film that rays shall be received at all angles of incidence from zero up to 56° (being the angle of which the secant is 1·788). The thickness of each stratum will vary in different parts of the photograph in simple proportion to the secant of the angle of incidence, and in the centre it will be equal to the half wave-length. It will therefore vary from 2×10^{-5} in the centre to $3{\cdot}6 \times 10^{-5}$ at the circle of 56° incidence. This photograph, viewed or thrown on a screen as nearly as may be normally, according to Prof. Lippmann's ordinary procedure, will be seen as a complete spectrum in concentric circles, with violet in the centre, and red, of wave-length $7{\cdot}15 \times 10^{-5}$, at the circle of 56° incidence; but, if viewed by an eye placed at the position of the source of the violet light which photographed it, it will, according to the principles explained by Dr. Lippmann in his paper, be seen of uniform violet light throughout its whole area.

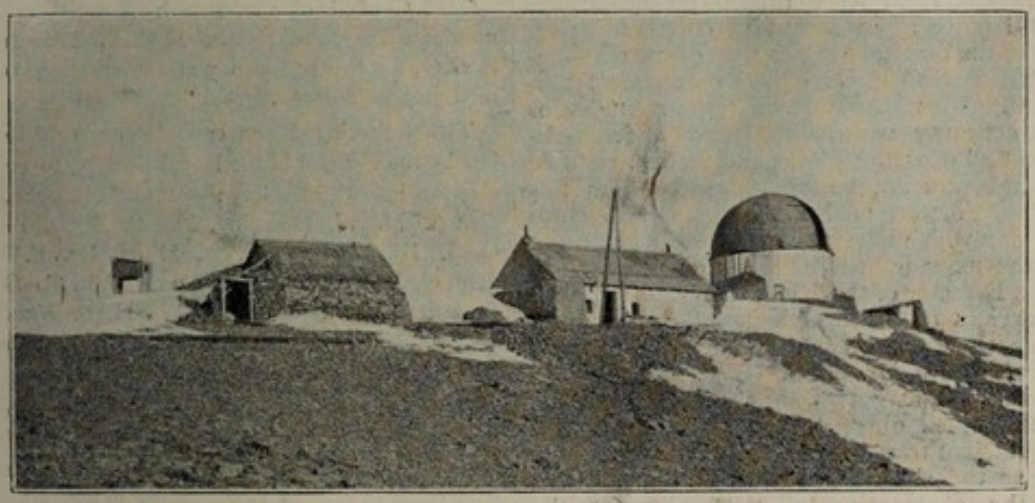
KELVIN.

[1] It is to be hoped however that, very soon, we shall have definite knowledge of wave-lengths of Röntgen X-light by diffraction fringes actually seen instead of estimates of their smallness from diffraction fringes not seen. I should explain that I am writing on the supposition which seems to me, after much correspondence with Sir George Stokes, to be exceedingly probable that Röntgen light is merely ordinary transverse-vibrational light of very short period. That its period is less than one-fifth that of green light seems well proved by the skilful experiments described by Perrin in *Comptes rendus*, January 27, 1896, p. 187; and by Sagnac, *Comptes rendus*, March 30, p. 783.

THE OBSERVATORY AT MONT MOUNIER.

THERE is no end to the generosity of M. Bischoffsheim. Not so very many years ago he endowed science with an observatory at Nice, and now again he has presented another, and this one is at the high altitude of over 8900 feet The observatory is situated on the summit of Mont Mounier, one of the peaks in the Maritime Alps. The advisability of having it at this spot was suggested by M. Bischoffsheim himself.

It was not till early in 1893 that the plans were worked out, but the observatory was sufficiently finished in August of the same year, to allow observations of Venus to be made before the planet passed into its inferior conjunction.



Mont Mounier Observatory (altitude over 8900 feet).

The buildings consist of a house for the astronome and his assistant, the actual observatory, which has a revolving metallic dome (26 feet in diameter), and a wooden hut, used as workshop or depôt. The house and actual observatory are united by a passage, which is indeed a necessary arrangement, on account of the very severe weather, and the snow, which sometimes lies thickly on the ground.

The observatory is a branch of the one at Nice, and at the time that important observations were being made at Nice, for the purpose of verifying M. Schiaparelli's discoveries on the rotation of the planet Venus, they were simultaneously being carried on at Mont Mounier by M. Perrotin, and with most successful results.

M. Bischoffsheim suggested that the observatory should be a meteorological station; it has therefore been furnished with Richard's recorders, and instruments for ascertaining the temperature, pressure, and other conditions of the air.

Nor is the observatory now isolated. For some weeks the house has been connected by telephone to Beuil, the nearest village with a telegraph office, a distance of five miles. This was also done at the expense of M. Bischoffsheim. It will therefore be possible to send daily reports to the central meteorological office of th observations made on Mont Mounier.

There can be no doubt that the Mont Mounier observatory, started under such favourable conditions, and so well supplied with instruments, will considerably assist in the advance of science.

DR. ADALBERT KRÜGER.

ASTRONOMERS in all observatories and of all nationalities will have learned with regret of the death of Dr. Krüger, the Director of the Kiel Observatory, but who, perhaps, will be more generally recalled as the editor of the *Astronomische Nachrichten*, and gratefully remembered for his services to that journal. From the time that Schumacher, under the auspices of the Danish Government, started the *Nachrichten*, no astronomical journal has proved itself so indispensable, both as a means for the publication of observations and the dissemination of astronomical knowledge, or contributed more to its advance and progress. For that large class of observations of which early publication is its greatest value, but the details of which are a weariness to most editors, the *Astr. Nach.* has stood unrivalled, and its general conduct has wisely preserved the broad lines on which it was originally established. And with the progress of time, as the eagerness of observers has increased with their numbers, Prof. Krüger has recognised the necessity of still more rapid means of communication, and by adding to his manifold duties that of the management of the *Bureau central des dépêches astronomiques*, he has made still further demands on our gratitude, for the ease and certainty with which astronomical discoveries are sent all over the globe, and made available to those who take advantage of the system he has elaborated. Prof. Förster, of Berlin, we believe, early advocated the plan which has proved itself so useful, but the details of the management have been wisely left in the hands of the Director of the Kiel Observatory.

But these services to science, rendered continuously from 1880, when the death of Dr. Peters made vacant both the positions which Dr. Krüger has since filled so admirably, should not put out of sight the fact that he has been both a skilled observer and an ardent astronomer. It is sufficient to recall here his more prominent services, such as the share he took with the late Dr. Schönfeld in the observation of the zones for the *Durchmusterung* at the Bonn Observatory: a work at first voluntarily undertaken on his part, but later in regular and active co-operation with Argelander and Schönfeld. Here, too, during an absence of Dr. Winnecke, which prevented the heliometer being used, he began and carried to a successful issue the determination of the parallax of 70 Ophiuchi, in two very accordant series.

In 1862 Dr. Krüger was appointed Director of the Helsingfors Observatory, in which the instrumental equipment was probably insufficient. There he busied himself with an inquiry into the orbit of Themis, with the view of obtaining a more accurate value of the mass of Jupiter, which the continued observation of that planet is likely to afford. The result, published in the *Proceedings* of the Finnish Society of Sciences, was to show that Bessel's value of the mass of Jupiter, the then received value, required to be increased by the 68/100,000 part, and to give a value intermediate between that of Airy and Bessel, as derived from the motions of the satellites.

From Helsingfors, Dr. Krüger went to the Observatory at Gotha, where he stayed five years, leaving that city to take up his final position at the well-equipped Kiel Observatory, in 1880. For after the termination of the Danish dominion in the Elbe Duchies, the observatory had been enriched by the instruments from the old observatory at Altona, and had been brought into closer relations with the university. This position naturally carried with it the editorship of the *Nachrichten*, to which allusion has already been made. It is true that since the journal has been under his care, the words "Unter Mitwirkung des Vorstandes der Astronomischen Gesellschaft" have appeared on the title-page, but we imagine Dr. Krüger has enjoyed a free hand in its management, with beneficial results to the journal and to his own reputation. In his capacity as Director, he has published many observations of comets, and prepared, or had prepared under his own eye, the orbits and ephemerides of many of these bodies. These computations have been occasionally enriched by notices of a mathematical character, such as the effect of perturbations by planets near the sun. He has also occasionally given original observations of stars observed with comets, and in many useful, if not brilliant, ways, he has shown his capacity as a Director of an observatory. His career has been marked by an energy and industry, to which might be applied the words of Schiller, "Beschäftigung die nie ermattet, die langsam wirkt doch nie zerstört."

NOTES.

THE first of the two annual conversaziones of the Royal Society was held last night, as we went to press.

THE Council of the British Association have resolved to nominate Sir John Evans, K.C.B., Treasurer of the Royal Society, for the presidency at the meeting whieh will be held next year in Toronto.

THE following fifteen candidates were selected on Thursday last by the Council of the Royal Society, to be recommended for election into the Society:—Sir G. S. Clarke, Dr. J. N. Collie, Dr. A. M. W. Downing, Dr. F. Elgar, Prof. A. Gray, Dr. G. J. Hinde, Prof. H. A. Miers, Dr. F. W. Mott, Dr. J. Murray, Prof. K. Pearson, Rev. T. R. R. Stebbing, Prof. C. Stewart, Mr. W. E. Wilson, Mr. H. B. Woodward, Dr. W. P. Wynne. The qualifications of the candidates will be found in another part of this issue.

THE Surinam Toads (*Pipa americana*), at the Zoological Society's Gardens, have recommenced breeding this year, and two of the females may now be seen with their backs covered with cells, in each of which an egg is located. The hitherto unexplained mode in which the eggs are transferred into their cells has been discovered, and the secret was divulged at the last scientific meeting of the Society.

AN unnamed donor has given Harvard University 100,000 dols. to found a Chair of Comparative Pathology, the only one of the kind in any leading American University.

