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"To the solid ground
Of nature trusts the Mind that builds for aye."—WORDSWORTH.

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NATURE

A WEEKLY JOURNAL OF SCIENCE

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Pasteurization of Milk

THE heat-treatment, or 'pasteurization', of milk before consumption has in the past been the subject of controversy, but as a result of much research and inquiry during the last few years, this measure has come to be generally accepted as the best solution of the several problems presented by the use of raw untreated milk, particularly that of the transmission of infections. Detailed criticism of the application of the pasteurizing process to the general milk supply was, however, formulated by Sir Arnold Wilson in his recent presidential address to the Central Council of Milk Recording Societies of England and Wales last March, and some of the points he raises merit consideration.

It is suggested that the "principal, if not the only, reason" why pasteurization is practised is that it makes it possible to transport large quantities of milk from great distances, and to market it several days after production, in competition with fresh milk. Whatever may have been done in the past, we believe that to-day such a statement is inaccurate. Some 90–95 per cent of London's milk is pasteurized, and the large bulk of this is conveyed in the raw state and treated after arrival, and we question whether anywhere now 'large quantities' of milk are pasteurized for purpose of transport.

Compulsory pasteurization, which has been advocated in some quarters, is viewed with grave concern as being likely to upset present economic conditions, with the deprivation of a number of farmers of their means of livelihood. The Report of the Committee on Cattle Diseases is quoted in support, and the important qualifying paragraphs (Nos. 155–160) are criticised; the reactions that might be caused by such a measure are not considered to be solved by the suggestions made. Dr. Norman Wright, director of the Hannah Dairy Research Institute, surveyed this subject in 1931, however, and concluded that the effect of compulsory pasteurization, were it introduced (and this would probably be only in the larger urban areas), would be to eliminate the casual producer-retailer from large cities, to the advantage of the general body of milk producers, the established producer-retailer eventually becoming the chief purveyor of high-grade raw milk from tuberculin-tested herds. Moreover, this seems to be the experience in New York State, where compulsory pasteurization is general, though the growth of tuberculosis-free herds in Great Britain, where State assistance is lacking, to reach the American standard of freedom from tuberculous infection, would be lamentably slow under present conditions. In this respect, more State assistance is an urgent need in Great Britain.

It has been proved beyond doubt that the infections transmissible by milk—tuberculosis, typhoid fever, scarlatina, diphtheria, undulant fever and others—are destroyed by efficient pasteurization. The risk of tuberculous infection (occasionally other infections also) has, unfortunately, been increased of late by the introduction of the hygienic system of conveyance of milk in bulk, 3,000 gallons or so, in glass-lined road- and rail-tanks, for, should any portion of the milk in such a tank be infected, the whole will become infected. In the case of tuberculosis, in particular, this risk is a real one, for the bulk-milk is necessarily the mixed milk of a number of cows, some of which under present conditions will almost inevitably be infected with tuberculosis. Whereas, before the present system of bulk transport, only at most some 8–10 per cent of samples of milk tested contained the tubercle bacillus, Minett and Pullinger and Pullinger, respectively, found that of 43 and 63 samples of rail-tank bulk supplies examined, every one contained living tubercle bacilli. Undulant fever (*Brucella*) infection was also frequent. It is noteworthy that all these samples, examined after efficient commercial pasteurization, were entirely free from living tubercle bacilli and *Brucella*, certainly a tribute to the value of the process. Sir Arthur Newsholme says in his recent book "Fifty Years in Public Health": "It is for this reason [pasteurization] that milk outbreaks of acute infectious diseases are much rarer now than in the past".

Some 1,500 deaths annually in Great Britain may reasonably be ascribed to bovine tuberculous infection, and it is admitted that human beings may contract tuberculosis from milk and milk products. Sir Arnold Wilson appears to argue that because the mortality from tuberculosis transmitted by milk is so insignificant compared with the mortalities from other forms of tuberculosis and from other diseases, it may be ignored—"We cannot avoid all dangers: we should aim at excluding the greatest, and the bovine [tubercle] bacillus is shown to be among the least". But this view does not take into account the increased risk of infection with the bovine tubercle bacillus introduced by the present system of bulk transport.

The possible damage that may be done to the nutrient qualities of milk by pasteurization requires consideration. It is alleged that the vitamin, calcium and phosphorus contents are diminished, and the general nutrient qualities are lessened. It may be admitted that, in the case of infants subsisting on complete diets of cow's milk, pasteurized milk does seem to be deficient and to require supplementing as regards vitamins and salts, but there is no body of evidence conclusive of the relative merits of raw and pasteurized milk, and the subject demands further investigation. For children the bulk of whose nutritive requirements is satisfied from sources other than milk, Stirling and Blackwood state that there are no good grounds for the belief that pasteurized milk is a less valuable component of the diet than raw milk (*Bull.* 5, Hannah Dairy Research Institute), and Prof. J. C. Drummond, in a series of animal experiments, failed to detect any evidence that pasteurization adversely affects the nutritive value of milk.

Milk pasteurization, if carried out, ought to be efficient and free from any possible source of failure. The recognised system consists in heating the milk to a temperature of not less than 145° F., and not more than 150° F., and maintaining at this temperature for 30 minutes, after which it is cooled. It is obvious that to hold a large volume of milk, it may be up to 500–1,000 gallons in the large plants, within two or three degrees of a particular temperature for half an hour, entails the use of an apparatus the thermal control of which must be one of delicacy and exactitude. If any portion of the whole bulk of the milk is maintained at less than the proper temperature for the requisite time, disease germs may escape destruction; if the temperature rises above the limit, the 'cream line' may be damaged, and an excessive proportion of the lactic organisms, which bring about souring and curdling, be destroyed, so that the milk does not sour normally on keeping, but undergoes undesirable changes that are not apparent to the consumer. It should be emphasised, however, that the modern commercial pasteurizer has reached a high state of perfection, and provided that the plant is properly laid out in the first instance, it can easily do what is required without risk of failure. The statement has been made that pasteurized milk is more liable in the home to become infected than raw milk, presumably because of the destruction of the inhibiting lactic organisms, but the widespread system now in use of retailing pasteurized milk in bottles or other containers must minimise any such problematical risk.

There can be no doubt that at the present time pasteurization is often carried out inefficiently. The Cattle Diseases Committee was so impressed

by the evidence given before it of the importance of securing efficiency for this process that it recommends in its report that pasteurization of milk should be permitted only in plants the design of which has been officially approved, that have been tested on erection to ensure that they conform to the approved design, and are frequently inspected and tested during working by an officer of the sanitary authority. This officer would need to possess knowledge of the practical working of pasteurization plants and of their construction, if he is to carry out his duties of inspection, testing and supervision properly. The information required by officers of local authorities for this purpose has in the past been largely lacking, but is now provided in a report by Sir Weldon Dalrymple-Champneys, just issued by the Ministry of Health ("The Supervision of Milk Pasteurising Plants." *Reps. Pub. Health and Med. Subjects*, No. 77. London: H.M. Stationery Office, 1935. 1*s*. 3*d*. net). In this, the construction of premises and general 'lay-out' of a plant are first described, and then the constituent parts and mode of working are detailed. Considerable space is devoted to the important subject of thermal control, temperature recorders and thermographs, with diagrams and description of these. The subject of bottle cleansing is also considered, and finally—most important for the supervising officer—a tabulated description is given of the principles of, and points to be noted in, the inspection of a pasteurizing plant.

The fear expressed in the past by many medical officers of health and others that pasteurization, by increasing the keeping qualities of milk, would lead to less cleanly production, has not been borne out in practice, and it is probably correct to say that the present standard of hygienic milk production is higher than it ever was.

Viewing the subject as a whole and in its wider aspects, under present conditions the efficient pasteurization of milk appears to have much to commend it, and the advantages to the community outweigh the reputed disadvantages.

Sir Arthur Newsholme is of the opinion that so far from discarding or limiting the pasteurization of our milk supplies, the process should be extended, for he says: "The time is ripe for compulsory supervised and standardised pasteurisation of all milk supplies. This would reduce to a minimum the distribution of disease germs by milk, including especially the distribution of milk containing tubercle bacilli of bovine origin".

African Music

The Musical Instruments of the Native Races of South Africa

By Prof. Percival R. Kirby. Pp. xix+285+73 plates. (London: Oxford University Press, 1934.) 35*s*. net.

THE present volume will be welcomed by all concerned with native music, but particularly by anthropologists, for the twofold interest its subject presents. Musical instruments, on one side, have always been a favourite object for ethnological studies, because as products of handicraft they are part of a people's material culture, and by magic and religious functions they play at the same time a prominent rôle in tribal life. The most ancient culture forms, on the other side, are found surviving among those primitive races who have been compelled to retire into the remotest and least accessible regions, for example, the Fuegians, the Tasmanians, the Andaman Islanders, the Vedda in Ceylon, or the Bushmen in the Kalahari. It is true that in South Africa this isolation even of the most primitive tribes, namely, Bushmen, Hottentots and Bergdama, has since long been far from complete, extensive tribal migrations, or smaller movements, particularly of Bantu negroes, having from time immemorial chequered the map of racial and cultural distribution. This very distribution, however, is the safest, if not the only, basis for a reconstruction of the early history of the country, that is, the history before the arrival of the European explorers.

Prof. Kirby, known as a distinguished specialist from his earlier contributions to scientific periodicals, has attempted to collect, and to present in this book, as comprehensive a material as possibly can be collected in our days. Living in Johannesburg, he had the opportunity during nine great and many smaller excursions into native territory, not only to watch the native musicians, to obtain first-hand information and to collect several hundreds of their instruments, but also to learn to play them himself, which, of

course, is the best way to a complete understanding. Besides, he was assisted in his inquiries by quite an army of able helpers; and for supplementary information he has consulted the literary sources from Fr. João dos Santos (1586) onwards, and compared the instruments which he collected with the specimens in South African and European museums.

Thus, the author has succeeded in compiling an almost complete inventory of musical instruments found south of the Cunene-Limpopo line, comprising under the term 'musical instruments'—as the ethnologist is bound to do—any device for sound-production. The instruments are minutely described, and profusely illustrated by excellent photographs. The technique of playing is explained with the help of musical examples (partly transcribed from phonographic records). A description of the social function of every type, of its ritual, magic or other meanings, and of the occasions of its use, is included, and the distribution among the tribes of South Africa as well as the history so far back as it is possible to go on the evidence of early writers and native tradition, is traced for every instrument.

The only thing likely to be regretted by ethnologists is the lack of physical measurements of the tuning of such instruments as xylophones or reed pipe series; for coincidences in absolute pitch (expressed in vibration numbers) have proved the safest guide in tracing back the instruments to their very origin. Thus the African xylophones, at least the types with calabash resonators, are related to their prototypes in south-eastern Asia and Indonesia not only by their similar shape, playing technique and the characteristic musical scales to which they are tuned, but even by very identity of pitch[1].

Out of the almost inexhaustible wealth of detailed information we owe to Prof. Kirby's work, only a few examples may be selected, which most strikingly show its value for comparative ethnology. The Venda in northern Transvaal have a large bowl-shaped wooden kettle-drum with pegged-on diaphragm (which in itself is an Asiatic way of fastening); when they use it, for example, in their initiation ceremonies, the drum is suspended on the horizontal pole of a frame by means of ropes tied to two of the four drum handles, which are fitted in an ornamental band carved round the drum. Now, the suspension, the style of this carved wave ornament and the four-legged 'handles', which are called 'frog's knee' by the Venda—all these details closely resemble the so-called 'bronze drums' of China and Tonkin, on the plate of which invariably four plastic frogs are placed on the outermost circle of relief ornaments, marking the cardinal points. (In fact, the eastern Asiatic 'bronze drums' are more or less hour-glass shaped and have, apart from the frogs, also 'ears' fixed on the side. For both these traits there are parallels in the drums of the Barotse and other tribes in the southern Congo basin.)

Drums of this kind are also played in pairs, by a man and a woman respectively, in connexion with the reed pipe dances which form an integral part of that most important sacrificial rite which the Venda perform for their royal ancestors in the sacred groves where they are buried. This rite is at the same time a fertility cult to secure the new crops. A similar ritual at harvest time is performed for the spirits of departed women-chiefs, who haunt a certain bamboo bush at a sacred place, guarded by special taboos. From this particular type of bamboo, that is, from the 'female' rods which are hollow (whereas the 'male' rods are solid) the pipe-sets are cut, and tuned by an old man to whom this function is entrusted, the pipe ensembles and dances being a royal prerogative. The leader of the orchestra keeps the instruments, together with the drums and other sacred implements, in the council hut, and is responsible for them to the chief.

We may feel doubtful as to whether a series of stopped pipes distributed among different players—which apart from South Africa is found in Central and East Africa, Lithuania and Upper Burma—should be regarded as a precursory form or as a variant of panpipes. But there is no doubt that in their social function, as exemplified by the Venda customs, there is a striking resemblance to a tradition from the classical land of ancestor worshippers, China. It refers to the very beginnings of Chinese civilisation. Hoang Ti, one of the five mythical emperors, ordered, as tradition has it, his minister Ling Lun (that is, 'master of music') to institute the right foundations of music. Ling Lun went to a certain place far in the west, where the appropriate kind of bamboo grew, and cut the male and the female series of pipes, tuning them to the pitches of the tones which he heard sung by a couple of phœnix birds. The standard-pitch pipes, which by their length represent the basis for the Chinese system of measurement as well, were kept until recently in the Ministry of Measures and Music under the superintendence of one of the Imperial princes. The ancient Chinese pitches still survive on modern panpipes, for example, in Oceania and South America, and on xylophones, for which they must have been adopted originally from the panpipes. For the Venda the real standards seem to be not the pipe-sets, but rather, as Prof. Kirby suspects, a very old set of xylophone slabs. It was, in fact, a Venda xylophone by which the reviewer was first led to

the discovery of the identity of African and Asiatic pitches.

Certain queer types of South African instruments are the product of contact with the various forms of foreign influence. The old Hindu bar-zither, which was played rested on the left shoulder, with its resonator up and the peg down, is popular with many South African tribes. Here it is still held in the old way, but the original gourd-resonator has more recently been exchanged for a paraffin tin, and instead of plucking the string one uses a miniature friction-bow. The instrument is thus made to resemble an Arabic fiddle from the Sudan, held upside down. Or we find a vertical flute, with two or three finger-holes near the lower, stopped end, and a globular fruit shell for a mouth-piece on the upper end, which is played by Karanga and Venda boys. It looks as if a clarinet of the 'pibcorn' type (spread from Java over Southern Asia and Southern Europe finally to England) had lost its reed, thus rendering useless the mouth-piece which had served as a wind-chamber. A mixture between a North African clarinet and a globular flute occurs in North-West Africa. The most curious fact, however, is that the Karanga performer, when playing this flute, sings at the same time a short tune. Even this practice has its counterpart in some other part of the world, namely, among the Maori of New Zealand, who used to 'speak' on their flutes[2], and possibly among the Australians, who do not blow their trumpets, but use them merely as megaphones.

E. VON HORNBOSTEL.

[1] Cf. *Z. Ethnol.*, **43**, 601 ; 1911.
[2] Cf. J. C. Andersen, "Maori Music", New Plymouth, New Zealand, 1934, p. 278.

Tropical Plant Diseases

(1) The Diseases and Curing of Cacao

By Prof. H. R. Briton-Jones. Pp. x+161. (London : Macmillan and Co., Ltd., 1934.) 10*s*. net.

(2) Diseases of the Banana and of the Manila Hemp Plant

By Dr. C. W. Wardlaw. Pp. xii+615. (London : Macmillan and Co., Ltd., 1935.) 30*s*. net.

THERE are several reasons for welcoming the first two of the manuals on the diseases of the major crops of the British Colonies, the need for a series of which was so strongly voiced at the Imperial Mycological Conference in 1929. They are from the West Indies, among the oldest of the Colonies and the most tried by the ravages of plant diseases. They have been written by members of the professorial and research staff of the Imperial College of Tropical Agriculture in Trinidad, where most scientific officers of colonial agricultural departments now complete their training, and are a testimony to the activity of that centre. They reflect the modern approach to phytopathology as concerned with safeguarding the health of the crop in its widest aspects, of which parasitic attack is but one. They are attractively written and produced, well illustrated, and with full and up-to-date bibliographies. In each case the important crop covered (Trinidad has 200,000 acres under cacao, and bananas are the mainstay of the export trade of Jamaica) is suffering from an epidemic disease which is causing much alarm.

(1) Prof. Briton-Jones's book on cacao diseases is written to interest, and be readily understood by, the educated planter. The diseases are clearly described, their cause indicated with as few technicalities as may be, and their control fully discussed. A chapter is given to the formidable witches' broom disease caused by *Marasmius perniciosus*, which reached Trinidad in 1928, though long known on the mainland of South America and doubtless indigenous in some part of that natural home of the cacaos. The disease in Trinidad is following the slow course which gradually extinguished cacao-growing in Surinam, and is not of the virulent type which caused a crisis in Ecuador in a few years after it first appeared there in 1921, probably coming from the Amazon basin, where it has recently been discovered to be widespread. It is in this area that the search for varieties that may be immune from infection is most likely to be fruitful. Breeding for resistance, however tedious, may be the only satisfactory means of control, though Prof. Briton-Jones indicates measures directed to increase the crop yield sufficiently to render the costly control by hand-picking the diseased parts profitable.

A useful section of this book, with a separate bibliography, is given to the preparation and curing of cacao.

(2) Dr. Wardlaw's book on the diseases of the banana, *Musa sapientum*, and the botanically allied Manila hemp plant, *M. textilis*, is planned on a more generous scale than the other. More is known of banana than of cacao diseases, and there are more of them ; the useful list of fungi and bacteria recorded on the banana which Dr. Wardlaw has compiled

includes more than fifty parasites, not counting several virus diseases destructive in Australasia and the Far East and beginning to appear in the New World. The discussion of each disease is exceptionally full, well documented, and often enriched by the author's personal studies; scientific details are not spared, and the book will appeal as much to the professional plant pathologist as to the planter. A valuable section deals with the wastage of the fruit in transport and storage, based largely on the author's work at the Trinidad Low Temperature Station.

In this book also one disease, the wilt or 'Panama disease' caused by strains of *Fusarium oxysporum*, receives extended treatment on account of its outstanding economic importance. Unlike cacao witches' broom, it occurs in most parts of the world where its host plant is grown, but it is only in the West Indies and Central America that it has proved a scourge; there is little doubt that this is due to the almost exclusive cultivation for export in this area of the highly susceptible but unrivalled shipping variety, the Gros Michel. The wilt is decimating the Gros Michel plantations of Jamaica, and has caused the abandonment of many thousands of acres of rich banana lands in Central America. But, unlike cacao witches' broom, practical immunity from wilt is possessed by several more or less well-known edible and wild bananas, and breeding for disease resistance combined with shipping qualities is already well advanced both in Jamaica and at the Imperial College in Trinidad. One may question some of the author's views regarding the parasitism of the wilt-inducing fungus, without in any way belittling his achievement in the preparation of this manual.

Both of these works should have a place in the libraries of colonial agricultural departments and of their plant pathologists. E. J. BUTLER.

Galileo and the Leaning Tower of Pisa

Aristotle, Galileo and the Tower of Pisa

By Prof. Lane Cooper. Pp. 102. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1935.) 7*s*. net.

IT is generally believed that Galileo, as a young lecturer on mathematics and physics at the University of Pisa, gradually became convinced of the untrustworthiness of many of the statements which were currently believed and taught on the authority of Aristotle. Indeed, he has been stated to have incurred a certain amount of unpopularity on account of the subversive nature of his views. Among other things he doubted the truth of the oft-repeated statement that when two dissimilar weights are dropped, the heavier will reach the ground sooner than the lighter in proportion to their weights; accordingly, so we have been assured, Galileo determined to try the case, and after ascending the Leaning Tower of Pisa with a 10 lb. shot and a 1 lb. shot, he let them fall. "Together they fell, and together they struck the ground," to the confusion of all the onlookers who held the so-called Aristotelian view.

This story has been retold with variations by many historians of science, and the historic occasion has been marked as a turning point between the ages of the older traditional, and of the newer or experimental philosophies.

Prof. Lane Cooper, of Cornell, being desirous of studying the evidence for this Leaning Tower experiment, and finding that there is no book to which a student with limited access to foreign or ancient books can refer, has now made a critical study of the literature and has reprinted many relevant quotations, with English translations where necessary. In the whole collection he has satisfied himself that no one passage can be accepted as proof that Galileo, in 1590–91, or before he left Pisa for Padua in 1592, did ascend the Tower and do his historic experiments either alone, or in the presence of "the whole body of students" of the University.

There is no need to cite here any of the modern versions of the story, but it is curious that Prof. Cooper should not have mentioned the excellent life of Galileo by J. Elliot Drinkwater in 1829. The relevant points are these. Galileo died in 1642, never having once alluded in any of his own writings to the Leaning Tower or to experimenting from it. His biographer, Viviani, writing in 1654, states that he proved that moving bodies of the same material but of unequal weight all moved at the same speed by repeated trials (*con replicate esperienze*) from the height of the Campanile of Pisa, "in the presence of the other teachers and the whole assembly of students". As a result "his rivals, stirred with envy, were aroused against him".

Prof. Cooper points out that if this be a true presentation of the case, it is extraordinary that

there should be no reference in contemporary literature to so important an occasion.

A "Comparison of Aristotle and Plato" was published by Mazzoni in 1597 in which Galileo's principles of motion are accepted, but although the writer is in opposition to Aristotle, he does not allude to any researches of Galileo at Pisa. Again, when Coresio in his "Operetta intorno al Galleggiare de Corpi Solidi" (1612) entered into controversy against Mazzoni, he would certainly have referred to such experiments had they been made publicly at Pisa. Further, Renieri, Galileo's own successor in the chair of mathematics at Pisa, did indeed make experiments from the Tower in 1641 and wrote to Galileo about them, but there is no suggestion in their correspondence that similar experiments had ever been made there fifty years earlier, nor did Galileo allude to his having done anything of the same nature.

What is known of Galileo's work is derived from: (1) his manuscript "De Motu", written about 1590, consulted by Viviani in 1654, but not published before 1883; (2) his "Discorsi Matematiche intorno à due Nuove Scienze", published in 1638, in which two imaginary characters, Simplicio and Salviati, discuss in dialogue the laws of motion, evidently as contained in the "De Motu". In all this there is nothing about Pisa or about experiments during Galileo's sojourn there.

On the other hand, a number of men of science much earlier in the sixteenth century had already attacked the view then attributed to Aristotle, that bodies fall with a speed proportional to their weight. Among these were Giovanni Battista Benedetti, in his "Demonstratio proportionum motuum localium contra Aristotelem et omnes Philosophos", Venice, 1554, who was followed by Jean Taisnier "Opusculum", 1562; Cardan "de Proportionibus", 1570; Beato of Pisa, Ghini of Bologna and others, and especially by Stevinus of Bruges. Their previously printed works would have deprived any Leaning Tower experiment of 1590 of the originality that was claimed by Viviani sixty years after the supposed great day of Galileo.

In conclusion, Prof. Cooper rightly accuses Galileo of causing his 'Salviati' to affect to quote from Aristotle words that are not found in Aristotle's writings; and it is possible that in this has lain the cause of all the trouble.

So far the author's case appears strong. It is when he comes to deal with Aristotle's supposed views that his arguments incline to the irrelevant. He admits that Aristotle must, if pressed, have said that bodies would fall at different rates, so that his disquisition on the meaning of πίπτειν and 'falling' is immaterial.

Aristotle would have naturally used the word ῥοπή because he considered velocity as a quality inherent in the body itself, instead of something relative. What is really interesting is the long tradition of opposition to Aristotle that goes back far beyond Galileo, indeed even to the days of Philopon, as shown by his commentary on Aristotle's "Physica", written about A.D. 533.

Although we consider that Prof. Lane Cooper might have marshalled his material rather better, we are grateful to him for directing our attention to so important a field of historical study.

R. T. GUNTHER.

Thorpe's Dictionary of Applied Chemistry. Supplement

By Prof. Jocelyn Field Thorpe and Dr. M. A. Whiteley. Vol. 2: *N*—*Z*. Pp. xx+727. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1935.) 60*s*. net.

THE second supplementary volume of Thorpe's "Dictionary of Applied Chemistry" departs from the original plan only in that it was not found possible to include an index, which will be published with a glossary in a third volume. Some of the articles are supplementary to those which appeared in the main series of volumes, for example, those on naphthalene by Prof. W. P. Wynne and Miss Turner, on proteins and their degradation products by Dr. W. V. Thorpe, on radioactivity and radium by Dr. A. S. Russell, on spectroscopy by Dr. R. A. Morton, on terpenes by Prof. J. L. Simonsen and on vitamins by Dr. L. J. Harris. On the industrial side, there is a very fully-documented article by Prof. J. R. Partington on the utilisation of atmospheric nitrogen, a long and well-illustrated article on petroleum by Dr. A. E. Dunstan, in addition to supplementary articles on sodium and potassium by Dr. R. N. Kerr, and on paint and varnish by Dr. R. S. Morrell.

