THURSDAY, SEPTEMBER 13, 1906.

THE PHENOMENON OF "DEAD-WATER."

The Norwegian North Polar Expedition, 1893–6. Scientific Results. Vol. v. On Dead Water. By V. Walfrid Ekman. (London: Longmans, Green and Co., 1906.) Price 20s. net.

ON August 29, 1893, the *Fram* was steaming in smooth and open water between the isle of Taimur and Almquist Islands; towards evening she approached thick ice in order to make fast to it. A very slight current was observed as she neared the ice, but the vessel made extremely slow progress, and the speed was reduced to 1 or 1½ knots, although the engines were working at full power, which would have given a speed of 4½ to 5 knots in ordinary circumstances. Nansen's journal attributed this singular behaviour to the *Fram* having "got into *dead-water*"—a condition which has been frequently met with by ships navigating the Norwegian fiords, and occasionally encountered elsewhere. Nansen consulted Prof. Bjerknes (in 1898) on the subject, and that gentleman suggested the explanation that "in the case of a layer of fresh water resting on the top of salt water, a ship will not only produce the ordinary waves at the boundary between the air and the water, but will also generate invisible waves in the boundary between salt water and fresh water; . . . the great resistance experienced by the ship being due to the work done in generating these invisible waves." After some discussion between Nansen and Bjerknes it was decided to make a rigorous experimental investigation; the work was entrusted to Dr. Ekman (assistant in the Central Laboratory for the International Study of the Sea at Christiania). Its history and results are recorded in the remarkable memoir under review, which occupies the greater part of the volume in which it appears, and forms an important item in the scientific results of the North Polar Expedition.

Dr. Ekman's memoir must be closely studied before its full merits can be appreciated. It contains an excellent summary of the present state of knowledge in regard to the resistance offered by water to the motions of ships, and deals in great detail with the wave-phenomena attending these motions through homogeneous fluids and through layers of different densities. The mathematical and experimental works of Scott Russell, W. Froude, Stokes, and Lamb are laid under contribution, and it is demonstrated that Prof. Bjerknes's suggestion furnishes a reasonable explanation of the phenomena of "dead-water." A great body of testimony regarding these phenomena is brought together from logs, journals, and letters of experienced seamen, who confirm the observation made by Nansen in the *Fram*, viz. that ships encountering a layer of fresh water or brackish water superposed on sea water of greater density do experience greatly increased resistance, lose in speed, and not infrequently become unhandy, not answering their helm. These results obtain when vessels are moving at very low speeds before they "get into dead-water"; they are much more frequently seen in sailing vessels than in steamers, and occur in the estuaries of rivers, straits, fiords, or other situations where fresh water accumulates. Sometimes ships get into dead-water when considerable currents are seen on the surface; at other times there is little or no current. In some cases the depth of fresh or brackish water has been less than the draught of the ship, and in others greater. Ships get into dead-water suddenly, and may become free again as suddenly. Any change of condition in the surrounding water, such as the passage of another vessel near the ship "in dead-water," or a sudden alteration in the speed of a ship, tends to destroy the "drag" of dead-water and to set the vessel free. Steamships possessing capacity for high speed may get into dead-water when moving very slowly, but have no difficulty in freeing themselves by using the engine-power in reserve. Sailing ships, or auxiliary steamships like the *Fram*, have not the same command of speed. It will be seen, therefore, that the elucidation of the problem has scientific rather than practical interest, but from the scientific side the experiments of Dr. Ekman deserve and will receive close study by all interested in ship propulsion and hydrodynamics. The experiments were necessarily made on a small scale, the larger model ships used being only one-hundredth of the full size (1 : 100). Dr. Ekman acknowledges the drawbacks unavoidable with such small models, and there is no need to dwell further upon the point; but great interest would attach to the performance of experiments of a similar character on a larger scale in experimental tanks now existing in this country and abroad, wherein the methods introduced by William Froude are followed and developed.

One cannot speak too highly of the extreme ingenuity and care bestowed by Dr. Ekman on these experiments, their numerical and photographic records, and the detailed analysis of results. The illustrative diagrams appended to the memoir are valuable and suggestive, and the broad conclusions reached command acceptance. A singularly close agreement is reached between the experimental results obtained with models and the observations made by Nansen in the *Fram*. The enormously increased resistance and loss of speed are shown to be fully accounted for by the energy expended in forming an invisible wave series at the boundary of fresh and sea water. This would hardly appear probable at a first glance. Supposing the speed of the *Fram* to have been diminished from 4½ to 1½ knots, the resistance at the lower speed in dead-water must have been about nine times as great as that when the *Fram* moved at the same speed in sea water of considerable depth. In the latter circumstances it is well known that nearly the whole resistance would be accounted for by friction of water against the bottom, and a very small part by wave making, as there would be little surface disturbance at so low a speed. These considerations make the results obtained by Dr. Ekman the more remarkable, and it is worth notice that even when a ship is "in dead-water" the disturbance of the upper surface may be very small, although that at the boundary

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between fresh and sea water may produce a large proportionate increase in resistance.

There are many other matters of interest that cannot be mentioned in the space available. The parallel drawn between resistance in shallow water and in layers of different densities is most suggestive. The determination of the critical speeds at which the influence of dead-water rapidly diminishes or disappears and the accompanying changes in the wave-phenomena are of great interest. On the whole Dr. Ekman is to be congratulated on his work on an obscure problem that has puzzled many persons; Prof. Bjerknes on his prescience in suggesting the solution and his selection of so capable an investigator; and Dr. Nansen on having decided to get to the bottom of the phenomena of "dead-water." It may be hoped that the subject will not be overlooked by other investigators possessing facilities for experiments on a larger scale.

W. H. WHITE.

SEGREGATION AS A FACTOR IN EVOLUTION.

Evolution, Racial and Habitudinal. By Rev. John T. Gulick. Pp. xii+269; three plates. (Washington: Carnegie Institution, 1905.)

MORE than fifty years ago Mr. Gulick collected snails on the island of Oahu, and was impressed and puzzled by the fact that each valley seemed to be inhabited by peculiar forms. "Valleys only a mile apart were occupied by distinct varieties, and often by distinct species." The more facts he accumulated the more puzzling did they appear, and a perusal of the "Origin of Species" left his riddle unread. In many cases of divergence diversity of sexual selection cannot be the cause; in the case of snails this hardly requires proof. In many of the same cases diversity of natural selection cannot be the cause, because in many cases the divergence is not in proportion to the degree of environmental difference, because the divergence is sometimes non-utilitarian, and for other reasons.

Gradually Mr. Gulick was led to the position, with which his name is honourably and familiarly associated, that isolation itself, by preventing all chance of crossing with the original stock, may open the way for new habits, for new forms of selection, and, in short, for new species. He believes that no process of natural selection, or of sexual selection, or of any other form of selection, can transform one species into two or more species without the prevention of free crossing between the branches that are thus transformed. "Isolation is an essential factor in the production and maintenance of divergent types." Segregation in particular, *i.e.*, the intergeneration of like with like, with the prevention of crossing between unlike groups, is one of the fundamental factors in the formation, continuance, and control of divergent types. To substantiate and develop this thesis is the aim of the present bulky volume, the full title of which should read, he tells us, "Habitudinal and Racial Segregation; or the origin and intensification of organic types, guided by innovation and tradition acting under segregate association, and established by variation and heredity acting under segregate intergeneration"!

Mr. Gulick distinguishes *racial* (or *aptitudinal*) segregation, produced by the intergeneration of individuals with like *innate* characters, from *social* (or *habitudinal*) segregation produced by the association of individuals with like *acquired* characters, but these two "spheres of evolution" interact. Hereditarily similar forms draw together, and we have "racial segregation"; modificationally similar forms draw together and we have "habitudinal segregation." Each of these is "controlled by two principles." The former is controlled by racial demarcation through *isolation*, and racial intensification through *survival* (in its two forms, selection and indiscriminate elimination). The latter is controlled by habitudinal demarcation through *partition*, and habitudinal intensification through *success* (in its two forms, *election* and indiscriminate failure). "We have, therefore, four main principles cooperating in the production of segregate types, namely, partition, success, isolation, and survival." All this sounds very "wordy," but it need hardly be said that the author illustrates his new distinctions by concrete instances. And, after all, the terms are of less importance than the analysis of the modes of segregation which they express.

Partition (P), acting on acquired characters, produces habitudinal demarcation with initial habitudinal segregation; election (E), acting on acquired characters, produces intensified habitudinal segregation; isolation (I), acting on inherited characters, produces racial demarcation with initial racial segregation; selection (S), acting on inherited characters, produces intensified racial segregation; but we must refer the reader to the book to see what is produced when P and E, I and S, P and I, E and S, respectively work together. The interaction of the principles of segregation is illustrated, *inter alia*, by the Tarpon Island cats, quoted from the New Orleans *Times-Democrat*, which wade freely off the beach, and even swim out to the oyster boats.