THE generous hospitality always dispensed to British men of science by continental Governments beggars anything ever done officially in England to welcome foreign visitors distinguished in science. We have already notified that the summer meetings of the Institution of Naval Architects will be held this year in Hamburg on Monday, June 8, and the following day. On Wednesday, June 10, the meetings ill be transferred to Berlin, on the invitation of the Imp rial Germa Government, and will be continued there during he remainder of the week. With a public spirit which should put British steamboat companies to shame, the Hamburg-American Company have generously offered to take the members over in a body from Tilbury to Hamburg in their twin-screw Transatlantic liner the *Fürst Bismarck* free of charge. The steamer will start either late on Saturday night, June 6, or else early on Sunday morning, June 7, and will arrive in Hamburg in about twenty hours after its departure. The meetings are receiving the warmest support from the Imperial Government, and the arrangements in Berlin are being carried out by the Imperial

Ministry of the Interior and the Imperial Ministry of Marine. A programme of exceptional interest for the instruction and entertainment of the members is already in course of preparation. The meetings for the reading and discussion of papers will be held in Hamburg in the Bürgerschafts-Saal in the building of the Patriotische Gesellschaft, and in Berlin in the large hall of the Technical High School. Papers have already been promised by the following German members of the Institution:—Herr Dietrich (Privy Councillor), Constructor-in-Chief of the Imperial German Navy, Herr F. Laeisz, President of the Chamber of Commerce of Hamburg, and by Mr. B. Martell and Dr. F. Elgar, amongst other home members of the Institution. It is hoped that the members of the Institution will do all in their power to assist in doing honour to their most hospitable hosts by attending in large numbers.

IT is with sad feelings that we read of the elaborate preparations that have been made abroad to celebrate the centenary of the discovery of vaccination, and reflect that nothing is being done in England to honour Jenner's memory. The *British Medical Journal* says:—On May 14, 1796, Edward Jenner performed the first successful vaccination. The centenary of that event is to be celebrated in a manner befitting its importance in the history of mankind in Germany, Russia, and the United States. In Berlin preparations have been made under the direction of a Committee which includes Profs. Virchow, Gerhard, von Leyden, Robert Koch, von Bergmann, Koenig, Heubner, Langerhans, Proskauer, and other leading representatives of medical and sanitary science, for a great meeting on May 14 in honour of the discoverer of vaccination. There is also to be an exhibition in the Medicinische Waarenhaus (Friedrichstrasse, 108 I, Berlin, N.) of literature, old and new, relating to vaccination, portraits, medals, instruments, &c. In St. Petersburg, the Russian Public Health Society, the Honorary President of which is the Grand Duke Paul Alexandrovitch, has, with the sanction of the Czar, organised a commemoration festival on a still larger scale. On May 14 a "general and solemn" meeting will be held in honour of the discovery. Four prizes will be awarded for the best works on vaccination. An exhibition of objects connected with vaccination will be held. A Russian translation of Jenner's writings, with a biography and portrait, and reproductions of his drawings, will be published under the editorship of Dr. W. O. Hubert. The Council of the Society, with the help of the Government, of provincial and municipal administrative bodies, of scientific societies, and private medical practitioners, has collected materials for a history of small-pox and vaccination in Russia, which will appear at the same time. In the United States arrangements for the celebration of the centenary have been made by a conjoint Committee appointed by the American Medical Association and the American Public Health Association. The celebration is fixed for May 7, the third day of the meeting of the American Medical Association at Atlanta, and the whole of that day will be occupied by addresses and discussions on Jenner and vaccination. Truly is a prophet without honour in his own country when that country is England.

SIR JOHN GORST stated in the House of Commons, on Thursday last, that arrangements are being made to open the Geological Museum in Jermyn Street on Sundays, but the continuance of the practice will depend upon how far the number of visitors appears to justify it.

THE *Botanical Gazette* has passed into the possession of the University of Chicago. It is not, however, to be the botanical organ of the University, but will be freely open, as before, to botanists of all parts of the globe. The object of the change is to secure permanence and possibility of development. The old editors, Prof. J. M. Coulter, Prof. C. R. Barnes, and Prof. J. C. Arthur, remain.

WE learn from the *Botanical Gazette* that the recent "Culver gift" of one million dollars to the University of Chicago for biological endowment has resulted in the establishment of a Department of Botany, in which Dr. John M. Coulter has accepted the head professorship. A large building, to be known as the "Hull Botanical Laboratory" has been planned, and its erection will soon be begun. The four stories of this building will contain ample space for lecture-rooms, libraries, laboratories, and private research rooms for morphology, physiology, and taxonomy. Above the fourth story a large roof-greenhouse will supply an abundance of living material under all conditions As the building will not be completed before April 1897, the full botanical staff will not be organised before the autumn of that year.

DURING the last few weeks some experiments in sea-fish hatching have been carried on at the Port Erin Biological Station, for the Lancashire Sea Fisheries Committee. Prof. Herdman has erected a series of wooden tanks and sand filters, through which the water is passed by the action of a water-wheel worked by the fresh-water tap. The Sea Fisheries steamer, *John Fell*, spent several days at Port Erin trawling for the spawning fish. The ova were fertilised on board, and then conveyed to the tanks. The first batch of young fish ("witches" or white soles) were hatched out on April 29, exactly seven days after fertilisation; and there are now in the tanks, far advanced in their development, lemon soles, witches, and grey gurnards. The work, so far, has been carried out successfully, and the result ought to encourage the Lancashire Committee to realise their project of erecting a sea-fish hatchery near the principal spawning grounds of the Irish Sea.

WE regret to note the death of the Rev. W. C. Ley, on the 22nd ultimo, at the age of fifty-five. He was ordained in 1863, and in 1874 was presented by the Lord Chancellor to the rectory of Ashby Parva, near Lutterworth, which he held until 1892. Mr. Ley had for many years paid special attention to the study of the clouds and the movements of upper air-currents. In 1872 he published an important work on "The laws of the winds prevailing in Western Europe," in which he showed how the preparation of synchronous weather charts, and the accumulating testimony of the universality of the law generally known as Buys Ballot's, connecting wind conditions with the distribution of barometric pressure, had proved some accepted weather theories to be erroneous, and had rendered necessary a new investigation of the general laws. In the year 1879 the Meteorological Council appointed him Inspector of their English stations, and in the following year they requested him to prepare a manual to facilitate the study of the weather in connection with the information supplied by their Daily Weathe Reports. This work, entitled "Aids to the study and forecast of weather," explains clearly the relations of weather conditions to the distribution of areas of both high and low atmospheric pressure. His most recent work, "Cloudland, a study on the structure and characters of clouds," published in 1894, was prepared for press by his son, owing to the serious illness of the author. It embodies the results of his life's work in connection with this subject; the nomenclature is probably too advanced for general adoption, but the treatise contains much valuable information upon the classification of the clouds and the origin of their formation, as well as upon the important bearing of cloud observation on the prognostication of weather. Many papers of minor importance were contributed by Mr. Ley to the *Journal* of the Royal Meteorological Society.

MR. F. E. BEDDARD, F.R.S., gave the first of a course of lectures on the animals in the Zoological Society's Gardens, in the

lecture-room at the Gardens, on Saturday last. The lecture was of an introductory character, explaining the position of Mammals amongst the Vertebrates, and their classification into three main divisions. The extinct Multituberculata and their possible relation to the Monotremes were also spoken of. The course will be continued every Saturday at 4 p.m. until July 4.

AT the International Meteorological Conference at Munich, in 1891, a Committee was appointed to consider the question of concerted observations on the direction of motion and the height of clouds. The report of this Committee was made to the International Meteorological Committee at their meeting at Upsala in 1894, the result being that all countries were invited to take part in the investigation of the upper currents of the atmosphere, by means of cloud observations, which are to commence on the 1st prox., and be continued for a year at least. For the use of observers who adopt the international classification recommended at Munich, a standard cloud atlas has been prepared, consisting of about thirty coloured pictures, and is now in course of publication in Paris; while persons who do not adopt that classification are at liberty to use the nomenclature employed in their country. The observations of motion may be made without instruments, or with simple nephoscopes; but the measurements of altitudes require the use of theodolites or photogrammeters, and can only be carried out at regular observatories. Descriptions of the methods to be employed have been published by Dr. Hildebrandsson, of Upsala, and others, and also in *Das Wetter* for February last. Various countries in Europe, the United States, and Java, have undertaken to make the more difficult instrumental observations, and it is recommended by the International Meteorological Committee that the observations from each country should be eventually published *in extenso*, as a separate publication.

THE south-east of Europe is one of the most pronounced seismic districts of the world, and it is gratifying to learn that the earthquakes there are to receive the attention they deserve. In a previous note, we have referred to the work of the seismological section of the meteorological observatory at Constantinople, and we have now to announce the formation of a similar section of that at Athens. This has been placed under the charge of Dr. S. A. Papavasiliou, who is well known for his careful investigation of the Locris earthquakes of 1894. Information with reference to Greek earthquakes has indeed been transmitted to the observatory since 1893, and the accounts of these shocks will be published later on. It is only, however, within the last few months that an attempt has been made to organise regular observations. At the observatory of Athens two Brassart seismoscopes of a simple character have been erected, one of them giving the time of occurrence of each shock felt there. The officials at the meteorological stations and telegraph offices (twenty-three in number) have been instructed to make observations, and forward their registers to the observatory; and, commencing with this year, a monthly seismological bulletin has been started. The number for January has just been published, and tends to confirm Dr. Papavasiliou's estimate that hardly a day passes without an earthquake being felt somewhere in Greece, for no less than thirty-four are recorded as occurring during January alone. The most interesting is an after-shock, on the 24th ult., of the great earthquakes of April 20 and 27, 1894, showing a still further displacement of the epicentre towards the W.N.W. along the great fault formed at the time of the last-mentioned shock.

IN Tunbridge Wells, on Saturday last, a congress was held of the naturalists of the South-Eastern District, with the object of forming a Union of Natural History Societies for mutual help and investigation. The idea originated with Dr. George Abbott, who carried out all the preliminary details for the congress. The first part of the day was taken up by the delegates inspecting the geological features of the town, and after luncheon they assembled in the Pump Room, where the congress was held, under the chairmanship of the Rev. T. R. R. Stebbing, President of the Tunbridge Wells Natural History and Philosophical Society, and whose name is amongst those selected for election into the Royal Society. A large number of delegates from important Natural History Societies of the south-eastern counties of England were present. Dr. Abbott described how the Union could be of assistance to science. Each Society in the Union would offer its members (1) free admission to their lectures and excursions; (2) copies of their Transactions; (3) the use of their library; (4) assistance in naming of specimens, and with the formation of school museums. The corresponding members, in return, would be asked to (1) forward surplus natural history specimens to their Societies' Museum; (2) supply prompt information on the following subjects: (*a*) new geological sections; (*b*) details of wells, borings, springs, &c.; (*c*) finds of geological and antiquarian interest; (3) answer such questions as the British Association or the local Society may require; (4) keep an eye on historic buildings; (5) assist the Selborne Society in carrying out its objects. Such appointments would be certain to stimulate individual investigation in the parishes, and useful scientific work would be done. After a discussion, the following resolution was adopted: "That the delegates from various scientific Societies of Surrey, Kent, and Sussex, assembled in congress at Tunbridge Wells on April 25, 1896, agree that the congress shall meet annually, by invitation, at the home of one or other of the associated Societies." The Rev. T. R. R. Stebbing was elected President of the Union, and Dr. Abbott, Secretary. It was agreed that Surrey, Kent, Sussex, Middlesex, and Hampshire should be included within the scope of the Union's operations.

