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CONTENTS.

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Lord Kelvin.[1]

THE hundredth anniversary of the birth of William Thomson, Baron Kelvin of Largs, was commemorated in Glasgow and elsewhere on June 25. Although Glasgow was the scene of Lord Kelvin's life-work, he was actually born in Belfast, where his father, James Thomson, was professor of mathematics at the Royal Academical Institution. The city of Belfast is, indeed, very proud of its association with the illustrious physicist, and an impressive statue of Lord Kelvin adorns its Botanic Garden, adjoining the Queen's University.

William Thomson was eight years of age when his father became professor of mathematics at the University of Glasgow, and the family exchanged Belfast Lough for the Clyde. Letters are still preserved which show Thomson's love of navigation and its problems, and how he tackled some of them in his youth with the help of his brother James, afterwards professor of engineering in the University of Glasgow. He was always a sailor at heart, and his name is one of the very few names of physicists which are familiar to mariners throughout the world.

Lord Kelvin's connexion with the University of Glasgow, which began in 1832 and was only severed by his death on December 17, 1907, witnessed an extraordinary series of changes in the status of science in the world's universities. In Glasgow, as elsewhere at the beginning of his career, "Natural Philosophy," as Dr. David Murray says, "was purely an Arts subject and was regarded as an instrument for what Francis Bacon terms 'that improvement of the understanding which results from the cultivation of natural knowledge, and that elevation of mind which flows from the contemplation of the order of the universe,' and was on the same footing as Logic and Moral Philosophy; it was not treated as part of a scheme for the training of specialists. This was certainly Professor Thomson's view, who held that Greek, as an instrument of culture and mental discipline, was an essential part of the Arts course and that every scientific man should have a fair acquaintance with it."

Lord Kelvin never went to school. All his education up to the age of ten was given him by his father, along with his brothers and sisters. He used to say that he never met a better teacher in *anything* than his father was in *everything*. At a dinner of the University of Glasgow Club in London, Lord Kelvin once said that the average boy should be able by the age of twelve to write his own language with accuracy and some elegance.

[1] "William Thomson, Lord Kelvin, 1824–1907: an Oration delivered in the University of Glasgow at the Commemoration on June 25, 1924, of the Centenary of Lord Kelvin's birth," by Dr. Alexander Russell. Pp. 22. (Glasgow: MacLehose, Jackson and Co., 1924.) n.p. "Lord Kelvin as Professor in the Old College of Glasgow," by Dr. David Murray. Pp. iv+22+4 plates. (Glasgow: MacLehose, Jackson and Co., 1924.) n.p.

He should have a reading knowledge of French and German, and be able to translate Latin and easy Greek authors. He should then study logic, in order to apply his words sensibly.

Lord Kelvin matriculated in the University of Glasgow at the age of ten, and at fifteen he gained a University medal for an essay on the figure of the earth. He entered Peterhouse, Cambridge, at the age of seventeen, and in 1845 was declared second wrangler and in the following year Smith's Prizeman. In this year, at the early age of twenty-two, he was elected to the chair of natural philosophy at the University of Glasgow. "Those," he said, "were the palmy days of Natural Philosophy—the pre-commissional days." They were the days when lectures were preceded by prayer, when the professor would "meet his classes" for two hours on five days of the week for six months, and would devote the rest of the time to original research, in which chosen students might take part as assistants. *Lehrfreiheit* was a reality then, and the professor might teach whatever seemed to him best for forming the character and stimulating the imagination of the students. There was no thought of training for manual dexterity, inventiveness, or practical research. "Science" had not yet arisen as a faculty to be cultivated for its own sake or placed on an equality with the *artes humaniores*. Had the commercial value and utilisation of science been an object of university training in 1846, William Thomson would, in all probability, not have accepted the chair. Yet he himself was a shining example of the economic value of scientific knowledge and invention based upon it. He made innumerable inventions, and from some of them he derived considerable wealth, which the poverty of his early days enabled him fully to appreciate.

The sixteen years from 1850, when a steam tug laid the first submarine cable between Dover and Calais, to 1866, when the first permanent cable was laid between Europe and the United States, showed Lord Kelvin in a new light. He formulated and expounded the theory of cable transmission, and when he became a director of the Atlantic Telegraph Company, he did the work of the "drummer boy" in steering the company through the crises produced by the repeated failures of the cables. "What has been done," he said to the shareholders, "will be done again." The 1865 attempt was a failure, 1800 miles of cable being left at the bottom of the sea. But in the summer of 1866 not only was a new cable laid, but the old one was also recovered and completed.

While his work on cables gave Lord Kelvin his knighthood and the freedom of the city of Glasgow, it gave the electrical world the mirror galvanometer and the siphon recorder. These were followed by the electrostatic voltmeter and the electrodynamic balance. Lord Kelvin was a convinced advocate of the metric system, and his strenuous partisanship stimulated his colleague, Prof. Macquorn Rankine, to write his ballad "The Three-Foot Rule," which begins:

Some talk of millimetres, and some of kilogrammes,
And some of decilitres, to measure beer and drams;
But I'm a British workman, too old to go to school;
So by pounds I'll eat, and by quarts I'll drink, and I'll
work by my three-foot rule.

Lord Kelvin's laboratory, or "experimental room," as it was called, was an entirely new departure, and was the earliest physical laboratory in Great Britain. His manner of lecturing has been much admired and much criticised. Some say he was always above the heads of his students, and that he could not conceive their being subject to error. Sometimes he would let a student work out a problem of mathematical physics in the class, and would himself write down what the student dictated. After he had covered the whole blackboard on one occasion, the bewildered student said, "I am afraid, sir, I do not see where I am going." "Neither do I, Mr. Gillies; you may sit down," and the professor then sponged out all the ridiculous operations he had written down. He would, however, not tolerate facetious or irreverent answers, and would reprimand them severely.

On another occasion he despatched two students to the top of the College tower to take some observation with an electrometer. They reported the result, but it was of the opposite sign to what Lord Kelvin had expected. The professor was nonplussed, and advanced all sorts of theories to account for the result, only to reject them all as inadequate. Next morning he said he had spent the night trying to arrive at some explanation, but had not succeeded. On the third morning he appeared radiant. "Gentlemen, I have it now; they turned the instrument upside down." "It was the last thing that occurred to him," says Dr. Murray, "that a student in the Natural Philosophy class in the University of Glasgow could do so stupid a thing."

Kelvin has often been likened to Helmholtz, and for some time, indeed, the two had similar eminence and standing in their respective countries. Kelvin's almost universal genius left a lasting impression on his age. His estimate of the age of the earth has been vastly extended by the discovery of radioactivity, and his bold conception of the vortex atom is no longer regarded as corresponding in any way to reality, but he was one of the mightiest physicists who ever lived—"the foremost Cambridge man of science since Isaac Newton, and the most distinguished of the professors of the University of Glasgow."

Instinct and Culture in Human and Animal Societies.

Le Monde social des fourmis, comparé à celui de l'homme. By Auguste Forel. 5 vols. Pp. xiv + 192; iii + 184; vii + 227; vii + 172; vi + 174. (Librairie Kundig, Genève, 1921–23.) 10 Swiss francs each vol. A Summary by the author: "Mensch und Ameise." Pp. 70. (Rikola Verlag, Wien, 1922.)

MAN is an animal, albeit a social animal, and unless the study of man be made to rest on the firm foundations of biology, this study is doomed never to become a real science. The truth of this has been keenly felt by the early sociologists. In fact it has been almost an obsession with them, and the analogy between society and organism, taken literally and applied as a unique principle of research, has misled and wrecked most of the earlier attempts at systematic sociology. For in science, as everywhere else, work done by proxy, by borrowing or copying, does not lead very far. Though sociology should never break its contact with biological science, it must achieve its results by its own efforts, and recognise that the entirely different nature of its subject requires specific methods, poses new problems, and opens up new aims. The relations between human individuals in society can be compared to the intercellular process within the living organism only in a mystic, semi-poetical simile and not in any scientifically useful analogy. As a method of sociological research and exposition this simile is worse than useless, as has been proved by the unfailing sterility of the many attempts at developing such social systems.

Yet the fallacy is so firmly established, so alluring, that even a sociologist and field worker so exact and critical as the late Dr. Rivers, attempted in his last book ("Psychology and Politics," Kegan Paul, 1923) to give it currency once again. We read there, on p. 62, that the resemblance between the living organism and society "is something more than an analogy, and depends on the operation of some fundamental laws of development common to both organism and society." Again, the leading British anatomist and anthropologist, Sir Arthur Keith, approaching the problem from the biological point of view, writes in a passage, which, I confess, gave me a genuine pang of dismay, "the resemblance between the body physiological and the body political is more than an analogy: it is a reality" (The Rationalist Press Association Annual, 1924, p. 11). I fail to see why a *reality* should disguise itself as a *resemblance* and be perceptible only through an *analogy*. In any case, it is not superfluous to question the opinion of two such eminent thinkers and to give a demonstration, as I shall presently attempt to do, that there exists no analogy whatever between society and organism, in any scientifically useful sense of the word.

There are sociologists again who, abandoning the hopeless confusion between intercellular process and social relations, yet try to transfer certain theories from the evolution of life to that of societies. They regard anthropology and sociology as a science of social evolution and adapt such concepts as "struggle for existence," "natural selection," "adjustment to environment," to explain all facts of society. Apart from the recent, in the main very pertinent, criticism of exclusive evolutionism in anthropology (Pater W. Schmidt in Austria, Dr. Graebner in Germany, Dr. Rivers, Prof. Elliot Smith, and Mr. Perry in Great Britain) there is no doubt that the laws and principles of organic evolution do not hold good with relation to human societies, where the facts of organisation and culture introduce a new element and change the whole aspect of the process.

Recently we have witnessed another intrusion from biology into social science in the assertive and stimulating theory of the so-called herd instinct, which is supposed to be at the bottom of all social force and to explain all human institutions, laws, beliefs, fashions, and customs. This view, very popular among the amateur psychologists and sociologists of the day, will not bear a close sociological examination.

The question therefore remains: In what way should the sociologist establish his contact with biological science? In what exchange of services can the two studies derive mutual benefit? Where, on the other hand, must they draw the line of demarcation and recognise that the difference of their respective subject-matters precludes borrowing or encroachment? The answer to these questions cannot be hit upon *a priori* by a happy simile, inspired phrase, or armchair formula. It must come from careful comparative study of animal and human societies.

When therefore a pioneer biologist, and a student at first hand of human nature in several of its departments, summarises his life work on the social relations of ants, and does it with his attention directed to the comparative problems of human and animal sociology, this is an event of unusual importance for those who want to understand the biological foundations of society. The perusal of these five volumes, beautifully written and magnificently produced, with numerous plates, figures, and illustrations, fulfils the most exacting expectations of those who have learnt to admire Prof. Auguste Forel as a great entomologist, first-rate student of the human mind, and daring social reformer. It would be superfluous to recommend the work to the attention of the zoologist or biologist, and

no psychologist or philosopher will fail to find a mine of inspiration and suggestion in it. But its value for comparative sociology might perhaps not be so obvious, and it is on this point that it will be well to enlarge here.

The sociologist who, after his preliminary introduction (in vols. 1 and 2) to the ants, their anatomy, physiology, mentality, classification and distribution, follows up the fascinating description of their social life, will be at once impressed by the breach of continuity between the human and insect societies. Whereas in human groups, collective behaviour is co-ordinated by certain social forces, resting on *organisation* and supported by a scaffolding of *culture*, there is among the ants a complete absence of these two elements. Instead of this we find co-ordination by *instinct* and by *anatomical and physiological arrangement*.

If we compare the sociability of the ants with that of man, we find, as I have said, that the insects achieve their unity of action by instinctive arrangements which prompt each individual ant to respond to a specific stimulus in the same manner. Take, for example, their constructive activities. Prof. Forel gives a description of their natural implements, the specific bodily organs adapted in different species to different building aims. He describes the architecture of their nests, which, measured by the stature of the builders, would in certain cases dwarf the Pyramids by their size and crush sky-scrapers by their mass. When we follow the little insects at work, we find that the division of labour is rooted in the natural fact of polymorphism; that their tools and their tasks are prescribed to them by their anatomical structure; that any social organisation in the sense of hierarchy or compulsion is absent; that every insect is put in its place and works at its task, following an inner instinctive urge. Compare this with a group of men at work. Whether it be a savage community building a house or a canoe, or engaged in a hunting or fishing expedition, or whether we consider modern working men employed in some large industrial enterprise, we have a different picture. The division of labour is not based on fundamental anatomical differences, and the implements are not given by Nature but supplied by culture. The individual workers are not moved by instinct, but by the forces of social organisation which allows a small number of leaders to compel or lead or persuade the rest to work at a task in itself unpleasant. The anatomical equipment and instinctive endowment are supplanted by the gifts of material culture and the forces of social organisation.

If we study the family life of an ant-heap, and compare it with human marriage, family, and kinship organisation, we come to a similar conclusion. The biological chapter in the story of propagation is much longer and more complicated with the ants than with humans. By a natural division of functions, only a small part of the insect community is anatomically fit to mate and to produce offspring. With them the romance and tragedy of the nuptial flight and annihilation of the males, so vividly and fully described by Prof. Forel, is much more sharply defined by instinct and provided with greater variety of incidents than is the case with man. The further history of the progeny is still more complicated and requires practically in every species of ants a co-operation of one or more polymorphic forms which act as nurses, defenders, carriers, and feeders of the brood. Yet, in each phase of this very complicated process, we see that everything happens merely by the promptings of instinct, in satisfaction of a physiological need or natural craving specifically adapted to the process.

In the simplest forms of the most primitive human society, similar ends are brought about by entirely different means. While the anatomical and physiological difference is limited to the division of sexes, we see that the instinctive promptings to mate and take care of the progeny are in every one of their most elementary manifestations moulded, complicated, and co-ordinated by forces of tradition, organisation, and culture, of which we can perceive not even traces in the insect society. From the moment of birth, nay, from that of conception, the new human organism in the womb is the object of traditional observances: taboos, magical or religious rites, in higher societies hygienic rules and customary observances. The nursing, tending, and education of the child in human societies is also largely defined and consistently moulded by the tradition of the tribe; by its economic conditions, its legal system, and its material culture. No doubt, both in sexual relations and in kinship bonds, the instinctive elements play a paramount rôle, yet in both they are invariably and powerfully modified by tradition. To this is due the fact that in no two savage tribes, in no two types of civilisation, do we find exactly the same sexual morals, marriage customs, or systems of kinship, while on the other hand we have to recognise that the underlying instincts and tendencies do not essentially differ throughout humanity.

M. Forel describes in detail the wars of ants, and with a certain zest of pessimism compares them with those of man. Here we see the same relation. As in love, so in hatred, the ants are moved by instinct and instinct alone. Every species, nay, every ant-heap, has its natural enemies—some stronger, some weaker, some belonging to the ant family, some to other animal domains. Against these the soldiers or workers will fight to death, using their natural anatomical weapons, moved one and all by the same hostile impulse, dropping naturally each into its place in the fighting-line.

How welcome would be such an army to one of those modern generals or politicians or journalists who seem to regard wholesale brutal destruction of life as the chief end of humanity! Yet human nature, bad as it is, and capable of unlimited depravation, is at least plastic, and it has to be fashioned into the negative evil, hostile attitude of hatred, even as it could be fashioned into an attitude of international tolerance, generosity, and desire for co-operation. Man has to manufacture the impulse of hatred, instinctively present in an ant-heap. In a savage tribe this is done by tradition, which, from generation to generation dictates to the tribesman who is his enemy and who is a friend. In our modern societies a shoddy mock-tradition of hatred is frequently manufactured in a week or so by the powerful, though despicable machinery of newspaper trusts, in which a leading mediocrity dictates to millions of others the basest and most negative feelings and impulses for destructive action. The weapons given by Nature to an ant-soldier, man had to create by means of civilisation —save the mark—and where in the insect army every soldier ant knows his place instinctively, man has to create his army organisation by ingeniously devised drill and subordination.

The chapters about the wars, predatory expeditions, and struggles of the insects in Prof. Forel's fourth and fifth volumes, read more excitingly than any imaginative novel or fantastic insect play. Some of the reflections of the author—notably in the small German booklet "Mensch und Ameise"—given with the vigour and enthusiasm of youth and with the wisdom and simplicity of age, afford admirable and inspiring reading.

We could similarly compare the economic activities of the ant-heap—their search for food, their "cattle," gardens, various arts and crafts—with those of man; or enlarge on the interesting problem of their means of mental communication and compare them with human language. The conclusion would be always the same. In human societies there exists a man-made system of material products, endowing the individual with the various implements, weapons, economic contrivances, each of which corresponds to some specific item in the anatomical equipment of the ants. Above all, there is the supreme human implement, language, which means thought and also community and continuity of thought. Language gives the possibility of tradition—that is, of the system of rules, ideals, moral precepts, laws, which mould, modify, and co-ordinate human instincts. In animal societies sociability is based directly on instinct: animals act in masses, for, having to live in masses, they are always moved by the same response to the same stimuli. Men act in groups because they are organised into societies—that is, their instincts have been shaped by tradition, a number of traditional motives has been inculcated into them, and they have been taught to use in co-operation the same apparatus of material culture, including language, the implement of thought. The animal, whether social or not, stands in immediate contact with the environment, its instincts being directly adapted to it. With man, culture stands between him and Nature as a secondary means of adaptation, and a secondary *milieu* at the same time.

This point of view will allow us to deal trenchantly with some of the fallacies enumerated at the outset: the society-organism simile, the herd instinct, and the wholesale borrowing by sociology of evolutional principles. Since the unity of the human group is brought about by the extremely complex process in which, through the co-operation of individuals and generations, tradition and culture and organisation are formed, sociology has to study this process, instead of comparing it to a thing so entirely different as a natural organic unity in which the cells of an organism are bound up. Again, since man, unlike the animal, does not stand in a direct immediate relation to environment, there is no use speaking about natural selection or struggle for existence, for these things do not apply to man, the only animal armoured by culture, tied with traditions, living in the artificial, secondary *milieu* of organised society.

Now, is there any specific herd instinct which would form the foundation of the sociability of an ant-heap? We have seen that life, in an insect community, follows several lines of typical, inherited behaviour, each associated with a special anatomical and physiological arrangement, each furnishing definite responses to specific features of the environment. Nutrition, propagation, search for food, various forms of aggression and defence, several types of symbiosis, all consist of a number of instincts each. But there is no special natural outfit, no physiological arrangement, not one single inherited tendency or response which would correspond to sheer sociality. Gregariousness is the general aspect of all their instincts, but certainly not one specific instinct. Prof. Forel does not show us anything or speak of anything even approaching herd instinct, nor can anything of the sort be detected by the most careful reader. If we have to discard this figment with reference to the most gregarious of animal societies, there can be still less room for it in the communities of man. "Human gregariousness" is even more removed from instinct than that of animals, and it consists essentially of the manner in which the various human instincts are moulded and co-ordinated by material culture and tradition, so as to result in the various mental uniformities which underlie organised behaviour.

We see, therefore, that even a brief summary of Prof. Forel's thorough and valuable results has enlightened us on the question of the biological foundations of society. We have seen that the distinctive features of human society are *organisation and culture*, the man-made, artificially created cohesion, and the man-made environment and equipment of the individual. Yet neither organisation nor culture is built up on the quicksand of human whim or creature imagination or contract or free will or historical accident or however we might call the "indeterminate mental." They are built on the foundations of instinct and in this the study of society stands in close relation to biology. But human instinct, unlike that of animals, is essentially plastic, and herein lies the possibility of culture. In studying how the plastic human instincts are modified in society, we learn to understand the nature of material culture, language, and tradition—the sum-total of civilisation. The further we push the study of the relation between instinct and culture, of the transformation of instinctive impulse into the social forces of beliefs, ideals, moral norms, and social sentiments, the better we learn to understand the enormous benefit derived by the sociologist from a comparative study of animal and human communities and the importance to him of a right understanding of the biological foundations of human character.

B. MALINOWSKI.

Oyster Mortality.

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 6, No. 3, 1923. An Account of Investigations into the Cause or Causes of the unusual Mortality among Oysters in English Oyster Beds during 1920 and 1921. Part I.: Report. By Dr. J. H. Orton (assisted in Laboratory Work by Miss Edith Worsnop. Pp. 199 + 12 plates. (London: H.M. Stationery Office, 1924.) 15*s.* net.

IN September 1920 there was a scare about the heavy mortality amongst the oysters on the layings of the Thames Estuary. This scare passed to Colchester, and to every part of the East Coast, and similar death-rates were also mentioned from the south and west. The matter was investigated by the Development Commission's Advisory Committee on Fishery Research, but so far as we can see from the Report before us, no accurate estimations were made of the deaths, either beforehand, or afterwards when it certainly would not have been too late; the Table given shows that unusual mortality was reported in the summer of 1921 in the Thames Estuary, and the only possible excuses for the lack of accurate investigation then are either that reports were not sent in at the time, or that the Development Commission refused to provide the funds for such. Oyster planters estimated the deaths in 1920 at 10 to 60 per cent. against an average of 10 to 15 per cent., but there is no indication upon what these estimates were based. As Holt in Ireland records losses from all causes of 39·6 and 54·6 per cent. on accurate figures, and Bulstrode showed that an English planter laid 241 millions in 13 years, and only picked up and sold 105 millions, we may be allowed to doubt the accuracy of the belief in this greatly increased and "abnormal" mortality, especially as no information is supplied as to deaths and the working of the layings in 1918 and 1919.

The Development Commission got to work with commendable rapidity. Drs. Orton, Brady, and Eyre, biologist, chemist, and bacteriologist, were engaged to investigate, and the first part of their Report is now published under Dr. Orton's name. The industry suggested poisoning by T.N.T. (tri-nitro-toluene), or some other poison, dumped into the sea, and the researches now described were mostly made to test this view. The examinations, analyses, and tank and other experiments were well conceived and done with the greatest care, but at the date on which the investigations commenced (Oct. 28) the mortality as indicated by hockley (hollow-sounding) oysters is stated to have been over. The work shows that it is "unreasonable" to suppose that the deaths can have been due to T.N.T. Various metals, nitrites, salts of picric acid and oil were considered one by one and eliminated. Indeed, the theory of poisoning would seem to have been almost definitely disproved, but we think that this disproof would have been stronger if there had been more investigation into the directions of the currents from the dumping areas, and if a systematic inquiry had been undertaken into the mortality of other animals, especially near the dumps, as laid down by the Advisory Committee on Fishery Research in their original resolution. Are there any records of heavy deaths among the slipper limpets or other molluscs, either on the oyster layings or elsewhere?

Coming to natural conditions, such as might be caused by fluctuations in weather, a comparison is made between 1912 and 1919 as two similar years, but no unusual mortality is recorded or recollected for 1912. The figures for layings and sales must surely be in the books of the chief oyster planters for the last twenty years, and would be interesting in this connexion; their publication could be of no harm from a trade point of view, as planters generally are sold out before the end of the season. The way the grounds are worked (cleaned up by dredging, harrowed, etc.) year by year would also require to be known, but the com-

plications introduced by that horrible American pest, the slipper limpet, would make figures of costs of little value. There were clearly large numbers of sea urchins and starfishes as well on the beds at Whitstable, but these are regarded as evidence of the healthy conditions of the beds, and the relative number of these most destructive animals in 1920 as compared with other years is not estimated; if 1919 was a year of poor shell growth, so far as thickness was concerned, either form might have caused a great rise in mortality in 1920. Dr. Orton especially asks for experiments as to temperature and salinity designed to cover yearly fluctuations.