Moreover, as to P, E, I, and S, each has its *reflexive* mode, produced by the action of the members of the species upon each other, and its *environal* mode, determined by the relations between the environment and the species; also its *regressive* aspects, caused by the cessation or reversal of the influence that has been ruling; and its *indiscriminate* aspects. There may be *conjunctional* P, E, I, and S; *sexual* forms of S, E, and I; *social* forms of P, E, I, and S. Moreover, under the environal mode of each principle, the relations between the group and its environment may be determined by conditions within the group (*endonomic* P, E, I, or S), or they may be determined chiefly by conditions lying outside of the group (*heteronomic* P, E, I, or S), Eleven forms of P, eleven forms of E, fifteen forms of I, and twenty forms of S are duly distinguished and defined, and we begin to feel that the grammar of evolution is not easy. Altogether twenty-one forms of segregation are found in natural species, and to these must be added institutional segregation and eight forms of intensive segregation found to occur in man.

Is it possible to state the gist of the contribution which the almost too analytic author has to make? Like draws to like; animals with similar acquired characters tend to come together and keep together in habitudinal segregation; "isolation" and "selection" in their varied forms work on inborn variations, and the habitudinal segregation is replaced by a stabler racial segregation. Segregate breeding, fortified by physiological and psychological incompatibilities, results in divergent evolution. "The whole process of bionomic evolution, whether progressive or retrogressive, whether increasingly ramified and divergent, or increasingly convergent through amalgamation, is a process by which the limitations of segregate breeding are either set up and established or cast down and obliterated." It is of value that all the various possibilities and actualities of segregation should be analysed out and illustrated as Mr. Gulick has so painstakingly and ingeniously done; and another great merit of the book is the insistence on the fact that, even in the case of invertebrate animals, members of the same species, exposed to the same environment in isolated groups, will often arrive at divergent methods of dealing with the environment, and so subject themselves to divergent forms of selection. Just as the social group may learn to determine its own social evolution, so, Mr. Gulick maintains, justly, we think, that the animal is in some measure master of its fate, and that changes in the organism are not controlled in all their details by changes in the environment. We are too much given to ranking the environment always first and the organism second; Mr. Gulick thinks this is putting the cart before the horse; and in this insistence on *active* or *endonomic selection,* he does not stand alone. For, as he says, there has been during the past ten or fifteen years an increasing recognition of the fact that not only sexual selection but other autonomic factors are more or less effective in controlling the forms of selection, and, therefore, in controlling the transformations of organisms. Do we not thus reach one explanation of the continuous advance—the determinate evolution—of certain large classes of animals? The recognition of autonomic factors in the process of evolution is giving new insight into the self-developing endowments of the organic world. In conclusion, we must direct special attention to the fact that Mr. Gulick's contribution to our understanding of the intricate factors of evolution is all the more valuable that he rises from biology to sociology—from the Hawaiian snails to Man himself.

J. A. T.

ENTOMOLOGICAL STUDIES.

The Hope Reports. Vol. v., 1903–6. Edited by Prof. E. B. Poulton, F.R.S. (Oxford: Printed for Private Circulation by Horace Hart, 1906.)

THIS is a substantial volume, some hundreds of pages being occupied by prints of papers contained in the Transactions of the Entomological Society of London or by prints of that society's proceedings, one, however, being of a paper in French contributed by Prof. Poulton to the "Annales de la Société Entomologique de France." These prints comprise a useful *résumé* of recent papers and discussions at the meetings of the English Entomological Society during the last three years on bionomic subjects, as well as the two presidential addresses of Prof. Poulton to that society on the questions, "What is a Species?" and "Are Acquired Characters Hereditary?" and in this and in other ways they deal with many matters of extreme interest to naturalists generally. These prints are followed by the reports proper, belonging to the great Hope collection, one for each of the years 1903, 1904, and 1905, occupying together nearly 160 pages. They tell a story of expansion, classification, and orderly rearrangement, all on an extensive scale. It is satisfactory to learn that the very considerable work which this entails is making great progress, and that, with the voluntary assistance so liberally given by competent persons in the different departments, the task of overtaking arrears is being rapidly pursued. The time seems not far distant when, notwithstanding the labour involved in disposing of the immense numbers of new specimens flowing in from various sources, there will be little wanting and much to approve in the Hope Museum as a reference and self-explanatory collection. Very valuable service has already been rendered by it and its officers and staff as a consulting and educative authority for effective observation by entomologists proceeding abroad.

Incidentally, many interesting observations find a place in the reports bearing on matters which have recently engaged much attention; among these reference may be made to illustrations of the extent to which insects are attacked by vertebrate animals, as well as by those predaceous two-winged flies, the Asilids, which successfully attack the stinging Hymenoptera, as well as less formidable victims often much larger than themselves.

A large part of the report for 1903 is devoted to an account of the work done upon the immense Burchell collection presented in 1866 to the Hope Museum by the sister of the illustrious naturalist, including the preparation of a complete and efficient catalogue. In connection with this the interesting story is told of the discovery, as the result of a lecture given by Prof. Poulton at Cape Town, of a portion of Burchell's original journal written in his ox waggon.

South Africa has been in so many ways disappointing that it is pleasant to find evidence in the "Hope Reports" of its extraordinary value to zoological science. Prof. Ray Lankester, in his recent address as president of the British Association at York, has told us that the study of insects, especially of butterflies, is one of the most prolific fields in which new facts can be gathered in support of Darwin and new views tested. It is not, therefore, surprising that many pages of the reports are devoted to butterflies, and to the numerous examples they furnish as to the magnitude and extraordinary character of the different kinds of variation they present, especially those from South Africa, differences in size, form, colour, and habits between parents and offspring and between offspring *inter se*, and the association of some of these differences with differing seasons and climates. Many large additions exhibiting striking variations of these kinds are recorded in the descriptions given of collections of butterflies received from South Africa, so wonderfully rich in these varied forms, as well as from New Zealand, the islands of the Indian Ocean, and elsewhere.

Special arrangements made at the museum for the study and illustration of mimicry in various orders of insects are described. All the orders receive attention and study there, and with such an affluence of contributors from all parts of the world, with the aid of the numerous willing and capable helpers to whom Prof. Poulton heartily acknowledges the obligations that science owes them, and with the enthusiastic and intelligent interest in the subjects that manifestly prevails in every department of the institution, the Hope Museum is plainly pursuing a career that is rendering it of great and increasing scientific value.

F. M.

OUR BOOK SHELF.

Insect Pests of the Farm and Garden. By F. Martin-Duncan. Pp. vii+143; illustrated. (London: Swan Sonnenschein and Co., Ltd.) Price 2s. 6d. net.

THIS little book appears in the Naturalists' Library Series. It deals with a number of common insects that are destructive in the field and garden, and at least one *rare* one. The printing and illustrations are good on the whole, and it is clearly and interestingly written. There are, of course, printer's errors, such as Br*a*chus for Bruchus, Ce*n*torhynchus for Ceutorhynchus, ov*ae* for ova, &c. A few illustrations are scarcely recognisable, such as that of the codling moth (Fig. 38), the currant gall mite, and the gooseberry red spider (the currant mite, evidently copied from the Board of Agriculture leaflet, being particularly poor, and quite unlike the actual acarus).

When one reads the part dealing with treatment the impression is at once formed that the author is not only not practically acquainted with the subject, but is not *au fait* with any up-to-date work. No mention is made of the most important insecticides, &c., such as arsenate of lead, which is superseding Paris green, caustic alkali wash, bisulphide of carbon, &c., whilst many of the receipts given are quite out of date.

Such advice as picking up maggotty apples, the cleaning of hop poles, and burning the bine, &c., will scarcely meet with the approval of farmers, and is certainly not necessary. One does not now see many hop-poles about to clean. Nothing up to date is given concerning wireworm, whilst, on the other hand, people are cautioned against having animals and fowls in orchards sprayed with Paris green; the author evidently knows nothing of the experiments carried out which show that we can safely keep stock of all kinds in the orchards even when they are actually being sprayed.

Some of the scientific names used are wrong; that of the celery fly is not *Tephritis onopordinis*; the names of the diamond-back moth and the red spider of hops are also wrong.

The work has evidently not been compiled from sufficiently up-to-date material to recommend it to the notice of practical men, and there is nothing new in it of scientific value.

Elementary Electrical Engineering in Theory and Practice. By J. H. Alexander. Pp. xii+208. (London: Crosby Lockwood and Son, 1906.)

IT is difficult to find much in this book to recommend. It is evidently not intended for the higher classes of students or engineers, but this fact is scarcely sufficient to warrant an entire absence of logical sequence or method in the arrangement of the material. The scope of the book is far too wide, taking in as it does fundamental principles, measuring instruments, electrical machinery, batteries, cables, transmission, and generating stations.

Such a wide range compressed into two hundred pages must inevitably lead to a superficial grasp of the subject. For instance, what can be the utility of such a paragraph as the following?

