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Science and Spiritualism.

THE recent correspondence in our columns on the attitude of men of science towards psychical research—particularly that branch of it which is usually called the 'physical phenomena of spiritualism'—has made it clear that the divergence between the two main views is as great as ever and shows no sign of compromise or conciliation. No useful scientific purpose would be served, therefore, by the publication of further letters on the subject.

The conservatism of official science in these matters is not unnatural. The conflict between the determination to accept only that which is based on irrefragable evidence, and that which relies on 'authority' and tradition, is as old as science itself. This conflict is as stern now as it ever was, and certain elements have lately arisen which enjoin a redoubled vigilance. The War gave a great impetus to the shadier forms of spiritualist activity and incidentally endowed unscrupulous mediums with large material resources. It is not surprising that these resources have encouraged the founding of 'psychic colleges' with resounding titles, and given a spurious air of scientific authority to the ordinary round of mediumistic pursuits. The capture of the citadel of official science would remove the last obstacle to the domination of public affairs by the new cult.

The distinction between spiritualism and psychical research is a somewhat artificial one. Spiritualism was the inspiring and driving force which founded the Society for Psychical Research in 1882. The S.P.R. founders were largely the Fabians of spiritualism. Their object was to sift the physical and mental phenomena of spiritualism and to sort out those to which they could give their adherence without loss of self-respect or scientific standing. The results of the labours of this Society have been published in thirty-six stately volumes, covering such varying subjects as hallucinations, telepathy, levitations, duplex personality, and haunted houses.

The late Sir William Crookes devoted four years to spiritualistic investigations (from 1870 until 1874) and announced the most amazing results. He then closed that chapter for the rest of his life, for reasons which, owing to the deliberate destruction of the necessary documents, it is now impossible to gauge. The forty-six years' activity of the S.P.R. has failed to duplicate Crookes's phenomena, or indeed to shed any light on them at all. With the doubtful exception of some sittings with Eusapia Paladino in 1909, and a few recent experiments not yet concluded, the evidence, for example, for telekinesis ('table-turning') and 'teleplastic' (or 'ectoplastic') structures has been entirely negative.

Nor can the evidence accumulated elsewhere be said to be more convincing. The work mostly quoted in favour of the existence of 'teleplasm' is Dr. von Schrenck-Notzing's "Materialisationsphänomene," which gives several hundred photographs of this mysterious substance. This work was of sufficient importance to lead to the study of its author's medium by the S.P.R. and by a Committee of the University of Paris. The official reports of both these bodies pronounced the phenomena observed to be quite inconclusive. Another attempt made by an academic body, this time the University of Vienna, to corroborate such phenomena, led last year to an equally pronounced failure. Thus Crookes's failure to convince the Royal Society may be said to have been the precursor of a consistent series of similar failures.

The tragic case of the late Dr. W. J. Crawford, of Belfast, is instructive. Here was a university lecturer of some distinction whose leaning towards mysticism made him an easy victim of a family of artisans with alleged mediumistic faculties. He devoted four years to their examination and endeavoured to duplicate and surpass the records of Crookes and Schrenck-Notzing. The 'invisible operators' who ruled the procedure led him on step by step until his records became the very travesty of scientific method, and gross imposition was presented in terms of his own psycho-physical guesses and speculations. When his career ended in suicide and an attempt was made to repeat his results, the repetition, which duly occurred, only served to reveal the *modus operandi* of the 'circle,' which was anything but spiritual. Such a *dénouement* is not, of course, unknown in purely physical science. Blondlot's *N*-rays were the subject of some fifty scientific papers, and his 'discovery' was recognised by the award of a substantial prize by the Paris Academy of Sciences. It is only natural that the caution wisely displayed by many physicists with regard to *N*-rays should be doubled and trebled when certain phenomena long discredited are presented in a new guise even on apparently unimpeachable authority.

Sir William Crookes in 1874 walked about in a well-lighted room with what he believed to be a 'spirit' on his arm, a 'spirit' resembling a girl of eighteen. No such amazing privilege has been vouchsafed to any man of scientific eminence since then. The phenomena obtained by scientifically trained observers have been poor in comparison with that high-water mark. This may be due to their 'unsympathetic' attitude, or it may be due to a wider knowledge of the chances of error and the means of deception. Investigators in search of ectoplasm have to be content with what looks like skin-bags or lengths of chiffon. As the control becomes stricter the results become poorer. When the control becomes rigid the phenomena cease altogether. That is the general rule, and it admits of only one interpretation.

The demands made upon the scientific investigator are nowhere more severe than in the cases of 'spirit photography' and the 'direct voice.' As the spirit 'extras' are not visible to the ordinary observer, we must suppose that they do not reflect ordinary light and are to that extent immaterial. Spiritualists usually meet this argument by saying that the effect on the photographic plate is not produced by light of any known wave-length but is a direct action on the plate itself. We must, therefore, assume that the invisible or disembodied artist can draw a likeness of a deceased friend of the sitter on the plate in such a way as to produce a correct negative. The difficulty of this feat is greatly increased if we remember that clairvoyants claim to see these spirit friends hovering about the sitters in the very attitudes shown on the photographs. Rather than face the innumerable difficulties in the way of a consistent theory conforming to the spiritualist view, most investigators will prefer to regard all so-called spirit photographs as examples of the almost numberless methods of deception which may be, and have been, practised in this most elusive department of spiritualist activities.

In the case of the 'direct voice,' we are confronted with even more formidable difficulties. There is nothing more 'spiritual' or less 'material' about a voice than there is about a brick wall, though the unscientific person may think otherwise. Where exactly does the material nature or structure of the direct voice begin? Do the spirits produce the necessary air waves direct at some focus in the air? One spiritualist view often met with is that the 'spirits' materialise a larynx and sufficient in the way of lungs and mouth cavities to produce the sounds heard. This does not make the matter any clearer. It is much easier to assume deception, more especially as fraud in this case is easy and 'convincing' and control extremely difficult, owing to the lack of orientation shown by most human ears in the dark. Here again the *onus probandi* must weigh heavily on those who claim that there is positive evidence.

The difficulties placed in the path of the observer all tend to make control more difficult and deception easier. Modern mediums work in total darkness or the dimmest of red light. The observer is not allowed to prescribe conditions. So long ago as 1880, Mr. Stainton Moses, an eminent spiritualist, said: "In 99 cases out of 100, people do *not* get what they want or expect. Test after test, cunningly devised, on which the investigator has set his mind, is put aside, and another substituted." Mediums may, by the rules of

the game, fail as often as they like and substitute other tests of their own devising. The patience displayed by expert investigators during some of their test sittings is astonishing. Hour after hour will go by without anything happening. The medium will fall asleep and wake up again. When anything does happen, if only the production of a rubber film (or something resembling it) from the mouth of the medium, it is eagerly scrutinised and carefully recorded.

Nobody can complain of unwillingness on the part of scientific men to investigate any phenomena offering a chance of extending the boundaries of knowledge, and the rewards, both material and social, of any such extension are very great. But after half a century of growing disappointment with spiritualistic phenomena, the number of qualified volunteers naturally shows signs of diminution. On the other hand, the flood of charlatans and impostors increases day by day. The 'new revelation' imported from the United States in 1852, with its combination of 'supernormal' telegraphy with Pentecostal gifts and Delphic oracles, has obtained almost undisputed sway over the mind of the masses thirsting for signs and wonders and determined at any price to believe.

It is for science to stem the tide of superstition and sift the true from the false. We are quite justified in assuming, with Sir Oliver Lodge, that man's future outlook on the universe will be very different from the orthodoxy of 1926. Such an evolution is bound to take place even on purely physical grounds, as indeed is shown by the prodigious changes in physical conceptions since 1895. But the fundamental principles of the scientific method will not change, and no set of phenomena which depends for its occurrence, not upon ascertainable laws, but upon the whim of invisible operators not amenable to a court of law, can appropriately form part of the subject matter of natural science.

In spite of all failures and discouragements, it is highly desirable that a competent body should exist for making out a *prima facie* case in favour of any alleged new phenomena of the class we are discussing. Such a body we have in the Society for Psychical Research, which has admirably fulfilled its functions in spite of material limitations such as do not hamper the wealthy 'colleges' of spiritualism. This Society has already done good work by its study of telepathy, hallucinations, and duplex personality. It includes people of the most diverse views, and can be relied upon to welcome any evidence of really unknown phenomena. It might possibly be associated usefully with the recently formed National Laboratory of Psychical Research, which is equipped with the means of studying psychical and related phenomena, but that should be easily arranged if desired. In the present state of this matter it is wisest and best for official science to wait for the recommendation of such a society before devoting any attention or labour to alleged 'supernormal' occurrences. The very use of the word 'supernormal' instead of 'abnormal' suggests that these occurrences belong to an order raised above the normal order of the universe (which would, of course, remove them from the province of science). That there may be such a supernormal order of things no philosopher can *a priori* deny, but the use of the word is too unpleasantly suggestive of a hieratic domination now happily overcome to be palatable to scientific men, and they will hesitate before installing the 'medium' in the high place from which, after much fighting and suffering, they have driven his ecclesiastical predecessor.

Education, Science and Mr. H. G. Wells.

The World of William Clissold: a Novel at a New Angle. By H. G. Wells. Vol. 1. Book the First: *The Frame of the Picture;* Book the Second: *The Story of the Clissolds—My Father and the Flow of Things.* Pp. 245. 7*s.* 6*d.* net. Vol. 2. Book the Third: *The Story of the Clissolds—Essence of Dickon;* Book the Fourth: *The Story of the Clissolds—Tangle of Desires.* Pp. 247-601. 7*s.* 6*d.* net. Vol. 3. Book the Fifth: *The Story of the Clissolds—The Next Phase;* Book the Sixth: *The Story of the Clissolds—Venus as Evening Star;* The Epilogue: Note by Sir Richard Clissold. Pp. 603-885. 7*s.* 6*d.* net. (London: Ernest Benn, Ltd., 1926.)

ALTHOUGH the critics have not been stirred by volumes 1 and 2 of William Clissold's achievement, there should be wigs on the green over volume 3, if it be not above them. Book V. is masterly in many ways—the less said of VI. the better, perhaps. No writer, other than the author, could have preferred the indictment he does against our public-school system and the ancient universities.

The attempt is made, in a preface, to justify the contention that the book is a novel: there is no novel in it: true it is, the story is told, ostensibly, by one William Clissold or through his brother Dickon but William is himself again, as he ever will be: from beginning to end, we are dealing with autobiography and early in the recital the writer gives himself away in saying—"Autobiography, provided that it be not too severely disciplined may be an almost inexhaustible occupation. Nothing is altogether irrelevant. Whatever interests me or has ever interested me is material." This, in a few clear words, is the book. It is a medical treatise—largely on social pathology.

The author is a photographer, working with a lens stopped down to a low aperture but of no great depth

of focus, giving very clear pictures of superficial appearances. A photographer neither analyses nor constructs—he must record what is before him. However much he may fake his picture in development, out in the open he must take what is offered him by Nature and, at most, can await a favourable light and so play with the shadows.

At the moment there is what amounts to little short of a conspiracy to represent science and religion as moving along the same path. They never can, unless and until we make a religion of our knowledge and recognise that, therefore, religion must be imperfect and ever correcting and shifting its boundaries. Science is ultimately the search after truth. Who can say what religion is? For every one the word has a different meaning. Our William, be it remarked, is a little fuzzy in his high lights. He can't be satisfied with what he has and may have and then leave it to the other fellow to have his turn, but hankers for more. He is so spoilt by frequent reprinting, that he must contemplate a new edition of himself, no doubt with special binding:

"To me it is far easier to suppose that this present unfolding of consciousness and will is only a birth and a beginning and that I am not merely myself but a participator in a Being that has been born but need not die."

Surely, he is here but seconding a vote of thanks to "that chap Oliver Lodge." Still, "belief in a living personal God—slight vestiges": we all have more or less as an ineradicable inheritance from primitive man.

The lapse into such anthropomorphism is proof how difficult it is for intelligence to prevail over convictions forced upon youth. The great problem before us soon in schools will be—how far we are entitled to go in retarding and repressing mental growth by forcing an 'established faith,' without explanation or qualification, upon children: whether parent and especially teacher be justified in misleading by baldly repeating assertions which have no authority other than tradition. The struggle is between knowledge and ignorance. Our William defines the position clearly and boldly:

"I do not know how Protestantism will end. But I think it will end. I think it will come to perfectly plain speaking and if it comes to perfectly plain speaking it will cease to be Christianity. There is now little left of the Orthodox Church except as a method of partisanship in the Balkans. The League of Nations may some day supersede that and then the only Christianity remaining upon earth will be the trained and safeguarded Roman Catholic Church. That is less penetrable, a world within a world, it shields scores of millions securely throughout their lives from the least glimpse of our modern vision."

Teachers of science, and examiners, are equally concerned. Over and over again, when advocating *the teaching of scientific method*, I have been told by my friends—"You must teach something definite: students ask for assurance and will not countenance any philosophic doubt": examiners, too, ask for positive answers. Tennyson's lines are not yet accepted even of science:

> There lives more faith in honest doubt,
> Believe me, than in half the creeds.

The attitude of all the schools is not merely unscientific but is one tending to systematise untruthfulness. Our William, at least, can think of better times:

"I can discover in all my world nothing enduring, neither in the hills nor in the sea, nor in laws and customs nor in the nature of man, nothing steadfast except for this—a certain growth of science, a certain increase of understanding, a certain accumulation of power. But there is that growth of science, there is that increase of understanding, there is that accumulation of power. I do not know why it should be so but so it is. It gathered its force slowly before man was. It goes on now with accumulating speed and widening scope and on it I build my working conception of the course of life. Man, unconscious at first, begins now, in an individual here and an individual there, to realise his possibilities and dream of the greatness of his destiny. A new phase of history is near its beginning. But it has not begun. Such science as we have brings us suggestions rather than direction."

William Clissold is not all religion, though considered under the conventional classification of *Wein, Weib* and *Gesang*, it has a limited range of subject. Wine is only once referred to—a single bottle of Château Margaux 1917, not a great vintage, produced at lunch by Sir Rupert Yorke. Still, this suffices to incite William's reflections upon Sir Rupert's sexual and religious outlook. It appears also to have led him to refrain from referring to certain questions he had intended to raise—the projected exchange of opinion would have been "as possible as with a pensive lion in the zoo." Pity it is perhaps that he has not met with more pensive lions in the course of his career and has not thereby been forced to concentrate upon some definite line of action.

After an over-full dose of *Weib*, we get music in the form of a study of futurism. Our William's swansong foreshadows a metamorphosis of mankind—new ways of living—one terrestrial anthill: this he regards as the necessary, the only possible, continuation of human history. He contemplates the organisation of a central police bureau to co-ordinate the protection of life, property and freedom throughout the world, without distinction of persons under an universally accepted code. In fact, the lions and lambs are all to lie down comfortably together. The coal strike was only begun when the book was issued. The history of Ireland, the

love lost between the States of Europe, the growing development during many years past of local self-government in Great Britain—such items are left out of account.

The men of large material influence are to reconstruct the world upon broader, happier and finer lines. Their first struggle is to be with the Press. Civilisation must be by newspapers. Open, candid, full and generous, these are the qualities the newspaper of the new life must possess. It must suppress nothing. It must bring to every mind capable of receiving it the new achievement of human and organising power, the victories of conscious change. The daily papers of educated people half a century ahead may be a tenth of the size and ten times the price of the present "wildly flapping caricatures of contemporary happenings." The Press apparently is to be the work of the men of affairs. Our William says, quite truly, the daily paper is a daily disappointment—but to how many? He has found but one newspaper that comforts his soul and that is NATURE, to which flattering reference is made. "Domestic bye-products," such as sons, will have to justify their sonship—there is to be a diminution of inheritance in property. The new social life will be aristocratic in the sense that it will have a decisive stratum of pre-eminent and leading individuals who will wield a relatively large part of the power and property of the community but it will be democratic in the sense, that it will open to every one with ability and energy to join that stratum and participate to the extent of his or her ability or energy. In the formal picture presented to us of the world republic, we shall be fully adult—a state to which few come now, doubtfully and each one alone:

"We shall put away childish things, childish extravagances of passion and nightmare fears. Our minds will live in a living world-literature and exercise in living art; our science will grow incessantly and our power increase. Our planet will become like a workshop in a pleasant garden and from it we shall look out with ever-diminishing fear upon our heritage of space and time amidst the stars. We shall be man in common and each one of us will develop his individuality to the utmost, no longer as a separated and conflicting being but as a part and contribution to one continuing whole."

Who shall say that our author is not an optimist and Holist?

The contemplated metamorphosis of mankind, our William contends at an early stage of his dream, demands a life based on broader and sounder common ideas, expressed in new terms and new artistic forms, accompanied by nervous and other physiological changes. This necessity to change and expand extends from man's soul to man's chemistry.

It is strange that a reader of NATURE and a pupil of the Royal College of Science should be so Lamarckian as to proffer such doctrine or believe that it can be realised within any period that is worth our consideration. The lesson of Tutankhamen's tomb seems to be lost upon him. Obviously, he has little knowledge of what is known in science. We have learnt sufficient of man's vital chemistry *to know*, that it proceeds along lines which are little short of fixed. This must be so. If open to variation away from our type, we should be all over the shop, to use a vulgarism. Still, the human mind is strangely variable—subject at all times to the caprice of chemical change, every function apparently controlled by a chemical secretion. The woman, at regular intervals, we know, is heavily drugged. Male desire, of which our William has much to say in Book VI., is probably of chemical origin, due to chemical changes induced by mental processes.

Coming down to sense, human control of the world, as our William says, has been a control in detail; there has been no comprehensive control—because there has been no comprehensive understanding. Hence his indictment of our educational system in Book V. It is worth noting, he makes the point, that the mind of youth is the primitive, medieval mind—conservative and reactionary:

"Few minds are mature enough and stout enough before thirty to achieve a genuine originality. The originality of the young is for the most part merely a childish reversal of established things. The independence of the young is commonly no more than a primitive resistance to instruction. The youthful revolutionary is merely insubordinate and his extremist radicalism an attempt to return to archaic conditions, to naturalism, indiscipline, waste and dirt. The youthful anti-revolutionary turns back to mystical loyalties and romance."

It is necessary to educate the young for the new order. Sections 14 and 15 on supersession of schoolmasters and an inquest on universities must be studied to be appreciated—almost every word is telling. On an experience of sixty years, I am prepared to vouch for the substantial accuracy of the indictment. Much that is said, I have said over and over again.

Present-day education is nothing short of a pretentious farce—taking into account the changed and fast-changing state of the world. It promotes inaction, where action is needed above all things. It degrades and only accidentally promotes intelligence. It is in the hands of a class of men who are eyeless to the needs of the times, of men who never will respond to the call that is now made upon the teacher. Yet parents and guardians smugly accept what is and make no attempt to improve the conditions. Even our William, being a man of words, only half sees what is, what might

and what should be. Education was begun in the monasteries, to serve clerical ends. We have long since got rid of monasteries—Henry VIII. did that for us. It were now time that we abolished the monastic in education. Only don't let us substitute co-education, the emasculating invention of the Evil One. The effect of the monasteries was of small account in comparison with that now being exercised by the survival of the system of training they instituted—it will yearly become a greater peril to us. Our William is explicit on this point:

"... the last human beings in the world in whom you are likely to find a spark of creative energy or a touch of imaginative vigour are the masters and mistresses of upper middle-class schools ... these schoolmasters and schoolmistresses, ... to whom we entrust nearly all the sons and daughters of the owning and directing people of our world, are by necessity orthodox, conformist, genteel people of an infinite discretion and an invincible formality. Essentially they are a class of refugees from the novelties and strains of life. I do not see how, as a class, they can be anything else. ... The whole crowd of upper-class youth has been picked over again and again before the schoolmasters come; the most vigorous and innovating men have gone in for diplomacy, the law, politics, the public services, science, literature, art, business, the hard adventure of life; and at last comes the residue. ... Its [the school's] mentality is the mentality of residual men.

"That is a neglected factor which has to be reckoned with in the history of the British Empire during the last hundred years. That is something the foreign observer has still to realise. A larger and larger proportion of its influential and directive men throughout this period have spent the most plastic years of their lives under the influence of the least lively, least enterprising, most restrictive, most conservative and intricately self-protective types it was possible to find. We have bred our governing class mentally, as the backward Essex farmer bred his pigs, from the individuals that were no good for the open market. The intelligent foreigner complains that the Englishman abroad has been growing duller and stiffer in every generation."

. . . . . .

"The clue to the manifest change in character that Britain and its Empire have displayed during the last hundred years, the gradual lapses from a subtle and very real greatness and generosity to imitative imperialism and solemn puerility is to be found, if not precisely upon the playing fields of Eton, in the mental and moral quality of the men who staff the public schools."

A true bill. Italy, the one country where there is government, has no public schools. No other explanation is possible of the way in which the courage is gone out of us—of our loss of the art of government, the courage to govern, never more obvious than in the present coal strike—of the disappearance of the naturalist—of the decline of industry, *e.g.* the textile trade. The schools, to-day, it should be added, are greatly aided: golf and the motor-car serve to complete their insidious effect upon character.

Our William is nothing if not thorough—he would improve the public school and schoolmaster out of existence but recognises the need and desirability, under our present social condition, of schools of the preparatory class, largely staffed by women and not very big, where children up to fifteen could have a quasi-family life. (*N.B.*—The public school gone, these would be rid of the curse of the 'Common Entrance' examination.) From fifteen onwards, the more directly a boy lives in contact with the real world, the better alike for the real world and himself. The reality of education for every one over fourteen, in a modern state, lies more and more outside any class-room; the fewer the school-made values a boy has, the juster will be his apprehension of reality. The new system will be one of special schools, studios and laboratories for arts, sciences, language and every sort of technical work. The style of work will be new.

All this is essentially sane. I saw the danger in early days and went so far as to express my opinion by saying, that I would not send my sons to a public school to save their lives and kept my word but was lucky in having at my door what was long, probably, the best day-school in London, if not in the country. I have also always held, that seventeen was the *very latest age* up to which a boy should be kept under monastic school conditions. I took my four boys away at that age and sent them to places of higher instruction, *where they were free to become men.* I have every cause to be satisfied: they may not be saints but neither are they serious sinners and the kick has not all been taken out of them.

The *Times*, on October 13, contained a most feeling obituary notice of Dr. E. A. Abbott, long well known as headmaster of the City of London School and a noted scholar. He is brought into comparison with F. W. Walker, the famous headmaster of St. Paul's School. We are told that Abbott, who relished Walker's half-cynical frankness of speech, used to relate how the latter showed him over his grand new school buildings at Hammersmith and how, when he (Abbott) expressed his admiration of everything and especially of the magnificent chemical laboratories, Walker replied: "Yes, they are all very well in their way; but, as we two are alone here, I may venture to say (lowering his voice to a confidential whisper) that you and I know that this sort of thing *is not education.*"

Surely such an episode is disgraceful to both men. If 'this sort of thing' were not education, why introduce it? If introduced, surely it was the headmaster's duty to see it made education. That two such men were able to scoff at a discipline that furnishes the key to

the comprehension of life is but proof of the hopeless narrowness and impenetrability of the classical and literary mind. Their attitude is that of most if not all our headmasters. 'Science,' we know, is a failure in schools—are the headmasters doing anything to improve the teaching, knowing as they must that to-day its dictates dominate the world?