The full results obtained by Dr. Eyre relating to oyster bacteria are deferred to Part II. of the Report, but interesting experiments with the filamentar Cladothrix are recorded. Weak oysters were found by Dr. Orton to have, as an almost constant symptom, peculiar muscle spindles, derived from the adductor muscle holding the shells together, individual spindles varying from 8μ to 90μ in length; they were also produced experimentally. This investigation and those on the crystalline style and on "bleeding" are largely new and will require to be read by every zoologist, to whom they will form the most valuable part of the researches.

The Report concludes by assigning no cause for the oyster mortality in 1920, the abnormality of which, as compared both with other years and the known conditions of certain of the grounds in 1919, the writer regards as unproven; in Part II. of the Report this matter should be considered. Some estimate of the months of greatest incidence of the mortality could easily have been made by the examination of the dead shells dredged up, and any correlation with the spawning season settled, this being a period of much death. We do not know enough about the food of oysters to make possible any consideration of the partial failure of their food supply at this season, this being in the writer's opinion the chief cause of death at Helford, provided that the layings are clean.

On the whole we consider that we are justified in calling this research a "panic study," and it would seem that it was really so as it was preceded by no accurate observations such as could have been made in three days off the Colne and at Whitstable. It was directly taken charge of by the Development Commissioners, and on the face of it the story as to T.N.T. and other poisons, comparing quantities dumped with the amount of water and its circulation, was a foolish scare. As an industrial matter it had to be undertaken in a special form, and certainly the excellent quality of the work put into it makes it scientifically valuable. All readers will be in agreement with Dr. Orton that we know far too little about the oyster, and that a good means of procuring knowledge would be that somebody "should found a Scholarship for Research on Oysters of a value of at least 300*l.* per annum" under suitable conditions, a suggestion that we would at once commend to the Development Commissioners.

J. STANLEY GARDINER.

Three-Dimensional Geometry.

Principles of Geometry. By Prof. H. F. Baker. Vol. 3: Solid Geometry, Quadrics, Cubic Curves in Space, Cubic Surfaces. Pp. xix+228. (Cambridge: At the University Press, 1923.) 15*s.* net.

IT is an undoubted fact that greater intellectual satisfaction is to be obtained from the proof of a geometrical theorem by the methods of pure geometry than from an algebraical investigation of the same theorem, and treatises on the methods of projective geometry are not uncommon, even in English. But apparently the application of such methods to the study of three-dimensional problems is considered difficult, for English text-books either confine themselves to plane geometry or else devote a chapter at the end to a meagre account of quadrics. As for investigating by this means the properties of a space cubic curve or a cubic surface, that is never dreamt of. Salmon's "Geometry of Three Dimensions" is, we believe, the only English book which gives at all a complete account of the cubic surface, and in Salmon, of course, the algebraical side preponderates. Prof. Baker's third volume fills, then, an undoubted gap. To get into 223 pages an account of quadrics, of the space cubic and of the cubic surface, has involved a great amount of compression which is perhaps to be regretted; the book makes difficult reading, but the matter is there, and whoever will take the trouble to study its pages with care will be amply rewarded.

The method of treatment follows on the lines laid down in the previous volumes, the second of which was noticed in our issue of September 22, 1923, p. 428, though naturally less emphasis is put upon the logical point of view and algebra is used more freely in illustration of and supplementary to the geometrical work.

The first two chapters, parallel to chaps. i. and ii. of vol. 2, deal with the quadric surface defined by means of its generators and with its relations to a fixed conic, the properties of spheres, of circular sections, and of confocal quadrics coming in in their natural place. The elements of the theory of the linear complex and of the tetrahedral complex are touched upon by the way. Chap. iii. treats of the space cubic curve, arising as the further intersection of two quadrics with a common generator, or obtained as the locus of intersection of corresponding planes of three related axial pencils.

A series of examples gives in summary form many properties of the curve and its construction to satisfy various sets of conditions; for example, it is shown that two general space cubics have ten common chords and that there are six space cubics having six arbitrary lines as chords. The theory of self-polar tetrads and of self-conjugate pentads and hexads on the curve is also developed.

The final chapter is introductory to the theory of the general cubic surface, which it is intended to discuss later in connexion with a configuration in four dimensions. The well-known double-six theorem is first investigated and examples are considered of the figure of twenty-seven lines arising therefrom. A geometrical definition of the cubic surface is then given, and it is shown that there are families of space cubics lying upon it. This leads to the representation of the surface upon a plane. Other matters which are summarised in this chapter are the reduction of the equation of the cubic surface to the sum of six or five cubes, the bitangents of a plane quartic curve, the Hessian surface of a cubic surface, the four-nodal cubic surface and its dual, the Steiner quartic surface.

This book, it is safe to prophesy, will become one of the most treasured possessions of the student of geometry. F. P. W.

Our Bookshelf.

The Flora of the Malay Peninsula. By Henry N. Ridley. (Published under the Authority of the Government of the Straits Settlements and Federated Malay States.) Vol. 2: Gamopetalæ. Pp. vi+672. Vol. 3: Apetalæ. Pp. vi+406. (London: L. Reeve and Co., Ltd., 1924.) 42*s.* net each vol.

VOL. 1 of this series was noticed in NATURE of January 6, 1923, p. 6. Of Vols. 2 and 3 which have now appeared, the former deals with the Gamopetalæ from Caprifoliaceæ to Labiatæ, and the latter with the Apetalæ from Nyctagineæ to Salicineæ. The arrangement of the natural families is that of the "Genera Plantarum" except that in the second volume the Plantagineæ are inserted after the Plumbagineæ, and the Cardiopteridæ after the Convolvulaceæ. In the third volume the Aristolochiaceæ and Nepenthaceæ are transposed, the Hernandiaceæ are separated from the Laurineæ and the Opiliaceæ are included. The Urticaceæ are, however, still retained as one general family.

It is easy and perhaps somewhat ungenerous to criticise a work of the size and importance of this first complete flora of the Malay Peninsula. Moreover, it is rare that such an expert in field work as is Mr. Ridley should be equally at home in the herbarium, but it is undoubtedly due to this uncommon combination of capabilities that we find many points which are apt to provide difficulties to less fortunately equipped workers. For example, the contrasting in certain of the keys of comparative values only renders them valueless to a worker who may be in possession of one of the species only. Again, the frequent use of the abbreviation *l.c.* entails considerable search for the orginal quotation, and in the majority of cases is not a saving of space. Had the measurements been given in parts of a metre instead of tenths of an inch the work would have been more in accordance with present-day standards.

The work generally is of the nature of the old-time flora intended purely for the systematist. There must be a mass of information available which might have been indicated briefly, as for example on the ecology of the plants cited, for the very short extracts of field notes quoted are but little help to a worker who has not an intimate knowledge of the country and its vegetation. For workers in Malaya an index to the vernacular names cited would have been of great help, for in that country, where Malay is the common language, the plant names are first learnt in that language, and such an index would introduce the work to a much wider circle.

The references to the new species leave much to be desired. In the second volume there are one hundred and five and in the third volume twenty new species and new names given. The differential diagnosis is confined to a wholly inadequate line or mention in the key, and where the affinity lies with an extra-Malayan plant it is left to an occasional footnote to give assistance. Further, and what is perhaps worse, in scarcely any cases are specimens quoted, only collectors' names. The figures are well drawn by Mr. Hutchinson, and it is to be regretted that they are so limited in number. It is a pity there are so many minor imperfections to detract from the value of a work of first-class importance executed by an author with such a unique experience.

Differential Equations in Applied Chemistry. By Prof. Frank Lauren Hitchcock and Prof. Clark Shove Robinson. Pp. vi+110. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 7*s.* 6*d.* net.

THE problem of providing a student of one of the experimental sciences with a broad basis of mathematical knowledge coupled with the special technical facility in the subject required for the development of his own field is no mean one. Especially does it become acute, now that increasing demands of the teachers of his principal subject establish an ever-greater monopoly of his time during training. Hence, partly, the reason why so many chemistry, physics, biology, and engineering students return in later years to their mathematical masters for expert assistance: but this is not the whole truth. Teachers of mathematics must equally share the blame.

A reorganisation of mathematical teaching along "functional" lines is clearly indicated, and until that is undertaken seriously so that the methods are consciously directed to, and arrive at a concrete end with a detailed application to real and not "mathematician's" problems, much of our present teaching must be futile. The attitude of many teachers to their subject is false and cramped. In the introduction to this otherwise excellent book, for example, we are informed that the student (of chemistry) has two important needs in mathematical technique:

(1) How to integrate the differential equation.

(2) How to perform the calculations needed to obtain an answer correct within the practical requirements of the problem.

Now this would be excellent were it not for the fact that (2) *is* (1) in practice; it is the exception to encounter an equation that can be "integrated" in the sense that it belongs to one of the so-called "Standard Forms," and recourse must then generally be had to approximations, *i.e.* to (2). But it is just the processes included in (2) that receive the least attention, and it is exactly a discussion of the "Standard Forms" that usually delimits the scope of the knowledge of differential equations acquired by physical and chemical students. The reason is not far to seek. They owe their pedagogic prominence to the position given to them in the earliest books on "Differential Equations," and retained ever since. For certain branches of "functional" teaching in mathematics little would be lost by "scrapping" the lot.

The present little book is an heroic attempt to make the best of both worlds by restricting attention only to equations that are integrable and useful.

H. LEVY.

Smithsonian Miscellaneous Collections. Vol. 74, No. 1: *Smithsonian Mathematical Formulæ and Tables of Elliptic Functions.* Mathematical Formulæ prepared by Prof. Edwin P. Adams; Tables of Elliptic Functions prepared under the Direction of Sir George Greenhill by Col. R. L. Hippisley. (Publication 2672.) Pp. viii+314. (Washington: Smithsonian Institution.)

THIS volume contains, in addition to the series of formulas of many branches of applied mathematics prepared by Prof. E. P. Adams of Princeton, a table of the elliptic functions, with an illustrated discussion of their chief applications in geometry, dynamics, and electricity.

The table of the elliptic function was prepared and calculated by Col. R. L. Hippisley; it gives, in a form suitable for immediate application, the series of functions $A(r)$, $B(r)$, $C(r)$, $D(r)$, $E(r)$, $G(r)$, $F\phi$, for every degree r of the quadrant, and every degree θ of the modular angle, where $\sin\theta=\kappa$ the modulus. These had been calculated already for the British Association, and printed, but held up for want of money.

Here A, B, C, D are the theta functions of Jacobi, but normalised to zero degree, so that with $\frac{r}{90}=\frac{u}{K}$,

$$D(r)=\frac{\Theta u}{\Theta_0},\quad A(r)=\frac{Hu}{HK},\quad B(r)=A(90-r),\quad C(r)=D(90-r),$$

giving

$$\sqrt{\kappa'}\,\mathrm{sn}u=\frac{A(r)}{D(r)},\quad \mathrm{cn}u=\frac{B(r)}{D(r)},\quad \frac{\mathrm{dn}u}{\sqrt{\kappa'}}=\frac{C(r)}{D(r)}.$$

Also $\phi=\mathrm{am}u$ is the inverse function of $u=F\phi$ of Legendre; and his elliptic integral of the second kind $E\phi=\frac{rE}{90}+E(r)$, so that $E(r)=Zu$, or $\mathrm{zn}u$ of Jacobi.

Provided with these functions, the third elliptic integral II can be expressed in a form that can be calculated numerically from the table, where the results are given to ten decimals.

Acoustics of Buildings: including Acoustics of Auditoriums and Sound-proofing of Rooms. By Prof. F. R. Watson. Pp. viii+155. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 15*s.* net.

THE acoustics of buildings is a subject which has always possessed importance, but with the increasing size of public buildings and the congestion of our urban populations, it has assumed much greater importance in recent decades. Though a good deal has been written on this subject, there are few books which present the problems to be solved in a lay form suitable for those not possessed of scientific attainments. Prof. Watson has succeeded in producing a volume which should prove of great value to architects concerned with the design or acoustic improvement of auditoriums, and has incorporated a number of his own researches. The volume is divided into three parts, a short introductory chapter on the principles of sound transmission scarcely deserving of a main separation, the acoustics of auditoriums, and the sound-proofing of buildings. In part 2, after explaining the behaviour of sound in a room, the nature and control of reverberation, the successful design of an auditorium and sound absorption are discussed, followed by a very interesting chapter on practical examples from existing buildings. Part 3 gives a number of experimental tests on materials by the author and others, followed by examples of sound-proofing rooms and buildings, and a special chapter on ventilation in reference to sound, while vibrations in buildings are shortly dealt with. The work is a successful attempt to bring the investigations of science to the aid of the artist and technician.

Practical Chemical Analysis of Blood: a Book designed as a Brief Survey of this Subject for Physicians and Laboratory Workers. By Prof. V. C. Myers. Second revised edition. Pp. 232. (London: Henry Kimpton, 1924.) 25*s.* net.

THE second edition of this book contains alterations and additions necessary to consider advances made in the subject during the last two years. An additional separate chapter gives the methods of blood analysis followed by Folin and Wu, and Benedict's new method of uric acid estimation is described. This edition also contains descriptions of the estimations of hæmoglobin, oxygen, calcium, inorganic phosphates, and acetone bodies, and a chapter on quantitative micro-methods of urine analysis. Numerous references to original articles, and appendices on colorimeters and standard solutions, perfect a valuable book on a subject of rapidly growing importance.

Nouvelles Vues Faraday-Maxwelliennes. Par Charles L.-R.-E. Mengès. Pp. v+94. (Paris: Gauthier-Villars et Cie., 1924.) 10 francs.

M. MENGÈS reprints and expands some papers which have appeared in the *Comptes rendus* of the Paris Academy of Sciences, chiefly on the electro-optics of moving systems. He finds the special theory of relativity self-inconsistent and proposes in some measure to revert to the older "classical" conceptions. Nothing but a detailed and complete discussion of his views would be worth undertaking; and since it is impossible to find space for this here, we offer no opinion concerning them.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor 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 Possible Explanation of the Behaviour of the Hydrogen Lines in Giant Stars.

WHILE the general behaviour of the absorption lines in stellar spectra has been well accounted for by thermodynamic theory, the Balmer series shows marked peculiarities. In spite of the very high resonance potential, these lines appear even in stars of class G, and their intensity is conspicuously affected by absolute magnitude—that is, by the density of the stellar atmosphere.

According to the elementary theory, the fraction of all the hydrogen atoms present which are in the two-quantum state (and hence ready to absorb the Balmer series) should be $f_2 = q_2 e^{-(\chi_1 - \chi_2)/kT}$, where k is Boltzmann's constant, $\chi_1 - \chi_2$ the resonance potential, and q_2 the weight of the two-quantum state[1]; and this fraction should be independent of the pressure. Introducing $\chi_1 - \chi_2 = 10{\cdot}16$ volts we find $f_2 = q_2 e^{-117000/T}$. For T = 5000° (roughly corresponding to the outer atmosphere of the sun), $f_2 = 6 \times 10^{-11} \cdot q_2$; for T = 3000° (rather high for the corresponding region in an M-star), $f_2 = 8 \times 10^{-18} \cdot q_2$; and even for T = 10,000°, $f_2 = 8 \times 10^{-6} \cdot q_2$.

For comparison, we may take λ4481 of Mg+, for which $\chi_1 - \chi_2 = 8{\cdot}85$, and $f_2 = 1{\cdot}2 \times 10^{-9} \cdot q_2$ if T = 5000°. Allowance for the fact that much of the magnesium in the sun is neutral may at most reduce f_2 to $10^{-10} \cdot q_2$ of all the Mg atoms present. Now λ4481 and H_α are the strongest lines absorbed by atoms in the corresponding states; yet the former is barely visible in the solar spectrum, and the latter is one of the strongest lines of all. This would demand an absurdly great abundance of hydrogen relative to magnesium (itself an abundant element) if the effective values of q_2 were comparable. Moreover, in giant stars, and especially in super-giants, such as α Orionis and the Cepheid variables, the Balmer lines are very much stronger than in dwarf stars of the same general spectral class, though the temperatures of the latter are higher.

It appears necessary, therefore, to assume that the effective value of q_2 for the two-quantum state of hydrogen is increased, in some special way, by a very large factor, which increases as the pressure diminishes.

A tentative explanation may be found in the fact that one of the two two-quantum states of hydrogen is metastable. The state called 2_2 by Bohr (or $2p$ in the ordinary series notation) can pass to the normal $1_1(1s)$ state by emission of the resonance line λ1216; but an atom in the $2_1(2s)$ state can (so far as we know) get out of it only by the absorption of radiation, or else by a collision of the second kind with another atom or an electron. A similar condition is found in helium, where the 1σ state (the lowest in the doublet system) is metastable. There is direct evidence[2] that a helium atom may remain in this state for an average life of the order of 10^{-3} sec. or more, as against about 10^{-8} sec. for an excited atom which can get rid of its energy by radiation. The 2δ state for Mg+, concerned in the absorption of λ4481, is of the latter type.

If it may be assumed that the number of hydrogen atoms in the $2s$ state in a star's atmosphere, and hence the effective value of q_2, is greatly increased when the life of the metastable state is long, the peculiar behaviour of the Balmer lines becomes explicable. The increase in the concentration of absorbing atoms accounts for the strength of the lines; while collisions, which get the atoms back to normal and diminish this concentration, will be more frequent in the denser atmospheres of dwarf stars.

The average interval between collisions, in a gas of pressure p mm. and temperature T° K, between an atom of molecular weight m and radius r cm. and atoms of molecular weight m' and radius r' is

$$\frac{2{\cdot}24 \times 10^{-24}}{p(r+r')^2} \sqrt{\frac{mm'T}{m+m'}}.$$

For excited hydrogen atoms (for which $r = 2 \times 10^{-8}$ cm., $m = 1$) moving in a gas of temperature 5000° and pressure 0·1 mm. (roughly the conditions in the sun's reversing layer) the collision-interval comes out $1{\cdot}8 \times 10^{-4}$ sec. if the "other atoms" are ordinary hydrogen ($m = 1$, $r = 5 \times 10^{-9}$), and 9×10^{-6} sec. if they are electrons ($m = 1/1850$, $r = 0$). In a giant star, where the pressure is probably from ten to a hundred times less, these intervals would be correspondingly increased. They are evidently quite of the right order of magnitude to be dominant in determining the mean effective life of a metastable state such as has been observed in helium, and without influence on ordinary states.

The influence here suggested will be important only for atoms in metastable states of high energy content, which are more likely to lose energy than to gain it, even in collisions with other excited atoms.

We might therefore expect to find it for the familiar lines of helium. Here $\chi_1 = 24{\cdot}5$ and $\chi_2 = 4{\cdot}7$ for the 1σ state, so that f_2 should be $10^{-10} \cdot q_2$ at 10,000° and $2 \times 10^{-7} \cdot q_2$ at 15,000° (which is probably near the temperature at which the helium lines reach their greatest intensity). For λ4481, at 10,000°, $f_2 = 2{\cdot}8 \times 10^{-5} \cdot q_2$. Here again the helium lines are stronger than might be expected from the probable abundance of the element (though the latter is hard to guess at). More definite evidence is found in super-giant stars like α Cygni, where the helium lines are present, though there is no trace of them in ordinary giants of Class A_2 or even A_0.

For the Pickering series of He+, $\chi_1 = 54{\cdot}2$, $\chi_2 = 3{\cdot}4$ and $f_2 = 6 \times 10^{-9} \cdot q_2$ even at 30,000°, so that the argument from abundance would appear to be applicable.

The red triplet of oxygen, λ7772-75, for which the excitation potential is almost the same as for the Balmer series, should be strengthened in giant stars and Cepheids, and would be interesting to observe.

The great concentration of atoms in metastable states, which is here postulated, would not be expected to occur in a gas in thermodynamic equilibrium. Such concentrations have, however, often been observed experimentally in vacuum tubes, which are of course very far from being in such equilibrium. Whether the departure from equilibrium in stellar atmospheres, which undoubtedly exists, would permit a sufficient concentration to explain the observed facts in the manner here suggested may prove a problem of interest to theoretical investigators.

An observational test appears, however, to be possible. The supposed concentration affects only the $2s$ state of hydrogen, and not the $2p$ state. Of the three components of H_α, $2s - 3p$ is at 6564·516 (I.A.), $2p - 3s$ at 6564·658, and $2p - 3d$ at 6564·720. In the laboratory, the components of longer wave-length are the stronger. In the stars, that of shortest wave-length should, on our hypothesis, greatly predominate.

There is no hope of resolution of this group in the

[1] Fowler and Milne, M.N., R.A.S., 83, 403, 1923.
[2] F. M. Kannenstine, *Ap. J.*, 55, 345, 1922.

stars, and measurement of the mean wave-length of the blend is greatly complicated by the effects of radial velocity, and of the "K term." The latter unfortunately indicates a shift in the opposite direction.

Even in the sun, radial velocity may greatly complicate the investigation. Could the Hα line be observed double in the prominences—or show to appear single when a pair of separation 0·15 Å would certainly be resolved—the question might be settled.

K. T. COMPTON.
H. N. RUSSELL.

Princeton University,
June 21.

Leaf-mould.

IT must be a matter of common knowledge to persons interested in woodlands that some woods and copses have a more or less thick deposit of leaf-mould, whilst in others this covering is absent. It is not a question of the presence or absence of particular trees, *e.g.* oak or beech, and it often happens that within the limits of a single wood considerable differences exist, in respect of leaf-mould formation, in different parts of it.

I have noticed that its presence or absence is very commonly correlated with the character of the surface soil. Sand or gravel promotes, whilst heavy, and especially calcareous, soils seem to inhibit its formation. In a small wood that I have had under observation for a number of years the surface varies from chalk to heavy clay, with a good deal of intermediate calcareous loam. Leaf-mould never forms naturally in this wood, although the conditions would seem to be generally favourable. The trees are reasonably thick, consisting mainly of beech and some oak. The ground is well drained and dry for the most part, whilst in other spots it is damp and even boggy. There are large hollows where leaves collect, and from which the winds never move them, even in winter. But no real leaf-mould ever forms. The mass of dead leaves and twigs rot down and evaporate, so to speak, next year. This is to be attributed to bacterial action, and I believe that for the most part the result is due to the bacteria being able to carry on the disintegration process, mainly to carbon dioxide and water, in the presence of the available calcium carbonate of the surface soil. In another wood near by there are deposits of sand and gravel overlying the loams and chalk, and there the abundance of leaf-mould is very striking.

It occurred to me that the presence of the "acid" silicious top soil might be the decisive factor in the situation. Such an acid soil, by not neutralising the products of bacterial action, would conduce to the arrest of bacterial activity and so might provide in the first-named wood the requisite condition for leaf-mould formation which had, up to that time, been lacking. This hypothesis received confirmation. A covering of sandy gravel spread over the surface of one of the hollows was followed by the formation of an excellent leaf-mould, though this had not occurred in this hollow before, nor did it take place at all in those hollows adjacent to it which had not received a coat of gravel.