New articles are those on the parachor by Prof. S. Sugden, on free radicals and on rhenium by Dr. T. G. Pearson, on the stereo-chemistry of cyclic compounds by Dr. W. H. Mills, on tautomerism by Dr. J. W. Baker, and on heavy water by Prof. H. V. A. Briscoe. On the industrial side, Dr. C. H. Lander contributes a new article on oil and petrol from coal. A curious limitation in the scope of the work is indicated by the fact that, whilst supplementary articles are provided on photography, photosynthesis and polarimetry (mainly in reference to new types of molecules exhibiting optical rotatory power), the general subject of photochemistry is not even indexed either in the original or in the supplementary volumes.

Since only the glossary and index are now outstanding, it may be said that the revision of the "Dictionary" has brought together a large amount of information that is not readily available in other publications, and that its value and usefulness are fully maintained by the new supplementary volumes.

Proceedings of the Fourth International Congress for Applied Mechanics, Cambridge, England, July 3rd-9th, 1934

Pp. xviii+283. (Cambridge: Printed at the University Press, 1935.)

THIS beautifully produced and illustrated book contains full reports of six general lectures together with short abstracts of more than a hundred sectional papers arranged alphabetically. The abstracts deal mainly with problems in mechanics, elasticity and hydraulics and their applications to elastic fatigue and plastic flow of solids and viscous and turbulent flow of liquids.

The first lecture, by V. Bush, on recent progress in analysing machines, describes an optical instrument for the evaluation of parametric integrals and solvers for simultaneous linear algebraic equations and for ordinary differential equations. The second by A. Caquot, on the definition of the elastic domain in isotropic media and intrinsic curves of apparent and true elastic resistance, after a brief review of the relevant classical concepts, treats of the relation between the magnitude and direction of the stress required to produce a permanent strain in concrete and steel, found experimentally and applied to the determination of the elastic limit. J. P. Hartog in the third lecture considers the vibration problem in engineering, with reference to instabilities caused by friction, phenomena in stretched wires and vibration caused by leakage flow.

The fourth lecture, by Th. v. Kármán, treats of some aspects of the turbulence problem, especially the stability of laminar motion, the transfer of momentum, vorticity and heat in turbulent motion, with practical applications, and atmospheric turbulence. In the fifth lecture E. Schmidt discusses the convection of heat for independent flow as well as for flow due to differences of temperature, in both its experimental and theoretical aspects, and the extension of the theory to problems of diffusion. The sixth lecture, by H. Wagner, deals with the steady gliding of bodies along a water surface and the landing and taking off of hydroplanes.

Science and Education in the U.S.S.R.

By Prof. A. Pinkevich. (The New Soviet Library, 12.) Pp. 176. (London: Victor Gollancz, Ltd., 1935.) 3*s*. 6*d*. net.

THE success of the planned economy of the Soviet Government probably depends as much upon education as upon any other single factor. This lucid but admirable account of what has already been done to provide the State with intelligent citizens, industry with competent workmen and efficient technicians and leaders, indicates the extent to which a population 64 per cent illiterate in 1917 is being converted into a nation capable of enjoying the advantages with which modern technology can endow it, as well as producing the technicians required for the execution of its plans. Prof. Pinkevich's survey of the position of scientific work in the U.S.S.R. reveals unparalleled co-ordination of such effort in the service of the national economy.

The Annual Register:

A Review of Public Events at Home and Abroad for the Year 1934. Edited by Dr. M. Epstein. Pp. xii+318+182. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1935.) 30*s*. net.

THE troubled history of last year with its many political crises and its social changes and economic problems is fully and impartially recorded in this valuable annual volume. About one third of the book is occupied with the history of Great Britain and the British Empire, the latter arranged under the different Dominions and India. Another third deals with the history of foreign countries, among which even the smallest find a place. The activities of the League of Nations are also reviewed. The final third is devoted to a chronicle of notable events, obituary notes, and lengthy surveys of literature, art, drama, music, finance and law, with fifteen pages of a record of scientific achievement which includes mention of notable books. Several public documents are given in full, including the memorandum on disarmament laid before Parliament on January 31, 1934. A full index enhances the value of the book.

Metallurgy: an Elementary Text-Book

By E. L. Rhead. New, revised and enlarged edition. Pp. xiv+382. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1935.) 10*s*. 6*d*.

A BOOK which is forty years old can claim to have established itself as useful. In spite of the fact that large additions have been made in many sections, the total length remains less than 400 pages, a sign that the matter has been condensed. In this edition new sections have been added on pyrometry, metallography and foundry work, and additions made in the sections dealing with fuel, electric furnaces, coking plant and other melting and smelting processes.

The revival of interest and prosperity in our iron and steel and metallurgical industries should attract an increasing number of technically trained men into them; indeed without these the revival will not persist.

Unit Processes in Organic Synthesis

P. H. Groggins, Editor-in-Chief. (Chemical Engineering Series.) Pp. xii+689. (New York and London: McGraw-Hill Book Co., Inc., 1935.) 30*s*. net.

THE chemist in industry is far more interested in the reaction, mechanism and technique of the processes employed than in the countless new carbon compounds which are synthesised; hence a textbook of organic chemical engineering which deals with the unit processes. Those chosen are nitration, reduction, diazotisation, halogenation, sulphonation, amination, oxidation, hydrogenation, alkylation, esterification, hydrolysis, Friedel and Craft's reaction, polymerisation. There is little doubt that this is the way to teach the subject, and that the new method will in time prevail.

The technical production of the book is excellent.

The Meaning of Biological Classification*

By Dr. W. T. Calman, F.R.S.

IN much of the academic teaching of biology at the present time, the view is expressed or implied that biological classification is meaningless except as a more or less convenient device for filing herbarium sheets or arranging our animal specimens on shelves, the inference being that our search for a natural system of classification is futile, because no natural system exists. It is possible that if we could cross-examine one of those who despise the work of the systematist, we might find him reluctant to go quite so far as this. We all, even the youngest of us, profess to accept the doctrine of evolution, if only as a convenient weapon with which to meet the fundamentalists, and we can scarcely believe in evolution while denying altogether that, in Darwin's words, "community of descent . . . is the bond which, though obscured by various degrees of modification, is partially revealed to us by our classifications". Darwin, indeed, saw clearly, so early as 1842, that "the natural system ought to be a genealogical one" and the idea was old even then. It is implicit in Buffon, in 1766, and Lamarck seems to take it for granted. Why then must we now abandon it, and what is to take its place ?

In the 'eighties of last century, a fresh direction was given to morphological thought by the rise of the new branch of biology to which Roux gave the name of *Entwicklungsmechanik*. This was an attempt to explain structure in terms of forces acting during the life-history of the individual organism, and to replace the 'historical morphology' of the period immediately preceding it by 'causal morphology'.

The profound influence which this school has exerted on biological thought is well known. In the passage which I have just quoted from Darwin I omitted one clause : Darwin wrote, "community of descent, the one known cause of close similarity in organic beings". It is not too much to say that causal morphology has revealed other factors besides community of descent as responsible for some of these close similarities. In other words, it has not only proved the possibility, but also explained a method, of convergent evolution on a scale unsuspected in Darwin's time.

This physiological point of view has tended to concentrate attention on those features of organic form that can be demonstrated experimentally to originate as individual responses to the pressure of environment, or to be the inevitable outcome of 'laws of growth' that are the same for organisms in different lines of descent. It has tended to neglect features for which no such explanation can as yet be imagined.

There is, however, one group of biologists who have never quite lost interest in questions of descent. Those who are concerned with the study of fossil animals and plants cannot, if they would, ignore the historical succession of organisms ; nor can they altogether avoid speculating on the nature of the links that relate each form to those that precede and those that follow it in the geological time-scale. Here again we find that modern research has led to the recognition of many incontestable instances of parallel and of convergent evolution. I need not illustrate this by citing examples, for the subject was admirably expounded only a few years ago by one of the most erudite and philosophical of palæontologists, the late Dr. F. A. Bather, in a presidential address to the Geological Society. His conclusions were that "the whole of our system, from the great Phyla to the very unit cells, is riddled through and through with polyphyly and convergence", and, in regard to the main subject we are considering here, "Important though phylogeny is as a subject of study, it is not necessarily the most suitable basis of classification".

When these words were uttered, they sounded to some of his hearers like a counsel of despair ; and now that their author no longer abides our question, we are left doubting what other possible basis of classification he could have had to suggest to us.

It would be mere presumption on the part of one who is not a palæontologist to criticise on palæontological grounds the deductions of an acknowledged master in that science ; but I must confess to a suspicion that things are not quite so bad as Dr. Bather painted them.

The number of instances in which the succession of fossils has been traced upwards through successive strata foot by foot with marvellous continuity must not blind us to the fact that such

* From the presidential address to the Linnean Society of London on May 24.

instances are, in the nature of things, quite exceptional. Darwin's chapter on the "Imperfection of the Geological Record" is, on the whole, as applicable to the state of knowledge to-day as it was when it was written. Many of the phylogenies which have been based upon palæontological evidence are little less conjectural than those based on morphological evidence alone. The main difference (and, of course, a very important one) is that palæontological series can only read in one direction, while we are sometimes in doubt which end of a morphological series comes first.

When these considerations have been allowed for, however, we have to admit that palæontology has revealed instances of convergence that are beyond question, although they are far from proving it to be so all-pervading as Dr. Bather suggested.

It would be easy to multiply instances to show that convergence has been too lightly assumed by some phylogenists as an easy way of getting over difficulties ; but, on the other hand, it is impossible to construct a reasonable scheme of phylogeny for any considerable group of organisms without finding it necessary to admit convergence in certain important characters.

When confronted with such examples of convergent, or, as Darwin called it, analogical resemblance, we are tempted to ask where we are to stop. Is structure ever an indication of phylogenetic affinity ? Is community of descent ever a cause of organic similarity ? Is blood ever, in fact, thicker than water ? Dr. Bather, as we have seen, came very near to answering these questions in the negative.

Most morphologists have believed that, however exact the resemblance produced by convergence, investigation would always reveal the underlying evidence of descent. As Darwin put it, "In all such cases some fundamental difference in the growth or development of the parts, and generally in their matured structure, can be detected".

We must, however, beware here of a very ancient type of fallacy.

"Treason doth never prosper. What's the reason ?
Why, if it prosper, none dare call it treason."

Convergent evolution, if carried out to the end, would obliterate the evidence of its own existence. Can we believe that it never does so ?

I do not profess to have any ready-made and conclusive answer to this question, but it seems to me that it might be helpful to approach it from another side ; from the side, namely, of the pure systematist.

Throughout great sections of the animal and vegetable kingdoms the broad outlines of a consistent and symmetrical natural system have now been established beyond all possibility, as it seems, of question. It is true that there still remain very considerable assemblages of both animals and plants of which the classification is still tentative and open to dispute. Since it is upon these debatable groupings that research and discussion have naturally concentrated, we may need sometimes to be reminded how extensive is the territory within which we no longer discuss the natural classification because it has long ago been settled, taken for granted, and put out of mind. Just as, for many of us, fading memories of the Latin grammar consist mainly of lists of exceptions, lingering on after the rules themselves have been forgotten.

It is certain that a natural system does exist. We may never be able to see all the details of its structure, and even its broad outlines may remain, here and there, a little blurred, but the general pattern cannot be mistaken. The framework of the *Systema Naturæ* is something different in kind from the framework of the London Telephone Directory. It is an objective fact, not an arbitrary construction of human inventiveness. It calls for explanation as urgently as, for example, the periodic classification of the elements ; and no scientific explanation other than that offered by community of descent has ever been given.

If Dr. Bather and those who think with him were right ; if the whole of the system were "riddled through and through with polyphyly and convergence", then it is inconceivable to me that the resulting ruins would have presented anything resembling the coherent pattern that we observe in our approximations to the natural classification of animals and plants. As Darwin pointed out in the fourteenth chapter of the "Origin", the categories of our classification cut across the categories of adaptation and those of environment. To suppose that they can be attributed to inherent laws of growth seems to verge upon mysticism.

I suggest, therefore, that the results of taxonomic research are, in their broad outlines, entirely inconsistent with the view that convergent evolution has been the rule rather than the exception in the phylogeny of animals and plants. It has often played an important part, but never the dominant one.

To know something of the course of evolution is a desirable preliminary to discussing the causes of evolution. If taxonomy can make a contribution towards our knowledge of the course of evolution, then it is a subject worthy of study.

The Institute of Chemistry

By Dr. Bernard Dyer

NEXT week the Institute of Chemistry will celebrate by a banquet and a reception the fiftieth anniversary of the granting of the Royal Charter which, in 1885, rewarded its already many years of effort to establish a definite form of recognition of the profession of chemistry as distinguished from the calling of pharmacy, with which in the lay mind it has been too often confused.

Before the letters F.I.C. or A.I.C. were used to designate fellows or associates of the Institute, there was no specific label by which the analytical and consulting chemist, the teacher of chemistry or the chemical research worker could briefly suggest the nature of his profession, except the vaguely significant letters indicative of fellowship of the Chemical Society—awarded not altogether without discrimination, but carrying with it no diplomatic significance; for the charter of the Chemical Society gave it no power to confer an examinational qualification.

In the late 'sixties and early 'seventies of last century, the desirability of some such distinction was, from time to time, discussed at formal and informal meetings, and in letters and articles in the Press; and in 1875, on the initiative of F. A. Manning, a well-known London analyst, a small organisation committee was formed to endeavour to formulate a definite plan of action. This committee was, from time to time, enlarged and reconstructed, and divers proposals were considered, with the result that two years later, in 1877, the Institute of Chemistry was incorporated under licence of the Board of Trade.

The first president was Prof. (later Sir Edward) Frankland (of the Royal School of Mines), and the other original subscribers to the deed of incorporation were Prof. Abel, Dr. Angus Smith, Prof. J. H. Gladstone, Prof. E. V. Tuson, Prof. W. Noel Hartley, F. A. Manning, E. Neison (later E. N. Nevill), Prof. Galloway, C. T. Kingzett, Prof. J. Attfield, Dr. C. A. Alder Wright, Dr. James Bell, Michael Carteighe, Prof. Crum Brown, and Prof. (later Sir) William Crookes. Of these signatories it is pleasant to be able to record that two are still with us, namely, Mr. E. N. Nevill (known to us then as Neison) and Mr. Charles T. Kingzett. Many chemists who had already given support to the movement in its preliminary stages were registered as original fellows, while admission was offered for the next six months to all whose positions or other evidence of fitness should commend them to the Council. After this, admission was to be restricted to applicants who had gone through a definitely stipulated course of training and experience; and the passing of a practical examination held by the Institute itself was soon prescribed as an additional requirement.

It was during these first six months that the writer of these notes—already in practice as a consultant at an age which would, in these days, surely seem precocious—was elected; but, as he remembers, he had at first to be satisfied with the rank of associate, until he attained the full age of twenty-four years fixed for admission to the title of fellowship. This, otherwise insignificant, incident is mentioned merely to indicate the duration of his association with the Institute and its activities, which is his excuse for yielding to the editorial invitation to occupy this space. The number of fellows and associates of the Institute recorded at the end of its first year was only 275. To-day its roll extends to considerably more than 6,000.

After three years, Prof. Frankland was succeeded as president by Sir Frederick Abel, who in turn was followed in 1883 by Prof. Odling, of Oxford, to whom fell, in 1885, the pleasure of announcing the reception of the Royal Charter, the grant of which forms the subject of the forthcoming Jubilee Celebration. The next president was Dr. James Bell who, in turn, was followed by Prof. (afterwards Sir William) Tilden, during whose time (1891–94), after a nomadic existence in temporary offices and reliance on the hospitality of the Chemical Society for general meetings, the Institute became possessed of a home of its own in Bloomsbury Square. It was also during Tilden's presidency that the Council was fortunate in obtaining the services in its secretarial office of a modest young man named R. B. Pilcher. The post of secretary and registrar had, from the beginning, been filled by Charles E. Groves (the well-known editor of the *Journal of the Chemical Society*) who had recently retired, being succeeded by Mr. G. H. Robertson, whose term of office, however, was cut short by illness. For the time being, Prof. J. Millar Thomson assumed the office of honorary registrar and secretary, with Mr. Pilcher as his lieutenant, and later (in 1900), when Thomson

became president, the full title of registrar and secretary fell to Mr. Pilcher, to whose zeal and energy the Institute owes not a little of its development and usefulness during the last thirty-five years.

Prior to Thomson's elevation to the chair, two other presidents had succeeded Tilden, namely, Dr. W. J. Russell (of St. Bartholomew's Hospital) and Sir Thomas Stevenson, the distinguished toxicologist. The presidency of the latter is chiefly memorable for the institution of the special examination in the analysis of food, drugs and water, and in microscopy, pharmacology and therapeutics, designed to meet the requirements of the Local Government Board (now the Ministry of Health), in considering the qualifications of candidates for appointment as public analysts, and the special diploma of the Institute has ever since been accepted by the Ministry as evidence of competency in this special work.

Succeeding presidents of the Institute were David Howard, Prof. Percy Frankland, Sir George Beilby and Prof. Raphael Meldola. It was during the term of office of the latter that, the lease of the Bloomsbury Square house having expired, the Institute migrated into the present commodious premises which, with the help of a generously supported building fund, it had been able to erect in Russell Square.

Meldola was succeeded in the chair by Sir James Dobbie (the then Government Chemist), whose influence helped to effect a long-contemplated and momentous change in the regulations for admission to the associateship. Hitherto all candidates had to be examined by the Institute itself, but it was then decided that the attainment of high chemical honours at the degree examination of any recognised university should be accepted as sufficient qualification. Promotion to the fellowship, however, was still, as now, to be awarded only after subsequent experience and the passing of a final examination in a special branch of chemistry, pure or applied, unless in exceptional cases in which the carrying out of advanced research, or the rendering of other signal service to chemistry, might be regarded by the Council as justifying exemption.

Later names on the list of past presidents are those of Sir Herbert Jackson, A. Chaston Chapman, Prof. G. G. Henderson, Prof. A. Smithells and Sir Christopher Clayton, while the now acting president is Prof. Jocelyn F. Thorpe (of the Imperial College) who has recently had the satisfaction of announcing that in celebration of its Charter Jubilee the King has been graciously pleased to accord to the Institute His Royal Patronage.

To attempt here any adequate indication of the present multifarious activities of the Institute would be futile; but it should be recorded that it has in Great Britain and in Ireland fourteen local sections, and at least five in the Dominions, all of which hold local meetings for the delivery of lectures and the discussion of papers, while in London advanced 'Memorial' lectures are given from time to time by eminent masters of special branches of science or of technology. The Council is always ready to lend advisory aid in administrative or other matters of public importance in which chemical considerations are involved, and sends representatives or delegates to many external conferences or standing committees. Not the least of the episodes in its history calling for retrospective satisfaction is the very multifarious help, civil as well as military, which, collectively as well as by individual effort, the Institute was able to render to the country during the War.

It should be added that the Institute issues a quarterly journal which records the proceedings of the Council and the activities of the various local sections and other items of domestic interest; and, in addition, often includes editorial articles which are not only informative but also healthily stimulative.

Obituary

Dr. C. E. St. John

CHARLES EDWARD ST. JOHN, who died on April 26 of pneumonia after a short illness, was one of the most lovable of men. Born on March 15, 1857, at Allen, Michigan, he graduated at the Michigan State University and studied afterwards at Harvard and Berlin. He was an instructor in physics at the Michigan State University and in 1897 became assistant professor, and later professor, of physics and astronomy at Oberlin College, and later dean of the College of Arts and Sciences. In the midst of these busy duties he found time in the summer to work at the Yerkes Observatory with Nichols on the measurement of radiation from the stars. At forty-nine years of age he joined Hale at the Mount Wilson Observatory and remained on the staff there until 1929 when he retired. He was made a research associate in 1930 and continued actively working, despite failing health, until the end, his last piece of work (left unfinished) being a general discussion of the problem of solar rotation.

It is as an enthusiastic and most successful

research worker in the general field of solar spectroscopy that St. John will be remembered. Among the problems that he worked at we may mention the gravitational displacement to the red of lines in the solar spectrum in accordance with the general theory of relativity. Closely allied with this was the study of systematic convection currents in the solar atmosphere invoked by St. John to account for anomalies in the observed Einstein effect. A full discussion of the Evershed effect in different levels in the sun's atmosphere in the immediate neighbourhood of sunspots was one of St. John's methods of analysing the layers in which the various Fraunhofer lines originated.

St. John's wide and exact knowledge of the solar spectrum in all its variants made of him a natural leader for the team recently engaged in the revision of Rowland's Preliminary Table of Solar Wave-Lengths, for St. John had been elected in 1922 president of the Commission on Standard Wave-Lengths and Tables of Solar Spectra of the International Astronomical Union. Later, when several of the solar commissions were combined into one—the Commission on Solar Physics—St. John was appointed its president, and he only gave up his active work for the Union a few months ago on account of failing health. He will be greatly missed at the coming meeting of the Union. St. John was also a member of the Commission on Solar and Terrestrial Relationships working under the International Council of Scientific Unions. He was elected an associate of the Royal Astronomical Society in 1917.

Mr. J. T. Cunningham

OF Joseph Thomas Cunningham, whose death occurred suddenly in London on June 5, at seventy-six years of age, it can with truth be said that he, more perhaps than most, through fair weather and through foul, preserved his youthful keenness and eagerness for biological research to the very end of a long life.

Born in London and educated at St. Olave's Grammar School, Southwark, Cunningham went up to Oxford, where his career was brilliant. He was Brackenbury science scholar of Balliol from 1878–81 and obtained first classes in mathematical moderations and in natural science. In zoology he was a pupil of Rolleston, who died in 1881. He was elected to a fellowship at University College, Oxford, in 1882, which he held until 1889.

After working for a time with Ray Lankester, Cunningham spent the winter of 1882–83 at the Naples Zoological Station. His first publication (*Q.J.M.S.*, Jan. 1882) was a review of recent work on karyokinesis. In 1883 he contributed to NATURE a description of the Naples Station, the occasion for which, he says, was the new Department of Comparative Physiology about to be opened there. In July of the same year there appeared two papers on his first researches, dealing with the nephridia of *Patella* and *Aplysia*.

Cunningham's career as a marine biologist commenced when, in 1884, after having been for a short time assistant to the professor of natural history at Edinburgh, he was appointed director of John Murray's floating marine laboratory (the *Ark*) at Granton, with Hugh Robert Mill as his colleague for hydrographical research. From 1887 until 1897 he was naturalist to the Marine Biological Association of the United Kingdom, being stationed at Plymouth until 1895 and then at Grimsby. He published during this time his monograph on the sole, which remains a standard work, and also his book on "Marketable Marine Fishes", in which much of his own research on the eggs and larvæ of fishes was summarised in convenient form. After serving for a period under the Cornwall County Council as lecturer on fishery subjects, he moved in 1902 to London, where he was engaged in teaching zoology, being from 1917 until 1926 lecturer at East London (Queen Mary) College.

Cunningham was a regular attendant at zoological meetings and frequently took part in the discussions. Although in later years theoretical aspects of biology were his chief interest, he seldom failed to direct attention to significant facts not generally known to his audience which had either come under his own observation or, although recorded, had been forgotten. When the present writer first knew him in 1892 his 'Lamarckian' outlook was already well established and he was always proud of the fact that he had received much help and encouragement in his study of the subject from Herbert Spencer. His own views were summarised in his book "Modern Biology: a Review of the Principal Phenomena of Animal Life in Relation to Modern Concepts and Theories" (1928), and his principal original contributions in "Hormones and Heredity" (1922), and "Sexual Dimorphism in the Animal Kingdom" (1900).

Cunningham was much interested in the experimental side of Mendelian work, as well as in experimental physiology, and always had in hand experiments of interest of his own. So recently as 1930, when more than seventy, he went to Marajo, in the mouth of the Amazon, to study the function of the external filaments which develop during the breeding season on the pelvic limbs of the male lepidosiren; there he satisfied himself that the observations he was able to make confirmed a view he had previously expressed, that these filaments emitted oxygen to the eggs and larvæ, which develop and grow in the almost oxygen-destitute water in a burrow in the swamp. E. J. A.

Mr. H. W. Clinton-Baker

THE death on April 19, at the age of seventy years, after a few days' illness, of Mr. H. W. Clinton-Baker, the Squire of Bayfordbury, removes a well-known Hertfordshire arboriculturist. Mr. Clinton-Baker will be best remembered for his keen interest in conifers, which he had made the hobby of a lifetime. He became the owner of the Bayfordbury estates in 1903 on the death of his father.

Mr. Baker's love for trees was no doubt inherited from his grandfather, Mr. William Robert Baker, who commenced the famous Bayfordbury pinetum in 1837. The Bayfordbury cedars, planted in 1765 by

an ancestor, Sir William Baker, to commemorate the building of the house, are still among the finest in Great Britain. The pinetum, which at one time contained the best collection of conifers in the country, was considerably enlarged by the late Squire, who from time to time made numerous additions to it. Just before the War he commenced the formation of a new pinetum at Bell's Wood on another part of the estate, which he had planted with conifers recently introduced from China and elsewhere.

Between 1909 and 1913, Mr. Baker's interest in conifers took a more definite shape, when he published three handsome quarto volumes of "Illustrations of Conifers" which contained 'close-up' photographs of all the hardy species in cultivation. The letterpress for the work was prepared by the late Prof. A. Henry and Mr. A. B. Jackson, two well-known authorities on the group. These volumes are a valuable contribution to the literature of conifers, and have been of considerable assistance in the identification of the species. A supplementary volume to the series was commenced some time ago, and will be issued shortly. It is deeply to be regretted that Mr. Baker did not live to see its completion.