Our William has something to say about science specifically but first let it be noted, that he extends his scepticism about schools to universities, particularly to "the universities for juveniles like Oxford, Cambridge, Harvard and Yale." We are all alive to the fact, that these are continuation boarding-schools, not free institutions as are the German universities. He is justified in his indictment, that there is a growing discontent with Oxford and Cambridge among those who have undergraduate sons—"sending their boys trustfully and hopefully to these over-rated centres, they find themselves confronted with pleasant, easy-going evasive young men up to nothing in particular and schooled out of faith, passion or ambition." I have said already, our William is an incomparable draughtsman. We must be prepared, he considers, to cut out this three or four-year holiday at Oxford or Cambridge and their American compeers from the lives of the young men we hope to see playing leading parts in the affairs of the world. So do I. We shall not get through with youths that are born tired, without method in their minds, such as we have to-day, who lapse into 'research' but make it an armchair occupation and put neither heart nor guts into the work.

To pass to specific science, our William's presentation of the Royal Society is of a piece with his appreciation of the universities. Perhaps it is worth while occasionally to see ourselves as others see us. He reports a meeting with his brother Dickon, at which the brother fingers his first paper in the *Phil. Trans.* The comments he makes are amusing and delightful parody.

"'Blastopore of the snail,' he objected. 'Fancy poking about at the blastopore of the snail! It's—indelicate. And cryo-hydrates! This chap Oliver Lodge seems to be all over them. Wonder what they are. Well, this is your affair, Billy. It's up to you to display the name of Clissold properly in these Philosophical Transactions. If that is the end of life. Not my pitch. Not in the least my pitch. I wouldn't try to see even a stethoscope through these Philosophical Transactions. No.'"

This is a confirmation, from outside, of the view I have often expressed, that the *Phil. Trans.* spell cremation, the *Proceedings* 'decent burial' of scientific discovery.

The brother, who has made his fortune out of advertising, then suggests giving the "dull old Philosophical Transactions" a real spirited Xmas number, a genuine advertisement display, with which "Temptation of St. Antony" won't be in the same field. The final opinion expressed by Dickon, to meet his brother's objection, that advertising would be vulgar, is again a noteworthy criticism:

"'If there's anything vulgar about modern advertising it's because it's been so concerned about pills and soap and pickles. Just a passing phase. A man or a class or a religion or—anything that will not advertise isn't fit to exist in the world. It means it doesn't really believe in itself. To want to exist and not to dare to exist is something beneath vulgarity. . . . That's why I have such a contempt for your rotten, shy, sit-in-the-corner-and-ask-the-dear-Prince-of-Wales-to-dinner-once-a-year-Royal Society. If the soap-boilers did no more for soap than your old Royal Society does for science,' said Dickon, 'nobody would wash.'"

Formerly, the opinion of the Society was often consulted in matters of importance to the State; now, the Department of Scientific and Industrial Research is more and more usurping this office. The individual original scientific worker, like the naturalist, may easily soon be ruled out of existence and an unimaginative being put in his place. We confine our activity to publishing work which is either largely premature and unfinished or even better left unpublished. Few attend the meetings and, at these, soft nothings are said and no one dare criticise. "We work submerged, we talk by no more than twos and threes," says our mentor. This is the way of the Society. It cannot be brought, it makes no attempt, to realise, how essential it is to organise the forces of science into a living body—what it could do if it formed itself into a great consultative scientific House of Peers. The only office it effectively serves is that of back-patting and bemedalling the supposed élite of the craft.

As our William truly remarks, "No great creative development can go on in modern social life beyond a certain point without a literature of explanation and criticism." We have no such literature: the result is that work is done and little use made of it. We keep no more than a casual profit-and-loss account and never seek systematically to balance our books. Our knowledge is never properly sifted and sorted and its values determined—no logical order is observed in filling in the blanks.

May it not be true that few would wash, if no more were done for soap than we do collectively for science? Is it policy to go on producing, paying insufficient attention to quality and demand, without taking proper steps to popularise and sell? Industry, to-day, we know is largely engaged in producing and forcing the sale of unnecessary goods: this is the manufacturers'

conspiracy. If we are not coming very near to producing goods and leaving them to rot, we are doing little to secure digestion of the food we provide. We finish nothing. To take an example. Cane sugar is now made, all but pure, in millions of tons and yet chemists cannot tell the manufacturer what it is—how its atomic bricks are built together. Children are put to such work, not experts: to-day, these are engaged in the study of poison gases.

Research work is fast being made an entirely selfish, narrow occupation, when not carried out for industrial purposes. A bureaucratic class of academic workers is fast growing up, fit for little more than drawing-room service, without practical outlook. We need a few Fords to introduce efficiency into the research machine—Mr. Ford is said to have a greater annual turnover of work-people than any other employer, which means that he takes the efficiency of the worker into account: our up-growing civil service, research system does not: the threatened result is that 'research' will become a merely parasitic occupation. The term will disappear from the field of practice.

We work submerged, says our William. We hand on our impressions and vague intentions only by the most fragmentary hints. In education nothing is done to record, preserve and utilise successful trials of method. Sanderson left no record of method behind him and to-day, apart from his buildings, Oundle has nothing to show of his influence—it has reverted to the primitive school type. His Home of Vision has no vision in it. One teacher succeeds another without ever considering his predecessor's methods. The Finsbury Technical College was proclaimed a success but its methods are on the dust heap.

Before attempting to form a world directorate, we need to run our own little shanty: to take notice of one another and be sympathetic and work together to make it really habitable for all. Not only leaders are needed but the apparatus also is not there. It is all very well to repeat Carlyle's saying, that the modern university is an university of books—the books are not there. Even in leisure hours, you cannot live on the dull-as-ditch-water-doings of a no-sight family, with or without spoons. Writers of the day have no knowledge within them to use, thanks to their schooling. Here is our William's future opportunity: he is only fifty-nine and has time to turn over many new leaves. Let him write up to his professions, to show, if possible, how the new and necessary knowledge may be brought home to youth and made of some general avail. He has recognised his and our limitations, in his preface, in a single line, which is probably the most significant in the book, in saying of men of the type of "the devout Mr. Belloc, the aristocratic Duke of Northumberland, the political Mr. Ramsay MacDonald," that he can only comment upon such types. *Their ultimate processes are inconceivable to him.*

We are all cryptic beings and no one of us is open to the complete inspection of his fellow-man. We differ vastly in mentality. This is why Oxford is obdurate and will teach nothing that is needed by the world to-day. The word-slingers it trains throw from empty slings—at times perhaps a few very beautiful stones from the past but not the bullets of to-day. By a strange process, by securing control of the schools by men of its own type, it has made itself a community of one type of mentality, with but few escapes from its rigidity: the mechanism for the appreciation of modern things is not built into the type. We shall never improve our system of education and make it fit the needs of the times until we take into account, in the most liberal manner possible, the strange variability of the human mind. Society being composed of all sorts and conditions of men, to provide for all will always be very difficult, the less, however, the more we are alive to the differences and not too immodest in our individual opinions.

HENRY E. ARMSTRONG.

Our Bookshelf

A Practical Treatise on Outbreaks of Fire. By Sidney Gompertz Gamble. Pp. xii + 543. (London: Charles Griffin and Co., Ltd., 1926.) 30*s.* net.

THE author of this book held for twenty-six years the position of second in command of the London Fire Brigade, and prior to this had the experience of seventeen years as borough surveyor and chief officer of the fire brigade in a provincial town. The knowledge thus obtained and embodied in his book causes it to appeal strongly to members of fire brigades and to all concerned in minimising fire risks. The volume is divided into five parts dealing respectively with (1) natural science, legal and general matters; (2) fires and their causes, together with insurance; (3) means of suppression, material and personnel; (4) fire prevention and construction of buildings from the fireman's point of view; (5) miscellaneous matters. Besides providing a great deal of information with which the fireman in service ought to be acquainted, presented in a form which he can appreciate and use, the book contains much that is of interest to the layman. The section dealing with the causes of fires makes very interesting reading, and many of the various cases are illustrated by photographs; this section also deals in detail with dangerous trades, and discusses the precautions which should be observed in them. Another section contains much that will be of value to the officer whose duty it is to report on suspected cases of arson and incendiarism. Fully illustrated details of automatic and other systems of fire notification are included as well as sprinkler systems.

A feature of the book which assists in rendering it very readable is the historical notes freely scattered among the pages. The illustrations of fire appliances

from the earliest times down to those in present use are extremely good, and the historical account of the progress of the fire-engine is especially interesting. The principles on which modern pumps work are explained adequately, and multiple centrifugal pumps are included. Fire prevention and panic in places of public resort is a wide subject which concerns the whole community, and the author devotes a great deal of space to it. Such buildings are classified, and each type is treated separately. Remembering the wide experience which Mr. Gamble has had in London, his opinions must be taken as authoritative, and will be invaluable to surveyors under public bodies. We have nothing but praise for this book, and consider that the author has rendered service, not only to the members of his own profession, but also to the public, in presenting so much that is of value in such an acceptable form.

Ergebnisse der exakten Naturwissenschaften. Herausgegeben von der Schriftleitung der *Naturwissenschaften*. Fünfter Band. Pp. iii+329. (Berlin: Julius Springer, 1926.) 21 gold marks.

THIS collection of articles by leading continental men of science possesses a great amount of interest for students of physical science, both pure and applied. Thus, we have an article on planetary radiation by Prof. Schoenberg, which is followed by a comprehensive treatment of the measurement of photographs by Dr. Seliger, and by an article on dynamic meteorology by Prof. Wegener. Prof. Bjerrum gives a very interesting account of the electric forces between ions and their effects, and Prof. Pringsheim gives an account of work on the photo-electric effect in gases, in which he describes the recent work of Foote, Mohler, and Auger. The article on atomic disintegration, by Dr. Kirsch, gives a survey of the experimental results obtained in Cambridge and Vienna, and the author attempts to interpret these results in terms of the explosion theory advanced by Pettersson. The experimental proof of the statistical nature of the law of radioactive decay is treated in a further section, by Prof. Kohlrausch, who pays particular attention to the work of Frl. Bormann, which provides, in his opinion, the first conclusive experimental proof of the correctness of the fundamental assumption on which the law is based. The absorption of gases under the influence of electrical discharge and allied phenomena are considered in full in an article by Dr. Pietsch, to which are appended several pages of references. Finally, we have an excellent and up-to-date account of the Compton effect by Drs. Kallmann and Mark.

Edward Thring, Maker of Uppingham School, Headmaster 1853 to 1887. By W. F. Rawnsley. Pp. iv+103. (London: Kegan Paul and Co., Ltd., 1926.) 3*s*. 6*d*. net.

EDWARD THRING and Sanderson will rank as the two English headmasters of the last generation who left most personal mark upon their scholars and built up great schools on the foundations of small, ancient, and neglected grammar schools. Such reconstruction was a familiar feature of the last half-century, but Uppingham and Oundle will always recall the names of their re-founders. Thring's work was in one way more heroic than Sanderson's, because he did it in the teeth of an obstructive and unsympathetic body of governors, while Sanderson was supported by the generous and loyal help of his.

In this short account of Thring's career, Mr. Rawnsley gives a vivid picture of the man and explains his extraordinary personal influence. Thring had in a high degree that combination of humour, sharpness, sympathy, and devotion which makes the strongest appeal to the English boy. Numerous examples are given of all these and of his cardinal principle in education that every boy is good for something and that you must make him work by appealing to his individual interests. Thring's own interests lay mainly in music and literature, and one does not hear anything of science or history. In this respect he and Sanderson would seem to have been rather complementary to one another. Both stand out as worthy types of the individuality of the great headmaster. F. S. M.

A Text-Book of Experimental Psychology: with Laboratory Exercises. By Dr. Charles S. Myers and F. C. Bartlett. Third edition. Part 2: Laboratory Exercises. Pp. viii + 121. (Cambridge: At the University Press, 1925.) 7*s*. net.

IT is satisfactory to note that this excellent text-book is now in its third edition. The student who has carefully worked through these exercises will have gained considerable practice in the very difficult art of psychological experiment. There is a fairly common belief that psychology can be evolved from the writers' inner consciousness without the limiting effects of an appeal to facts demanded by other branches of knowledge. Much futile discussion and many fantastic theories would be avoided if all exponents of psychology could have the discipline of working through this book.

There are four sections, designed to cover about a year. The first part deals with the technique of psychological experiment, the second with problems of the special senses, the third with perception and the higher thought processes, while the fourth is supplementary, giving additional experiments.

This revised reprint will be very useful.

Die Gattung Synedra in systematischer, zytologischer und ökologischer Beziehung. Von Dr. Konrad Gemeinhardt. (Pflanzenforschung, Heft 6.) Pp. iv+88+4 Tafeln. (Jena: Gustav Fischer, 1926.) 6 gold marks.

THIS monographic treatment of the abundant diatom genus Synedra will appeal chiefly to the specialist, but is not without points of general interest. The author supports a classification based on the features of the valves rather than on the characters of the chromatophores and throws out a suggestion that nuclear structure may afford a basis for distinguishing the larger groups of diatoms. No proper spindle is formed during nuclear division in Synedra, and a centrosome is lacking. In the considerable section devoted to ecological data it is made clear that all species of Synedra require water with a certain minimum lime-content. It is significant that, in the course of more than a year's continuous observation, no auxospore-formation was observed.

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.*]

The Structure of Catalytically Active Copper.

THE nature of the change that occurs on the activation of a metallic catalyst by alternate oxidation and reduction, or by continued use, and the change that occurs during sintering, has been an open question (cf. *Proc. Roy. Soc.*, A, vol. 107, p. 277; vol. 110, p. 283). The solution of this problem

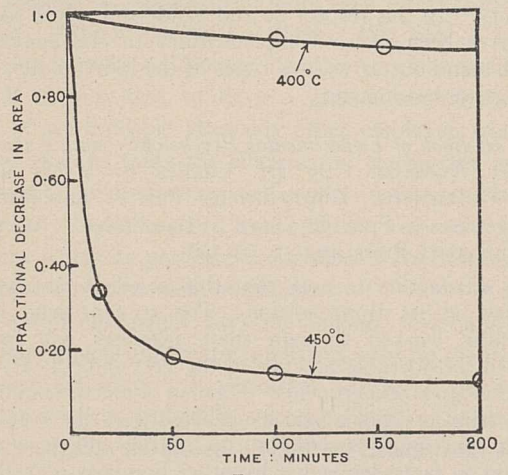

FIG. 1.

definitely would go far towards establishing the theory of centres of activity on an indisputable foundation, since it is necessary to show that both the area and the nature of the surface change (cf. the discussion by Hinshelwood, "Kinetics of Chemical Change in Gaseous Systems," Clarendon Press, p. 194).

Now the observations of Dunn (*Proc. Roy. Soc.*, A, vol. 111, p. 210) on the use of interference colours, in following quantitatively the growth of the oxide film on copper, give a method of estimating the linear rate of growth of the oxide covering the individual grain compared with that on 'inactive copper.' Palmer (*Proc. Roy. Soc.*, A, vol. 103, p. 444) showed that the conductivity of a mixed copper–copper oxide film was directly proportional to the copper content of the supported film; thus the rate of fall of the conductivity of the film is a measure of the mass of copper being oxidised in unit time, and a method is available for estimating the massive rate of growth of the oxide compared with that on 'inactive copper.'

Let a be the thickness of the oxide film, S represent the area of surface, and C be the electrical conductivity of the mixture of oxide and metal. Let the suffix 1 denote the values of these quantities for an activated or sintered catalyst, at time t after the commencement of the oxidation at constant temperature; and the suffix 2 represent the same variables either for the film before activation, or for the fully activated film before annealing.

Then

$$\frac{\left(\frac{da}{dt}\right)_1 \cdot S_1}{\left(\frac{da}{dt}\right)_2 \cdot S_2} = \frac{\left(\frac{dC}{dt}\right)_1}{\left(\frac{dC}{dt}\right)_2} \quad \ldots \quad (1)$$

Thus S_1/S_2 can be evaluated, and we have a method of measuring the increase of area on activation, and the decrease of area on sintering.

The observations for the activation of a catalyst present experimental difficulties, owing to the irregular nature of the first reduction and oxidation in many cases; but they are of great theoretical interest and, so far, seem to indicate that the increase in area of the supported copper films on successive reduction is not large. The nature of the surface alters considerably, since the linear rate of oxidation increases markedly.

In the case of sintering, the observations can be made with accuracy; the nature of the surface is changed since the linear rate of oxidation falls, and the increase in surface area is marked. Continued exposure to high temperature does not cause the area to diminish indefinitely, but a definite limit is reached corresponding to each temperature. The effect of annealing a supported copper film at 450° C. and 400° C. is shown in the accompanying diagram (Fig. 1), the results being worked out by the method previously described.

The relative rate of increase of thickness of the oxide film slows down very considerably, as the time of sintering is increased. Dunn's conclusions (*loc. cit.*) that "the structure of a metal may be brought out owing to the variation of the oxidation rate of different crystal faces," and that "For a definite time of oxidation each crystal face will be characterised by a different colour," seem to provide indisputable evidence that, as well as the area change that occurs during activation and sintering, there is also an unmistakable change in the nature of the surface.

F. H. CONSTABLE.

St. John's College,
Cambridge.

Magnetic Properties of Single Crystals of Nickel.

THE magnetic properties of single crystals of iron have been examined by Webster (*Proc. Roy. Soc.*, **107**, p. 497, and **109**, p. 570), Honda, Kaya, and Masuyama (NATURE, May 29, 1926), and more recently Gerlach (*Zeit. für. Phys.*, **38**, p. 828, 1926). Considerable differences have been shown to exist between the

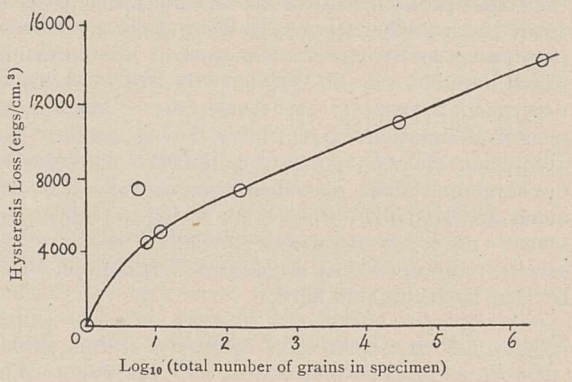

FIG. 1

magnetic properties of the polycrystalline metal and the single crystal.

We have recently succeeded in preparing crystals of nickel of several cubic centimetres in volume, from which specimens large enough for magnetic measurements can be obtained. The present note contains an account of a preliminary investigation on the variation of hysteresis loss with grain size. The specimens used were cylindrical rods of 20 mm. by 2 mm. diameter. The hysteresis loss, as in the case

of iron, decreases with the number of grains in the specimen, as shown in the accompanying graph (Fig. 1) and table.

Number of Grains in Specimen.	Hysteresis Loss (ergs/cm.^{3}).	Coercive Force (Gauss).
$2{\cdot}8 \times 10^6$	14,600	13
$2{\cdot}7 \times 10^4$	11,100	10
$6{\cdot}4 \times 10^2$	7,300	5
12	5,150	4·3
8	4,500	3·7
1	<290	$<{\cdot}5$
7	7,600	5

The hysteresis loss for a single-crystal specimen was less than the experimental error, and was certainly less than 1/50 of that for ordinary nickel. The point off the curve was obtained with a specimen containing seven grains. In this particular case the etch pattern indicated that the grains were considerably distorted. For the specimens containing eight and twelve crystals respectively, the demagnetising factor was appreciably greater than for the other poly- and single-crystal rods of the same dimensions. In these two cases it is significant that most of the crystals occupied the whole cross-section of the rods. Gerlach's experimental results for iron indicate the presence of similar phenomena in that metal.

The intensity of magnetisation of the single crystal specimen in an effective field of 300 gauss was 565 units. Saturation was not complete in this field.

Further experiments on the magnetisation and magnetostriction along the different crystalline axes are in progress.

W. SUCKSMITH.
H. H. POTTER.

Physics Department,
University of Bristol,
October 14.

Invention as a Remedy for Unemployment.

THE very interesting analysis of the relationship of present patent law and patent procedure to invention and to the unemployment problem, which appeared in NATURE of September 18, should serve to stimulate clear and earnest thinking on a subject of great national importance.

A storm of indignant protest is always aroused if any one has the temerity to suggest that Great Britain is falling behind in the application of science to industry, or in the practical application to useful ends of newly discovered scientific truths. I am, nevertheless, of the opinion that, except perhaps in the allied fields of steam and marine engineering, it would be difficult indeed to prove that some such declension from our former pre-eminence has not taken place. It would be a wearisome task, and certainly provocative of controversy, to recite the evidence in support of this view, but an unprejudiced observer who considers, for example, the course of invention during recent years in such fields of useful activity as incandescent gas-lighting, electric traction, alternating-current engineering, or in the design of type-writing, addressing, and calculating machinery, will find it difficult to resist the conclusion suggested above.

That this failure to lead in the realm of commercial invention is not due to any diminution in the mental energy or native ingenuity of the race is abundantly evident from the splendid achievements of British scientific workers during the first quarter of the twentieth century.

It is probably true that since the death of Faraday the international reputation of British science has never stood higher than it does to-day.

I would in particular direct attention to the astonishing experimental skill and inventive ingenuity which have distinguished the work of our physicists. Without citing any names or making any detailed and, possibly, invidious comparisons, it may safely be claimed that in this respect no other nation has surpassed—if any have equalled—the freshness and power of attack exhibited by British workers.

Even in the realm of organic chemistry, in fields formerly almost abandoned to foreign labourers, the achievements of British investigators and inventors during the last eight or nine years constitute a truly wonderful record of steady progress in one of the most difficult of applied sciences. The same story of rapid and successful attack can be told in connexion with the manufacture in Great Britain of optical and heat-resisting glasses.

In all this there is abundant room for encouragement; for it makes clear the fact that where we are failing to lead in applied invention and applied scientific method, the failure is not due to lack of inventive ability.

It suggests that in countless instances invention is inhibited and inventors discouraged by the fact, still lamentably true, that the average Englishman possessing money—the man to whom new ideas are brought for development—is hopelessly at sea in respect of general scientific knowledge and general manufacturing processes. More often than not he is a gentleman, a man anxious to act fairly towards his fellows, and a man not unenterprising—quite willing, in fact, to risk money wherever he believes there is a reasonable chance of winning more—but the words the inventor uses and the drawings he exhibits are expressions in an unknown tongue.

The man of money remembers more of the Greek and Latin he laboriously learned at school than of the fragments of mechanics or chemistry he imbibed under the head of 'Science.' He turns the inventor down because he does not understand.

This inability does not prevail to anything like the same extent in the United States of America or in Germany. Generally speaking, in those countries the man who commands money knows at least enough of mechanics, or physics—knows enough about *things* as distinguished from *words*—to take a very intelligent interest in what an inventor has to say.