I do not suppose that the whole story of leaf-mould formation is contained in the foregoing, and it may well be that in other situations additional or other factors are concerned. Indeed it seems certain that soil drainage also influences the process, perhaps through its affecting conditions of suitable aeration. At any rate it happens that when pans of clay occur near the surface of a gravel or sandy soil in woods, with the result that the ground is water-logged for a part of the year—in such places one looks in vain for leaf-mould, though a black peaty deposit may occur in its place. These peaty deposits are very different from genuine leaf-mould, though both owe their origin to the disintegration of vegetable matter.

Leaf-mould, regarded from the point of view of the succession of organisms that are concerned in its production, and of the complex chemical changes therein involved, offers an attractive field for research. It is perhaps scarcely necessary to emphasise the fact that in addition to problems of more purely scientific interest, there are others connected with it which are of industrial importance as well. J. B. FARMER.

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The Theory of Hearing.

REFERRING to Prof. Scripture's letter in NATURE, June 28, the following observations on the vowel response of piano strings, which differ from those described, may be worth recording.

Using a small Broadwood upright piano with the lid open, and singing or speaking well into the instrument, I have found, (1) That a recognisable vowel response is given to *all* the English vowel sounds, though those to *i* (as in eat) and I (as in it) are relatively faint, owing to the poor response of the strings to frequencies of 2000 and more.

(2) That the response *is* given almost equally well, whether the vowels be intoned as prolonged or as relatively instantaneous sounds.

(3) That quite a good response is given to vowels sung "portamento" (with a variation of pitch of about an octave) or spoken as short sounds of varying laryngeal pitch. In some cases, especially in that of *u* (who), the "portamento" response is quite as good as that for the same vowel when intoned at constant pitch.

Experiment shows that a vibrating rubber strip "larynx," attached to a double resonator, will produce a constant vowel sound while the frequency of the larynx note is varied over an octave or more, by variation of the air pressure supplied to the larynx.

It seems reasonable to suppose that, in the production of a "portamento" vowel sound in the human mouth, the same thing applies—*i.e.* that the resonance frequencies of the vocal cavity remain substantially constant, though the frequency of the laryngeal puffs which evoke them is progressively changing. R. A. S. PAGET.

74 Strand, London, W.C.2.

IN reply to Prof. Scripture's letter in NATURE of June 28, I am not able to discuss the more recondite points he raises as to the nature of vowel sounds, or the mathematical formulæ by which alone, as he states, they can be subjected to analysis. I cannot, however, accept his statement that the undamped piano strings fail to respond to short spoken vowels. The facts can be tested in a moment by any one who has access to a piano. The fuller the tone of the instrument the clearer will be the response.

My own observation is that one gets a recognisable and distinguishable vowel however short the utterance, and that the quality of the resonated vowel is not noticeably changed by shortening or lengthening the vocalisation of the vowel sound; and further, that the characteristics of the vowels are as clearly distinguishable in the sharply uttered as in the sung vowel: ă, ā, i, oe, oo, all seem to come out fairly clearly and distinguishably. As Helmholtz says, the

ee is not so good. I believe this vowel contains high-pitched partials. The effect is improved by directing the voice rather more to the upper end of the sounding board so as to bring out these particular partials. The deduction that one would naturally draw from this simple experiment is that the vowels do contain musical partials, capable of being resonated so as to produce a combination of tones which is characteristic of the particular vowel employed. Of course the vowels may also contain other constituents which are incapable of being resonated, at all events by so imperfect a resonator as a piano.

The two fundamental points on which we are at issue appear to me to be these: (1) Are noises, as distinct from musical sounds, capable of being analysed by a series of resonators? (2) Are sounds of rapidly changing pitch capable of such analysis? In answering the first of these propositions in the negative, is not Prof. Scripture assuming that the limitations of analysis by Fourier's theorem and of analysis by resonators are the same? Fourier's theorem is by definition restricted to the case of recurring wave forms, *i.e.* (so far as concerns the present discussion) musical sounds, and to their analysis into fundamentals and harmonic partials. But is not this restriction imposed upon mathematicians by reason of the fact that the permutations and combinations possible when inharmonic partials are admitted are practically infinite, and consequently defy mathematical analysis? May not all sound waves be looked upon as being compounded of simple harmonic vibrations and consequently theoretically capable of analysis into their constituents? If it be admitted for the moment that the fibres of the basilar membrane with their associated fluid columns in the cochlea do actually form a complete series of resonators, any succession of pressure changes communicated to the fluid in the cochlea will set in harmonic vibration a certain number of transverse sectors of the membrane. If the components of the exciting wave are harmonic, the sectors of the membrane set in vibration will be narrow bands definitely spaced, and the result will be the sensation of a compound musical tone. If they are inharmonic the tendency will be for the different vibrating sectors to overlap so as to form vibrating *areas* with no distinguishable maximum point, and we should then have a sensation of noise of indefinite pitch.

With regard to the possibility of the resonance of inharmonic partials, inharmonic tones sounded simultaneously on a musical instrument are capable of being analysed by resonators. How then can it be maintained that inharmonic partials from a single source are not amenable to a similar analysis?

In the case of sounds of rapidly changing pitch, the completeness with which they can be analysed will depend partly on the relation of the rate of change of pitch to the periodicity of the vibrations, and partly on the degree of damping of the resonators. To speak of "damped" and "undamped" resonators, as Prof. Scripture does, seems to be rather a loose use of terms. There are no absolutely "damped" or "undamped" resonators (so far as sound is concerned). Resonators are of all degrees of damping. The cochlea is rather heavily damped, and consequently the location of resonant response in it may be changed much more rapidly than in the case of piano strings. (The silencing of piano strings when the "dampers" are down is not damping in this sense at all).

In Dr. Hartridge's pendulum experiment (NATURE, May 17, p. 713) the vibration period of the pendulums is much longer than that of sound waves. The alteration of the length of the driving pendulum must therefore be much slower than in the case of change of pitch of a musical sound if a "jangle" is to be avoided. But in Prof. Scripture's example of the Savart's wheel, or siren, which is being speeded up, if the speeding is done very rapidly the result is a disagreeable noise, which probably results from some such irregular jangle of vibrations in the cochlea as is seen in the pendulum experiment when the rate of vibration is altered too rapidly.

Still it must be conceded that the question of degree of damping and sharpness of resonance in the cochlea is the most difficult factor in the resonance hypothesis. It is far too complicated a problem to be discussed adequately in the limits of a short letter.

GEORGE WILKINSON.

Sheffield.

Specular Reflection of X-rays.

LORENZ has developed the approximate expression for the index of refraction of X-rays

$$\mu = 1 - \frac{ne^2}{2\pi m\nu^2},$$

where "n" is the number of electrons per unit volume and "e" and "m" refer to the charge and mass of the electron. This expression would indicate that at very small angles X-rays should be totally reflected by the refracting medium. The critical glancing angle is given by the formula

$$\sin\theta = \sqrt{2(1-\mu)}.$$

A. H. Compton in the June 1923 issue of the *Philosophical Magazine* shows that he finds this reflection and that it is truly total reflection. His work was done by the ionisation chamber method.

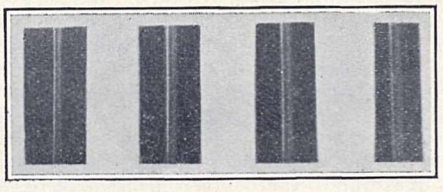

FIG. 1.

I have repeated his experiment by the photographic method, reflecting the general radiation of a molybdenum tube from crown glass. The arrangement of the apparatus differed somewhat from his. The radiation passed through a slit about 0·5 mm. wide and fell upon the surface of the glass, which was mounted on a spectrometer table. In order to obtain a sufficiently narrow beam of X-rays, the width of the beam was limited by mounting a piece of lead on the spectrometer table and pushing it as close to the glass as was necessary. The zero position of the glass was located by trial, it being taken as the position in which the primary beam was most intense. The photographic film and the slit were both 31 cm. from the centre of the glass. The angle through which the reflecting surface was rotated was measured on the spectrometer table. Angular separation on the film was twice the angle of rotation. The exposures for the reflected beam were ten minutes.

Reflection was obtained at the angles 6′, 8′, 10′, 12′. The intensity at the first three was approximately equal; at 12′ it was much less (Fig. 1). The reflected beam disappeared at 14′. These results are in accord with Compton's. The intensity of the reflected beam in this work, however, is not equal to that of the primary, being less than 20 per cent. as great. This

is probably due to the fact that the energy of the radiation from a molybdenum tube is largely concentrated in wave-lengths of about 0·4 and of about 0·7 Å.U., which have a very small critical angle. It was the longer wave-lengths, those in the region of 1 Å.U. and more, that were reflected at the angles of this experiment. This difference in intensity, therefore, is not contrary to Compton's results.

H. E. STAUSS.

Physics Laboratory, Washington University,
St. Louis, U.S.A., June 13.

Science and Labour.

IT was obviously impossible in the general article in NATURE of June 14, on the Science and Labour Conference held at Wembley last month, to devote more than a few lines to any speaker; but for this reason I have been asked by representatives of certain research associations to correct an impression which might be gathered from the summary of my remarks concerning those associations, for the initiation of which previous governments were responsible.

In justice to the scientific workers in those associations, I should be glad if I might be permitted to explain that my criticisms were levelled against the suggestion contained in the last published report of the Advisory Committee of the Privy Council on Scientific and Industrial Research, that unless more financial support were forthcoming from the manufacturers' associations, the Government could not continue them after the expiration of the original contractual period of five years.

To my mind this amounts to a confession of the failure of the *policy* of the Advisory Committee and of the failure of a great many industries to realise the importance of research. In the first place, if the policy was to succeed, the research associations should have been given a much longer period of support. Five years is a short time to devote to most important problems in research, and even when they are solved there is abundant evidence that it takes many more years for the solutions to be applied, through no fault of the research worker, and sometimes through no fault of the manufacturers.

If the idea of co-operative research for groups of manufacturers is dropped, then, however important and commercially valuable the research already done may be, the primary object has not been achieved, and in that sense the money devoted to that object has been lost. I believe, in common with the members of the Research Committee of the National Union of Scientific Workers, that research must be fostered, and the staffs who have devoted their past few years to industrial research must be protected and kept together, with or without the financial support of the manufacturers, for industry exists for the nation and not primarily for the manufacturers. I believe the policy was wrong initially and the machinery defective, but it would be disastrous if the knowledge and the experience gained by the competent research workers were not utilised for the country. A. G. CHURCH.

House of Commons.

Birds as a Geological Agent.

MR. MARTIN has directed attention in NATURE of July 5, p. 12, to the fact that birds may carry shellfish to heights considerably above sea-level, and I remember as a student being warned against a too ready assumption of elevation of the land relatively to the sea founded on the occurrence of remains of mollusca above high-water mark. But the operations of birds in the past history of the world were probably far more extensive. Their efficiency in the distribution of seeds and minute organisms over seas is now generally acknowledged, and of course we are indebted to birds for valuable deposits of guano.

It is possible, however, that they may have played an even more important part in the destruction of other forms of life. The evolution of highly predacious sea-birds in later Mesozoic times must have been fatal to many types which had been developed without provision for protection against such foes, and it seems possible that the cessation of so many groups at the close of the Cretaceous period may be attributed to this cause. The cephalopods whose careers then came to an end would appear to have passed much of their time at the surface of the sea, where they would be an easy prey. At the same time the eggs and young of many reptiles would also be exposed to attack. The chelonians may have survived because they buried their eggs, as they do still.

Prof. Bonney suggested that it was our ancestors, the small primitive mammals, that disposed of their reptile enemies in this way. It may have been, but I cannot help thinking that the Hesperornis and its comrades were better equipped for the task. The Archæopteryx and the pterodactyls were older and presumably less efficient denizens of the air.

J. W. EVANS.

Imperial College of Science and Technology,
S. Kensington, S.W.7, July 7.

The Atlantic Salmon in New Zealand.

AN event of importance in the history of the acclimatisation of Salmonidæ has just recently been noted in New Zealand. For nearly sixty years New Zealand and Australia have been endeavouring to acclimatise the Atlantic salmon. (It is of interest to note that the quinnat salmon from the Californian coast is now thoroughly established in the South Island of New Zealand; recently I have identified examples from the south of the North Island.)

Fisheries' inspectors and anglers have reported that for the last two or three years *Salmo salar* was to be taken in large numbers in Lake Te Anau in Otago; but no specimens had been seen by me until recently, when Wellington fishermen took an alleged quinnat salmon in Cook Strait. This fish was examined and found to agree in most essential respects, notably the disposition of the teeth, with descriptions of *Salmo salar*. The scales, however, were smaller than commonly found by European observers. An interesting question to be decided in the future is whether we have developed our own *Salmo salar novæ-zealandiæ*, or whether we have here a chance variety which readily adapts itself to the environment.

Cook Strait is equivalent in latitude to the Spanish coast or northern part of the Mediterranean. So far as is known to science, the specimen above noted is the first Atlantic salmon ever taken in the sea in the Southern Hemisphere.

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The Isotope Effect in Line and Band Spectra.

IN a recent letter to NATURE (June 7, p. 820) the use of quotation marks around the word "theory" in the fourth paragraph conveys an impression which was not intended. In the original manuscript the word was underlined, meaning that it should be italicised; but apparently this was misunderstood, and quotation marks were used instead.

ROBERT S. MULLIKEN.

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Mountain Sickness.

By Prof. JOSEPH BARCROFT, F.R.S.

SCIENTIFIC men, according to no less an authority than Longstaffe, were the pioneers of mountaineering. Its vogue as a sport followed. "During the latter part of the eighteenth century, that great period of awakening interest and research into physical science, mountain ascents were encouraged and performed only by scientific men. Such men, practical observers, and expecting to be severely affected by what we consider to be only moderate diminutions in atmospheric pressure, noted even the smallest abnormal symptoms in themselves. . . . On the other hand, during the last fifty years mountaineering has become a sport and is practised by a much larger and very different class, although it is true that many men of scientific attainments are to be found among the ranks of the modern mountaineer."

The question naturally arises: why did the ascent of mountains awaken such keen interest in the scientific men of bygone days? And it is followed by another, namely: what has been the fruit of their researches? Those were the days in which almost nothing was known about the causation of disease—in fact it is difficult to realise how little was known on this subject even so recently as falls within the memory of the still middle-aged. I cannot say what may be the limits of middle age, but I know many men born in the early 'seventies who would account themselves young rather than old, and yet if we look back to, say 1872, and ask ourselves what was then known about the causation of disease, the answer is instructive enough. Since that date the whole science of bacteriology has arisen and has enlightened us as to the cause of innumerable complaints, the micro-organisms of which are known, and by analogy as to a number of others attributable to a flora as yet undiscovered. Then there are all the diseases which are caused by trypanosomes and other parasites, the life histories of which have been worked out; the hosts which transport them have been recognised, and therefore the mechanism of their causation is understood. Or, again, consider such troubles as swollen joints, which scarcely rank among the epidemics, and yet in how many cases are they caused by micro-organisms which can be recognised. In 1872 all these things were unknown, and therefore a pathological condition which could be pinned down to an evident cause was a *rara avis* among diseases.

Such was mountain sickness: by ascending you could acquire it, and, what was perhaps more remarkable, by descending you could, within limits, throw it off. Such was the interest which, as I make out, it held for scientific men.

Mountain sickness is called in the Peruvian Andes "seroche," and the fact that it is given a definite name, which appears in medical cyclopædias, coupled with the natural scepticism of the scientific inquirer, leads to the question, "Is mountain sickness a definite medical entity?" The question is the more pertinent because its manifestations differ greatly in different individuals —differ in degree and in kind. Dr. Alfred C. Redfield, in a paper read to an American society, the manuscript of which he kindly sent me, has stated the claim of "seroche" to a place among human maladies so clearly that I can do no better than quote him. "So definite," he says, "is its symptomatology, so general is its occurrence in these not unpopulous regions, that it deserves some attention as a clinical entity. Its severity is sufficient to give it, in connexion with the mining industry, a certain economic importance. While a few men were met who had never felt it, and many who had suffered but mildly, a very large number are so greatly affected as to be completely incapacitated for several days. In at least one authentic instance the 'seroche' of a normal healthy individual has been terminated by death. Each case is an individual story and up to the present no one has been able to predict who will and who will not be affected. A description of cases of two degrees of severity will serve to picture the chief features of the disorder. Making the ascent by train,[1] one lightly touched by 'seroche' experiences his first symptoms at an altitude of 10,000 feet or more. Subjectively lassitude, then headache, usually frontal, growing in severity, and perhaps nausea, are felt. One feels cold, particularly in the extremities, the pulse quickens, respiration becomes deeper and more frequent, the face is pallid, lips and nails are cyanotic. On descending from the summit to Oroya (12,000 ft.), though a marked improvement is felt one finds himself reduced to a helpless condition of weakness which renders the least muscular effort irksome and productive of shortness of breath, dizziness and palpitation. The night's sleep is restless, and on waking one feels much as he does on venturing to his feet after recovering from an acute infection. In two or three days one's strength returns, the colour improves somewhat, and all but the more severe forms of exertion may be taken without distress. The majority are less fortunate than this. During the ascent, the symptoms are qualitatively the same, but frequently more severe, and nausea gives way to vomiting. The night's sleep fails to bring relief. Severe headache, gastro-intestinal instability, and weakness continue for several days; the body temperature may be supra-normal (102° F. in the rectum) and at times one is aware of palpitation. Cyanosis is marked. After three or four days in bed relief comes, and in a week normal activity may be resumed."

There is probably more unanimity now than at any other time as to the cause of "seroche," for there can be few, if any, men of science who do not attribute it to deficiency of oxygen. At an altitude of about 14,200 feet, the barometer stands at 457 mm., and the partial pressure of oxygen in the air cells of the human lung is just about half the normal—about 50-55 mm. instead of 100–110.

During the century and a half which have elapsed since the time when, according to Longstaffe, scientific men commenced to make observations upon mountain sickness, opinion as to the cause of the complaint has vacillated a good deal. Two theories have been serious competitors to that stated above, and they have come from very different sources: one was the invention of the distinguished physiologist, Mosso;

[1] Of the Central Railway of Peru. The train leaves Callao at the sea level about 6 A.M. and reaches the summit, 15,885 feet in altitude, near the station of Ticlio, about 3 P.M. the same afternoon.

the other was due to the entrance of the sportsman into mountaineering. Let me first discuss the latter of these two theories; it is that mountain sickness is due to a combination of fatigue, cold, bad feeding, and other discomforts incident to attempts by unfit or unathletic men to climb mountains which are beyond their physical powers.

I yield to none in my esteem of the "modern mountaineer," but, with all due respect, I would submit that he is the last person whose opinion on this subject is of value, and I have no difficulty in "stating my reasons in writing." It is of the nature of all sound scientific investigation that, in seeking out the cause of any phenomenon, only one variable should be altered at a time. Of the four variables, temperature, physical exertion, diet, and oxygen pressure, the Alpine rock climber alters all simultaneously and then pronounces to which the "seroche," if felt, is to be attributed. If you wish to see mountain sickness, do not study it among trained athletes in the Alps, whose very training makes them abnormal beings, who can only attain the rather moderate altitudes on European mountains by the performance of notable feats of physical prowess combined with exposure to extreme cold and long periods spent without a normal meal. If you wish to find out whether or no "seroche" is due to oxygen want, go to some place at which the alteration in oxygen pressure can be attained by all and sundry for a sufficient time to bring on the symptoms, but without the complications to which reference has been made. Of these localities, Pike's Peak in Colorado is good, but the best is undoubtedly that to which reference has already been made, namely, the Ticlio summit on the Central Railway of Peru.

There (year in, year out), on any of the six working days of the week, you may see a train full of passengers arrive; and if you see what I saw at Ticlio station, it will be two long coaches of the Pullman type with a head extended from each window, for, as Dr. Redfield truly says, "The majority are less fortunate . . . nausea gives way to vomiting." Here is a train load of persons, Indian, half-breed, Peruvian, European, who have been transported, if going east, from the sea level in eight or nine hours with no effort to themselves. They have had hot meals on the way, for the principal occupation of the inhabitants of the town of Matucana, at an altitude of 7700 feet, appears to be that of feeding the passengers on the train. They have not been subjected to cold; Ticlio itself is not above the snow line, though about the height of the summit of Mt. Blanc, and even if it were, the train (or at least the compartment in which I was) was heated by a stove. There, and not in the Alps, you see the clean experiment; but the truth is that you may see it without going so far afield. Many laboratories contain respiration chambers of one sort or another in which the partial pressure of oxygen may be reduced either by exhaustion, as at the Consumptive Hospital at Brompton, or in Prof. Dreyer's laboratory at Oxford, or by partial replacement of the oxygen by an indifferent gas, such as may be done in the chambers used by Dr. Haldane and by his workers in the Cambridge Physiological Laboratory. In this last-named structure it has been my unhappy fate to suffer the classical symptoms of "seroche." The pressure of oxygen was decreased from day to day till it fell to that which corresponded to an altitude of 18,000 feet. After sleeping (I use the word rather euphemistically) the night in that atmosphere, I arose to make the usual analysis of the air which was my first duty each morning. I was scarcely out of bed before vomiting set in, I suffered from an intense headache, and gas analysis was a matter of great difficulty; by an effort of concentration I could read the graduations on the gas burette, but all outside the very centre of the field of vision was a blur.

The theory of Mosso that "seroche" is due to acapnia, or insufficient carbonic acid dissolved in the tissues of the body, is not seriously now held.

Taking it, therefore, as settled that mountain sickness is due to oxygen want, the question arises, "Oxygen want of what?" And the answer is, "Of the brain."

Such evidence as is at our disposal goes to show that the brain wants but little oxygen; that little, however, it wants very badly indeed. Complete deprivation of oxygen would abolish consciousness in a matter of a few seconds. An appreciable inadequacy in the supply produces the symptoms which Dr. Redfield has enumerated. These symptoms are manifested by many organs in the body, but a careful scrutiny of them shows that they are essentially not the effects of want of oxygen on the organs themselves, but they are evidence of deficient oxygen supply to the centres in the medulla oblongata which govern the activities of these organs. Let me take a single example, that of palpitation of the heart. The effects of oxygen want on the vertebrate heart when isolated and kept beating outside the body are slowing and ultimate cessation of the beat, and a lengthening of the time which elapses between the auricular and the ventricular contractions. Yet the effect of insufficient oxygen on the heart beat in the human body is just the opposite. Dr. Somerville stated in an account of the doings of the 1922 Everest Expedition, at the Royal Society of Medicine, that on the day on which he approached 27,000 altitude his pulse was about 200 "all day" (this last phrase colloquially).

Such a phenomenon may be due to lack of vagus control over the heart, or it may be due to asphyxial nervous stimulation of the suprarenals through the sympathetic system or to direct sympathetic stimulation, or to all together, but it is not the direct effect of oxygen on the heart tissue. Yet this nervous quickening of the heart may have results which are far-reaching enough. The only observations of which I know on the circulation in a case in which the heart beat at 200 were made on a student in the Cambridge Laboratory who suffered from occasional attacks of paroxysmal tachycardia. The heart in these attacks became very inefficient, only driving about half the normal quantity of blood round the body, and almost none through the skin, which therefore became very cold. Such a condition on Everest would court frost-bite in circumstances when already it is difficult enough to cope with the cold. In this last connexion it is very interesting to note, in the experience of the Everest party, the breathing of oxygen at once brought a glow of warmth to the skin.