"Storage cells are always fixed up in a separate room. Brickwork or stone, laid in cement and concrete, are used for the foundations for the machinery. The coal bunkers should allow of a store of coal supply for three or four weeks."

The author would be well advised to concentrate his attention on one of the sections mentioned above instead of attempting to include in a single volume so much that cannot adequately be treated in so small a space.

Immanuel Kants Grundlegung zur Metaphysik der Sitten. Dritte Auflage. Edited by Karl Vorländer. Pp. xxx+102. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1906.) Price 1.40 marks.

THIS is the third edition of one of Kant's best-known works in the excellent series of the Philosophische Bibliothek. The introduction contains a well-informed account of Kant's occupation with ethical subjects between the years 1764 and 1785, and of the interest excited by the publication of the "Grundlegung." The text is based on the best authorities, and variant readings are added in the footnotes. A full index of names and subjects completes the volume.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Mixed Transformation of Lagrange's Equations.

RETURNING to Padua after a month's absence, I read in NATURE of August 2 (p. 317) a letter by Mr. A. B. Basset on "The Mixed Transformation of Lagrange's Equations."

The letter begins:—"I should fancy from the review by 'G. H. B.' in NATURE of July 19 (p. 265) that the papers of Prof. Levi-Civita relate largely to the *mixed* transformation of Lagrange's equations, the complete theory (Proc. Camb. Phil. Soc., vol. vi., p. 117; 'Hydrodynamics,' vol. i., p. 171) of which was first given by myself so far back as 1887"; it is then shown that the *mixed* form of Lagrange's equations may be obtained in the most simple way through an elegant artifice of elimination.

The words here quoted give the impression that my papers deal principally with the announced theory, and that they may be little more than the reproduction of some previous papers by Mr. Basset. I wish, however, the readers of NATURE to know—and Mr. Basset will be the first to recognise the fact—that the case is quite different. The papers in question (as it appears from the general title, "Sur la Recherche de Solutions particulières des Systèmes différentiels et sur les Mouvements stationnaires," and as it seems to me to result also from the review by

"G. H. B.") are essentially dedicated to the *effective research* of particular solutions of dynamical equations. Not a word is said of transformations, *mixed* forms, &c., and ignoration of coordinates is mentioned only in the preface, because this was Routh's point of view in defining and studying the stationary motions.

T. LEVI-CIVITA.

University of Padua, August 29.

I DO not recollect by whom the phrases "ignoration of coordinates" and "ignored coordinates" were originally introduced, but on consideration I am of opinion that they are singularly inappropriate ones, and I much prefer the phrase "kinosthenic coordinates."

The advantages of the mixed transformation are that, whenever a generalised momentum is known to be constant the motion can be determined without knowing anything about the coordinate or the velocity corresponding to this momentum. The first trace I can find of this idea is contained in a paper published by Lord Kelvin about 1872 (see "Hydrodynamics," vol. i., p. 177).

The discovery of the mixed transformation was the result of certain hydrodynamical investigations relating to cyclic irrotational motion, but the circumstance that I originally published it in a hydrodynamical form may have obscured the character of the result as a general theorem of dynamics.

A. B. BASSET.

September 4.

The alleged Triassic Foraminifera of Chellaston, near Derby.

IN NATURE for July 26, in a notice of Mr. Fox-Strangway's memoir on the Loughborough district, reference is made to certain Foraminifera of Liassic type, at one time believed to come from the local Trias. Prof. Rupert Jones, F.R.S., has kindly directed my attention to his explanation of the matter in the "Foraminifera of the Crag," part ii., p. 161, published by the Palæontographical Society in 1895. He there gives a history of the observations, including personal inquiries, and believes that the Foraminifera in question came from Liassic clay in Leicestershire, which was "inadvertently thrown in with the 'red clay' on its journey to Cubitt's works in London." Mr. Fox-Strangways gives a reference to this passage, but does not quote it, and suggests on his own part that the Foraminifera may have come from Liassic material in the drift.

GRENVILLE A. J. COLE.

White- and Brown-shelled Eggs.

BIRDS which lay their eggs in comparatively unprotected places and in a hollow in the ground, as is the case with the pheasant, partridge, jungle fowl, &c., always lay coloured eggs closely resembling in tint the colouring of their surroundings. White-shelled eggs are laid only by birds which make a good nest—those which make it in a secluded spot, or which take the precaution of covering their eggs with leaves, &c., when they are off the nest. It is a strange fact, therefore, that the non-sitting breeds of our domestic fowls lay white-shelled eggs, whereas in the eggs of the sitting or Asiatic breeds the protective colouring is retained in the shell of the egg. This loss of colour cannot be merely the result of centuries of domestication, or all breeds of domestic fowls would lay white-shelled eggs. The systematic repression of the maternal instincts of the hen carried on by man for a number of years has certainly produced the white-shelled egg. It would almost appear to be the case that the hen, knowing she will have nothing to do with the hatching and rearing of the chicken in the egg, loses all interest in the egg, and leaves it, as it were, to its fate. For this reason she neglects in some mysterious way to impart to the shell the protective colouring which is so necessary, in a state of nature, for the preservation of her race. If this be really the case there is an insurmountable obstacle in the way of obtaining brown eggs from the non-sitting breeds of domestic hens, and poultry keepers are only wasting time in trying to accomplish the impossible.

L. M. F.

FLASHLIGHT PHOTOGRAPHS OF WILD ANIMALS.

FROM the popularity of his well-known work "Mit Blitzlicht und Büchse" (or its English translation, "With Flashlight and Rifle"), there is, we believe, a very general impression that Mr. C. G. Schillings was the pioneer in the practice of photographing big game animals by night in their native haunts by combining the use of the flashlight with the camera. It appears, however, from a most interesting and profusely illustrated article in the July number of the *National Geographic Magazine* that the true claimant to this position is an American sportsman, the Hon. George Shiras. With regard to his position in the matter of flashlight-photography, Mr. Shiras writes as follows:—

FIG. 1.—A White-tailed Deer watching a light on bushes in the distance. From the *National Geographic Magazine*.

"While a number of the present illustrations were taken in the daytime, this method of photography is now so well known that I will not attempt to describe such pictures in detail; but in view of the fact that I was the first to attempt flashlight pictures of wild game, and for the first fifteen years was the sole occupant of this attractive field of photography, it may be of interest to the readers of this article to learn something about this rather odd way of picturing wild animals."

One of the author's most successful plans in the forests of North America was to mount his apparatus in the bow of a boat manned by a selected crew, and then to set forth in search of his quarry. Describing the photographing of a deer the presence of which has been made known by the light reflected by his eyes, the author writes that "The flashlight-apparatus has been raised well above any obstructions in the front of the boat, the powder lies in the pan ready to ignite at the pull of a trigger; everything is in readiness for immediate action. Closer comes the boat, and still the blue translucent eyes watch it. . . . Suddenly there is a click, and a white wave of light breaks out from the bow of the boat—deer, hills, trees, everything stands out for a moment in the white glare of noonday. A dull report, and then a veil of inky darkness descends. Just a twenty-fifth of a second has elapsed, but it has been long enough to trace the picture of the deer on the plates of the cameras, and long enough to blind for the moment the eyes of both deer and men. Some place out in the darkness the deer makes a mighty leap; . . . and soon he is heard running, as only a frightened deer can."

A variation of the plan is to let the creature take its own portrait, and here again we may quote the author's own phraseology:—

"A string is passed across a runway or other point where the deer are likely to pass, which, when touched, sets off the trigger and ignites the magnesium powder. The same method can be used for daylight pictures, except that here a slender black thread is laid across the path, one end of which is attached to the shutter of the camera. The shutter revolves as soon as there is any pressure upon the thread, and a picture of any passing object is taken instantaneously. Not the least interesting part of this species of photography is that the operator does not know until he develops his plates what manner of beast, bird, or reptile has caused the shutter to open."

FIG. 2.—A Raccoon taking his own portrait. From the *National Geographic Magazine.*

Although many of the portraits thus obtained are not in every detail satisfactory to the naturalist, yet they frequently reveal the animal in characteristic and unsuspected attitudes, or display peculiar alarm-features, such as the expansion of the hairs of the light rump-patch of the wapiti revealed in one of the author's pictures. Such pictures are indeed especially valuable in the case of many of the smaller mammals, the nocturnal habits of which make it so difficult to become acquainted with their mode of life.

Whether photography—flashlight or otherwise—will, as the author and Sir Harry Johnston (in the introduction to the English edition of Mr. Schillings's book) hope, ever induce sportsmen to be satisfied with pictures instead of the lives of their quarry remains to be seen. R. L.

A SEARCH FOR A BURIED METEORITE.

THE mode of origin of a remarkable terrestrial feature, known as Coon Butte or Coon Mountain, has been the subject of much speculation and study, of which an account was given in the year 1895 to the Geological Society of Washington by Mr. Grove Karl Gilbert, of the United States Geological Survey, in a presidential address entitled "The Origin of Hypotheses."