News and Views

Iron and Steel

WHEN delivering the Christmas lectures at the Royal Institution in 1925 on "Old Trades and New Knowledge", Sir William Bragg took for the subject of one of his lectures the trade of the smith. One of the objects of this lecture was to show how science has been applied to one of the oldest arts, and what it has revealed. Somewhat the same subject, but under the more prosaic title of "Iron and Steel", and dealt with in a different manner, was taken by Sir William Larke for his Friday evening discourse at the Institution on March 22, and this address is reproduced as a supplement in our issue this week. Within an hour, Sir William reviewed the whole history of the manufacture of iron and steel, pointing out some of the outstanding landmarks, referring to some of the chief inventors and touching upon some of the great achievements rendered possible by the metallurgists.

SINCE iron and steel were first used some thousands of years ago, and since iron was as precious as the crown jewels, many unknown inventors all over the world have added their contributions to the art of iron making, but as Mr. Charles Schwab said, every invention of fundamental importance in the modern iron and steel industry is British in origin. Such names as Darby, Huntsman, Cort, Neilson and Bessemer are well known, and the rise of the iron industry in Great Britain may be regarded both as a cause and a result of the so-called Industrial Revolution. Since the Norman Conquest, said Sir William, there may be said to have been three main phases of industrial development. The first extended to the beginning of the eighteenth century, when power was obtained from animals and men, the second lasted nearly a century and a half and may be described as the age of Iron and Coal, while the third phase, that of the development of metallurgy and alloy steels, has only lasted a quarter of a century, and we may be said to be at the beginning of a new era. Iron manufacture has profoundly influenced the standard of life in the past, and its effect on our social organisation is likely to continue to increase.

Dr. Irving Langmuir, For.Mem.R.S.

THE many friends of Dr. Irving Langmuir will note with pleasure that he has just been elected a foreign member of the Royal Society. It will be remembered (see NATURE, p. 768, Nov. 19, 1932) that he was awarded the Nobel Prize for Chemistry in 1932. In referring to this award, it was pointed out that it is to Irving Langmuir that we owe the conception of the orientated monolayer as the state of material at phase boundaries. A clear and simple interpretation was found for many of the phenomena occurring at interfaces, and new light was thrown on such varied subjects as thermionics, heterogeneous catalysis and surface tension. More recently, Langmuir has been investigating the stability of oil lenses on water as determined by the nature of the monolayer of the interface, a problem with many biological implications. In addition, as the late Sir William Hardy first observed, the orientated monolayer on a metal surface plays an important function in lubrication. During the last two years, Langmuir has also made the important discovery that these layers are destroyed by the passage of a rubbing surface, but if the film be made thick enough, self-repair is effected. Finally, with his co-workers, Langmuir has been investigating the conditions of mobility of substances adsorbed in monolayers on metal substrates, one of the factors to be considered when the rates of catalytic actions are under review.

Prof. Max Weber, For.Mem.R.S.

THE election of Prof. Max Carl Wilhelm Weber as a foreign member of the Royal Society gives well-deserved recognition to one whose influence on biological science is of outstanding importance. After earlier work on Crustacea, Prof. Weber soon entered upon his studies of fish, which were eventually to bring him into the front rank of ichthyologists of the day. His contributions to our knowledge of fish fauna have been very great and resulted from his personal travels into the far north, South Africa and the East Indian Archipelago. The fruits of his researches culminated in his comprehensive joint

work with L. F. de Beaufort on "The Fishes of the Indo-Australian Archipelago" published in three volumes between 1911 and 1916. But to biologists in general, Max Weber is probably better known for his able leadership of the Dutch *Siboga* Expedition in 1899–1900. This expedition covered a distance of about 12,000 sea miles in the different basins of the East Indian Archipelago, and was equipped with the best oceanographical apparatus of the time. The reports of the *Siboga* Expedition edited by Max Weber form one of the major contributions to the science of oceanography, and have filled a large gap in our knowledge of the fauna of that region. Weber himself undertook the study of the fishes collected by the *Siboga* Expedition and published in 1913 his great volume, in which no less than 131 new species were described and 240 species recorded for the first time in the Indo-Australian Archipelago. This work he dedicated to his wife, Mme. Dr. A. A. Weber-van Bosse, who accompanied him on his travels and is herself a botanist of great distinction. Prof. Weber is also the author of the most comprehensive text-book on the Mammalia to be found in any language. The first edition of this work, "Die Säugetiere", was published in 1904 in one volume; the second and latest edition, in two volumes, appeared in 1928. Taking a general view of the work, it is the most complete account in existence of the taxonomy and structure of mammals, living and fossil.

Prof. Moriz Benedikt

PROF. MORIZ BENEDIKT, a leading Austrian neurologist, was born at Eisenstadt in Hungary on July 6, 1835. His medical education was carried on in Vienna, where he studied under Hyrtl, Brücke, Skoda, Oppolzer, Rokitansky and other well-known teachers, and qualified in 1859. During the period 1861–75 he was chiefly concerned with electro-therapy and neuropathology. Afterwards he turned his attention to a comparative anatomical investigation of the brain in man and animals, and craniometric and psychological studies. In 1899 he was appointed professor of neurology in the Vienna medical faculty. In addition to a large number of articles on neuro-pathology, most of which were published in the *Wiener medizinische Presse* between 1869 and 1882, he wrote on anthropology, ophthalmology and otology. Like his contemporary, Charcot, he took a keen interest in art, and a few days before his death, which took place on April 14, 1920, at the age of eighty-five years, published an essay on Raphael. His name has been attached, at Charcot's suggestion, to a syndrome characterised by oculomotor paralysis on one side with paresis and tremor of the upper extremity on the other.

Electrical Units and the I.E.C.

THE practical system of units now in use is consistent, in the sense that the product of a resistance in ohms and a current in amperes gives a potential difference in volts; but it suffers from the defect that the units themselves are not those which would most naturally be derived from the fundamental mechanical units. As a consequence, the product of current in amperes and potential difference in volts gives the power, not in the usual mechanical unit (ergs per second), but in joules per second, that is, in watts. A degree of simplicity is maintained by making the relation between the practical and the absolute unit an integral power of ten in each case. We understand that the International Electrotechnical Commission at its meetings last month adopted the proposals of Prof. G. Giorgi (discussed in NATURE of April 21, 1934, p. 597) to regard these units as derived, not from the centimetre-gram-second system, but from a metre-kilogram-second system. In this system, the unit of velocity is the metre per second, so that the kinetic energy of unit mass (1 kgm.) moving with unit velocity would be 1000×100^2, that is, 10^7 times that of a gram moving with a velocity of 1 cm. a second. Thus the unit of mechanical energy on this system is 10^7 ergs $= 1$ joule, just as in the practical electrical system.

IT is clearly not sufficient to arrange that the product of current and E.M.F. shall give power in watts, but if a further relation is imposed, then the whole system—ohm, volt, ampere, farad, coulomb, henry, joule, watt and weber—becomes definite, and the powers of ten by which these units are related to their C.G.S. counterparts need not burden the memory; they can be recovered at any time by a simple argument. For the additional relation required, Prof. Giorgi assigns the value unity to the present international ohm, and thus makes all the units on his system identical with those of the practical system. An argument in favour of this particular choice, rather than that of current or voltage, for example, is that dimensional formulæ are appreciably simplified if resistance is taken as the fourth independent magnitude, in addition to length, mass and time. The Commission has at the same time endorsed the resolution passed at Oslo in 1930, to the effect that μ_0, the permeability of empty space, should be retained in magnetic formulæ as a physical quantity and not as a mere numeric differing from unity. On the other hand, authors are left free to use the rationalised or unrationalised formulæ, according as the value which they choose to assign to the permeability of a vacuum does or does not absorb the constant 4π.

Archæological Discovery in Crete

A DISCOVERY in Crete, of which the intrinsic interest is enhanced by the recent publication of the concluding volumes of Sir Arthur Evans's "Palace of Minos", in which he deals with the Minoan script, is announced from Athens. A dispatch from the correspondent of *The Times*, which appears in the issue of June 28, states that Dr. Marinatos, director of the museum at Candia, has announced that among antiquities discovered in the Arkalokori district is a copper double axe on which is a three line inscription in characters not previously known in the Minoan civilisation, but bearing some resemblance to those on the famous Phaistos disc. The antiquities with which this inscribed axe was found are dated at about

the sixteenth century before Christ, a period at which the Minoan culture was at its zenith. The discovery is otherwise remarkable in that it includes swords of exceptionally large size, which are said to be greater in number than any other single find of swords ever made in prehistoric Europe. Associated with them were some hundreds of copper axes, a number of silver axes and twenty-seven gold double axes with golden shafts. The claim that the newly discovered script is itself unknown, but bears a resemblance to characters known from the Phaistos inscription, constitutes the chief interest of the find; though it has other points which will intrigue archæologists. In the circumstances, its full publication should be delayed as little as possible, even though this should entail postponement of full discussion.

Soviet Stratosphere Research

IT is learnt from the reports in *The Times* of June 27 and 28 that stratosphere research is very active in the U.S.S.R. It will be recalled that the Russians hold the altitude record of 12 miles for manned balloons made by M. Prokofiev in October 1933, whilst the U.S.S.R. *Stratostat*, which crashed in January 1934, killing its occupants, rose even higher. The present ascent, which was only of 2½ hours' duration, was made from Moscow on June 26, during which time the balloon travelled 100 miles due south. The commander-pilot was M. Kristap Zille, who was accompanied by a physicist, Prof. Alexandre Verigo, of the Central Geophysical Observatory at Leningrad, and a mechanic named Prilutsky. It is stated that during the short flight the altitude reached was more than 9 miles and that the crew landed safely by parachute, apparently as an exercise. Prokofiev's gondola was used, its instruments were landed intact, photographs of the earth were made and varied cosmic ray records taken. It is incidentally stated, though extremely interesting to hear, that the commander had made two other stratosphere ascents in June.

London Transport Scheme

ARRANGEMENTS have been concluded between the Government and the Standing Joint Committee of the London Passenger Transport Board and the main line railways for the development of a transport scheme for London. On June 5, the Chancellor of the Exchequer announced to the House of Commons that a £35,000,000 plan had been concluded. In addition to the extensive schemes included in the Private Bill of the Transport Board, it is intended to electrify the suburban lines of the L. and N. E. Railway in north-east London entering Liverpool Street, and to extend tube railways to give new connexions between these electrified lines and the City and the West End. The high level at which Government credit now stands enables an Exchequer guarantee to be given of loans sufficient to enable the whole undertaking to be started at once. It involves the building of about 12 miles of new tube railways, the electrification of 44 miles of suburban railway and the doubling and electrification of about 12 miles of further suburban railways. In addition, we were glad to learn that trolley buses are to be substituted for tram cars on 148 route miles. These buses, like the cars, are driven by electricity, but they leave the highways more open and much safer for road traffic. It is hoped to complete the works within five years from the date of the loan. Among the improvements, we notice that escalators will be used instead of lifts and will provide ample accommodation for the increased traffic.

Gas or Electricity for Domestic Heating?

THE question of whether to heat our houses by gas or electricity is discussed in an article in the *Nineteenth Century and After* of June by Prof. W. A. Bone. He is naturally proud of the progress made by the gas industry during the past hundred years. He points out that the electrical industry is only fifty years old and has the attractiveness and self-confidence of youth, and so is apt to impress uncritical minds with its superiority. We agree that a London gas consumer buys as much potential heat for 8·6*d.* as would cost an electricity consumer nearly half a crown at 1*d.* per unit. On the other hand, every bit of the electric heat can be utilised, whilst an appreciable fraction of the gas heat passes up the chimney. Electricians are well aware of the relative costs of gas and electricity for heating, and where economy is the primary consideration, water heating by electricity is only advisable in certain cases. We do not agree with Prof. Bone that a chimney is necessary for the suitable ventilation of bed- and living-rooms. Many systems for ventilating rooms have been devised. Possibly in a few years time chimneys will be considered relics of barbarism, and roof gardens will add to the amenity of life. In London, many consumers now get their electricity at 0·5*d.* per unit and are delighted with their electric heaters and cookers, even although they have previously had extensive experience of gas rings and fires. Electricians are continually experimenting, just as are gas engineers; and are remedying some of the defects of the early installations. It is now customary to have the switch for the electric fire about three feet above the floor so that the heat can be regulated without moving an armchair.

Institute of Physics Lectures at Manchester

THE annual lectures on recent advances in physics arranged by the Manchester and District Local Section of the Institute of Physics were held in the Physics Department of the University of Manchester on June 24 and 26. The first lecture was given by Prof. Franz Simon, who is now working at the Clarendon Laboratory, Oxford, and whose researches on low temperatures are well known. He chose as his subject "Low Temperature Research—its Objects and Methods", and gave an account of recent advances in experimental technique whereby temperatures of the order of a fraction of a degree from absolute zero may be obtained. The principles underlying the experimental methods were considered

and reference made to the peculiar properties of certain substances at low temperatures. Prof. M. Polanyi, professor of physical chemistry in the University of Manchester, gave the second lecture, his subject being "Reaction Velocity and Thermodynamics". He discussed the general effect of pressure on the velocity of chemical reactions, using relations deduced in accordance with thermodynamical principles, and referred among other things to the alteration of the equilibrium of reactions due to pressure, the grouping of reactions, and the connexion between reaction velocity and the heat of reaction. He also described recent work on the mechanism of ionogenic reactions. The lectures were well supported by members and friends, and were followed by helpful discussions of the various points raised.

Chemical Industry and Water Problems

THE presidential address of Mr. Edwin Thompson, at the annual general meeting of the Society of Chemical Industry at Glasgow on July 2, dealt with the question of water supply in Great Britain and covered a wide range of topics in that connexion. Mr. Thompson considered the problem of a national water policy to call for immediate investigation. He deplored the spirit of localism which still manifests itself in connexion with every water supply scheme of magnitude, despite the recommendation made nearly seventy years ago by the Royal Commission of 1868 "that no town should be allowed to appropriate a source of supply which naturally and geographically belongs to a town or district nearer to such source, unless under special circumstances which justify the appropriation". He said there is too much selfishness among water undertakings, and that they could do much to relieve the needs of those who have no water supply. He went on to discuss a number of difficulties and problems which are associated with questions of supply: water pollution, rural requirements, misuse and waste of water, the increase during recent years of the *per capita* consumption, diversion of supplies for canals, storage reservoirs, biological factors of storage, sewage effluents into rivers, compensation water, etc. He alluded to and endorsed the necessity for a survey of the water resources of Great Britain and instanced from the report of the British Association Committee the example set in this respect by other nations. The idea of a water grid was dismissed. The valuation of waterworks for rating purposes has a serious financial bearing on the administration and working expenses of an undertaking. The formation of a Select Committee of the Houses of Parliament to go fully into the question of national water supplies made him confident that the anxieties and hardships of the past year will never be repeated.

The Annual Tables of Constants

AT the conference of the International Union of Chemistry, held in April 1934 in Madrid, it was recommended that a substantial part of the funds at the disposal of the Union should be transferred to the International Committee of Annual Tables of Constants, in order to assist in the publication of these valuable tables. This recommendation was passed unanimously by the Union's executive in Paris in last October and confirmed by the national organisations representing the various countries adhering to the Union, such as Verband Deutscher Chemischer Vereine representing Germany, Comité National Belge de Chimie representing Belgium, National Research Council, Division of Chemistry, representing the United States, and so on. The sum thus put at the disposal of the Committee of the Annual Tables is 150,000 francs; the amount indicates the importance which international chemical circles attach to the continuation of the Annual Tables. This sum will be used up for printing the index of the second series (vol. 6–10, 1923–1930), which is now ready. In return for this gift, the Committee of the Annual Tables is going to put at the disposal of the chemical organisations adhering to the Union a certain number of complete sets of the Tables.

Atmospheric Pollution

THE twentieth report on atmospheric pollution issued by the Department of Scientific and Industrial Research (H.M.S.O., 5*s*. net) records observations for the year ending March 31, 1934. This report, like its forerunners, shows that preconceived notions are not always supported by measurement. If the conditions of sampling and test are valid, then the City of London has the most polluted atmosphere observed in Great Britain, and deposits of solids and tar show annual increase. Again, foggy weather, judged by measurement of 'smoke haze', appears to reach greatest prevalence in Westminster, and some of the highest figures for sulphur pollution are also found in London observing stations. Some so-called industrial cities apparently have atmospheric conditions much superior to those in London. London may, however, take comfort from the fact that comparable measurements show that atmospheric pollution in Philadelphia is almost twice as bad. Experience is recorded with the use of a 'candle' of lead dioxide for measuring atmospheric sulphur compounds. Another interesting apparatus has been devised for recording the quantity of light. The light received by a photo-electric cell develops a current which imparts to a condenser a charge. When this reaches a certain amount, it discharges through a neon lamp and causes an ordinary counter to advance one unit. The difference between the records at the various stations is great, and it may be inferred that large improvements in atmospheric conditions are possible by using experience already known.

Epidemic of Green Fly

WE learn from the Ministry of Agriculture and Fisheries that, in many districts in the southern half of England, oats have suffered from severe infestations by aphides or 'green fly'. Similar attacks on grassland have taken place in certain northern counties, including Lancashire. The insects occurred often in swarms, smothering the crops and causing

much damage. The species concerned is a common one which often causes local and temporary injury to grass. Its appearance in epidemic form on cereals is quite unique in recent times. The reasons for the outbreak are unknown, but they are probably associated with the relatively mild autumn and winter and the advanced condition of the crops. The standard control method would be the application of an insecticidal dust by means of a powder sprayer. The necessary equipment, however, is not available on many farms, and expenditure to meet this treatment seems scarcely justifiable in view of the damage that has already been done. It is probable that the aphids will shortly migrate, while natural enemies are already actively at work.

Metals in Food

THE Society of Public Analysts has issued a useful "Bibliography of the More Important Heavy Metals occurring in Food and Biological Material", the period covered being the years 1921–33. The elements dealt with are antimony, bismuth, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, thallium, tin and zinc. Each reference indicates the nature of the information to be found in the paper. The largest sections deal with copper, lead and manganese, which account for half the references quoted. The pamphlet (30 pages) can be obtained from the Editor of the *Analyst*, 85 Eccleston Square, London, S.W.1 (2*s*. to members of the Society ; 3*s*. to non-members).

Principles and Design of Precision Gauges

IN these days of motor-cars, electric fittings and so on, everyone learns something of the value of interchangeability of parts and also experiences the disadvantage of finding that a part 'will not fit'. The progress of manufacture, indeed, depends largely on parts being interchangeable, and in mass production it is absolutely necessary to place limits on the permissible variation from standard dimensions. This necessity has given rise to the system of working to gauges, a system which received a great impetus through the manufacture of vast quantities of munitions during the War, and which to-day is perhaps used most extensively in the manufacture of motor-car engines and other parts. From being a comparative novelty, gauging has become a matter of ordinary routine, while the making and testing of gauges has itself become an industry. There will thus be many persons who will be able to appreciate the pamphlet of Mr. R. J. Foster on "The Principle and Design of Precision Gauges for Interchangeability" recently issued by the Association of Engineering and Ship-building Draughtsmen, and published by the *Draughtsman* Publishing Co., Ltd. (2*s*.). In this the reader will find sections on tolerances and fits and limits, plug gauges, pin gauges, external and internal gauges, height and depth gauges and comparators, together with many sketches and useful notes.

International Geological Congress

PRELIMINARY arrangements are announced from Moscow for the meetings of the Seventeenth International Geological Congress, which is to be held in the U.S.S.R. during the summer of 1937, the year of the twentieth anniversary of the Soviet Government. It is proposed that the first half of August should be devoted to the sessional meetings. The special topics suggested for discussion include petroleum, coal, ore-deposits, rare elements, geophysical methods, the Permian system, tectonic and geochemical problems, the relationship of magmatic rocks and ore-deposits to tectonics, and the history of geological knowledge. Three series of excursions, *A*, *B* and *C*, are provisionally arranged, to take place respectively before, during and after the sessions, the whole programme extending from the beginning of July to the end of September. The *A* series includes excursions to the north (Pre-Cambrian and Khibina Complex) ; the Urals ; the south (Crimea and Donets Basin) ; the Volga Basin ; and the Caucasus. The *C* series are on a larger scale and cover very wide regions. They are described as petroleum and stratigraphical (main oil districts and Central Asia) ; Central Asia (stratigraphy, tectonics and volcanic phenomena ; transcontinental (stratigraphy, tectonics and economic geology of Urals to Soviet Far East) ; and Turkestan-Siberia (Perm, Altai and Kuznetsk). More detailed descriptions will be given later. Meanwhile inquiries are invited and should be addressed to the Organisation Committee of the Seventeenth International Geological Congress, Moscow, 4, Kotelnicheskaya, Naberezhnaya, 17.

A Recent Sunspot

A FAIRLY large group of sunspots has recently been visible whilst crossing the sun's disc on June 23–July 6 in long. 305° and lat. 24° S. Its area on June 28 was 1000 millionths of the sun's hemisphere, of which 850 millionths was the area of the leader spot. When near central meridian passage, which occurred on June 29·9, the group was visible to the naked eye. Though itself not a return of an individual spot of the previous rotation, the recent spot represented a continuation of localised disturbance which has been apparent for the last two months in this part of the solar surface. In an ordinary telescope, the group has been an interesting object with conspicuous 'bridges' across the leader spot in particular. The spectroscope offered, as usual, a further range of observation. On June 26 at $8^h\ 45^m$ G.M.T. a bright eruption took place that was observable visually in the hydrogen *C* line of the solar spectrum and should have been possible to photographic records in the *H* and *K* lines of ionised calcium. The spectrohelioscope showed with perfection the contour of the areas of the brilliant hydrogen (Hα) emission and the dark filaments of gas bordering them at a later stage. The largest radial velocities measured at Greenwich for the absorption filaments were 20 km. a sec. outwards and 60 km. a sec. inwards to the sun. On June 29 at about $8^h\ 45^m$, several moderately large radial

(*Continued on p.* 27.)

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Iron and Steel*

By Sir William J. Larke, K.B.E., Director of the British Iron and Steel Federation

NO single element has exercised such a profound influence on the social organisation of mankind as iron. To-day, directly or indirectly, it enters into every moment of our lives, sleeping or waking; the production of our food, our clothing, our homes, our furniture; and without it modern transport by sea, land and air, the distribution of gas, water and electricity, in fact all the amenities of modern civilisation, would be impossible. We are still in the Iron and Steel Age, and likely to become more and more dependent on them for our material well-being.

Fortunately Providence has ordained that 4·44 per cent of the earth's crust consists of iron in various forms. Though widely scattered, it is found in varying degrees of richness in iron content from a trace up to 60–70 per cent. It is usually only described as iron ore when the iron content is at least 20–30 per cent, as the iron is too costly to extract with smaller content. A feature of all early iron production, owing to the difficulty of obtaining a high temperature, which in primitive furnaces seldom exceeded 1,100° C., was the use of iron ore or sand of high iron content, a fact which limits the area likely to have given birth to the iron culture.

The qualities of iron were aptly described by Dr. Ure in his "Dictionary of Arts and Manufactures". "Every person," he says, "knows the manifold uses of this truly precious metal. It is capable of being cast in moulds of any form, of being drawn out into wire of any desired strength or fineness, of being extended into plates or sheets, of being bent in every direction, of being sharpened, hardened or softened at pleasure. Iron accommodates itself to all our wants, our desires, and often our caprices. It is equally serviceable to the arts, to science, to agriculture, and the same ore furnishes the sword, the ploughshare, the cannon and the bomb. It is a medicine of much virtue and the only metal friendly to the human frame. The ores of iron are scattered over the crust of the globe with a beneficent profusion proportionate to the utility of the metal; they are found under every latitude and every zone, in every mineral formation and are disseminated in every soil."

Iron beads and other articles have been discovered under conditions indicating that iron was known as a precious metal in Egypt at least 4,000 B.C. A sickle blade found by Belgoni under a sphinx at Karnac, and a portion of a cross-cut saw found in one of the pyramids by Colonel Vyse, estimated at 3,000 B.C., are the earliest evidence of its use for purposes other than ornamental. Such early iron has been proved to be of meteoric origin, and indeed the word iron in most cultural languages is derived from a root meaning 'something hard from the sky'. This acceptance of its origin was very widespread. According to Zimmer and others, de Cortez, whilst in Mexico in 1519–21, found that the Aztecs possessed knives and daggers of iron, which were prized higher than gold, being of great rarity; but they had no knowledge of how to smelt it, and when asked, stated that the material came from the sky.

Zimmer in his paper on meteoric iron points out that as meteoric iron contains 3 per cent of nickel, the ancients possessed a steel which (when they were fortunate in the mass they used, as it was of very unequal constitution) was not available to mankind by a manufacturing process until 1890. He points out that 99 per cent of the then (1916) known mass of about 250 tons of meteoric iron is ductile. It was not, however, until a famous fall of meteorites was witnessed at L'Aigle in Normandy on April 26, 1803, by thousands of people, that the celestial origin of meteoric iron was generally accepted in modern times. Such iron contains iron, nickel, copper, cobalt, phosphorus, and in most cases in addition sulphur, carbon and silicon, so that it is a highly complex alloy. There is little doubt that all the early iron in North America up to the fifteenth century was meteoric in origin. Man doubtless discovered the existence of terrestrial iron through the accidental fusing of ore in a camp fire, but there is no evidence to show at what date.