That makes all the difference.

A classical education may be the best possible preparation for any calling that succeeds it—I happen to think this is so—but the price Great Britain has paid, and is paying now, for the past almost total neglect of science in our public schools is incredibly big.

Until science, and 'knowledge of things,' take their proper place in our great schools, invention will continue to languish and inventors to cross the Atlantic.

Reform of the patent laws may certainly help the cause of invention, but alone it will not do nearly enough.

I would warmly advocate a more thorough and a wider official search, as in Germany and in the United States. I would also advocate the establishment of a British petty patent similar to the German *Gebrauchsmuster*, so as to eliminate the absurdity of giving the same kind of protection to a man who 'invents' a method of making some simple object

out of sheet-metal instead of casting it, as to the inventor of the steam turbine.

The issue of such patents as are suggested above is one of the least creditable branches of the Patent Office's activity during recent years.

The encouragement of real inventiveness will unquestionably diminish unemployment. Even in the case of 'process' and 'cheapening' patents, any temporary increase of unemployment thus created is more than balanced by increased production, and the consequent absorption of more and more men into employment. Generally speaking, the world is always hungry for goods, if the goods are useful and the price is right.

W. A. BENTON.

Research Department,
W. and T. Avery, Ltd.,
Soho Foundry, Birmingham.

A Breeding Ground of the Nursehound (*Scyliorhinus stellaris*) in the Fal Estuary.

DURING recent years I have had considerable experience on the oyster-beds and adjacent grounds in the Fal Estuary, and as a result of observations made at various times I consider that the greater part of the Laminarian zone in that estuary forms an extensive and regular breeding ground for the nursehound (*Scyliorhinus stellaris* = *Scyllium catulus*). In the autumn of 1924 a few egg-cases containing embryos of this shark-like fish were dredged on Laminaria on the Falmouth North Bank, Carclase, and on other grounds in ½ to 1¾ fathoms. (A chart of the grounds of this region is given in my report on a "Survey of the Fal Oyster Beds," 1926.) During the summer of 1926, egg-cases have been frequently taken on Laminaria at Turnaware Bar—which is situated about 1½ miles farther up the estuary than the grounds just mentioned—and young ones recently escaped from the egg-case have been seen at low water on this ground on several different occasions. Young nursehounds have also not infrequently been taken in oyster-dredges in autumn.

During the recent spring tides, the Laminarian zone at Brown Rose Bar—about 1 mile below Turnaware—was being examined for oysters, and, in an area of not more than 20 square yards, 8 egg-cases of the nursehound containing eggs or embryos, as well as a few empty purses, were found; probably others were on the ground and not seen. Two of these egg-cases had been laid within the last few days, and had the thong-like horny extensions of the corners of the case wrapped round the whole of the anastomosing roots of a bunch of old Laminaria stipes. In one instance the new egg-case had been attached to a group of stipes which also carried older egg-cases at a higher level. Four of the egg-cases contained embryos respectively about 12·5 cm. and 10 cm. long, both with internal gills, and two about 6·0 mm. long. It is interesting to note that Ford (*Jour. Mar. Biol. Assoc.*, vol. 12, p. 492, 1921) estimated that embryos would begin to have the gills covered at a length of about 10·0 cm. Thus the collection of egg-cases contained eggs or embryos of four different ages, and therefore of four different spawnings.

While examining one egg-purse in its natural position under water, two *Nassa reticulata*, sometimes called dog-whelks, were observed with their probosces inserted in a natural crack in the case, where the base of one corner thong arises from the body of the case. After observing the Nassæ for a few minutes, each was pulled off separately and at least half an inch of pink proboscis pulled out of the case. On opening the case, however, to see what damage had been done, there was found no trace of either yolk or embryo and only a remnant of albumen. As the purse was fixed in an upright position in the water, and the Nassæ were at the lower end, it was possible—but not probable—that they might have eaten the large amount of yolk generally found in the eggs, but on examining the other egg-cases, one similar in age to that attacked by the whelks was opened and also found to contain nothing but albumen, although the egg-case was intact and full of albumen.

It is clear, therefore, in this latter instance, that the nursehound had made an egg-case and had omitted—perhaps forgotten—to put an egg in it. The contents of both these purses were healthy in so far as they had no noxious smell. It is not improbable that Nassæ and similar forms may normally attack the embryos of the nursehound and its allies at the vulnerable natural slits in the egg-case (described by R. S. Clark, *Jour. M.B.A.*, vol. 12, p. 584, 1922).

It is well known that the nursehound breeds regularly in the gullies at Wembury Bay West, inside the Mewstone, near Plymouth, but there the egg-cases are usually attached to the strong, stockily growing sea-weed Cystoseira. It would seem, therefore, that so long as the nursehound can lay its egg-cases in fairly shallow water—on the south coast of England—the fish may use either Laminaria or Cystoseira and probably any other weed so long as it be strong and permanent enough. It is necessary that the weed used for attachment should remain *in situ* for nine months to a year, and perhaps longer, to enable the embryo to develop fully; and presumably the spawning fishes know that both Cystoseira and Laminaria are both strong enough and permanent enough even in a situation near low-water mark to serve their purpose; Cystoseira, from observation, grows certainly for more than one year, and is so firmly rooted that it is either difficult or impossible for a man to pull the weed off the rock. *Laminaria saccharina*, the species used by the nursehound, may shed its frond at the end of one summer's growth, but the stipes to which the egg-case is attached remains *in situ* and strong for a much longer period. The problem of how the nursehound found out that Laminaria and Cystoseira would suit its purpose is only one more of the millions of evolutionary problems awaiting explanation.

J. H. ORTON.

Marine Biological Laboratory,
The Hoe, Plymouth, October 21.

Application of the Drop Weight Method to the Determination of the Surface Tension of Colloidal Solutions.

IN connexion with some work by Henry N. Harkins and myself on the surface tension of certain colloidal solutions, it seemed essential to hold the drop used for the determination at almost full extension any desired length of time before it was allowed to fall. As usual, the drop was allowed to fall from a tip of horizontal circular cross-section into a stoppered weighing bottle (method of J. L. R. Morgan). The weighing bottle was immersed in a thermostat, and was kept dry on the outside by an enclosure of glass and brass, such as was used by Harkins and Brown. This is shown diagrammatically in Fig. 1. The new modification consisted in supporting the supply bottle entirely by the rod A, which was supported in turn by a microscope stand upheld by a heavy tripod which rested on a pier outside the thermostat. The rod was made so small that there was no contact with the inside of the tube C′. There should also be no contact between the stopper of the bottle E and the inverted capillary U tube upon which the tip D is

ground, since the adjustment of the level of the bottle E must transmit no vibrations to the hanging drop.

The form of the drop which hangs from the tip D depends both upon R/a and R/h. Here R is the radius of the tip, a is the square root of the capillary constant, and h may be designated as the 'pressure-height,' which is the difference in height between the bottom of the drop and the level the liquid in the bottle E would have provided the area of its meniscus were infinite.

The method was applied to pure liquids by Dr. Paul Gross, and it was found that the accuracy of the drop weight method is thereby increased considerably, so that the precision of the new method is to within a few hundredths of one per cent. To apply the method the cross-hair of the telescope of a cathetometer is adjusted by trial with the hanging drop, so that its level corresponds to the lowest level at which the bottom of the drop may be held without falling. To attain this level the height of the meniscus in E is adjusted by trial to the proper height by the use of the coarse and fine adjustments of the microscope stand. If the proper technique is used, the drop may be held at practically full extension for as many hours as may be desired. A study of the relation between the pressure-height and the stability of the hanging drop was carried out by Dr. Gross, and the results will be presented in a later more complete discussion of the improvements in the drop-weight method. The modifications introduced do not of necessity lengthen the time necessary for a determination of surface tension, since the greater certainty with which the proper conditions may be attained makes it possible to reduce the number of drops used, and in much work on colloidal solutions only one drop needs to be allowed to fall in the final determination.

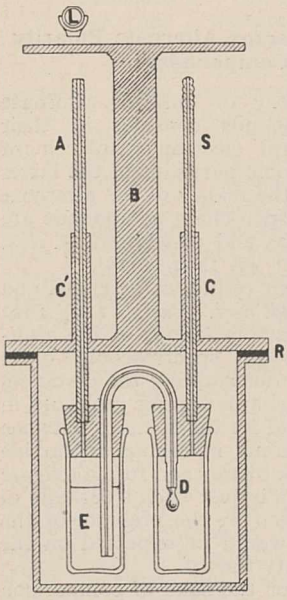

FIG. 1.

For those who prefer to use the less accurate ring method, a method which as commonly used has been in error by so much as ten per cent. or more, it may be mentioned that Dr. T. F. Young, Y. C. Cheng, and the present writer have recently determined experimentally the corrections for this method. The use of these corrections reduces the error to one per cent., and it is hoped that the work now under way will still further reduce this to one-tenth per cent.

WILLIAM D. HARKINS.

University of Chicago,
September 16.

Tertiary Man in Asia: the Chou Kou Tien Discovery.[1]

A RICH fossiliferous deposit at Chou Kou Tien, 70 li [about 40 kilometres] to the south-west of Peking, was first discovered in the summer of 1921 by Dr. J. G. Andersson and later surveyed and partially excavated by Dr. O. Zdansky. A preliminary report on the site was published by Dr. Andersson in March 1923 (*Mem. Geol. Surv. China*, Ser. A, No. 5, pp. 83-89), followed in October of that year by a brief description of his survey by Dr. Zdansky (*Bull. Geol. Surv. China*, No. 5, pp. 83-89). The material recovered from the Chou Kou Tien cave deposit has been prepared in Prof. Wiman's laboratory in Upsala and afterwards studied there by Dr. Zdansky. As a result of this research, Dr. Andersson has now announced that in addition to the mammalian groups already known from this site, there have also been identified representatives of the Cheiroptera, one cynopithecid, and finally two specimens of extraordinary interest, namely, one premolar and one molar tooth of a species which cannot otherwise be named than *Homo ? sp.*

Judging from the presence of a true horse and the absence of Hipparion, Dr. Andersson in his preliminary report considered that the Chou Kou Tien fauna was possibly of Upper Pliocene age, an opinion also expressed by Dr. Zdansky. It is possible, however, in the light of recent research, that the horizon represented by this site may be of Lower Pleistocene age. Whether it be of late Tertiary or of early Quaternary age, the outstanding fact remains that, for the first time on the Asiatic continent north of the Himalayas, archaic hominid fossil material has been recovered, accompanied by complete and certain geological data. The actual presence of early man in eastern Asia is therefore now no longer a matter of conjecture.

While a complete description of these very important specimens may shortly be expected in *Palæontologia Sinica*, the following brief notes may be of interest here. One of the teeth recovered is a right upper molar, probably the third, the relatively unworn crown of which presents characters appearing from the photographs to be essentially human. The posterior moiety of the crown is narrow and the roots appear to be fused. The other tooth is probably a lower anterior premolar, of which the crown only is preserved. The latter also is practically unworn, and appears in the photograph to be essentially bicuspid in character, a condition usually to be correlated with a reduction of the upper canine.

The Chou Kou Tien molar tooth, though unworn, would seem to resemble in general features the specimen purchased by Haberer in a Peking native drug shop and afterwards described in 1903 by Schlosser. The latter tooth was a left upper third molar having a very much worn crown, extensively fused lateral roots, and from the nature of its fossilisation considered by Schlosser to be in all probability Tertiary in age. It was provisionally designated as *Homo ? Anthropoide ?* It is of more than passing interest to recall that Schlosser, in concluding his description of the tooth, pointed out that future investigators might expect to find in China a new fossil anthropoid, Tertiary man or ancient Pleistocene man. The Chou Kou Tien discovery thus constitutes a striking confirmation of that prediction.

It is now evident that at the close of Tertiary or the beginning of Quaternary time man or a very closely related anthropoid actually did exist in eastern Asia. This knowledge is of fundamental importance in the field of prehistoric anthropology; for about this time also there lived in Java, Pithecanthropus; at Piltdown, Eoanthropus; and, but very shortly after, at Mauer, the man of Heidelberg. All these forms were thus practically contemporaneous with one another and occupied regions equally far removed respectively to the east, to the south-east, and to the west from the central Asiatic plateau which, it has

[1] Announcement of the Chou Kou Tien discovery was first made by Dr. J. G. Andersson on the occasion of a joint scientific meeting of the Geological Society of China, the Peking Natural History Society and the Peking Union Medical College held in Peking on October 22, 1926, in honour of H.R.H. the Crown Prince of Sweden.

been shown elsewhere, most probably coincides with their common dispersal centre. The Chou Kou Tien discovery therefore furnishes one more link in the already strong chain of evidence supporting the hypothesis of the central Asiatic origin of the Hominidæ.

DAVIDSON BLACK.

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Action of Magnetic Fields on the Refractive Index of Carbon Dioxide Gas.

A. GLASER (*Ann. d. Physik*, 75.4, pages 459-488, and *Ann. d. Physik*, 78.4, 641-658), in determining the susceptibility of diamagnetic gases, noticed that, under a definite magnetic field, the susceptibility decreases as the pressure of the gas is decreased, approximately proportional to the pressure. For a certain pressure range, however, there is a deviation from the above law, and the law of variation, instead of being linear, follows approximately a parabolic law, and above and below this range the linear law has different characteristics.

Working to detect any relationship between the refractive index and pressure, Fraser (*Phil. Mag.*, April 1926, pp. 885-890), using the Jamin refractometer, failed to notice any change in the refractive index when the gas is subjected to a sudden magnetic field of about 184 gauss within a pressure range of 0·001 to 8 mm.

The present authors have noticed a decided change in the refractive index of pure dry carbon dioxide gas,

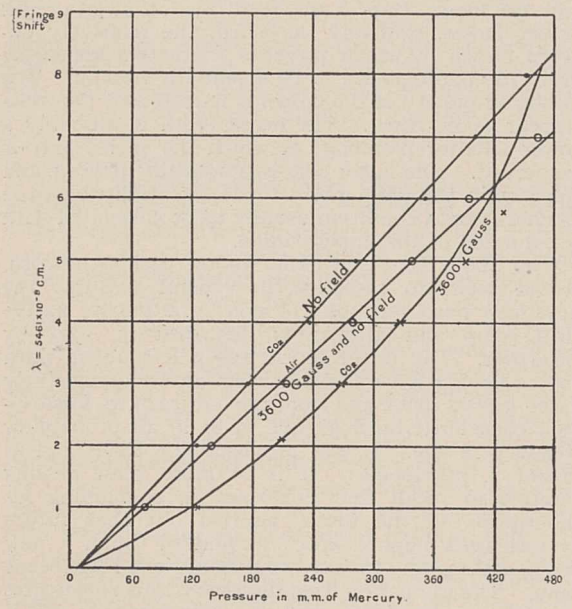

FIG. 1.

when subjected to a constant magnetic field of 3600 gauss, acting transversely to the direction of propagation of light and the pressure gradually increasing from 10 mm. to 400 mm. A Michelson type of interferometer was used for the purpose, and all parts were carefully selected to be non-magnetic. The graph (Fig. 1) shows the relation between the shift of fringes and the pressure variation within the range 10 mm. to 400 mm. for air and carbon dioxide. In the case of air, the magnetic field has no influence whatever on the refractive index, whereas with carbon dioxide the fringe shift nearly follows a parabolic path in the same region of pressure, as has been noted by Glaser. This shows a decided orientation of the molecules under the magnetic field, at least in the case of a dipolar gas of the type of carbon dioxide.

Experiments are in progress to determine the change with different temperatures and other dipolar gases.

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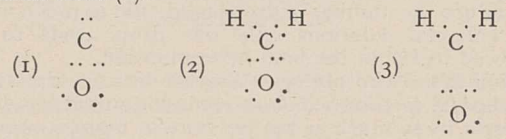
September 29.

Electron Displacement *versus* Alternate Polarity in Aliphatic Compounds.

ADHERENTS of the theory of induced alternate polarity in carbon compounds consider in their deductions also the general electron displacement effect of Lewis's theory; some partisans of the latter theory, however, question the reality of the alternate effect, especially so far as open-chain compounds are concerned. (Cf. H. F. Lucas and co-workers, *J. Am. Chem. Soc.*, 46, 2475 (1924); 47, 1462 (1925).)

It seems to me that recent results of V. Henri and Sv. A. Schoú [*C. R. Acad. Sci. Paris*, 182, 1612 (1926)] afford strong evidence in favour of the alternate effect. Making use of spectroscopic data, these authors succeeded in determining the distances between the atoms in some simple organic molecule, in the gaseous state. They find for the distance between the carbon and oxygen atoms in carbon monoxide 1·02 Å.U., whereas the same distance in formaldehyde is found to be 0·9 Å.U. It is just such a *decrease* of the distance carbon to oxygen by the presence of the two hydrogen atoms, that would be expected on the basis of the alternate polarity theory.

Indeed, let us suppose for the sake of comparison that in carbon monoxide the four binding electrons are lying at equal distances from the nuclei of the two atoms (1). In formaldehyde, then, according to the alternate effect and considering the positivity of the hydrogen atoms, the carbon atom must become less positive, *i.e.* it attracts the electrons of its octet, and together with them the oxygen nucleus, nearer towards itself (2).



On the contrary, the general Lewis effect would require a displacement of the binding electrons towards the oxygen nucleus, and thus an *increase* of the distance between carbon and oxygen (3).

In phosgene, $COCl_2$, the reverse effects would be expected according to both theories on account of the negative chlorine atoms; the data for distances are, however, not yet available in this case.

If one assumes a triple bond in carbon monoxide (cf. Lewis, "Valence," 1923, p. 127), the above conclusions become doubtful, since it is not known how interatomic distances are influenced by the transition of bonds; only a direct comparison of the distances in formaldehyde and phosgene could afford conclusive evidence then.

G. BERGER.

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October 5.

Science and Psychical Research.

MY departure for New Zealand having been delayed for a month, perhaps I may be allowed a short reply to Sir Bryan Donkin's remarks in NATURE of Nov. 6. Sir Bryan and myself have come much closer in our views, apparently, but he still misunderstands some of the main points both in my original article and following letter. The term 'supernormal phenomena' certainly includes both 'physical' and 'mental' phenomena of the type under discussion; on that we are agreed. But Sir Bryan goes on: "In the mental part, however, are included practically all the various 'phenomena' known generally under the term 'spiritualistic,'" or, later in his letter, 'ghostly.' It is here that I disagree. The genuine psychical researcher does not allow that these may be termed either, since both words connote a hypothetical explanation of the phenomena which we hold is not yet proven. Sir Bryan keeps trying to tie me down to an acceptance of the spiritistic hypothesis, whereas the whole of what I have written shows clearly that I am studying the evidence with an absolutely open mind. Another remark of his, "Seeing that the present discussion has been mainly concerned with these [*i.e.* the mental] phenomena," suggests that he cannot really have read carefully what I have written. Throughout, I have emphasised the importance of the *physical* phenomena, not the mental, and it was Sir Bryan himself who, by his narrowing of the field to the mental phenomena, attempted to deprive me of my chief argument.

As regards the subject of *trance*, Sir Bryan and I are alike in not knowing what it is. The only difference in our attitudes, I take it, is that I consider it a phenomenon worthy of scientific study, whereas Sir Bryan does not. I wonder whether Sir Bryan considers the phenomenon of *sleep* to be worthy of scientific study, or whether he would take the stand of the physicists who (mostly, but not all) maintain that the only phenomena which science may properly take account of are those which can be always repeated accurately under given experimental conditions. If I put Sir Bryan to bed and tell him to go to sleep, can he always do so? Is sleep any the less a fit subject for scientific study because it cannot be produced to order in an experiment? Trance, if anything, is more amenable to such procedure than is sleep. It is therefore undoubtedly a fit subject for scientific study. My complaint is that those who have the necessary knowledge and training refuse to become interested in these things; they seem to think that the year 1926 marks the culmination of human knowledge in some way, and that there is nothing more to learn about life except on the purely mechanistic side. My whole article was really a protest against this view.

R. J. TILLYARD.

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Active Nitrogen.

FURTHER experiments have tended to confirm the work recently published by Dr. Rideal and myself upon the energy and nature of active nitrogen.

A study of the effect of the admission to the afterglow of a number of gases, elementary, compound, and mixed, shows that in no case so far examined does any chemical action resulting in the formation of definite compounds occur when the critical increment of the gas introduced exceeds *c.* 45,000-50,000 cal./gm. mol.

Experiments upon the action of active nitrogen upon the metals in the form of fine filaments show that catalytic decay takes place at their surfaces and in some cases (*e.g.* copper) is very marked. The efficiencies of the metals in this respect depend upon the stability of their nitrides. Calculations from the data obtained here again show that the energy of active nitrogen is *c.* 45,000 cal./gm. mol.

The decay of the afterglow has been measured by optical methods, and it has been found that the process is in all probability bimolecular with respect to the active nitrogen, but termolecular in reality since the total pressure appears to exert a marked influence, as suspected by Lord Rayleigh.

The line of reasoning adopted by Dr. Ludlam and Mr. Easson is sensibly the same as that of Saha and Sur. It is quite probable that an unstable compound such as N_2I_2 or a quasi-molecule of sorts is first formed when the iodine vapour is admitted to the afterglow, but is then broken up by collision with another molecule of active nitrogen, the energy liberated going to produce the line they mention. The nitrogen halides are notoriously unstable compounds and hence probably highly endothermic.

An alternative explanation is suggested by the presence of the β and γ bands in the spectrum of the afterglow. While the weight of evidence appears to be against their being really part of the true nitrogen afterglow bands, they invariably appear when the gas is purified in the usual manner. Since they extend at least so far as $\lambda 2154$, collisions between molecules of iodine and those of nitrogen or nitric oxide at this level may result in the appearance of the line in question.

This explanation could easily be tested by increasing the intensity of the β and γ bands, by the addition of oxygen, as in the recent experiments of Johnson and Jenkins (*Phil. Mag.* Sept. 1926); an increase in the strength of this iodine line should then follow. It is surely not at all legitimate to attempt an evaluation of the energy of active nitrogen from the spectral phenomena to be seen in the presence of such factors of totally unknown magnitude.

E. J. B. WILLEY.

Laboratory of Physical Chemistry,
Cambridge, October 27.

Liveing's Fire-damp Indicator.

SOME years ago I made frequent use of Mr. Liveing's very ingenious instrument, referred to in NATURE of October 30, p. 626, and I found its indications to be both accurate and excellent. The only drawback to its use in those days was the shaking which accompanied the turning of the handle to produce the glow, as this made accurate observation of the percentage of fire-damp somewhat difficult.

W. GALLOWAY.

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October 30.

The Imaginary Roots of Equations.

PROF. C. RUNGE has informed me that the method I gave under the above title in NATURE of October 30, p. 627, has already been given by him in the "Encyclopädie der mathematischen Wissenschaften," vol. I. 1, p. 431. I need scarcely add that I was not aware that I had been anticipated when I sent my letter to NATURE.