AN extremely interesting series of experiments on the action of a powerful magnetic field on the kathodic rays in Crookes' or Hittorf s tubes, is described by Herr Kr. Birkeland in the *Elektroteknisk Tidsskrift* (Christiania). These experiments prove that in such a field, the kathode rays are st rongly deflected in the direction of the lines of force, and can even be concentrated on to the surface of the tube until the glass melts. Moreover, the evidence suggests that the rays which emanate from one and the same kathode fall into groups, of which the physical constants are connected by some definite law, just as are the frequencies of the different tones emitted by a vibrating rod. The investigation has an important bearing on the theory of the Aurora Borealis. The Danish meteorologist, Herr A. Paulsen, is of opinion that the aurora owes its origin to phosphorescence of the air produced by kathodic rays in the upper strata of the atmosphere, and Herr Birkeland suggests that the earth's magnetism may be the cause of this phosphorescence becoming intensified in the neighbourhood of the terrestrial poles.

UNDER the editorship of Mr. F. S. Macaulay, of St. Paul's School, the first number of a new series of *The Mathematical Gazette* has just been issued by the Association for the Improvement of Geometrical Teaching. The size of the pages has been changed from quarto to demy octavo; by this change the *Gazette* has been brought into uniformity with the leading English and continental mathematical and other scientific octavo publications. The present number contains articles on "The Geometrical Method," by Dr. J. Larmor, F.R.S.; "Annuities treated without Progressions," by Dr. G. H. Bryan, F.R.S.; and "The Conic determined by Five Given Points," by the editor; together with a large number of problems and solutions. The *Gazette* deals exclusively with points of interest in the history and teaching of elementary mathematics (not extending beyond the Calculus), and it thus covers a somewhat different range of

subject-matter to any other mathematical journal in the United Kingdom.

MESSRS. DULAU AND CO. have just issued a catalogue (No. xv.) of works on geographical botany, containing more than four thousand titles, offered for sale by them.

THE Appendix of "Quain's Elements of Anatomy" (Longmans, Green, and Co.), which completes the tenth edition of the work, has now been published. The subject, "Superficial and Surgical Anatomy," is treated by Profs. G. D. Thane and R. J. Godlee.

WE learn from the current (and final) number of the *American Meteorological Journal*, that the New England Meteorological Society has been dissolved. It was formed in Boston, in June 1884, to promote the study of atmospheric phenomena in the New England States, and to establish systematic observation. It has done much useful work, especially relating to rainfall, thunderstorms and range of temperature, the results of which have from time to time been published in the above-named journal. The system of regular meteorological observations and the publication of a monthly bulletin were transferred to the New England Weather Service, in connection with the Washington Weather Bureau, several years ago.

THE Rebman Publishing Company have issued the first number of the *Archives of Clinical Skiagraphy*, by Mr. Sydney Rowland, being the commencement of a series of collotype illustrations, with descriptive text, illustrating applications of the new photography to medicine and surgery. In an introduction Mr. Rowland gives a brief account of Röntgen's discovery, and describes the great advantages obtained by the use of the form of Crookes' tube known as the focus tube, devised by Mr. Herbert Jackson. The excellent results obtained by British investigators working with X-rays are almost entirely due to the introduction of this form of tube. As to the constitution of fluorescent screens, Mr. Rowland agrees with the conclusion arrived at by Mr. Jackson after a systematic examination of numerous substances, viz. that the best salt to use is platinocyanide of potassium. The plates included in the present number of the *Archives* show the skeleton of a full-grown child, aged three months (exposure fourteen minutes), a needle embedded in a finger (exposure two minutes), knee-joint, from a case of multiple exostosis (exposure nine minutes), and hand of same case (exposure three minutes), wrist and forearm showing syphilitic disease of radius (exposure six minutes). The illustrations may be taken as an indication of how the Röntgen photography is able to supplement diagnosis in all cases of bony disease. It is really astonishing to think that, though Prof. Röntgen's discovery is but a few months old, it has already taken its place among the approved and accepted aids to diagnosis, and a publication has been started to deal with its developments in medicine and surgery.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Mr. E. Turnham; a Fennec Fox (*Canis cerdo*) from Egypt, presented by Mr. J. G. Mackie; a Mexican Skunk (*Mephitis macrura*) from Mexico, presented by Mr. Henry Heath Cochrane; a Brahminy Kite (*Haliastur indus*) from India, presented by Mr. A. Kemmis-Betty; an African Tantalus (*Tantalus ibis*), a Leopard Tortoise (*Testudo pardalis*) from East Africa, presented by Captain Dugmore; a Canary Finch (*Serinus canarius*) from Madeira, presented by Mr. H. B. Hewetson; a Great Wallaroo (*Macropus robustus*, ♀), a Gould's Monitor (*Varanus gouldi*), a Black and Yellow Cyclodus (*Cyclodus nigroluteus*) from Australia, a Yellow-headed Conure (*Conurus jendaya*), two Brazilian Tortoises (*Testudo tabulata*) from Brazil, five Meyer's Parrots (*Pæocephalus meyeri*), two Alario Sparrows (*Passer alario*) from South Africa, a Brown-throated Conure (*Conurus æruginosus*) from South America, deposited; a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, a Red-naped Fruit-Bat (*Pteropus funereus*), —— Bandicoot (*Perameles* ——) from Australia, two Spotted Tinamous (*Nothura maculosa*) from Buenos Ayres, purchased.

OUR ASTRONOMICAL COLUMN.

THE PLANET MERCURY.—An unusually good opportunity of observing the planet Mercury with the naked eye, or with an opera-glass, will be afforded about the middle of the present month. The planet will be at its greatest eastern elongation on May 16, when it will be 22° from the sun, and will remain above the horizon for two hours and a quarter after sunset. At this time the apparent diameter of the planet will be 8″, and about 0·4 of the disc will be illuminated. On May 14, at 6 p.m., the planet will be in conjunction with the moon, Mercury being 2° 24′ to the south; at 9 p.m. on the same evening, the crescent of the two days' moon will be about 3° N.N.E. of the planet.

COMET SWIFT 1896.—The following continued ephemeris for the new comet is from revised elements computed by Dr. Schorr for Berlin midnight:—

	R.A.	Decl.	Brightness.
	h. m. s.	° ′	
May 8 ...	2 12 41 ...	+62 58·1	
10 ...	1 58 52 ...	64 46·1 ...	0·35
12 ...	1 44 41 ...	66 17·4	
14 ...	1 30 19 ...	+67 33·9 ...	0·26

The unit of brightness is that on April 16. The comet was easily visible in a three-inch telescope on April 30, when the computed brightness was 0·7.

NEW DIVISIONS OF SATURN'S RINGS.—In the current number of the *Comptes rendus*, M. Flammarion gives particulars of some very interesting observations of Saturn's rings which have been made at his observatory by M. Antoniadi during the last month. Between the Cassini division and the Crape ring, three new divisions of the ring have been noted. The darkest of these, which is easily visible when the air is transparent, nearly bisects the inner bright ring; the fainter divisions, one on each side, are only observed with difficulty. The inner bright ring is thus divided into four zones, gradually darkening towards the planet.

This is by no means the first time that divisions of this kind have been recognised. Herschel, De Vico, Bond, Hall, and others, have in turn observed or suspected them, but Cassini's division is the only one which seems to be certainly permanent. M. Flammarion concludes that the fainter divisions observed on the rings are variable, and possibly dependent upon the varying attractions of the eight satellites upon the meteoritic particles of which the rings are composed.

DETERMINATION OF THE GENERAL BRIGHTNESS OF THE CORONA.—In the current number (vol. vi. No. 6) of the *Journal* of the British Astronomical Association, Mr. Joseph Lunt suggests a method by which a numerical value could be obtained for the general photographic intensity of the light of the corona during a total solar eclipse.

The method consists in photographing a "sensitometer window," consisting of twenty-five numbered squares of graduated opacities (like a Warnerke's sensitometer, but with different values). The opacities are so adjusted that an exposure of ninety seconds to full moon-light, which approximates to the coronal light, should yield a negative showing the figure 12. The negative could be obtained either by direct contact with the "sensitometer window" (as in lantern-slide making), or by forming an image of the "window" on the plate by means of a lens. The plates could be standardised by exposure to any standard artificial light or to full moon-light, according to Mr. Maunders' suggestion, in order to reproduce the precise illumination of the sensitometer window given by the corona. The conditions of development of the negatives for comparison should be identical, and the plates used should all be of identical sensitiveness.

The apparatus required is very simple, consisting of a box of square section, about three feet long, closed at one end by a ½-plate dark slide, and at the other by the ¼-plate sensitometer,

screened by a dew-cap. A diaphragm in the middle carries a lens to form an image of the sensitometer on the plate. A simpler way is to obtain the negative by direct contact, in which case the sensitometer should be screened from the general sky illumination of the horizon.

OBSERVATIONS ON ISOLATED NERVE.

THE work which Dr. Waller has recently summed up in the Croonian Lecture, is an experimental study of the influence of reagents upon excitable—that is to say, living—protoplasm. The choice of nerve as the most convenient form of living matter in such an inquiry is justified by the consideration that nerve, as is now generally admitted, is practically inexhaustible. That nerve fibre, apart from its end organs, is peculiarly responsive to even slight changes of chemical condition; and, further, that with this tissue there is the advantage of a wide and regular range between minimal and maximal effects. A previous research had shown (*Brain*, 1895) that in nerve, contrary to what obtains in muscle, stimulus and response, cause and effect are proportional, the curve expressing their relation to one another being a straight line. Probably, however, the autographic records of these nerve experiments will afford the most convincing argument for the employment of nerve fibre as a test tissue.