So it is with the other symptoms; the vomiting is no doubt the effect of oxygen want, not in the alimentary

canal but in the brain; the breathlessness also is a medullary effect, but it at least has a beneficent aspect, for the greater the quantity of air passed through the lungs (other things being equal) the higher the oxygen pressure in the air-cells, and therefore the less the tendency to mountain sickness.

We may conclude with a few sentences on the subject of acclimatisation. In an article in NATURE on the return of the Cerro de Pasco Expedition nearly two years ago (vol. 110, p. 152, July 29, 1922), I have already discussed acclimatisation in some detail. So far as the observers on that expedition could judge, the factors in acclimatisation were, as had been found by previous workers, of two categories, those which tended to increase the pressure of oxygen in the arterial blood, and those which tended to increase the quantity of oxygen which each cubic centimetre of blood carried at any specified pressure. In the latter category are (1) the increase in the number of corpuscles in each cubic centimetre of blood coupled with a corresponding increase in the hæmoglobin; (2) an increase in the affinity of the hæmoglobin for oxygen, which is probably caused by a greater alkalinity of the interior of the red corpuscle.

Among the factors which tend to increase the pressure of oxygen in the alveoli of the lung, and so of the arterial blood, is the increase in the volume of air passed through the lungs. Probably the peculiar size and shape of the chest of the native inhabitants of the Peruvian Andes tends in the same direction. A native whose height is sixty-one inches has a chest of about the same size as a European of seventy inches in stature. No account of the factors concerned in acclimatisation can be complete without reference to a possible one, namely, a more copious blood supply to the medulla. Stress has already been laid upon the fact that symptoms of mountain sickness are medullary, and more accurate knowledge is desirable of the factors which govern the blood supply of this part of the brain. Since our return from Peru, however, the work of Roberts has shown that the medullary blood supply is not simply the toy of circumstances, but is under the control of the brain itself.

Insects and Flowers.

By Dr. E. J. SALISBURY.

THE more definite relationships which subsist between organism and organism, whether it be between the algal and fungal partners of the lichen complex; between the forest tree, the orchid, or the gentian and their respective mycorrhiza; or between the Planarian worm *Convoluta Roscoffensis* and the alga Carteria, all alike bring home to one the delicacy of biotic relationships and the efficiency of whatever be the *modus operandi* of the evolutionary process. The relation between entomophilous flowers and the insects through the agency of which their pollination is effected constitutes no less remarkable an example of mutual specialisation than those already cited. It is scarcely surprising that the subject has attracted the attention of a considerable number of investigators from the observational period rendered notable by the publications of Koelreuter (1761), Delpino (1867), Mueller (1883), Darwin (1876), Kerner (1876), and Knuth (1898), to the experimental period of modern times initiated by the extensive researches of Plateau (1877–1910), and so ably followed by Lubbock (1882), Frisch (1913–19), Knoll (1919–22), and the work of Clements and Long, which has prompted and is the basis of the present article.[1]

The problems involved, though they admit of approach from either the botanical or the entomological point of view, can only be appreciated adequately if the interaction and interdependence of plant and animal be constantly before the investigator's mind. On the other hand, the earlier writers often obscured important issues by too teleological an attitude, as in the assumption that nectaries had been developed as organs of attraction for insects, whereas it is probable that, as the writer suggested fifteen years ago, all nectaries, both floral and extrafloral, originated as osmotic hydathodes and have secondarily acquired biological significance in relation to pollination. Occasionally extrafloral nectaries may themselves be important sources of honey supply, as has recently been noted for the partridge pea, *Cassia chamaecrista* (*Dixie Beekeeper*, 1922).

Every one recognises that insects, and especially bees, visit flowers for either honey or pollen, and that the process of pollination is incidental thereto. That this result ensues is the outcome of two factors, namely, the efficiency of the flower and the efficiency of the insect. With respect to floral structure, it is significant that, when closely related actinomorphic and zygomorphic types are compared, the latter are usually found to exhibit a reduction in the number of stamens and not infrequently in the ovary also; a reduction that could scarcely have come about without detriment to the race, but for the increased precision of the pollination mechanism which the zygomorphic form ensures.

It is, however, too often forgotten that pollen wastage would be enormous and insect agency almost as precarious as anemophily, were it not for the habit which bees in particular exhibit, of restricting their attentions, on a given flight, to a particular species of flower. Aristotle commented on this disposition, but the evidence respecting the degree of constancy seems to be somewhat conflicting, largely perhaps owing to lack of discrimination between the behaviour of the individual and the behaviour of the species. The observations of Clements and Long, for example, showed that the bumble bee, *Bombus juxtus*, visits at least twenty-seven species of flowers belonging to as many as twenty-two genera, and including such varied and specialised types of floral mechanism as Aconitum, Monarda, Thermopsis, and Gentiana. But when attention is confined to single individuals of this same species, the apparent fickleness of behaviour is seen to be illusory. This is sufficiently shown by the examinations of the pollen loads of twenty-five individuals of *Bombus juxtus* carried out by these investigators. Of these loads, nineteen consisted of one type of pollen only, whilst the remaining six were mixed pollen. Similar examinations of thirty-one honey-bees yielded

[1] "Experimental Pollination: an Outline of the Ecology of Flowers and Insects." By F. E. Clements and F. L. Long. Pp. vii. + 274, with 17 Plates. Carnegie Institution, Washington. 4.00 dollars.

twenty-eight pure loads and three mixed loads. This high degree of constancy is not, however, always maintained with respect to the collection of nectar. The male bees, which in common with the Lepidoptera visit flowers mainly for nectar, may visit a variety of flowers even in a single flight, though constancy to one species is the general rule.

Numerous experiments in which flowers were placed in competition with one another as attractions to bees seem to show that these insects are remarkably constant to particular flowers, and that this is largely a matter of habit which tends to be perpetuated and developed owing to the increased dexterity resulting from practice. Mueller (1881) believed that the behaviour of bees indicated a psychological differentiation between the sexes, the males visiting the most accessible and fragrant flowers, whilst the thrifty females visit those which give the greatest yield of honey.

Admitting then the fact of constancy (oligotropism), it remains to inquire how the bee is attracted to the flower from a distance and on what features its taxonomic discrimination depends. The extensive experiments of Plateau, in which he employed artificial flowers of extreme perfection, showed that such are usually completely ignored, even though placed amongst their natural prototypes. The conclusion seems warranted that the perception of form and texture by bees is extremely acute. Experiments performed by Allard with the flowers of the cotton plant showed that Melissodes also has considerable discrimination with respect to structural detail. The story, recorded by F. P. Bedford, of the cabbage white butterfly which followed the artificial lilies of the valley on a lady's hat down a London street is scarcely less remarkable than that of the bee which flew to a coloured botanical wall-chart! The implied compliments in such occurrences are, however, more imaginary than real and bear testimony rather to the importance of colour and conspicuity as attractive devices than to the verisimilitude of the artifacts employed.

The experiments performed by Lubbock, in which he employed glass slips bearing honey and resting on variously coloured papers, indicated not only a preference of bees for blue, but also their colour-memory. Mueller and Lovell both obtained similar results, whilst the recent comprehensive study of Frisch (*Ver. Deut. Zoo. Ges.*, 1914), in which the range of colours was supplemented by numerous shades of grey, fully confirmed Lubbock's conclusion that bees recognise colour as such, and showed further that though distinguishing nuances of colour, there is a certain confusion similar to that of human beings colour blind to red and green.

Several investigators have shown that bees can be trained to visit a certain colour and exhibit association of impressions in a marked degree. Turner's experiments (1911) with diverse colour patterns demonstrated that amongst a mixed assemblage of these, bees usually return to the pattern to which they had become habituated. It is significant that the failures which have been experienced in the training of bees were associated with attempts to train for pure red and blue-green, unpleasant odours and geometrical patterns; that is, in respect to characteristics seldom if ever encountered by the bee under natural conditions.

It would seem to be fairly well established that colour and conspicuity are important agents of attraction up to a distance of ten metres, whilst the memory of a particular form and the less powerful odours, or their associations, serve as guides over smaller ranges of distance.

When several colour varieties of a given species are grown in proximity to one another, bees appear to visit them indifferently, which shows that form-association may predominate over colour-association. But the case of Pulmonaria shows that when colour differences are important, they are as much regarded as form. Bees visit the pink flowers of this plant freely, whereas when the corolla has turned blue, at which stage the flow of nectar has practically ceased, the flowers are neglected.

Clements and Long employed natural flowers of a variety of species, which they painted with water-colours and observed 420 visits to them as against 845 visits to the unpainted flowers. When artificial flowers were used, however, the number of visits was only about 12 per cent. of those to natural flowers, and in no case was a honey-bee deceived in this way. But, whilst this attests to the delicate perception of form, the frequent inspections made of the artificial flowers show that minute differences of structure are only detected at close range.

That vision plays an important part in influencing the flight of bees is shown by the tests on the so-called "homing" instinct. These experiments, and others using isolated plants and flowers, also show the pronounced place-memory which bees possess, despite which, however, their radius of action is usually short (about a mile from the hive).

Attraction for considerable distances may evidently be effected by strongly scented flowers, but our ignorance respecting such phenomena as the "assembling" of moths sufficiently indicates how much is still to be learnt regarding long-distance perception of stimuli. An increased number of visitors was noted by Clements and Long to flowers from which all the conspicuous parts had been removed, a result which was attributed to the greater accessibility of the nectar. In this connexion, one may recall that quite inconspicuous flowers with little or no scent but containing honey are freely visited. The odour of honey itself has been suggested as the effective agent of attraction in these cases, but the addition of honey to artificial flowers has little effect in increasing the number of visitors to them. On *a priori* grounds it would seem not unlikely that the range of light and scent perception in bees should be different from our own, but there appears to be little experimental evidence to support such a view. Various attempts have been made with mutilated insects to determine the seat of sense perception, but with regard to most of these, whatever view may be held as to the humanity of their conception, there can be little doubt as to their lack of scientific value.

There are but few observations and still fewer experiments which give any indication as to the importance of competition between flowers for the visits of insects. Robertson (1914) held that the flora is the limiting factor to the size of the bee population, whereas Lovell (1914) held that bees only collect a portion of the available pollen and nectar. The latter is probably the more correct view, and cases have been recorded

from gardens of species which are normally visited being entirely neglected for more attractive types. Upon the acuteness of this competition depends the importance to be attached to the sequence of flowering periods. Clements and Long, using the method of reciprocal bouquets, came to the conclusion that habit was the most important factor in determining preference, but that abundance of nectar or ease of access might overcome the effect of custom.

The marked capacity for memorisation by bees which training experiments reveal show that features of floral construction, of an apparently trivial character, may be of real importance in facilitating recognition. Moreover, the readiness with which bees discriminate the most profitable and easily worked flowers gives added significance to the minutiæ of floral architecture.

Further progress in the study of insect behaviour in relation to flowers would appear to demand the use of marked individuals of freshly hatched insects which have not acquired the habits that so largely determine their actions when adult.

X-ray Studies on the Crystal Structure of Iron and Steel.

AT the recent meeting of the Iron and Steel Institute Messrs. A. Westgren and G. Phragmen presented a continuation of work published by them two years ago at the same Institute. The present paper deals with the crystal structure of δ iron, the crystal shape of Cementite, and the structure of Austenite. In their previous paper a series of powder photograms of α, β, γ and δ forms of iron was reproduced. At that time all attempts to get a photogram of δ iron (stable only above 1400° C.) in the pure state had failed. Its interference lines were mingled with those originating from γ iron. By improved heating arrangements it has been possible to obtain a more uniform temperature, and the new photograms are quite free from γ interferences and confirm the conclusion previously drawn, namely, that δ iron has the same lattice structure as α and β iron.

The question as to how the atoms are grouped in Cementite (Fe_3C) has even now not been solved. The powder photogram contains a very large number of lines, some of which flow into one another. As many of the interferences of this orthorhombic substance practically coincide it could not be settled definitely, without a more thorough experimental investigation, to which of the net planes the lines of the powder photogram correspond. To decide this question so-called "complete photograms" or "rotation photograms" have been taken of a Cementite crystal obtained from the blow-hole of a spiegel melt. The only developed faces (001) were finely striated parallel to [010]. The precision camera designed for this purpose was described by the authors in NATURE of January 26, p. 122. The theory of the photograms obtained has been given by Schiebold and Polanyi. A special camera was constructed for establishing the lattice dimensions and the authors showed photograms thus obtained. The edges of the elementary parallelepiped are 4·518Å, 5·069Å, and 6·736Å. This corresponds with an axial ratio of 0·671 : 0·753 : 1. Laue photograms taken parallel with the three axes have given an axial ratio in perfect accordance with the above. If it is assumed that the elementary parallelepiped contains four molecules of Fe_3C the density of Cementite must be 7·68. Values hitherto available range from 7·74 obtained by Benedicks to 7·59 by Levin and Dornhecker.

The discrepancy which has hitherto existed with regard to the crystal structure of Cohenite—the iron carbide present in meteorites—has been cleared up. Weinschenk, who first investigated this mineral, found that its composition corresponds to Fe_3C, but concluded that it probably belonged to the regular system. Goniometric measurements were afterwards carried out by Hussak on a Cohenite crystal obtained from a Brazilian meteorite. In spite of the small size of the crystal, the fact that its faces were frequently curved, and that most of them gave very poor reflections, Hussak concluded that Cohenite belonged to the regular holohedral system. Even so, some of his angles differed 2° or more from the values characteristic of the cubic crystal. The authors show powder photograms of cementite and Cohenite which are practically identical. These two substances are therefore orthorhombic.

The authors have also used their precision camera to investigate the structure of Austenites obtained in various ways, both pure and intermixed with Martensite. They conclude that carbon dissolved in γ iron has an enlarging influence on the lattice dimensions, and that the lattice parameter changes from 3·606Å in the case of Austenite containing 0·9 per cent. of carbon, to 3·629Å in the case of the saturated solution containing 1·7 per cent. The Martensite lines, however, are too cloudy and broad to enable conclusions to be drawn concerning the lattice dimensions of the α iron in quenched steels. The authors reason that if carbon atoms replace iron atoms in the γ iron lattice the dimensions should decrease with rising carbon content, since the carbon atoms are much smaller than those of iron. Since, however, the opposite is the case, it seems probable that Austenite is not formed by simple substitution, but represents an addition product with the carbon atoms in the interstices between the metal atoms.

Precision photograms of a manganese Austenitic steel, having a lattice parameter of 3·624Å, show that in all probability this is the case. The density of the steel can be calculated either on the assumption that the iron and carbon atoms replace each other in one and the same lattice, or that the mass of the carbon atoms is uniformly distributed among the metal atoms which occupy the points of the face-centred cubic lattice. In the former case the density is 7·36, in the latter 7·83. The experimental value found was 7·83. The second assumption therefore is correct, and this Austenite is not formed by simple substitution but is an addition product. The real nature of the addition of carbon atoms cannot be decided on the basis of the results so far obtained. The authors suggest that it may be a substitution of the atoms of the γ iron lattice by complexes consisting of an iron atom combined with one or more carbon atoms.

H. C. H. C.

Obituary.

SIR JETHRO TEALL, F.R.S.

BY the death on July 2 of Jethro Justinian Harris Teall, one of the most noted and revered of living geologists has been lost to science. Accomplished in all branches of geology, he gained a world-wide reputation more especially as a pioneer in petrography, at a time when the study of igneous and metamorphic rocks was as yet in its infancy. Born on January 5, 1849, he was the son of Jethro Teall by his marriage with Mary, daughter of Justinian Hathaway, of Gloucestershire. On leaving school he went to St. John's College, Cambridge, and by so doing contributed to the development of the noted school of geology which was then coming into existence under Bonney's auspices. He was bracketed second in the first class of the Natural Science Tripos in 1872, and in 1874 was awarded the Sedgwick Prize for his researches on the Lower Greensand. He held a fellowship at his college from 1875 until 1879.

For a few years after taking his degree, Teall was engaged in delivering University Extension lectures, but his tastes lay rather in the direction of original research, more especially as regards the composition and origin of igneous rocks and the phenomena of metamorphism. In such studies British geologists had been outpaced by continental workers, but the balance was restored by the publication of Teall's "British Petrography," a book which was not only far in advance of its time, but was also a classic, and still remains a standard work of reference on the subject with which it deals. In the preface he alludes briefly to circumstances which threatened a tragic termination. "The work was commenced in February 1866, and completed in March 1888. One hundred and sixty-four pages and twenty plates were issued to subscribers in monthly parts. The issue then ceased, owing to the failure of the publishers, and I was compelled to take the work into my own hands in order to finish it." A discussion which took place between Teall and some of his friends in the Geological Survey, when the fate of the book lay in doubt, remains fresh in my memory. It was distasteful to press the author to dip so deeply into his own pocket as would be necessary to complete the publication, yet it was impossible to contemplate the abandoning of a work of such outstanding importance. In the end he faced the risk of loss, and I have reason to believe was eventually recouped by the sales what he had expended on publication. He had intended to include detailed petrographic descriptions of the sedimentary rocks and crystalline schists, but though some plates were included, he was unable to find space for the letterpress. Both kinds of rocks have since received much attention, but it is a matter for regret that they were not dealt with by the same master hand.

At this time it had become apparent that the whole-time services of a petrographer were required for the Geological Survey. Assistance in the identification of igneous rocks in the field required by the surveyors, and the technical descriptions of such rocks in the Memoirs, called for the services of an expert petrographer. At the same time, the care of the petrographical laboratory and the custody of the specimens collected in illustration of the field work, pointed to the necessity of that petrographer possessing businesslike habits. Sir Archibald Geikie, Director-General at the time, selected Teall for the post, as now standing in the first rank of British petrographers. The appointment was made on June 20, 1888, to the lasting benefit of the service. Though the nature of his duties necessitated attendance at the office for a large part of the year, the petrographer was able himself to take a small share in the surveying. Thus Teall was responsible for the mapping of the northern part of Raasay, an area occupied by schists and intrusive igneous rocks.

In 1901, on the retirement of Sir Archibald Geikie, Teall was appointed Director of the Geological Survey and of the Museum of Practical Geology. The institution had recently come under the consideration of a strong committee, the appointment of which had been strongly pressed for by the staff. The committee included representatives of various Government Departments and of scientific and mining interests. The recommendations made were sound and practical, and the task of giving them effect could not have been entrusted to more capable hands than those of the new Director. While the public service benefited, the time available for his own research work was unfortunately curtailed. But for his heavy administrative duties, we may suppose that "British Petrography" might have been completed on the lines originally contemplated. In 1914 Teall retired, leaving the institution as regards its work, organisation, and remuneration in a stronger position than it had ever before held. In 1901–5 he served as a member of the Royal Commission on Coal Supplies, representing geological interests with Mr. Lapworth as his colleague, until the latter resigned on account of ill health. He received a somewhat belated honour of knighthood in 1916.

Teall received honorary degrees from the Universities of Oxford, Dublin, and St. Andrews. He was elected a fellow of the Royal Society in 1890 and twice served on the Council, once as vice-president. In 1893 he was president of Section C (Geology) of the British Association, and in 1900–2 was president of the Geological Society of London. From that Society he received the Bigsby Medal in 1889, and its highest honour, the Wollaston Medal, in 1905. In 1907 he was awarded the Delesse Prize by the Paris Academy of Sciences. In presenting the Wollaston Medal, the president (Dr. Marr) addressed Teall in words which all who knew him will endorse. "You have ever placed your great store of knowledge at the disposal of other workers. How much work was thus due to you will never be known . . . but was it known, I can safely aver that it would be found to have promoted researches concerning the mineral structures of the Earth, to so great an extent as to render you doubly deserving of this medal."

A. STRAHAN.

SIR HARRY JAMES VEITCH.

FOR several decades past there has been no such outstanding figure in the horticultural world as Sir Harry Veitch, whose death on July 6, in his eighty-fifth year, we regret to record. His chief ability was his highly developed business faculty, for he could

lay no claim to scientific distinction, probably not even to a taste for science. Nevertheless, during a long and honourable career, he did more than any one to enrich our gardens with beautiful plants from foreign countries, and in that way helped on the cause of botanical science very considerably. Whilst his primary interest was to introduce to Great Britain plants valuable from the trader's point of view, he never grudged the time his collectors spent in making pure botanical collections of dried material. The collections made by his brother, John Gould Veitch, in Japan, consisting largely of cones of pines, firs, spruces, etc., helped greatly towards the elucidation of the coniferous flora of that country, just as, thirty years later, did the collections made by Wilson that of central and western China.

Sir Harry had that supreme endowment of the business man—the faculty of finding capable assistants—and in the long roll of collectors who worked for the firm, from William Lobb in 1840 to E. H. Wilson in 1900, there are included many famous names. Scarcely less noteworthy were the activities initiated by him in the hybridisation of plants. Under his direction, the first hybrid orchid was raised, *Calanthe Dominii*, the forerunner of a branch of horticulture that has grown to enormous dimensions at the present time. Very valuable work, too, was done in the improvement of hippeastrums, the East Indian group of rhododendrons, as well as in fruits and vegetables.

Sir Harry played a great part in the International Horticultural Exhibition of 1912, and his work for it was acknowledged by the bestowal of a knighthood on him. It is interesting to recall also that he was the last survivor of the managing committee of the previous International Exhibition of 1866. His career may be safely described as unique in horticulture in its length and activity. Two valuable standard works, the "Manual of Coniferæ" and the "Manual of Orchidaceous Plants," were published under his auspices, although the actual work was done by his assistant, A. W. Kent.

About ten years ago he retired from business and, having no one to succeed him, the Chelsea firm of Veitch came to an end, an event which can only be regarded as a calamity to British horticulture, for never had it stood higher in public estimation than during the days when gardeners, both amateur and professional, watched in sadness its famous collections of trees, shrubs, and hothouse plants being dispersed under the hammer. For the rest of his life, until within a few months of his death, Sir Harry worked actively in the interests of the Royal Horticultural Society, the astonishing success of which owes much to him, and in helping the many charities in which he was interested.

WE regret to announce the following deaths:

Dr. R. Kidston, F.R.S., the distinguished palæobotanist, on July 13.

Prof. A. Marshall, emeritus professor of political economy, University of Cambridge, on July 13, aged eighty-one.

Sir Sydney Russell-Wells, member of Parliament for the University of London and vice-chancellor of the University 1919–22, on July 14, aged fifty-four.

Mr. Dean C. Worcester, first secretary of the Interior, Philippine Islands, who was largely responsible for the establishment of the Bureau of Science, the Philippine General Hospital and the College of Medicine in the islands, formerly assistant professor of zoology and curator of the museum at the University of Michigan, on May 2, aged fifty-seven.

Current Topics and Events.