This so-called mountain, situated in Central Arizona, rises only 130 to 160 feet above the surrounding plain. When climbed, it is found to contain a crater 530 to 560 feet deep, the dry bottom being thus 400 feet below the level of the land surrounding the rim. The crater is almost exactly circular, and is nearly three-quarters of a mile across, two diameters at right-angles with each other measuring 3654 and 3808 feet respectively. From the crest of the rim to a distance of about three and a half miles outwards the surface of the country is strewn with fragments of sandstone of various colours; for the first half-mile the fragments are large blocks, some of them of enormous size, 60 or even 100 feet in diameter; for the next half-mile the fragments are smaller and less plentiful; beyond this distance they are isolated from each other, and become smaller and less frequent as the distance from the crater increases.

In 1886 some shepherds encamped on the slopes of Coon Mountain found among the rock-fragments on the rim some lumps of iron, which they mistook, as is not infrequently the case, for native silver. The general distribution of the fragments and the nature of their material suggested to the shepherds that all the scattered masses, both stony and metallic, had been shot from the crater of the mountain. A few years later some of the metal fell into the hands of the late Dr. A. E. Foote, of Philadelphia, for whom it was analysed by Prof. G. A. Koenig, of that city. In structure and chemical composition the metal proved to be identical with ordinary meteoric iron, but of exceptional interest as enclosing microscopic diamonds. Since that time the celestial origin of the iron masses found about Coon Mountain has been recognised as beyond doubt, and the meteorite has become well known under the name of Cañon Diablo, small masses having been found in the cañon of that name distant about two and a half miles from the mountain. During the oral discussion which followed the reading of the paper of Dr. Foote on August 20, 1891, before the American Association for the Advancement of Science, Mr. Gilbert, who chanced to be present, suggested that the fall of the iron masses might have been connected with the formation of the crater, and that the large hole might have been caused by the penetration of the earth by an enormous iron meteorite, perhaps 1500 feet in diameter, large enough to be termed an asteroid. In such case the asteroid is buried in or near the hole and probably at no great depth.

Not being at that time at liberty to visit Coon Mountain himself, Mr. Gilbert asked his colleague, Mr. Willard D. Johnson, to examine the district and try to discover what had been the mode of origin of the crater. On his return Mr. Johnson reported that the crater had probably been produced by a tremendous steam explosion, the fragmental material around being the original contents of the hole. Within a radius of fifty miles there are hundreds of vents, from which lava has issued during the later geological periods, and thus there existed at one time a neighbouring mass of molten material sufficient to account for the production of the required amount of steam. In such case the fall of the masses of iron had been independent of the formation of the crater.

The rocks in the region containing the crater, however, are stratified and of sedimental origin, and the strata, except at the hole itself, are still quite horizontal. They are of late Carboniferous age, and consist, to a considerable depth, of coloured sandstones, one kind being so calcareous as to have claims to be regarded as a limestone. But all round the hole itself the strata have been bent, and are now directed upwards, approximately towards the same point.

This explanation and report being of an extraordinary character, Mr. Gilbert's interest in the problem became even greater than before, and he soon seized an opportunity of making an examination himself. This was done with such minuteness that he was able to draw contour lines of the crater and district for every ten feet of difference of level, and could form an approximate estimate as to the positions of the contour lines at the time the crater had been formed; hence he was able to calculate the respective volumes of the crater and the fragmental material. He came to the conclusion that the two volumes were virtually equal (eighty-two millions of cubic yards), and thus that no asteroid could have buried itself there. Further, he made a delicate magnetic survey of the district; no magnetic disturbance being discoverable, he concluded that no mass of iron large enough to have produced the crater could be lying within some miles of the earth's surface, whereupon he renounced the asteroidal hypothesis, and accepted the explanation which had been given by his colleague.

Some years later the crater and the speculations as to its origin became known to Mr. D. M. Barringer and Mr. B. C. Tilghman. They formed the opinion that the asteroidal hypothesis had been renounced by Mr. Gilbert on insufficient grounds. In the first place, according to their calculations, there is a great difference between the volume of the crater and that of the fragmental material; in the second place, the absence of magnetic disturbance may be due to the asteroid having been broken up into smaller masses, each of them polarised, and each having its magnetic axis in an accidental direction. So convinced were they that in 1903 they "located" the mountain under the United States Mineral Land Laws, and at great expense proceeded to sink shafts and make bore-holes with the hope of finding the buried asteroid. The results of this work, so far as it has yet gone, were recently recorded in two papers published in the Proceedings of the Academy of Natural Sciences of Philadelphia (December, 1905). One of them has been written from the point of view of the geologist (Mr. Barringer), the other from those of the physicist, chemist, and mathematician (Mr. Tilghman). The former says:—"They do not leave in my mind a scintilla of doubt that this mountain and its crater were produced by the impact of a huge meteorite or small asteroid"; the latter feels that "he is justified, under due reserve as to subsequently developed facts, in announcing that the formation at this locality is due to the impact of a meteor of enormous and unprecedented size."

It may be mentioned that a few years ago a successful search was made by Finnish geologists for a large meteorite which was believed by them to have buried itself within a certain area. But in that case the presumptive evidence was very strong. A meteor had lighted up a large extent of the country, and the next morning a newly made hole, with cracks radiating from it in various directions, had been found in the ice covering the Baltic Sea, near Bjurböle, in Finland. After a patient search the mass was at last located at a considerable depth below the sea-bottom, and eventually extracted. What are the prospects of a similar success at Coon Mountain?

For many miles round the crater the order of succession of the rocks, beginning at the surface, is as follows:—

(1) Red sandstone, 20 to 40 feet thick.
(2) Yellowish (calcareous) sandstone, 200 to 350 feet.
(3) Whitish sandstone, probably 400 to 500 feet.
(4) Yellow sandstone, thin layer.
(5) Reddish-brown sandstone, more than 1000 feet.

The uppermost stratum has been largely eroded, and remains only as widely separated flat-topped buttes scattered about the plain.

This upper stratum of red sandstone still existed at the place at the time when the crater was formed, for it is the material of the upper part of the rim. It has been raised 140–180 feet above its original position. The upper part of the interior of the crater consists of sandstone cliffs, the lower part of talus. The lower portion of the latter is covered with horizontally stratified sediments having a total thickness of 60–100 feet and a nearly level upper surface of circular outline and 1800 feet in diameter. The material must have settled in a shallow fresh-water lake once occupying the crater.

The fragmental material of the rim consists of the débris of the strata in which the crater has been formed, the blocks being piled one upon another in the utmost confusion. Further, there are many millions of tons of pulverised sand-grains, much of the material being an impalpable powder. It constitutes a great part, not only of the rim, which is three miles in length round the base, but also of the bottom of the crater, for it has been found by means of bore-holes to extend to a depth of more than 850 feet.

The masses of meteoric iron, being of pecuniary value as specimens, have been much sought for, and masses small and large, amounting altogether to about fifteen tons, have been found among the upper blocks on the rim, and on or near the surface of the surrounding plain in all directions from the crater; none have been found within the latter. Several masses weigh from 600 lb. to more than 1000 lb. Mr. Gilbert states that some of the iron has been found outside the range of the rock débris, one large mass being as much as eight miles distant from the crater. There have also been found lumps of oxide of iron, in great quantity and having a similar distribution to that of the metal. Mr. Gilbert (and also Dr. Foote) regarded them as also being of meteoric origin, and as perhaps having resulted from the weathering of a particular constituent of the meteorite, namely, the protosulphide of iron; but Mr. Barringer and Mr. Tilghman have found that they contain much nickel, and that many of them consist internally of magnetic oxide of iron, sometimes itself containing a nucleus of meteoric iron. Mr. Barringer, like Dr. Foote, suggests that the magnetic oxide resulted from the combustion of the iron when the meteorite was travelling through the air, but in the opinion of the present writer all the oxide, magnetic or not, is a result of weathering. There has been plenty of time for this action, for cedars now 700 years old are growing on the rim of the mountain. Further, the masses of iron found on the surface of the plain must have penetrated the earth to some depth at the time of the fall, and have been since exposed by denudation of the penetrated material. The authors roughly estimate the fall to have taken place not more than 5000 years ago, perhaps much less.

Though all the masses of iron found in the rim have been got from the surface, lumps of the meteoric oxide have been met with to a depth of 27 feet, and this is of interest because some of them were lying beneath big blocks of sandstone, through which, whether as metal or as oxide, they could not have passed. They must have taken up their present positions at the same time as the blocks themselves. To the present writer it seems probable that they had been buried, possibly a long time, in the upper layers of sandstone, and were ejected with the rock-fragments when the crater was formed, but Mr. Barringer explains them as fragments which had been broken from the asteroid during its passage through the air, had diverged from the path of the meteor, and had while still burning become entangled, and afterwards smothered, among the blocks of sandstone and minute débris projected into the air through the penetration of the earth by the main mass.