The main principle upon which the inquiry is based is the proposition of Du Bois-Reymond and of Hermann, that disturbed protoplasm is electro-negative to the normal; that excited is electro-negative to resting protoplasm. The excised and still living nerve of the frog gives off to the galvanometer a current, called by Hermann "the current of inquiry," which current, on stimulation of the nerve, undergoes a reversal of direction, the "negative variation," or "current of action." Supposing the nerve to be set up so that the current of inquiry is manifested as a northward deflection of the galvanometer (the arrangement followed in these experiments), the negative variation will be south. It is the magnitude of this negative variation which is taken as the index to the magnitude of chemico-physical change aroused in the nerve under various chemical conditions. To a series of stimuli of uniform intensity and duration, given at regular intervals, the nerve responds by a series of uniform deflections or negative variations, which persist for an indefinite time in the absence of modifying agents. A short series of such normal deflections precedes, in these experiments, the application of a reagent, after which, the stimuli being continued, the effect of the drug appears as increase, diminution, or abolition of the negative variations, as the case may be. The galvanometer deflections are recorded on a slowly-moving photographic plate.

The nerve, it should be said, is enclosed in a moist chamber, and rests on two pairs of electrodes, those leading off to the galvanometer, and a pair of wires from an induction coil by which the stimulations are sent in; these consist of weak tetanising currents of 8 secs. duration, given at minute intervals. Where gases are used, they are simply driven through the nerve chamber by pressure; where drugs in solution are employed, the nerve is removed from the electrodes and bathed in the solution for one minute.

Such is, briefly, the method employed. Of the results hitherto obtained, those which relate to the action of anæsthetics upon living matter will have a wide interest from their bearing upon a great practical issue. There is, of course, no question of the crude application of laboratory experience to therapeutics; yet a test so delicate and regular in its working, cannot but have its value in any estimate of the relative advantages and perils of various anæsthetic agents.

The comparative action of carbon dioxide, of ether, and of chloroform has been studied at length. All these in small quantity produce primary augmentation, and a pretty experiment consists in simply blowing through the nerve chamber, when the characteristic rise is produced by the carbon dioxide contained in the expired air. In larger quantity carbon dioxide gives abolition or diminution (Figs. 5 and 6); several minutes may elapse during which there is no response to the regularly repeated stimuli, but the abolition is not permanent, the deflections reappear, attain to, and for a time surpass their normal size. Ether vapour produces a more prolonged anæsthesia, followed by complete recovery of excitability (Fig. 1). Chloroform vapour gives a still more prolonged and often final abolition, recovery, where it takes place, being much less complete than in the case of ether (Fig. 2). Carbon dioxide added to chloroform counteracts the toxic effect and renders it more perfectly anæsthetic—that is to say, there is complete abolition followed by complete recovery.

Of the many other gases tried, oxygen (Fig. 3), carbon monoxide, and nitrous oxide (Fig. 4) give little or no effect, anæsthesia by the last is probably a carbon dioxide effect.

Passing by many groups of chemical substances of which the action has been tested, we may note merely that the study of the comparative action of haloid salts brings out with much clearness the analytical value of the method.

In regard to the acids, a fundamental question to be determined was as to whether their action upon living protoplasm was in proportion to acidity or to avidity. The answer obtained is to

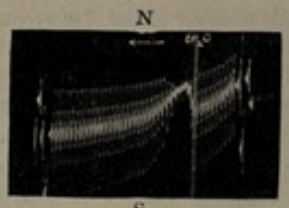


FIG. 1.

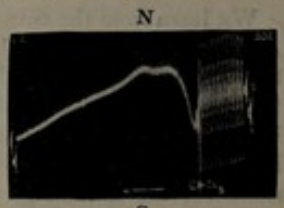


FIG. 2.

the effect that acidity is the chief determining factor. Three acids of widely different avidities, viz. nitric, sulphuric and acetic, have approximately equal effects at the same acid strength. Yet acids have also their specific action, a comparison of, for instance, lactic and oxalic acids of equal strength shows the former to be far more powerful than the latter.

But the most interesting result of these experiments, from the purely physiological point of view, is the demonstration of the evolution of carbon dioxide in the nerve itself. As the chief terminal product of protoplasmic activity carbon dioxide had received a large share of attention, and its influence had been recognised as giving the clue to a curious puzzle with regard to the nerves. In the earlier experiments, when a frog was killed, one sciatic nerve was removed for use, while the other was

FIG. 3. FIG. 4.

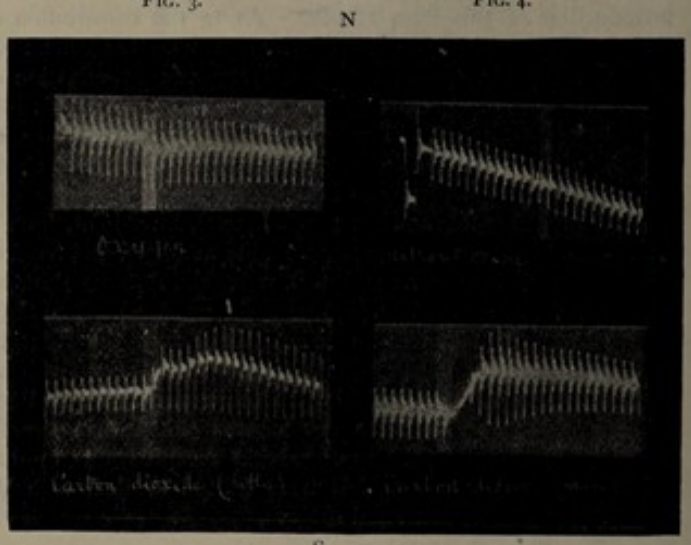


FIG. 5. FIG. 6.

The light band across the plates marks the passage of the gas through the nerve chamber.

left in the body until required. It was noticed that the second nerve was usually more excitable than the first, and when, as sometimes happened, a nerve had been left in the body all night, the negative variation was often a very large, though a declining one. To recognise that this augmentation was due to carbon dioxide given off by the surrounding tissues, was to have a fresh example of the delicacy of nerve as an indicator of the presence of the gas; and the question suggested itself: Supposing carbon dioxide to be evolved during nerve activity, *i.e.* prolonged tetanisation, ought not its presence to be marked by the now familiar augmentation of the negative variation? To test this, recourse was had to a very simple experiment; but before making it, a forecast of its probable course was drawn upon a

black-board. The usual series of normal deflections having been recorded, tetanisation was to be prolonged for five minutes, with the result that the succeeding variations would show an increase which would gradually sink back to the normal. In the actual experiment these anticipations were exactly fulfilled.

Further experiments upon nerve in different conditions (the particulars of which cannot here be described) showed the effect of carbon dioxide as still coinciding with that of prolonged tetanisation, such effect consisting primarily in an augmentation of the negative variation; hence the conclusion is drawn that tetanised nerve evolves carbon dioxide.

In favourable conditions augmentation of the negative variation may be produced by the series of brief tetani employed in the rhythmic excitation of the nerve, when the effect closely resembles the well-known "staircase" phenomenon occurring in contractile tissue. Dr. Waller leaves it an open question whether or no the phenomenon is of carbon dioxide production in muscular as well as in nervous tissue.

Of other sub-positive considerations touched upon, one of chief interest is the surmise as to the functional and chemical relations between grey axis and white sheath in a medullated nerve fibre. The stability of nerve is that of perfect compensation, not that of slowness or absence of change; and it is probable that the investing white sheath supplies the means of rapid repair to the functional grey matter.

It is perhaps not too much to hope that an elucidation of the processes of assimilation and dissimilation will be among the gains to our knowledge of living matter brought about by this new method in the immediate future. S. C. M. S.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual Spring Meeting of the Institution of Mechanical Engineers was held last week on the evenings of Wednesday, April 29, and Friday, May 1. The President, Mr. E. Windsor Richards occupied the chair on both occasions. The meetings were held in the theatre of the Institution of Civil Engineers, lent by the Council of that body for the purpose. The new buildings, which are now being erected for the Institution of Mechanical Engineers, are fast progressing, and probably the present year will be the last during which the latter Society will be dependent for a meeting-place upon the hospitality, always so freely accorded, of the older Institution.

The agenda for the meeting contained two papers, as follows:—

(1) "Steel Steam Pipes and Fittings, and Benardos Arc Welding in connection therewith." By Mr. Samuel MacCarthy, of London.

(2) "Research Committee on the Value of the Steam Jacket. Experiment on a Locomotive Engine." By Prof. T. Hudson Beare and Mr. Bryan Donkin.