* Friday evening discourse delivered at the Royal Institution on March 22.

Earliest remains indicate that the smelting of iron was known in India approximately 1,400 B.C.; and the discoveries at Hallstatt in Styria and Carinthia (the Roman Noricum), in the famous cemetery, where some thousand graves have been investigated, fixes the date of a highly developed iron culture at approximately 1,200 B.C. The importance of the Hallstatt finds is that examples of bronze and iron weapons found side by side, exactly the same in shape and design, show they were made in a transition period from the Bronze to the Iron Age. Dr. Percy in his great work on metallurgy pointed out that the Iron Age must have preceded the Bronze Age, since it was obviously easier for primitive man to have smelted iron than to have made an alloy of copper and tin; but it is suggested that bronze was almost certainly the result of the smelting of an ore of copper and tin found in the same mine, and that the alloy was not until later a controlled mixture.

The evidence in favour of either centre, Europe or Asia, as the birth-place of iron smelting is of necessity speculative. It is significant that both iron and steel are indiscriminately referred to by ancient writers in describing the material, and there is no doubt that, in the early processes of smelting, iron of varying degrees of hardness and varying qualities was produced.

Early remains indicate that the first iron furnace consisted of a hole in the ground lined with clay, in which were set alternate layers of charcoal and iron ore. The product was a mass of spongy iron mixed with slag and charcoal, which had to be reheated and hammered to eliminate the impurities and render the metal fit for forging into weapons and tools. The resulting metal was no doubt soft, and it is recorded of some of the ancient tribes who were iron workers, that when fighting the Romans, who were then armed with bronze, their weapons frequently bent and required to be straightened.* The production of steel of a high quality under controlled conditions seems to have been established in India several centuries before the Christian era.

According to Colonel Belaiew, wootz, the steel from which the famous Damascus swords were made, was produced by a crucible process. The spongy mass of iron produced from the furnace was broken up, remelted in a crucible with charcoal, allowed to cool, and then reheated and hammered several times; finally being hammered into small cakes about 5 in. in diameter and ½ in. thick, called wootz, which was then an article of merchandise carried from India to Damascus and to Toledo in Spain. This process produced a beautiful steel for the purpose, which, when etched with acid, developed a blue watermark known as Damascening. Its constitution was a eutectoid steel of approximately 0·9 per cent carbon containing segregations of glass-hard carbide of iron, cementite (Fe_3C), which in the process of production had become spheroidal. The steel gave the swords remarkable flexibility when tempered, and the glass-hard spheroidal particles of cementite took and retained a very sharp edge.

Between the soft weapons of the early Iron Age in Europe and the more highly finished steel of the early productions of India, there is the complete range of qualities in iron and steel which ultimately led to the transition from the Bronze Age to the Iron Age. The hard bronze weapons of the Romans were at least a match for those of soft iron produced directly from the ore; but as the production of steel became more general, the steel weapons were able to pierce bronze armour. The importance of iron for weapons was recognised by the Etruscan King Porsena, 507 B.C., who in the conditions of peace prohibited the Romans from using iron, except for agricultural purposes. It seems evident that iron and steel weapons displaced bronze after Marathon, approximately 490 B.C. About the same period the Phœnicians established colonies in Spain and introduced iron making as followed by the Greeks, and during the second century B.C. Spain became the greatest iron centre, and remained so for centuries. The Romans during the second century B.C. adopted Spanish swords, and Toledo blades were famous long before the Christian era. There was a great belief at this period in the efficacy of the qualities of certain waters, particularly the River Salo in the north of Spain, for tempering—a belief that has been revived even in modern times, when competitors of Sheffield have attributed qualities to the local water which were the result of the abilities of the local people.

Although examples of the Hallstatt iron weapons have been found in Great Britain, and according to Ault were the cause of the people turning their attention to iron, the Iron Age seems to have commenced here about 400 B.C. The iron mines of Sussex were famous until the eighteenth century. The advent of iron tools for wood working and for agriculture converted man from a hunter to a farmer, and thence to a capitalist as he accumulated at first stores of grain, and then more and more tools. It was at this stage that iron assumed its first economic importance. From this period until the eighteenth century its influence and importance with regard to social and economic development was of the same character, though increasing in degree. The furnaces in which the ore was smelted with charcoal, consisting of holes in the ground with goat skin bellows, gave way to structures reared above the

* Polybius's account of Addua 223 B.C.

ground, in which were inserted tubes or tuyeres for the blast. These structures were called bloomeries, from the Anglo-Saxon *bloma*, a lump. They were adopted by the Romans and ultimately used with water-driven bellows, and hammers for *forging* or *refining* the iron. This method of production continued well into the seventeenth century.

During the period of the modern history of England, that is, from the time of the Norman Conquest, there may be said to have been three main phases of industrial development. The first and longest phase lasted until the early part of the eighteenth century, being the era in which physical force was only obtainable from the strength of horse and man. It was the era in which the influence of iron became important as an adjunct to wood, in forming the manual tools for agricultural and structural purposes. The second industrial phase lasted nearly a century and a half, and may be described as the age of iron and coal; while the third phase, that of the development of metallurgy and alloy steels, has only lasted a quarter of a century, and we may be said to be at the beginning of a new era.

In the seven centuries of the first period, iron was too costly for general use, except in a very limited way, and its main use was service in war. But so early as the ninth century, the iron horseshoe had been introduced—an invaluable adjunct, which not only adapted the horse to work in regions other than grass lands, but greatly increased his effective pulling power.

The large-scale development of the use of iron, even in the form of manual tools, was delayed due to the difficulty of producing it.

While copper can be melted at a temperature of 1,100° C., and some of the bronzes at a much lower temperature, it requires at least 1,600° to melt steel. Until the difficulties involved in producing material at such a high temperature on a large scale were finally solved, the use of iron was confined to the most essential needs of agricultural implements and arms. At the same time, it must be recognised that, except as a means of improving the efficiency of manual tools and producing them in greater quantity, the need for large-scale production had not arisen and could not arise until the advent of the Machine Age in the eighteenth century.

Cast iron was not used in Europe until about 1340. In the reign of Edward III, iron was of such importance that an act was passed prohibiting the export of any iron, whether made in England or previously imported, under penalty of forfeiting twice as much to the king as was taken out of the country. According to Parker, the iron pots, spits and frying pans were classed among the Crown jewels.

Cast iron was largely used for cannon and cannon shot, which were exported from Ilsenberg in Germany in the fifteenth century; iron stoves were cast in Alsace in 1490. A small iron industry grew up in the wealds of Kent and Sussex, where iron ore and timber were both available; but it gradually acquired a national importance with the advent of cast iron in the sixteenth century, and became notable for the production of cannon which were exported to other countries. In fact, complaint was made that British cannon were used against England in the wars with Spain in the sixteenth century.

Generally it may be said that the iron industry had for some centuries exercised great influence on the development of civilisation. So far as it gave predominance to any particular people over others, it was mainly in the production and improvement of arms and agriculture. Having regard to its limited use, the industry had reached a considerable magnitude in England in the sixteenth century. As timber was urgently required for shipbuilding, legislation was enacted, restricting the production of iron and encouraging its importation. This was so effective that, while there were 300 furnaces recorded in England in 1665, these had been reduced to 59 by 1740. In 1750 a petition was made to Parliament by the tanners of leather in and about the town of Sheffield in Yorkshire, against the bill encouraging the importation of iron from the American colonies, on the grounds that if English iron were not produced, the tanners would be deprived of the oak bark, which was stripped from the oak before it was converted into charcoal.

Thus even towards the middle of the eighteenth century the iron industry in Great Britain was a decaying one, iron and steel being largely imported from Europe and the American colonies. But at this time commenced the most remarkable development of our material civilisation. Abraham Darby at Coalbrookdale had been experimenting with the use of stone coal in the production of iron, owing to the limitations of the use of charcoal. In 1735 he used coke in the blast furnace, and this date marks the birth of the modern iron and steel industry. The blast at this time was still created by the use of bellows driven in many cases by a water-wheel. Dud Dudley had claimed to have smelted iron with stone coal in 1620, but never brought it into general use (see NATURE, 134, 842; 1934.)

The scale of the industry in England may be gauged from the fact that the total production of iron in the year 1740 was only 17,350 tons, which was the second highest production of any country in the world, Sweden then being the highest, owing to her large resources of timber.

This has enabled Sweden to-day to maintain her supremacy in the production of charcoal iron. She possesses no natural supply of stone coal.

Darby's use of coke for smelting instead of charcoal gradually spread over the whole country, and by 1760 was common practice. This had the effect of transferring the iron industry from the wooded districts of the wealds of Surrey, Sussex and Kent, immediately to the Black Country, and finally to the other coal districts of South Wales, the north-east coast of England and Scotland. The full advantage, however, of Darby's method could not be obtained by the inefficient water-driven bellows then available. By a remarkable coincidence, Watt developed his improved steam engine in 1769. This development was facilitated by the improved production of iron by Darby, but Watt's engine made available to the iron industry vastly increased blowing power, thus increasing the possible temperature in larger furnaces, and modern blast furnace development became possible.

The blast furnace is the most economic means of extracting iron from its ores. The iron is contained in the form of oxides, or in some cases of carbonates, mixed with a gangue material consisting mainly of silica. The furnace is charged with iron ore, coke and in most cases, depending on the nature of the materials used, limestone. The iron oxide is reduced chiefly by the gas passing upwards through the furnace, which contains carbon monoxide produced by the introduction of hot air at the bottom of the furnace. The lime produces an easily fusible slag with the gangue materials of the ore and, as the materials pass by gravity through the furnace, they reach the hearth at the bottom in a molten state where they separate naturally into two layers, the lower being molten pig iron and the upper slag. The final elimination of the oxygen contained in the iron takes place in the hearth. Two tap holes are provided in the hearth, one above the other. From the upper, slag can be withdrawn, and the pig iron flows by gravity from the lower. The iron thus produced contains about 4 per cent of carbon, varying proportions of silicon, and small percentages of impurities such as sulphur and phosphorus, depending upon the ore used or purpose for which the iron is required. Other elements may be introduced, if required, by including suitable materials in the burden charged at the top.

Blast furnace practice has been enormously improved, but the fundamental principles remain identical with those which have characterised the production of cast iron since the fourteenth century, the earliest period in which it was known. But whereas a single furnace could only produce, even so late as the end of the seventeenth century, less than 200 tons a year, and the average output of the charcoal furnace in 1806 was of the order of 700 tons a year, the coke furnaces were by that time producing approximately 1,700 tons a year. The average production of the blast furnace to-day in Great Britain is 60,000 tons a furnace a year, and there are single furnaces in operation producing 4,000–5,000 tons a week. There are some on the Continent, and in India, producing nearly twice as much as this.

The size of the blast furnace is governed to-day by the market requirements of the resultant product, and in Great Britain—the birth-place of the modern iron and steel industry—there is still made a wider diversity in qualities of iron and steel products than in any other country in the world. The volume of production in Great Britain is now the fourth highest, but is still only one quarter in volume of the normal production of the United States.

It should be mentioned that the most important results of the technological improvements in the blast furnace have been the reduction in the quantity of fuel required. The invention of the hot blast by Neilson in 1828 in Scotland reduced fuel consumption from more than 8 tons of coal to 5 tons per ton of pig iron produced, and by 1840 the average quantity had fallen to $3\frac{1}{2}$ tons, but very much lower in many furnaces. The consumption in modern practice depends on the nature of the ore used, and particularly its iron content; but under suitable conditions with suitable materials, 1 ton of pig iron has been produced with a consumption of 15 cwt. of coke (equivalent to say 22 cwt. of coal).

Referring to the enormous increase in the capacity of blast furnaces, it should be noted that in 1878, when the average annual production of pig iron per furnace in Great Britain was approximately 6,400 tons, there were 948 furnaces, whereas to-day there are actually only 96 in blast with an average production of 60,000 tons a year. So late as 1920 there were 481 furnaces in existence, 284 in blast, with an average annual output of 28,000 tons.

It is not an exaggeration to say that the Machine Age and the Industrial Revolution owe their birth to the inventions of Darby and Watt, since by making iron much more readily available, the inventions of that very remarkable period of 150 years from the middle of the eighteenth to the end of the nineteenth century were made possible which resulted in the replacement of handicraft by machines, and revolutionised production.

The production of individual industries rapidly increased with the application of the steam engine and machinery beyond the absorptive capacity of accessible markets, in view of the limitation of transport. Thus, on the introduction of railways in 1825, there existed a surplus of production in

many centres of the country, awaiting distribution. It was the fact that industrial production had overtaken the immediate consuming power of the communities accessible to the producers that created for the railways such a period of feverish activity and prosperity.

The construction of the railways absorbed the greater part of the iron and steel production, even up to 1881. In that year, out of the total production of steel in Great Britain of 1,778,000 tons, 1,000,000 tons was used for rails alone, and in the United States, which in the same year produced 1,000,000 tons of rails, the total steel production was only 1,588,000 tons.

Early railway development was based entirely on iron. While the development of the rail track had passed through the stage of a flat timber wagon way with flat wheels, followed by an edge rail in timber, in the later stages covered with iron, with flanged wheels, it was not until Jessop introduced the edge rail, which consisted of cast iron rails 3 ft. long by 1½ in. with a raised head and flanged wheels, in 1790, that the modern railway track may be said to have been born.

It is of interest to note how the use of iron has passed from what might be termed wrought iron in the prehistoric and early historic period, to the more frequent use of cast iron, particularly after the advent of Abraham Darby. It was not until 1784, with the invention by Cort of the grooved rolling mill for rolling iron bars, and of the puddling furnace for converting cast iron into what is now called wrought iron, that the forged material again became of prime importance.

In 1805 wrought iron rails were produced 15 ft. in length, which was a great advance over the cast rails, which could only be made at that time about 4 ft. long. Wrought iron takes its name from the fact that the iron is refined in a plastic state and never allowed to become molten, the grains of iron being welded and wrought into shape by a kneading process, either that invented by Cort of puddling pig iron, or by direct reduction from the ores, the resultant spongy mass being frequently hammered and reheated to eliminate slag and ash, as in ancient times.

The Delhi Column is perhaps the most remarkable example of ancient wrought iron extant. It was erected by the Majaraiah Dhava about A.D. 320. This column weighs 6½ tons, and is 24 ft. long, 16½ in. in diameter at the foot, and 12½ in. at the top. A sample of the material has been analysed by Sir Robert Hadfield, and proved to be iron of an extraordinary high purity—no less than 99·72 per cent. The means by which so massive an object, of a material of such high quality, could have been produced 1,600 years ago are still a matter for conjecture.

The metal part of wrought iron is pure ferrite crystals. Interspersed between them are minute threads of slag. Slag is not in this case an impurity, because it confers upon wrought iron its powers of resistance to corrosion. Wrought iron is easily forged, and has been used for some of the most important structures in the world, notably the two bridges over the Menai Straits, Telford's suspension bridge in 1825 and Stephenson's tubular railway bridge, 1850. The latter consists of two wrought iron tubes each 1,510 ft. long. As a testimony to the resistance to corrosion of wrought iron, it may be mentioned that only a few links of the suspension bridge have needed to be replaced, and none of the plates of the two tubular tunnels. The weight of wrought iron in the tubular bridge is 10,540 tons, a very remarkable structure, having regard to the period in which it was erected.

At about the same period Robert Stephenson built the high-level bridge at Newcastle across the Tyne. This is one of the largest cast iron structures in the world. It was opened by Queen Victoria in 1849, and carries both road and railway. The total length of this bridge is 1,337 ft. It is 112 ft. above high-water to rail-level. There are six spans of 125 ft. each and the lower roadway is 22 ft. 7½ in. below the rail-level. The total weight of iron used is 5,050 tons and the total cost was £243,000. Cast iron is still an important structural material; the tunnels of the tube railways and the Mersey tunnel are lined with cast iron sections; no less than 80,000 tons of cast iron were used in the construction of the Mersey tunnel.

In 1850, steel was only made in small quantities in crucibles or by cementation, which were long and costly processes. According to Bessemer, this steel, when rolled into bars, was sold at £50–£60 per ton. He desired to produce a metal having the mechanical characteristics of wrought iron, which could be run into an ingot mould in fluid condition. After years of experiment, he finally developed the process associated with his name, the decarburisation of molten iron by blowing air through it in a vessel called a converter.

This invention by Bessemer marked the birth of the modern Steel Age, as it made steel available in quantities much greater and at a cost much lower than was possible in the case of wrought iron. For many purposes steel immediately proved a superior material, being harder to wear and stronger mechanically. It could also be cast, rolled and forged and was thus able to meet all the demands of the engineers in its application to the production of structures and machines. The first Bessemer steel rail was rolled at Dowlais, Glamorgan, and laid on the main line of the

Midland Railway at Derby in 1857, and it proved to have some twenty times the wearing life of existing iron rails.

About 1860 Siemens developed a regenerative furnace in connexion with glass-making. Faraday delivered one of his last lectures in the Royal Institution in June 1862 on the simplicity, power and economy of the regenerative open hearth furnace, but it was not until 1865 that the first experimental plant was erected by Sir William Siemens at the Sample Steel Company, Birmingham, and the furnace for making steel was put to commercial use.

The open hearth Siemens-Martin process was developed by Siemens and Martin in 1864–67. It had the great advantage over the Bessemer process that, whereas the refining in the latter took 20–30 minutes and the degree of refinement was a matter of empirical judgment, in the case of the open hearth process the time required was at least eight hours and the degree of refinement and quality of the product could be tested by means of samples during the process. The result was that a more consistent quality of product was obtained, and the open hearth process ultimately displaced the Bessemer process in Great Britain.

It is interesting to note that with improvements in the process and particularly the control of the qualities of pig iron, which is the key to the control of the quality of the resultant steel, the Bessemer process is again being used for many purposes in Great Britain. For the past fifty years it has been supreme on the Continent.

The next great advance in steel production was the invention by Sydney Gilchrist Thomas in 1877 of the basic process. Thomas originally intended to be a doctor, and was preparing for his matriculation at the age of seventeen years, when his father died. He was thrown on his own resources and accepted a junior clerkship at Bow Street at a salary of £90 a year. He devoted his spare time to the study of science, principally chemistry. Mr. Challenor, in a course of lectures at the Birkbeck Institute in 1870, said: "The man who eliminates phosphorus by means of the Bessemer converter will make his fortune." This fired the imagination of Thomas. Working under great disadvantage in co-operation with his cousin Gilchrist, who was a chemist in a works in South Wales, they ultimately succeeded. His paper on the process, however, in 1878, before the Iron and Steel Institute, was actually not read for lack of interest until an adjourned meeting in 1879. However, this invention was taken up in that year by Messrs. Bolckow Vaughan, of Middlesborough, who were already producing steel by the original acid Bessemer process and desired to use the Cleveland ironstone which was not suitable for that process, but the use of which was rendered possible by Thomas's invention.

It should be stated that the acid process does not eliminate the sulphur and phosphorus from the iron. For this reason the materials charged must be of a high degree of purity, particularly with regard to sulphur and phosphorus content, as these two elements have a deleterious effect on the quality of the finished steel. The materials charged may be either pig iron or steel scrap of suitable quality, or both. The basic process, as invented by Thomas and Gilchrist, removes phosphorus through the action of a basic slag largely consisting of lime, and the sulphur partly by the slag and partly by the action of manganese contained in the basic pig iron. When the steel has been cast from the furnace into the ladle, any residual oxygen is removed by the addition of aluminium or some similar suitable reagent. If decarburisation has been carried out to a greater degree than is required, the carbon content may be brought up to the required figure by the addition of anthracite in the ladle; also other elements as may be required are frequently added in the same manner.

By far the most important immediate result of Thomas's invention was its adoption on the Continent, as it rendered possible the use of the large deposits of high phosphoric ores in Alsace and Lorraine. The result has been the application of the basic process to open hearth practice and the consequent enormous increase in the production of steel throughout a large part of the civilised world, as can be seen from the growth of world production, with a rapidity which has had an influence, the importance of which can scarcely be exaggerated, on the development of population and improvement in the standard of life.

United Kingdom and World Production of Pig Iron and Steel 1835–1934
(in millions of tons)

Year	Pig Iron		Steel	
	World	U.K.	World	U.K.
1835	1·88	1·00	—	—
1845	2·95	1·51	—	—
1855	5·06	3·22	—	—
1865	8·97	4·82	—	—
1869	11·10	5·45	0·42	0·16
1875	13·61	6·37	1·79	0·71
1885	19·33	7·42	6·19	1·89
1895	28·50	7·70	16·65	3·26
1905	53·24	9·61	44·22	5·81
1915	59·70	8·79	65·57	8·55
1925	75·69	6·26	88·93	7·39
1929	97·35	7·59	118·37	9·64
1931	54·73	3·77	68·07	5·20
1932	39·69	3·57	50·11	5·26
1933	48·77	4·14	65·74	7·02
1934	61·34	5·98	78·93	8·86

It is interesting to compare the growth of population in relation to iron and steel production. From 1066 until 1760 the population of England and Wales increased by some 5½ million, considerably

less than one million per hundred years, while in the next hundred years it increased by 13 million. Similarly, iron production increased slowly from possibly a few hundred tons in 1066 to about 50,000 tons in 1760, and then rose rapidly to nearly 4 million tons in 1860. The rapid expansion of iron production not only coincided with, but also may well be said to have made possible the rapid growth of population. It is interesting

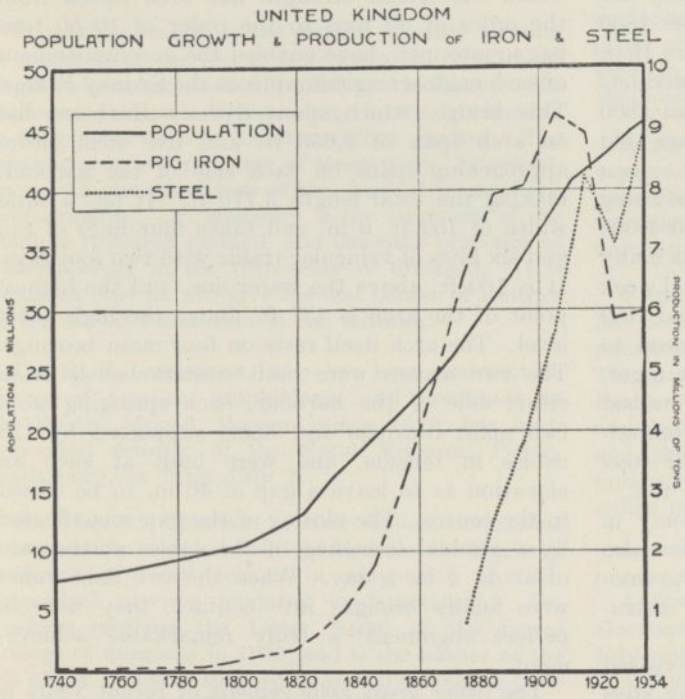

FIG. 1.

to note that the iron output increased much more quickly than the population. Too much significance must not be attached to the relation of these curves, but their general trend shows the paramount influence of the development of iron and steel on population (Fig. 1).

The invention of the basic process was one of the greatest fundamental inventions. Mr. Chas. Schwab, president of the American Iron and Steel Institute, has pointed out that every invention of fundamental importance in the modern iron and steel industry is British in origin, as may be seen from the accompanying table of notable dates:

NOTABLE DATES IN THE IRON AND STEEL INDUSTRY

Payne and Hanbury produced tin sheets, Pontypool	1728
Abraham Darby first used coke in blast furnace	1735
Huntsman produced crucible steel	1740
Smeeton invented blowing cylinder	1760
Watt improved steam engine	1769
Cort grooved rolling mill	1783
Cort puddling furnace	1784
Stevenson's locomotive	1815
Stockton Railway	1825
Neilson invented hot blast	1828
Nasmyth steam hammer	1838
Nasmyth pile driver	1843
Bessemer process	1855
Siemens open hearth steel furnace	1864–67
Thomas-Gilchrist basic process	1877–79

In the third phase of our material civilisation, to which I have referred, and of which we are only in the first quarter-century, we are experiencing a revolution as a result of the application of scientific discovery, which has produced materials possessing qualities as to resistance to corrosion and stress undreamt-of even in the nineteenth century.

In 1832 Faraday, who certainly by his discoveries exercised a wider and more far-reaching influence on our modern civilisation than any other single man, discovered that the resistance of a metal to oxidation was due to the existence of an oxide film which formed on the surface. It was not until nearly a hundred years later that this was conclusively demonstrated by Dr. Ulick Evans in his beautiful research work at Cambridge, by which he succeeded in actually removing the film and examining it microscopically. Faraday had experimented, 1819–24, with a number of alloys of iron with other metals, and was the discoverer of the enormous potentialities of alloy steels. The scope of Faraday's work in this direction was not generally realised prior to Sir Robert Hadfield's examination of the specimens in the possession of the Royal Institution.

The influence of chromium alloyed with iron in facilitating the automatic production of the protective film was first brought out by Monnartz in 1911. The industrial development of this phenomenon can be traced to the research of Mr. Harry Brearley in the Brown-Firth Laboratories, who found that the resistance of iron chromium alloy to nitric acid was increased as the percentage of chromium was increased.