As for the enormous amount of pulverised silica, the authors hold that it cannot have been produced otherwise than by the action of an enormous projectile penetrating the sandstone. But it is difficult to see why the crushing of the grains could not have been produced by an enormous pressure of steam, such as must have preceded, according to Mr. Johnson, the formation of the crater. The following remark made by the late M. Daubrée was published by him in 1879, before Coon Mountain had been heard of, and is also suggestive ("Géologie Expérimentale," part ii., p. 645):—"In the deep and hot portions of the globe, for instance in volcanic reservoirs, water is present under enormous pressure. The pressure of that which forces lava up to the summit of Mt. Etna must certainly exceed 1000 atmospheres. It is therefore quite comparable with the tension developed in the chamber in which these experiments have been made. When water escapes to the surface by narrow fissures in such circumstances, it must bring different substances into a state of pulverisation simulating that of volatilisation."

Two other observations are relied on by the authors in their support of the asteroidal hypothesis. According to the first observation, obstacles at a great depth and probably of small size were found to interfere with the boring. They were inferred, chiefly from their hardness and from the difficulty of removal of a magnet let down to the bottom of the bore-hole, to be probably metallic iron, and to be parts of the broken asteroid. But the presence of some small masses of iron beneath the crater is to be expected if all the masses were lying embedded in the sandstone before the crater was formed. Those which were projected nearly vertically upwards must have fallen back into the large hole and be deep down among the débris. According to the second observation, a stratum at a considerable depth contains small particles of oxide of iron thought to be of meteoric origin. The same kind of material is said to occur on the surface of the surrounding country for several miles. The material in which these small particles of oxide are distributed in the crater must either be *in situ* or have fallen back into the hole: in the former case they cannot be of meteoric origin, for small particles would not have had the requisite penetrative power; in the latter case, it is probable that they were lying near the surface before the steam-explosion, and fell back with the fragmental material into the hole.

It is found as a matter of experience that meteorites on striking the ground have a comparatively small velocity—only a few hundreds of feet a second. Is it possible that an asteroid after passing through the earth's atmosphere could retain a velocity large enough for the production of such a crater? Applying a method devised by Schiaparelli and numerical data obtained from artillery experiments, the present writer has made some calculations as to the velocity of a meteoritic ball on reaching the ground, the ball being supposed to have a specific gravity seven times that of water, to have entered the earth's atmosphere at a speed of fifty miles a second, and to have travelled vertically. Neglecting the small additional velocity due to the action of gravity for the few seconds of flight, and the diminution of size of the ball during the flight, the numbers are as follows:—

Radius of ball in metres	Final velocity in metres
0·1	21
1·0	694
10·0	2590
100·0	8261
1000·0	25,461

According to Mr. Gilbert, it has been found in artillery experiments that a spherical projectile striking solid limestone with a velocity of 1800 feet a second will penetrate to a depth of something less than two diameters. It would appear, then, that a meteorite of large size would not be prevented by the earth's atmosphere from having a penetrative effect sufficient for the production of such a crater.

L. Fletcher.

PROF. H. MARSHALL WARD, F.R.S.

IT is long since the cause of British botany has sustained so severe a loss as that from which it is now suffering by the deaths, within a few days of each other, of Charles Baron Clarke and of Harry Marshall Ward. Though differing widely in most respects, in age, in pursuits, in circumstances, yet this they had in common, high distinction in their respective lines of work and a long record of devoted and unremitting toil. It is not for me to attempt an appreciation of Clarke—that will be done by more competent hands—but I cannot forbear this slight tribute of esteem and regard. Nor is it possible for me, within the limits of space and time at my disposal, to give an at all adequate account of Ward's life and work. I can only aim at recalling some of the memories of a personal association at one time most intimate, at no time entirely severed, and at merely indicating the scope and the value of his achievements.

My acquaintance with Ward dates from the year 1875. In the spring of that year I was assisting Sir William Thiselton-Dyer at the Royal College of Science, South Kensington, in the conduct of a course of instruction in botany, one of the earliest courses of practical study, in the modern sense, ever given in this country. We were both struck by the singular intelligence and enthusiasm of one of our pupils, who, we felt, ought to be secured for the service of botany. That pupil was Ward. At our suggestion he became a candidate, in the spring of 1876, for an open scholarship in natural-science at Christ's College, Cambridge, where I was a lecturer, and, having obtained the scholarship, he came into residence in October of that year. His undergraduate career was marked by a further development of those characteristics that had so impressed Sir William Thiselton-Dyer and myself at South Kensington. Under considerable difficulties, the practical teaching of botany was being established in the University; but whatever the shortcomings of the instruction, they were amply compensated by the earnestness of the students, who, besides Ward, included Prof. Bower, F.R.S., of Glasgow; Dr. Hill, Master of Downing College; Prof. Hillhouse, of Birmingham; Dr. Walter Gardiner, F.R.S., and others. However, Ward did not confine himself to the study of botany, but availed himself to the full of the excellent opportunities for acquiring a sound knowledge of physiology under Sir Michael Foster, and of comparative anatomy under the late Prof. F. M. Balfour. A first-class in the natural sciences tripos of 1879 was a fitting close to his undergraduate days at Cambridge.

After taking his degree Ward went abroad for purposes of study, and worked for some time under the late Prof. Sachs at Würzburg; but the respite from botanical duty was not long. In 1880 he was called upon, as cryptogamic botanist to the Government of Ceylon, to go out and investigate the coffee-leaf disease then ravaging the island, a difficult task that he accomplished with considerable success. On his return, in 1882, he was elected Berkeley fellow at Owens College, Manchester, and became assistant to the late Prof. Williamson, F.R.S. Here he laboured for three years, and did much to promote the growth of the botanical school, leaving Manchester in 1885 to become professor of botany in the forestry department of the Royal Indian Engineering College, Coopers Hill. In the meantime (1883) he had been elected a fellow of his old college at Cambridge. For ten years he remained at Coopers Hill, throwing himself with his habitual energy into the life of the place, until in 1895 he succeeded the late Prof. C. C. Babington, F.R.S., as professor of botany in the University of Cambridge, becoming at the same time professorial fellow of Sidney Sussex College. In this larger and most congenial sphere he found full scope for the play of his activities in every direction. Supported by a highly competent staff, and with such colleagues as Mr. F. Darwin, F.R.S., reader in botany, Dr. Gardiner, F.R.S., and Mr. Seward, F.R.S., university lecturers, Ward soon succeeded, by his infectious enthusiasm, in giving a fresh impulse to the progress of his science at Cambridge. He himself always took charge of the large elementary class, and won therefrom many recruits for the ranks of botany by the attractiveness of his lectures; he gave besides one or more courses on advanced subjects during the year, generally, as might be expected, on some groups of fungi. His weak point as a teacher is eminently characteristic—it was that he generally attempted to cover a great deal more ground, to convey a great deal more information in his lectures, than was possible either physically or mentally. He educated many who have since done excellent botanical work, for he not only taught his pupils what was known, but also inspired them to attack the unknown. Under him the botanical school attained such importance that the University allotted a large portion of the benefaction fund to the erection of a new botanical institute, one of the best in the country, which, together with other university buildings, was formally opened by His Majesty the King in March, 1904.