The first business of the meeting, the usual formal proceedings having been disposed of, was the reading of his address by the President. Mr. Richards, as is well known, is a prominent steel manufacturer, having held important positions in steel works both in South Wales and in the Cleveland district. As might have been expected, therefore, he dealt more with the raw material which engineers use, rather than the methods of working it up; that is, mechanical engineering proper. It would be ungracious to find fault with the address, which must have involved much labour in its preparation, but the members of the Institution could hardly but feel a little disappointed that the President did not deal more with the machinery used at iron and steel works, rather than with the form of blast furnaces and their products. Mr. Richards' wide experience would have made of the greatest value his remarks on rolling-mills, rolling-mill engines, blowing engines, and many other pieces of machinery which are strictly examples of mechanical engineering used in iron and steel works. However, he elected to confine his attention more particularly to blast furnaces, and his remarks on the subject, although perhaps more in keeping with the other technical society, of which he is a yet more prominent member, the Iron and Steel Institute, were nevertheless of considerable interest. Mr. Richards referred to the delegation organised last year, through the British Iron Trade Association, to visit Belgium and Germany, with a view to ascertaining how it was that these countries were able not only to compete with us in neutral markets, but were also able to sell their products even in our own markets. As the address said, the inquiry undertaken by the delegation involved great labour, and some of our readers may perhaps remember that at the time it stirred up some very angry feelings; the Germans specially resenting what they considered an intrusion into their country. We have not space to follow the President in his discussion upon blast furnace practice in various countries, though it may be generally stated that the Americans show an amount of intelligence and energy in their iron and steel works, which is not surpassed and hardly equalled in any other country. Indeed in blast furnace practice the United States may justly claim to take the leading position in the world, not even excepting ourselves. At the present time near Pittsburgh there is being erected an addition to the Duquesne Works, which will cost about £600,000. Four blast furnaces of a height of 100 feet are being erected, together with the necessary blast engines and other plant. A production of 500 tons of pig-iron every twenty-four hours is expected from each furnace, thus bringing the total product for the year up to the enormous amount of 180,000 tons. Quick working generally means short life in a blast furnace, as in so many other things, and it has been often contended by English iron-makers that the slower working followed in this country is more profitable. If, however, it be allowed that the lining of the new American furnaces only lasts for four years, no less than 700,000 tons of pig-iron will be obtained in that time; a quantity which, as the address pointed out, an English furnace would require fourteen years to produce. Putting aside the question of furnace lining and renewing, it will be easily seen the large advantage a system of quick working gives in respect of labour, establishment charges, and, in fact, all the items that go to make up the cost of producing pig-iron, excepting the raw material. Under these circumstances it is hardly to be wondered at that the American output in the iron trade is advancing with such gigantic strides. Mr. Richards stated that generally in America the whole labour cost per ton of Bessemer pig-iron, is from 80 cents to 1 dol., and it is expected that the new Duquesne plant will reduce that cost by nearly one-half. English manufacturers have, however, perhaps less to fear from competition across the Atlantic, than from that of continental States, and from this point of view the details given of the production of the German and Luxemburg iron districts are of great interest. We do not find the same gigantic output as in America, but "in Germany there is a readiness to adopt new methods, and to take advantage of every point in the game of international competition, which cannot but go far to ensure success." A good example of this is given in the readiness with which German steel makers have adopted the basic process. This process had its origin in England, and though taken up by a few enterprising firms of steel makers, it may be said to have been received with but cold welcome by the trade in general. English makers preferred to import the hematite ores suitable for the acid process, neglecting our own vast resources of ore not suitable for acid steel. The Germans having somewhat similar iron ores, eagerly took up basic steel making, so as to utilise native deposits, and did not rest until they had overcome those defects and difficulties in manufacture, which always attend a new process, and which were, perhaps, exceptionally formidable in this case. They have received their reward, for at the present time an enormous trade is done in Germany in basic steel which can be produced at a cheap rate, whilst the quality is sufficiently good for ordinary engineering purposes. In Belgium, too, we see the result of an intelligent appreciation of modern improvements—both by masters and men—combined with a perseverance and industry which enables advantage to be taken of the smaller details that, in the bulk, go to make success. One thing the English manufacturer has against him is railway rates, and this is very strikingly brought out in a comparison made between the facilities which English manufacturers possess, as against those of the Belgium and German producer. As regards labour cost, Mr. Richards tells us there is not much to our disadvantage, but he says that our labour has become "far more difficult to manage, is much more ready to stop work in order to obtain an increase of wages, and is constantly agitating for fewer hours of work. Every concession made renders it more and more difficult to compete with the continent in the markets of the world, but our workmen cannot yet be brought to see this, neither can they be persuaded to cease opposition to machinery devices for saving labour and reducing cost; indeed all such appliances are jealously watched, and, if possible, their success is prevented." There is much truth in these remarks of

Mr. Richards, and the only cure for the evils he enumerates is to improve the intelligence and the status of the working classes. It is with regret that Englishmen too often see continental employers superior to those of this country in regard to the thoughtful care bestowed upon their workpeople. In some cases it is true, care of the workman is forced upon the manufacturer by legislation, but in a great many instances the continental iron and steel maker has recognised the wisdom of treating his workpeople liberally. Doubtless in England we may find many large-minded employers who, either from self-interest or from motives of a higher character, pay much attention to the well-being of their workmen, but too often the "hands" are looked on as simply an extension of the plant, their sole function being to give the maximum of labour on the minimum of outlay. It is hardly to be wondered at, under these circumstances, that self-seeking persons obtain the ear of the working man in this country, and so often advise them to their own detriment and that of the nation at large.

Mr. Windsor Richards concluded his address with some remarks on technical education. Referring to the want of intelligence on the part of operatives he said, "yet the favourite remedy of this state of things is, in many minds, to spread technical education all over the country; whereas if the results they desired unhappily be attained, the last state of the trade would be worse than the first, for we should have no hewers of coal, nor makers of steel." "Technical education" is so uncertain a quantity that it is not easy to arrive at what Mr. Windsor Richards exactly meant by his expression. We think, however, that his words are likely to be misleading if not mischievous. The most hopeful solution of the labour problem, in fact the only solution, is higher intelligence on the part of the workman, and there is no better way of fostering this intelligence than by giving operatives such knowledge as will enable them to appreciate the processes in which they are engaged. Experience proves that a man does not become less efficient as a labourer, even as a hewer of coal and a maker of steel, because he is educated, although frequently he may, by virtue of his education, rise above these positions. We must, however, leave Mr. Richards' address, and turn to the other parts of the proceedings.

At the last meeting of this Institution, a paper by Mr. W. H. Patchell, on "Steam Superheating" was read, the discussion on which was adjourned until the present meeting. Mr. Patchell's paper referred to various designs of superheater, the principal one treated upon being that of McPhail and Simpson. In this apparatus steam is taken from the boiler and passed to a superheater which utilises the waste gases from the furnace. In this way the steam acquires a certain amount of superheat. It is then taken back to the boiler, and circulates in the water space of the latter by means of an internal pipe. After this it passes to the engine. The object of the invention is to obtain thoroughly dry steam without the risk of it being highly superheated, and thus cutting cylinder faces, or leading to defects which have been experienced in time past in using steam above the temperature normal to the pressure. It will be seen, of course, that this superheater, so called, is not necessarily a superheater at all; it may be, or may not be, the result depending on the quantity of heat imparted to the steam by the waste gases, and to the length of time the steam is subjected to the influence of the water in the boiler by means of the internal pipe. Supposing the steam be superheated several degrees and then returned to the boiler, it will be subjected to the influence of water at a lesser temperature than itself, for the water in the boiler is practically at the temperature of saturated steam due to the boiler pressure. The superheated steam may be reduced to that temperature, but will not fall below it. Practically, we believe, in an installation with a McPhail superheater, as usually designed, the steam finally emerges from the internal pipe at a temperature above that due to its pressure, but generally to a small extent. It will, of course, be dry steam on finally emerging from the internal pipe; though possibly, in some cases, surface radiation in the steam pipe between the boiler and the engine may deprive the steam of its superheat. It is further to be noted that the heat which the superheated steam parts with, to the water in the boiler, is not lost, but goes to aid evaporation. If the degree of superheat of the steam as t passes into the engine cylinder be small, some of the steam will be almost immediately liquefied by the usual process of extraction of heat incidental to the working of any steam engine. If the heat used for superheating be wholly waste heat, there will of course be a gain due to the adoption of the apparatus; but against this must be put the first cost of the superheater. In any case it is an advantage to get dry steam, and the McPhail device must be credited with this.

The principal contribution to the discussion was made by Prof. W. C. Unwin, who claimed that Hirn should be credited with the practical introduction of the use of superheated steam. In Alsace he said superheaters are generally in use, and are found to be of great practical value. If the apparatus were intelligently designed, it was possible to use superheated steam without any of the dangers and troubles of which so much had been heard. A few years ago superheaters were largely fitted to a large number of steamships in the form of the well-known steam chimney, as doubtless the majority of our readers are aware. The advent of higher pressures, and consequent higher temperatures, however, brought difficulties. When steam of 30 to 60 lb. pressure was used, it was possible to increase the temperature of steam above that normal to the pressure, without introducing much complication, but when temperatures rose much above those mentioned, as they speedily did with the advance in boiler practice, superheating became a more serious matter. Improvements in the packing of glands, and the introduction of mineral lubricants, now enabled still higher temperatures of steam to be used without danger. It may be as Prof. Unwin says, that we can take useful example from the Alsatian practice, and thus another era of superheating has arisen. The introduction of the water tube-boiler also may supply an incentive to marine engineers in this direction. The limited water and steam space with this type of generator make it often difficult to get dry steam, so that a superheater would fill a useful place. Another point to be observed is, that if superheating of steam be used, steam jacketing is not necessary, or at any rate not so necessary as when non-superheated steam, often containing a considerable quantity of water, is passed to the engine. Perhaps when the paper on steam jackets by Messrs. Hudson and Donkin is read, we may get further light on this subject, and it is to be hoped ample time will be given for its discussion.

Mr. MacCarthy's paper on "Electric Welding of Steam Pipes" was a valuable and interesting contribution. Higher steam pressures have brought trouble to the marine coppersmith. The old brazed copper pipes have been found, by sad experience, to be dangerous fittings, several lives having been lost by their failure. Steel pipes have been accordingly substituted where high pressures are used; and so far as the pipes themselves are concerned, there is not much difficulty in producing a trustworthy article. The longitudinal welds of a lap-welded pipe are made either by rolls or by the gas-welding system with a hammer, in a thoroughly satisfactory manner, and experience has shown how flanged junctions can be made. It is where joints, such as elbows, T-pieces, &c., are required that the difficulty arises, and it is here that electric welding has come to the help of the marine engineer. On the table of the theatre Mr. MacCarthy exhibited several very fine specimens of steam fittings of the kind referred to, a four-way branch being a notable example. These were all made by the Benardos system of arc welding. Flanges are also welded to the length of pipe in the same manner; the method of working was described by the author as follows:—

"Ordinary low-tension continuous-current lighting dynamos are used; to the terminals of these a battery of Benardos accumulators is connected, into which the current flows continuously. When the welding circuit is closed, the current flows from the dynamos and accumulators; and large resistances are used when necessary. In this way a large discharge is obtained, equal to about twice the capacity of the dynamos, and the load factor of the apparatus is high. For some purposes it is possible to work without accumulators; but when this is done, the efficiency of the apparatus is not so high, because during part of the working period no current whatever is passing, and the machinery is running light."

For attaching the flanges to the pipes, the following method is adopted:—

"The flange is stamped out under the steam hammer in such a way that a V-shaped groove is left on the inside edge, extending about three-fourths through the thickness of the metal. The flange is next shrunk upon the tube, with its flat face outwards or at the end of the tube, and is carefully set in the exact position required. The welding consists in laying small pieces of steel in the V-shaped grove, and welding them in one by one by means of the electric arc, the welds being freely hammered between

each heat. The welder makes a complete circuit of the back of the flange, and fills it up sufficiently to make a fillet of about 1½ inches radius. In this way the flange is solidly welded to the tube at the back, and about three-fourths of the way through its thickness; but the front or outer side is not yet welded. The tube is then up-ended, and the outer side of the flange is welded to the tube, the only difference being that the heat of the arc is used to burn out a cavity all round the junction of the pipe and the flange, until the depth is reached at which the two have already been united; this cavity is then welded up in the same way as the back of the flange, thus ensuring that the flange is welded solid to the pipe right through."