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Reflex Regulation of Posture.[1]

By Dr. F. M. R. WALSHE.

TO those interested in the physiology of the nervous system, the history of our knowledge of the neuro-muscular mechanisms underlying posture must form one of the most fascinating chapters in the records of the science, and it is but fitting that any account of it should be prefaced by an expression of homage to Sir Charles Sherrington, to whose labours we owe the entire foundation of that knowledge.

Sherrington's investigations, in the course of which muscle tonus has been revealed as a purposive reflex reaction and the basis of all postural activity on the part of the musculature, are now thoroughly embodied in physiological thought and do not require detailed reference. It is of interest, however, when we recall the vicissitudes through which the term 'tonus' and our conceptions of muscle tone have passed to refer briefly to the experimental preparation which in the hands of Sherrington, and later in those of Magnus of Utrecht, has provided the key to the elucidation of those intricate neuro-muscular processes which underlie reflex posture. I refer to the decerebrate preparation. Prior to its discovery and description the nature, and even the very existence, of muscle tonus were subjects of conflicting opinion and observation. Numerous investigators had sought for this peculiarly elusive form of muscular activity in the single muscles of cold-blooded animals, and such glimpses of it as had been gained were too restricted in extent and too fugitive for any clue to its nature to be apparent. "To glimpse at the aim of a reflex," as Sherrington has remarked, "is to gain hints for further experimentation on it . . . the larger the muscular field involved in the reflex effect, the plainer usually its purpose."

The decerebrate cat is an animal in which the brain stem has been severed in the region of the tentorium, the section putting out of action all that part of the brain, including the forebrain, which lies anterior to the posterior corpora quadrigemina. Such a preparation may be called a ponto-spinal animal. Following this procedure, there appears an abnormally heightened tonus selectively distributed in those muscles which maintain the animal in its habitual standing posture—in other words, in the group of 'antigravity muscles.' This hypertonus has been called 'decerebrate rigidity,' and its intensity and characteristic incidence throughout the skeletal musculature have made possible a minute analysis not alone of the origin and nature of muscle tone, but also of its significance. Decerebrate rigidity is reflex standing. It will be apparent, therefore, that the discovery of this preparation opened a new and most fruitful era in the physiology of the nervous system.

Briefly, we have in muscle tone an enduring reflex muscular contraction of low intensity, endowed with a quality of plasticity in virtue of which the muscle can maintain a steady tension at varying muscle lengths, and readily overset transiently by intercurrent reflex reactions of phasic or movement type. It is a proprioceptive reaction, the stimulus arising in the muscle engaged in the reflex and consisting of those variations in tension produced by the voluntary motor activities of the animal (Sherrington and Liddell). It is believed that the tonic contraction is of the same nature, and is a function of the same elements in the striated muscle fibre as that seen in the muscle engaged in movement (phasic contraction), its peculiar qualities depending on the fact that now the elements respond in rotation, groups of individual muscles giving asynchronous series of responses.

In that beautiful analysis of reflex reaction which Sherrington has embodied in his book, "The Integrative Action of the Nervous System," he has pointed out that the skeletal musculature is controlled by two great reflex systems, which in the intact animal are in turn controlled by the cerebral cortex. Each system influences its own groups of the musculature, employing them in characteristic fashion. One system, the phasic system, is concerned with short-lived muscular movements and the arcs involved are predominantly spinal. The flexion reflex is a typical example in the group. The other, or tonic, system with which we are now concerned maintains and regulates that steady tonus or tonic contraction which is the basis, the raw material, of posture. Between the two systems there is a close and harmonious relationship, or, in Hughlings Jackson's apt phrase, "a perfect co-operation of antagonism." Every movement starts from and ends in a posture, and even the most superficial observation of some voluntary purposive movement betrays the existence of these two elements. For the effective performance of some movement of a limb it is essential that the organism as a whole should be oriented with reference to gravity and other external forces. The minute experimental analysis of muscular movement confirms this impression and has revealed the activity of the two systems mentioned above.

The tonic reflex system includes the autogenous reaction in the muscle which we call muscle tone, and also a complex series of controlling reactions by means of which tone is adapted to follow up the numerous and diverse movements made by the intact animal.

These regulating tonic reactions arise in the otolith organs of the labyrinths, in proprioceptive nerve endings in the muscles and tendons throughout wide regions of the body, and also in the nerve endings in the body wall which subserve the sense of pressure.

In 1909, as he relates, Magnus chanced to be working with a decerebrate preparation and noticed when he turned the animal from the lateral into the supine position that the extensor hypertonus of its limbs underwent an appreciable increase with the adoption by the limb of an attitude of more complete extension. Further, when the head was so flexed upon the trunk that the line of the mouth made an angle of 45° above the horizontal, an additional increase was seen to set in after a latent period of several seconds. These modifications of tone, and afterwards of limb posture, persisted so long as the new position of the head which had given rise to them was maintained.

[1] Opening paper of a discussion on "Reflex Posture" before Section I Physiology) of the British Association at Oxford, August 9.

Simultaneously and independently, Sherrington observed that with the animal in a fixed position, rotation of the head to one side caused a similar increase of extensor tonus in the two limbs of the side to which the snout pointed. Extirpation of the labyrinths left the reaction intact, but division of certain cervical posterior roots abolished it. It therefore arose in proprioceptors in the neck musculature.

These observations formed the starting-point of Magnus's great work upon reflex posture, and have resulted in the discovery and classification of an extremely complex series of tonic reactions, which in sum make up the nervous mechanism by which normal postural activity is attained. In addition, Magnus has revealed the existence of a group of phasic reactions arising in the semicircular canals, and these with the tonic reflexes under discussion constitute the whole reflex mechanism of normal co-ordinated muscular activity.

Magnus and de Kleijn found that by imposing variations in the position of the animal's head in relation to the horizontal plane of space certain constant modifications of limb tonus, and therefore limb posture, could be produced. Further, after bilateral labyrinth destruction, variations of head posture in relation to the trunk also elicited certain other constant tonic reactions. These two groups are the so-called tonic labyrinthine and neck reflexes and together make up a group of 'standing reflexes.' By appropriate manipulation of the head by the observer, the animal can be made to take up a wide range of attitudes, corresponding to those habitually adopted by the animal during life. They found, however, that although it could stand, the decerebrate animal, if overturned, lay like a log and had no power of reflex control over the posture of its head. It was clear, therefore, that there must exist in the intact animal other tonic reactions governing head posture. Transection of the brain stem immediately anterior to the mid-brain led to the discovery of these other reactions. The mid-brain animal, for so such a preparation is called, does not exhibit hypertonus, but tone of normal intensity. It can stand, walk, and jump, and if overturned at once actively reassumes the normal sitting posture. If thrown from a height it lands upon its feet. The reactions by which these results are obtained are purely reflex, and the animal is a reflex automaton.

Further analysis of the preparation's activities has revealed the existence of a group of labyrinthine, neck and body 'righting reflexes,' in virtue of which the animal is able to maintain its head right side up in the world. This righting of the head sets in train secondarily all the other reactions by which the trunk and limbs are in turn brought into line with the head. Slow motion kinematograph photographs of the cat falling through space reveal the successive tonic and semicircular canal reflexes described by Magnus and his collaborators. First the head is righted, the anterior and the posterior portions of the trunk follow in turn, and finally, in virtue of phasic semicircular canal reactions, the limbs are outstretched so as adequately to receive the body weight as the animal reaches the ground. The ease and accuracy with which each of the various tonic and phasic reactions separately analysed by Magnus can be followed in such photographs are the most convincing demonstration of the minute accuracy of his observations.

In apes there is added to these labyrinthine and proprioceptive reactions a group of retinal righting reflexes of tonic character.

The reflex arcs of the various reactions we have been considering lie entirely within the limits of spinal cord and brain stem and do not pass through the cerebellum or basal ganglia. There is laid down, then, in the central nervous axis of the animal a mechanism which makes possible all the phasic and postural activities of the intact animal. By an automatic mechanism the animal is kept right side up in the world.

It is to observations made at the bedside by the clinician that we must turn to determine whether or not the laws governing the regulation of posture in a wide range of animal forms—from guinea-pig to ape—hold also for man. The evidence accumulated during the past fifteen years goes conclusively to show that they do.

Warned by the difficulties which the pioneer investigators met with in their animal experiments, the clinician has sought for a form of hypertonus resembling experimentally produced decerebrate rigidity. The student of nervous diseases is familiar with several forms of tonic muscular contraction of considerable intensity, but all except one of these may readily be dismissed as bearing no resemblance to the condition in question. It might be thought that in man a condition of decerebration is not compatible with continued existence, and indeed complete bilateral decerebrate rigidity is one of the rarest observed phenomena. We have, however, in the hypertonus, or spasticity, of the residual hemiplegia left after a cerebral hæmorrhage or softening, a unilateral state of tonic muscular spasm in the limb muscles which is manifestly qualitatively identical with decerebrate rigidity. It arises as a proprioceptive reflex in the muscle concerned, and destruction of the muscle's afferent nerve supply abolishes it. It is plastic, and easily overturned by the same phasic reflexes as have this effect in the animal. It may persist undiminished for years. It has a selective incidence in the limb musculature: in the extensor, or antigravity, muscles of the legs, but in the flexors of the arms. This altered incidence in the upper limbs of man is related to the profoundly altered functions of the fore limbs in this erect animal, and the reasons for so thinking need not now concern us. Further, it has recently been shown that the tonic neck and labyrinthine reflexes of Magnus and de Kleijn may be present in these rigid and paralysed limbs, following the same rules which govern their occurrence and form in the decerebrate animal.

In addition it has been possible to recognise in a very familiar clinical phenomenon the existence of another group of tonic reflexes, arising in the proprioceptors of the normal limb and acting upon the paralysed limbs. It has long been known, and every hemiplegic subject soon discovers the fact for himself, that when with the normal arm the subject makes some forceful, tonically sustained, voluntary movement, the contralateral paralysed limb goes into strong tonic

spasm and takes up a new attitude, which is sustained for so long as the voluntary muscular act evoking it. The form, latency, and duration of this so-called 'associated movement' shows it to be a tonic reflex of the same type as those described by Magnus. Further, in favourable cases, a beautiful interaction between labyrinthine, neck and limb reactions may be observed if we combine changes in the position of the subject's head both in relation to space and to his trunk.

It is clear, in short, that the tonic reactions of Sherrington and of Magnus are present in the human subject. In a single personally observed case of complete decerebrate rigidity in the human subject, in which physiological 'decerebration' was performed by a tumour compressing the mid-brain, a perfect decerebrate rigidity with tonic neck reflexes and phasic flexion and crossed extension reflexes were obtainable.

These observations upon the subjects of disease and injury of the nervous system are of a double interest. They serve to correlate the work of the experimental physiologist with that of the clinical observer, they bring the human subject into line with animals lower in the scale. Further, they illustrate the value to the clinician of experimental physiology. For many years the labours of clinical neurologists have accumulated a vast mass of 'physical signs' of disease, which have been used empirically as aids to diagnosis; but so far as possessing other meaning was concerned they remained like the jumbled pieces of a mosaic. Thanks to the light received from the physiological laboratory, it is now possible to piece them together into a coherent and intelligible pattern, and they have become manifestations of a dissolution of nervous function, pregnant with physiological significance. Thus may the clinician not only derive information of inestimable value to him in his analysis of the phenomena of disease, but he may also, in a measure, repay some of his debt to the physiologist by carrying over the latter's animal observations to man.

Some Recent Advances in Astrophysics.[1]

By Prof. E. A. MILNE, F.R.S.

OF late years astronomers have become increasingly despairing as to what the stars are doing—in what direction they are evolving, how they produce the energy they radiate, whether (and if so why) some of them pulsate, how the stars are born and whether they die. At the same time astronomers have become increasingly confident as to what the stars are really like. It is proposed here to deal briefly with one province of this less speculative side of astrophysics, namely, that which is described, broadly speaking, as the subject of stellar temperatures and stellar spectra.

What are called the 'effective temperatures' of the stars have been determined by measurement of their colour, much in the same way as the temperature of a piece of red-hot iron may be estimated from its colour. With the piece of iron, we may measure either the total radiation leaving each square centimetre of its surface, or the ratio of the intensities of radiation for two different constituents of its spectrum. From either of these measurements we may infer the other. Both types of measurement are possible for the sun, and by the work of Abbot, Plaskett, and Fabry and Buisson, they have been shown to be in general agreement. For the stars in general, only the colour type of measurement is possible. It is true that of recent years the heat radiated by the stars has been measured directly, but such measures by themselves yield no more information than a determination of apparent magnitude. Colour-measures, however, by the use of Planck's law, yield the amount of radiation leaving each square centimetre of the star's surface—a quantity expressed parametrically by the effective temperature, or surface brightness.

The importance of this quantity lies in the fact that the total radiation leaving the surface per second is precisely the amount generated in the interior per second, assuming a quasi-steady state. Two examples of its employment in fundamental calculations may be mentioned. The amount of light from a star (a quantity given by the apparent magnitude) reaching the earth is equal to the product of the surface brightness into the solid angle subtended by the star. Hence a determination of surface brightness plus one of apparent magnitude is equivalent to a determination of the angular diameter of the star as seen in the sky from the earth. The confirmation of such estimates by the direct measurement of angular diameters at Mount Wilson by means of the Michelson interferometer affords a useful check on one of the steps in the reasoning, namely, the deduction of radiation per unit area per second from an observation of colour. The second example is that of the estimate of the densities of the components of a double star. The density-ratio of the components may be readily calculated in terms of the ratio of the surface brightnesses, the mass-ratio, and the difference of the apparent magnitudes. In this way it was inferred that the companion of Sirius must have a density some 60,000–70,000 times that of Sirius itself, and the verification of this by Adams at Mount Wilson, by measurements of the Einstein shift in the lines of the spectrum, has been one of the most sensational scientific events of the past year.

The effective temperature, however, is not the temperature of any particular portion of the star. The question arises, Is there any method of determining the actual temperature in the surface regions of a star, which alone we can directly observe? Have we a thermometer? The answer is in the affirmative. We can use the atoms volatilised in the atmosphere of a star as their own thermometer, by observing the absorption spectrum they produce.

The theory depends on the recent progress in atomic physics. It has long been known that the spectra of the great majority of stars fall into a single linear sequence, in which, as we pass by ascending effective temperatures from the red stars to the blue stars, some lines decrease in intensity, others increase, attain a maximum and decrease, others again only appear far on

[1] Substance of a lecture delivered before the Manchester Literary and Philosophical Society on October 19.

in the sequence. Such a linear array of spectra could scarcely be due to differences in chemical composition, and it was emphasised by Russell and others that in some way the ordered sequence of spectra must be related to the sequence in effective temperatures. The true explanation, however, was only discovered in 1920, by Saha.

It was Saha who first pointed out that at high temperatures the atoms composing stellar atmospheres must dissociate into ions and free electrons according to the same laws of thermodynamics used by chemists to calculate molecular dissociations. Given the ionisation potentials of the atoms, the degree of dissociation is a function of temperature and pressure—to be precise, the partial pressure of the free electrons—and for a given pressure the ionisation increases with the increasing temperature. Consequently, for each element we shall have first the spectrum of the neutral atom, then that of the once-ionised atom, followed in turn by that of the twice-ionised atom, and so on. At the highest temperatures the spectrum of the neutral atom should completely disappear, in general. Further, the absence of an element from a stellar spectrum does not necessarily mean the absence of the element from the stellar atmosphere. It may only mean that the lines it is capable of producing in its then stage of ionisation are outside the accessible range of spectrum.

It is necessary to distinguish the ultimate lines of an atom in any given stage of ionisation from the remaining lines. The ultimate lines are absorbed only by the atom or ion in its normal, or unexcited stage. The theory shows immediately that the ultimate lines of a neutral atom should steadily decrease in intensity with increasing temperature: the ultimate lines of an ionised atom should increase at first, slowly attain a maximum and then decrease as further ionisation ensues. Calcium provides an illustration of both types of lines.

Intermediate between successive stages of ionisation we have atoms in excited states, with corresponding absorption spectra. Only a minute fraction of the atoms are in any given excited state at any instant, but the fraction is a definite one given the temperature and pressure, on the assumption of thermodynamic equilibrium. Moreover, this fraction has a comparatively sharp maximum. It is easy to see that a maximum must occur. At lower temperatures, comparatively few of the atoms are excited. As the temperature increases the excited fraction of atoms in the given state of ionisation increases, but the total number of atoms in the given state decreases owing to the next stage of ionisation setting in, and ultimately all the atoms pass into the next stage of ionisation. The number of excited atoms is thus practically zero at both low and high temperatures. In between it must have a maximum.

Following the method of Saha, it has been found possible to calculate at what temperature such a maximum should occur. We then identify the maximum in the number of excited atoms with the observed maximum of the corresponding absorption lines in the stellar sequence. We thus arrive at a truly thermometric scale of stellar temperatures. The most recent and detailed comparisons of observed and theoretical maxima are those contained in the researches of Miss Payne, of the Harvard College Observatory, and the following is her table of temperatures.

Class.	Temperature.	Class.	Temperature.
K_5	3,000°	A_0	10,000°
K_0	4,000°	B_8	13,000°
G_0	5,000°	B_3	17,000°
F_0	7,500°	$B_{1\cdot5}$	18,000°
A_5	9,000°	B_0	20,000°

At present there still remains an empirical element in the temperature scale. It is necessary to assume a value for the pressure—the partial electron pressure—in stellar atmospheres, and to assume that the pressure is the same in all stars. The removal of this empiricism promises to open up a still more important line of work. A synthetic theory of the structure of a stellar atmosphere would not in fact deal with the pressure at any particular level. Starting with the value of gravity at the surface of the star, and the atomic absorption coefficients, it would proceed to calculate the distribution of atoms through the atmosphere, taking due account of the varying effects of selective radiation pressure on the individual atoms. Ultimate lines, for example, will give rise to much more intense radiation pressure than lines corresponding to excited states. Different classes of atoms will thus be at different horizons in the atmosphere, and so at different pressures. The nature of the spectrum itself controls the pressure, and so in turn the degree of ionisation. This double relatedness of spectra to ionisation, due to the intervention of radiation pressure, may lead after further study of stellar spectra not only to an improved temperature scale with the empiricism removed, but further to determinations of surface gravity and to astrophysical determinations of relative, perhaps even absolute, atomic absorption coefficients. The possibility of the latter type of determination serves to remind us that astrophysics contributes to atomic physics as well as borrows from it.

A further by-product of the theory is the determination of the relative abundances of the different elements in stellar atmospheres. Observations of maxima provide temperatures, and are independent of relative abundances: each maximum is a thing *per se*. But the places of first or last appearance of a line in the stellar sequence depend on the amount of the corresponding element available, and in the hands of Miss Payne have been used to estimate the relative abundances. It must suffice to state that the abundances bear a relation of rough similarity to the abundances of the same elements in the crust of the earth, with the exception of hydrogen and helium, the behaviour of which is anomalous.

It has already been mentioned that intensities of spectral lines are connected with the surface values of gravity. Empirical connexions of line-intensities with the absolute luminosities of the corresponding stars are now well known: they are another aspect of the same phenomenon. By a method originated by Kohlschütter, Adams and Joy, they are now used at many observatories to determine the parallaxes of stars spectroscopically. In conclusion, reference may be made to a similar method recently developed in the brilliant work of Ch'ing-Sung Yü at the Lick Observatory. He has investigated the continuous absorption spectrum associated with the limit of the Balmer series

of hydrogen. This spectrum is produced by the ionisation of hydrogen atoms: its intensity is a measure of the fraction of hydrogen atoms remaining un-ionised. Yü has found empirically that it is a function of colour-temperature and of absolute magnitude. The method eliminates one unsatisfactory feature in the method of Adams and Joy, namely, the use of different empirical reduction curves for stars of different types. Yü's photometric measures determine colour-temperature and hydrogen absorption from the same spectrogram, and from these two quantities the absolute magnitude may be inferred. It is too early to estimate the ultimate value of the method, but it is at once a new weapon for the determination of parallaxes by calibration on known stars, and a challenge to theoretical investigators.

Obituary.

PROF. W. J. HUSSEY.

PROF. W. J. HUSSEY died suddenly in London on Thursday, October 28. He reached England on October 23 with Mrs. Hussey and with Mr. and Mrs. Rossiter. They proposed to leave for the Cape on October 29, taking with them a large telescope of 27 inches aperture and 41 feet focus. This was to be installed near Bloemfontein, Prof. Hussey remaining until the building was completed and leaving Mr. Rossiter in charge to carry out an extensive programme of double star observations. Prof. Hussey had only lately recovered from an attack of pleurisy, but seemed fairly well on October 27, when he gave an address to the British Astronomical Association.

William Joseph Hussey was born at Mendon, Ohio, on August 10, 1862, and graduated B.S. of the University of Michigan in 1889. For some years he taught mathematics in the University of Michigan, and was acting director of the Detroit Observatory. In 1892 he was appointed assistant professor of astronomy at the Leland Stanford Junior University, afterwards succeeding to the chair. From Leland Stanford it was a natural transition to the post of assistant astronomer in the Lick Observatory, not many miles away.

Hussey's knowledge and enthusiasm were such as to enhance the high traditions of this famous observatory. Barnard and Burnham had left, and their places were filled by Aitken and Hussey. The first important work Hussey undertook was the re-observation and discussion of the double stars observed by Otto Struve. The results form vol. 5 of the Lick Observatory publications. Hussey measured many close and difficult double stars which were only within reach of the largest telescopes. Among them may be instanced δ Equulei, which has an elliptic orbit, and the two stars are only separable when near elongation. He followed this star closely and found it to have a period of 5·7 years, one of the shortest known, while previous observers had supposed the period to be about double this length. It may be interesting to note that he determined the parallax of this star by a combination of line of sight determinations of linear velocity with the determinations of angular movement resulting from double star measures.

In 1899 Hussey joined Aitken in a systematic examination of all stars between the pole and $-22°$ down to $9{\cdot}0^{m}$ or $9{\cdot}1^{m}$ to discover which of them were double. They worked on this programme from sunset to sunrise, and when Hussey left in 1906 to be professor of astronomy and director of the observatory of the University of Michigan, he had discovered so many as 1327 new double stars. Here he was engaged in spectroscopic work and in building and organising a new observatory. In 1911 the directorship of the observatory of La Plata was added to that of the University of Michigan. Before his resignation of this post in 1917, he had discovered 312 new southern double stars.

In 1902 Hussey was appointed to make telescopic tests of the suitability of sites in South California and Arizona for a solar observatory, and strongly advocated the selection of Mount Wilson. From 1917 he had in mind the possibility of the establishment of an observatory in the southern hemisphere specially for double star work. Three years ago he visited South Africa, and was very favourably impressed with the site of Bloemfontein. A personal friend from college days, Mr. Lamont, has recently provided funds for a telescope, designed and built under Hussey's direction, with an object-glass by Zeiss. This telescope was completed and was being taken to Bloemfontein at the time of Prof. Hussey's death. We understand that arrangements have been made to go forward with the establishment of this observatory, and that Mr. Rossiter left for South Africa on November 5. This, we may be sure, would have been in accordance with Prof. Hussey's wishes.