So far I have spoken of Ward only as student and as teacher; I have yet to speak of him as investigator, his most important *rôle*. The bent towards original research was strong within him from the very first. His earliest papers date back to 1879 (Journ. Linn. Soc., vol. xvii.; Quart. Journ. Micr. Sci., vol. xx.), and relate to the embryo-sac, a subject that, owing to the brilliant discoveries of Prof. Strasburger and others, was at the time especially engaging the attention of botanists; but it was not until his visit to Ceylon that he entered upon what was to be his life-work, the investigation of the fungi and bacteria. The first fruits of his work there was a series of three elaborate reports on the coffee-leaf disease to the Colonial Secretary (1880–1), and a scientific paper on the fungus producing it (*Hemeleia vastatrix*), read before the Linnean Society on June 1, 1882 (Journ., vol. xix.); moreover, his experience in this case led him to form views on the physiology of parasitism that influenced all his subsequent work. However, when in Ceylon his attention was not so wholly absorbed by the coffee disease as to prevent him from making other observations, the results of which are embodied in a paper on the perithecium of Meliola, published in the Phil. Trans. of the Royal Society, 1883, and in another on a curious epiphyllous Lichen, *Strigula complanata*, that appeared in the Trans. Linn. Soc., vol. ii., 1884. After these, and two other papers on the Saprolegniæ and on Pythium in the Quart. Journ. Micr. Sci., vol. xxiii., 1883, there was for a time, owing to his transfer to Coopers Hill, a lull in the activity of publication, broken by the appearance in 1887 of two papers in the Phil. Trans., the one on *Entyloma Ranunculi*, the other on the tubercular swellings on the roots of *Vicia Faba*, of which the latter is of special interest. At this time the causation of these swellings and their relation to the nitrogenous nutrition of the plants bearing them was one of the leading problems of plant physiology. To the solution of this problem Ward's paper contributed the important facts that (1) the tubercles are undoubtedly of parasitic origin, and (2) that the parasite gains admission by the root-hairs, though he thought the parasite was a myceloid fungus, whereas it has since been proved to be a bacterium. The whole subject was admirably resumed by him in an article contained in vol. i. of the *Annals of Botany* (1887–8), of which periodical he was one of the founders. The same volume opens with a paper by him and Mr. T. Dunlop on the histology and physiology of the fruits and seeds of Rhamnus, perhaps one of the best of his researches, in which it is shown that the yellow pigment (rhamnin), obtained from the fruits for dyeing purposes, is formed by the decomposition of the glucoside (xanthorhamnin) contained in the pericarp by a ferment existing principally in the testa of the seed. In the second volume of the *Annals* (1888–9) there is an elaborate paper, "A Lily-disease," the chief point of interest being the discovery that the fungus (Botrytis) penetrates the cell-walls of the host by means of a ferment (since termed *cytase*) secreted at the tips of the hyphæ. Ward's views on parasitism were further developed in his paper "On some Relations between Host and Parasite in certain Epidemic Diseases of Plants" (Proc. Roy. Soc., vol. xlvii., 1890), which gained the honour of selection as the Croonian Lecture for that year. Passing over with mere mention the papers on Craterostigma (Trans. Linn. Soc., 1890) and on the Ginger-beer Plant (Phil. Trans., 1892), I come to his most laborious achievement, a series of reports on the bacteriology of the Thames, presented, in conjunction with Prof. Percy Frankland, F.R.S., to the Water Research Committee of the Royal Society in the years 1893–6. It is difficult to form any adequate conception of the unfailing assiduity necessary to the working out, as Ward did, of the life-histories of the no less than eighty different bacterial organisms that he found in the river, nor is it possible here to give an account of these voluminous documents, a *résumé* of which, so far as his share of the work is concerned, was given by him in the fifth report (Proc. Roy. Soc., vol. lxi., 1897). He had proved his fitness for this difficult task by his paper "On the Characters or Marks employed for Classifying the Schizomycetes" in the *Annals of Botany*, vol. vi., 1892, and the accomplishing of it gave rise to such interesting *parerga* as the papers "On the Action of Light on Bacteria" (Phil. Trans., 1895), "A Violet Bacillus from the Thames," and "Some Thames Bacteria" (*Ann. Bot.*, xii., 1898). The first of these papers is of considerable importance in that the bactericidal effect of light, whether of the sun or of the electric arc, is conclusively demonstrated, and is shown to be confined to the more highly refrangible rays of the spectrum.

Ward was a regular attendant at the meetings of the British Association for the Advancement of Science, and was president of the botanical section at the meeting in Toronto in 1897. His address on that occasion dealt with a subject that was always in his mind, the economic significance of the fungi, of which he gave a characteristically exhaustive account. In fact, all his subsequent work was the expression of this idea. Thus in 1898 (Phil. Trans.) he published an investigation of *Stereum hirsutum*, the fungus that attacks the wood of the oak, having succeeded, by means of pure cultures, in tracing its life-history from the spore to the fructification, and he did the same for *Onygena equina*, the horn-destroying fungus (Phil. Trans., 1899). He then entered upon what was destined to be his last line of research, the investigation of the Uredines or Rusts, with an energy that was remarkable even for him; but it was not until 1902 that the publication of the results began, so long and so numerous were the experiments from which they were drawn. The first paper on the subject was read before the Cambridge Philosophical Society in January, 1902 (Proc., vol. xi.), treating of the physiological races of these fungi, with special reference to the Brown Rust of the Brome-grasses. Having shown that certain species of Bromes can only be attacked successfully by certain forms or breeds of the Rust, he arrived at the striking conclusion that "the capacity for infection, or for resistance to infection, is independent of the anatomical structure of the leaf (of the Grass), and must depend upon some other internal factor or factors in the plant." Two papers published later on in the year (Proc. Roy. Soc., vols. lxix. and lxxi.) discuss the question, with an answer in the negative, as to whether or not susceptibility to infection depends upon the nutritive conditions offered by the host to the parasite, the foregoing conclusion being re-asserted thus:—"All the evidence points to the existence, in the cells of the fungus, of enzymes or toxins, or both, and in the cells of the host-plant of anti-toxins or similar substances, as the decisive factors in infection or immunity, although I have as yet failed to isolate any such bodies." In the meantime yet another paper had appeared in the *Annals of Botany* (vol. xvi., June, 1902) confirming his previously expressed conviction that differences in details of anatomical structure do not afford any explanation of the relations between the Bromes and their Rusts. His last paper on this subject is that dealing with the adaptive parasitism of the Brown Rust (*Annales Mycologici*, vol. i., 1903), in which he developed the interesting idea of the existence of what he termed "bridging species." The idea is briefly this, that although it is generally true that the adapted races of the parasitic fungus are restricted to groups of closely allied host-species, there do occur host-species which serve as intermediaries in the passage of the parasite from members of one section of the host-genus to those of another section.

Incidentally, a controversy arose between Ward and Prof. Eriksson, of Stockholm, with reference to the "mycoplasm-theory" of the latter. In order to account for the occurrence of sudden and widespread epidemics of Rust, Eriksson had assumed the persistence in a dormant state, within the tissues of the host-plants, of a combination of the protoplasm of the fungal hyphæ with that of the host, which he had described and figured and had called "mycoplasm." As stated in his paper on the question (Histology of *Uredo dispersa*, &c., Phil. Trans., Ser. B, vol. cxcvi., 1903), Ward was unable to confirm Eriksson's observations, and regarded his assumption as unnecessary. One of the most interesting discussions in Section K during the Cambridge meeting of the British Association, 1904, was that in which the *pros* and *cons* of this theory were urged by the two protagonists. Their views were subsequently published, side by side, in the *Annals of Botany* (vol. xix., January, 1905).

At this point the record of his work as an investigator abruptly ends, when great things might still have been anticipated, and it might well be deemed sufficient to have occupied all the time and energy at his disposal. However, this is far from being the case. Besides writing all these papers, many of them illustrated by elaborate drawings—for Ward was an excellent draughtsman—as well as others necessarily omitted here, he produced several books:—a translation of Sachs's "Physiology of Plants," 1884; "Timber and some of its Diseases," 1889; "The Oak," 1892; an edition of Laslett's "Timber and Timber-trees," 1894; "Diseases of Plants," 1889; "Grasses," 1901; "Disease in Plants," 1901; "Trees," a considerable work, of which several parts have appeared, and I understand that some MSS. remain to be published.

It is pleasant to reflect that so much good work was not allowed to pass unrecognised. In addition to the distinctions already mentioned, many others were conferred upon him. Ward became a Fellow of the Linnean Society in 1886, and was elected a Fellow of the Royal Society in 1888, receiving a Royal medal in 1893; he served on the council of the Linnean Society, 1887–9, and on that of the Royal Society, 1895–6. He was elected an honorary fellow of Christ's College, Cambridge, in 1897, and in 1902 received the degree of D.Sc. *honoris causa* from his first *Alma Mater*, the Victoria University, having previously taken the same degree at Cambridge. He was president of the British Mycological Society, 1900–2, and had received the honorary fellowship of the Manchester Literary and Philosophical Society and of other societies.

Beginning in 1854 at Hereford, his life is a story of unremitting and successful effort until its close at Torquay on Sunday, August 26, 1906. I remember Ward as a genial companion, a man of varied interests, delighting especially in music; but the dominant impression is that of his whole-hearted devotion to his science; all else counted with him as nothing in comparison with that. No doubt this led him to impose too severe a strain upon a constitution never very robust: but such as he was, it could not have been otherwise. He was laid to rest in the Huntingdon Road Cemetery, Cambridge, on September 3, attended by many friends and colleagues, amid tokens of regret from near and far.

S. H. VINES.

CHARLES BARON CLARKE, F.R.S.

THE death of Mr. Charles Baron Clarke on August 25, in his seventy-fourth year, deprives the botanical world of an able worker, and takes from a wider circle still a friend endeared for his breadth of sympathy and charm of manner.

Born at Andover in 1832, Clarke was educated at King's College School, London, and at Trinity and Queens' Colleges, Cambridge. He graduated in 1856, being bracketed third wrangler. Elected a fellow of Queens' in 1857, he was in 1858 called to the Bar at Lincoln's Inn, and appointed mathematical lecturer of his college. This position he held until 1865, when he joined the Bengal Educational Department.