One point in connection with electric work, to which the author called special attention, was the length and size of the arc which is used in the welding of various kinds of work. With a short arc, the carbon point is brought down too close to the steel, and the result is inferior work, not only from the presence of the carbon, but also because the heat is concentrated upon so small a surface that the strains set up in cooling are considerable. The longer the arc, the softer and more defined is the heat; and any slight strain which may be set up can be got rid of by careful annealing. A long arc is therefore indispensable to the proper working of the system.

The reading of this paper was followed by an animated discussion in which trade interests were not altogether neglected. One manufacturer from Sheffield expressed a preference for flanges forged solid from the end of the pipe, rather than for those electrically welded on in the manner described. No doubt the electrical welding gives a very trustworthy attachment between the flange and pipe—experience has proved this; and, equally without doubt, the solid forged flange is an excellent device. The merits of the two systems are reduced to commercial considerations. The same speaker, whilst bearing testimony to the very fine junctions, bends and T-pieces shown by the author, said that recourse to electrical methods for producing these was not necessary, as they could be made equally well, and at a cheaper rate, in the shape of crucible steel castings. That, however, is also a commercial point upon which we need not enter. The question as to whether electrical welding is really welding or fusing, was also discussed by several speakers at the meeting. The problem appears very much to be one simply of names. No doubt electrical welding, as described by the author, is not welding in accordance with the forgeman's old vocabulary; but whether it be welding or fusing, so long as it gives a good and trustworthy junction of the two metals, is a matter of small importance. There is no doubt that electrical fusing, if engineering purists insist on the term, enables work to be done which could not be attempted in any other way, and it will surely take its place in times to come as an engineer's workshop process. The methods of making the longitudinal seams in steam pipes by welding were described by the author in his paper. These methods are well known now, and have been in use for some years, so we need not refer to this part of the paper, further than to state that it gave rise to a discussion on the respective merits of solid drawn tubes made from the ingot (which of course have no longitudinal weld) and lap-welded tubes. On this point Mr. Mark Robinson gave some instructive data. He had made tests with lap-welded steel tubes and solid drawn steel tubes. We will not quote the details, as they were rather voluminous, but we will simply say that the lap-welded tube showed considerable superiority. It may be stated, however, that at the present time seamless steel tubes are being made by one firm in 12 ft. lengths, the diameter being 1 ft.; this is rather a remarkable development of the industry.

The meeting was brought to a close by the discussion on this paper.

The Summer Meeting of the Institution will be held this year in Belfast, and will commence on Tuesday, July 28.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Sir G. G. Stokes, Prof. A. R. Forsyth, and Prof. J. J. Thomson are to represent the University at the celebration in Glasgow of Lord Kelvin's jubilee next month. Prof. Thomson will also represent the University at the Sesquicentennial celebration of the founding of the College of New Jersey and the inauguration of Princeton University, to be held next October.

In view of the extreme financial depression which has befallen the Colleges, the Chancellor has diminished by £3000 a year the contribution payable by them to the University in 1896–98.

The Council of the Senate has reported in favour of the affiliation of the University of Toronto and the University of Bombay.

Prof. T. W. Bridge and Mr. Charles Davison have been admitted to the degree of Doctor of Science.

OWING to the efforts of the Chairman of the District Council, it will not be long before the town of Bilston is provided with an efficient technical and art school. No less than £2400 has been locally subscribed, and it is confidently expected to bring the amount up to £2500 at least, when it will be possible to claim £1000 from the Science and Art Department, and £500 from the County Council, making a total of £4000. A Committee has been formed in connection with the workmen of the district for raising £250 towards the expenses of furnishing.

SCIENTIFIC study is given a little encouragement by the London Chamber of Commerce. Among the prizes offered for competition in the Chamber's seventh examination for junior commercial education certificates, to be held in the Hall of the Institute of Chartered Accountants, Moorgate-street, E.C., on July 6, are:—Prizes of £5 and £2 for proficiency in commercial history and geography; prize of £5 for proficiency in algebra, Euclid, mechanics, and hydrostatics; prizes of £3 and £2 for proficiency in chemistry; prizes of £3 and £2 for proficiency in electricity and magnetism; prizes of £3 and £2 for proficiency in sound, light and heat; and prizes of £3 and £2 for proficiency in natural history. There will also be awarded the "Princess Louise" prize of £35 for general proficiency, and the "Textile Section" prize of £36 15*s.* (conditions undetermined); while the Aberdeen Chamber of Commerce offer a prize of £2 2*s.* for proficiency in mathematics.

AT a meeting of the Technical Instruction Committee of the Cornwall County Council, held at Truro last week, the Agricultural Sub-Committee recommended "That in view of the Government proposals, affecting secondary education, as set out in the Education Bill now before the House, it is desirable to defer taking immediate steps to secure land and premises for the purpose of establishing a farm school in this county." The recommendation, which was proposed by the Chairman, was eventually adopted. During the discussion which took place upon the matter, it was made clear that the original intention had been to found a central institute because the only suitable efficient schools in the county were of a proprietary character, and from the provisions of the Technical Instruction Act, 1889, it was impossible to assist these. The object of deferring the question was to enable the Committee to see if, by the terms of the new Act, schools of only a semi-public character could be assisted, and also to first become acquainted with the powers of the new Educational Committee before they committed themselves to any policy.

A SHORT time ago attention was called in these columns to the low financial condition of the University College, Bristol. We now learn from the *Lancet* that the Council of the College issued last week an urgent appeal for pecuniary assistance to the inhabitants of Bristol and the West of England. The Council earnestly appeal for a capital sum of £10,000 to clear the college from debt, and for an addition to the annual sustentation fund of £700, which would restore the fund to the £1200 subscribed in 1882, not less than which is required to meet the annual expenditure and to secure the Government grant. The Council also emphasise the need of a permanent endowment, and suggest that wealthy citizens of Bristol and the West should associate their names, as in other colleges, with the endowment of professorships. The donations already promised for the capital fund amount to £5334, and to the sustentation fund about £100. We note with pleasure that, at a recent meeting of the Technical Education Committee of the Bristol Corporation, it was decided to recommend the Council to make a grant of £2000 to the funds now being raised on behalf of the college, to be conditional upon the £10,000 being obtained, and on the acceptance of two representatives of the Town Council upon the Governing Body.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xviii. No. 2, April.—The intermediary orbit, *i.e.* the Moon's periodic orbit relatively to the Sun obtained from the variation terms when all terms but those depending on the ratio of the mean motions only are omitted, has been considered in vol. i. by Dr. Hill, and subsequently in the *Acta Mathematica* (vol. viii.) the same writer obtained an expression for the motion of the Moon's perigee, so far as it depends on the ratio of the mean motions. These papers have been followed by others by Prof. E. W. Brown, in which the terms depending on the solar parallax and the lunar eccentricity are computed.—The object of the opening paper of the present number, on the inclinational terms in the Moon's coordinates, by P. H. Cowell, is to take into account, according to Dr. Hill's method, the inclination of the orbit, considering it as being the manifestation of a small oscillation about Dr. Hill's distorted circular orbit, which relatively to the Sun is a closed curve. The terms multiplied by the first power of the inclination have been calculated to the sixth order, and an expression for the part of the motion of the Moon's node, that depends upon the mean motions only, has been found as far as the eighth order, *i.e.* one term further than in Delaunay's series. The terms multiplied by the square of the inclination have been calculated to the fifth order, and the terms multiplied by the third power of the inclination to the fourth order in m. The notation adopted is that of the paper by Prof. Brown (*Am. Journ. Math.*, vol. xvii.).—A short note by A. S. Chessin, on non-uniform convergence of infinite series, brings out more clearly a point in a previous note (vol. xviii. No. 1), which the writer says has been misunderstood.—On a certain class of equipotential surfaces, by B. O. Peirce, discusses the nature of such systems of plane curves as are at once the right sections of possible systems of equipotential cylindrical surfaces belonging to distributions of matter which attract, according to the law of nature, and the generating curves of possible systems of equipotential surfaces of revolution.—M. Petrovitch contributes "Remarques sur les équations de dynamique et sur le mouvement tautochrone."—A note on C. S. Peirce's paper on a quincuncial projection of the sphere, by J. Pierpont, corrects an inaccuracy in that paper (vol. ii. p. 394). Mr. Pierpont, in a note on the invariance of the factors of composition of a substitution-group, gives a much simplified proof of this important theorem.—H. Maschke, in a long article (pp. 156–188) on the representation of finite groups, especially of the rotation-groups of the regular bodies of three- and four-dimensional space, by Cayley's colour diagrams, shows that Cayley's method (the theory of groups, graphical representation, *Am. Journ.*, vol. i., and on the theory of groups, *Am. Journ.*, vol xi.) can be readily applied to the construction and investigation of numerous groups of higher orders. In particular, the writer says, the colour diagrams for the rotation groups of the regular bodies can be arranged in such a way that they lend themselves much easier, at least in some respects, to a study of the groups concerned, than even the models of the regular bodies. Numerous diagrams of interest accompany the paper.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, March 19.—Mr. A. G. V. Harcourt, President, in the chair.—The following papers were read:—The constitution of a new organic acid resulting from the oxidation of tartaric acid, by H. J. H. Fenton. The acid obtained by the oxidation of tartaric acid in presence of iron seems to be a dihydroxymaleic acid of the constitution C(OH)(COOH):C(OH)(COOH); an isomeric acid has also been prepared, which is possibly the corresponding dihydroxyfumaric acid.—The volume and optical relationships of the potassium, rubidium and cæsium salts of the monoclinic series, $R_2M(SO_4)_2$, $6H_2O$, by A. E. Tutton. A detailed investigation of the physical properties and volume relationships of the twenty-two salts of this series, of which the author has previously determined the morphological constants, leads to a number of important conclusions; the alkali metal R in salts of this series, exerts a predominating influence on the crystallographical characters of the substances.—Comparison of the results of the investigations of the simple and double sulphates containing potassium, rubidium and cæsium, by A. E. Tutton.—The bearing of the results of the investigations of the simple and double sulphates containing potassium, rubidium and cæsium, upon the nature of the structural unit, by A. E. Tutton. No considerable contraction occurs in the formation of the double salts of the series $R_2M(SO_4)_2$, $6H_2O$ from its constituent salts, so that it is improbable that these constituents are in chemical combination in the solid state; this conclusion is supported by the fact that these salts do not exist in solution, and that many of them are very unstable. It is not necessary to assume that the structural units of crystals consist of more than one chemical molecule in the case of double salts or salts containing water of crystallisation.—The hydriodides of hydroxylamine, by W. R. Dunstan and E. Goulding. The only crystalline hydroxylamine hydriodides which the authors have been able to prepare have the compositions $3NH_3O$, HI and $2NH_3O$,HI.—An analysis of water from the dropping well at Knaresborough in Yorkshire, by B. A. Burrell.—Contributions to the knowledge of ethylic acetoacetate. Part I. Acetonylmalic acid, by S. Ruhemann and E. A. Tyler. Ethylic sodioacetoacetate and ethylic chlorofumarate react with formation of ethylic methyldihydrofurfurantricarboxylate, which on hydrolysis with alcoholic potash yields acetonylmalic acid CMe(OH):CH.CH(COOH).CH(OH).COOH.—The action of lead thiocyanate on the chlorocarbonic esters. Part I. Carboxyethylthiocarbimide and its derivatives, by R. E. Doran.—An auxiliary assay balance, by R. Law. The author describes a balance for assay work, which gives the weight of the gold "cornet" with such accuracy that on its transference to the ordinary assay balance, the observer can put the requisite weight on the balance pan at once; the remaining fraction can then be determined by the rider alone.—Charas: the resin of Indian hemp, by T. B. Wood, W. T. N. Spivey, and T. H. Easterfield. Charas, the resin of *Cannabis indica*, contains a terpene, a sesquiterpene, a paraffin, $C_{29}H_{60}$, and a red oil, $C_{18}H_{24}O_2$; the latter, in doses of 0·05 gram, produces intoxication and sleep.—Note on the decomposition of α-chloronitrocamphor, by A. Lapworth.—On heating α-chloronitrocamphor, camphorquinone is produced.—π-Bromocamphor, by C. Revis and F. S. Kipping.—Oxidation products of α-bromocamphorsulphonic acid, by A. Lapworth and F. S. Kipping. On oxidising ammonium α-bromocamphorsulphonate with nitric acid, products are obtained which seem to be a sulpholactone, $C_{10}H_{12}SO_4Br_2$, a hydroxydibromocamphorsulphonic acid and an ammonium dihydrogen π-sulphocamphoric acid.—On the xylic and xylidinic acids, by W. H. Bentley and W. H. Perkin, junr.