Prof. Hussey had many friends among English astronomers, who admired his gifts of industry and enterprise, and were always pleased when occasions like eclipse or other expeditions brought him to London and gave an opportunity of meeting him. He had been a foreign associate of the Royal Astronomical Society since 1903. F. W. D.

WE regret to announce the following deaths:

Prof. F. M. Caird, emeritus professor of clinical surgery in the University of Edinburgh and a past president of the Royal College of Surgeons of Edinburgh, who worked as a student under Lister, on November 1, aged seventy-three years.

Dr. W. Romaine Newbold, Seybert professor of moral philosophy in the University of Pennsylvania, who wrote on suggestibility, automatism and kindred phenomena, on September 26, aged sixty years.

Dr. Francis E. Nipher, emeritus professor of physics in Washington University, St. Louis, whose work covered aspects of gravitating nebulæ, wind pressure, and the electric discharge, on October 6, aged seventy-eight years.

Dr. Franz Pfaff, formerly professor of pharmacology and therapeutics at the Medical School of Harvard University, on September 26, aged sixty-six years.

Dr. C. A. Waldo, emeritus professor of mathematics in Washington University, St. Louis, known for his work on warped surfaces, on October 1, aged seventy-four years.

News and Views.

ON Saturday, November 27, the authorities of the town and cathedral of St. Albans will commemorate the six hundredth anniversary of the election of a prelate famous in the history of the Abbey—Richard of Wallingford, Abbot 1326–1335. This fact has interest for men of science and archæologists, for Wallingford was a scientific pioneer, as well as a distinguished abbot. At Oxford, where he was a student and doctor in the 'Hall' maintained by the leading Benedictine houses for the reception of promising youths from their local schools, he won fame as a mechanician and astronomer, almost as a magician. In this he shared the lot of 'Friar Bacon,' whose follower, though not immediate pupil, he was; it seems that that pioneer genius started what might have been a great school of science at the university. Wallingford was the author of scientific treatises, one of which, "The Rectangulus," survives in MS. to this day. Many of the scientific instruments he invented are preserved, either actually or as reproductions, in the Ashmolean Museum, and were the basis on which later men could work. His scientific *chef d'œuvre*, however, was the astronomical device 'Albion' ('all by one'), which showed "the action of the tides and the revolutions of the planets."

THE above commemoration will be attended by Sir Frank Dyson (the Astronomer Royal), Prof. H. H. Turner, Dr. R. T. Gunther, and other scientific men (including representatives of the Clockmakers' Company), and will take the form of a service in the Abbey of St. Albans at 4 P.M., at which a wreath will be placed on Wallingford's tomb, and his prayers used. Later, there will be a gathering in the Town Hall, when papers will be read on Wallingford's work as man of science and abbot, and there will be a small exhibition of his scientific instruments. It is hoped that this will include the actual instrument 'Albion,' for it was acquired from the Royal Commissioners at the time of the dissolution of the abbey, by a local 'Squire,' and it has ever since been an heirloom in his family. The instruments will be explained by Dr. Gunther. The service and gathering are, naturally, public, and any one desiring more information on the matter should apply to the Hon. Secretary, Wallingford Commemoration, Kingsbury Knoll, Verulam Road, St. Albans.

ACCORDING to a recent message of the Stockholm correspondent of the *Times*, the following awards of Nobel prizes have been made: The reserved prize for physics for 1925 between Prof. J. Franck of Göttingen and Prof. Hertz of Halle; the prize for physics for 1926 to Prof. Jean Perrin; the prize for chemistry for 1925 to Prof. Richard Zsigmondy; the prize for chemistry for 1926 to Prof. The Svedberg. Prof. Franck is professor of physics and director of the physical laboratory in the University of Göttingen and is the author of many papers on atomic structure, ionisation by collision, and related topics. Prof. Perrin is professor of physical chemistry at the Sorbonne; he is the author of a standard work on atomic chemistry which has passed through many editions and has been translated into French and German. He was elected a foreign member of the Royal Society in 1918. Profs. Zsigmondy and Svedberg are both best known for their work on the colloidal state. Prof. Zsigmondy is professor of inorganic chemistry in the University of Göttingen; he has worked largely on the gold sols, and his book on colloids and the ultra-microscope has been translated into English. A recent volume, "Das Kolloide Gold," by Prof. Zsigmondy and P. A. Thiessen, is the first of a new series of monographs in which the scattered work on the physics and chemistry of colloids is being brought together under Prof. Zsigmondy's guidance. Prof. Svedberg, professor of physical chemistry at the University of Upsala, has carried out numerous and fundamental researches on colloidal solutions of the suspensoid type and has made noteworthy contributions to our knowledge of the chemistry of photographic processes.

AT a luncheon given on November 12 by the Imperial College of Tropical Agriculture to the Dominion Prime Ministers and representatives, Mr. Amery made the important announcement that 96,000*l.* out of the 100,000*l.* which Lord Milner set out to obtain as an endowment fund for the College has now been raised. Sir Arthur Shipley, who presided, pointed out the great need there is for agriculturists who have been thoroughly trained in tropical agriculture; men of this type are wanted everywhere, and it is this want that the Trinidad College is hoping gradually to satisfy. One of the difficulties is that there is not at present a sufficient supply of schoolboys with any biological training. Sir Arthur deplored the fact that it is now possible for a student to take honours in a Natural Science Tripos at Cambridge without taking at least one biological subject. At the present moment the market for chemists and engineers is gravely overstocked, whereas there is an appalling dearth of entomologists and mycologists. This state of affairs the College is endeavouring to redress. Both Mr. Bruce, the Prime Minister of Australia, and Mr. Coates, the Prime Minister of New Zealand, stated that they took the greatest interest in the College, although neither was able to make any immediate promise to provide funds for its enlargement.

IT is doubtless true that the number of fatal flying accidents to service flying officers this year—more than seventy to date—large as it is, is in diminishing ratio to the number of hours flown as compared with previous years since the War. It is probably true also that many of the accidents which occur are due to errors of judgment on the part of the pilots. The number of accidents is sufficiently large, however, to occasion concern and to re-emphasise the need for more and more research in connexion with the design and construction of aircraft, and obviously for the exercise of more care in the selection of pilots and more care in their training. Whether the private aircraft construction companies should be granted subsidies with which to carry out their own research programmes, the suggestion made by Mr. Handley Page

in his letter published in the *Times* on November 12, or whether it would be better for the Royal Aircraft Establishment to undertake aircraft construction as well as design, is a debatable question. It is obvious that Great Britain, however favourably it compares with other countries as regards accidents, has still to carry out much research work before a type of aircraft is evolved which will combine stability with manœuvring capacity. There is still much work to be done in connexion with the elimination of the possibility of fire on 'crashing,' and other safety precautions. There is little doubt that every aeroplane accident, whether it is a service machine or a commercial machine involved, shakes the confidence of potential passengers in the safety of air travel and reacts unfavourably against the development of commercial air services.

ON November 23, the centenary occurs of the death of Johann Elert Bode, the famous German astronomer. Born at a time when scientific studies in Germany were recovering from the set-back brought about by the disastrous Thirty Years' War, Bode was the first to diffuse a general taste for astronomy among his fellow-countrymen. He was the Lalande of Germany, and his name is known to every one as the author of "Bode's Law." That law, it is true, is to be found in the writings of Titius, Wolf, and others, but it was Bode who first directed attention to it. His world-wide reputation, however, rested on other grounds. The son of a schoolmaster, and born in Hamburg, January 19, 1747, Bode at the age of twenty-one years published a popular treatise on astronomy and an essay on the transit of Venus of 1769. Three years later Frederick the Great made him astronomer to the Berlin Academy of Sciences, in which position he did much to stimulate astronomical studies. His well-known "Astronomische Jahrbücher" were commenced in 1774; two years later he published an essay on the constitution of the sun, and in 1778 made known the law bearing his name. He closely followed Herschel's newly discovered planet, and it was he who named it Uranus when Herschel would have called it Georgium Sidus. His "Uranographia," or Great Celestial Atlas, appeared in 1807 and contained observations of about 17,000 stars. Long regarded as the head of German astronomers, he was younger than Mayer, but among his contemporaries were such as Harding, Gauss, Schumacher, Struve, and Encke.

THE opinion among engineers of the value of a training in the scientific principles of the profession has altered greatly during the past twenty years, and there are few, even among the older school of engineers, who do not now recognise the advantages of such a training. But although few subjects have been more widely discussed, there are still wide differences of opinion as to how, when, and where such a training is best obtained, and as to exactly what it should include. Should it be obtained at a technical school in evening classes, or in a full-time course at a university? Should it precede, be carried on simultaneously with, or follow a course of practical training in works or office? Should the university attempt anything in the nature of practical training? How long should the period of practical training last? In a paper read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on October 29, Principal Sir Theodore Morison, of Armstrong College, Newcastle, suggested the formation of a committee of the Institution with the view of giving an authoritative answer to these and other cognate questions.

THE outcome of Sir Theodore Morison's suggestion will be of interest, and we look forward to a report of the discussion of the paper. Numerous committees of engineers have considered the subject in the past in Great Britain and other countries, without by any means exhausting its possibilities. Since the report of the committee of the Institution of Civil Engineers on engineering education some years ago, the scope of engineering has in many respects changed, and the ideal scheme of fifteen years ago is not of necessity best fitted to satisfy to-day's requirements. Such a committee has recently been considering the subject in the United States of America. Perhaps the most interesting part of its report is the general insistence on the importance of cultural subjects, and of a thorough grounding in the general physical principles of engineering. The idea of specialising until a late period of the course, and even then of too pronounced specialisation, is in general deprecated. We are of the opinion that this is a very sound view. We believe that the majority of the engineering schools of the universities of Great Britain do aim at giving this sound fundamental training. At the same time, provision should be made at certain selected universities for highly specialised courses of post-graduate standing. At the moment, this would appear to be the weakest part of the university training of engineers in England. Such a committee as the one suggested might well consider what courses of this nature might most usefully be instituted.

IT seems probable that in the immediate future the development of electricity supply in Ireland will rapidly increase. At present it is more backward in this respect than any country in Europe. The consumption in Northern Ireland is 43 units per head of the population, and in the Free State only 16 units per head. This compares with a consumption of 2500 units in Norway, 900 in Switzerland, and 140 in Britain. In his presidential address to the Irish section of the Institution of Electrical Engineers, Mr. Kettle, the city electrical engineer to Dublin, took a favourable view of the future of electricity supply in Ireland. He said that the Shannon scheme is not mainly a 'power' scheme. It is more a 'transmission' scheme comparable to the Swiss Central Board arrangement and the British Government scheme. He admitted, however, that the promoters of the Shannon scheme seem to anticipate that it will be a commercial success from its commencement—an altogether too sanguine view to adopt. The Free State has anticipated the ordinary course of events

by about ten years, but having put its hand to the plough it cannot turn back. The country has been definitely committed to the scheme, and the fullest co-operation with other schemes is necessary in order to make it a success. A second Shannon Power Bill is apparently expected in the near future and it will probably deal with the supply and control of the entire electricity supply of the Irish Free State. A transmission scheme has been outlined for Northern Ireland, but the authorities there appear to be disposed to proceed more gradually than those of the Free State. There is not much difference between the two schemes except that one would use coal and the other water power. Mr. Kettle thinks that both networks should be so designed that they can be combined to form an all-Ireland scheme at a future date.

THE story of Clerk Maxwell has hitherto been mainly confined to biographical details of his life and general career. As, however, it is now nearly fifty years since he died, it is possible to see how much his work has influenced the development not only of physics but also of applied engineering. In particular, every radio expert claims him as one of the great pioneers of electrical communication because of the invaluable help his electromagnetic theory of light has been in the development of their art. In the October issue of *Electrical Communication* Mr. Rollo Appleyard begins a series of articles on the pioneers of electrical communication by an eloquent eulogy of Maxwell. In 1856 Maxwell accepted a professorship at Aberdeen. In 1860 he became a professor at King's College, London, and in 1871 he became professor of experimental physics at the Cavendish Laboratory, Cambridge. It has to be remembered that from 1851 to 1865 very rapid progress had been made in submarine telegraphy, and many data in connexion with electrical phenomena had been collected which Maxwell had to interpret from the theoretical point of view. His great paper on the "Dynamical Theory of the Electromagnetic Field" was published in 1865. On this paper the electrician has built his practical theory of the working of the alternating current transformer and much of the modern theory of electrical communication. Maxwell admitted electricity to the rank of a physical quantity, but he warned us against assuming too hastily that it was either matter or a form of energy. He considered that it was proved that electricity could not be annihilated and that it could not be created. He has left us a memory of individual thought and achievement which has rarely been rivalled in the history of the world.

PROF. A. P. LAURIE delivered a lecture to the students of the Royal Academy, London, on Wednesday, November 10, on "The Theory of Colour and its Application to Painting." Modern pictures in oil vary frequently and lower considerably in tone in the course of years. One cause of this is the yellowing of the oil, and an investigation was undertaken to see whether some other cause was not also present. Pigments may be regarded as translucent particles of varying refractive index, and the light received from their surface will consist partly of light reflected from the first surface struck by the ray of light, and partly by light transmitted through the pigment, and then reflected. The first reflection will consist principally of white light. The ratio between the reflected and the transmitted ray varies according to a somewhat complex formula with the difference between the refractive index of the medium in which the pigment is ground and that of the pigment itself. Thus, if the refractive index of a linseed-oil film increases with age, the result will be gradually to lower the tone of the pigment ground in it. Experiments have shown that in nine months the change is sufficient to affect the opacity of white lead and the tint of cadmium yellow. A rough table was then prepared of the principal bright pigments used by artists, these pigments being arranged in the order of transparency by examination in media of higher and higher refractive index and also in their spectrum order, so as to enable artists to pick out those least affected by the two changes taking place in linseed oil. These experiments throw new light on the methods of oil painting in the fifteenth and sixteenth centuries; the painters of that time were evidently experimentally aware of both of these properties of linseed oil and based their technique upon these facts with the view of keeping up the colour key of their pictures.

THE thirteenth Thomas Hawksley Lecture was delivered at the Institution of Mechanical Engineers on November 5 by Prof. E. G. Coker, the subject chosen by the lecturer being "Elasticity and Plasticity." After a brief historical introduction, Prof. Coker described the advances which have been made in recent years in the science and technique of photo-elasticity. An interesting feature of this part of the lecture was the description of the apparatus now used for measuring the applied load, which depends upon the elastic deformation of a steel ring loaded diametrally. Photo-elastic methods are employed to determine the most suitable form of ring, and a mechanical multiplying device fixed within the ring serves to record visually the diametral extensions. Prof. Coker then outlined the mathematical theory of photo-elasticity, in regard to the determination of the principal stresses both by direct measurement of the lateral strains, and by Filon's development of Clerk Maxwell's method of integration along the lines of principal stress, using as an illustration of the latter the dovetailed joint used for steam turbine blades. Dealing next with the subject of elastic breakdown, Prof. Coker described the various attempts which have been made to discover a law governing failure under all systems of stress, and referred particularly to those involving combinations of the single criteria proposed by Rankine, St. Venant, and Guest, and to the strain energy theory of Haigh and its modification by von Mises. A most interesting portion of the lecture was devoted to the subject of plasticity, the researches of Prandtl, Hencky, and Nadai being brought under review, particularly in their application to the phenomena associated with the pressure of a die in a steel plate. The manner in which the soap film method used by

Griffiths and Taylor for the determination of stress distribution in torsion can be extended to the case of plastic strain was described, and the lecture concluded with a review of the present state of knowledge regarding the application of optical methods to the determination of plastic stresses.

MR. P. A. BUXTON, of the London School of Tropical Medicine, to whose researches in the New Hebrides reference was made in the article on West African Development which appeared in NATURE of November 6, writes to correct a rather important misapprehension of his conclusions regarding the relation between malaria and abortion. In commenting on the omission in Mr. Ormsby Gore's report of any reference to Mr. Buxton's important memoir on "The Depopulation of the New Hebrides," the statement was made that "it seems fairly well established from the recent researches of Mr. Buxton in Melanesia that malaria is one of the principal determining causes of abortion and still-births." This was based on the statements on page 425, vol. 19, *Trans. Roy. Soc. Trop. Med. Hyg.*, to the effect that "abortion is common in all the islands of Melanesia"; the probability "that methods of obtaining abortion, which have been known [to the natives] from time immemorial, have been used more and more frequently within the last half-century," partly due to increasing monogamy, the outcome of the white missionary's zeal; and the supposition "that unprovoked abortion is common in the New Hebrides, owing to the malaria, and therefore any procedure which is adopted to produce abortion will occasionally be followed by the desired result, even if it is intrinsically harmless." Too much has been read into this last statement, for Mr. Buxton writes: "My conclusions may be summarised thus: malaria and the practice of abortion (not abortion caused by malaria) are both concerned in the disappearance of these peoples. But I have never showed, or tried to show, that malaria caused enough abortions to make it a factor in the depopulation, and it seems improbable that this is so, for the depopulation is an event of the last century and the malaria is an indigenous disease.'

REFERRING to our note in the issue of November 13, p. 708, on the distances at which the 'concentration shoot' off Portland on October 30 was heard, Prof. A. E. Boycott writes stating that the firing was heard very clearly in the open near Aldenham, Hertfordshire, about 125 miles from Portland, and was mistaken at first for thunder. There was a fairly strong north wind blowing. Dr. R. T. Gunther, 5 Folly Bridge, Oxford, states that the firing was distinctly heard on the towing-path near Oxford and it also caused the windows of his house to rattle. Oxford is about 110 miles from Portland.

IN the issue of *Science* for October 1 there is a short but interesting contribution from Dr. Edgar F. Smith on Priestley's life in America, whence he withdrew in 1794 from the animosity to which his religious views had given rise in England. Priestley's daily life in his adopted home is briefly described, and his manifold activities summarised. Persecution followed him across the Atlantic, mainly on account of the anonymous attacks on him which are stated to have been written by William Cobbett, "an Englishman whose pen, dipped in gall, spared the venerable scientist in no wise." He was, however, a friend of American divines. Priestley's advanced views on education are compared with those of Herbert Spencer, and the article is a sympathetic account of a man who has not, perhaps, had the credit paid to him which is his due.

IT is announced in *Science* that the John Fritz Gold Medal of the American Societies of Civil, Mining and Metallurgical, Mechanical and Electrical Engineers for 1927 has been awarded to Elmer Ambrose Sperry, of New York, for the development of the gyrocompass and the application of the gyroscope to the stabilisation of ships and aeroplanes.

AT the annual general meeting of the Cambridge Philosophical Society, the following officers were elected for the session 1926–27: *President*, Dr. H. Lamb; *Vice-Presidents*, Mr. G. Udny Yule, Prof. J. T. Wilson, Prof. A. Hutchinson; *Treasurer*, Mr. F. A. Potts; *Secretaries*, Mr. F. P. White, Mr. R. H. Fowler, Mr. H. Munro Fox; *New Members of Council*, Prof. T. M. Lowry, Dr. H. Jeffreys, Dr. F. J. W. Roughton, Mr. F. T. Brooks.

IT is now announced that the Proceedings of the Optical Convention, 1926, held at the Imperial College of Science and Technology, South Kensington, on April 12–17 last, will be ready in the first week of December. The book is in two cloth-bound and fully illustrated quarto volumes, each of more than 500 pages, and contains the presidential address and the papers read at the Convention, with a full report of the discussions thereon. The address of the Secretary of the Optical Convention is 1 Lowther Gardens, Exhibition Road, London, S.W.7.

A NATIONAL Coal Products, Chemical, and Engineering Exhibition, arranged by the Manchester Section of the Society of Chemical Industry with the assistance of Provincial Exhibitions, Ltd., was opened at the City Hall, Manchester, on November 16 and will remain open until November 27. Scientific exhibits have been obtained from the fuel departments of the universities of the north of England, from the Fuel Research Board, and from the Lancashire and Cheshire Coal Research Association, and there are models, diagrams, and photographs of special interest to those engaged in the mining and utilisation of coal. In connexion with the Exhibition, a Conference on Tar will be held on November 26; three sessions have been arranged, the chairmen of which are Prof. A. Smithells, chairman of the Fuel Section of the Society of Chemical Industry; Mr. T. Glover, president of the Institution of Gas Engineers; and Mr. E. Escott Wood, president of the Coke Oven Managers' Association.

THE Smithsonian Institution of Washington announces the dispatch of a botanical exploring expedition to Colombia under the leadership of Mr. E. P. Killip. Starting from Cartagena, the expedition will follow the valley of the Magdalena River to

Puerto Vilches and then cross over to Bucaramanga and Pamplona near the Venezuelan frontier. The expedition forms part of the programme decided on in 1917 by the Smithsonian Institution, the New York Botanical Garden, and the University of Harvard, for the systematic exploration of the four north-western states of South America, and continues the work begun in 1922 by Mr. Killip in the country around Buenaventura.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—Two laboratory assistants at the Low Temperature Research Station, Cambridge—The Superintendent, Low Temperature Research Station, Downing Street, Cambridge (November 27). An assistant in mycology in the Pathological Laboratory, Harpenden, of the Ministry of Agriculture and Fisheries—The Secretary to the Ministry, 10 Whitehall Place, S.W.1 (November 29). A lecturer in chemistry at Armstrong College, Newcastle-upon-Tyne—The Registrar (December 1). Chemists, physical chemists and physicists for work under the Research Association of British Paint, Colour and Varnish Manufacturers—The Director of the Association, 8 St. Martin's Place, W.C.2 (December 2). An assistant lecturer in organic chemistry in the University of Leeds—The Registrar (December 6). A demonstrator in mathematics at the Royal College of Science, South Kensington—The Secretary, Imperial College of Science and Technology, South Kensington, S.W.7 (December 7). A professor of anatomy in the University of Lucknow — The Registrar (December 31). A principal of the Denbighshire Technical Institute—The Secretary and Director of Education, Education Offices, Ruthin (December 31). A lapidary (male) for the Department of Mines, Ottawa, Canada—The Secretary, Civil Service Commission, Ottawa, Canada (January 6). A professor of physiology in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (January 31). A principal of the University College of Wales, Aberystwyth—General Secretary of the College (January 31). A lecturer in geography at the Bedford Training College—The Principal, The Crescent, Bedford. A lecturer in mathematics in the Gordon College, Khartoum—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 (marked "Lecturer").

Our Astronomical Column.

COMET COMAS SOLA.—This comet is 1926 *f*, being the sixth to be detected during the year ; but four of the six, also Neujmin's Comet, 1926 *g*, were periodic comets observed on their return to perihelion. Mr. G. Merton has photographed the new comet on two nights, and Mr. B. M. Peek sends the following notes on its physical appearance. With a 12-inch mirror, power 200, the diameter of the nebulosity is 1′ using averted vision. Direct vision shows a coma of 15″ diameter, and a stellar nucleus of 12 mag., the total light being fully 11 mag.

Herr Ebell has deduced the following orbit, which is still uncertain owing to the distance of the comet and its slow motion :

T	1927, May 14·333 U.T.
ω	62° 48′
Ω	57 15
i	24 57
log q	0·24405

EPHEMERIS FOR 0^h U.T.