REPRESENTATIVES of a number of educational, scientific, and commercial bodies in Great Britain and Overseas attended a conference organised by the Decimal Association at the Institution of Electrical Engineers on July 9. The main subjects discussed were the Association's proposal to divide the shilling into ten pence instead of twelve, and to alter the Imperial gallon so as to make it equal to four litres. The former proposal means a twenty per cent. increase of the value of a penny, and by it "an almost complete decimal coinage would be secured, while preserving the old names of *l. s. d.* and the three-column method of book-keeping, and incidentally a reasonable solution of the present impasse in penny postage and penny fares would be found." At present, services and commodities which could be profitably provided for slightly more than a penny are subjected to a fifty per cent. increase, whereas a penny would be sufficient if the value were increased as suggested. Mr. Harold Cox, who was a member of the Royal Commission on Decimal Coinage in 1920, said at the conference that if this proposal had been before the Commission he believed the majority of the members would have been in favour of it. The proposal to make the Imperial gallon equal to four litres instead of the present 4·54, so that the quart would become one litre and the pint half a litre, arises largely from the present confusion in the use of the designation "gallon" in commercial transactions relating to motor spirit and lubricating oils. The American gallon has a capacity twenty per cent. less than the Imperial gallon, and in South America a capacity of four litres is being called a gallon, so that a single name is being used for three different quantities. The introduction of a four-litre gallon would, of course, be an important step towards the adoption of other metric weights and measures in Great Britain. Whatever may be said in favour of the British system, it can never become an international system, and as trade develops with new countries the need for the use of a universal language of quantity by British firms must become more important every year. The conference passed resolutions urging the Government to appoint a committee to examine and report upon the proposals discussed.

IN connexion with a recent paragraph concerning the therapeutic action of chlorine gas, it is of interest to observe an account in the *Sunday Express* of July 6 of the introduction as an antiseptic of a compound containing chlorine. There are two ways in which chlorine can be used therapeutically; in one method, a very dilute mixture of the gas in air is

inhaled; in this case the effect is confined to the respiratory tract; in the other method a solution containing chlorine in very dilute solution is applied directly to the injured area as an antiseptic. It is not usual to utilise a solution of the gas itself, but some compound which is readily split up giving rise to an evolution of chlorine. Solutions of hypochlorous acid and hypochlorites were thus used during the War in the method of continuous irrigation of wounds. The new substance referred to in the *Sunday Express* by Callimachi is trichlorophenylmethyliodosalicylic acid. It will be observed that the basis of the compound is salicylic acid, which has itself antiseptic properties, but is more frequently in use as an antipyretic. Combined with the chlorine group, it is probable that a compound actively germicidal may be obtained; the chlorine dissociated from it will stimulate the tissues to pour out white blood cells and lymph to destroy the bacteria, while at the same time the salicylic acid radicle itself will attack the latter directly. It may be remarked that the other radicles combined with the salicylic acid will probably enhance the antiseptic value of the compound.

A RECEPTION was given at one of the conference halls of the British Empire Exhibition, Wembley, on July 8, by the Italian delegation to the World Power Conference, at which some films and slides were shown and interesting particulars were given of Italian power plants. Ing. G. Semenza introduced Sen. Prince Ginori Conti, who gave an illustrated lecture on the production of power from natural steam, which, after a certain amount of experimenting, is now used on a practical scale in various parts of the country. The steam issues from natural fissures, or bored wells, at pressures not exceeding 3 to 5 atmospheres, at temperatures up to 150° C. On account of this low pressure and the difficulty in condensing, owing to the presence of various gases mixed with it, the natural steam is not employed direct in the engines, but is used to heat special boilers to produce pure steam at a higher pressure. The largest plant of this kind, at Lardarello, contains three turbo-alternators, each of 4000 H.P. Ing. Emirico Vismara then showed some films illustrating hydro-electric power development in Italy, which started in 1892 with the famous Tivoli-Rome transmission, and in connexion with which plants will shortly be complete aggregating about a million kilowatts. Very high heads are available in the mountainous districts. The Moncenisio plant, for example, works under a head of 4200 ft., and among the extensive schemes projected in the Trentino is one for utilising a head of 6150 ft. Illustrations were given of the combination of irrigation schemes with electric power development and the manufacture of cyanamide artificial manures by the electric furnace. The linking up of the many water-power stations into one vast national power network is in active progress. This will involve a connexion to Sicily across the Straits of Messina, for which the relative merits of a submarine power cable, a tunnel, and an aerial line are being investigated. The last mentioned would require the construction of two towers, each a thousand feet high and two miles apart, to allow for a sag of 900 ft. The films shown included some very beautiful examples of Italian scenery.

IN the year 1876 Lord Kelvin, then Sir William Thomson, took an active interest in the formation of the Loan Collection of Scientific Apparatus exhibited in the Western Galleries of the Science Museum, then part of the South Kensington Museum. He was a vice-president of the section "Physics," and at the Science Conferences held in the Western Galleries in May 1876 read two papers: "The Principles of Compass Correction" and "Electrical Measurement." Many of the original instruments of his invention which were lent by him for inclusion in the Loan Collection were allowed to remain permanently on exhibition in the Museum as gifts or loans, of great interest in the history of science. Since last autumn, when the Western Galleries were cleared to make room for the Imperial War Museum, most of these valuable objects have been stored away with 80 per cent. of the science collections previously exhibited in the Western Galleries. By utilising the main gangway of the unfinished gallery of the new Science Museum building in which, since last November, the remaining 20 per cent. of the collections have been exhibited, it has been possible to bring together these original Kelvin instruments so as to form a temporary exhibition of considerable interest in connexion with the Kelvin centenary. The following objects are included: Marine galvanometer used in the Atlantic cable expedition of 1858; iron-clad marine galvanometer used on board the *Great Eastern* in the Atlantic cable expedition of 1866; double curb transmitter; syphon recorder; various types of electrometer; original models of the tide-predicting machine; harmonic analyser for tidal computation; navigational sounding machine; binnacles; mariner's compasses.

A TEMPORARY exhibition of geophysical apparatus, etc., has been placed in the new building of the Science Museum, South Kensington, in the southern half of an unfinished gallery, the contents of which have been entirely rearranged. By arrangement between the Board of Education and the Royal Society Committee organising the Exhibition of Pure Science at the British Empire Exhibition, Wembley, it was intended that this exhibition should be placed in one of the new galleries of the Science Museum, but delayed progress towards the completion of these galleries has made it necessary to arrange the collection as above. It consists chiefly of objects selected from the permanent collections of the museum. To these have been added certain objects which, owing to the limited space available in the British Government Pavilion of the British Empire Exhibition at Wembley, cannot be shown there during the whole period of that Exhibition. The collection serves to give some idea of the history of the different sciences (meteorology, seismology, gravity, terrestrial magnetism, atmospheric electricity, geodesy) included under the general heading of geophysics, and to illustrate recent British contributions to these sciences.

ARRANGEMENTS have been made to establish at Oxford in October next the Imperial Forestry

Institute, which is intended to serve as an educational and research centre for the British Empire. It will be a University institution, with the professor of forestry as its director; but it will be under the control of a Board of Governors, with a Forestry Commissioner as chairman. The educational work of the Institute will comprise (1) post-graduate training of forest service probationers and other qualified persons, (2) training of research officers in special subjects, and (3) provision of courses for selected officers already serving. The Institute will be open to various categories of students, who must as a rule have had previous training at a university in forestry or some allied science. The normal course of study will extend over one academic year, and the subjects dealt with will cover the whole range of forestry. The main cost of the Institute will fall in the first instance on the Forestry Commission and the Colonial Governments; but it is hoped that the Dominion Governments and India will give some financial assistance. Temporary accommodation has been arranged; but larger buildings will be necessary, and the formidable task of obtaining funds for the purchase of a site and the building of the Institute remains.

SUDDEN changes of temperature were characteristic of the weather conditions which prevailed in England at the close of the second week of July. An anticyclone to the south-east of the British Islands had asserted itself and was temporarily controlling the prevailing weather. With a south and south-east wind blowing from the heated continent of Europe, high summer temperatures were experienced on Saturday, July 12, the thermometer in the shade registering 87° F. at Kensington Palace, the recording station of the Meteorological Office for London, a similar reading being registered at South Farnborough and Hunstanton, while at Nairn, in the north of Scotland, the temperature was 80°. This is the highest temperature as yet this year, although it is not uncommon for summer temperatures of 90° and above to occur occasionally in London; during the heat wave and thunderstorm in July last year the thermometer on July 11 and 13 registered 92° at Greenwich, and at the corresponding time in 1921 the shade reading was 94°, while in 1900, 1911, 1912, and 1914 the thermometer rose to 90° and above in July. The highest shade temperature on record at Greenwich is 100° on August 9, 1911. Owing to the spreading in of a cooler current of air from the Atlantic, which caused a temporary displacement of the anticyclone, there was a brisk fall of temperature on Sunday, the transition occasioning thunderstorms and heavy rains in places. The anticyclone surged to the north-westward again on Monday, July 14, and there was a return of the bright and hot weather.

A MEMORANDUM forecasting the probable amount of monsoon rainfall in 1924 was submitted in the early part of June to the Government of India by Sir Gilbert T. Walker, the Director-General of Observatories. The monsoon rainfall of India is affected by previous conditions over various parts of the earth. Snow in the mountain region north-west of India is an important feature; the accumulations at the end of May were markedly about normal from Afghanistan to Almora, especially at the higher elevations, and this excess of snow may be expected to retard appreciably the development of the monsoon. Among other factors are the rainfall percentages over Java; these were in defect during the period October to February, which indicates abundant monsoon rainfall in India. For the Peninsula, the indications from S. America, the Cape, Java, S. Rhodesia, Zanzibar, and the Aleutian Islands are this year all favourable. For north-west India most considerations are favourable. Summarising the effects, it is forecasted that there will probably be some delay in the establishment of the Arabian Sea monsoon, particularly in north-west India. In the rainfall of the Peninsula an excess may be expected. The indications for north-west India are said to be conflicting, but in spite of heavy snowfall the rains there are likely to be normal or in excess.

DR. R. F. RUTTAN, director of the Department of Chemistry, McGill University, has been appointed Dean of the Faculty of Graduate Studies and Research to succeed Dr. F. D. Adams, who has resigned from the University. Dr. Ruttan was president of the Royal Society of Canada in 1919 and of the British Society of Chemical Industry in 1922. He was appointed an original member of the Honorary Advisory Council for Scientific and Industrial Research for Canada in 1916. He represented the Dominion at Brussels in 1919 on the International Research Council and was a member of the committee which framed the constitution and statutes of the International Union of Pure and Applied Chemistry. Dr. Ruttan is an active and successful investigator, a good organiser, and has developed a very strong graduate school in chemistry at McGill. He is regarded as an excellent choice for the head of the Graduate Faculty.

W. C. ALLEE refers in *Science* (vol. 59, p. 521, 1924) to his recent two months' visit to Barro Colorado Island, the site of the new station for tropical research in Gatun Lake, Panama Canal Zone. The island was the largest of the old hills rising above the valley of the Chagres River and consequently is now the largest of the islands in the man-made Gatun Lake. Comfortable living quarters have just been erected and equipped so that a small party can live and work with comfort in the jungle, which is of the rain forest type and spreads over the five square miles of the island. Ants and termites are common and offer excellent opportunities for the study of habits and for the collecting of commensals; several new species of the latter have already been found. Peripatus occurs on the island. Birds, lizards, armadillos, peccaries, racoons, night monkeys, white-faced monkeys and black howling monkeys are common and relatively tame, and among other mammals found either on the island or near by are tapirs, sloths and ant-eaters. The station affords an opportunity for the study of the physical conditions under which animals live in this sort of jungle and has the great advantage of ready accessibility—being only two hours' journey from Panama City.

SIR WILLIAM POPE has been elected a foreign member of the Reale Accademia Nazionale dei Lincei of Rome, in the Section of Physics and Chemistry and their Applications.

THE autumn meeting of the Iron and Steel Institute will be held at the British Empire Exhibition, Wembley, on September 4-5. Applications to attend the meeting must be received at the Institute not later than August 15.

WE learn from *Science* that William Gaertner, president of the Gaertner Scientific Corporation, Chicago, has been awarded the Howard N. Potts Gold Medal by the Franklin Institute, "in consideration of his notable achievement as a designer and maker of scientific instruments, materially contributing to the success of the research in physical science."

APPLICATIONS are invited for an inspectorship of agriculture under the Sudan Government. Candidates for the post must have had a thorough practical and scientific training in agriculture and possess the national diploma or a university degree in agriculture. Particulars of the appointment are to be had from the Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W.1.

THE Department of Scientific and Industrial Research invites applications for the post of superintendent of its chemical research laboratory. Candidates should have special knowledge of some branch of pure or applied chemistry. Particulars of the duties attaching to the post and a form of application can be obtained from the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1. Applications must reach the department not later than September 30.

THE International Commission on Illumination will hold its sixth session at Geneva from July 21-July 25. The session meets under the presidency of Dr. E. P. Hyde. Twenty-six papers on subjects connected with illumination are being presented, and delegates from America, France, Great Britain, Italy, Japan, Poland, and Switzerland will be present. The papers deal with photometric nomenclature, primary standards of light, heterochromatic photometry, automobile and industrial lighting, and legislation. It is expected that, as a result of the discussions, progress will be made on several problems in which international agreement and co-operation is desirable.

THE annual meeting of the British Medical Association opens with the meeting of the Representative Body on July 18, and on the evening of Tuesday, July 22, Mr. Basil Hall will deliver his presidential address at the Regent Picture House, Manningham Lane. Among the eminent foreign guests who will be present are Dr. Alexis Carrel of New York, Prof. Ignacio Barraquer of Barcelona, and Dr. Van den Bergh of Leyden. Before this address, the president will present the Stewart Prize to Prof. E. Mellanby, of the University of Sheffield, for his important discoveries on the relation between rickets and dietetic deficiency, and the Gold Medal of Merit of the Association (the highest award in the bestowal of the Association) to Dr. H. B. Brackenbury for his arduous and distinguished services to the Association and the medical profession.

THE summer conversazione of the Natural History Museum Staff Association was held on July 2, and was attended by a large number of members and visitors, many of the latter coming from overseas. The remarkable series of specimens which had been arranged by the desire of Dr. W. Bateson, a Trustee of the Museum, to illustrate the variation in characters in three zoological groups—birds, mammals, and molluscs—attracted much attention. Considerable interest was also taken in the selection exhibited from the collection mainly of vertebrate fossils made by the late Mr. R. W. Hooley in the Wealden of the Isle of Wight. This extensive collection has recently been acquired by the Trustees. Other notable exhibits included a new plant genus belonging to the family of Umbelliferæ and collected by the Misses Godman in Central Africa; and a few examples of the splendid photographs taken by Mr. M. Maxwell of the elephant and the rhinoceros.

THE Lecture Bureau of the Selborne Society has already issued its list of lectures for the 1924–25 season. The names of more than fifty lecturers appear in the list; the subjects offered number considerably more than three hundred, and thus afford a very wide field for selection by those desirous of engaging lecturers during the forthcoming season. The Bureau caters for all tastes: literature, art, scenery, folk-lore, commerce, psychology, and many of the branches of natural science are well represented on their list. We note, however, that while physical and biological subjects are named fairly frequently, there is an absence of those concerned with chemical processes. Considering how largely these enter into the industrial life of the present day, we venture to suggest that there are, up and down England, numerous audiences eager for clear information on such topics. Inquiries concerning these lectures should be addressed to the Secretary, Selborne Society, The Hermitage, Hanwell, W.7.

THE Rockefeller Foundation has issued a review of its activities during 1923, compiled by the president, Mr. George E. Vincent. A sum of more than eight million dollars was expended in forwarding public health and medical education in all parts of the world. The work included the support of 636 fellowships, international visits, emergency relief to institutions of 15 European countries, contributions to schools of hygiene, hookworm campaign in conjunction with 20 governments of the world, yellow fever campaign in Brazil, contributions for medical education in Great Britain and other countries, and malaria control in several countries.

IN a lecture given by Mr. T. Thorne Baker at the Royal Society of Arts on "Photography in Science, Industry, and Medicine" (R.S.A. Journal, June 23), which was illustrated by a very large number of examples, the lecturer said that "the plate chemist has learned the secret of the sensitiveness to light of

silver bromide, he can produce an emulsion in gelatin of this unique substance, which shall have a predetermined size of grain, of contrast-giving power and rapidity. He can make it sensitive to all the colours of the spectrum, to the invisible infra-red and ultra-violet rays, to the X-rays and shortest wave motions produced by radium." Mr. Thorne Baker explains that the sudden disappearance of pictures transmitted by telegraph was because the cost of transmission proved to be "altogether prohibitive." He hopes that before long a new system will be available on a really commercial scale—the time of transmission being reduced to 2½ minutes.

WE have received No. 118 of Abderhalden's "Handbuch der biologischen Arbeitsmethoden" (Lieferung 118, Abt. 2, Physikalische Methoden, Heft 4. Die meteorologischen Messmethoden, von Walter Georgii; Die Makrophotographie, von Marie Kundt; Farbenphotographie, von Walter Thiem. Pp. 483-618. Berlin und Wien: Urban und Schwarzenberg, 1924. 6·40 Schw. frs.). It deals with meteorological measurements, such as temperature, pressure, moisture, wind-strength, etc.; macro-photography and colour photography. The matter is strictly practical, and not overburdened with a variety of methods or formulæ. In the photographic section, the support and manipulation of the camera and the support of subjects of various kinds are dealt with at length, as well as the numbering of series, as for indexing purposes, the copying of diagrams, engravings, and so on. The few pages on colour photography give just the extra assistance needed for the use of autochrome and "Agfa" colour plates by daylight and artificial light.

MR. F. S. SPIERS, secretary and editor to the Faraday Society and secretary to the Institute of Physics, has moved his office to 90 Great Russell Street, W.C.1 (Telephone, Museum 5718). The publishing office of the *Journal of Scientific Instruments* is now also at this address.

Our Astronomical Column.

THE LESSER MAGELLANIC CLOUD.—There have already been several estimates published of the distance of this object. Prof. Harlow Shapley (Harv. Coll. Obs., Circ. No. 255) revises these in the light of new photographic determinations of the magnitudes and periods of the numerous Cepheid variables in the Cloud. The results point very consistently to a distance of 31 kiloparsecs or 100,000 light-years. He notes that Dr. R. E. Wilson's researches on the proper motions of galactic Cepheids tend to make the estimated distances of clusters and the Magellanic Clouds smaller by 20 or 30 per cent.; but that this reduction may be cancelled if Kapteyn's suggestion of systematic errors in the accepted proper motions in declination should be correct. He proposes, therefore, to postpone any correction till the question is settled.

The diameter of the Cloud is 6500 light-years, and its depth in the line of sight is presumably of the same order, so that it is no inconsiderable universe in itself. Its brightest stars are estimated to be of absolute magnitude −7·0, and diameter 1000 million kilometres, thus exceeding Betelgeux and Antares in size. It has been found possible to ascertain the general spectral types of some of them: types K5 and M occur among these, and the largest diameters are to be expected in these types.

The Cloud is receding with a speed of 170 km./sec., equivalent to a kiloparsec in 6 million years; Prof. Shapley suggests that it may have been a galactic star cloud 200 million years ago.

DISTRIBUTION OF ENERGY IN STELLAR SPECTRA.—The spectral energy curves of stars of types F5, A, and B have been measured by M. J. Baillaud, *Comptes rendus* of the Paris Academy of Sciences, May 12, and are found to be distributed into three groups, one for each type. The curve of Procyon (F5, dwarf) is the only one of those measured which approximates throughout to the "black body" form; those for types B and A have no relation to a black body curve, whatever temperature is assumed, at any rate for wave-lengths shorter than 500 mμ; it is thus impossible to use the curves for the determination of temperature. The author concludes that the origin of the observed continuous spectrum is not the same for the white stars as for the yellow; for the sun and dwarf stars like Procyon, the continuous spectrum apparently comes from a photosphere consisting of incandescent solid particles; for A and B stars the radiation seems to come from masses of gas at high temperatures; hydrogen and certain metallic vapours have been observed to emit continuous spectra, of a similar nature to those of these stars, in the laboratory. In certain cases, there appears to be a combination of the above sources of radiation; this may be due to the emission of black body radiation by a central nucleus, and of a high peaked continuous spectrum by surrounding gases.

SPIRAL STRUCTURE IN STAR CLUSTERS.—Attention is directed by Dr. P. ten Bruggencate, in the *Zeitschrift für Physik* for June, to the discovery of remains of spiral structure in the B stars of the star cluster Messier 13, by Freundlich and Heiskannen. Dr. Bruggencate has plotted the bright and the fainter stars separately, on millimeter paper, for Messier 3 and Messier 15; and finds that the 150 bright stars of the former cluster show distinct signs of a spiral structure, while 270 fainter stars indicate an elliptical arrangement, the direction of the major axis of the ellipse being estimated with considerable certainty. Apparently the line joining the two points on either side of the cluster from which the arms of the spiral proceed, coincides in direction with the major axis of the cluster, as is required by the theory of Jeans. For Messier 15 there is not much evidence of spiral structure; but the Bonn catalogue is not sufficiently complete for accurate investigation of this cluster. Messier 37, which is an open cluster, shows Shapley's phenomenon, *i.e.* the giant stars are brighter the redder their colour, which indicates that they have a common origin; the complete catalogue of this cluster by v. Zeipel and Lindgren was employed, and it was divided into four concentric rings, the principal axis of inertia for the B and A stars of each ring being determined by counting. The direction of this axis was found to be constantly twisted in the counter-clockwise direction in proceeding outwards, the total observed twist being a little more than 45°. Thus even in an open cluster remains of a spiral structure may be found when the larger stars belonging to it are examined, the smaller stars which originally had a similar structure having become irregularly scattered.

Research Items.

DISINTEGRATION IN PRIMITIVE SOCIETIES.—Capt. G. Pitt-Rivers, in his presidential address to the Section of Ethnology and Anthropology of the Australasian Association for the Advancement of Science in 1923, which has recently been issued in the Report of the Association, offers some interesting suggestions in reference to tests which might be applied in estimating the trend of development in any given community, referring in particular to the changes which are brought about in a primitive society when in contact with white civilisation. For this purpose a comparison of different cultures and their social and moral systems is not adequate; but a standard or norm is to be found in the tendency to integration or disintegration. Taking, for example, the Papuo-Melanesian and Micronesian cultures, the principal factors of social integration are: (1) the chieftainship; (2) magic and sorcery; (3) the system of exchange of gifts, partly economic, partly ceremonial and non-economic. In the case of each of these the effect of contact with white civilisation has been disintegrative. In Papua the institution of a village policeman as the chief district authority has undermined the position of the chief without ensuring that the substitute shall be of a type to take his place in the native's estimation; while by suppressing sorcery and magic the administration has destroyed the strongest influence which made for law and order.

FORAMINIFERA OF LORD HOWE ISLAND.—Messrs. E. Heron-Allen and A. Earland (Journ. Linn. Soc., Zool., vol. 35, 1924) describe a collection of Foraminifera, made by Prof. R. D. Laurie at Lord Howe Island, South Pacific, which contains 199 species and varieties. Two new genera are described—Craterites, which is related to Orbitolites, and Diffusilina, the neatly constructed test of which and the high proportion of cement in its finished exterior surface indicate affinities with the Lituolidæ, but it has no close relationship to any previously recorded type. The authors direct attention to the profuse occurrence of species in reproduction, both by viviparity—young examples being found in a cavity resulting from the absorption of the internal septa of the test—and by "budding" from the aperture. The material was from the reefless area of the island only, and the authors believe that many species would have been added to the list if a collection had also been made among the reefs and in the lagoon. The material shows that a large proportion of the specimens are not of local origin but are more or less water-worn and have travelled some distance. Many of the species recorded have a wide range, from East Africa through the Malay and Australian seas to the Pacific.