March 26.—Anniversary Meeting.—Mr. A. G. V. Harcourt, President, in the chair.—After the reading of the presidential address and the transaction of the usual business, a ballot was taken for the election of officers and Council for the ensuing year.

Geological Society, April 15.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President announced that a portrait in sepia of Prof. Bonney, executed by Mr. Trevor Haddon, had been presented to the Society by thirty-four subscribers, Fellows of the Society.—The following communications were read:—The Junction-Beds of the Upper Lias and Inferior Oolite in Northamptonshire. Part I. Physical and Chemical, by Beeby Thompson. The author, while combating the view that a considerable unconformity existed between the Upper Lias and the Inferior Oolite of Northamptonshire, brought together much evidence to illustrate the effects of slipping, and to show that these effects may be mistaken for those of unconformity. He also applied the evidence which he had collected to illustrate certain points in the physics of valley-formation. After giving details as to the horizon of the springs of the district, the distribution of water in the Inferior Oolite, and the development of the springs, he argued that every valley of the district has been elongated in the direction which it now has by a stream originating in a spring always at its head, and that the development of channels towards particular points of discharge had been the chief agent in initiating the formation and guiding the direction of all the minor valleys of the river-system within the influence of the same set of beds. A description of the characters of the slopes followed, and their significance was discussed. The structure of the hills and valleys of the district occupied the next portion of the paper, and the author considered that corresponding to the deepening of a valley by denudation there was uplifting of the beds below it, and at the same time an outward and upward thrust along the hillside which lifted beds there; also, that hills were reduced in height by sinking as well as by denudation of their

upper parts. In discussing the question of unconformity between the Inferior Oolite and Upper Lias, the rarity of exposures of true junctions was noted, the junctions which have been chiefly examined by other observers being obscured by slipping; and reasons were given for inferring an absence of unconformity at the horizon, both on account of the character of the true junctions, and from other considerations. The author, however, gave reasons for believing that a slight unconformity occurs in the Upper Lias, so that the lower part of the *jurensis*-zone is absent, and not its upper part, as has been elsewhere inferred.—Contributions to the stratigraphy and palæontology of the *Globigerina*-limestones of the Maltese Islands, by J. H. Cooke. A bibliography of the *Globigerina*-limestones, followed by some remarks on the physical features and general distribution of the strata.—On the geology of the neighbourhood of Carmarthen, by Miss Margaret C. Crosfield and Miss Ethel G. Skeat. The area described lies approximately within a four-mile radius of Carmarthen. The beds of the district have been subjected to complicated foldings, amongst which an earlier set, giving rise to a number of small anticlines with north-and-south axes, and a later more extensive set, due to the series of earth-movements which produced the great Condrusian ridge, producing anticlines and synclines having a general east-and-west trend, can be made out. The rocks forming the subject of the present paper occur in one limb of a complex anticline produced during the latter set of movements. In the discussion that followed, the President congratulated the authors on the important discoveries which they had made. The finding of Tremadoc rocks in the neighbourhood of Carmarthen was a fact of great importance, and might lead to the discovery of still older rocks in that area. The succession closely resembled that found in Pembrokeshire; but it was now carried further east than had previously been done, though the work of the late T. Roberts and Mr. Marr had led to the idea that rocks at least as old as those of Arenig age would be found in this area.

Linnean Society, April 16.—Mr. W. Percy Sladen, Vice-President, in the chair.—Mr. George Massee read a paper on the types of Fungi in the collection of the late Rev. M. J. Berkeley, which was presented to Kew in 1879, and which contains rather more than 11,000 species. Many of the species were described more than fifty years ago; hence the diagnoses are in some cases too brief, and do not embody points which at the present day are considered to be of importance. In many instances this has led to the same species being re-described by others as new. Mr. Massee now supplied careful descriptions of the types, with a view to obviate future confusion, and to secure for Berkeley as the original describer the priority in nomenclature which is justly his.—Mr. A. D. Michael read a paper upon the internal anatomy of *Bdella* (the Red-snouted Mite), giving the results of three years' work and of many hundreds of dissections and serial sections. The material was furnished chiefly from the Zoological Station at Port Erin, and the subject is practically new, only one paper (describing a few parts of the female) having been hitherto published.

Zoological Society, April 21.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—Mr. Sclater exhibited and made remarks on some specimens from Nyasaland, lately sent home by Sir H. H. Johnston, K.C.B. Amongst these was a fine head of the sable antelope (*Hippotragus niger*) from the Zomba plains, and an example of the brindled gnu (*Connochætes gorgon*), or of a nearly allied form, believed to be the first specimen of this antelope sent home from British East Africa.—Mr. Sclater also exhibited, by the kind permission of Mr. Justice Hopley, of Kimberley, a pair of horns of the so-called *Antilope triangularis*, said to have been obtained somewhere on the Zambesi. These horns were now generally supposed to be abnormal horns of the cow eland.—Mr. W. E. de Winton gave an account of a small collection of mammals from Ecuador, lately sent to the British Museum by Mr. L. Söderstrom, H.B.M. Consul at Quito. It contained examples of only three species, but two of these appeared to be new to science. One of them was a new deer, proposed to be called *Pudua mephistophelis*, and the other a rodent of the genus *Ichthyomys*, which was named *I. söderstromi*.—Mr. F. E. Beddard, F.R.S., read a paper on the anatomy of a grebe (*Æchmophorus major*), and added some remarks upon the classification of the Charadriiform birds, to which he considered the auks to be more nearly related than to the grebes.—A communication was read from Messrs. F. D. Godman, F.R.S., and O. Salvin, F.R.S., on the butterflies of St. Vincent, Grenada, and the adjoining islands, based on the collections made by Mr. Herbert H. Smith.—A communication was read from Miss E. M. Sharpe containing an account of the Lepidoptera obtained by Dr. Donaldson Smith during his recent expedition to Lake Rudolf. Examples of ninety-one species were obtained, of which two were apparently new. These were described as *Panopea walensensis* and *Papilio donaldsoni*.—A second paper by Miss E. M. Sharpe contained an account of the Lepidoptera obtained by Mrs. E. Lort Phillips in Somaliland. Eighty-four species were enumerated, one of which, *Teracolus ludoviciæ*, appeared to be undescribed.—A communication from Mr. W. F. Kirby contained descriptions of some dragon-flies obtained by Mr. and Mrs. Lort Phillips in Somaliland. Three of these were described as new to science.

PARIS.