While at Cambridge Clarke was one of a brilliant group holding advanced economic views, which included Henry Fawcett, Leslie Stephen, and John Rigby. His interest in political economy continued throughout his life, and found expression in occasional pamphlets on economic subjects, which he treated in a manner pleasing for its lucidity and freedom from political bias.

Before he left England, Clarke, as a recreation, was interested in field botany. On reaching India he printed at Calcutta, in 1866, a list of the plants of Andover, his birthplace. Clarke began his Indian career as a teacher in the Presidency College, Calcutta, but soon became an inspector of schools. His work as inspector involved touring within the circle allotted to him, and gave him facilities for botanical field work. Of these he made the utmost use, and supplemented them by vacation visits to districts outside his circle and provinces beyond Bengal. He made extensive collections, and at the same time found material for contributions to ethnology and geography. From 1869 until 1871 Clarke was in charge of the Royal Botanic Garden at Calcutta, with the use of a well-equipped herbarium at his command. The administrative work of these two years left little time for publication of results, but, on reverting to his own department, Clarke, while as ardent a collector as ever, found time to commence the issue of his valuable contributions to Eastern botany. His monographs of the Indian Cyrtandraceæ and Commelynaceæ were issued in 1874; that of the Indian Compositæ appeared in 1876. In the former year also, Clarke, at his own risk and cost, issued a new and cheap edition of Roxburgh's "Flora Indica," which had become almost unprocurable.

The extent and value of the field work done by Clarke during the first ten years of his Indian service may be best measured by the character of the collection presented by him to Kew in 1877. This included 25,000 numbers, representing some 5000 species. The fulness of the notes, often accompanied by useful analyses; the precise indication of localities and altitudes; the excellence of the specimens themselves, combine to render this contribution one of the most munificent additions ever made to the Indian material at Kew. It represents journeys in the Bengal plain, on the Chutia Nagpur plateau, in Chittagong, in the Khasia Hills, in Sikkim from the Terai to the snows, in the Punjab Himalaya, in Kashmir and thence to the Karakoram, in the Nilgiri Hills. No botanist since Griffith had seen more of India; none since Hooker had more fully examined the areas visited.

Early in 1879 Clarke was placed on special duty in England, and for four years was engaged at Kew assisting Sir Joseph Hooker in the preparation of the "Flora of British India"; for the second, third, and fourth volumes of this work he prepared the accounts of many important natural families. While in England Clarke also published, in 1880, a review of the "Ferns of Northern India." He returned to India early in 1883, and towards the close of 1884 he was appointed to act as Director of Public Instruction, Bengal. In 1885 his services were transferred from Bengal to Assam, a change of province which admitted of his further exploration of the Surma and Brahmaputra valleys and of the Khasia and Jaintia Hills, and enabled him to make a botanical journey in the Naga Hills and Manipur, new ground even for him, the results of which were published in the Journal of the Linnean Society.

In 1887 Clarke retired from the Indian Service and settled at Kew, so as to be near the herbarium there, in which he worked for nineteen years as a volunteer. Early in his Indian career he appears to have been particularly attracted to the study of the Cyperaceæ, and one of the objects of his life was the completion of a general monograph of this difficult family, with regard to which Clarke became the recognised authority to whom botanists in every country sent their collections for identification and description. His devotion to this group, accounts of which he prepared for the "Flora of British India," the "Flora Capensis," and the "Flora of Tropical Africa," was not, however, exclusive, for he elaborated several important families for both the African "Floras" and for the "Flora of the Malay Peninsula," and communicated numerous botanical papers to the Linnean and Royal Societies.

Clarke joined the Linnean Society in 1867, when his active botanical work in India first began. In the society's fortunes he took the keenest interest, being, while on special duty in England and again since his retirement, one of the most trusted councillors of the society, over which he presided from 1894 until 1896. He was elected a Fellow of the Royal Society in 1882, and served on the council in 1888–9. He was also a Fellow of the Geological and of the Geographical Societies.

NOTES.

THE jubilee of the coal-tar industry will be celebrated in America next month, and Sir William Perkin, F.R.S., the discoverer of "mauve," will leave England on September 22 for New York to receive a public tribute from Americans for the services he has rendered to chemical industry and science. At a public meeting held last May, the committee submitted the following programme:—(1) To invite Sir (then Dr.) W. H. Perkin to be present at the American celebration as the guest of the Americans, the date of the event to be October 6 (subject to the approval of Sir William Perkin), and to consist of a banquet and symposium on the coal-tar industry; (2) the presentation to Sir William Perkin of a personal token; (3) the foundation of a Perkin medal, to be awarded annually to an American chemist for distinguished work in applied chemistry; (4) the establishment of a nucleus of a fund at the Chemists' Club in New York City for a reference and circulating library covering the entire field of theoretical and applied chemistry, which is to be in charge of a salaried librarian, and to contain duplicate sets, one of them to be used for circulation among American chemists. A sum of at least 50,000 dollars was estimated as necessary to place the library on a permanent basis. It is also expected that a substantial contribution will be made to the international fund in London. The American committee includes the names of about 150 of the leading scientific and public men in the United States.

WE notice with deep regret the announcement that Prof. Ludwig Boltzmann, professor of theoretical physics in the University of Vienna, died by his own hand at Duino a few days ago.

ON October 1 Sir George Watt, C.I.E., reporter on economic products to the Indian Government, will deliver the opening address of the session at the School of Pharmacy of the Pharmaceutical Society of Great Britain, and the president of the society will present the Pereira medal.

A REUTER message from Tiflis reports that the township of Kwareli, covering an area of five kilometres in the district of Telaff (Caucasus), has been almost entirely destroyed by an avalanche of mud, sand, and stones from the neighbouring mountain-side. Disasters of this nature are of frequent occurrence in the Caucasian valleys.

A MEETING of the German Astronomical Society opened yesterday morning at Jena, and will continue in session until Saturday. In addition to scientific business, visits will be paid to the optical works of Zeiss and to Schott's glassworks. The meeting of the German Association of Naturalists and Physicians will open at Stuttgart on September 16, so that members of the Astronomical Society who propose to attend it will be able to leave Jena in time to do so.

THE Government of Cape Colony has placed a sum upon the Supplementary Estimates toward the expenses incurred in carrying out investigations upon defects in ostrich feathers, under the direction of Prof. J. E. Duerden, of Rhodes University College, Grahamstown. A letter upon the subject appeared in NATURE of May 17 (p. 55).

THE famous engineering firm of Friedrich Krupp, Ltd., of Essen, is contemplating the erection of a technico-physical laboratory at a probable cost of 2,500,000 marks.

PROF. MAX TOEPLER, the inventor of the mercury pump bearing his name, and professor of physics at the Technical High School, Dresden, celebrated his seventieth birthday on September 7.

THE Berlin municipal laboratories for the analysis of foodstuffs will be ready shortly. On the first floor will be the chemical and microscopical sections, in a hall on the ground floor there will be a collection room for tests and samples, while above the chemical and microscopical sections there will be rooms for bacteriology, electrolytic work, the hydrology bureau, and the library, with reading room. A special outbuilding will be used for animal examinations.

PROF. WILHELM HITTORF will shortly celebrate his golden "Universitäts-Jubiläum" in Münster. In 1848 he was a privatdocent at the then Münster Akademie; from 1852–6, extraordinary professor of physics and chemistry; and from 1856–1875, ordinary professor of both subjects, but since the latter date he has only retained the professorship of physics. His professorial colleagues are presenting him with a marble bust of himself, by Herr Rüller, of Münster. Prof. Hittorf has presented 25,000 marks to the science faculty for the purpose of furthering scientific work.

AN international congress for the study of the Polar regions was opened on September 7 at the Palais des Académies, Brussels, under the presidency of M. Beernaert, Ministre d'État. The *Times* correspondent states that among those present were Dr. Nordenskjöld, M. Arctowski, M. de Gerlache, Captain Scott, and Prince Buonaparte. Baron de Favereau, the Belgian Minister for Foreign Affairs, welcomed the delegates. A draft scheme for the formation of an international Polar commission was adopted on Tuesday. The primary aims of the commission are to bring about closer relations among Polar explorers, to coordinate scientific observations, and to assist Polar enterprise, without, however, organising expeditions on its own account. It was resolved to submit this scheme to the approval of the respective Governments. At the final meeting M. Charcot announced his intention of organising a fresh expedition to the South Pole, and Dr. Nordenskjöld expressed a hope that Belgians would cooperate with the French in this undertaking.

THE committee of the Quekett Microscopical Club has arranged for a series of demonstrations at 20 Hanover Square, W., on "The Practical Use of the Microscope and its Accessories," to be given from 7 p.m. to 8 p.m. on the third Friday in each month during the ensuing session. The first will be on November 16, when Mr. H. F. Angus will deal with axial substage illumination, including the use of the plane and concave mirrors, substage condensers, and methods of centring the illuminant and of obtaining critical illumination. At other demonstrations, the order of which is not yet finally settled, the following subjects, among others, will be considered:—substage non-axial illumination, including oblique and dark ground illumination; the use of the micropolariscope; various methods of illuminating opaque objects; the testing and comparison of objectives; and the employment of micrometers and finders. These demonstrations will be in addition to the "Gossip" meetings of the club, which are held on the first Friday, and to the ordinary meetings, held also on the third Friday of the month at 8 p.m. Further particulars may be obtained from the hon. sec., Mr. A. Earland, 31 Denmark Street, Watford, Herts.