MEDICAL PROTOZOOLOGY.—In a recent lecture on medical zoology (*Amer. Naturalist*, vol. 58, pp. 1-23, 1924) Prof. R. W. Hegner surveyed the recent investigations on protozoa carried on in his department of the Johns Hopkins University. He said that various theories had been put forward to account for relapses in malaria, and that one of these seemed now to be proved, for Dr. Ben-Harel had been able to show, by working on canaries infected with Proteosoma, that when parasites are apparently absent from the blood they exist in small numbers in the spleen and bone-marrow, where they undergo asexual reproduction in a normal manner. He referred to the work of Dr. Taliaferro on *Trypanosoma lewisi* in rats, and stated that pure lines of this species had been obtained by inoculating clean rats with single trypanosomes, and an intensive study had been undertaken of the resistance which the rat offers against infection. There are three manifestations of such resistance: (1) the rate of reproduction of the parasites is retarded until it is inhibited altogether by about the tenth day; (2) a large number of parasites are destroyed between the 10th and 14th days; and (3) the rest of the trypanosomes—non-reproducing adults—are finally destroyed. The first resistance is due to the formation in the blood of the rat of a reaction product which inhibits reproduction of the trypanosomes but does not destroy their vitality; the second resistance is as yet not explicable, but the third—the destruction of the organisms—is brought about by the formation of a lysin. Suggestive observations are recorded on the effects of a change of diet on *Trichomonas muris* in the cæcum of the rat—for when heavily infected rats were put on a well-balanced carnivorous diet for a week, the number of Trichomonas decreased almost to disappearance, apparently owing to alterations in the bacterial content of the cæcum and in the products of their activity. Prof. Hegner suggests that a carnivorous diet might be an effective method of treatment of flagellate dysentery in man, and states that the method has been put into practice in a few cases with "remarkably rapid and satisfactory" effects.

ACIDOPHILUS MILK.—Artificially prepared soured milks have been made use of as articles of diet in various parts of the world from time immemorial, and years ago Metchnikoff introduced the use of milk soured with the Bulgarian bacillus as a preventive of the onset of old age! Recently Prof. L. F. Rettger, of Yale University, has found that the *Bacillus acidophilus* produces a soured milk of considerable value in the treatment of intestinal toxæmias (*Science*: Science Service Supp., June 13). Skimmed cow's milk is boiled and cooled and inoculated with the organism, which is allowed to grow for twenty-four hours. At the end of this time the milk is curdled with a soft curd, and on shaking assumes the consistency of thin cream. Taken daily in quantities of from one to two pints, the fermentive and putrefactive bacteria in the intestines are much reduced in numbers with corresponding benefit in suitable cases.

TEMPERATURE IN THE NETHERLAND INDIES.—In Verh. No. 8, vol. 1, part 5, the Royal Magnetic and Meteorological Observatory of Batavia has recently published a discussion of temperature by Dr. C. Braak in continuation of other discussions on the climate of the Netherland Indies. A brief English summary is given as well as the full discussion in Dutch. Recent observations have been mostly used, as the older observations are generally untrustworthy, owing to defective exposure. Temperature is fairly uniform during the whole year, and in addition to the annual variation of winter and summer there is the influence of the monsoon. Whether the wind blows from south or north it brings air of equal temperature. Rain showers may cool the air temporarily, but generally uniformity of temperature is apparent. For daily differences in the dry season, the maximum temperatures are usually higher than in the wet season and the minimum lower, the daily range being greater in the dry season. The time of the maximum varies with the height above sea level, and the maximum occurs relatively early at the high mountain stations, where night frosts are occasionally noted in August and September. Diurnal variation of mean air temperature from observations in the Archipelago and in the adjacent Indian Ocean gives an extreme range of 0·87° C., while for the sea it is 0·75° C. The average air temperature is 26·05° C., the sea 27·10° C., the sea water being thus 1·05° C. warmer than the air. The decrease of temperature with increasing height in the free atmosphere is discussed, and the variation of soil temperature with depth. Monthly series of isotherms of air and sea over the adjacent waters, and

copious tables and diagrams, are given in the original text. The discussion is of the highest value for the advancement of the world's meteorology, dealing with the temperature of the part discussed in the most complete and scientific manner.

THE SURFACE LAYERS OF OCEANIC WATERS.—After studying the records of the *Challenger* soundings and plotting the density and temperature against depth, M. J. Thoulet has found that there is a limited layer, near the surface of the oceans, in which the denser water, due to evaporation at the surface, sinks, and is mixed by wave action with lighter water, containing less salt, produced by the action of rain, the melting of ice and the inflow of rivers (*Comptus rendus* of the Paris Academy of Sciences, May 12). The mean thickness of this layer of mixture, or of rapid diffusion, varies in different parts of the ocean between 600 and 800 metres, being greater in the tropics than near the poles; a layer of minimum density divides it from the lower oceanic water, where there is only slow diffusion. The paper gives an account of the seasonal variations of this upper layer, which cause a movement of water towards the poles in summer, and a reverse movement in winter. The density in the minimum density layer varies from 1·0289 in hot regions to 1·0253 near the poles, with a mean value of about 1·0275. It is particularly regular in the South Atlantic and the Pacific, where it is rarely so high as 1·0280.

THE VACUUM TUBE DISCHARGE.—In the July issue of the *Philosophical Magazine*, Sir J. J. Thomson puts forward a theory of the electric discharge in gases at very low pressures such as are used in the older X-ray tubes, which is in better agreement with the experimental facts than the theory which depends mainly on the collisions between cathode rays or positive ions and the molecules of the residual gas for the source of ionisation. The process which takes place in the tube is rather as follows. The positive ions on striking the cathode emit radiation which, falling on the cathode, causes a photoelectric emission from the cathode. The electrons emitted acquire a high speed, and cause the molecules of the gas to emit a second radiation, which in turn ionises the molecules it encounters. The recombination of the ions so produced constitutes the negative glow. On this theory, the difference of potential between a point in the dark space and the negative glow is proportional to the square of the distance of the point from the inner edge of the glow, which has been found to be the case by Dr. Aston.

ACTION OF A TRANSVERSE MAGNETIC FIELD ON THE CATHODE DARK SPACE.—A communication from the Physikalisch-Technischen Reichsanstalt in the *Zeitschrift für Physik* for May, by Dr. A. Günther Schulze, describes an ingenious device for obtaining a self-adjusting, plane, horizontal cathode, which allows the magnet poles to be brought fairly close together, and at the same time enables the glow discharge to be produced at a distance from the glass walls, so that it is unaffected by them. A glass tube, diameter 4 cm. and length 28 cm., is closed at one end, half filled with mercury, which forms the cathode, closed by a rubber stopper through which pass a glass tube connecting with the air pump and the connecting wires, and is laid horizontally between the magnet poles, so that the lines of force pass across parallel to the surface of the mercury cathode. The anode is near the stopper, and with a fairly high vacuum the glow discharge is deflected in a narrow band towards the sealed end of the tube. The width of the dark space, measured vertically, is obtained by means of a cathetometer; there is a minimum value for this distance d (*Fallraum*), which for all the gases investigated is near 0·70 mm.; for pressures of not less than 20 mm., d is very little greater than this minimum value with zero magnetic field; but for low pressures it is much larger, and can then be reduced to the minimum value when the field is increased sufficiently.

EXTRA HIGH FREQUENCY γ-RAYS FROM RADIUM.—The secondary β-ray spectrum from lead, excited by the γ-rays of radium and its disintegration products, has been photographed and investigated by M. J. Thibaud (*Comptes rendus* of the Paris Academy of Sciences, May 19). Eight lines have been found, the energy in kilovolts of each being as follows:

1	2	3	4	5	6	7	8
152	203	258	330	516	593	671	1034.

All of these lines correspond with lines in the spectrum of radium and its disintegration products; 1, 2, and 3 are identical with lines found by Ellis to belong to radium-B, 4 has been observed by de Broglie and Cabrera in the spectrum of the same substance, 5 corresponds to a β-ray originating in the K level of radium-C, 6 to one from the L level of the same substance; the difference between the energies of these two lines is 77,000 kilovolts, which agrees with the number, 75,000 kilovolts, calculated from other lines of the radium-C spectrum for these two levels. According to Ellis's theory, these lines may be due to a nuclear γ-ray, with energy 605,000 volts; while line 8 of the lead secondary spectrum, which corresponds to a line from the K level of radium-C, is due to a γ-ray with energy 1,123,000 volts. Lead, which was used as the secondary radiator, is an isotope of radium-B, and the production of lines 1, 2, 3, and 4 in its spectrum is to be expected. That the lines of radium-C are also obtained is regarded as due to the fact that the variation of the energies of the levels of radium-B and C is of the same order as the experimental errors.

SYNTHESIS OF METHANE FROM COAL GAS.—Work on the synthesis of methane from coal gas has been carried out in the laboratories of the South Metropolitan Gas Company, and some results were described at the annual meeting of the Institution of Gas Engineers. The preliminary complete purification of the gas from sulphur compounds necessary to avoid poisoning the catalyst involves the partial elimination of valuable unsaturated hydrocarbons from the gas, and the conversion of part of the carbon monoxide content of the gas to carbon dioxide. The loss resulting from these causes and the heat loss attributable to the exothermicity of the hydrogenation reaction would cause a considerable increase in the cost of the gas produced.

PHOTOGRAPHIC DEVELOPMENT AFTER FIXING.—Messrs. Lumière and Seyewetz have communicated to the Paris Academy of Sciences a method which places development after fixing upon a practical basis, which is recorded in the *British Journal of Photography* of June 27. Hitherto this process has required about ten times the usual exposure, presumably because the substance of the developable image, whatever it may be, is soluble in the "hypo" used for fixing. By adding a little ammonia to the "hypo" and to the wash water, this drawback is overcome. The developer preferred contains sodium sulphite and paraphenylene-diamine in addition to silver nitrate, and yields negatives that recall those on collodion plates in appearance and other characteristics. The developer is exhausted in about an hour, and if more density is required it may then be replaced by a fresh portion, and thus continued up to 10 or 12 hours' duration. By this longer time the particles are about equal in size to those of the original silver bromide of the plate. Photomicrographs are given of the grain produced by development for 1, 3, 7, 24, and 48 hours. Even the coarsest grained plate gives a fine grained image unless development is unduly prolonged or the image is intensified.

The Kelvin Centenary.

IN the presence of a large and distinguished company, including delegates from the principal scientific societies of Great Britain, the British Dominions, Belgium, Denmark, France, Italy, Japan, Mexico, the Netherlands, Norway, Poland, Russia, Spain, Sweden, Switzerland, and the United States of America, Sir Charles Morgan (president of the Institution of Civil Engineers) handed the Kelvin medal to Prof. Elihu Thomson in the great hall of the Institution of Civil Engineers on Thursday, July 10.

In making the presentation, Sir Charles Morgan explained that the medal (Fig. 1) was founded in 1914, principally by British and American engineers, to commemorate the advancement by Lord Kelvin of those branches of science which are especially applicable to engineering. The award is dealt with by a committee of the presidents of the representative British engineering institutions, after their consideration of recommendations received from similar bodies in all parts of the world, and, in accordance with the terms of the trust, it is made to the person whom the committee finds to be the most worthy to receive this recognition of pre-eminence in the branches of engineering with which Lord Kelvin's scientific work and researches were identified. The only previous award of the medal was that made in 1920 to Dr. W. C. Unwin, whom he was glad to see present. He reminded his hearers that Prof. Elihu Thomson has been connected with the applications of electricity to lighting and power from the early days of the Thomson-Houston arc lighting system to the vast present-day activities of the General Electric Company of Schenectady. Prof. Thomson has made far-reaching discoveries relating to alternating and high-frequency currents and was a pioneer in electrical resistance welding. A past president of the American Institute of Electrical Engineers, he has been the recipient of many high honours. In receiving the medal, Prof. Elihu Thomson said that he regarded the award as a compliment not only of a personal nature but also to the whole American electrical engineering profession. He liked to think of Lord Kelvin as the supreme example of what a man of engineering science could be.

Sir Richard Glazebrook then took the chair and directed attention to the great progress achieved during the hundred years that they were looking back upon. To this progress, no one had contributed more than the great man whose memory they were met to honour that day. The celebrations originated in a suggestion of Dr. Alexander Russell (president of the Institution of Electrical Engineers), but they were being taken part in by a long list of British institutions and by delegates from foreign societies, who had come from all parts of the world to do honour to Lord Kelvin's name. The chairman then received addresses in writing from a large number of foreign delegates who were present.

SIR JOSEPH THOMSON.

Sir Joseph Thomson then proceeded to deliver the Kelvin oration. In his opening remarks, he characterised Lord Kelvin as the Admirable Crichton of physical science. A great physicist, he was at the same time a great mathematician and a great engineer. He could make inventions as well as he could write text-books, and could take out patents as well as he could write papers. Few men had sprung to fame at such an early age. Born at Belfast, where his father was professor of mathematics, he commenced his studies at Glasgow at ten years of age, when his lifelong connexion with that city and university began. Before he was eleven he had won two prizes in mathematics, and before he was thirteen he had gained further distinction in this subject as well as in natural philosophy and logic. During these early years, his thoughts were turned to two subjects which were destined to play great parts in his subsequent career, the figure of the earth and Fourier's theorem. His later work with regard to the former produced one of his most important contributions to physics, and the latter formed the underlying basis of much of his other work. William Thomson, as he then was, went into residence at Peterhouse, Cambridge, in 1842, and was soon recognised as the most brilliant mathematician of his year, although he had to be content with the position of second wrangler in the mathematical tripos of 1845. He was, however, easily first in the examination for the Smith's Prize in the following year. After taking his degree, he worked for a few months in the laboratory of Regnault in Paris. This had a great influence on his career, not only in familiarising him with laboratory methods but also in introducing him to the work of Sadi Carnot, on which the second law of thermodynamics

FIG. 1.—The Kelvin Medal.

was afterwards based. In October 1846 he was appointed to the chair of natural philosophy at Glasgow, which he held with such brilliance for fifty-three years, soon extending the meagre facilities for experimental demonstration which he found there. Throughout his professorial career he may be said to have acted rather as an inspirer than as an instructor. He filled the ablest students with enthusiasm, the others with despair.

The decade of 1850–60 saw the establishment of the second law of thermodynamics, and Kelvin's work in this connexion has claim to be regarded as the most important of his many important contributions to physics. Continuing this work, he published in 1851 a paper expounding the position of thermodynamics in a masterly way, introducing the idea of an absolute scale of temperature corresponding to the readings of the gas thermometer. He also found time to devote to thermo-electricity and magnetic and other problems. It is important to record that his paper on transient electric currents in 1853 revealed the discovery of the oscillatory nature of the discharge of a condenser in certain circumstances, which is the basis upon which the whole study of electrical oscillations and wireless telegraphy and telephony is founded. In further papers he dealt without intermission with discoveries of fundamental importance in nearly every branch of physics. An outstanding feature of his equipment for the attack of dynamical problems was his engineer's intuition of how matter in motion would behave. The secret of his success in applying mathematics to physical problems was that he knew what to expect. With his striking originality, he was greater in developing his own methods than in following the lead of previous workers. In this respect he might be described as a good radiator but a bad absorber. For sixty years he worked at the elucidation of the theory of the luminiferous ether, and no small proportion of his total of 661 papers is devoted to this subject. Although he had to admit failure as regards direct results, a good deal of benefit arose indirectly from these investigations. The lecturer referred briefly to the new outlook opened up in the teaching of dynamics, etc., by the publication of Thomson and Tait's work on natural philosophy, to Lord Kelvin's fascination by gyrostatic problems, and his theory of the age of the earth, which was afterwards invalidated by the discovery of radio-activity.

It was in 1855 that Kelvin first turned his attention to submarine telegraphy and took up the study of the propagation and retardation of currents in cables, and his first connexion with Atlantic cable enterprise was his election, in 1855, as a director of the Atlantic Telegraph Co. to represent the Scottish shareholders. He soon took a more active part and accompanied the original unsuccessful expedition on the *Agamemnon* in 1857, and the expedition in the following year, when only brief communication was established, as well as the final successful expedition of 1866. It is well known that the conversion of failure into success was in no small degree due to the ability and courage with which he faced the problems involved and to the instruments, including the marine galvanometer and the siphon recorder, which he devised. His instruments of another type revolutionised the practice of electrical measurement generally; and the formation of the British Association Committee of 1861 on electrical standards was mainly due to him. It was he who devised the first method of measuring resistance absolutely by the spinning coil.

Kelvin was a keen yachtsman, and his interest in the sea led him to make most important contributions to navigation in his deep-sea sounding machine, tide predictor, and other apparatus. In addition to the direct results of his investigations, he produced great effect on scientific progress indirectly by the enthusiasm which he stimulated in others. This was very particularly seen at the meetings of Section A of the British Association, which his personality filled with life and interest. Kelvin was a man of outstanding vigour in the union of theory and practice and in untiring devotion to a great idea.

Dr. Alexander Russell.

An inspiring account of Kelvin's life and work was given by Dr. Alexander Russell in an oration delivered at the centenary commemoration at the University of Glasgow on June 25 and published in pamphlet form. Dr. Russell, himself an old student of Glasgow who attended Kelvin's lectures, spoke of Kelvin's belief that the chief importance of science lay in its applications for the material benefit of the human race, and his unbounded enthusiasm in applying it to ameliorate our everyday life. He was impatient of the slow progress made in improving means of communication, systems of lighting, and methods of transport by land and sea. His vivid imagination saw the world as it might be if science, engineering, and human labour had no limitations.

Dr. Russell proceeded to outline Kelvin's early years at Belfast, his brilliant career as a student at Glasgow and Cambridge, and his subsequent greatness as a professor, and spoke of the importance of his original work in mathematical physics generally and particularly in thermodynamics, submarine telegraphy, terrestrial magnetism, and the oscillatory discharge of the Leyden jar, and his applications of the theories of gyrostatic action and vortex motion. Kelvin was also greatly interested in atmospheric electricity and his well-known navigational instruments include his deep-sea sounding machine, his tide predictors and analysers, and his famous magnetic mariner's compass. It is not so generally known that he was also a pioneer of the gyrostatic compass, of which he made a model in 1884. The wonderful series of electrical measuring instruments designed by Kelvin bears witness to his energy, his inventive skill, and his practical genius. His electrometers and electrostatic voltmeters are in use in every country of the world to-day. In 1878 he pointed out how simply electrical energy could be transmitted over great distances, and his law determining the size of mains has done much towards cheapening the cost of electrical distribution. Attention was also directed to the importance of his work on electrical units and standards. "For the number, variety, and importance of his great contributions to science," continued Dr. Russell, "he stands without a rival. His works are a gift to universal Humanity. Had it not been for Kelvin the world would have been perceptibly poorer to-day. . . . And as the years roll on our debt to him grows ever greater."

Overseas Electrical Engineers.

A large party of representatives of overseas electrical engineering institutions who are visiting England, partly in connexion with the World Power Conference at Wembley, was entertained during the past week by the Institution of Electrical Engineers. The proceedings, which were to some extent combined with the Kelvin centenary celebrations, were inaugurated on Wednesday, July 9, at a reception at the Institution building on the Victoria Embankment, when the president, Dr. Alexander Russell, gave a brief address of welcome to the visitors. In the course of his address, he emphasised the truly international character of electrical science as evidenced by the names of our electrical units commemorating

great workers from many lands. It was particularly fitting that their visit coincided with the Kelvin centenary celebrations and the award of the Kelvin medal to Prof. Elihu Thomson, the successor of Lord Kelvin as chairman of the International Electrotechnical Commission. In another American representative they were glad to welcome Prof. Kennelly, of Harvard. Prof. Keith (secretary of the Engineering Institute of Canada) replied on behalf of the visitors, and in paying tribute to the work of Lord Kelvin referred to the part that he had played in the early days of the harnessing of Niagara. Representatives were present from the following societies: The American Institute of Electrical Engineers, Associacion de Ingenieros de Caminos, Canales y Puertos (Madrid), Associazione Elettrotecnica Italiana, Dansk Ingenirforening, Norske Ingenirforening, Engineering Institute of Canada, Institute of Engineers (India), Institution of Engineers (Australia), Koninklijk Institut van Ingenieurs (Holland), Schweizerischer Electrotechnischer Verein, Société Belge des Électriciens, Société Française des Électriciens, South African Institute of Electrical Engineers, Svenska Teknologforeningen, Vereening van Directeuren van Electricitatabedrijvenin Nederland, and other bodies.

The reception was followed by a luncheon at the Hotel Cecil, at which some three hundred members and guests sat down. The toast of the visitors was proposed by Mr. Ll. B. Atkinson (past president), who included in his speech a few words of welcome in nearly every language of the visitors, and was responded to by Mr. J. W. Lieb (past president of the American Institute of Electrical Engineers). Most of the visitors attended at the presentation of the Kelvin medal to Prof. Elihu Thomson and the delivery of the Kelvin oration by Sir Joseph Thomson at the Institution of Civil Engineers in the afternoon. The full programme of entertainment of the visitors, as we have already announced, included the Kelvin banquet on Friday, July 11, and visits to Wembley, Cambridge, the Birmingham district, and Windsor, and a lunch on Tuesday by invitation of Lord Ashfield, chairman of the Underground Electric Railways of London, Ltd.

Electrical Progress and its Unsolved Problems.

THE above was the title of the James Forrest lecture delivered at the Institution of Civil Engineers on Tuesday, July 8, by Prof. Elihu Thomson. The lecturer recalled Col. Crompton's James Forrest lecture in 1905 entitled "Unsolved Problems in Electrical Engineering," and proposed to deal with similar matters from the present point of view, directing attention to the recent advances in various departments of electrical work.

Speaking first of the electrical phenomena in Nature, Prof. Thomson referred to terrestrial magnetism, and made the suggestion that the oxygen in the atmosphere, being magnetic in property, must in a measure influence the direction of the lines of dip within the atmospheric layer. Of all natural electrical manifestations the thunderstorm is the source of most difficulty in electrical undertakings. The view of its cause now generally adopted is that of Simpson, making it a water-drop phenomenon. With the rapid passage of condensed drops through an uprising current of air, a fine spray is torn from them carrying a negative charge, and leaving the diminishing drops positively charged. The lecturer inclined to the view that the lightning flash is more of a steep wave-front discharge in one direction than a true oscillatory discharge. This, however, does not prevent structures capable of oscillation being activated by the shock of a heavy discharge. There are still many unsolved problems connected with protection of electrical apparatus and lines from the effects of lightning, but with increased transmission voltages and their greater degree of insulation, lightning troubles may be expected to diminish. For the protection of buildings, however, there is ample security in the intelligent application of the principle of providing a best path to earth. The so-called "ribbon" discharges, or successive discharges down the same ionised air streak, stationary or travelling with the wind, are the most dangerous. With regard to the explanation of globular lightning, which undoubtedly exists, little progress has been made.