Academy of Sciences, April 27.—M. A. Cornu in the chair.—Observations of the Swift comet (April 13, 1896) made with the large equatorial of the observatory of Bordeaux, by MM. G. Rayel, L. Picart, and F. Courty.—Macular or perifoveal œdema of the retina, by M. J. P. Nuel.—New divisions in the rings of Saturn, by M. Flammarion (see p. 17).—Remarks on a communication of M. R. Liouville, entitled "On the rotation of solids," by M. N. Joukovsky. A claim for priority for some Russian mathematicians.—On the transition from the state of flow through an orifice to flow over a weir, by M. Hégly.—On a self-registering thermometer balance, containing either gas or saturated vapour, by MM. H. Parenty and R. Bricard. The two arms of a balance carry respectively a barometer and an air thermometer, both dipping into the same mercury trough. At constant temperature, and with varying atmospheric pressures, the alterations in the weights of the two arms caused by the movements of the mercury are identical, and the balance remains in equilibrium, but an alteration of temperature causes a motion of the beam, which can easily be made self-registering. For a small range of temperature the sensitiveness of the apparatus is considerably increased by substituting a volatile liquid for the gas. The device also readily acts as a temperature regulator.—Mode of action of the X-rays upon a photographic plate, by M. R. Colson. An account of some experiments made with a view to ascertain whether the X-rays impress the photographic plate directly, or whether they are transformed by the glass or film into secondary radiations of a phosphorescent nature, to which the photographic action may be ascribed. All the results pointed to the action being direct, no trace of action due to secondary rays being observable.—On the heterogeneity of the radiations emitted by Crookes' tubes and on their transformation by screens, by M. F. P. Le Roux. The name "hyperdiabatic radiations" is proposed as more suitable than X-rays.—Action of the X-rays upon electrified bodies, by MM. L. Benoist and D. Hurmuzescu. A study of the effect of the nature of the gaseous dielectric in which the electrified substances are placed upon the rate of discharge by the X-rays. The speed of dissipation in air was found to be approximately proportional to the square root of the pressure. At the same pressure the rate of loss of charge with air and carbon dioxide, and air and hydrogen was roughly inversely proportional to the square roots of their densities.—On electrified Röntgen rays, by M. A. Lafay.—Optical superposition of six asymmetric carbon atoms in one active molecule, by MM. P. A. Guye and C. Goudet. The rotations for four divaleryl tartrates of amyl are given, the number calculated from the assumption of the algebraic superposition of the optical effects of the several asymmetric carbon atoms approximates to one of these experimental values.—On a basic nitrate of magnesia, by M. G. Didier. By adding magnesia to a strong solution of magnesium nitrate, the nitrate $Mg(NO_3)_2.2MgO + 5H_2O$ is obtained.—On crystallised sesquiphosphide of iron, by M. A. Granger. Ferric chloride heated to redness in the vapour of phosphorus gives the phosphide Fe_2P_3, which is obtained in the crystalline form if the reaction is carried on slowly.—Study of peridinitronaphthalene, by M. C. Gassmann.—On the tartrate of phenylhydrazine and its derivatives, by M. H. Causse.—Heat of combustion of some cyanogen derivatives, by M. Guinchant. The introduction of the cyanogen group increases the molecular heat of combustion by ninety calories.—On the distillation of the first acids of the fatty series, by M. E. Sorel.—On zeolites and the substitution of the water they contain by other substances, by M. G. Friedel.—On the determination, by a new photometric method, of the laws of luminous sensibility to blacks and greys, by M. C. Henry.—Measurement of odours

in the air, by MM. A. Gerardin and M. Nicloux. The variation in volume of air after treatment with a glowing platinum wire is suggested as giving a measure of bad odours in air.—Statistical researches on the cultivated oyster on the coasts of France, by M. G. Roché.—On the metamorphic gypsums of Algeria, by M. L. Gentil.—The allotropic state of the elementary gases, by M. C. V. Zenzer.—A new general method for calculating the roots of algebraical equations which contain four terms and more, by M. Wisthaler.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MAY 7.

ROYAL SOCIETY, at 4.30.—On the Liquation of certain Alloys of Gold: E. Matthey.—On the Occurrence of the Element Gallium in the Clay-Ironstone of the Cleveland District of Yorkshire. (Preliminary Notice): Prof. Hartley, F.R.S., and H. Ramage.—The Electromotive Properties of Malapterurus electricus: Prof. Gotch, F.R.S., and G. J. Burch.—The Occurrence of Nutritive Fat in the Human Placenta (Preliminary Communication): Dr. T. W. Eden.

ROYAL INSTITUTION, at 3.—The Art of Working Metals in Japan: W. Gowland.

LINNEAN SOCIETY, at 8.—On the Tooth-Genesis of the Canidæ: Dr. H. Marett Tims.—Exhibitions: Lantern-Slides illustrative of the Habits of the Tiger-Beetle, Cicindela campestris: F. Enock.—Preparations of the Hermaphrodite Glands of Apus: H. M. Bernard.

CHEMICAL SOCIETY, at 8.—Ballot for Election of Fellows.—Morin, Part I.: Dr. H. Bablich and A. G. Perkin.—Luteolin, Part II.: A. G. Perkin.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The "James Forrest" Lecture: Physical Experiment in relation to Engineering: Dr. Alexr. B. W. Kennedy, F.R.S.

IRON AND STEEL INSTITUTE (Institution of Civil Engineers), at 10.30 a.m.

GRESHAM COLLEGE (Basinghall Street), at 6.—The Planet Saturn: Rev. E. Ledger.

FRIDAY, MAY 8.

ROYAL INSTITUTION, at 9.—Electric Shadows and Luminescence: Prof. Silvanus P. Thompson, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Note on a Determination of Precession and Drift, based on Auwer's Proper Motions: R. H. M. Bosanquet.—Royal Observatory, Greenwich: Diameters of Jupiter measured with the Filar and Double-Image Micrometers.—And *probably*: Photographs of the Spectra of the Helium Class of Stars: F. McClean.—Royal Observatory, Greenwich: Observations of Comets *a* 1896 (Perrine-Lamp) and of Comet *b* 1896 (Swift).

PHYSICAL SOCIETY, at 5.—On Dielectrics: R. Appleyard.—On the True Resistance of the Electric Arc: Messrs. Frith and Rodgers.

IRON AND STEEL INSTITUTE, at 10.30 a.m.—On the Rate of Diffusion of Carbon in Iron: Prof. W. C. Roberts-Austen, C.B., F.R.S.—On some Alloys with Iron Carbides: J. S. de Benneville.—On Mond Gas as applied to Steel-making: John H. Darby.—On Hot Blast Stoves: B. J. Hall.—On the Hardening of Steel: H. M. Howe.—On the Introduction of Standard Methods of Analysis: Baron Hanns Jüptner von Jonstorff.—On the Production of Metallic Bars of any Section by Extrusion: Perry F. Nursey.—On Mr. Howe's Researches on the Hardening of Steel: F. Osmond.—On the Treatment of Magnetic Iron Sand; E. Metcalf Smith.—On the Making of the Middle Lias Ironstone of the Midlands: E. A. Walford.

AFFILIATED PHOTOGRAPHIC SOCIETIES, at 8.—Process Work Applications: W. T. Wilkinson.

GRESHAM COLLEGE (Basinghall Street), at 6.—The Planet Saturn: Rev. E. Ledger.

MALACOLOGICAL SOCIETY, at 8.

SATURDAY, MAY 9.

ROYAL BOTANIC SOCIETY, at 3.45.

GEOLOGISTS' ASSOCIATION (Liverpool Street Station), at 2.3.—Excursion to Chingford Museum and Epping Forest. Director: T. V. Holmes.

MONDAY, MAY 11.

SOCIETY OF ARTS, at 8.—Applied Electro-chemistry: James Swinburne.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Through the Central Sudan to Sokoto: William Wallace.—Hausaland: Rev. Chas. H. Robinson.

TUESDAY, MAY 12.

ROYAL INSTITUTION, at 3.—Ripples in Air and on Water: C. V. Boys, F.R.S.

SOCIETY OF ARTS, at 8.—The Future of the Fine Art of Wood Engraving: W. Biscombe Gardner.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Recent Observations on the Andamanese by Mr. M. V. Portman: Dr. J. G. Garson.—Photographic Apparatus for Travellers: Dr. J. G. Garson.—The Cranial Characteristics of the South Saxons compared with those of some of the other Races of Great Britain: R. J. Horton-Smith.—An Unpublished Batak Creation Legend: Heer C. M. Pleyte.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: American and English Methods of Manufacturing Steel Plates: Jeremiah Head.—Four American Rolling-Mills: Samuel T. Wellman.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Dry Plates for Röntgen Ray Photography: H. Snowden Ward.—Notes on the Pyro-developed Image: Alfred Watkins.—A New Stripping Film for Negative Work: J. B. B. Wellington.

ROYAL VICTORIA HALL, at 8.30.—The New Photography: A. W. Porter.

WEDNESDAY, MAY 13.

SOCIETY OF ARTS, at 8.—Tunnelling by Compressed Air: E. W. Moir.

GEOLOGICAL SOCIETY, at 8.—An Account of a Head or Gateway driven into the Eastern Boundary-Fault of the South Staffordshire Coalfield: William Farnworth.—Dundry Hill: its Upper Portion, or the Beds marked as Inferior Oolite (G 5) in the Maps of the Geological Survey: S. S. Buckman and E. Wilson.—On the Geographical Evolution of Jamaica: Dr. J. W. Spencer.

THURSDAY, MAY 14.

ROYAL INSTITUTION, at 3.—The Art of Working Metals in Japan: W. Gowland.

SOCIETY OF ARTS, at 4.30.—Tea Planting in Darjeeling: G. W. Christison.

MATHEMATICAL SOCIETY, at 8.—On the Application of the Principal Function to the Solution of Delaunay's Canonical System of Equations: Prof. E. W. Brown.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses in Transformers: Stanley Beeton, C. Perry Taylor, and I. M. Barr.

FRIDAY, MAY 15.

ROYAL INSTITUTION, at 9.—Cable-laying on the Amazon River: Alexander Siemens.

EPIDEMIOLOGICAL SOCIETY, at 8.

QUEKETT MICROSCOPICAL CLUB, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Biological Experimentation: Sir B. W. Richardson (Bell).—Elementary Practical Physics: W. Watson (Longmans).—Quain's Elements of Anatomy, Appendix, 10th edition (Longmans).—The Student's Lyell: edited by Prof. Judd (Murray).—Riverside Letters; G. D. Leslie (Macmillan).—A History of the Warfare of Science with Theology in Christendom: Dr. A. D. White, 2 Vols. (Macmillan).

PAMPHLETS.—Slavery and Servitude in the Colony of North Carolina: Dr. J. S. Bassett (Baltimore).—The Crambidæ of North America: Dr. C. H. Fernald (Massachusetts).—Report of the Marlborough College Natural History Society, 1895 (Marlborough).

SERIALS.—Memorie della Societa Geografica Italiana, Vol. v. Part 2 (Roma).—Humanitarian, May (Hutchinson).—Bulletin de la Société Impériale des Naturalistes de Moscou 1895, No. 4 (Moscou).—Fortnightly Review, May (Chapman).—History of Mankind: F. Ratzel, translated, Part 8 (Macmillan).—National Review, May (Arnold).—Himmel und Erde, April (Berlin).—Journal of the Scottish Meteorological Society, third series, Nos. xi. and xii. (Blackwood).—Century Magazine, May (Macmillan).—Geographical Journal, May (Stanford).—Contemporary Review, May (Isbister).—Proceedings of the Physical Society, May (Taylor).—Scribner's Magazine, May (Low).—Zeitschrift für Physikalische Chemie, xix. Band, 4 Heft (Leipzig).—Archives of Clinical Skiagraphy: S. Rowland, Part 1 (Rebman).—Westminster Review, May (Warne).

CONTENTS.