After a long research investigating the limiting ranges of composition giving high resistance to corrosion, Mr. Brearley developed the well-known stainless cutlery steels, containing about 0·3 per cent of carbon and 12–14 per cent of chromium. The rustless steels now available industrially are either chromium-nickel steels or chromium-nickel steels to which other elements such as manganese and silicon have been added.

The variations of this class of steel and the qualities and purposes for which they are used require an exhaustive study in themselves. They are applied to all uses where super-corrosion resistance is necessary, that is chemical plant, aircraft fittings when exposed to the action of acids, manufacturing machinery, general engineering where resistance to abrasion is required or a good cutting edge is necessary. They are largely used in food manufacturing, chemical and textile industries,

but it is obvious from their constitution, in view of the value of chromium which they at present must contain, that they are unlikely, in spite of their high mechanical qualities as regards tensile strength and yield point, to be used for general structural purposes.

There is another entirely different class of steel, which is still made by the crucible process, of which Sheffield is the centre, and of these varieties and qualities and the service for which they are used, the number is legion. One maker since 1860 has produced steels of this quality to more than twenty thousand different analyses. The products vary in value from £45 a ton to more than £800 a ton, and when converted to tool steel, are sold at a price which works out at £840 a ton. In a works of this character, instead of the output being measured in figures of the order of 3,000–4,000 tons a week with 12–20 different sizes and as many different qualities, the production in a typical week was 50 tons with 135 different sizes and 109 different qualities. Hair-spring wire reduced to 9/1,000 in. diameter from a 4 in. diameter ingot, which is drawn through a diamond die in its last stages, has a value of 16*s*. a pound or approximately £1,800 a ton. Ordinary structural steel has a selling price of approximately £8 a ton.

These high-grade steels are used not only in engineering trades, motor cars, aeroplanes, but also by watchmakers and for needles, razors, gramophones, wireless, telephones and electrical instruments and apparatus of all kinds.

Another modern development is the increased resistance to mechanical stress of the alloy steel series, which has rendered possible the development of industrial processes requiring very high pressures, such as the hydrogenation of coal, in which the vessels used have to sustain pressures of three or four thousand pounds per square inch; and high-pressure steam boilers working up to 1,500 lb. per square inch at very high temperatures. These conditions introduce other difficulties, particularly the phenomenon known as 'creep', or the slow expansion of the metal under stress at high temperatures.

The development of alloy steels, both in their qualities of resistance to corrosion and high mechanical stress, has permitted the remarkable development of the aeroplane, the weight of the engines of which in the last few years has been reduced by nearly half for normal service. Radial engines had a weight of 2 lb. per brake horse-power fifteen years ago, and the latest for normal service are 1·2 lb. The first engines used during the War had a weight of 6·5 lb. per brake horse-power and those in normal use to-day are less than 1½ lb. The famous Schneider Trophy engines had a weight of only ¾ lb. per brake horse-power, and there seems little doubt that the normal aircraft engine in the near future will not weigh more than 1 lb. per brake horse-power for ordinary service, capable of 500 hours of operation without overhauling. In the case of the Schneider Trophy engines, it will be realised that they were designed as light as possible for a relatively short period of service.

The improvements in structural material, of which the tensile strength has been raised from the order of 30 tons to the order of 40–50 tons per square inch, have enabled the accomplishment of such engineering triumphs as the Sydney Bridge. This bridge, which spans Sydney Harbour, has an arch span of 1,650 ft. and five steel girder approaching spans on each side of the harbour, making the total length 3,770 ft. It has a total width of 159 ft. 6 in. and takes four lines of rail and six lines of vehicular traffic with two footways. It is 160 ft. above the water-line, and the highest point of the arch is 437 ft. above the high-water level. The arch itself rests on four main bearings. The two arches were built simultaneously from either side of the harbour, each springing from two main bearings and being supported by 128 cables in tension, and were built at such an elevation as to leave a gap of 40 in. to be closed in the centre. The closing of the gap was effected by a gradual loosening of the cables at the rate of about 2 in. a day. When the two half arches were finally brought into contact, they were in perfect alignment, a truly remarkable achievement.

The other great achievement of recent years is undoubtedly the Cunard White Star liner the *Queen Mary*, which, when launched, it was claimed, represented in its mass of 40,000 tons of steel the greatest mass ever moved by man unaided by mechanical power.

What of the future? As an engineer, I am presumptuous enough to think that metallurgy is even yet more of an art than a science. This view I believe is shared by many of our leading metallurgists. When, with the help of physical research, and the application of the ever-increasing means of physical investigation, we are able to ascertain more of the physical structure of the elements with which we are dealing, and thus perhaps predetermine some of the characteristics of the alloys of iron with other elements, we may well open up possibilities in the development of new materials, with such an improvement in mechanical properties as will render possible further developments in our use of mechanical power which may indeed transcend the limits of which we are at present capable. The influence of iron and its derivatives on our social organisation is therefore likely to continue to increase.

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velocities were recorded for about ¼ hour. The minimum of the preceding 11-year cycle having occurred at 1933·8, the present spot with respect to size is not unusual, but it is the largest one seen for more than a year, and its appearance is one of several indications that the new cycle is now well-established.

Announcements

DR. RICHARD ANSCHÜTZ, professor of chemistry in the University of Bonn, has been elected a foreign honorary fellow of the Royal Society of Edinburgh.

IT was announced at the general monthly meeting of members of the Royal Institution on July 1 that the Managers had elected Dr. Edward Mellanby to be Fullerian professor of physiology in the Institution, in succession to Sir Grafton Elliot Smith. The appointment is for a term of three years, in accordance with the provisions of the deed of trust of the professorship. Dr. Mellanby is the secretary of the Medical Research Council, and emeritus professor of pharmacology in the University of Sheffield. It is expected that he will give his first course of lectures at the Royal Institution in the autumn.

DR. R. F. LAWRENCE, who has been assistant in charge of reptiles, amphibians, and arachnids at the South African Museum since 1922, has been appointed director of the Natal Museum, Pietermaritzburg, as from July 1.

DR. HARVEY CUSHING, of New Haven, Conn., has been recently awarded the Gold Medal of the National Institute of Social Science in recognition of "distinguished services rendered to humanity". Dr. Cushing received the Lister Medal of the Royal College of Surgeons in 1930, and is the author of the life of Sir William Osler which won the Politzer prize for biography in 1925.

THE Hungarian Academy of Science has elected as honorary member Baron A. Koranyi, professor of internal medicine at Budapest.

THE annual conference of the Association for Combating and Preventing Corrosion, under the auspices of the Society of German Chemists (Verein deutscher Chemiker e.V., Berlin W 35, Potsdamer Str. 103a), will be held in Berlin on November 18–19, 1935. The subject for discussion is "Corrosion by Water".

THE President of the Republic of Peru has appointed a committee composed of the director of public health, the president of the National Academy of Medicine and Prof. Constantino Carvallo, as representatives of the medical faculty to elaborate a plan for the establishment of a serological institute which, in addition to producing serums and vaccines, will undertake researches in chemistry, bacteriology and biochemistry.

AN Electrodeposition Exhibition will be held in the Science Museum, South Kensington, from July 25 until October. The purpose of the exhibition is to illustrate all phases of electrodeposition and the underlying scientific principles. It has been organised by the Electrodepositors' Technical Society, Northampton Polytechnic Institute, London, E.C.1, from which further information can be obtained.

THE friends, colleagues and pupils of the late Prof. Léon Bernard, formerly president of the Health Section of the League of Nations and physician to the Hôpital Laennec, Paris, desire to honour his memory by placing a medallion of him in his hospital, and founding an international prize for social medicine. A reproduction of the medallion will be given to each subscriber. Subscriptions should be sent to the treasurer, M. Georges Masson, 120 Boulevard St. Germain, Paris, 6e.

A PARTY of Moscow men of science is about to explore the Kara Kum desert in Central Asia. The expedition will be absent for four months, and will investigate the natural resources of areas in the northern and south-eastern parts of the desert.

UNDER the title "Iodine for Livestock", a pamphlet has been issued free of charge by the Nitrate Corporation of Chile, Stone House, Bishopsgate, E.C.2. The pamphlet, which has been compiled by Mr. Frank Corrie, contains several excellent illustrations, and deals at length with the relation between iodine and the various problems of animal health and nutrition, and practical advice is given on the use of iodine in feeding stock.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

A lecturer in engineering in the Plymouth and Devonport Technical College—The Secretary for Education, Cobourg Street, Plymouth (July 10).

A lecturer in production engineering in the Dudley and Staffordshire Technical College—The Clerk to the Governors, Education Offices, St. James's Road, Dudley (July 10).

A lecturer and a student demonstrator in botany in University College, Exeter—The Registrar (July 12).

A chief Government mining engineer in the Department of Mines, Southern Rhodesia—The Official Secretary, Office of the High Commissioner for Southern Rhodesia, Crown House, Aldwych, London, W.C.2 (July 15).

An assistant professor of mathematics in the Royal Naval College, Greenwich—The Adviser on Education, Admiralty, Whitehall, S.W.1 (July 15).

An assistant demonstrator in physics in the Royal Holloway College, Englefield Green, Surrey—The Principal (July 17).

A lecturer in mathematics in the Bingley Training College—The Education Officer, County Hall, Wakefield, Yorkshire (July 24).

An assistant lecturer in civil engineering in Battersea Polytechnic, London, S.W.11—The Principal.

A lecturer in botany, zoology and microbiology in the College of Technology, Leeds—The Director of Education, Education Department, Calverley Street, Leeds, 1.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 33.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Adsorption of Aluminium Hydroxide by Kieselguhr

ALUMINIUM hydroxide is readily adsorbed by kieselguhr to form an adsorption complex which is remarkably stable. The hydroxide is deposited by the slow addition of a small excess of ammonia to a de-aerated suspension of 10 gm. of specially purified Superfloss kieselguhr in 100 c.c. of 2 per cent ammonium nitrate solution containing a known amount of aluminium nitrate, the suspension being vigorously stirred. The curve (Fig. 1) shows the relation between the ζ value of the preparations in $N/10$ acetic acid and the amount of aluminium hydroxide adsorbed by 100 gm. of kieselguhr.

This curve indicates that the surface of 100 gm. of kieselguhr is completely coated by 0·00486 gm.-mol. of aluminium hydroxide and that a maximum ζ value of +75·4 mv. is then obtained. Increasing the amount of aluminium hydroxide causes a decrease in the ζ value until a value of +61·2 mv. is reached, when 0·00972 gm.-mol. has been deposited. The deposition of further quantities of aluminium hydroxide does not change the ζ value of 61·2 mv., which is that of free unsupported aluminium hydroxide in $N/20$ acetic acid.

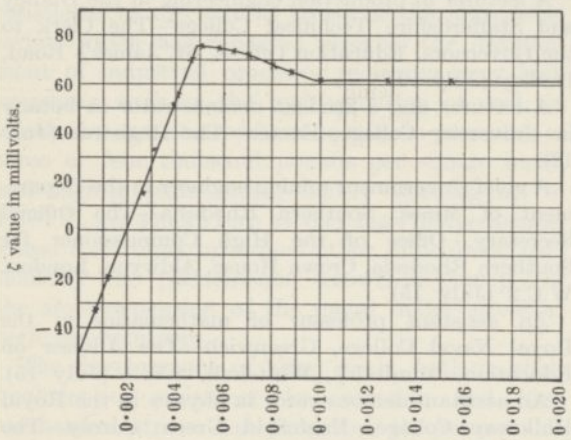


FIG. 1.

The total surface area of 100 gm. of the kieselguhr was determined by measuring the rate of sedimentation by the international pipette method, the assumption being made that the particles are spherical. By differentiation of the cumulative percentage curve, the values of $dW/d\log r$ were obtained and from these the values of $dS/d\log r$ were calculated. The area under the $dS/d\log r$, $\log r$ curve gave the total surface area as $1{\cdot}54 \times 10^6$ sq. cm. and it is manifest that this must be much less than the true surface area. If the true surface area be taken as five times that calculated, that is, $7{\cdot}7 \times 10^6$ sq. cm., then when 0·00486 gm.-mol. of aluminium hydroxide completely covers that area the diameter of each particle of the hydroxide on the surface is found to be $5{\cdot}77 \times 10^{-8}$ cm. Since this is of molecular dimensions, it follows that aluminium hydroxide is first adsorbed as a uni-molecular layer by the kieselguhr surface and that when this layer is completed the ζ value is +75·4 mv. It further follows that when a second uni-molecular layer of aluminium hydroxide has been deposited, the ζ value falls to +61·2 mv. and that this second layer has the same properties as the un-adsorbed substance.

Since the number of aluminium hydroxide molecules in the first and second layers must be the same, the enhanced ζ value indicates that the molecules in the adsorbed uni-molecular layer must be activated in some way. The observations, therefore, are analogous to those of de Boer and his colleagues[1].

In explanation of this activation, it may be suggested that an adsorption complex is formed of the type proved to exist in the case of solvates[2]. If the molecules in the surface be denoted by E and those of the adsorbed substance by S, the adsorption complex will be represented by E^-S^+, the molecule E having given one or more of its rotation-vibration quanta to the molecule S. Since this transference of energy cannot take place unless the two molecules have rotation-vibration frequencies in common, a surface must possess a selectivity in its absorptive power. It is interesting, therefore, to note that kieselguhr does not adsorb iron hydroxide ($Fe(OH)_3$) in spite of the similarity between the properties of $Fe(OH)_3$ and $Al(OH)_3$.

E. C. C. BALY.
W. P. PEPPER.

University,
Liverpool.
June 8.

[1] *Physica*, **1**, 753, 935, 953, 960; 1934.
[2] B.A. Report, 1928, p. 35.

Spontaneous Super-Contraction of Animal Hair

SUPER-CONTRACTION induced in silk fibres by acid, and in wool by means of steam and chemical reagents, has been described by Farrell[1], Astbury and Woods[2] and Speakman[3] respectively. I have recently obtained evidence of super-contraction in the guard hairs of raw pelts taken from fur-bearing animals, the phenomenon probably arising through oxidation of

the disulphide link in keratin. As the furs had received neither heat nor chemical treatment, the condition described below apparently developed on the living animals. The fibres under consideration are distinguished by extra-normal curvature (Fig. 1*a*) which is generally greatest at the tip of the hair, and has been observed most frequently on the pelts of white and red foxes. The phenomenon may occur locally or be general to the whole skin, and when severe it gives a markedly frizzy appearance to the affected region.

Exposure of these fibres to steam increases the deformation in the same direction: a fox hair, the tip of which was deflected 180° before treatment, shrivelled to a close spiral of four or five turns, and contracted still further on drying (Fig. 1*b*). Immersion in strongly acid solutions reduces (in some cases reverses) the curvature, but subsequent washing and drying leads to an increase in the initial direction. Cold water reduces the curvature of the fibres whether or not they have been treated with chemical reagents or steam, but its action is reversed by drying. The curvature of these fibres before and after treatment can only be explained as due to a small difference in super-contraction of the keratin chains on opposite sides of the fibre.

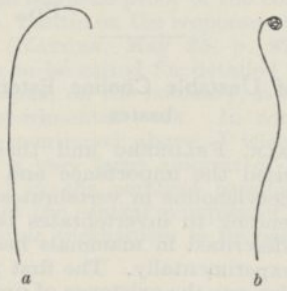


FIG. 1. White fox guard hair showing curvature due to super-contraction: (*a*) untreated; (*b*) steamed 10 minutes and dried. ×2½.

Disulphide and salt linkages between adjacent peptide chains appear to be prime factors opposing the contraction of keratin. When both are attacked, super-contraction occurs, as is evident from experiments carried out by Speakman[4]. There is no evidence that, in the absence of tension, either steam or acid has any rapid effect on disulphide linkages, but either is capable of disrupting the salt linkages[5]. Hence, in the abnormal fibres described, the contribution of the disulphide link to the lateral bonding of the molecules has been reduced sufficiently to permit super-contraction, which is greatly enhanced by opening the salt linkages.

The uncurling of fibres by acid, and the effect of cold water are obviously explicable in terms of swelling. The mechanism by which the disulphide link is attacked is probably oxidation via atmospheric oxygen in the presence of water and under the influence of light (ultra-violet ?) This view is supported by Berger's observation[6] that sulphuric acid is produced in wool by exposure to sunlight. The production of curvature in normal fibres, by reagents that attack the disulphide link and permit super-contraction, is further evidence of the significance of this link in the phenomenon described. Such artificially damaged fibres behave, qualitatively, in the same way as abnormal specimens taken from the raw skin.

As some species appear to be free from the characteristic features described, it would be of considerable interest to know how widespread the abnormality is. I should be glad to hear details of cases in which it has been observed on living animals.

R. O. HALL.

C. W. Martin and Sons, Ltd.,
61 Grange Road, S.E.1.

[1] *J. Soc. Dyers Col.*, **21**, 70; 1905.
[2] *Phil. Trans. Roy. Soc., A*, **232**, 333; 1933.
[3] *J. Soc. Chem. Ind.*, **50**, 1T; 1931. NATURE, **124**, 948; 1929.
[4] NATURE, **132**, 930; 1933.
[5] NATURE, **128**, 1073; 1931. *J. Soc. Dyers, Col* **49**, 180; 1933.
[6] *Melliand's Textilber.*, **7**, 451; 1926.

Nova Herculis and Cosmic Rays

SINCE the appearance of Nova Herculis in December last year, a number of notes have appeared in various scientific journals dealing with a possible effect of the nova on the intensity of cosmic rays, but the conclusions arrived at by different observers have been rather conflicting. It seems, therefore, desirable to examine as many observations as possible at different places and with different types of apparatus. The data obtained by means of a photographically recording Kolhörster electrometer of the latest type which was kept in continuous action at the Solar Physics Observatory, Cambridge, during the period from February 14 until March 20, appear to confirm Kolhörster's observations made with Geiger-Müller counters.

The instrument was installed inside a box-shaped shield of which the base was made of cast iron blocks of 6 inches total thickness and the walls and the top were made of 100-year old lead slabs of 4·5 inches total thickness. Between February 14 and March 4 the observations were made with the shield closed on all sides, while during the period March 4–March 20 the shield was open at the top. Hourly values of the cosmic ray intensity were determined from the photographic records and all the values were reduced to a common atmospheric pressure (about 29 in.), the pressures during the different hours being obtained from simultaneous barograph records. In order to find out if the nova was making any contribution to the cosmic rays the day was divided into four six-hourly intervals and the average values of the cosmic ray intensity were calculated for the different intervals. The results are given in the following tables:

CLOSED SHIELD (MEAN NOVA MAGNITUDE—3·3m)

Interval (G.M.T.)	Intensity in ion-pairs/cm.²/sec.	Remarks	
13h—19h	1·561	Nova highest	1·561
19h—1h	1·477		
1h—7h	1·546	Nova lowest / Average	1·492
7h—13h	1·452		

Increase = 4·5 per cent

OPEN SHIELD (MEAN NOVA MAGNITUDE—4·6m)

Interval (G.M.T.)	Intensity in ion-pairs/cm.²/sec.	Remarks	
14h—20h	2·506	Nova highest	2·506
20h—2h	2·449		
2h—8h	2·440	Nova lowest / Average	2·449
8h—14h	2·457		

Increase = 2·3 per cent

It will be seen that both for closed and open shields the intensity of cosmic radiation is highest during the 6-hour interval during which the nova is also at its highest altitude, but the intensity is lowest when the nova is at its lowest altitude only for the open shield observations. It is difficult to explain why for the 'closed shield' observations the intensity during the 'nova lowest' interval should be next in magnitude to that for the 'nova highest' interval. The observations have been taken at a time when the nova and the sun have been well separated in hour angle. That the observed effect is not due to a solar term can be seen from the following figures :

Closed Shield		Open Shield	
Interval	Intensity	Interval	Intensity
9h—15h	1·486	9h—15h	2·473
21h—3h	1·489	21h—3h	2·472

A detailed examination of the whole series of measurements is in hand, and the results will be published later.

A. K. DAS.

Solar Physics Observatory,
University of Cambridge.
June 19.

Crystallisation of Seralbumins

IN NATURE of February 23, 1935 (vol. 135, p. 307), Dr. Muriel E. Adair and Dr. G. L. Taylor describe crystallised human seralbumin obtained by them.

It will interest readers of NATURE to learn that in the Biological Physical-Chemical Laboratory of which I had charge in the "Instituto Bactereológico" of the National Department of Hygiene (Director, Dr. A. Sordelli) a student of mine, Dr. Moisés Grinstein, made a systematic study of the crystallisation of seralbumin from different species of animals. His work was presented at a meeting on August 16, 1934, of "Las Sesiones Quimicas Argentinas" but the records have not yet been published.

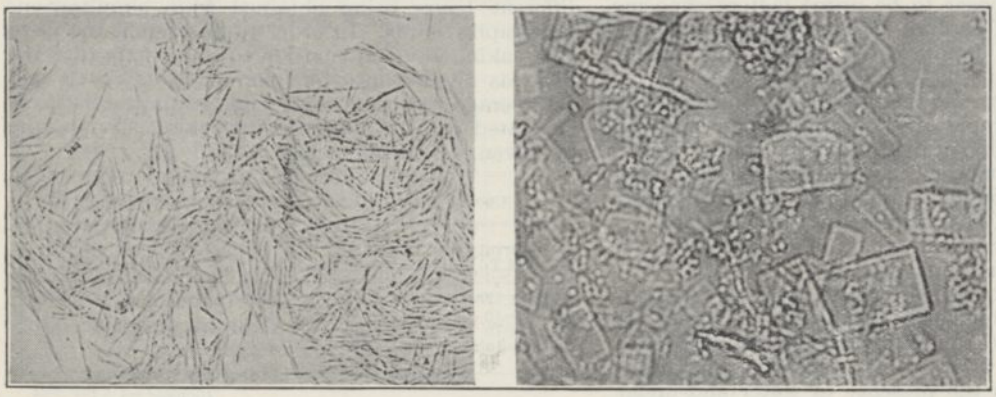
The technique used was that advised by Sörensen for crystallising horse seralbumin : the globulins are precipitated from the serum or plasma by semi-saturation with sulphate of ammonium. After filtering through paper a transparent liquid is obtained. This liquid is acidified by $0{\cdot}5N$ sulphuric acid until a permanent turbidity is obtained, shaking continually ; this happens when the reaction corresponds to a pH 4·6–4·8. After about twenty-four hours the precipitate is completely crystallised.

RAUL WERNICKE.

Buenos Aires.
April 19.

IN addition to the two photomicrographs here reproduced, Prof. Wernicke sent others of horse and mule albumins, but as the crystal form of horse albumin is well known, these photomicrographs are not reproduced. Dr. Adair and Dr. Taylor may be absolved from negligence in being unaware of Dr. Grinstein's work, as it has not yet been published. In the summary of their letter, which appeared in NATURE of February 23, p. 310, it should have been stated that the crystals obtained by them were from normal human sera and not from the sera of dropsical patients.

ED., "NATURE".



(*a*) (*b*)

FIG. 1. Crystal of (*a*) human seralbumin, (*b*) guinea pig seralbumin.

Dr. Grinstein tried to obtain crystals of seralbumin from men, horses, asses, mules, guinea pigs, rabbits, llamas, pigs, oxen, dogs and birds, and he obtained positive results with horses, asses, mules, guinea pigs and men.

I enclose photomicrographs of the crystals obtained (Fig. 1).

Occurrence of Unstable Choline Esters in Invertebrates

LOEWI, DALE, FELDBERG and their co-workers have emphasised the importance and physiological activity of acetylcholine in vertebrates[1]. The possibility of extending to invertebrates the cholinergic mechanisms described in mammals has, so far, not been tested experimentally. The first point investigated at Naples was the existence of unstable choline esters in tissue extracts of marine invertebrates.

Using Chang and Gaddum's technique[2], I have been able to find, in trichloracetic extracts of various tissues of *Octopus vulgaris*, a substance which possesses all the properties of unstable choline esters. Its action on the leech muscle, on the frog's rectus and the longitudinal muscle of *Holothuria stellata* is sensitised by eserine ; its inhibitory action on the frog's heart and its vasodilator action in the eserinised cat is abolished by atropine. Like acetylcholine, the substance is destroyed in 10 minutes at room temperature by treatment with $2N$ caustic soda ; it is also rapidly hydrolysed by an esterase present in the fresh blood of *Octopus*.

The activity of the same extract in different tests is about the same if expressed in acetylcholine

chloride. Hence it is believed that the substance present in extracts of invertebrate tissues is acetylcholine. The content in the organs of *Octopus* ranges from 0·1–0·2γ per gm. (skin, median ventricle) to 3γ per gm. (arms without skin) of wet tissue. The stomach and posterior salivary glands contain a fair amount (1·3γ per gm.). The blood and testicles have very little or none. The apparent acetylcholine content of *Sipunculus nudus* and of the longitudinal muscles of *Holothuria tubulosa* ranges from 0·9γ to 1·7γ per gm. Choline esterase is present in the blood, not only of *Octopus vulgaris*, but also of *Aplysia depilans* and *Murex*.

It thus seems that, in at least some invertebrates, the conditions for cholinergic nervous action are realised. This second point is now being investigated in *Octopus*.

Z. M. BACQ.

Stazione Zoologica,
Napoli.
May 15.