	R.A.	N. Decl.	log r.	log Δ.
Nov. 21	2^h 40^m 25^s	7° 36′	0·4437	0·2614
29	2 32 25	8 19	0·4326	0·2548
Dec. 7	2 25 6	9 11	0·4213	0·2518
15	2 19 8	10 13	0·4097	0·2528

The comet is well placed for observation, being on the meridian before midnight. It is likely to become an easy telescopic object during December.

MODERN ASTRONOMY.—The July issue of *Natural History*, the journal of the American Museum of Natural History (vol. 26, No. 4), is an attractive number devoted entirely to astronomy. Prof. S. A. Mitchell (Director of Leander M'Cormick Observatory) writes on total solar eclipses, of which he has seen six, involving journeys of 50,000 miles in all. The three latest American eclipses of 1918, 1923, 1925 are described in great detail. That of 1923 had the best weather prospects, but the least successful results. Beautiful coloured reproductions of these three eclipses, by Mr. Howard Russell Butler, are given. He describes his method of working in the second article. He notes that there are three factors of colour—brightness or value, prismatic hue, saturation. He makes rapid outline sketches, indicating in shorthand the values of these factors for each region, and works the picture up from these, using photographs to improve the outlines. He also reproduces a coloured picture of a lunar crater lit by a low sun. The sunlit portion is nearly white, with various faint tints. The part in shadow, lit by the sunlit walls and by the earth, varies from greenish brown to brown. The gibbous earth is shown, the ocean being blue, polar regions and solar reflection white, clouds and land light brown ; the sky is dead black and star-studded.

Prof. G. E. Hale writes on solar tornadoes. He gives some beautiful spectroheliograms of prominences, filaments, and vortices, describing the paddle apparatus he has invented for imitating the latter. He mentions the curious change in polarity of sunspots at the beginning of new cycles, but points out that the change is not shared by the high-level hydrogen vortices, which seem to follow the same law of rotation as terrestrial storms. Incidentally, he refers to stars using their energy to build up the atom from electrons and protons. Inasmuch as other physicists are relying on the stars deriving their energy from the atom, to explain the immense duration of their life as suns, there would seem to be need of co-ordination, so that astronomers may not be liable to the accusation of forgetting the conservation of energy, and trying both to "eat their cake and have it."

W. J. Luyten writes on "island universes." He takes the recently adopted distances (ranging from a million light years) as fully established, and studies their size, etc., on this basis. He dates the "era of island universes" from Lord Rosse's discovery in 1845 of the great spiral nebula in Canes Venatici ; but surely Sir William Herschel is entitled to the pioneer honours. Many of his estimates of the size and distance of these objects were of the same order as those adopted to-day.

Research Items.

ILLEGITIMACY AND RACIAL INVASIONS IN BRITAIN.—Dr. John Brownlee has published in *Man* for October an interesting note on the distribution of frequency in illegitimacy in the north of England and Scotland, and its relation to and bearing upon the evidence for racial migration. In the north of England there is a sufficiently close correspondence between the distribution of the round barrow and that of illegitimacy to suggest that this custom was introduced at the beginning of the Bronze Age, and that the invasion of Angles was not sufficient to do more than introduce a new racial element into this part of the country without modifying the custom. Information on illegitimacy in Scotland has been studied in more detail. The range of variation is much greater, the highest percentage of illegitimacy occurring in Aberdeenshire and in the southern districts of Scotland, especially Dumfries and Galloway. The Aberdeenshire district contains a larger proportion of broad-headed persons than any other part of Scotland; but the broad-headed population of the Aberdeenshire tombs is more closely allied to the type of central Europe than is that of Yorkshire and southern England. The percentage of illegitimate to legitimate births is 12 to 15, a rate comparable with that of central Europe. In Dumfries and Galloway there is no broad-headed association, the population being the most narrow-headed in Scotland; but here a close association with a certain type of hill-fort appears. This type of fort belongs to some period about the beginning of the Christian era. In the Norse settlements, Orkney, Shetland, and the western islands, the illegitimacy rate is low, but there are pockets in the north, chiefly adjacent to the coast, where the rate is high.

FOSSIL APES AND MAN.—In the recent issue of the *Bulletin of the Geological Society of China* (Vol. 4, No. 2) Dr. Davidson Black reviews our present knowledge of the distribution of the primates, living and extinct, with special reference to the ancient geography of Asia and its bearing on the ancestry of man. He accepts the principles enunciated by Dr. W. D. Matthew in his well-known essay on "Climate and Evolution" published in 1915, and refers to them repeatedly in his discussion of the subject. He especially emphasises the fact that at any one time the most advanced members of a group of animals must be nearest the original centre of its dispersal, while its lowest or most conservative members are farthest from this centre. Dr. Black then shows on a series of maps the present distribution of the several groups of primates, with the few known records of their extinct representatives. Central Asia, north of the Himalayas, is thus suggested as the region in which they successively originated and from which they were dispersed. Finally, Dr. Black shows the distribution of the known fossils on six maps which represent the continental lands of the successive Tertiary periods, according to Dr. A. W. Grabau. A discussion of these maps leads to the same conclusion, and Dr. Black looks most hopefully to an exploration of the Tertiary sediments in the southern foothills of the Tian-Shan mountains for the discovery of remains of the immediate ancestors of man. Both geologists and anthropologists will await the result with great interest.

FERTILITY IN THE COMMON MULE.—Dr. E. Warren (*Ann. Natal Mus.*, vol. 5, pt. 3, 1926) records an interesting case of fertility in a mule about the authenticity of which there appears to be no doubt. The mule is the result of a cross between a jack donkey and a dark chestnut mare, and was in foal to a hackney stallion. It was eight years' old when it first foaled and is believed to be in foal again. It produced abundant milk and suckled its foal in a perfectly normal manner. Dr. Warren describes the sire, the mule dam, and the foal in some detail with special reference to the degree of likeness of the latter to each parent. He finds that the extent of the prepotency of the parents, and the dominance of the characters, with respect to features which are diagnostic of the two species, horse and ass, vary within wide limits and range from nearly complete dominance to perfect blending.

AUSTRALIAN BIRDS.—The second edition of the official check-list of the birds of Australia has now been issued by the Royal Australian Ornithologists' Union. It has been published only after considerable deliberations on questions of nomenclature by a representative committee of Australian ornithologists and adheres fully to the code of the International Commission. The list gives for each bird the accepted generic, subgeneric, specific, and vernacular name, the range in Australia and beyond, references to the original use of the accepted name and to the standard works of Gould, Mathews, and other workers on Australian birds. A very useful appendix gives the derivations, pronunciations, and origin of all the scientific names used. The work appears to have been very thoroughly and completely done, and, as it has been compiled after due consultation with Mr. G. M. Mathews, who has worked intensively in this field of late years, the list may be regarded as authoritative. As such, it will prove invaluable to ornithologists generally and to museums in particular.

PLANT GROWTH IN THE SEA.—The third number of the *Journal of the International Council for the Exploration of the Sea*, edited by Dr. E. S. Russell and published in Copenhagen in August, keeps up the high standard of interest and utility of the first two numbers. The present issue contains an article on chemical factors concerned in plant growth by W. R. G. Atkins, and original papers by P. Jespersen, Oscar Sund, and C. H. Roberts, whose observations on the rate of absorption of atmospheric oxygen through thin films of fuel oils show how rapidly this may occur, and indicate that oil pollution does not markedly slow down the oxygenation of sea water, although it may be directly harmful to marine animals, since all the oils tested were found to be toxic to fish. In the first article, Atkins correlates a large amount of information concerning chemical factors, most of which has been obtained during the past ten years, as may be seen from the bibliography of more than fifty references. The information has not been brought together previously, and compilations of this kind are much wanted. A point of general interest which has arisen from these researches is the great fertility of the sea; from changes in alkalinity and hydrogen ion concentration it is calculated that the suspended vegetable organisms in the open water of the English Channel every summer use sufficient carbon dioxide in photosynthesis to produce 3 grams of dextrose from every cubic metre of water, or 250 metric tons of dextrose over an area of 1 square kilometre. This corresponds to the annual production of 1400 metric tons wet weight of vegetable plankton organisms per square kilometre in this district, a value which is confirmed by the amount of phosphate utilised annually.

STARCH FORMATION IN THE PRESENCE OF DIFFERENT SALT RATIOS.—The real complexity presented to the investigator by 'calciphobe' and 'calciphile' vegetation is probably well indicated by some recent experiments by Dr. V. S. Iljin upon starch synthesis in the presence of salts of calcium and sodium (*Bulletin de l'École supérieure d'Agronomie*, Brno, 1925.) Leaves of plants were immersed in weak solutions of maltose or glucose in the presence of varying concentrations of chlorides of sodium or calcium and the concentration noted which brought starch formation to a standstill. Plants growing on soils of high calcium content still continued to form starch in the presence of high calcium concentration; on the other hand, even low concentrations of sodium salt prevented synthesis. Halophytes, on the other hand, continued to form starch in concentrations of sodium up to 0·35-0·5 *M*. Some species reacted in this respect at definite salt concentrations quite irrespective of the nature of the soil on which they were previously growing, whilst other species behaved quite differently when taken from soils rich or poor in calcium. Iljin concludes that we may not speak of 'phily' or 'phoby,' but only of the degree of tolerance of the plant to the injurious action of some salt. A plant particularly resistant to such injurious action may be placed at a considerable advantage in the struggle for existence in a soil in which the salt in question is present in a relatively high concentration.

INHERITANCE OF MELANISM IN LEPIDOPTERA.—Heslop-Harrison (*Journ. of Genetics*, 17, 1, 1926) continues the description and discussion of his remarkable experiments upon the inheritance of wing colour and pattern in the lepidopteran genus Tephrosia. He finds that, in interspecific crosses between *T. crepuscularia* × *T. bistortata*, melanism, introduced by the latter, remains, as it does within the limits of a species, a Mendelian recessive; that the progeny carrying two female characters (♀ ♀) out of a *bistortata* (female) × *crepuscularia* (male) mating are non-viable; that in back-crosses between *bistortata* (♀ ♀) and the two possible of the F_1 generation carrying two male characters (♂ ♂), one half of the ♀ ♀ dies; and that in the reciprocal *crepuscularia*(♀) × *bistortata* (♂ ♂) crosses, the sex-ratio among the offspring is undisturbed.

THE INFECTION OF TREE ROOTS BY *ARMILLARIA MELLEA*.—This root rot is one of the most serious of tree parasites and is usually assumed to enter through a wound. Considerable interest therefore attaches to the observation of S. M. Zeller (*Phytopathology*, 16, 479-484, July 1926), who gives grounds for thinking that if an infected root runs across a healthy root, even when both are of considerable age, infection gradually spreads to the healthy from the diseased root, layers of dead flakes being sloughed off the surface of the healthy root as new cork layers are formed in the bark parenchyma. With prune trees, evidence has also been obtained of the entry of the fungus through the little collar around the base of the emergence of a branch root, presumably as the result of the rupture of the bark parenchyma of the parent root during the emergence of the lateral.

THE POSSIBLE IDENTITY OF DIFFERENT MOSAIC DISEASES.—An important paper upon this subject by M. N. Walker appears in *Phytopathology* (16, 431-458, July 1926). Cross inoculation with the mosaic diseases of cucumber, tomato, and physalis confirms other accounts as to the difference in behaviour of the virus in the expressed juices of these plants; thus tomato and physalis juice withstand ageing, drying, dilution, etc., whilst the virus of cucumber juices is much less resistant to such treatment as drying. On the other hand, the disease on tomato produced by injecting with cucumber mosaic shows the usual properties of tomato mosaic, and, conversely, the disease on cucumber obtained after inoculation from either physalis or tomato shows the usual great susceptibility of the extracted virus in cucumber juice. The conclusion would appear to be that the infective principle in each case was the same, and the differences in the properties of the extracted virus are to be attributed to the properties of the juice of the host plant.

A TERTIARY INTER-BASALTIC FLORA FROM WESTERN AMERICA.—Dr. F. H. Knowlton has studied the fossil flora of the beds of clay and shale, named the Latah formation and found in Washington and Idaho (*U.S. Geol. Survey Prof. Paper* 140-*A*, 1926). These beds were formed by the obstruction of the drainage due to the advance of the great lava flows of the Columbian plateau, and are in places overlain by a later series of flows. The plants are unusually well preserved and are of interest as affording evidence bearing on the age of the lavas. Ninety-five forms are recognised, of which 51 are regarded as species new to science, 25 as species found in other areas, and 18 are not named specifically. As a whole, the flora is very modern in appearance, the oaks, elms, maples, and poplars being similar to certain living forms. Taxodium was one of the most abundant forms, and a Sequoia is also common, while Ginkgo is represented by a few specimens. Most of the new species are founded on remains of leaves, but a considerable number of remains of reproductive structures are present, some of which have not been specifically identified. The floras are regarded as showing affinities with those already described from beds of Miocene age. The diatoms of the deposit are described by Dr. A. Mann, who describes 11 new species and some interesting twin forms.

NEW THEORIES OF THE MOTHER-ROCK OF CALIFORNIAN PETROLEUM.—In any oilfield the point of chief theoretical interest is the original source of the oil and the character of the organic matter whence it was derived. Since 1907 the generally accepted theory ascribed the bulk of Californian oil to Miocene diatomaceous shales, and the example has been used repeatedly to illustrate an almost ideal mother-rock, and further in advancement of the hypothesis of marine organic origin of petroleum. With the development of the great oilfields of the Los Angeles Basin, however, there has latterly been some doubt raised as to the validity of the diatomaceous shale theory; in fact, in one case, that of Santa Fé Springs, it would seem to be established definitely that the oil originated in younger formations, namely, the clay-shales of the Fernando group (Pliocene), since the deepest well, drilled to 7215 feet, was not abandoned until it was 2500 feet below the top of the rich oil-bearing sands, the last 1000 feet being barren beds; at the bottom of the well some fossiliferous Fernando beds were proved, thus showing that the Miocene (Puente) shales had not been reached. It is reasonably argued that the great thickness of barren beds present in the lower part of the Fernando formation inhibits the theory of a Miocene mother-rock for the Santa Fé Springs oil, since, had this older horizon been competent in this respect, the Fernando sands would have been successively richer in depth. The fact that Santa Fé Springs has been one of the largest oil-producing fields in the world (for many months in 1923 it was giving a daily production of more than

42,000 tons of oil), is further significant. Recent papers of G. C. Gester, J. E. Eaton, G. E. Cunningham, and T. F. Stipp in *Bulletins of the American Association of Petroleum Geologists* have done much to create the doubt of alleged oil-source in this region, in fact throughout California; but with the appearance of W. A. English's *Bulletin* (*No. 768*) on the Puente Hills Region (which includes part of the Los Angeles Basin), recently to hand from the United States Geological Survey, the alternative theory receives official support, and it is clear that we must prepare to modify considerably our faith in diatom-shales as ideal mother-rocks. Foraminifera, not Diatomacea, are the prominent organisms of the Fernando beds, especially of the oil-measures.

Coefficients of Expansion at Low Temperatures.—An accurate knowledge of the coefficients of expansion of solids at low temperature is necessary for testing theories of the solid state, and R. M. Buffington and W. M. Latimer have obtained expansion data for aluminium, copper, silver, rock salt, quartz parallel to the optical axis, and pyrex glass between 90° and 315° K. The Fizeau interference method was used, and a full description of the investigation is published in the *Journal of the American Chemical Society* for September. The coefficients of expansion of the crystalline solids, which change slightly more rapidly than do the specific heats, approach zero at low temperatures, in agreement with the prediction of Nernst. It was possible, from the data on aluminium, copper, and silver, to introduce terms depending on the constraints between the atoms into the equation for the entropy of solids, and the entropies of six monatomic solid metals are shown to be satisfactorily represented by the new equation.

Photography at Low Pressures.—The May issue of the *Memoirs of the Kyoto College of Science* contains a paper by Osamu Masaki on the effects of low pressure on the sensitivity of the photographic plate. Two pieces cut from the same plate were enclosed in two compartments in a glass-fronted brass box. The pressure in one of the compartments could be reduced to that of 0·005 cm. of mercury. The box was placed behind a rotating Hurter and Driffield wheel, the openings in which exposed strips of the plates for times in the ratio 1, 2, 4, 8, 16, etc. to the light of a 50-watt incandescent electric lamp of milky glass placed a metre away. The density of the film after development for 3 minutes was measured by means of a photo-electric cell and electrometer. In almost all cases the plates were more sensitive under reduced pressure, the effect being greater for slow than for fast plates. The reduction of pressure also reduced the tendency to fog. The greater part of these effects appears to be due to the drying of the emulsion, but some part is played by the removal of occluded gases under the reduced pressure.

Velocities of Diffusion in Gels.—The *Science Reports of the Tôhoku Imperial University* for July 1926 contain a paper by M. Watanabé on the relation between the diffusion velocity and the concentration of the diffusing substance. The equation $K = m\log C + n$, in which K is the value of $d/\sqrt{t}$ at the beginning of diffusion (d being the distance of the diffusion in time t), C the original concentration of the diffusing substance, and m and n constants, was found to hold at the beginning of diffusion of a salt from solution into a gel containing a reacting substance. O. von Fürth and F. Bubanovic consider that the equation holds if $K = \log d/\sqrt{t}$. For a limited range of concentrations it is clear that both formulæ apply, and Watanabé shows that this is due to the diffusion of the substances dissolved in the gel, which renders the results inaccurate. When a colloidal reactant was used the formula $d/\sqrt{t} = m\log C + n$, was found to apply over a wide range of concentration, while Fürth and Bubanovic's expression is limited to a few concentrations. In a further paper in this journal the formula is applied to the results of experiments on the diffusion of mixtures of copper and zinc sulphate solutions.

The Rate of Reaction of Nitric Oxide and Oxygen.—H. B. Baker has shown that carefully purified and dried nitric oxide and oxygen do not react; but under ordinary conditions combination takes place rapidly, and W. A. Patrick and R. L. Hasche have studied the effect of increased glass surface on the reaction velocity. In the *Journal of the American Chemical Society* for September, Hasche describes further experiments in which the influence of a paraffin-coated reaction chamber, and moisture, sulphur dioxide, and nitrogen tetroxide have been measured. It was found that moisture increased the speed of combination, and the decrease in velocity caused by the paraffin surface is thought to be due to a decrease in the amount of moisture. In the absence of water vapour, a period of induction of about 10 sec. was noticed at initial partial pressures of less than 14 mm. The effect of sulphur dioxide and nitrogen tetroxide was negligible.

Heat Loss and Frictional Resistance in Air Currents.—The relation between the heat lost by a hot surface when cooled by a current of air passing over it, and the frictional resistance experienced by the surface, has been subjected to investigation by many research workers. So early as 1874 Osborne Reynolds examined this question. That such a relation may exist appears clear from the fact that both the frictional resistance and the heat transference occur in association with the passage of momentum in the air in the neighbourhood of the surface. A further contribution to this subject has appeared in the Aeronautical Research Committee Report, R. and M. No. 1004 (H.M. Stationery Office, 1*s.* net). In this paper Miss D. Marshall has recorded two distinct series of tests. In the first place a short heated section of pipe, 5 in. in diameter, was cooled by a current of air forced through it, the heat transmitted being estimated from the rising temperature of the air. In the second test, thin rings of nickel heated electrically were supported in a wind channel, the transmitted heat being measured from the energy supplied to the ring. In this latter case the effect of artificially roughening the surface of one of the rings was specially investigated. In common with previous experiments, a considerable discrepancy is found to exist between the observed heat transmission and that calculated from the measured surface friction, a difference of 20 per cent. being found in the case of the smooth rings. In the case of the roughened rings, however, fairly close agreement is found over a considerable range of speed. Thus it will appear that the effect of surface roughness is much greater than would be anticipated, the dimensions and form of the irregularities constituting quite an important factor. The investigation must prove of considerable interest in its bearing on the surface friction of thin plates in the neighbourhood of the leading edge, for these results are in fairly good agreement with the law of surface friction deduced by Blasius from Prandtl's theory of the boundary layer. This agreement extends both to the law of variation of frictional resistance with speeds and the actual value of the forces.

Progressive Lightning.

DR. N. ERNEST DORSEY (*Jour. Franklin Inst.*, 201, pp. 485-496, April 1926) in America, and Dr. G. C. Simpson (*Proc. Roy. Soc.*, A, vol. 111, No. 757, May 1926) in England, have recently published papers in which they have discussed from theoretical considerations the start and progress of a lightning flash, and in a recent number of NATURE (August 7, p. 190) these two authors discuss the question again, and even if they do not arrive at opposite conclusions they, nevertheless, are not by any means in accord.

So long ago as 1900 I made some apparatus with a view to obtain by experimental means, if possible, some evidence as to the progressive character of the lightning flash; but before dealing with this I think it well to refer the two authors to a paper by Dr. H. H. Hoffert (*Proc. Phys. Soc.*, 10, 1890, pp. 176-179) which appears to me to bear on the subject, and which I think they have overlooked. Dr. Hoffert desired to test an assertion which I had made in a discussion on a paper by Mr. Whipple (NATURE, May 16, p. 71, 1889), to the effect that very often the lightning flash was multiple; two, three, or many more succeeding one another very rapidly along exactly the same path, which I thought was obvious to every one, but the truth of which, nevertheless, was not readily accepted. He therefore exposed a camera during a very heavy thunderstorm in the direction in which the frequent flashes were seen, and kept it waggling rapidly to and fro. So far as he knew, he exposed the plate to a single flash only. In the first place he obtained a triple photograph of the flash he had seen, the three images being widely separated. They are all identical in form, bearing out fully what I had said, but the photograph showed much more than this, and it is these other points that bear, so I think, on the later theoretical discussion. I have three prints which Dr. Hoffert gave me at the time, which are entirely untouched.

The print accompanying the paper is exceedingly faithful and true for the purpose of illustration, and there is a skeleton diagram with reference to which Dr. Hoffert gave a very full discussion of all that is shown. The point of greatest interest in connexion with the controversy above mentioned is the almost certain conclusion that a flash within the cloud and terminating (or starting ? C.V.B.) at a point from which the main flash started preceded this by a very evident interval. The other point of interest is that this region remained luminous all that time and until the third main flash had occurred; also that the more marked angles in the main flash, which may have been foreshortened portions directed towards the camera, also remained luminous in the intervals between the three main flashes. These were more in the upper part of the flash from which branches directed towards the ground emanated, and the branches were far more conspicuous in the first of the three main flashes. The lower part was devoid of branches and of continuous luminosity. Reproduced herewith is one of Dr. Hoffert's prints (Fig. 1), but I doubt if the more delicate features can be reproduced. It would be better added to Dr. Simpson's collection if it interests him.