Magnetic storms and auroræ are now generally recognised to be connected in some way with sun-spot conditions. It would seem that from the spot areas, streams of electrified particles are projected at speeds possibly up to 2000 miles per sec. If the earth is moving in its orbit near such a stream a disturbance of the magnetic field is inevitable. When the earth is directly immersed in the stream, the outer thin envelope of gas entangles the electric particles, resulting in a decided elevation of charge or potential of the outer partially conducting layer. This charge may be carried around with the revolving earth, so that on the dark side a discharge takes place into the shadow of the earth, continuing until the received charge is exhausted, or there is no further entrance or absorption of ions on the side towards the sun. This would account for the fact that most short-lived auroræ begin in the evening, and for the induced effect on telegraph lines during the disturbance.

The old phenomenon of St. Elmo's fire has in late years a counterpart in the corona surrounding high-voltage lines, which, since it involves a loss of energy, should be avoided by increasing the wire diameter or otherwise, such as possibly by jacketing the line with hollow beads or shells. The same potential limitation exists in wireless antennæ, where corona discharge is apt to produce distortion as well as loss of energy.

Turning to questions of transmission of energy, Prof. Thomson said that in the broadest sense all transmission of energy is electrical in its nature, as all the properties of matter now seem to be fundamentally electric. He dealt briefly with the conditions of transmission lines, recalling that the flow of energy itself is not in the conducting wire but in the space surrounding it. In ordinary low-frequency currents little of the energy is radiated away into the space. At high frequencies the radiation loss is a measurable quantity, and at the highest frequencies, as used in wireless transmission, practically all the energy is radiated. In the past few years, the advances made in this form of electric transmission have given rise to a new art of unprecedented importance in the future. The lecturer dwelt upon some of the features of this advance, particularly in the development of the three-electrode thermionic valve, and mentioned interference of conditions of land surface, atmospherics, and "fading" as among the unsolved problems. He was inclined to think that the last-mentioned may be caused by displacement of phase relations by changes in the electrical condition of the lower atmosphere preceding distant lightning discharges.

Outside of high-frequency work, most of electrical engineering is based on the magnetic properties of iron, and although no great advance on the high figures of efficiency now attainable may be expected,

no definite limit can yet be set upon the reduction of iron losses by improved material. The recently discovered "Perm-Alloy," which magnetically saturates even in the earth's field alone, points the way to improvements in instruments, and raises questions as to the possible discovery of other alloys with equally surprising magnetic qualities. It is not to be expected that any real substitute for copper as a conductor can be found, although aluminium can sometimes be substituted for transmission lines, and its higher resistance is even an advantage in certain cases of rotors of induction motors. In the matter of insulation, however, there will always remain room for further advances. The difficulties in the design of large generators are now mechanical rather than electrical.

Applications of electric transmission of power of another kind were mentioned in electric ship propulsion now applied to the largest battleships, to transmit power from the high-speed turbines to the low-speed propellers with advantages of efficiency and facility of control, and in other craft in connexion with Diesel and other oil engines as well as on land in Diesel locomotives, "petrol electric" automobiles, etc. The still unsolved problem of continuous or alternating current motors for railway traction was also dealt with, and other points in connexion with electric traction referred to included modern methods for suppressing flashing over at the commutators of rotary converters, and improved forms of control, including automatic control of sub-stations. In connexion with the beginnings of so-called "super-power" systems, an important problem is the control of power factor, and there is room for improved construction of static condensers for this purpose.

Passing on to the application of electricity for the production of heat, the lecturer indicated that it is more in localised heating for special purposes, or in the production of very high temperatures, that the field of electricity lies, than for the general warming of buildings. He dealt at some length with the possibilities of electric resistance welding of the "flash" and "spot" welding varieties, which is fast superseding riveting in a great variety of work. Arc welding has also considerable application. In electric furnace work a recent development is the Northrup high-frequency induction furnace in which iron cores are dispensed with and currents induced in the crucible at a frequency of the order of 10,000 cycles per sec. It is possible that currents of the necessary high frequency may be provided by valve or arc generators instead of special high-frequency alternators. The great advantage of electric heating in furnaces is the excellent control of temperatures and exclusion of gases. Electric heating can be carried out in vacuo, or, on the other hand, high pressures may be used with suitable furnace design.

Dealing with electric lighting, the lecturer traced the progress from the open carbon arc to modern magnetite and other arc lamps considerably used in America, and often in conjunction with mercury vapour rectifiers, and in the incandescent lamp, from the carbon filament lamp of forty years ago to the gas-filled tungsten lamp of to-day. It would seem, he said, that but little further advance in this field is to be expected. There is, however, much room for improvement in the application of the lighting units in illumination.

Reviewing the situation regarding storage batteries, Prof. Thomson expressed the view that the ideal has not yet been reached either in the lead battery or in the nickel-iron cell, both of which have serious disadvantages, especially for electric vehicle work. Even the latter, useful as it may be in certain circumstances, does not provide a true solution of the storage battery problem; "perhaps," he continued, "there is no solution possible."

There are many directions in which it is impossible to predict the developments of the future. "Who is there," Prof. Thomson said, "to tell us of the momentous issues and events which may arise out of the studies in pure science, of atomic and molecular structure, and the energy relations involved, which have become in large measure the chief study in physical science of our day? Perhaps our comparatively feeble beginnings in thermionic emission and the manipulation, so to speak, of electric ions, infinitesimally small though they be, coupled with the knowledge of the electric structure of matter in all its forms, may be the foundation of a greater super-science of electricity of enormous importance to the future achievements."

University and Educational Intelligence.

ABERDEEN.—At the Summer Graduation on July 10 the honorary degree of LL.D. was conferred on Dr. Michael Comport Grabham. Dr. Grabham delivered a lecture on July 9 on the "Natural History of Madeira."

The degree of D.Sc. was conferred on Mr. H. E. Magee, for a thesis on "The Influence of Food on the Respiratory Exchange of the Ruminant."

EDINBURGH.—The following are among the changes announced recently in the staff of the University: Prof. J. C. Meakins, professor of therapeutics, is leaving in September to take up his duties as professor of medicine, McGill University, and physician-in-chief in the Royal Victoria Hospital, Montreal; Dr. Bevan B. Baker, lecturer in mathematics, is resigning on being appointed to the chair of mathematics in the Royal Holloway College; Dr. O. S. Gibbs, lecturer in materia medica, has left to take up duties as professor of this subject in Dalhousie University, Halifax.

Dr. Frederick Walker, research student in the Geological Department of the University, has been awarded a Rockefeller Travelling Fellowship by the International Education Board. Dr. Walker will undertake petrological research in the Geophysical Laboratory of the Carnegie Institution of Washington.

LONDON.—The hundredth anniversary of the foundation of University College will be celebrated in 1926, and Sir Gregory Foster asks members and friends of the College to send records, reminiscences, pictures, photographs, etc., which are being collected with a view to the production of a history of the College as a part of the Centenary Celebrations. All documents will, in due course, be returned unless the owners desire to present them for the College archives. Communications and parcels (marked "Centenary") should be sent to Sir Gregory Foster at the College.

The Sharpey Physiological Scholarship, of the annual value of 160*l*., founded in memory of Prof. William Sharpey, will shortly be filled, on the recommendation of the Faculty of Medical Sciences of University College, London. The Scholar has opportunities for research, and takes a small share in teaching and demonstrating to students. Applications should be sent to the Secretary of University College, London (Gower Street, London, W.C.1), not later than Saturday, July 26.

ST. ANDREWS.—Applications are invited for the post of lecturer in chemistry in University College, Dundee. Preference will be given to candidates who have specialised in physical chemistry. Applications should be received (in triplicate) by the Secretary of the University by, at latest, August 31.

SHEFFIELD.—The following appointments have been made: Dr. G. A. Clark, to a lectureship in

physiology; Mr. E. F. Baxter, to an assistant lectureship in mathematics.

THE Technical College, Bradford, invites applications for the headship of its newly established department of commerce and banking. Particulars of the post and forms of application may be obtained from the principal, to whom the completed forms must be returned by, at latest, July 28.

THE British Research Association for the Woollen and Worsted Industries is inviting applications, to be received not later than July 31, for research fellowships and advanced scholarships. The fellowships will each be of the maximum annual value of 200*l*., and are tenable, in the first place, for one year, at an educational institution or elsewhere if suitable resources are available. The advanced scholarships are open to students and others, and are designed to enable the scholar to specialise. Courses of training in research work should generally be included in a candidate's proposed curriculum. Applications, with particulars of past records, proposed course of work, and so on, should be addressed to the Secretary, British Research Association for the Woollen and Worsted Industries, Torringdon, Headingley, Leeds.

EDUCATIONAL RESEARCH appears to have been pursued during the past two or three years with extraordinary enthusiasm in the United States. According to the Biennial Survey, 1920–22, of the Bureau of Education (Bulletin, 1923, No. 42) no less than 80 city, state, and university bureaus for educational research have been maintained, experiments were extensively carried on in all phases of school administration and instruction in numerous institutions, including 22 college and university laboratory schools and about 50 experimental schools for "progressive education," while from numerous presses issued an abundant stream of articles, monograph series, reports, and books. Among the national educational organisations which play a prominent part in promoting educational research are the American Council on Education (now closely associated with the American University Union in Europe), which studies the larger questions of educational policy, the Educational Research Association, the National Society for the Study of Education, the National Society of College Teachers of Education, the Carnegie Foundation for the Advancement of Teaching, and many others. The Bibliography appended to the Bulletin comprises 543 items. Those classified under organisation and administration deal largely with plans for classification in ability groups to the end that America may have no mute inglorious Miltons.

THE following awards, tenable at the Imperial College of Science and Technology, South Kensington, during the year 1924–25, have been made by the Governing Body of the College: (*a*) The Henry George Plimmer Fellowship in pathology to Mr. H. R. Hewer, for a continuation of his research on "The Rôle of Stimuli received by the Eye in the Colour Changes of Amphibia and Nerve Supply of the Pituitary"; value about 300*l*. (renewal). (*b*) The Gas Light and Coke Company's Research Fellowship, established by the Company for the purpose of encouraging experimental research in relation to carbonisation, gaseous fuels and combustion, to Mr. F. R. Weston, for a continuation of his research on "The Spectroscopic Investigation of the Flames of Carbon Monoxide and Hydrogen and matters cognate thereto"; value 200*l*. (renewal). By the Trustees of the Beit Fellowships for Scientific Research: Research Fellowships of the value of 250*l*. each to Mr. O. M. B. Bulman, for a continuation of his work on "Stratigraphical Geology; The Fauna of the Shineton Shales" (renewal); Dr. W. E. Downey, for research on "Photochemical Problems"; Mr. L. A. Harvey, for research on "The Nature and Function of the Cytoplastic Inclusions (Mitochondria and Golgi Bodies) in the Cells of Vertebrates"; Mr. R. Quarendon, for research on "The Combustion of Gases in Nitrous Oxide."

THE *University Bulletin* issued by the Association of University Teachers has until recently been confined mainly to recording the activities of the Association. The June number includes several articles of a more general nature. Among these is one by Dr. Brodetsky, reader in mathematics in the University of Leeds, on the anti-Jewish policy said to be prevalent in certain universities in Poland and Austria. The admission of Jews to these universities is severely restricted by applying what is known as the "Numerus clausus" principle, which consists in limiting the proportion of students belonging to a particular race to the ratio between the total number of persons of that race in the country and the total population of the country. Many Jews have in consequence gone from Austria to Italian universities, where they are welcomed. In an article on "A new residential university," Principal Childs, of University College, Reading, describes the circumstances in which his college is renewing its application for the grant of a university charter. Faculty organisation is discussed by Mr. C. B. Fawcett, reader in geography in the University of Leeds, who advocates reversion on the part of the newer universities to the medieval plan of a general faculty for all non-professional studies and the discontinuance of the practice of awarding several different first degrees—B.A., B.Sc., B.Com., a practice which makes for confusion and misunderstanding, and obscures the essential unity of knowledge.

THE progress of engineering education in India in recent years cannot be said to have kept pace with industrial developments. The official quinquennial Report on Education in India, 1917–22, shows that although during this period expenditure on colleges of engineering and other technical and industrial schools increased by 80 per cent., the number of students in the four Government engineering colleges decreased from 1319 to 1236, and in the other institutions increased only from 13,202 to 15,000. Doubtless there is in India a considerable amount of education in engineering which does not figure in the official returns, but in view of the extent and importance of industrial enterprises already established and the boundless field open to development, these figures must be regarded as astonishingly small, and suggest the question: What would have been the condition of India to-day if the Government's expenditure during the past fifty years on education had been directed by a policy aiming primarily at the development of the material resources of the country instead of being devoted almost exclusively to the dubious benefits of literary curricula on the lines of those of western schools. In Western India, there are signs of a growing appreciation of the benefits of engineering and other technical education, there being keen competition for admission to such institutions as the N.E.D. Civil Engineering College at Karachi, the Victoria Jubilee Technical Institute of Bombay, and the Poona Engineering College, notwithstanding that comparatively high fees are charged.

Early Science at the Royal Society.

July 17, 1661. Sir Paul Neile having mentioned, that the king had, within four days past, desired to have a reason assigned, why the sensitive plants stir and contract themselves upon being touched; it was resolved, that Dr. Wilkins, Dr. Clarke, Mr. Boyle, Mr. Evelyn, and Dr. Goddard, be curators for examining the fact relating to those plants.

July 20, 1664. Notice being given, that some ships were ready for Guinea, it was desired, that such, as had inquiries to be made in those parts, might prepare them against the next meeting.

1687. Mr. Hooke shewed the experiment of vibration of the rods, as a pendulum, which was by suspending a large Indian-cane of about thirty feet long by two pack-threads about eight feet in length: by which it was plain how the weight of such rods or poles for communication of traction or pulsion at a distance might not only be made to move freely and with ease, but also be in the nature of a sway. The same thing was also tried with a large scaffold-pole of about forty feet long.

July 22, 1663. Sir Robert Moray mentioned, that the king had made an experiment of keeping a sturgeon in fresh water in St. James's Park for a whole year: it was moved to kill it, and to see how it would eat.—He related that prince Rupert had made a new kind of gunpowder, in strength so far exceeding the best English powder, that trial being made with a powder-trier, it was found to be in the proportion of 21 to 2. It was desired, that a trial of it might be made before the society.

1669. The society being made acquainted by Mr. Oldenburg, that Mr. Edward Diggs intended to go shortly to Virginia, and offered his services for philosophical purposes; it was ordered that the inquiries formerly drawn up for that country should be recommended to him.

July 23, 1662. The amanuensis was ordered to translate from the French Monsieur Huygen's letter to Sir Robert Moray, dated at the Hague, July 14, 1662, containing some objections to some parts of Mr. Boyle's "Defence of the doctrine touching the spring of the air" against Franciscus Linus and Mr. Hobbes.

1684. Upon a complaint of Mr. Flamstead, that he had been reflected upon by Mr. Hooke in the minutes of the society, it was ordered that a line should be drawn through the places complained of, and that there should be written on the side, "cancelled by order of council": and that the journal-book should be brought to the next meeting of the council, who should see it done.

July 24, 1679. Mr. Haak produced a book intitled "Propositions of Optic Glasses," printed at the theatre at Oxford. Mr. Hooke who had read somewhat of the book, said, that he had not found anything in it, which was new, and that it contained some propositions about the place of the image, which were not true: that it came far short of the theory of optics now well known, which he conceived to have been first well understood by Kepler, and highly improved by Des Cartes.

July 25, 1667. The experiment of opening the thorax of a dog made at the last meeting not having succeeded, it was ordered to be made again at the next; and Dr. King was desired to bring in writing an account of that whole operation, though it failed.

July 26, 1682. Dr. Grew read a letter from Dr. Coga, Vice-chancellor of the university of Cambridge, wherein he mentioned, that Hevelius's last book was not to be found in that university.

Societies and Academies.

LONDON.

Physical Society, June 13.—Mr. F. E. Smith in the chair.—G. E. **Bairsto**: On a method for the synchronous and instantaneous illumination of objects rotating or vibrating at very high speeds. It is capable of giving instantaneous photographic records, and gives a precision of the order of half a microsecond. It is much more precise and able to give a more intense spark than any contact breaker and coil method.—E. A. **Owen**, N. **Fleming**, and Miss W. E. **Fage**: The absorption and scattering of γ-rays. The absorption and scattering of γ-rays from radium filtered through 23 mm. of lead have been measured in magnesium, aluminium, zinc, tin, and lead. Assuming that the mean effective wave-length of the radiation employed is 0·021 Å, the experimental results are consistent with the following statements: (i.) When γ-rays traverse matter, the characteristic radiations of the absorbing medium are excited; (ii.) the atomic fluorescent absorption coefficient of γ-rays depends upon the wave-length of the incident radiation and the atomic number of the absorber according to the law $\tau/\rho.\omega = K\lambda^3 N^4$, which holds for X-rays; (iii.) the radiations which accompany this fluorescent absorption are the characteristic radiations of the K, L, M, . . . series of the absorbing elements; (iv.) the absorption of γ-rays in light elements is due almost entirely to scattering; (v.) the pure atomic scattering absorption coefficient is proportional to the atomic number of the absorber; (vi.) in addition to fluorescent and scattering absorption, a true absorption exists, the atomic coefficient of which is proportional to the atomic number. Compton's formulæ would account for the experimental results if the wave-length of the incident radiation were 0·020 Å. Jauncey's formulæ would require the wave-length to be 0·029 Å.—W. N. **Bond**: The flow of compressible fluids, treated dimensionally. The method of dimensions treatment that is applicable to the pressure gradient at a point in a system through which non-compressible fluids of finite viscosity are passed, is extended by means of the thermo-dynamical equations for gas flow to the case where appreciable changes in density of the fluid occur, but where no heat passes across the walls of the system. The theory is developed in detail only for the case of flow through a straight parallel-walled tube, and has been tested by experiments in which water and air at high velocities pass through small tubes. The air in some experiments had a velocity of more than two-thirds of the velocity of sound in the air. Errors due to moisture, pulsating flow, heat conduction through the walls, and proximity to the entrance to the tube are small; an error of moderate amount is attributed to the partial neglect of the variation of the variables over the transverse section of the tube.—D. B. **Deodhar**: Note on Israj, a remarkable Indian stringed instrument.

Aristotelian Society, June 16.—Prof. T. Percy Nunn, president, in the chair.—A. D. **Lindsay**: Sovereignty. The theory of sovereignty is the storm-centre of political theory. For one school it is inherent in the very conception of government, for another it is nothing but a stone of stumbling, an anachronistic theory to be got out of the way as the essential preliminary to any solution of social questions. Austin approaches the doctrine of sovereignty with the purpose of defining law. Law is essentially a command and depends therefore on a distinction between the sovereign and the subjects. The originality of his theory is that he gives up all attempts to derive the

right of the sovereign from a supposed social contract, and bases it on the previous relation between him who commands and him who obeys. The command is a law consisting in the fact that the person who obeys has been in the habit of obeying the person who commands. Sovereignty is thus based on fact. As constitutional government developed, political theorists tried to describe it in terms of sovereignty. They invented a new kind of person, the people, the general will, the state or the nation, which they distinguished from the individuals composing the community. Bosanquet's "Philosophical Theory of the State" is a theory of sovereignty which he describes as "the general will" and represents as diametrically opposed to the Austinian. He is dealing, however, with a quite different question. He is showing that the real basis of law, as of everything else in society, is the whole of society. What is wanted is a link between this common life of society and the political machinery. The true theory of the sovereignty of the constitution maintains that the link between the social and juristic aspect of the State is the adherence by the great mass of the members of a society to a definite principle of settling differences.

Mineralogical Society, June 17.—Dr. H. H. Thomas, vice-president, in the chair.—Miklós **Vendl**: The chemical composition and optical properties of a basaltic hornblende from Hungary. Complete determinations were made, all on the same sample of material, of crystals of a black hornblende occurring in volcanic tuff near Lake Balaton. The mineral is rich in titania, alumina, ferric iron, and alkalis, and the composition is expressed by the mixing of simple metasilicate molecules (including 14·62 per cent. H_2SiO_3) with aluminate (14·40 per cent. $MgAl_2O_4$) and ferrate (4·32 per cent. $MgFe_2O_4$).—G. **Abbott** and W. A. **Richardson**: The micropetrography of the structures of the magnesian limestone of Fulwell. The structures of the magnesian limestone show a wide variety of forms ranging from simple spherical concretions to highly complex coral-like masses. The more complex types are built up by a combination of rods, tubes, and bars. The microstructure shows more uniformity. The prevailing type is finely granular but crystalline. Where impurities or lines of pigmentation are present the matrix becomes quite microcrystalline as a rule, whilst on the borders of cavities there is a coarser growth. Banded pigmented forms show the same structure as banded chert. Spheroids have either a coralloid structure, or if solid are microcrystalline at the centre with a radial crystallisation towards the surface. The microstructure by itself throws little light on the origin.

Royal Statistical Society, June 17.—J. **Hilton**: An inquiry by sample: an experiment and its results. At the end of 1923 a need was felt of a more detailed and intimate analysis of the million and a quarter or more workpeople in Great Britain who were then being returned week by week as unemployed; and it was evident that such an investigation must be by sample, and that the information desired was of a kind that necessitated personal interviews. It was decided to "tab" every hundredth claim on the live claim file at each Exchange, and invite the claimants thus indicated to attend in the manager's room for interview. Every Exchange was given a different point on its live claims file at which to start, and the starting points were distributed as evenly as possible over the whole occupational classification. The interviews took place in the week ended November 10, 1923, and 9997 reports were received. Comparison with the results of previous inquiries showed that the 1 per cent. sample is nowhere very wide of the mark, and has answered most of its purposes quite as well as a 10 per cent. or 33 per cent. inquiry. The sample only becomes untrustworthy when very small absolute numbers are involved.

Royal Meteorological Society, June 18.—Mr. C. J. P. Cave, president, in the chair.—C. K. M. **Douglas**: Further researches into the European upper air data, with special reference to the life history of cyclones. The temperature in the troposphere is much higher over a Bjerknes' "warm sector" than over the other parts of a cyclone. This leads to the conclusion that a cyclone is superficial in its initial stages. Relevant observations are few, since the development of a cyclone usually takes place in the Atlantic. A large part of the great increase of kinetic energy observed when a cyclone develops is supplied by a convectional overturning between adjacent warm and cold masses of air. The cold mass must have a depth of fully 6 or 7 kilometres, or about the depth of the troposphere in high latitudes in winter. In an appendix it is shown, by means of a criterion due to L. F. Richardson, that an inversion can only exist at a very small angle with the horizontal without becoming increasingly turbulent, a conclusion which is confirmed by observation. In a developing cyclone, the slope of the surface of separation between the cold and warm masses is of the order of 1 in 50, and the inversion is inevitably destroyed by mixing.—Miss L. F. **Lewis**: The effect of the source of air on its temperature at 4000 feet and 10,000 feet. During the winter months, the chief factor in determining the temperature of the air up to 2000 feet is its passage over a large expanse of land or sea. Air from the Continent is cold, while air from the Atlantic is relatively warm. On the Atlantic, however, some polar effect is shown when the path of the air is followed back for two days or more. At 4000 and 10,000 feet the chief factor is now the north to south component of the air's path, while the land and sea effect is small. Trajectories show that it is the latitude of the air two days before or even longer that determines the temperature.—L. H. G. **Dines**: A simple electrical time-marking system for use with self-recording meteorological instruments. The simple system of synchronous electrical time-marking installed a few years ago at Valencia Observatory, Cahirciveen, Co. Kerry, is described. A central clock operating hourly and minute contacts in series closes an electrical circuit once an hour. The circuit includes electro-magnets acting on suitable portions of the recording mechanism of the self-recording instruments which it is desired to include in the scheme. By this means time marks are easily obtained to an accuracy of a second or less.