[1] Dale, H. H., "Nothnagels Vorlesung", Urban and Schwarzenberg, Vienna, 1935.
[2] Chang, H. C., and Gaddum, J. H., *J. Physiol.*, **79**, 255; 1933.

P.S. The above letter had been sent to the Editor before I saw an advance proof of the communication by Mr. C. F. A. Pantin on the response of the leech to acetylcholine (NATURE, May 25, p. 875). *Hirudo* does not seem to be suited for detailed physiological analysis; *Octopus*, on the contrary, is a remarkable animal for experimental work. In addition to the facts already mentioned above, I wish to add the occurrence of a very large amount of acetylcholine (77γ per gm.) in the cerebral ganglia; this fact suggests that at the central synapses of this cephalopod a cholinergic mechanism is probably involved.

Z. M. B.

May 23.

Dietary Hæmorrhagic Disease in Chicks

A NUTRITIONAL disease of chicks characterised by subcutaneous, intramuscular and abdominal hæmorrhages, prolonged blood-clotting time and erosions of the gizzard lining has been described in detail by Holst and Halbrook[1] of this laboratory. They were able to cure the disease by the use of fresh cabbage. The gizzard erosions and bleeding tendencies have been noted by McFarlane, Graham and Hall[2]. Dam and Schönheyder[3] have also produced the hæmorrhagic symptoms in chicks, and have shown that the disease is not caused by lack of any of the known vitamins. The same finding has been obtained by Halbrook[4].

Dam[5] has reported that the disease is caused by lack of an organic substance which was found present in hog-liver fat, hemp seed, tomatoes, kale and, to a less degree, in many cereals. The anti-hæmorrhagic factor was found to be present in the fat-soluble, unsaponifiable, non-sterol fraction.

Since the first publication from this laboratory[1], additional findings have been made. The disease can be prevented by so little as one half per cent of dehydrated alfalfa, and the anti-hæmorrhagic factor is located in the unsaponifiable, ether-extractable portion of alfalfa. Completely extracted alfalfa, chlorophyll and the saponifiable fraction of alfalfa ether extract fail to prevent the disease. The factor can be adsorbed from its ether solution by activated carbon. It is stable to heating at 120° C. for 24 hours.

The disease can be prevented by a concentrate prepared from alfalfa and fed at the level of 1/1,000 per cent of the basal diet. This basal diet consists of fish meal 20, dried brewer's yeast 12, polished rice 65, limestone 1, cod liver oil 1 and salt 1. Birds on the basal diet develop the disease to a severe extent, comparable with that described by Dam and Schönheyder[3].

In addition, the fish meal used in our basal diets can protect against the disease if allowed to remain in a wet condition for several days, thus affording opportunity for the action of micro-organisms. Rice bran treated in the same way will also afford complete protection, while the untreated rice bran fails to prevent the disease. A sample of the fish meal, completely extracted with ethyl-ether and kept in a moist condition for several days, will, after drying, yield a potent ether extract effective in small amounts when added to our basal diet containing the untreated fish meal.

For these reasons, anti-hæmorrhagic power cannot be attributed specifically to any feed ingredient unless the possibility of action upon it by micro-organisms has been guarded against. These results offer an explanation for the failure of Cribbett and Correll[6] to obtain symptoms of the disease on the Holst and Halbrook diet, and for the fact that samples of fish meals, meat scraps and commercial casein have often failed to produce the disease.

In an experiment to determine a possible causative factor in fish meal, the fish meal was diluted with varying amounts of a mixture of purified casein and bone ash compounded so as to resemble the fish meal. The sample of fish meal used in this case was a different lot from that formerly used although obtained from the same manufacturer. When this fish meal alone was used as the animal protein, the symptoms were only moderately severe. However, the severity and early onset of the disease markedly increased as the proportion of purified casein replacing the fish meal increased. The severity of the disease was also noticeably greater on lower levels of dried brewer's yeast. The results indicated the presence of small but inadequate amounts of the anti-hæmorrhagic factor in both of these samples of fish meal and yeast, rather than a specific disease-promoting factor in the fish meal.

Replacement of 50 parts of polished rice by wheat or yellow corn fails to prevent the disease. The results indicate very little, if any, of the anti-hæmorrhagic factor in these cereals.

In regard to the chemical and physical properties of the anti-hæmorrhagic factor, our work closely agrees with that of Dam[5]. The nature of this substance is being actively investigated.

H. J. ALMQUIST.
E. L. R. STOKSTAD.

University of California,
Berkeley.

[1] W. F. Holst and E. R. Halbrook, *Science*, **77**, 354; 1933.
[2] W. D. McFarlane, W. R. Graham, Jr., and G. E. Hall, *J. Nutrit.*, **4**, 331; 1931.
[3] H. Dam and F. Schönheyder, *Biochem. J.*, **28**, 1355; 1934.
[4] E. R. Halbrook, Thesis, University of California; 1935
[5] H. Dam, NATURE, **135**, 652, April 27, 1935.
[6] R. Cribbett and J. T. Correll, *Science*, **79**, 40; 1934.

An Insulin Inhibiting Agency in the Duodenum

HELLER[1] and Labarre[2] have reported that some of their preparations of the insuletropic hormone failed to demonstrate the usual increase in sugar tolerance in animals, and are unable to ascribe this to any definite cause. Others also report inconsistent results. Since 1929, using a method reported in conjunction with N. B. Laughton[3], I have noted that it is extremely critical, and deviation at one stage yields negative results.

The inertness of the preparations could not be ascribed solely to mere deficiency in the hormone content, since, while such preparations did not affect the blood sugar values of normal rabbits, these animals displayed a distinctly lowered sugar tolerance. Also such preparations were hyperglycæmic in their action on diabetic patients.

Striking effects were obtained where 'inactive' preparations were investigated on the insulinised rabbit. Controls were given 1 rabbit unit of insulin per 2 kgm. weight and the blood sugar values observed for 6–8 hours. These invariably gave the usual response—the sugar values dropping to 50 mgm. within 2 hours and remaining at this level for 3–4 hours longer. Afterwards, these same animals were treated with the defective preparations and then this standard amount of insulin administered. In some cases no fall in the blood sugar was observed, while in average cases the blood sugar values did not fall below 70 mgm. in 2 hours, and returned rapidly to 100 mgm., usually reaching 130–150 mgm. 4 hours after administration of insulin.

The failure to observe the customary effects of the insuletropic hormone was due to the preponderance of this insulin antagonistic element. After this had been separated, the preparations became insuletropically active, although extreme activity could be developed by further treatment.

The effect of the insulin inhibiting principle, like that of the insular hormone, persists for some weeks after its discontinuance, and a study of this factor in cases of hyperinsulinism is in progress.

The methods by which the above results were obtained will form the basis of a subsequent publication.

A. BRUCE MACALLUM.

Department of Biochemistry,
University of Western Ontario,
London, Ontario.
May 29.

[1] Heller, *Archiv. Exp. Path. u. Pharm.*, **177**, 127; 1934.
[2] Labarre, *Bull. Acad. Roy. Med. Belg.*, **12**, 620; 1932.
[3] Laughton and Macallum, *Proc. Roy. Soc.*, *B*, **111**, 37; 1932.

Experimental Deafness

CONTINUED investigation similar to that described elsewhere[1] has provided evidence for the view that the phenomenon designated 'auditory fatigue' by Ewing and Littler[2] and Rawdon-Smith[1] is in reality the result of the intervention of certain cortical factors. The marked decrease in sensitivity of the human ear following upon stimulation by loud pure tones for several minutes is, it has been found, not confined to the ear stimulated. The nominally unstimulated ear suffers a loss of sensitivity sometimes as great as that in the stimulated ear. Further, the loss of sensitivity in either may be temporarily removed or lessened in many cases by subjecting the observer to an unexpected stimulus (such as momentary darkness). This will be clear from Fig. 1.

It would seem, therefore, that the phenomenon of so-called auditory fatigue may more correctly be termed *inhibition*. The result of an unexpected stimulus is to produce momentary disinhibition.

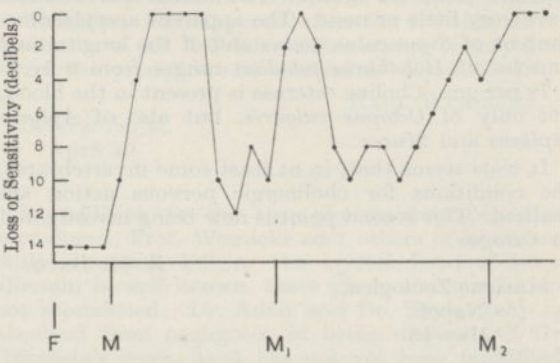


FIG. 1. Chart from actual record obtained from male subject. Each point represents one threshold reading. The points have been joined merely for convenience of interpretation—there is no indication that the threshold would fall on the line between readings. Frequency of stimulating and test tones = 2000 cycles per second. The stimulating tone ceased at *F*; *M*, M_1, M_2, represent points of application of momentary darkness in the sound-proof room in which the tests were made.

These effects find their nearest parallel in the phenomena of inhibition and disinhibition (or inhibition of inhibition) of conditioned reflexes described by Pavlov[3].

It is hoped shortly to publish these results in greater detail.

A. F. RAWDON-SMITH.

Psychological Laboratory,
Cambridge.
June 10.

[1] A. F. Rawdon-Smith, *Brit. J. Psychol.*, **25**, 1, 77; 1934.
[2] A. W. G. Ewing and T. S. Littler, *Brit. J. Psychol.*, **25**, 3, 284; 1935.
[3] I. P. Pavlov (tr. G. V. Anrep), "Conditioned Reflexes" Oxford Univ. Press, 1927.

The Band Spectrum of NH

IN the course of our investigation of the spectrum of discharges through streaming ammonia, it has been possible to record the λ 2530 band of NH, described by Hori[1], with a Hilger E.1 quartz spectrograph, using an improved type of hollow cathode. In addition, we have obtained four weaker bands at λλ 2730, 2835, 2885 and 2980 which appear to be due to the ion NH^+.

Our analysis with higher dispersion shows the necessity for revising Hori's interpretation of the λ 2530 band. The initial level is found to be $^1\Sigma^+$, while the final level is identified with the $^1\Pi$ level common to the λ 3240 band ($0,0\ ^1\Pi \rightarrow {}^1\Delta$) and the λ 4502 band[2] ($0,0\ ^1\Pi \rightarrow {}^1\Sigma^+$).

Full details will be published shortly.

R. WINSTANLEY LUNT.
University College, London, W.C.1.
R. W. B. PEARSE.
Imperial College of Science, London, S.W.7.
E. C. W. SMITH.
University College, London, W.C.1.
June 6.

[1] *Z. Phys.*, V, **59**, 91; 1930.
[2] NATURE, **135**, 508, March 30, 1935. Cf. also forthcoming paper in *Proc. Roy. Soc.*, A.

The Classification of Coals

I HESITATED to answer the letter published in NATURE of June 1 from Prof. Bone because so long ago as the year 1918 he indicated to me with emphasis that he did not desire any co-operation between chemical and palæobotanical work on coal.

May I, however, point out that he incorrectly says that the terms vitrain, clarain and durain are "imported from France". They are words coined *de novo* by myself in my paper in the *Philosophical Transactions of the Royal Society* in 1919. They do not correspond to the popular 'bright' and 'dull' coal, but were originally diagnosed for ingredients recognised as containing materials with distinct physical properties, and different types of cokes.

That Prof. Bone does not adopt my nomenclature or care to see the differences perceivable to others is a matter for his own orientation about which argument is unsuitable. But he is surely ill-informed to imply that "outside the exclusive circle of the 'Coal Research Club' " these ingredients do not receive recognition. A complete bibliography of coal research since 1919 would show how widely they are adopted. He is briefly answered by the words of M. Duparque (secretary of the Geological Society du Nord), *not* a member of the Coal Research Club, who, writing in 1924 of the laminations in coal, cited the important works of Bertrand, Renault, Grand 'Eury, Wheeler, Seyler, Potonie, Zalessky and others and said : "De tous ces travaux, ceux de Madame Marie Stopes ont eu la plus grande influence sur la direction de toutes les recherches concernant la houille".

MARIE C. STOPES.

Norbury Park,
Nr. Dorking,
Surrey.

Stationary Optical Paths

REFERRING to Dr. Karl Darrow's[1] article on quantum mechanics, Mr. T. Smith[2] has pointed out that optical paths are not (as Darrow repeats in his article) paths sometimes of maximum and sometimes of minimum time ; but that the time is a minimum if the path does not include an image of an end point, and if the path includes an image then the time is neither a minimum nor a maximum. Smith has further elucidated this point in connexion with Darbyshire's[3] recent letter.

The close analogy so significant on wave mechanics between the principle of least action in classical mechanics and the principle of stationary time for optical paths (Fermat's principle) is well known. The principle of least action[4] states that the action is a true minimum, provided that in passing along the trajectory of the particle the final point is reached before the kinetic focus of the initial point. But when the kinetic focus of the initial point is reached before we arrive at the final point, the action is neither a maximum nor a minimum. The definition of the kinetic focus is akin to the definition of image given by Smith in his recent note. Thus we see that the relationship between Fermat's principle and that of least action is not fully exhibited unless we take into account for optical paths the facts emphasised by Smith and so often ignored in text-books on optics.

D. S. KOTHARI.

Department of Physics,
University, Delhi.

[1] Darrow, "Reviews of Modern Physics", **6**, 23 ; 1934.
[2] Smith, NATURE, **133**, 830 ; 1934.
[3] Darbyshire, NATURE, **135**, 586 ; 1935.
[4] Whittaker, "Analytical Dynamics" (1927), Section 103.

Points from Foregoing Letters

FROM the amount of aluminium hydroxide adsorbed by kieselguhr (diatomaceous earth) and from the resulting electrokinetic potential (ζ) of the particles, as shown by their movement in an electric field, Prof. E. C. C. Baly and Mr. W. P. Pepper conclude that aluminium hydroxide is first adsorbed as a unimolecular layer giving a ζ-value of 75·4 millivolts. This layer is then able to adsorb a second molecular layer, resulting in a drop in the value of ζ to 61·2 mv.

Super-contraction of animal fibres has been induced artificially by various means. Dr. R. O. Hall describes a naturally occurring example of the phenomenon and proposes a tentative explanation in terms of the disulphide linkage of keratin.

Dr. A. K. Das gives results obtained by means of a continuously recording electrometer which was in action at Cambridge from February 14 until March 20. These photographic records appear to confirm Kolhörster's observations, made with Geiger-Müller counters, indicating an increase in the intensity of cosmic rays during the hours when the star Nova Herculis was at its greatest altitude.

Following upon the recently-published note in NATURE by Dr. Adair and Mr. Taylor, who had succeeded in obtaining seralbumin from normal human sera, Prof. Raul Wernicke now submits photomicrographs of crystals of human and guinea pig seralbumin obtained last year by Dr. Moisés Grinstein of Buenos Aires, and describes the method used in obtaining the crystalline preparations.

Having succeeded in extracting from various organs of the *Octopus* and other invertebrate marine animals a substance giving the physiological reaction of unstable choline esters, Dr. Z. M. Bacq infers, as C. F. A. Pantin did recently, that the rôle of acetylcholine in the nervous mechanism of invertebrates is similar to that in the higher animals.

Mr. H. Dam recently indicated the existence in hog liver fat, tomatoes, etc., of a new vitamin, K, which prevents a deficiency disease in chicken, leading to bleeding tendencies and other symptoms. H. J. Almquist and E. L. R. Stokstad point out that the new vitamin is also present in dehydrated alfalfa and in fish meal or rice bran that have been kept in a wet condition.

Prof. A. Bruce Macallum describes experiments indicating that certain extracts from the duodenum contain, in addition to the hormone which stimulates the secretion of insulin, a further component which is antagonistic to insulin.

The effect of unexpected stimuli in reducing or eliminating experimental deafness produced by loud 'pure' noises, and the fact that such deafness extends to the other ear even when it is not directly exposed to the noise, leads Mr. A. F. Rawdon-Smith to attribute the so-called auditory fatigue to an inhibition effect in the brain cortex rather than to a local effect in the ear.

Research Items

Roman Fort at Brough

THE existence of a Roman fort at Brough, Yorks, where Ermine Street crosses the Humber, as distinct from a riverside settlement, has been determined only recently. In 1933 an investigation was made of the character of the Roman occupation, previously well attested by frequent finds of coins, sherds, etc., by trial trenches dug in the Bozzes Field by Mr. T. Sheppard, Dr. J. L. Kirk and Mr. Philip Corder. In an interim report by the last-named (Hull Museum Publications, No. 182) a number of facts were established, notwithstanding that at the time of writing the excavation was not complete. A military station involving at least two, and probably three, ditches was established at Brough before the campaigns of Cerialis and Agricola. On the south side, the two outer ditches had been levelled and succeeded by an occupation area represented by floors, hearths and a rubbish pit. In the rubbish pit were Roman sherds, imitating Belgic forms, dated from material from Colchester at somewhere between A.D. 56 and 76. From these the inference is drawn that the occupation antedates the campaign of Cerialis, who founded Malton and York in the seventies. The earliest rampart on the east side was of compact sand and has not yet been positively dated. It is probably contemporary with the ditches on the east and south sides of the fort. Eventually the rampart was cut back and a solid stone revetment added. This was probably in the second century. Sherds from the filling of the ditches are none of them later than the Antonines. Probably the ditches were filled in the second century, when the military occupation was moved to the northern frontier. Third and fourth century occupation is attested by coins and pottery, and a large rectangular building in Trench 1 must fall within these centuries. It is not aligned with the ditches and may have been built after they had ceased to exist. Pottery of the fourth century was found unstratified in considerable quantity.

Bay Islands' Culture, Honduras

'LAS ISLAS DE LA BAHIA', a little-known group of islands off the northern coast of Spanish Honduras, have been investigated by expeditions of the American Museum of Natural History (1931) and the Smithsonian Institution (1933), and archæological collections were made in 1930 and 1931 by Mr. Mitchell-Hedges on behalf of the Museum of the American Indian, Heye Foundation. In a study of the archæology of the islands by Dr. W. D. Strong (*Smithsonian Misc. Collect.*, **92**, 14) the observations of the two expeditions are combined and the material collected by Mr. Mitchell-Hedges is used for purposes of comparison. The majority of the known archæological sites are on hill-tops, next come caves and rock-shelters; springs and water-holes and large level sites are less frequent. The majority of the sites are shrines, or places of offering of some sort; habitation sites are rare, only four being known, of which one is doubtful, though showing the only known example of, possibly, the foundation walls of a house. Low earth mounds contain scattered burials. The pottery is classified as Monochrome, Elaborate Monochrome, Polychrome i and Polychrome ii, a chronological sequence in which Elaborate Monochrome and Polychrome i seem to be contemporary. The Bay Islands' culture lies on the northern fringe of an important, but little-known, cultural region. It appears to have certain affinities with Maya culture, but this is late and indirect, whereas the affiliation with the western Nicaraguan and northern Costa Rican culture is both intimate and direct. Southern traits permeate the whole culture, and seem to be early and basic. Historical evidence, ethnology, archæology, and linguistics, all combine to suggest that peoples of South American affiliations must have been responsible for most of the remains on Bay Islands and probably for those of northern Honduras as well.

Factorial Analysis of Human Abilities

IN the *Human Factor* (**9**, No. 5) Prof. Godfrey H. Thomson states briefly, and in as non-mathematical a way as possible, his criticism of Prof. Spearman's 'Two-Factor Theory'. He regards g as a mathematical variable without any real existence as a separate entity; and argues that the g arrived at by one set of tests is not necessarily the same as that arrived at by another set of tests. He refers to the American work on factorial analysis, which has been concerned with applying the method to any team of tests, and not only hierarchical teams of tests, and points out that an infinite number of mathematically satisfactory results are possible. Prof. Thomson gives illustrations to show the innumerable interpretations that could be made from any one set of correlation coefficients. Determining which of them should be selected is the business of the psychologist, not the statistician. His own belief is that the mind cannot be divided up into unitary factors, but is "a rich comparatively undifferentiated complex of innumerable influences".

Musculature of the Blue Crab

MISS DORIS M. COGHRAN has studied the musculature of the blue crab, *Callinectes sapidus*, Rathbun (Smithsonian Miscellaneous Collections, vol. 92, No. 9 (Publication 3282), Jan. 1935). This is an excellent piece of work and one much wanted, for few accurate observations have been made on such an important subject. The chief myological publications in existence relate to crayfish, shrimps and prawns. The complete fusion of the segments of head and body in the crab has resulted in the disappearance of those intersegmental muscles which, in crustaceans like the shrimp and crayfish, give a high degree of flexibility to the movements of the body. On the other hand, the muscles of the appendages are highly complicated, as are also those of the stomach with its gastric mill and of the alimentary system. The abdomen of the blue crab, in the male at least, is apparently progressing towards a condition of partial rigidity, as the third, fourth and fifth segments are immovably fixed in that sex. This fusion is not yet completely established, as the former segmentation is still partly

maintained in its musculature. The female's abdomen has six distinct segments, all of which have the muscles well developed. All these muscles are described in great detail, and there is a discussion of the general structure of the crustacean appendage. The numerous illustrations in the text add much to the value of this undoubtedly valuable work.

Marine Fauna of the Dutch East Indies

NEW parts of Résultats Scientifiques du Voyage aux Indes Orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique (*Mém. Roy. d'Hist. Nat. de Belgique*, Hors série, Vol. 11) recently published embrace Opisthobranches and Silicodermes (Onciades) by A. Labbé; Prosobranches Parasites by W. Adam (fasc. 14); Sponges by H. V. Bröndstad (fasc. 15) and Cephalopoda by W. Adam (fasc. 16). A. Labbé has discovered that the Oncidiidæ possess a siliceous armature, hitherto unknown, and that the different members of the family have in their bodies more or less widely distributed spicules of silica. For this reason he has proposed the sub-order Silicodermatæ, being synonymous with the Oncidiidæ of Gray. Not only has he made this innovation, but he has also placed them among the Opisthobranchs rather than the true Pulmonates, for he is of the opinion that the Silicoderms play the same rôle with regard to the Opisthobranchs as the Pulmonates do with regard to the Prosobranchs. Seven species were taken by the expedition, five *Oncidium*, three new, two already known, one not determined owing to bad preservation, and one *Oncidiella*. No mention is made of the very careful monograph on South African Onchidella by Hugh Watson (*Ann. South African Mus.*, **20**, 1925) which contains valuable anatomical work and discussions on the geographical distribution. The capulid *Thysa crystallina*, parasitic on the echinoderm *Linckia*, is described by W. Adam, who has discovered the minute male, hitherto unknown, under the shell of the female. The male is mature although less than a millimetre in length and has no disc of fixation. The author, agreeing with Jonker, determines that this disc, which has been subject to much discussion, is part of the head, being innervated exclusively by the cerebral ganglia.

Pacific Entomological Survey

Two publications (Nos. 6 and 7) of the Pacific Entomological Survey have been issued as Bulletins 113 and 114 of the Bernice P. Bishop Museum, Honolulu, 1935. Bulletin 113 is concerned with reports of various specialists on the insects and other arthropods collected in the Society Islands. Bulletin 114 comprises the second instalment of reports on the insects, arachnids, etc., obtained in the Marquesas Islands. These two bulletins are well illustrated and contain descriptions of numerous species hitherto unknown. The bulletins are of interest to students of geographical distribution and of island life in particular, as well as to specialists in the diverse groups concerned.

Physiological Differences between Geographical Races in Forest Mice

INVESTIGATION of the effect of mountain climate upon the human organism has shown that the ascent of high mountains causes an increase in the hæmoglobin content and in the number of erythrocytes in the blood. It is known also that these values are higher in the blood of some mountain animals, as well as of men living normally at high altitudes. The nature of these differences, however, have remained unknown; they may represent either a temporary individual adaptation (as in the case of a man ascending a mountain peak), or they may become fixed during individual or phylogenetic development. Some light on this interesting problem has now been thrown by Kalabuchov (*C. R. Acad. Sci.*, Leningrad, **2**, No. 1, 1935) who has made a comparative experimental study of two sub-species of the forest mouse, *Apodemus sylvaticus ciscaucasicus* living at high altitudes, and *A. s. mosquensis* from the plains. Careful counts of the number of erythrocytes proved that the number was constantly higher in the mountain race than in that from the plains. When mice of the mountain race were transferred to the plain, the number of erythrocytes in their blood at first decreased, but two months later the number became normal, and even rose somewhat above the normal. In the controls, consisting of an equal number of plains mice race kept with the experimental animals, no change in the erythrocyte number was observed. This shows that there is a constant physiological difference between two races, independent of the environment.

A Fertile Species-Hybrid

GENETICISTS usually find that when two species are crossed, the offspring, if any, are sterile. Several garden plants have, however, originated as hybrids between two well-defined species, and now another plant has been found to have a similar origin. It is the pink-flowered chestnut, *Aesculus* × *Carnea*, recently described by Mr. M. B. Crane (*J. Roy. Hort. Soc.*, April 1935). Several well-authenticated instances of successful propagation of the hybrid from seed have been described in the garden literature of last century. Mr. Crane shows that each of the parents has twenty chromosomes, and upholds Skovsted's demonstration that *Aesculus Hippocastanum* has twenty small chromosomes in the germ cells, whilst *A. Pavia* has a similar number of large ones. The hybrid has forty, half of which are large, and the others small. Doubling seems to have been effected by autosyndesis—the non-reduction of both parental germ nuclei—since no parental types appear in the offspring. Several other species-hybrids are mentioned in the paper.