Before describing my apparatus of 1890 I should like to refer to an observation which I made about the year 1876, as in a life's observation of lightning the phenomenon then accompanying every flash is one which I have seen on no other occasion. It may have some bearing on the conclusions of the two authors. A storm one evening in the autumn had passed directly over the village of Wing in Rutland and moved away to the north, leaving a clear starlit sky above the thundercloud, with the stars of the Great Bear in their lowest position far above. When the storm was distant about ten miles and more, for every flash seen in the rain cloud and below, and simultaneous with it, there were one or more very slender flashes of typical lightning form from the cloud upwards and many times as long as the usual kind of lightning below. According to my recollection, these reached one-third or perhaps half-way towards the stars of the Great Bear, and in one instance there were seven of these flashes going simultaneously into the clear sky.

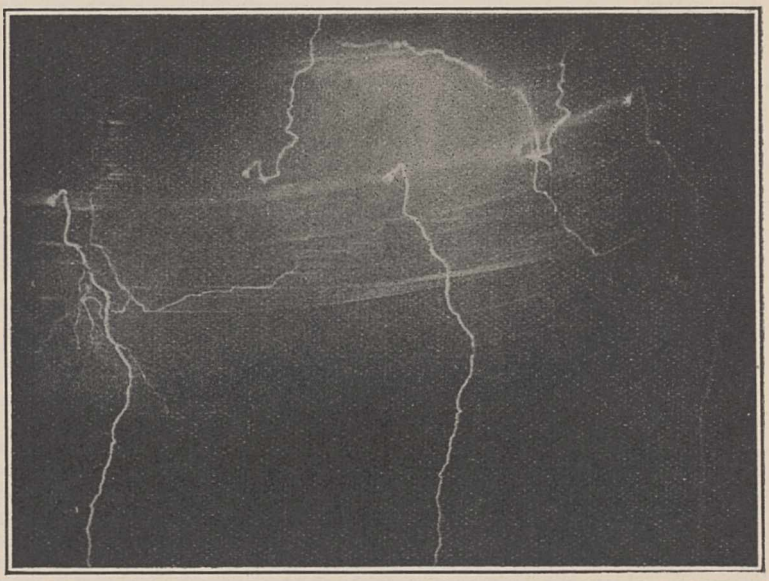

FIG. 1.

Coming now to the year 1900, I wished to obtain some experimental evidence, if possible, of the progress of the lightning flash. The impression that there is a downward direction in a flash is very common, and occasionally observers believe one has an upward direction. Without paying too much attention to impressions of this kind, and yet not ignoring them altogether, I desired to make a conclusive test, and to get any information possible as to the beginning or to the progressive character of the flash. The scheme was to use a pair of identical camera lenses (specially selected for stereoscopic photography) and to mount these on a disc which could be rotated by hand through gearing at any desired speed. In the apparatus I then made I could drive them at any speed up to about forty turns a second. The lenses were four inches apart, centre to centre; the two images of a lightning flash would then be carried in opposite directions at any speed up to about forty feet per second, and if the flash in each part of its length should be 'instantaneous' a difference in time between the two ends of the flash of about $\frac{1}{40000}$ second would be observable. If, for example,

the flash were a vertical line and the lenses at the moment were one above the other, one image would be tilted in one direction while the other would be tilted in the other direction, and the more so the greater the duration. If the lightning were not at any part 'instantaneous,' by which I mean if it lasted long enough for its image to be broadened —that is, $\frac{1}{10,000}$ second or more—the two images would fade away, but on opposite sides, and the sharp side would still be available for comparison. If the lenses should happen to be on the same level, then one image would be lengthened and the other shortened, and measurements between well-defined kinks would show this. Similarly for other positions of the lenses there should be both tilting in opposite directions and change of length. If the duration of the illumination at each point in the flash should be sufficiently short the stereoscopic method of observation seemed to promise to be most convenient. For this purpose it would be necessary to cut a print, taken from the 10 × 8 backed plate used to receive the images, into two parts, and to slide the two parts so as to bring the two images to stereoscopic distance, and so that the motion due to the lenses was parallel to the line joining the eyes. If then they were maintained strictly parallel to their former positions, the effect of the movement due to the lenses, if apparent, would be to make the stereoscopic image appear to leave the plane of the paper; and owing to the extreme delicacy of the stereoscopic sense, this might be as valuable a test as a micrometric one and much more convenient.

I made this apparatus in 1900, and carried it about with me, for example, to the British Association meeting at Glasgow the following year, and only once obtained a moderately good view of a few flashes, but the developed plates showed nothing at all! Though I have had this now for twenty-six years, I still have not succeeded in obtaining any photograph. It had been my intention to go on until I did get a result before describing the method, but as I now have no window in London with a good sky view, and in my present house at St. Marybourne in Hampshire, while I have all the sky there is, I have no 'compact' storms such as we so often have in London. For twelve years I have not seen a storm in which the lightning is fairly frequent and in one direction, which is what I mean by 'compact,' and therefore if any results of interest are ever to be obtained in this way they must be by some one else. If Dr. Simpson thinks the method worth following, the apparatus with the 10 × 8 double back, which it is made to take, is freely at his disposal.

In the case of a multiple flash on the same track the different pairs of images would be at altogether different azimuths, and the wheel of lenses might well have made more than one turn between each. They would therefore in no way clash when examined. There might, however, be a marked difference between the first and succeeding flashes if the first showed any sign of progressive character due to the operations discussed by Drs. Dorsey and Simpson. The first flash has certainly left the whole track conducting, and succeeding flashes therefore might well fail to show any such progression.

There is one more experiment which I have wished to make with this apparatus. This is to fire a rocket towards or into a thundercloud when it is getting ripe for another flash. The ordinary display rocket would do perhaps, especially if its head were removed and its stick lightened. I should, however, prefer to make suitable rockets on purpose with perhaps an extra calibre of composition over the spindle and no head. Such a rocket would go at an immense speed to twice the usual height if undisturbed by lightning on the way, leaving a conducting trail of potash smoke and ions of every kind. A six-oz. rocket ($\frac{7}{8}$ inch) or a half-pound (1 inch) would be the most convenient to use. The pound rocket ($1\frac{1}{4}$ inch) is more difficult to make, but it would be very persuasive, while a 3 lb. rocket ($1\frac{3}{4}$ inch), the largest within my experience, is too much of an undertaking and too dangerous in its descent to be lightly selected.

If a photograph were obtained with the revolving lenses of a flash striking a rocket a good way up, the rocket itself might be expected to be the place of origin of the flash, and this position would be obvious on the plate, as below this the lightning would no doubt follow the rocket trail.

Rocket-directed lightning also would be good for spectrum examination, as a prismatic camera could be employed with certainty as to time and direction. There might be some indication of potassium in the spectrum below the rocket, and a great splash of potassium at that place if the lightning got inside and fired the remaining charge all at once.

To fire such a rocket, the only safe plan would be to pull a string lying on the ground and leading to a striker at the rocket. No slow match would work at the desired instant, and electric communication by wire would be too dangerous. I am unable to make the rocket experiment as I am in a village of thatched houses.

C. V. BOYS.

The Detection of Icebergs.

THOUGH navigation in iceberg-infested waters has been recognised from early times to be fraught with special dangers, it is only comparatively recently that attempts have been made to apply scientific methods to the detection of these floating dangers to navigation. Early whalers and explorers in Arctic and Antarctic waters met and surmounted these dangers without such assistance, but the present circumstances of sea travel in waters occasionally subject to invasion by icebergs are so different as to render special precautions necessary. Some of these circumstances are the increasing size and speed of passenger vessels, the replacement of wooden hulls by steel, and the need, in the face of competition from rival steamship companies, to complete the voyages within scheduled times. The small ice 'growler,' floating almost submerged, is not only the most difficult to detect, but is also almost as dangerous an obstruction to modern steel ships as the iceberg of large dimensions, which is likely to be more readily perceived even in a fog.

The apprehension of the need for early warning of the approach of the ice has been especially lively since the *Titanic* disaster in 1912. This disaster led directly to the formation of the International Ice Patrol, which now maintains a continuous patrol during the ice season in the dangerous area of the North Atlantic. This organisation is maintained by the United States, the countries chiefly concerned contributing to the cost in proportion to their shipping tonnage. At present the chief duties of the Ice Patrol are: The continuous location of ice endangering the shipping lanes, and dissemination of relevant information to vessels approaching the danger area; oceanographical

work associated therewith; the investigation of various devices and aids to the location of casual icebergs, and of the waters of polar origin in which they are found.

The early experiments of Profs. Barnes and L. V. King on the detection of icebergs by temperature differences in the neighbouring sea water, which were carried out with the assistance of the Canadian Government, seem to have been unsuccessful, since we find that attention is now being concentrated on underwater echo methods of detection similar to those used for echo sounding. These methods formed the subject of a recent illuminating article in NATURE, May 9, 1925, p. 689. In the 1925 season an echo sounder of U.S. Navy type was tried by the Ice Patrol, and it was established that weak echoes could be obtained from a large iceberg in favourable circumstances at a maximum range of 2500 yards, the echoes being, however, first reflected from the bottom of the sea. 'Growlers' and very small bergs did not reflect well under normal conditions.

In the meantime, it is encouraging to note that the Canadian Government and the Research Council of Canada have afforded Prof. Boyle and his co-workers the financial and material assistance which has enabled them to institute a series of fundamental investigations[1] on the properties of ultrasonic (high-frequency) sound waves in water. Some tests have also been carried out at sea. The investigations included the measurement of the energy in an ultrasonic sound beam in water by means of a torsion pendulum, together with the measurement of the energy reflected from various materials, such as steel, various types of rock, and ice immersed in the water. The lateral distribution of energy in the sound beam has also been determined in this way. One of the most striking experiments has been the production of stationary waves in a small tank, which were made evident by the pattern formed on a tray by the dust of coal cinders which had fallen slowly through the acoustic energy field above. This method of rendering visible the interference pattern due to the combination of direct and reflected beams has been utilised to check the values of the coefficient of reflection from different substances by decreasing the energy output of the transmitter until a definite pattern just failed to form in the case of each reflector.

The experiments showed that ice was, of the materials tried, the worst reflector of sound. This, indeed, was expected from the fact that the products (density × velocity of sound) for ice and water differ little from one another. The circumstance that ice in its natural condition contains a considerable amount of included air in the form of bubbles held under pressure will, however, tend to make the detection of icebergs by echo methods less unpromising than might be judged from calculations on the basis of the data relating to pure ice, while the variations in temperature and salinity in the water surrounding a melting berg must also be taken into consideration.

The final report details the results of some practical trials to determine the range of iceberg detection at sea by the use of a high-frequency sound transmitter fitted on the s.s. *Montcalm*, a vessel maintained by the Department of Marine and Fisheries of Canada. It was anticipated that the small transmitters used would enable echoes to be obtained from rocks at a range of about 1000 yards, and this estimate was found to be justified. Echoes from a medium-sized iceberg were detected at a range of only 250 yards, but echoes due to multiple reflections between the berg and the ship were observed in other cases at a distance of 150 yards. In spite of this statement, it is clear that a very accurate measurement of time interval between echoes must be made before the explanation of the cause of the multiple echoes can be accepted. It is stated that the tests, which were carried out in shallow water, showed that echoes from the bottom and surface of the sea were a source of disturbance up to and beyond the time of arrival of the echoes from the iceberg.

The results obtained by Prof. Boyle are promising in that more powerful transmitting apparatus has already been constructed by him. Whether a reasonable increase in power will permit detection of the smaller icebergs and 'growlers,' which must be considered the most dangerous types of ice, can only be decided by further practical experiments at sea. In view of the attitude already displayed by the Canadian Government and by the Research Council of Canada, there is room for little doubt that Prof. Boyle will be enabled to continue his investigations to a point which will decide whether the directional high-frequency, or the relatively non-directional low-frequency, sound beam is better adapted for the detection of floating ice. C. S. W.

[1] *Trans. Roy. Soc. Can.*, Third Series. Vol. 19, 1925, p. 167. "Visualisation and Energy Survey of a High-Frequency Diffraction Beam." By R. W. Boyle, J. F. Lehmann, and C. D. Reid. Vol. 20, 1926, p. 245. "Reflecting Powers of Various Materials for Ultrasonic Waves." By R. W. Boyle and G. B. Taylor. Vol. 20, 1926, p. 233. "Practical Experiments on the Detection of Icebergs and on Sounding by Means of an Ultrasonic Beam." By R. W. Boyle and C. D. Reid.

The Total Solar Eclipse of January 14, 1926.

A JOINT meeting of the Royal Society and Royal Astronomical Society was held at Burlington House, London, on Thursday, November 11, to discuss the results obtained by the British eclipse expedition to Sumatra in January of this year. The Astronomer Royal opened the discussion with an account of the coronal pictures obtained by various eclipse expeditions in the past sent out from the Royal Observatory, Greenwich. In addition to the well-known changes of form with the solar cycle, he pointed out the close connexion of certain prominences with arches in the corona, and also certain changes detected as taking place during an eclipse, as seen from a comparison of plates taken at widely distant stations.

Mr. C. R. Davidson gave an account of the instrumental arrangements made for the Sumatra observations (see NATURE, February 27, p. 306), and of the chief results obtained from it. A study of the objective-prism spectra obtained by Col. J. Waley Cohen with a camera of 38-foot focal length, and by Dr. F. W. Aston with a 19-foot camera, gives the heights to which the different elements can be traced, the observed heights being in general accordance with previous results. The coronal rings show evidence of intensification in the neighbourhood of several prominences; the brightening does not quite coincide either in position or in form with the prominences, but some close relation seems to be indicated. The plates taken with the Grove-Hills flint slit-spectroscope do not go beyond the oxygen triplet at λ 7772. The dicyanin stain failed to work satisfactorily under the conditions of heat and damp prevalent in Benkulen. The wave-lengths of the two coronal lines in the green and the red were determined as 5303·4, 6374·1 I.Å.U. The flash spectrum obtained by Mr. Davidson with the Grove-Hills quartz slit-spectroscope extends down to λ 3066. The lines have been measured and

grouped in series, where the data are available. In the coronal spectrum obtained with the same instrument, the lines from a high prominence, which also appear on the plate, gave an excellent scale for the coronal wave-lengths. These have been determined as 3387·95, 3454·11, 3601·03, 3642·87, 3800·77, 3986·82, and 4086·30 I.Å.U. The relative brightness of the lines of the corona differs from the values found in previous eclipses, but it is easily apparent that the lines themselves differ in the distribution of intensity with height above the sun's limb.

Mr. Stratton gave an account of the photometric work which has been done, by the kind permission of Prof. L. S. Ornstein, by Dr. Minnaert and himself on the ultra-violet slit-spectra with the aid of the Moll spectro-micro-photometer at the physical laboratory at Utrecht. The trustworthiness of the actual measures of intensity of the lines have been tested by examining certain multiplets which have been found to have relative intensities in close accordance with their proper values. The intensity of the K line has been measured at eight different heights and a satisfactory accord found over a range 30,000 km. to 100,000 km. of height with the theoretical value calculated by Mr. P. A. Taylor from Prof. E. A. Milne's theory of the chromosphere. The coronal lines also have been measured for intensity at different heights, and curves plotted connecting the intensity with the height. The lines were divided into three well-marked groups; the extreme groups confirmed the results found some years ago by Sir Norman Lockyer through a study of variations in the coronal rings from different sources. Attempts have been made from a study of line intensities to determine the temperature of the sun at different levels. In the Balmer series an application of Schrödinger's formula has given a temperature which decreases as the height above the sun's limb decreases. The temperatures deduced cannot be accepted, but what the observations gave was a measure of the weakening at lower levels in the chromosphere of the lines in the Balmer series corresponding to the atoms with the larger orbits. This weakening was to be expected from the increased ultra-violet radiation from the sun streaming through these lower layers; its extent has now been measured. Balmer lines from Hδ (6) to H 29 have been used in this work. The hydrogen continuous spectrum which extends towards the violet from the head of the Balmer series has also been examined. From this a measure of the temperature (the distribution of the velocities of the electrons) was possible. The value thus found, 1700° K. at 8000 km. height, is too low, as checked by a cross-determination from the relative intensities of certain ionised titanium lines at that same level and in the low level of the flash spectrum. One further result of interest in the photometric work is a study of the continuous spectrum in the low corona or high prominence at a height of 20,000 km. In agreement with the result obtained by Deslandres in 1893, this continuous spectrum when compared with that of a black body gave a lower temperature than the sun's temperature. The result is consistent with Ludendorff's recent work on the distribution of intensity in the continuous spectrum of the corona, which he finds to be unaltered from that of the sun. But Ludendorff's results come from much higher layers and are consistent with the light being scattered by electrons. The suggestion is that at the lower layers concerned the light is, partly at least, affected by Rayleigh scattering from atoms.

Prof. Ornstein raised the point whether a formula due to Miss Bleekers which fits many laboratory spectra need be rejected because when applied to the Balmer series it gives a negative temperature. This is very little different in reality from the extremely low temperatures given by the Schrödinger formula. Both formulæ make it clear that some disturbing factor is affecting the relative intensities of the lines, which clearly do not correspond to thermodynamical equilibrium. He welcomed the co-operation in this work of physicist and astrophysicist.

Dr. Minnaert dealt with the problem of comparing intensities at different wave-lengths and urged the necessity of extending our knowledge of a trustworthy curve of the intensity of the solar radiation for different wave-lengths. Abbot has not used sufficient resolving power to meet present requirements of spectrophotometers, and H. H. Plaskett's work needs to be extended more towards the ultra-violet. It is desirable that astrophysicists living in suitable climates should make further measures by photographic methods, if full value is to be obtained from future eclipse records.

The president of the Royal Society, Sir Ernest Rutherford, expressed his appreciation of Mr. Davidson's beautiful photograph of the Balmer series and of the kind co-operation of the Dutch scientific workers in reaping the fruit of the eclipse expedition, their own expedition having failed through bad weather conditions. It is the first time that intensity measures have been made on eclipse spectra; and the possibility of this has been due to the work of Prof. Ornstein and his colleagues at Utrecht.

Prof. Newall expressed great pleasure at hearing from the Astronomer Royal that Mr. Wesley's drawings of the corona are to be reproduced, and added his view that Mr. Davidson's ultra-violet spectra are the best yet achieved in eclipse work. He, too, welcomed the co-operation with the Dutch physicists and astrophysicists.

Prof. Fowler expressed admiration for the photographs, and pointed out with what refinement the adjustments must have been made. The photographs seen that day were remarkable for the large size of the solar image, and they should add considerably to our knowledge. He was interested to hear about the suggested relation between the coronal intensity and the prominences, as there is no evidence for it in earlier eclipses. The increased accuracy of the wave-lengths of the coronal lines should help in the further investigation of their source. What is now required is higher resolution and more powerful instruments. Longer exposure is necessary, and this could be obtained by working on the edge of the belt of totality or even outside it.

Prof. Milne pointed out that the theories being tested at this eclipse are all of very recent growth. Prof. Ornstein must feel gratified that his contribution is bearing fruit so soon. It is possible that some of the theories of solar physics will need to be revised. He was much interested in Mr. Taylor's results. It is clear that radiation pressure must play its full part in supporting the atoms at high levels if the chromosphere reaches the heights indicated. The low temperatures found at the lower levels of the sun only indicate that the fraction of the more highly excited atoms there is less than it would have been if the atmosphere had been in thermodynamical equilibrium. If the distribution of intensity in the continuous spectrum is due to atomic scattering, then it looks as though the prominence must consist of a mass of material thrown out with a comparatively high density.

Mr. R. H. Fowler suggested that it is the laws of a perfect gas that are failing at lower levels rather than those of thermodynamical equilibrium. He had made a rough numerical estimate of the falling off of

intensity of lines of the higher quantum numbers and compared it with Urey's correcting factor. That will account partly for the result expressed in terms of the parameter, T, as indicating a lower temperature.

Prof. Lindemann supported the view that the future of eclipse work lies with photometry rather than with the determination of wave-lengths. In discussing the continuous light, the possibility of light-scattering in the instrument should be borne in mind. He would like to see a negative temperature gradient in the sun, such as might fit the demands of convective equilibrium.

Dopes and Detonation.

WE have received a copy of the Air Ministry Reports and Memoranda, No. 1013, by H. L. Callendar, R. O. King, and C. J. Sims, published by H.M. Stationery Office. The primary object of the investigation which is described was the determination of the physical actions that delay or prevent detonation in the cylinder of an internal combustion engine.

The addition to petrol of non-detonating fuels, such as benzene, has long been familiar as a means of checking the onset of 'pinking' in a high-compression engine. In the case of benzene a large addition is required; alcohol and toluene are more effective than benzene by about 50 per cent., though they still appear to act mainly by dilution of the original fuel.

There are, however, other classes of substances, many times more effective than toluene, the action of which cannot be explained by dilution. Thus, in the case of lead ethide, the addition of 0·25 per cent. by volume is nearly as effective as 100 per cent. of toluene. Nickel carbonyl shows a similar order of effectiveness.

The action of such 'dopes' must evidently depend on some specific property requiring further investigation. It has been shown that the heavier paraffins, on account of their high critical temperatures combined with low critical pressures, are exceptionally liable to persist in the form of nuclear drops, which serve as foci of simultaneous ignition by compression owing to their low ignition temperature. The marked effect of pressure in promoting detonation is explained by the rapid increase of nuclear condensation with increased density of charge. The action of a dope in delaying detonation is to 'infect' the nuclear drops in such a way as to delay their ignition. The fact that these drops form a small percentage of the whole mixture helps to explain the possibility of a relatively small quantity of the dope being effective. It has been shown that lead ethyl and nickel carbonyl, two of the most effective metallic dopes, when mixed with petrol residues, decompose rapidly at temperatures above 200° C., depositing a film of metal on the surface of the liquid. This metallic film would tend to protect the nuclear drops from oxidation, and would help to keep down their temperature by reflecting radiation.

Organic dopes, such as methylaniline and xylidine, have the advantage that much higher compression ratios can be employed than in the case of metallic dopes without risk of fouling the engine with deleterious deposits. On the other hand, much larger quantities are required than in the case of lead ethide. Organic dopes probably act mainly by the dilution of the nuclear drops, which results in a rise in the ignition temperature; but the chemical reactions which may occur are very complicated and require further investigation.

University and Educational Intelligence.

CAMBRIDGE.—Honorary degrees are to be offered to the Maharajadhiraja Bahadur of Burdwan, the Right Hon. W. L. Mackenzie King (Prime Minister of the Dominion of Canada), the Right Hon. J. G. Coates (Prime Minister of the Dominion of New Zealand), and to Mr. W. T. Cosgrave (President of the Executive Council of the Irish Free State).

Amongst those elected to the Council of the Senate are Sir H. K. Anderson, Dr. T. C. Fitzpatrick, Prof. A. C. Seward, Mr. T. Knox Shaw, and Mr. F. J. M. Stratton. Mr. R. E. Priestley, Clare College, assistant registrary, has been elected secretary of the general board of the faculties, a body that is to be elected for the first time on November 30.

Mr. W. H. Florey, lately John Lucas Walker Student and Rockefeller Research Fellow, has been elected to a fellowship at Gonville and Caius College.