Linnean Society, June 19.—Dr. A. B. Rendle, president, in the chair.—C. E. **Salmon**: A hybrid between *Carex remota* and *C. divulsa*. This occurred near Mayfield, in Sussex, in one large clump with a quantity of *C. remota* and a little *C. divulsa*. It differs from *C. remota* by its more scabrous stem, only one (or at most two) bracts, spikelets male at the summit, or even wholly male, and in other particulars. *C. remota* × *divulsa* seems extremely uncommon and is perhaps new.—T. A. **Dymes**: The seed of *Orchis latifolia*. The seeds of the British Dactylorchids fall into two groups: (1) Maculatæ, and (2) Latifoliæ. A form, agreeing in other respects with *O. latifolia* L., the seeds of which are obviously pure, has been found. The seeds belong to group (2) Latifoliæ, and are very like those of *O. prætermissa* Druce, and it seems probable that the two forms are close allies of the same species.—J. H. **Priestley** and Miss Lorna I. **Scott**: Leaf and stem anatomy of *Tradescantia fluminensis*

Vell. Vascular development in the leaf is first basifugal and afterwards basipetal, and the backward development of the subsidiary veins through the leaf sheath is associated with the subsequent development of the system of peripheral bundles, which lie in the sclerenchyma very near the periphery of the adult stem. Thus the functional vascular supply to the leaf passes through two stages in the stem. In the young internode, communication is maintained by means of the medullary and perimedullary bundles; as the growing internode extends in length the xylem of these bundles is disorganised, but at this time the peripheral bundles are differentiated throughout the internode and become functional.—T. B. **Blow**: Charophyta collected during a recent visit to Madagascar. These plants are interesting by reason of their affording a possible means of preventing the spread of malaria by acting as larvicides. The country covered was the east coast line, where are great marshes and much water, and where malaria is rampant, the higher ground around the capital, Tananarive, where the climate is much healthier, the mountainous portions near Antsirabe, where mosquitoes scarcely exist, and the district of the great Lake Alaotra, which is probably the most malarious part of Madagascar. It was noticed in connexion with several species of Chara that, where they abounded, there were rarely any mosquito larvæ in the water. The species that seemed to keep the water quite free of mosquito larvæ were as follows: *Chara Zeylanica*, *C. gymnopitys*, *Nitella Roxburghii*, and some other species of Nitella probably new.

DUBLIN.

Royal Dublin Society, May 27.—Prof. E. A. Werner in the chair.—W. R. G. **Atkins**: Notes on the filtration and other errors in the determination of the hydrogen ion concentration of the soil. As a general rule, the effect of increasing or decreasing the soil to water proportion, within limits, does not alter the P_H value by as much as 0·1 for soils between P_H 6 and P_H 8. With more acid or more alkaline soils larger alterations are thus caused. For lightly buffered acid soils one part of soil to two parts of water seems a safe proportion to adopt; for other soils a one to five proportion is convenient and, apparently, trustworthy. The P_H value of some soil extracts is markedly modified by filtration, even when a first filtrate is rejected. Both untreated and acid-extracted filter-papers may reduce the acidity. The use of large volumes, about 160 c.c., of filtrate, and a filter appropriate to the soil, reduces these errors: where possible, cleaning by the centrifuge is desirable. The fibres of acid-extracted papers act towards indicators as if as acid as P_H 4·8, but washing was not found to render them less acid. Unextracted papers are at about P_H 7·0-7·6, and give up traces of alkali to distilled water. The indicator brom-cresol green is to be preferred to methyl red for the same P_H range.—J. L. **McWhinney**: The soil fauna of a permanent pasture. A census of the invertebrate fauna resident on the surface, and in the soil to a depth of nine inches, of a permanent pasture forming part of the experimental farm of the Albert Agricultural College, Glasnevin, Co. Dublin, reveals a considerably greater density of population than has been found by other workers elsewhere. If the soil be dried before the count is made, numbers of the smaller species may be overlooked.

EDINBURGH.

Royal Society, June 2.—Prof. F. O. Bower, president, in the chair.—D. A. **Allan**: The igneous geology of the Burntisland district. Penetrating the Lower Carboniferous rocks of this area is a group of eleven volcanic necks, one of which is recorded for the first time. An examination of the boulders in the agglomerate has failed to produce material younger in age than the surrounding rocks. The lava flows comprise olivine basalts of the Dalmeny and Hillhouse types, together with a pyroxene-rich variety now designated as being of the Kinghorn type. From a consideration of the variation of the lavas, it has been possible to establish upon broad lines a series of zones. The intrusions include olivine basalts, teschenites, olivine dolerites, olivine-free dolerites, and quartz dolerites, the last named being probably the latest in development.—Ada M. **Malcolm**: The magnetic quality of very pure nickel. A nickel bar was examined by the magnetometric method (*a*) in a horizontal position, (*b*) in a vertical position, with and without an additional stress of ½ kgm. weight—the magnetising fields being of very low order. With the same bar in the horizontal position, complete hysteresis cycles were made, the field being increased in one case step by step, and in the other being continuously varied. The constant values of the susceptibility (K) and the permeability (μ) were calculated: K = 4·17 to 4·20; μ = 53·53 to 53·77. A circular coil of nickel wire was also used, and its saturation point determined by means of a ballistic galvanometer. The graph tended to become straight in the neighbourhood of a field of 100 gauss. The purity of the nickel was not less than 98·5 per cent.—Winifred J. **Smith**: The law of recurrence and decay of after-images. The sequence of colours observed, after exposing the eye to white light for a given period, can be represented graphically by the combined effect of three exponentially decaying periodic curves, representing the sensations of red, of blue, and of green. Differential equations were derived from the curves chosen to represent the experimental results. The form of these differential equations suggests two different physical analogies, one to the interaction of three condensing electric circuits, and one to the motion of elastically connected masses.—H. **Briggs**: Apparatus to facilitate the use of an oxygen-carbon dioxide mixture on the treatment of carbon monoxide poisoning. The orthodox treatment by means of oxygen of a case of carbon monoxide poisoning is not especially effective, being apt to bring about sub-normal breathing at a time when the reverse is needed. Henderson and Haggard, of Yale University, have developed the method of treatment by oxygen plus 5 per cent. of carbon dioxide, a mixture which has not the same disadvantage. It stimulates breathing from the moment of application, and reduces the chance of serious sequelæ. The mixture is now obtainable commercially in America under the name of "carbogen." As carbogen cannot yet be bought in Great Britain, it was necessary to devise an apparatus to make it. The liquid carbon dioxide in a large-sized "Sparklet" bulb can be discharged into an oxygen cylinder of 290 litres capacity, the cylinder being then charged with oxygen to the standard pressure of 120 atmospheres. The mixture so made contains 5 per cent. carbon dioxide.—R. S. **Vaidyanathaswamy**: On mixed determinants. This paper deals with the extended determinants, containing suffixes of two different kinds (the "signants" and "non-signants" of Rice), and leads up to the concept of "inert suffixes" of matricular invariants, and the concept of "extensional invariants." Some features of the determinant-theory advanced are: (1) a new account of the "decomposition" of a determinant into determinants of lower dimensions, as a quoted development by linkage of "suffixes"; (2) a systematic use of "one-dimensional determinants"

as the ultimate entities of determinant-theory; (3) a new and improved version of the theory of multiplication of determinants.

PARIS.

Academy of Sciences, June 16.—M. Guillaume Bigourdan in the chair.—Louis **Gentil**: The structure of the *Dorsale Tunisienne*.—Charles **Richet** and Mme. A. **Le Ber**: The relation between the time of action and the concentration of a sterilising substance (hydrogen peroxide). In sterilising a culture with an antiseptic two factors intervene, the concentration of the antiseptic and the period of time during which it is allowed to act. Results of measurements of the minimum sterilising dose of hydrogen peroxide are given for times varying between 3 minutes and 15 hours.—E. **Leclainche** and H. **Vallée**: Symptomatic anthrax and gas gangrene in cattle. Clinical and bacteriological studies of *B. septicus* and *B. chauvœi*, and their pathological and immunising effects on cattle and horses.—A. **Desgrez**, H. **Bierry**, and L. **Lescœur**: A mode of differentiation of sulphurous waters.—Ch. **Depéret** and L. **Mayet**: Reply to the observations of S. Stefanescu on the phylogeny of elephants.—Jean **Effront**: The absorbing power of vegetable pulps.—Paul **Vuilemin**: Anomalies of leaves caused by alloplasy.—**de Montessus de Ballore**: The unsymmetrical curves of Gauss.—V. **Illavaty**: Remark on the quasi-asymptotic curves of Bompiani.—J. A. **Schouten**: The conformal and projective connexions of Cartan and the general linear connexion of König.—R. H. **Germay**: Application of the method of successive approximations to a lemma of Weierstrass and to its generalisation.—Georges J. **Rémoundos**: Couples of functions which satisfy an algebraic equation.—A. **Bloch**: The theorems of M. Valiron on integral functions, and the theory of uniformisation.—R. **Gosse**: Explicit integrals of equations of the first class, $S = f(x, y, z, p, q)$, which admit an intermediate integral of the first order.—André **Metz**: Concerning the geometry of a disc turning in a Galilean system.—C. **Kolossoff**: The torsion of prisms having a right-angled triangle as base.—A. **Gros**: Finite bending of a circular ring compressed diametrically.—J. **Seigle**: Some observations relating to the effects of permanent torsions on steels.—Louis **Roy**: Electrodynamical and electromagnetic induction in continuous media in motion.—Y. **Rocard**: Extension of some results of the kinetic theory of gases.—G. **Athanasiu**: The distribution of energy in the mercury arc spectrum. Measurements were made on three groups of lines, using a spectrometer with a quartz optical system, and a thermocouple for reading the energy of the radiations. The mercury arc lamp was maintained with a current of 3·75 amperes, the voltage varied between 30 and 80 volts. It was found that the energy curves of lines belonging to the same series had the same general shape. The ratio between the intensities of two lines of the same series remained practically constant when the energy consumed by the arc lamp varied between 100 and 300 watts.—Jean **Lecomte**: Quantitative studies on the infra-red absorption spectra of organic substances. In the infra-red region the opacities of the different substituting groups are not additive.—A. **Dauvillier**: Spectrographic researches on the A. H. Compton effect. The Compton effect only appears in the case where the selective absorption is very small, and it is far from having the generality predicted by the theory.—Max and Michel **Polonovski**: The derivatives of eserine obtained by hydrogenation.—Léon **Guillet**: The influence of the velocity of cooling on the properties of commercial aluminium. The mechanical properties and the electrical resistance of aluminium are modified by the velocity of cooling, at least, if the percentage of silicon is a little high. The properties of commercial tempered aluminium do not sensibly change on keeping.—K. v. d. **Grinten**: Adsorption and cataphoresis. An application of the method of electric transport observed with the ultramicroscope.—Sir William J. **Pope** and F. G. **Mann**: 1.2.3 triaminopropane. Its preparation; formation of complex metallic derivatives. The method of preparation of this triamine given by Curtius and Hesse is tedious and not without danger. The new method involves the following steps: citric acid, acetone dicarboxylic acid, di-isonitroso-acetone, diaminoacetone, diacetyldiaminoacetoxine, 1.2.3 triaminopropane. The yields are good throughout, and with the base thus obtained the complex cobalt and rhodium compounds $[Co(NH_2 . CH_2 . CH(NH_2) . CH_2NH_2)_2]Cl_3$ and $[Rh(NH_2 . CH_2 . CH(NH_2) . CH_2NH_2)_2]Cl_2$ have been prepared. The stereo-chemical study of this new type of metallic complex is being carried out.—Marcel **Delépine**: The origin of fenchol in the reaction of Bouchardat and Lafont. Turpentine treated with either mineral acids or organic acids always gives a mixture of borneol and fenchol esters.—C. **Vournazos**: The formation of the bismuthamines.—H. **Gault** and Y. **Altchidjian**: The dissociation of hexadecene at high temperatures.—R. **Locquin** and L. **Leers**: The dehydration of some new pinacones. Starting with the pinacones $R(CH_3) . C(OH) . C(OH) . (CH_3)_2$, hydration by Meerwein's method yielded the ketones $R(CH_3)_2 . C . CO . CH_3$ (R being normal propyl, butyl, or amyl) with no indication of the presence of the isomeric $(CH_3)_3 . C . CO . R$. Ketones of the latter type were prepared by another method for the purpose of comparison.—E. **Raymond** and G. **Clot**: The acetyl index of fatty materials. The method proposed is based on the volume of methane produced by the action of magnesium methyl iodide in anisol solution on the dried fat, with correction for fatty acid present.—P. **Lebeau** and J. **Marmasse**: The quantity and nature of the gases evolved by solid combustibles under the action of heat and a vacuum: lignites.—L. **Cayeux**: The felspathic grits of the Hercynian Chain and the products of Permo-Triassic evaporation.—Gaston **Astre**: The tectonic units of the Sierras del Cadi, of Port del Compte and of some adjacent massifs (Catalanian Pyrenees).—M. de **Lamothe**: The tectonic evolution of the relief of the southern Vosges during the Quaternary, and solution of the problem of Noir-Gueux.—Ch. **Mourain**, E. **Salles**, and G. **Gibault**: The value and variations of the terrestrial field at Val-Joyeux, near Paris. Curves summarising results obtained with the self-recording apparatus installed at the Val-Joyeux Observatory, showing the annual variation of the terrestrial electric field as a function of the period of the year, and also of the time of day.—E. **Bauer**, A. **Danjon**, and Jean **Langevin**: Crepuscular phenomena on Mont Blanc.—W. **Kopaczewski** and M. **Bem**: The electrical conductivity of mineral waters as a means of their control.—H. **Colin**: The sugar beet and the forage beet.—Mme. B. **Brilliant**: The water content in leaves and assimilating power.—Fernando de **Buen**: The biology of the sardine in Galicia (Spain).—Louis **Fage**: A new type of Mysidacea in the subterranean waters of the island of Zanzibar.—André **Leroy**: The transparency of the shells of hen's eggs, and the modifications which it undergoes with time.—Ch. **Pérard**: Researches on the coccidia and coccidoses of the rabbit.—T. **Mutermilch**: The nature of the heterologue hæmolysins (Forssmann).—N. **Ishimori** and T. **Metalnikov**: The immunisation of the caterpillar of *Galleria melonella* by non-specific substances.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 5, May).—E. **Tomanek** and E. B. **Wilson**: Is pneumonia increasing? Statistics have been gathered of all forms of pneumonia in the United States registration area for the period 1900–1920. Making due allowances for the increase of registration area during that period, for the changed standard of life and economic conditions, and for difficulties of diagnosis, it is inferred that the disease is neither increasing nor decreasing.—G. A. **Miller**: Prime power substitution groups whose conjugate cycles are commutative.—R. L. **Moore**: (1) An extension of the theorem that no countable point set is perfect. (2) Concerning the prime parts of certain continua which separate the plane.—J. R. **Kline**: Concerning the division of the plane by continua.—F. B. **Sumner**: The partial genetic independence in size of the various parts of the body. Castle's figures for the correlation between total size and the size of individual organs or members are calculated from data from a "mixed population." Much lower correlations are obtained if sets of calculations are confined to a single race.—W. E. **Castle**: Are the various parts of the body genetically independent in size? A reply to the preceding paper. The calculations were based on a "mixed population" deliberately. It was sought to discover whether with change in general body size through genetic (not environmental) agencies there was a corresponding change in different parts of the body; hence it was desirable to start with differences in body size as great as possible.—L. L. **Woodruff** and E. L. **Moore**: On the longevity of *Spathidium spathula* without endomixis or conjugation. This organism was cultured by daily isolation in standard beef extract for 444 days, after which the animals suddenly appeared abnormal and died. The graph giving the average daily rate of division of the four lines of culture used shows only such fluctuations as may readily be accounted for by external factors. Pedigree cultures of *S. spathula* have shown progressive lengthening of life without endomixis or conjugation, and it is now considered that the organism can reproduce indefinitely in this way, given suitable environment.—D. L. **Webster**: A possible explanation of tertiary line spectra in X-rays. Objection is raised to the hypothesis of Clark and Duane on the grounds that the energy of the tertiary beam would be very small and that the narrow peak observed in the ionisation curve cannot result from reduction by filtering on emergence from the radiator of a continuous spectrum. It appears more probable that the atoms ejecting the photo-electrons are the source of the radiations. Data from the spectra of thin targets are in general agreement with this hypothesis.—G. L. **Clark** and W. **Duane**: On the theory of the tertiary radiation produced by impacts of photo-electrons. The short wave-length limits and the angles corresponding to them, calculated from Webster's theory, are not in accord with experimental and theoretical results obtained by Clark and Duane except for elements of low atomic number. This is to be expected since the difference between the theories resolves itself into a difference, which increases rapidly with the atomic number of the element, between a critical absorption frequency and that of a given emission line. Clark and Duane's theory also offers an explanation of the radiation found by de Broglie on the long wave-length side of radiations from a tungsten-carbon target.—S. K. **Allison** and W. **Duane**: Absorption measurements of certain changes in the average wave-length of tertiary X-rays. The "hump" of tertiary radiation in Clark and Duane's experiments shifts towards longer wave-length with increase in the angle between the primary and secondary X-rays. Using the secondary radiation of maximum intensity and employing a polished silver plate as secondary radiator, the effects of tellurium, antimony and iodine screens were investigated. An appreciable quantity of radiation shifts over to longer wave-lengths at angles greater than 40°.—I. S. **Bowen** and R. A. **Millikan**: The series spectra of the stripped boron atom (B III.). All the lines which, from theoretical considerations, can be expected in any strength from a boron atom deprived of all valence electrons, have been identified. Lines hitherto not identified or now discovered occur at λλ 4499·0 A, 2077·79 A; another line at 677·1 A is shown to a doublet with a separation of 0·15 A (correct to at least 0·01 A) or in frequencies, of 32·7 cm.$^{-1}$. The line at 758·5 A is the first term of the sharp series of B III.

Official Publications Received.

Mellon Institute of Industrial Research of the University of Pittsburgh. Industrial Fellowships. Pp. viii+21. (Pittsburgh, Pa.)

Bulletin of the National Research Council. Vol. 8, Part 2, No. 44: The Continental Shelf off the Coast of California. By Andrew C. Lawson. Pp. 23. (Washington, D.C.: National Academy of Sciences.) 25 cents.

Fourth International Congress of Refrigeration, London, June 1924. First International Commission of the International Institute of Refrigeration. Reports and Communications presented by the President, H. Kamerlingh Onnes. Pp. viii+257. (Leiden: Edouard Ijdo.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 22, Part 8: New American Asteraceæ. By S. F. Blake. Pp. xi+587-661+plates 54-63. (Washington: Government Printing Office.) 20 cents.

Meddelanden från Statens Skogsförsöksanstalt. Hälfte 21, No. 1: Ett Bidrag till Kannedomen om Brunjords- eller Mulljordstypens Egenskaper och Degeneration i södra Sverige; ein Beitrag zur Kenntnis der Eigenschaften und der Degeneration der Bodenarten vom Braunerdetypus im südlichen Schweden. Av Karl Lundblad. Pp. 48. Hälfte 21, No. 2: Den å Böda Kronopark utförda Grönkvistningen av Tall; die Aufastung an Kiefer im Staatsforst Böda. Av Erik Lundh. Pp. 49-100. Hälfte 21, No. 3: Om våra Främmande Barrträds Vinterhärdighet; über die Winterfestigkeit fremder Nadelbäume in Schweden. Av Nils Sylven. Pp. 101-148. (Stockholm.)

Transactions of the Optical Society. Vol. 25, No. 3. Pp. 97-148. (London: Imperial College of Science.) 10s.

University of Illinois Engineering Experiment Station. Bulletin No. 140: The Viscosities and Surface Tensions of the Soda-Lime-Silica Glasses at High Temperatures. Part 1: The Viscosity of Glass at High Temperatures. By Prof. Edward W. Washburn and George Reed Shelton. Part 2: Surface Tensions of Glasses at High Temperatures. By Prof. Edward W. Washburn and Earl E. Libman. Pp. 74. (Urbana, Ill.) 45 cents.

The National Physical Laboratory. Report for the Year 1923. (Published for the Department of Scientific and Industrial Research.) Pp. 228. (London: H.M. Stationery Office.) 13s. 6d. net.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 44: The Propagation and Cultivation of Citrus Trees in Egypt. By Thos. W. Brown. Pp. vi+88+30 plates. Bulletin No. 45: The Insect Pests of Citrus Trees in Egypt. By W. J. Hall. Pp. iv+30. (Cairo: Government Publications Office.) 5 P.T. each.

Reprint and Circular Series of the National Research Council. No. 49: Statement of Activities of the National Research Council for the Year July 1, 1922-June 30, 1923. By Vernon Kellogg. Pp. 16. 25 cents. No. 51: The Higher Agricultural Education of the Future. By E. Marchal. Pp. 6. 20 cents. No. 52: The Specific Heat and Thermal Diffusivities of certain Explosives. By A. M. Prentiss. Pp. 44. 25 cents. No. 53: A List of Research Problems in Chemistry. By J. E. Zanetti. Pp. 9. 15 cents. (Washington, D.C.: National Academy of Sciences.)

Trinidad and Tobago: Council Paper No. 15 of 1924. Agricultural Credit Societies: Report by the Registrar of Agricultural Credit Societies for the Years 1922 and 1923. Pp. 12. (Port-of-Spain: Government Printing Office.) 6d.

Department of the Interior, Canada. Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 2, No. 15: Evidence of the Bending of the Rays of Light on passing the Sun, obtained by the Canadian Expedition to observe the Australian Eclipse. By C. A. Chant and R. K. Young. Pp. 275-287. (Ottawa: F. A. Acland.)

The Journal of the Institute of Metals. Vol. 31. Edited by G. Shaw Scott. Pp. xi+680+40 plates. (London: 36 Victoria Street, S.W.1.) 31s. 6d. net.

Proceedings of the Edinburgh Mathematical Society. Vol. 42 (Session 1923-24), Part 1, April. Edited by Dr. Archibald Milne and Dr. T. M. MacRobert. Pp. 59. (London: G. Bell and Sons, Ltd.) 5s. net.

Third Report of the Hayling Mosquito Control, May 1923 to May 1924. Pp. 12. (South Hayling: J. F. Marshall, Hon. Director, Seacourt.)

Report of the Director of the Royal Observatory, Hongkong, for the Year 1923. Pp. 18. (Hongkong.)