Effect of Rootstocks on the Nutrition of Apple Trees

MR. L. G. G. WARNE, of the University of Bristol, and Dr. T. Wallace, of Long Ashton Research Station, have investigated "The Composition of the Terminal Shoots and Fruits of Two Varieties of Apple in Relation to Rootstock Effects" (*J. Pomol. and Hort. Sci.*, **13**, No. 1, pp. 1–31, March 1935). Several metabolic disturbances, such as leaf-scorch, have been observed in association with the use of certain types of rootstocks, and the paper under review shows that the various clones of stocks classified by Hatton at East Malling Research Station have certain well-marked effects upon the metabolism of the scion with which they are grafted. Malling stocks types II and V, known to be susceptible to potash deficiency, showed evidence of potash starvation even when that element was present in the soil in abundance. Rootstocks promoting great vigour in the scion produced a high ratio of potash to nitrogen

in the shoots, whilst a positive correlation was established between the ratio of phosphate to nitrogen in the wood, and precocity of bearing of the tree. The dwarfing effect of type IX could not be explained chemically. Many other results are set out in detail in the paper, and the chemical analyses have been correlated with extensive pomological records collected by Dr. T. Swarbrick and his colleagues.

Atmospheric Visibility

A DISCUSSION of the principles underlying the choice of the marks used in the estimation of atmospheric visibility, by W. E. Knowles Middleton, of the Meteorological Service of Canada (*Monthly Weather Review*, January 1935, p. 17), summarises very briefly the results of recent work in Germany and America on the measurement of the transparency of the atmosphere. This is a subject that has become more important in the last twenty years on account of the development of aviation, and is one which abounds in practical difficulties. It has long been known that the distance expressing the so-called 'visibility' of the atmosphere when determined by observation of the distance of the farthest of a selected group of objects such as trees, buildings, etc., is influenced by a number of factors unconnected with the state of the atmosphere, for example, by the excellence or otherwise of the observer's eyesight, and perhaps still more by the nature of the selected objects and the background against which they are seen. Mr. Knowles Middleton states that it is a common opinion that observations of this element made by the method just described are of no use in synoptic meteorology. He goes on to show that it is only when the objects used are black or nearly black and are seen against the sky that we are in effect measuring σ, the extinction coefficient of the atmosphere, defined by the equation $dE = -\sigma E dx$, where E is the flux density in a parallel beam of light travelling in the direction of x. His remedy is to use only black or nearly black objects against the horizon sky during the daytime, and never objects against terrestrial backgrounds, and to use interpolated values obtained from observations of such objects rather than misleading observations derived from an inspection of objects which appear against terrestrial backgrounds; and to have night observations made with the aid of some standard transmission meter, so that these may be independent of the local distribution of lights not set up specially for observations of visibility.

Solidification of Nitrogen and Argon

THE *Proceedings of the American Academy of Arts and Sciences* of March contains Prof. P. W. Bridgman's account of his determinations of the melting points of nitrogen and argon under pressures up to 6,000 atmospheres, their change of volume on, and latent heat of, fusion. The gas was contained in a chromium-nickel-steel cylinder closed by a gas-tight piston the movement of which gave the change of volume. The cylinder was surrounded by a liquid propane thermostat, the temperature of which was regulated by a hydrogen thermometer. The temperature of the gas was measured by a copper-constantan thermo-couple and its pressure by a manganin wire resistance gauge. The melting point of nitrogen rises from 63·3° K. at 1 atm. to 149° K. at 6,000 atm., the increase of volume on melting changes from 0·072 to 0·026 c.c. and the latent heat of melting from 218 to 346 kgm.-cm. per gram. For argon the figures are 83·9° K. to 193° K., 0·080 to 0·021 c.c. and 280 to 288 kgm.-cm. per gram. In each case, the change of melting point is nearly a linear function, and the increase of volume a hyperbolic function, of the pressure. The latent heat of fusion is in both cases nearly constant at pressures above 3,000 atmospheres.

Diffusion of Gases through Metals

C. J. SMITHELLS and C. E. Ransley (*Proc. Roy. Soc.*, A, May) have examined the diffusion of several gases through different metals, and thus obtained a more definite conception of the mechanism involved. The metal tubes were heated electrically and provision was made for analysing the gas which had passed through the tube walls. The dependence of the diffusion on pressure and temperature was investigated. The effect of temperature was satisfactorily represented by Richardson's exponential expression. Except at low pressure, the variation with pressure follows a $\sqrt{P}$ law, the diffusion probably taking place in the atomic state. According to the view of the authors, diffusion is always preceded by adsorption, and the deviation from the square root law may be explained by the use of the Langmuir isotherm. The diffusion is found to be strongly specific; nitrogen, for example, will diffuse freely through iron, chromium, or molybdenum, but not through copper, while no diffusion of argon or helium could be detected with any metal. This agrees with the view that activated adsorption is necessary for the diffusion.

Chemical Aspects of Biological Oxidation

IN his presidential address at the annual meeting of the Indian Chemical Society on January 4, Prof. N. R. Dhar discussed the chemical aspects of biological oxidations (*J. Indian Chem. Soc.*, 12, 96; 1935). Researches carried out in his laboratory have shown that organic substances, which are not directly oxidised by atmospheric oxygen at the ordinary temperature, can be oxidised by simply passing air through their solutions or suspensions when they are mixed with compounds which readily undergo oxidation in air, such as sodium sulphite, phosphorus, or freshly precipitated ferrous, cerous and manganous hydroxides. It has been found that proteins are more readily oxidised than carbohydrates, and carbohydrates than fats; in fact, the order is the same as was found by Voit in feeding experiments; with cerous hydroxide, as much as 83 per cent of egg white is oxidised, 57 per cent of starch and 30 per cent of butter. In all cases, the substance is oxidised completely to carbon dioxide and water. Prof. Dhar contrasted this process with the rapid oxidation of foodstuffs with hydrogen peroxide or a ferrous or ferric salt, in which intermediate compounds are formed, and compared the former with normal metabolic oxidations and the latter with the changes occurring in abnormal metabolism, such as the appearance of the 'acetone' bodies in diabetes or fasting, from the incomplete combustion of fats. In conclusion, he suggested that certain biologically active compounds, which are reducing agents, owe their activity to their power of inducing oxidations in other substances, and also directed attention to the effect of sunlight in inducing oxidations in the presence of air.

The National Physical Laboratory, Teddington

INSPECTION BY THE GENERAL BOARD

ON June 25, the General Board of the National Physical Laboratory made its annual inspection of the Laboratory. A large number of visitors were present, including members of scientific and technical institutions, Government departments and industrial organisations, and were received by Sir Frederick Gowland Hopkins, president of the Royal Society and chairman of the Board, the Right Hon. Lord Rayleigh, chairman of the Executive Committee, and the director of the Laboratory, Sir Joseph E. Petavel.

In the Physics Department of the Laboratory a number of problems connected with air conditioning of public buildings are being studied. Mention may be made of an examination of the water vapour absorptive properties of various classes of books, and of an investigation of the relationship between humidity and length for a number of hygroscopic substances, to ascertain their suitability for use in humidity-controlling apparatus. In the course of an investigation of the action of the wet and dry bulb hygrometer at low temperatures, a dew point apparatus has been developed for use as a standard of reference. In this, paraffin oil cooled by solid carbon dioxide circulates in a spiral path, attached to the back of a disc of chromium-plated silver, the temperature of which is measured by means of a thermo-element.

The apparatus devised for the determination of the ratio of the specific heats of carbon monoxide has been modified so that measurements of the velocity of sound can be made quickly at any one of several widely spaced frequencies. Electrically maintained quartz crystals are carried on a plate capable of rotation beneath the opening of a vertical furnace containing the gas under test. Each crystal gives a definite frequency so that the change of velocity with frequency can be determined at various temperatures of the gas.

For the measurement of the thermal conductivities of refractory materials, a test slab eighteen inches square and two inches thick is used. One face can be heated to 1,100° C., and the heat transmitted through the central area is determined by means of a water-flow calorimeter.

In the Radiology Division the relation between crystalline structure and the magnetic, electrical and tensile properties of materials is under investigation by X-ray diffraction methods, special attention being given to the detection and measurement of internal strain. This strain results in a broadening of the diffraction lines, and the degree of broadening can be used as a measure of the amount of strain present. New equipment has been added to the Division for the study of materials by electron diffraction methods.

The measurement of gamma-ray dosage in röntgens is under investigation and experiments have been made with both 'free-air' and 'air-wall' chambers, the latter having walls composed of materials of effectively the same atomic number as air. The effect of wall thickness on the ionisation produced in 'air-wall' chambers is being examined. A thick-walled chamber appears to indicate the dosage under conditions prevailing in deep-seated therapy, while a thin-walled chamber measures virtually the dose received at the surface.

In the Acoustics Laboratory considerable attention is being given to the problems of noise abatement and measurement. Investigations are being carried out on the sound-insulating properties against impact and air-borne noise of walls and floors of various designs. The use of absorbent materials in this connexion is being studied. For the measurement of noise, a portable acoustimeter has been developed in the Department. The instrument gives equal indications for notes of the same loudness, irrespective of pitch.

In the Optics Division a new type of colorimeter containing no rotating elements has been constructed. The light enters the mixing chamber through a condensing lens equipped with variable apertures containing the primary colour filters. Colour mixing is effected by the use of a small integrating sphere as a mixing chamber, the intensity of each primary stimulus being controlled by variation of the apertures.

In the Electric Standards Division of the Electricity Department consideration has been given to the construction of standard attenuators of calculable phase angle for the calibration of commercial attenuators at radio frequencies up to 1 mega-cycle per second. A combination of two of the laboratory residual inductance standards in the form of a potential divider can be used as an attenuator, and a number of units of this type have been constructed ranging in value from 1 decibel to 110 decibels.

An apparatus for the automatic comparison of frequencies by counting beats has been developed in the Division. The apparatus makes use of a system of relays which actuate, on one hand, a counter registering the number of beats produced by the two frequencies being compared, and, on the other hand, a counter registering seconds or fractions of a second down to one tenth of a second.

In the High Voltage Laboratory, oscillographic methods have been applied to the testing of lightning arresters. Experimental arrangements have been developed for determining the volt-ampere characteristics of arresters, the lag in their response to steep fronted overvoltages and their ability to interrupt the flow of current when the overvoltage has been disposed of. Records were shown illustrating the voltage acquired by a piece of apparatus with and without the arrester connected across it.

Research work is being carried out in the Electrotechnics Division of the Department on the alternating-current resistance of conductors for heavy currents. Formulæ have been developed for solid circular conductors giving close agreement with experimentally measured values. The problem of tubular conductors is now under examination.

An investigation is in progress in the Photometry Division to determine the illumination at which it becomes necessary to supplement daylight by

artificial light, and automatic means have been developed for recording this in the case of a number of selected office lights. A solenoid included in each office lighting circuit operates the shutter of a cine-camera when the light is switched on. Each exposure records the date, the time of day, which office light is switched on, and the reading of a calibrated ammeter and rectifier photo-cell unit. This reading determines the illumination in the office. In the same Division research is being undertaken to determine the change of sensitivity of the eye during recovery from exposure to high brightness backgrounds or to isolated bright sources of light. The work has applications to the problem of the recovery of eye sensitivity from the glare of motor-car headlights.

In the Radio Department an exhaustive examination of the factors responsible for departure from frequency stability has revealed the necessity for high thermal and secular stability on the part of the inductance and capacitance. An inductance coil and variable condenser possessing extremely low temperature coefficients were exhibited; in these, use is made of differential expansion systems.

Attention has been given to the use of inverted diodes, split-anode triodes and magnetron oscillators as generators of very high-frequency oscillations. A demonstration was given of the generation, by a four segment magnetron, of ultra-short waves in a Lecher-wire system connected to the segments of the anode.

In the course of research on direction finding, a potentiometer method has been developed for the excitation of a rotating radio-beacon. The method utilises a dual potentiometer connecting an oscillator to two amplifiers which feed two pairs of aerials arranged at right-angles. The motion of the potentiometer contacts is such that the voltages applied to the two amplifiers vary sinusoidally and in opposite phases, producing a rotating field in the aerial system.

In an investigation into the nature and origin of atmospherics, oscillographic records have enabled the wave form and direction of individual atmospherics to be determined. Simultaneous records obtained at two different stations permit the place of origin of the atmospheric to be ascertained. Results obtained have shown that the recorded wave form of an atmospheric depends on the distance of the source producing the disturbance.

In the Metrology Department the standard leading screw lathe used for the correction of the pitches of lead screws has been entirely reconstructed. The traverse has now been extended to five feet and, by the introduction of change gears, screws having any English or metric right-handed pitches can be dealt with. Calibration of the reconstructed lathe has shown that its cumulative pitch is correct to within 0·0003 inch throughout its traverse.

New apparatus has been constructed for the direct testing of mercurial barometers at pressures varying from 2 in. to 34 in. of mercury, the pressure being accurately controlled by a specially designed barostat. The apparatus can accommodate five barometers for test in addition to the standard mercury barometer. A standard barometer has been constructed combining the principles of the Fortin, Newman and Kew barometers, so that instruments of all three types can be tested directly in the new apparatus.

The study of fatigue in relation to crystal structure has been continued in the Engineering Department and the effect of crystal orientation on fatigue strength is being examined for a number of single crystals of aluminium. Attention is also being given to the effect of intercrystalline boundaries on fatigue failure and tests are being made on specimens consisting of several crystals of aluminium. Specimens and results illustrating these two phases of the work were exhibited. For the determination of the fatigue strength of materials under combined alternating stresses, high-speed machines, in which different combinations of plane bending and torsion can be applied, have been constructed. Various plain and alloy steels and cast crankshaft materials are under examination.

Investigation is being made into the industrial applications of air injectors with reference to their use in maintaining air streams laden with granular matter. An experimental pneumatic conveyor has been constructed and experiments are being carried out to determine its performance.

The Department is investigating the principles underlying the design of satisfactory pipe-line joints capable of withstanding high temperatures and pressures. The work entails the study of the behaviour of flanged joints under pressure at air temperature, and at high temperatures, and measurements of bolt creep. The equipment permits tests to be made on 8-in. pipe flanges at temperatures up to 1,000° F. and at steam pressures up to 1,400 lb. per sq. inch.

A number of lubrication problems are receiving attention. Mention may be made of research on the aspect angle and attitude of a journal bearing under varying load, speed, clearance and temperature, and experiments on the effect of running in a clearance bearing at the seizing temperature of oils. Sensitive apparatus has been developed for measurement of the profile of bushes to determine the change of shape caused by running.

In the Metallurgy Department the production of iron of a high degree of purity has been achieved by the direct reduction of pure iron oxide in hydrogen. Specimens with a purity of the order of 99·99 per cent and of great softness and ductility were exhibited.

In view of the importance of oxide surface films in connexion with the problem of removing gases from molten metals, a systematic examination of the structure of such films is in progress by means of electron beam diffraction methods. The work has been extended to the study of oxide films formed on solid metals and alloys under atmospheric conditions and at high temperatures.

Considerable work is being carried out on the production of magnesium alloys, with the view of developing alloys stronger than those at present available for use at ordinary and at elevated temperatures. The microstructure, constitution and rolling and mechanical properties of various magnesium alloys are being investigated. The difficulty experienced in rolling and forging many of these alloys has been largely surmounted by slow pressing at high temperatures. A new experimental slow-speed rolling mill has been installed for use in breaking down the cast ingots.

In the Aerodynamics Department problems relating to the landing and take-off of aircraft are receiving attention. The work is of a two-fold character. The effect of landing flaps on stability near stalling incidence is being examined by means of the rolling balance. Measurements are made of the tendency of various wing sections, fitted with flaps and mounted on the balance, to accelerate or diminish rolling motion. The effect of proximity to the ground on the forces acting on an aeroplane is

also under investigation. Systematic measurements are made of the lift, drag and pitching moment of models at various distances from the ground.

Research is being carried out on the effects of gusts on the stresses in aircraft, and apparatus has been designed for recording the changes in vertical wind velocity in a gust. The use of this apparatus in conjunction with a recording anemometer measuring the mean horizontal wind speed, gives sufficient information to permit the effect of the gust to be predicted.

The performance of a number of high-pitch airscrews covering a wide range of pitch/diameter ratio has been measured and the results have been correlated with modern airscrew theory. Examination is now being made, by means of the hot spot method of flow photography, of the periodic flow through such airscrews, with the view of obtaining a direct experimental check of the basic assumptions of theory.

In the William Froude Laboratory, the effect of waves on ship resistance and propulsive efficiency together with the influence of hull form on this problem is under investigation. Demonstrations were given with a self-propelled model of a high-speed, twin-screw vessel. The speed, the propeller thrust, the amount of pitching and heaving, and the power required to drive the model are automatically recorded during its passage through rough water.

A number of model propellers made of a special aluminium alloy developed in the William Froude Laboratory were exhibited, together with apparatus for conducting tests with model propellers in open water.

The British Waterworks Association

ANNUAL MEETING

THE annual meeting of the British Waterworks Association at Cambridge on June 26 was the occasion for a vigorous and outspoken presidential address by Prof. C. E. Inglis, who, after a brief but interesting account of the origin and early development of the University, reviewed the policy of successive Governments in the past in respect of water supply for the needs of the country, and made some caustic comments on the "futile process of appointing water Commissions and pigeon-holing their reports" which has been its chief characteristic. He added that he regretted to observe the reappearance of the "policy of procrastination which has blighted waterworks legislation for the past 60 years" in the recent announcement by the Minister of Health in the House of Commons that as a preliminary to water legislation of a general character, a Joint Committee of the House of Lords and the House of Commons was to be set up to report "on measures for the better conservation and organisation of water resources and supplies in England and Wales".

Four papers presented to the Conference were more or less technical in character. One on "Water Softening at Cambridge", jointly written by Dr. Suckling and Mr. Philip Porteous, described the particular nature of the water at Cambridge, and the method of softening adopted after full consideration of the relevant data. The Cambridge water, which is derived from the Chalk, a formation which outcrops in the southern half of the county, is stated to be "uniformly clear, bright and colourless" containing no iron or manganese in solution. "The total solids, magnesium content and permanent hardness are not unduly high and sodium salts are only sparingly present. The water is neutral in reaction, the content of carbonic acid is low and no corrosive tendency has been exhibited during many years of use." It is also of excellent organic and bacterial purity. Being convinced on these grounds that the desired degree of softening could be satisfactorily attained by either the lime or the base-exchange process, the final decision of the local water company in favour of the latter was made on the basis of financial and engineering considerations. Tabular analyses are given of the water before and after softening, the total hardness of the untreated water being 24·0 (temporary hardness, 17·5; permanent hardness, 6·5). After treatment and blending, the total hardness (entirely temporary) is 11·5. The softened water sent into supply is described as "clear, bright, colourless, odourless and palatable". The water-softening plant consists of six units, each of 9 ft. diameter, capable of delivering "zero hardness" water continuously at the rate of 16,000 gal. per hour for 10 hours, after which it is put out of commission for regeneration. Each cylinder contains about 10 tons (420 cu. ft.) of Doucil, a synthetic zeolite, and is supported on a 12-in. bed of graded gravel. The synthetic zeolite was chosen in comparison with natural zeolite on financial and engineering grounds as in the case of the process. The salt consumption for regeneration is guaranteed not to exceed a rate 5,600 lb. per million gallons of water softened to zero hardness.

The paper by Mr. Philip Ulyott on "Biological Research in Relation to Water Supply" was a brief statement of the results of modern investigation in the subject, and of the sequence of events connected with plant life in an aqueous environment. A lengthy paper, full of interest from the historical and engineering point of view, was contributed by Mr. H. C. Darby on "Windmill Drainage in the Bedford Level" in the southern part of the Fens. Writing in 1748, Thomas Neale states that "there are now no less than two hundred and fifty [windmills] in the Middle Level. In Whittlesey parish alone I was told by some of the principal inhabitants there are more than fifty mills and there are, I believe, as many in Donnington with its members. I myself, riding very lately from Ramsey to Holme, about six miles across the Fens, counted forty in my view." But, as Mr. Darby points out, the windmill was a "wayward co-operator at the mercy of wind and gale and frost and calm. It was never powerful and it never provided a satisfactory solution to the problem of clearing water from the drains." Finally, there was a paper of a financial and administrative character by Mr. T. G. Rose on "Modern Methods of Management Control".

Petroleum Industry of France

MR. VICTOR FORBIN'S recent article on the French petroleum industry (*La Nature*, No. 2952, 385–396, May 1, 1935) is in effect an unanswerable vindication of France's claim to recognition as a petroleum power in the world to-day. Admittedly, at the beginning of this century and during the great development of the world petroleum industry, actuated by invention and universal adoption of the internal combustion engine, France had little right to recognition, for at this time tariff protection had been withdrawn and she was only able to supply 10 per cent of her domestic requirements of petroleum and products. This position was more or less maintained until 1925, when l'Office National des Combustibles Liquides was founded to give expression to the French desire "de devenir une puissance pétrolière". Close co-operation between this body and the Government led to drastic reorganisation of the entire industry and finally, in 1928, to the passing of a law which is now regarded as the charter of the French petroleum industry.

Under the new regime initiated by this law, authorisations were granted for importation and refining of crude petroleum in France for periods up to twenty years. Eleven industrial concerns contributed capital amounting to nearly 3,000 million francs for the erection of refineries at suitable places along the coast. Thus France acquired at Le Havre, at the mouths of the Rivers Loire, Gironde and Rhône, etc., some of, perhaps, the most modern refineries in the world. Systematic co-operation within the industry and far-seeing dispensation of resources led to the optimum equipment of each refinery for some particular type of raw material. Some are capable of producing the whole range of petroleum products, while others confine their activities to production of petrol, kerosene, gas-oil, etc.; throughout the industry there is a wholehearted spirit of co-operation and a common desire that France should have a petroleum industry comparable with that of other nations.

France is now definitely reaping the benefit of this far-sighted policy initiated some five years ago, for when the first consignment of Iraq oil was conveyed by the pipe line to Tripoli in August 1934, there were new tank-ships ready for its conveyance to Le Havre and everything was in readiness for its reception. During the last five months of 1934, after completion of both branches of the Iraq pipe line, 600,000 tons of crude oil were exported from the twin ports of Tripoli and Haifa, 520,000 tons of which were destined for France. In 1934 French refineries treated 3¼ million tons of raw material, and it is estimated that this quantity will be increased to 4 million tons in 1935, as compared with 1,034,819 tons in 1932 and 2,739,305 tons in 1933.

During the first eight months of 1934, France exported 28,647 tons of kerosene and 682,292 tons of gasoline to Great Britain, Switzerland, Italy and other countries. These facts and figures should confute those who are still under the impression that the French petroleum industry is directed by foreigners.

Pollination Mechanism in Conifers

PROF. JOSEPH DOYLE and Miss Mary O'Leary have published (*Sci. Proc. Roy. Dublin Soc.*, 21, N.S., Nos. 19, 20 and 21, February 1935) a series of papers upon the pollination mechanisms in conifers. Their researches include records of intensive observations in the field, which are interpreted most interestingly in the light of the wide knowledge of the senior author of the comparative morphology of the reproductive structures in the group.

The authors point out that our knowledge of the movement of pollen on to the nucellus in *Pinus* has so far rested upon second-hand statements, most of them derived from some incidental observations by Strasburger. Strasburger appears to have assumed, on the basis of other well-known cases, that a fertilisation drop was formed and, in view of their turgid transparent appearance, to have ascribed its formation to the two characteristic prolongations of the integument beyond the micropyle.

As the result of very patient investigation, the Irish observers have at last seen this fertilisation drop—but at 2 a.m. in the morning—and by 7.30 a.m. every ovule is dry! This secretion appears to come from the nucellus, and though at night it may be found in almost every mature unfertilised ovule as it wells out of the micropyle and part of the way along the micropylar projection, it usually soon picks up some pollen grains from these arms. When these are immersed in the fluid, in the inverted ovule, they rapidly float with their winged surface uppermost on to the nucellus; the grain is thus brought against the nucellus with the surface towards it through which the pollen tube emerges. More remarkable still, within ten minutes of the grain being thus transferred to the nucellus, the drop is once more reabsorbed while it still remains in the unpollinated ovule. The authors have tested this by introducing pollen into the drop at night. They argue cogently that the function thus suggested for the winged expansions to the pollen grain is much more reasonable than its use for transport of the grains in the air, as the larger grains of *Larix* and *Pseudotsuga* are without wings.

On the other hand, the authors have to solve the problem how these wingless pollen grains of *Larix* also reach the surface of an inverted ovule. In *Saxegothæa* and *Cedrus* they describe the germination of pollen grains well away from the micropyle and their growth to the nucellus: they also figure and discuss the function of the stigma-like projections in the integuments of *Pseudotsuga* and *Larix*. These papers are full of stimulating discussion of new data that are a permanent contribution to our knowledge of the pollination mechanisms of the conifer.