MANCHESTER.—The Council has made the following appointments: Dr. William Susman, to be lecturer in morbid anatomy and histology; Mr. C. J. Polson, to be assistant lecturer in chemical pathology; Mr. A. M. Downie, to be assistant lecturer in bacteriology; Dr. F. A. Mason, to be lecturer in tinctorial chemistry and dyestuffs; Mr. Arthur Riley, to be assistant lecturer in textile engineering; Mr. F. W. Bailey, lecturer in papermaking.

Dr. Ivar Waller has been awarded an honorary research fellowship in physics.

Dr. James A. Bowie has been appointed Director of the Department of Industrial Administration in the Manchester College of Technology. After the War, Dr. Bowie was appointed lecturer at the College, where he devoted his attention to industrial relations with special reference to problems of wages, profit-sharing, and copartnership.

THE Universities of South Africa form the subject of an article by Prof. H. Clement Notcutt, of the University of Stellenbosch, in the October number of the *University Bulletin* (issued by the Association of University Teachers). It is pointed out that whereas the Act of Parliament which brought the Union into existence provided that the English and Dutch languages should both be "official," Afrikaans, which differs from the Dutch of Holland both in vocabulary and in syntax and is the home language of a large part of the inhabitants of Dutch descent, has recently been given by Parliament the same status. Consequently there are now three official languages. In the schools, English and Afrikaans are taught with the intention that all children of European descent growing up in the country shall have an adequate knowledge of both languages, but there is an ever-present danger of their failing to acquire the power of using either with that exactness which is necessary for clear thinking. Prof. Notcutt might have added that the prestige won for Afrikaans has reacted unfavourably on the position of Dutch, and a movement inspired largely by enthusiasm for maintaining the Netherlands connexion and cherishing the traditions handed down from the original Dutch settlers is in fact tending to estrangement, for the Dutchmen of Holland cannot, generally speaking, find time to learn Afrikaans, nor can the Afrikanders spare for Dutch so much time as they could before Afrikaans became a literary and official language. It is estimated that a higher proportion of the *white* population is attending college or university than in Great Britain or any of the other British Dominions. A noteworthy characteristic of South African university students is their devotion to sports, in which respect they resemble the students of Oxford and Cambridge rather than those of the other English universities.

Contemporary Birthdays.

November 20, 1851. Prof. John Merle Coulter.
November 21, 1866. Sir John Carruthers Beattie.
November 22, 1868. Sir Thomas H. Holland, K.C.S.I., K.C.I.E., F.R.S.
November 22, 1875. Prof. L. N. G. Filon, F.R.S.
November 23, 1864. Dr. P. Chalmers Mitchell, F.R.S.
November 26, 1851. Prof. J. Cossar Ewart, F.R.S.

Prof. COULTER, botanist, was born at Ningpo, China, and he was educated at Hanover College, U.S.A. Early in his career, when only twenty-one years of age, he was botanist with the United States Geological Survey in expedition work in the Rocky Mountains. Afterwards he returned to his old college, becoming professor of natural sciences; next he accepted the chair of biology in Wabash College. President, and professor of botany in Indiana University from 1891 until 1893, he has been, since 1896, professor and head of the department of botany in the University of Chicago. He is a member of the National Academy of Sciences, Washington and of the National Research Council; and a foreign member of the Linnean Society of London.

Sir J. C. BEATTIE, a graduate of the University of Edinburgh, studied also at Berlin and elsewhere abroad. Professor of physics in the South African College, Cape Town, from 1897 until 1918, he is now vice-chancellor and principal of the University of Cape Town. In 1909 (collaborating with Prof. J. T. Morrison) he brought to successful issue a magnetic survey of South Africa.

Sir THOMAS HOLLAND, Rector of the Imperial College of Science and Technology, received his scientific training at the Royal College of Science, South Kensington. He joined the Geological Survey of India in 1890, and was appointed professor of geology and mineralogy in the Presidency College, Calcutta, in 1893. From 1903 until 1909 he was director of the Geological Survey of India. Returning to England he became professor of geology and mineralogy in the University of Manchester, occupying the post for nine years. The Geological Society of London awarded him its Bigsby medal in 1913 in recognition of eminent services rendered to geology, more especially during his tenure of office in India. Sir Thomas is chairman of council of the Royal Society of Arts.

Prof. FILON has been Goldsmid professor of applied mathematics and mechanics in the University of London since 1912. Born at St. Cloud, France, he was educated at University College, London, and his energies, in the past and present, have centred there.

Dr. CHALMERS MITCHELL was born at Dunfermline. He graduated at the University of Aberdeen and Christ Church, Oxford, studying as well at Berlin and Leipzig. Since 1903 he has been secretary of the Zoological Society of London. Dr. Mitchell has made notable contributions to biological science, and has in addition promoted wide interest in scientific progress generally by numerous articles and other works.

Prof. J. COSSAR EWART was born at Penicuik, Midlothian, and graduated at the University of Edinburgh. Sometime occupant of the chair of natural history in the University of Aberdeen, he returned to Edinburgh in 1882, becoming Regius professor of natural history. Prof. Ewart has specially studied fishery questions; whilst he has written many critical memoirs on the development of the horse and on animal heredity.

Societies and Academies.

LONDON.

The Physical Society, October 22.—Ernest **Wilson**: The corrosion products and mechanical properties of certain light aluminium alloys, as affected by atmospheric exposure. Experiments have been made upon the electrical conductivities, the corrosion products and tensile properties of high purity aluminium, and certain light aluminium alloys, which have been exposed to London atmosphere for a period of twenty-four years. The elements concerned are copper, nickel, manganese, and zinc in varying amounts up to a few per cent. There is also a note on the corrosion products of high conductivity copper.—M. C. **Johnson**: The distribution of intensity in a positive ray spectral line (Part 2). The distribution of velocity among the particles contributing to the 'moving' spectrum is compared with the distribution of velocity in positive rays measured by the electromagnetic method and with some investigations of Betschinsky and Döpel. The appearance of the many-lined spectrum of hydrogen in the positive rays, and the ratio of intensity of the 'moving' and 'resting' spectra is also considered. The inverse square law of probability of electron capture, and some consequences of the work of Wien and Rüchardt, are the most likely controlling factors in the several phenomena.

Optical Society, October 28.—R. **Kingslake**: The analysis of an interferogram. It has been frequently suggested that it should be possible to analyse mathematically the interferometer pattern produced by a lens, in order to obtain a measure of the aberrations from the coefficients of the terms in the various orders of x and y. x and y are here the co-ordinates of a point on the interferogram, the optical path difference of which relative to the central ray of the lens is known at once by counting the fringes. Results obtained by this method do not agree well with those obtained under identical conditions by the oblique Hartmann test.—T. **Smith**: The stationary value of axially symmetric functions (Part 2). Alternative methods to those described in Part 1 of constructing a series representing the stationary value of a given function are developed and applied to evaluate all the terms not involving powers and products of the coefficients of the function higher than the eleventh. The formula in its optical applications enables the first 451 monorythmic aberrations of a symmetrical optical instrument to be determined.

Mineralogical Society, November 2.—L. J. **Spencer**: (1) Schultenite, a new mineral from South-West Africa. The colourless platy crystals from Tsumeb are monoclinic ($a:b:c = 0{\cdot}8643:1:0{\cdot}7181$, $\beta = 84° 36'$ and gave on analysis by E. D. Mountain the formula $PbHAsO_4$. They are identical with crystals prepared artificially by the late Baron A. de Schulten in 1904 (see NATURE, Sept. 18, 1926, p. 411). (2) Aramayoite, a new mineral from Bolivia. This was found in 1925 in a silver-tin vein in the Animas mine at Chocaya. It shows a confused aggregate of cleavage plates with iron-black colour and brilliant metallic lustre. In addition to the perfect basal cleavage there are also good cleavages following a steep tetragonal pyramid. The mineral is pseudotetragonal. Analyses by T. B. McGhie and by E. D. Mountain give the formula $Ag(Sb, Bi)S_2$.—K. **Yardley**: (1) X-ray examination of aramayoite. Some photographs taken with the beam perpendicular to the perfect basal cleavage (001) show no symmetry; powder photographs also show that the tetragonal symmetry

apparently indicated by the cleavages does not actually exist. Ionisation spectrometer data reveal the triclinic nature of the mineral and give a complete crystallographic description: $a = 5{\cdot}672$ Å.U., $b = 5{\cdot}688$, $c = 5{\cdot}623$; $\alpha = 86°\ 55'$, $\beta = 90°\ 53'$, $\gamma = 93°\ 18'$. The structure is pseudo-tetragonal with two molecules of $Ag(Sb, Bi)S_2$ in a minimum cell. (2) The structure of baddeleyite and of prepared ZrO_2. The natural form of ZrO_2 is monoclinic with four molecules in the unit cell. Ionisation spectrometer measurements on a single crystal and powder photographs both indicate a distorted CaF_2 arrangement of the ions. The structures of three specimens of the mineral from entirely different sources are practically identical, except for slight variations of spacing due to the presence of impurity. Powder photographs of prepared zirconia from two distinct sources are almost identical with those of baddeleyite and show that prepared zirconia is also monoclinic and not (as previously stated) tetragonal.—W. **Binks**: The crystalline structure of zircon. X-ray examination of zircon shows the structure of zircon to correspond to the space group D_{4h}^{19}. The unit cell containing eight molecules $ZrSiO_4$ has dimensions $a = 9{\cdot}30$, $c = 5{\cdot}93$ Å.U. The silicon and zirconium atoms form two interpenetrating face-centred lattices, and the oxygen atoms are arranged tetrahedrally around the silicon atoms. The structure has some resemblances to that of anhydrite ($CaSO_4$).

Society of Public Analysts, November 3.—W. R. **Schoeller** and C. **Jahn**: Investigations into the analytical chemistry of tantalum, niobium, and their mineral associates. (vi.) The precipitation of the earth acids by sodium compounds. When tantalic oxide is fused with potassium carbonate and the solution of the mass treated with sodium chloride, 4 : 3 sodium tantalate is precipitated. Niobic oxide treated in the same manner yields 7 : 6 sodium niobate. The precipitates are dense, crystalline powders. Sodium tantalate and niobate are decomposed by dilute acid. The quantity of the latter is proportional to that of the alkali in the precipitates. This reaction was applied to the indirect volumetric determination of the earth acids in the mixed sodium salts, but the end-point could not be ascertained with sufficient sharpness with colour indicators.—A. E. **Parkes**: A simple method of testing for sulphites in foods. The food (if not a liquid) is mixed with water and placed with fragments of marble and dilute (about 2*N*) hydrochloric acid in a conical flask, closed with a rubber stopper bearing a small thistle funnel bent twice and having a small bulb on each limb. The funnel contains a few drops of dilute (0·01*N*) iodine solution and dilute barium chloride solution. After evolution of carbon dioxide has ceased, the flask is heated, and, in the presence of a sulphite, the colour of the iodine in the funnel is discharged and the liquid becomes opalescent (barium sulphate). The test may be made approximately quantitative.—J. W. **Haigh Johnson**: A critical review of the methods of analysing waters, sewages and effluents, with suggestions for their improvement. Present methods yield results which are often inconsistent. Recent modifications in sewage treatment have greatly increased the amount of nitrogen oxidation products. Comparing the Wanklyn, Kjeldahl, acid chemical, and biological processes, the first is too vague, whilst the acid chemical test yields only a fifth of the result obtained biologically. A method of combining the Wanklyn test and the alkaline oxidation method is described, and suggestions are made for improving the Kjeldahl test and for the biological determination of absorbed oxygen.

PARIS.

Academy of Sciences, October 18.—G. **Bigourdan**: The equations of diverse origins, which may affect the pendulum corrections C_p adopted at the Bureau International de l'Heure (B.I.H.), year 1925. Marin **Molliard**: The dimorphism determined in the gall of *Mikiola Fagi* by a secondary parasite. Some oak galls from the forest of Fontainebleau were observed to differ in shape and other characteristics from the normal gall, and this has been shown to be due to another parasite, identified by Ch. Ferrière as *Secodes coactus*. Similar galls have since been observed in abundance in other parts of France, Normandy, Brittany, Savoy.—Charles **Richet** and **Oxner**: The accommodation of salt-water fish to supersaturated waters. A study of the effect on *Sargus Rondeleti* of a gradual increase in the proportion of sodium chloride in the water. This fish could support a salinity 37 per cent. above the normal, but a diminution to 18 per cent. below the normal caused death. J. **Costantin**: The variability of living beings according to prehistoric man.—Ch. **Depéret**: The neolithic layer of Glozel (Allier). Some doubt has been thrown on the authenticity of the objects found at Glozel: the author's own excavations and observations confirm the view of Morlet that the find is authentic, and of extreme importance.—Léon **Guillet** and Albert **Portevin**: The influence of the chemical composition of alloys on the possibility of making castings.—E. **Bataillon** and Tchou **Su**: Activation and rectification in the parthogenesis of the echinides by hypertonic solutions alone.—Paul **Alexandroff**: The dimension of closed *ensembles*.—Léon **Pomey**: Partial differential equations and linear integro-differential equations with an infinity of variables.—Leonida **Tonelli**: The double series of Fourier.—G. **Cerf**: The characteristics of partial differential equations of the first order.—André **Roussel**: Certain isoperimetric problems.—H. **Galbrun**: The propagation of a sound wave in the atmosphere.—A. **Toussaint** and E. **Carafoli**: The theory of supporting wings.—A. **Dauvillier**: The discovery of the characteristic *O* and *N* series of low frequency. Spectrographic joining of the X-rays and the extreme ultra-violet. Utilising a thorium filament prepared by M. de Boer, good spectra have been obtained with 25 milliamperes at 2800 volts. These show the pure low frequency spectrum of thorium, consisting of the characteristic *N* and *O* radiations. The line 121 Å.U. approaches the optical spectra obtained by Millikan in the extreme ultra-violet (limit of aluminium, 136 Å.U.).—H. **Pilon** and A. **Laborde**. The immersion of metals in homogeneous media opaque to the X-rays. Improvement of radiographic methods. The method suggested consists in immersing the metallic body in a homogeneous saline solution the absorption co-efficient of which, for the X-rays used, is nearly that of the metal. Some suitable solutions are given: for aluminium a 35 per cent. solution of barium chloride, for iron, barium iodide (159 gm. in 100 c.c. of solution), for copper, the same barium iodide solution. Under these conditions discontinuity in the metal is very clearly shown.—Jean **Bouldoires**: The transformations undergone by aluminium bronzes. Results are given of a thermal analysis, measurements of resistance and micrographic study of aluminium bronzes submitted to varying heat treatment.—Georges **Delbart**: The magnetic permeability of cold-drawn steels.—Emile **André** and Mlle. Th. **François**: The saturated fatty alcohols of the oil of the sperm whale and of *blanc de baleine*.—Guy **Emschwiller**: The action of magnesium on methylene iodide. The reaction (in ether) is vigorous and takes place

in two directions, one giving ethylene, the other the magnesium compound $CH_2(MgI)_2$. The latter gives methane on treatment with water.—Alfred **Carpentier**: The extension of the Weald in the north of France.—A. **Maige**: Observations on the amylogenesis in the cotyledons of the pea.—F. **Henrijean**: The signification of the electrocardiogram.—René **Hazard** and Raymond **Hamet**: The circulatory action of pseudo-pelletierine.—H. **Barthélemy**: Comparative influence of the *p*H and the saline concentration on the duration of survival of the spermatozoids of *Rana fusca*.—Mme. Anna **Drzewina** and Georges **Bohn**: The activation by light of the effects of silver on Convoluta. The destruction of Convoluta by metallic silver in water is partially dependent upon light. In a strong light the poisonous action is much more rapid.—René **Fabre**: Cholesterol allophanate and its use in biological chemistry. The preparation and properties of cholesterol allophanate is described: it may prove useful in various problems in biological chemistry.—Constantino **Gorini**: The action of *B. typhosus* on milk.

Diary of Societies.

SATURDAY, NOVEMBER 20.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A.M.—W. R. Ivimey Cook: The Genus Ligniera.—Prof. O. V. Darbishire: Isidia and Soredia of the Lichen Peltigera.—W. J. Dowson: An Extraordinary Botrytis causing a Disease of Narcissus Leaves.—W. A. Roach: On the Nature of Disease Resistance in Plants, with Special Reference to Wart Disease of Potatoes.—Miss A. Lorrain Smith: A New Family of Lichens.

ROYAL SANITARY INSTITUTE (at Town Hall, Colchester), at 11 A.M.—Discussions on Rheumatism in School Children and The Plan and Design of a Public Elementary School.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—L. F. H. Booth: Screening and Washing Plant at Deaf Hill Colliery.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. E. M. Walker: The Study of History (3).

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at College of Technology, Manchester), at 7.—A. H. Goodger: The Foundry Cupola.

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—O. C. Dinermann: Starters for Alternating-current Motors.

MONDAY, NOVEMBER 22.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory, Cambridge), at 4.30.—Dr. H. W. B. Skinner: On the Polarisation of Mercury Lines Emitted from a Discharge Tube in a Magnetic Field.—C. F. Sharman: The Application of the Method of the Magnetic Spectrum to the Study of Secondary Electronic Emission.—L. H. Thomas: The Calculation of Atomic Fields.—L. Wertenstein: A Contribution to the Theory of Diffusion Pumps.—*To be communicated by title only*:—W. Burnside: On a Group of Order 25920 and the Projective Transformations of a Cubic Surface.—Dr. P. A. M. Dirac: The Compton Effect in Wave Mechanics.—J. B. S. Haldane: A Mathematical Theory of Natural and Artificial Selection. Part IV.—R. Hargreaves: Geodetic and Dynamical Principles, a Comparison and Connexion.—G. C. Steward: On the Addition of the Primary Aberrations.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. F. Shipley and others: Discussion on Comparative Electrical Progress in European Countries.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (Informal Meeting) (at Sopwith's Lounge, Newcastle-upon-Tyne), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems and the Problem of Standardisation.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—Lt.-Col. E. Kitson Clark: Archæological Engineering (Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Prof. H. L. Callendar: Recent Experiments on the Properties of Steam at High Pressure (II.).

CHEMICAL INDUSTRY CLUB, at 8.—C. S. Garland: The Incandescent Gas-Mantle Industry.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. E. W. Fish: Further Notes on the Lymph Supply of Enamel and Dentine.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. Gillman: South-West Tanganyika Territory.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. C. Riviere and J. E. Roberts: The Treatment and Diagnosis of Bronchiectasis.

TUESDAY, NOVEMBER 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Imperfect Crystallisation of Common Things (1).

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall, S.W.1), at 7.—Inventors' Evening. Discussion of Motor Car Devices not yet on the Market.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—Lecture.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with South Wales and Bristol Sections of Institution of Civil Engineers and South Wales Section of Society of Chemical Industry) (at Technical College, Cardiff), at 7.30.—T. M. McKenzie: Asphaltic Roads.

ROYAL ANTHROPOLOGICAL INSTITUTE (jointly with English Folk-Dance Society and Folk-Lore Society) (at Royal College of Music, South Kensington), at 8.30.—Miss Violet Alford: The Ritual Dance.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. B. Glück: Current Tendencies in American Criminology.

WEDNESDAY, NOVEMBER 24.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. C. W. Saleeby: From Heliotherapy to Heliohygiene.

INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—J. E. Southcombe: Recent Research on Friction and Lubrication.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

ROYAL SOCIETY OF ARTS, at 8.—W. S. Bradley: Industrial Welfare in Practice.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Mrs. S. Gretton: Oxford Village Pedigrees.

THURSDAY, NOVEMBER 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. R. R. Marett: The Archæology of the Channel Islands—Neolithic and Bronze Ages.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. R. Ackerley: Presidential Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates' Meeting) (at Luton), at 7.30.—T. T. Brown: Lubrication.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Clinical Pathological Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (at Bristol).—Prof. E. G. Coker: Elasticity and Plasticity (Thomas Hawksley Lecture).

FRIDAY, NOVEMBER 26.

SOCIETY OF CHEMICAL INDUSTRY (Manchester and Fuel Sections) (at Municipal College of Technology, Manchester), at 10 A.M.—Tar Symposium.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall), at 3.30.—R. L. Quertier: Modern Air Compressor Practice in Oil Engine Installations.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—H. C. Hepburn: Electro-endosmosis and Electrolytic Water Transportation.—L. Hartshorn: The Input Impedance of Thermionic Valves at Low Frequencies.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 6.—Dr. E. V. Telfer: The Practical Analysis of Merchant Ship Trials and Service Performance.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—H. J. D. Palfrey: The Measurement of Light.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Col. the Master of Sempill: Petrol and its Substitutes for use in Internal Combustion Engines.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section).

SATURDAY, NOVEMBER 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. C. Simpson: Atmospheric Electricity (1).

PUBLIC LECTURES.

SATURDAY, NOVEMBER 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. MacLeod: Eclipses of the Sun.

SUNDAY, NOVEMBER 21.

GUILDHOUSE (Eccleston Square), at 3.30.—Dr. G. C. Simpson: Meteorology in the Service of Man.

MONDAY, NOVEMBER 22.

SHEFFIELD UNIVERSITY, at 7.30.—H. E. Stilgoe: Water Supply and its relation to Public Health (Chadwick Lecture).

TUESDAY, NOVEMBER 23.

GOLDSMITHS' HALL, at 4.—Prof. J. S. Huxley: Biology and Human Life (Norman Lockyer Lecture).

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: Modern Theories of the Nature of Value in Psychology and Philosophy. (Succeeding Lecture on November 30.)

WEDNESDAY, NOVEMBER 24.

UNIVERSITY COLLEGE, at 5.30.—Dr. W. D. Johnston: The Library of Congress, its Functions as a National Library.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 6.—G. W. Mayne: The Monroe Calculating Machine.

THURSDAY, NOVEMBER 25.

COLLEGE OF NURSING (Henrietta Street, W.), at 5.30.—Dr. Mary Buchan Douie: The Adolescent and Social Hygiene from the Standpoint of the Home.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Brig.-Gen. H. Hartley: Chemical Warfare.

FULHAM CENTRAL PUBLIC LIBRARY, at 8.—A. D. Allen: Home-Grown Food.

SATURDAY, NOVEMBER 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: Nature in Southern England.

SUNDAY, NOVEMBER 28.

GUILDHOUSE (Eccleston Square), at 3.30.—Viscount Haldane: The Wider Meaning of Relativity.

CONFERENCE.

FRIDAY, NOVEMBER 26.

TAR CONFERENCE (at the College of Technology, Manchester), at 10.30 A.M.—F. S. Sinnatt and Dr. J. G. King: A Study of Tars and Oils obtained from Coal.—W. G. Adam: A Plea for Standardisation of Analytical Methods in Coal Tar Products Specifications.—H. M. Spiers: (*a*) The Viscosity of Tar; (*b*) The Consistency of Bitumen Mixtures.—At 2.—Dr. A. Parker: Tar from Steamed Vertical Retorts.—J. McLeod: Notes on Vertical Retort Tar.—M. Barash: The Production of Road Tar from Vertical Retorts.—H. Hollings: The Influence of Carbonising Conditions on the Free Carbon Content of Tar.—At 5.—H. G. Adam and H. W. Robinson: Tar from the Point of View of the Highway Authority.—A. C. Tait: Coal Tar Disinfectants.—H. F. Taylor: Pitch.