Educational Topics and Events

EDINBURGH.—At the graduation ceremony on June 28, the honorary degree of LL.D. was conferred on the following: The Right Hon. the Viscount Bledisloe, Governor-General and Commander-in-Chief of New Zealand; Dr. J. L. Garvin, editor of the *Observer*; Dame Maria M. Ogilvie Gordon, geologist and vice-president of the International Council of Women; Prof. J. Graham Kerr, M.P., regius professor of zoology in the University of Glasgow; Prof. John Laird, regius professor of moral philosophy in the University of Aberdeen; Sir George Macdonald, formerly secretary of the Scottish Education Department, archæologist, numismatist and historian; Dr. J. D. Pollock, Hon. Surgeon-Commander, R.N.V.R.; The Hon. Lord St. Vigeans, formerly chairman of the Scottish Land Court.

The degree of D.Sc. was conferred on the following, for the theses indicated: A. B. D. Cassie ("Infra-Red Absorption Spectra and Molecular Structure of Triatomic Molecules"); D. Clouston ("The Identification of Grasses by Leaf Anatomy"); Dr. J. MacLeod ("The Ecological Complex controlling Activities and Distribution of *Ixodes ricinus*"); Dr. H. W. Melville ("The Kinetics of Gaseous Chain Reactions").

OXFORD.—Sir Charles Sherrington has resigned the Waynflete chair of physiology, which he has held since 1913, as from October 1.

Mr. L. S. Bosanquet has been granted the degree of D.Sc.

At Christ Church, Mr. D. Roaf has been elected to the Duke of Westminster research studentship (that is, fellowship) for work in nuclear physics, and Mr. J. A. Moy Thomas to a lectureship for research in vertebrate palæontology.

At the Queen's College, Mr. E. W. Yemm has been elected to a junior research fellowship in botany.

DR. JOHN A. WHEELER has been appointed assistant professor of physics in the University of North Carolina, at Chapel Hill. During the past year, Dr. Wheeler has pursued research in nuclear physics at the Institute of Theoretical Physics in Copenhagen.

GERMAN universities are, one gathers, like other cultural institutions in Germany, being remoulded so as to conform with Nazi aims. A letter from the Berlin correspondent of the American Medical Association tells of a new decree releasing the general student body from obligatory attendance on the special political training course prescribed, together with enrolment in a hostel, for members of the Nazi student league. The director of this league has announced that "during the past year and a half the student has been tossed about to such an extent that he has lost most of his faith in attempts to direct the thinking of students. A reawakening of this faith I regard as a necessity . . ." Last winter new regulations made compulsory for all students participation in physical exercises and sports, including *fünfkampf* training and rifle exercise during the first three semesters as a pre-requisite for any degree. Another interesting development is the provision made for permitting twenty of the most talented sons of workmen to attend a university without presenting a diploma of completion of a secondary school course. For such special entry the Universities of Heidelberg and Königsberg are being considered.

SEX education in schools is discussed in a remarkable paper by Dr. E. P. Phillips which has been published by the Transvaal Education Department in its monthly circular for April. Dr. Phillips writes as a biologist. He begins by emphasising the fact that notwithstanding the fundamental biological discoveries of the past seventy-five years, we still think in terms handed down to us by earlier civilisations, terms involving an often inextricable entanglement of religious ideas with ideas relating to sex. Hence arise divergences between mental outlooks which he classifies as the orthodox religious, the biologist's, and that of the large body of parents who, while not holding very strict religious views, are ignorant of the elements of biology. There should, he holds, be no course of sex education *as a subject*, taught either by the school staff or by visiting doctors; but all children should receive instruction, which should begin before the age of puberty, in some of the more important biological facts about themselves as human beings. It should be inculcated that mankind is faced, like myriads of other species, with the two fundamental problems—the struggle for individual existence and the struggle to maintain the species. Thereafter, the similarity of mankind to the rest of the animal kingdom having been sufficiently demonstrated, the overwhelming importance of the reasoning faculty which differentiates the human from other species should be stressed in connexion with man's social development. To adolescents who have received such a grounding, information about the dangers and implications of sex can be imparted without difficulty. The crux of the scheme for such a broad biological course is the supply of suitable teachers. These should have studied biology, chemistry, physics and geology, should have read widely, and should have tact, sympathy and understanding. The course should not be taught as an examination subject, thereby suppressing the individuality of the teacher. It should be a necessary part of every child's social, moral, ethical and religious training.

Science News a Century Ago

Lyell and Sir John Herschel

LYELL, whose "Principles of Geology" had been published originally in three volumes in 1830, 1832 and 1833 respectively and had been republished in four volumes in 1834, wrote to Sir John Herschel on July 6, 1835: "I heard some months ago from Whewell that you had, in one of your letters to him, expressed much pleasure at some parts of my book, which I think you read when on your way to the Cape. It has been so much altered, enlarged, illustrated, abridged, and I hope improved since the first edition, that I am anxious, if you ever refer to it again, that you should see it in its amended state. Some of my friends have read letters of yours which they have received, to me, and I rejoice that your grand scheme of visiting the Southern Hemisphere has answered so well."

"When at Copenhagen last year Oersted, who was reading your paper on double stars, was talking of

it continually, and trying to make me understand the *poetry* of some speculations, which only amused me, from seeing that it was deep mathematics with which he was delighted, as with a romance."

"Murray has sold 1,750 copies of my book in the last ten months, so that I have the satisfaction of being much read. . . ."

The Science of Education

AN advertisement in *The Times* for July 6, 1835, ran as follows: "A Course of Seven Lectures on the Science of Education will be delivered in Willis's great Rooms, 26 King-street, St. James's, commencing tomorrow the 7th of July at 3 o'clock, and continued on Tuesdays, Thursdays and Saturdays at the same hour, by the Rev. R. J. Bryce, LL.D., Principal of the Belfast Academy. The object of these lectures is to reduce the art of teaching and managing children to scientific principles, derived from the known laws of the human mind; to point out the best methods in each department of education; and to show the means of varying those methods to correspond with the endless varieties which occur in the minds of children. The formation of such a science of education has been spoken of as a great desideratum by the most eminent philosophers of modern times, and has long been anxiously wished for by the most distinguished friends of education. . . . The proceeds of the lectures, after paying necessary expenses, will be placed at the disposal of a committee of the audience, to be by them applied to the promotion of some object connected with the improvement of education."

J. D. Forbes in the Pyrenees

THE travels of Prof. J. D. Forbes began when, as a boy of sixteen years of age, he visited France, Germany and Italy. This journey led to the publication of his first scientific memoir, "Remarks on Mount Vesuvius", which appeared anonymously in the *Edinburgh Journal of Science*. Six years later, in 1832, he first visited Switzerland, from which he hastened home to enter successfully for the chair of natural philosophy at Edinburgh. His favourite subject was heat, and in the summer of 1835 he set out to study the hot springs of the Pyrenean valleys. His letters and journal contain many interesting observations on his travels. On July 7, 1835, he went from Bordeaux to Pau by diligence and on July 9 he records: "A splendid morning. . . . The whole range of the Hautes Pyrenées was now uncovered, and presented as noble and rugged an outline as I ever saw. . . ." He then went to Eaux-Bonnes and to Eaux-Chaudes with its splendid gorge. "If ever there was a valley of disruption," he wrote, "it is this one, though I do not pretend always to decide. This confirms Dr. Daubeny's theory of hot springs, especially as these waters issue just at the junction of the granite and limestone. The limestone rises always to the granite, more as it approaches it, and at last is elevated in horizontal strata on the top of it—at least so far as I can judge from a very imperfect examination. What confirms the view of the granite being the upheaving agent is that the valley of disruption is perpendicular in direction to the strata (Hopkins' theory). It is remarkable that there are signs of water wearing (obviously not weathering) on the rocks at a great height above the torrent."

Societies and Academies

LONDON

Royal Society, June 27. W. A. BONE, R. P. FRASER, and W. H. WHEELER: A photographic investigation of flame movement in gaseous explosions. A new view of the detonation wave in gaseous explosions is advanced. It can no longer be regarded as simply a homogeneous shock wave in which an abrupt change in pressure in the vicinity of the wave-front is maintained by the adiabatic combustion of the explosive medium through which it is propagated, but it must now be viewed as a more or less stable association, or coalescence, of two separate and separable components, namely, of an intensively radiating flame-front, with an invisible shock wave immediately ahead of it. According to the new view, detonation in an explosive gaseous medium is the propagation through it, as a wave, of a condition of intensive combustion, initiated and maintained in a shock wave by radiation from an associated flame-front; and spin ensues whenever the conditions are such that the radiation from an attenuated flame-front causes a localised intensive excitation of molecules in the shock wave just ahead of it. The experimental part of the work has been mainly concerned with detonations in a moist $2CO+O_2$ medium, which has proved to be specially adapted to the elucidation of the dual character of the phenomenon. O. H. LATTER and H. ELTRINGHAM: The epigamic behaviour of *Euplœa* (*crastia*) *core asela*, Moore (Lepidoptera, Danainæ) with a description of the structure of the scent organs. Observations in the field show that the male butterfly diffuses, from brushes exserted from the abdomen, a scent which attracts females from a distance. While male scent organs of great complexity are found in many insects, no evidence has previously been obtained of the distant action of such organs, termed here 'telegamic'. B. F. J. SCHONLAND, D. J. MALAN, and H. COLLENS: Progressive lightning (2). A general account, based on the study of 95 flashes photographed with the Boys and other cameras, is given of the mode of development of the lightning discharge. It is shown that the leader-return stroke sequence is present in almost all the cases examined. Leaders to first strokes are stepped, those to subsequent strokes generally dart-like. In certain cases of very slow dart leaders, these change to the stepped form at their lower ends. Slower leader velocities and higher intensities of return strokes are associated with longer time-intervals between strokes and their predecessors; hence the degree of pre-existing ionisation in the channel governs the velocity of the dart-leader. The downward-branching of lightning and its characteristic zig-zag form arise during the stepped leader process before the first return stroke.

PARIS

Academy of Sciences, May 20 (*C.R.*, 200, 1697–1804). CHARLES ACHARD and AUGUSTIN BOUTARIC: The physicochemical study of the changes undergone by the blood serum under the influence of heat. The diluted serum is treated with charcoal, and the quantity of the latter determined which completely removes the colloidal substances, use being made of the surface tension. Data are given for results obtained by heating for various times at temperatures between 55° C. and 62° C. PIERRE WEISS: The

equation of state of fluids. The negative internal pressure at high temperatures. CHARLES NICOLLE and MME. HÉLÈNE SPARROW: Infection by the conjunctiva of small apes with the murin I typhus virus from Tunisian rats. JEAN MIRGUET: The continuity of the biparatingent. PAUL ALEXANDROFF: Suites of topological spaces. ADOLPHE BUHL: The integral of Stieltjes. LADISLAS FEJES: Cauchy's exponential series. N. GÜNTHER: The resolvant of certain integral Hermite equations. A. KOLMOGOROFF: The Laplace transformation in linear spaces. JEAN BRAÏTZEFF: The fundamental formula of the theory of Dirichlet's series. FLORIN VASILESCO: Remarks on the various methods of solution of the problem of Dirichlet. PAUL LÉVY: A tensorial form of the functional differential equations of Green's and Neumann's functions. LÉON BRILLOUIN: The transversal physical waves in wave mechanics and the harmonic oscillator in four dimensions. PAUL BERNARD: The measurement of the pressures developed by explosive substances. A comparison of crusher pressures with true pressures measured by a piezoelectric dynamometer. The results with a light and heavy piston in the crusher manometer are compared graphically. DANIEL BARBIER, DANIEL CHALONGE and ETIENNE VASSY: The interpretation of the continuous absorption of hydrogen in stars of early spectral types. AUREL POTOP: The thermal conductivity of metals examined in the form of small bars. JACQUES VAN MIEGHEM: The velocity of transport of electromagnetic energy. CHARLES BÉCHARD: The electrolytic deposit of alloys of copper and tin. PIERRE SÜE: The conductivity and hydrolysis of the sodium niobates. The orthoniobate is completely hydrolysed: the salt, $7/6\ Na_2O, Nb_2O_5$, is strongly hydrolysed and in equilibrium with the metaniobate. AURELIAN NAHERNIAC: The study of a characteristic band of the OH group in the near infra-red. MME. LUCIE LEFEBVRE: The absorption spectrum of ozone in the region of the photographic infra-red. The tubes employed were equivalent to a column of 50 cm. of pure ozone: the region explored was between 6500 A. and 10,000 A. EMILE SEVIN: The play of waves, spin and numbers. PIERRE AUGER, LOUIS LEPRINCE-RINGUET and PAUL EHRENFEST: The absorption of the soft fraction of the cosmic corpuscular radiation. An account of results obtained at the International Laboratory at the Jungfraujoch. FRANCIS PERRIN: The mechanism of the capture of slow neutrons by light nuclei. MME. L. S. MATHIEU-LÉVY: The influence of complex formation on the adsorption of copper in ammoniacal solutions by precipitated ferric hydroxide. MLLE. M. QUINTIN: The application of Debye's theory to solutions of cadmium chloride. CHARLES TOURNEUR: Study of the action exercised by alcohol on gum arabic sols, as shown by the polarisation of the diffused light. ARAKEL TCHAKIRIAN and HENRI VOLKRINGER: The Raman spectra of the bromine compounds of germanium and of tin. Comparative diagrams are given of the Raman spectra of the compounds RBr_4 and $RHBr_3$, where R is carbon, silicon, germanium or tin. AUGUSTIN MACHÉ: Contribution to the study of the determination of ozone. Comparisons of the iodide and fluorescin methods. For low concentrations of ozone the latter is more accurate. A. P. ROLLET: The potassium borates. Study of the system B_2O_3, K_2O. MAURICE BILLY and PAUL BRASSEUR: The preparation of anhydrous titanium trichloride. The tetrachloride is reduced with precipitated antimony, afterwards removing the excess of tetrachloride with carbon tetrachloride and the antimony chloride with anhydrous ether. PIERRE CARRÉ and HENRI PASSEDOUET: The relative mobilities of the normal primary alkyl groups from C_1 to C_{16} in their chloroformates. G. MULLER: The oxidation of mineral oils by gaseous oxygen at moderate temperatures. The chemical nature of the oxidation of mineral oils is the same whatever their origin or previous treatment, although the amount of deposit may vary considerably. The white refined oils are most strongly oxidised. ALEXANDRE DINCA-SAMURACAS: The polarisation of seismic waves in the primary phase of earthquakes. LOUIS FAGE: The localisation in the intermediate waters of the Pacific of the little-known *Ceratolepis hamata*. A single specimen of this organism was collected by the *Challenger* between the New Hebrides and Australia. During the last voyage of the *Dana* in the Pacific, Schmidt was able to collect nearly two hundred specimens of this Crustacean. The results obtained from this material are given, completing the description given by Sars of the *Challenger* specimen. M. BURGAUD: Magnetic observations in the south and south-west of China and a map of the isogonics and isodynamic lines. LOUIS EMBERGER: New botanical researches in the eastern Grand Atlas. JEAN CHAZE and ANDRÉ SARAZIN: The parasitism of mushroom beds by the mole is a reversible phenomenon. ARMAND DEHORNE: The anatomical and cytological characters of the thoracic nephridia of *Sabellaria*. PAUL MATHIAS: The evolutive cycle of a holostomid trematode, *Cyathocotyle Gravieri*. OCTAVE DUBOSCQ and MLLE. ODETTE TUZET: A new stage of development of the calcareous sponges. GEORGES UNGAR and MLLE. MARIE ROSE ZERLING: The intervention of a humoral transmission in vasodilatation known as antidromic. Arguments in favour of the existence of histaminergic nerves. MME. VÉRA DANTCHAKOFF: The equivalence of the somatic tissues in the gonads of the fowl. PIERRE GRABAR and ANDRÉ RIEGERT: The nature of urease: approach to the study with the aid of fractional ultra-filtration. The activity of urease is intimately connected with very bulky molecules of protein nature: Sumner's crystallised urease, in aqueous solution, was the most homogeneous of the preparations studied. AUGUSTE and RENÉ SARTORY, JACQUES MEYER and FRÉDÉRIC ARNOLD: Comparative attempts at the determination of the phosphorus and potassium contained in an arable soil by means of Hilgard's chemical method. Neubauer's biological method and that of Niklas, utilising *Sterigmatocystis nigra*. The Niklas method is very suitable for determining the immediate requirements of a soil. CONSTANTIN LEVADITI and JEAN VIEUCHANGE: The inoculability of certain neurotrope viruses (herpes, poliomyelitis) through the external auditory canal.

VIENNA

Academy of Sciences, May 9. F. WESSELY, K. DINJASKI, W. ISEMAN and G. SINGER: Bitter principles of kolombo root—kolumbin. G. KIRSCH: Viscosity and melting curves. E. HASCHEK and H. MACHE: Dependency of spark-noise on the electrode material with a rapid succession of sparks. E. CHWALLA: Bulging of rhomboidal plates under pressure and shear loading. W. PASSER: Pressure distribution through an elastic layer. W. W. LEPESCHKIN: Fundamental substances of living matter (vitaids) and their significance in biology.

The importance of 'vitaids' to life is probably due to the part they play in the structure of the consistent phase of the protoplasm. F. ROCH and F. MOLL: New terenid species. F. HERITSCH: Uppermost lower Devonian and lower mid-Devonian. A. THURNER: Position of the Trias in the mountains around Murau. O. GUGENBERGER: The Cardita layers of Launsdorf in mid-Carinthia and their fauna. H. REBEL: Lepidoptera from the Ægean Islands. F. WERNER *et al.*: Insects and arachnoids of the Ægean Islands. L. FLAMM: Algebraic electrodynamics. A. SKRABAL: Chemical induction. In continuation of investigations on the kinetics of intermediate reactions, those general systems are considered which can be decomposed into separate systems with different total reactions. M. PESTEMER and L. WILIGUT: Ultra-violet absorption of certain aromatic hydrocarbons (3); constitution of tetrahydrodiphenyl. Substances with double linkings conjugated to the benzene nucleus show a marked increase in the extinction, whereas the extinction of the benzene bands is not increased by substitution with alkylenes or olefines in which the double linking is separated from the benzene nucleus by more than one carbon atom. From this it follows that the tetrahydrodiphenyl obtained by hydrogenation of diphenyl has the constitution of the known 1-phenylhexene-1. E. ABEL and J. PROISL: Mechanism of the lead-chamber reaction (1); reaction between sulphurous and nitrous acids in the dilute system. A. PONGRATZ and G. MARKGRAF: Perylene and its derivatives (44). A. VERDINO and E. SCHADENDORFF: Condensations of ethyl chlorocarboxychlorate with amines and phenols. W. KOSMATH: Process for measuring the momentary radon content of the open air at spas with radioactive waters. Use is made of the arrangement previously described, which consists essentially of two similar cylindrical air-tight ionisation chambers (measuring chamber and compensation chamber) of about 9 litres capacity, and a Lindemann electrometer with switch-box. T. KORMOS: Revision of the small mammal remains of Hundsheim. A. WAGNER: Daily course of cosmic ultra-radiation. A reply is made to Hess's criticisms of the author's previous communication. A. FINK, P. GROSS and H. STEINER: Conductivity of strong acids in mixtures of heavy and light water. Determinations have been made of the conductivities of hydrochloric and perchloric acids in about 0·01 *N* solutions in mixtures of heavy and light water at 18° C. The value of the equivalent conductivity of hydrochloric acid at infinite dilution falls from 377 to 250 in pure deuterium oxide, the fall being non-linear. K. UNNA and L. WALTERSKIRCHEN: Action of anti-diuretic pituitary hormone on dogs to which water is or is not given.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Sunday, July 7

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—Miss M. R. J. Edwards: "The World 50,000,000 years ago, 150,000,000 years ago and 1,000,000,000 years ago".*

INSTITUTE OF CHEMISTRY, July 9–10.—Charter Jubilee Celebrations, to be held in London.

Official Publications Received

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 5: The Mathematical Representation of the Energy Levels of the Secondary Spectrum of Hydrogen, 2. By Dr. Ian Sandeman. Pp. 49–61. 1*s*. Vol. 55, Part 1, No. 6: The New Crystallography. By Prof. W. L. Bragg. Pp. 62–71. 1*s*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The British Science Guild. Gas Defence. By J. Davidson Pratt. Pp. 18. (London: British Science Guild.) 1*s*.

True Temperance Scientific Committee. Monograph No. 1: The Problem of the Intoxicated Motor Driver. Pp. 15. (London: True Temperance Scientific Committee.) 2*d*.

Joint Board of Research for Mental Disease: City and University of Birmingham. Annual Report, 1934–1935. Pp. 14. (Birmingham.)

Empire Cotton Growing Corporation. Report of the Fourteenth Annual General Meeting. Pp. 8. (London: Empire Cotton Growing Corporation.)

Financial and Economic Position of Basutoland: Report of the Commission appointed by the Secretary of State for Dominions Affairs. (Cmd. 4907.) Pp. viii+225. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1649 (S. 163, 195, 211, 221): Wall Interference and Depth Effect in the R.A.E. Seaplane Tank and Scale Effect Tests on Hulls of Three Sizes. By L. P. Coombes, W. G. A. Perring, D. W. Bottle and L. Johnston. Pp. 30+35 plates. (London: H.M. Stationery Office.) 3*s*. net.

British Non-Ferrous Metals Research Association. Supplement to Research Monograph No. 2: Bibliography of Literature on Spectrum Analysis. Compiled by D. M. Smith. Pp. 20. (London: British Non-Ferrous Metals Research Association.) 1*s*. 6*d*.

The Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 24: A Simple Titrametric Method for the Approximate Determination of Milk Phosphates. By G. T. Pyne. Pp. 223–229. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1934. Pp. viii+456+66+11 plates. (London: H.M. Stationery Office.) 12*s*. 6*d*. net.

London Shellac Research Bureau. Technical Paper No. 2: Identification and Analysis of Lac. By Dr. R. Bhattacharya. Pp. 28. (London: London Shellac Research Bureau.)

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Twentieth Annual Report, 1934. Pp. 107. (Cheshunt: Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd.)

Board of Education. Report of the Advisory Council of the Science Museum for the Year 1934. Pp. 52. (London: H.M. Stationery Office.) 1*s*. net.

Other Countries

Obras completas y Correspondencia cientifica de Florentino Ameghino. Vol. 15: La perforación astragaliana y el credo. Edición Oficial ordenada por el Gobierno de la Provincia de Buenos Aires. Dirigida por Alfredo J. Torcelli. Pp. 730+40 plates. (La Plata.)

U.S. Department of Agriculture. Circular No. 346: Insect Parasites and Predators of Insect Pests. By Curtis P. Clausen. Pp. 22. (Washington, D.C.: Government Printing Office.) 5 cents.

Chemical Industry's Contribution to the Nation, 1635–1935: a Record of Chemical Accomplishment, with an Index of the Chemicals made in America. A Supplement to *Chemical Industries*, May 1935, published in celebration of the Tercentenary of the founding of the American Chemical Industry by John Winthrop, Jr. Pp. 176. (New York: *Chemical Industries*.) Paper, 1 dollar; cloth, 2 dollars.

Annuario della Reale Accademia d'Italia. 6: 1933–1934. Pp. 383+4 plates. (Roma: Reale Accademia d'Italia.) 25 lire.

Imperial College of Tropical Agriculture. Fourth Annual Report on Cacao Research, 1934. Pp. 87+4 plates. (Trinidad: Government Printer.) 5*s*.

Report on the Administration of the Government Museum and Public Gardens, Trivandrum, for the Year 1109 M.E. Pp. 13. (Trivandrum: Government Museum.)

Comptes-rendus des Travaux du Laboratoire Carlsberg. Vol. 20, No. 11: Studies on Enzymatic Histochemistry, 9–13. By D. Glick, Heinz Holter, K. Linderstrøm-Lang and A. Sœborg Ohlsen. Pp. 127+1 plate. (Copenhague: H. Hagerup.) 6.75 kr.

Survey of India. Geodetic Report 1934. Pp. xii+143+32 plates. (Dehra Dun: Survey of India.) 3 rupees; 5*s*. 3*d*.

Svenska Linné-Sällskapets Årsskrift. Årgång 18, 1935. Pp. v+172. (Uppsala: Almquist and Wiksells Boktryckeri A.-B.)

Union of South Africa: Department of Mines. Geological Series, Bulletin No. 3: Gypsum in the Union of South Africa. By Dr. B. Wasserstein. Pp. 35. 1*s*. Geological Series, Bulletin No. 4: The Travertine Deposits near Port St. Johns. By Dr. W. Kupferburger. Pp. 15. 6*d*. (Pretoria: Government Printer.)

Straits Settlements. Annual Report of the Director of Gardens for the Year 1934. By R. E. Holttum. Pp. 9. (Singapore: Government Printer.) 50 cents; 1*s*. 2*d*.

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1934. Pp. 12. (Entebbe: Government Printer.) 1*s*.

Annuaire de l'Académie Royale de Belgique, 1935. Pp. 138+4 plates. (Bruxelles: Académie Royale de Belgique.)

Observatoire de Zi-ka-wei. Annales de l'Observatoire de Zô-Sè (Chine). Tome 20: Coopération de l'Observatoire de Zi-ka-wei à la Révision International des Longitudes, Octobre-Novembre 1933. Par R. P. Pierre Lejay, R. P. Maurice Burgaud, R. P. E. de la Villemarqué. Pp. 99+5 plates. (Sung-kiang: Observatoire de Zô-Sè.)