IT is well known that during the last few years the study of protozoa has made remarkable advances. It has been shown that numerous protozoa play an important *rôle* in human and animal diseases, and the unravelling of their life-histories has been attempted by many workers with enthusiasm and success. Among these workers no one has done more than Fritz Schaudinn, whose premature death this summer has been lamented by the whole world of biologists. He not only made many discoveries of importance, he opened up new lines of investigation which are full of promise. His work has made it safe to prophesy that protozoology will surely develop into a department not less important than bacteriology. Doubtless influenced by his master, F. E. Schulze, Fritz Schaudinn began about ten years ago to study protozoa, and he soon attained the rank of a discoverer. His researches on multiple nuclear division, the central corpuscle of heliozoa, and the dimorphism of foraminifera (at the same time elucidated by Mr. J. J. Lister) were of much interest, but it was his working out (along with Siedlecki) of the life-history of Coccidia (1897) that first indicated his characteristic ability. During the last few years he published memoir after memoir on the life-histories of parasitic protozoa, such as Trypanosoma and Spirochæte, and made excursions into the field of bacteriology, *e.g.* in the discovery of the spirillum of syphilis. He founded the *Archiv für Protistenkunde*, now in its seventh volume, and he had time to indulge in some purely zoological work, *e.g.* the study of Tardigrada. He was cut off in June last in the midst of his labours, at the early age of thirty-five—an irreparable loss to science. Nor does the sadness end here, for Schaudinn has left a widow and young family very inadequately provided for. As he has left the world his debtor, it is to be hoped that success will attend a proposed international memorial, in which many prominent biologists and physicians in this country have already interested themselves. Subscriptions should be sent to the treasurer, Mr. Adam Sedgwick, F.R.S., New Museums, Cambridge.

The May issue of the Proceedings of the Academy of Natural Sciences of Philadelphia contains a paper by Mr. J. A. G. Rehn on non-saltatorial orthopterous insects (inclusive of Mantidæ and Phasmidæ) from British Guiana, in which several new species are named and described, and a second, by the same author, on five new species of Orthoptera from Tonkin.

The whole of the second part of vol. lxxxiv. of the *Zeitschrift für wissenschaftliche Zoologie* is taken up by a paper of 155 pages on the terminal nerve apparatus in the mouth-parts of birds, and the general mode of nerve termination in vertebrates as a whole. The author, Dr. E. Botezat, concludes that the terminations of peripheral nerves conform to a common fundamental plan, and have a definite structure of their own, which is unlike that of the nerve terminations of the higher sensory organs.

The habits and reactions of the American pond-snail *Lymnaeus elodes* (probably only a local phase of the European *L. palustris*) form the subject of No. 6 of Cold Spring Harbour Monographs, the author in this instance being Mr. H. E. Walter. Although the creature ordinarily breathes by coming at intervals to the surface and filling its lung-chamber with air, in exceptional circumstances it is able to breathe without rising to the surface at all, the lung-chamber being then filled with water. This secondary adaptation is, however, at once relinquished when the inducing circumstances disappear.

Science Bulletin No. 8 (vol. i.) of the Brooklyn Institute of Arts and Sciences contains notes on birds from Trinidad, by Mr. G. K. Cherrie; descriptions of various North American moths and their larvæ, by Mr. H. G. Dyar; and a list of geometrid moths from Utah, Texas, and Arizona, with descriptions of new species, by Mr. R. T. Pearsall. A number of star-fishes from the Pacific coast of North America are described as new by Mr. W. K. Fisher in vol. viii., pp. 111–139, of the Proceedings of the Washington Academy of Sciences. A detailed monograph, with illustrations, is promised later.

The contents of the September number of the *Entomologists' Monthly Magazine* include a continuation of the nomenclature of the Microlepidoptera by Lord Walsingham and Mr. J. H. Durrant, a further instalment of Dr. J. H. Wood's synopsis of the British flies of the genus Phora, and a paper by Mr. N. H. Joy on beetles infesting the nests of birds and mammals. Having taken the beetle *Cholera colonoides*, as well as other supposed rare species, in birds' nests last year, the author of the paper just mentioned came to the conclusion that if such "stations" were carefully searched the rarity of the beetles in question would prove a myth. Put to the test of experiment, the theory has turned out to be true, while the nests of the smaller mammals have proved an even more productive source of interesting Coleoptera.

The fourth part of vol. xxxv. of Gegenbaur's *Morphologisches Jahrbuch* opens with a eulogy of the founder delivered by Prof. C. Seffner at the unveiling at Heidelberg on May 12 of a bust of the great anatomist. A photograph of the bust accompanies this brief *résumé* of Carl Gegenbaur's life and work. A large part of the rest of the issue is occupied by a long and elaborate description and discussion, by Mr. H. Braus, of Heidelberg, on the fore-limb and operculum of the larva of the frog Bombinator. Attention is directed to a certain correlation between the fore-limb and the operculum, more especially with regard to the perforation in the latter. Dr. Charlotte Müller discusses the development of the human thoracic cavity, while Messrs. G. Kolossoff and E. Paukul formulate a mathematical theory to explain the papillary ridges and grooves on the palm and sole of the human hand and foot.

During last year's visit of the British Association to South Africa, Mr. C. F. Rousselet occupied himself, so far as circumstances would permit, with collecting the rotiferous animalcules of the country. Despite very unfavourable conditions for collecting, the result of his labours has been enormously to increase the South African list, especially if Natal (where more work on the group had been done than elsewhere) be excluded. Mr. Rousselet's paper on this fauna is published, with illustrations, in the August number of the Journal of the Royal Microscopical Society. At the conclusion of his paper the author comments on the extraordinarily wide geographical distribution of many of these minute organisms. "The best explanation is that the Rotifera, in addition to thin-shelled summer eggs which hatch at once, produce resting eggs with thick tough shells capable of withstanding any amount of desiccation, and which may be wafted up with the dust of dried-up pools, and carried very long distances by the wind and air-currents, and thus scattered over the whole surface of the earth, and then come to life and produce their kind."

An account in *Naturwissenschaftliche Wochenschrift* (July 8) of the Sigillarieæ, by Dr. W. Koehne, indicates how the impressions or casts, known as *incrustations*, of these fossil Lycopods are produced, and contrasts them with petrifactions in which cell structure is preserved.

For several years the application of electricity to agriculture has been increasing in Germany, where the owners of large farms have been brought to see the advantages of this system. Some of the large electrical manufacturing firms have entered actively into the development and supply of machinery in this new field, and some striking illustrations are given by Mr. Franz Koester in the *Engineering Magazine* (vol. xxxi., No. 5) showing views taken on farms where electricity is used exclusively for motive power.

IN the *Revue de Métallurgie* (vol. iii., No. 2), issued as a supplement to the *Bulletin de la Société d'Encouragement*, Mr. Guillery describes a new method of determining the elastic limit of metals by recording the variations in the electric resistance of the test-piece as the load in the testing machine is increased. The method is not yet fully developed, but the results of a number of tests made by the author at Denain, and the simplicity of the apparatus used, render it worthy of careful consideration.

IN the case of an engine using saturated steam, the PV diagram can be converted into the $\theta\phi$ equivalent either by a somewhat tedious calculative method or by Boulvin's graphic method. The latter necessitates the preliminary re-plotting of the diagrams to the pressure and volume scales before the graphic transference can be carried out. A modification of this method has been devised by Mr. W. J. Goudie, and is described in the *Engineering Review* (vol. xv., No. 2). A direct transference from the actual indicator diagrams is effected, and the saving in time and labour should render the method useful to engineers who make frequent use of the temperature-entropy chart.

THE September issue of the new bi-monthly journal *Concrete* contains admirably illustrated articles on the micro-structure of Portland cement by Dr. C. H. Desch, and on reinforced concrete at the Milan Exhibition by Mr. F. R. Farrow. This new addition to technical periodical literature should prove a valuable source of information to all workers in concrete and cement. The details of the new uses to which concrete and reinforced concrete are put are very remarkable. The use of reinforced concrete as a substitute for timber in exposed positions is rapidly increasing. Railway sleepers, telegraph posts, and fence posts are being tried, and efforts are being made to prove that reinforced concrete is an excellent substitute for brickwork where structures of great height are required.

WE have received from the Geological Survey of Canada three reports of special economic interest. The report (No. 923) on the Chibougamau mining region in the northern part of the province of Quebec, by Mr. A. P. Low, records the discovery of an area of serpentine rocks containing asbestos of excellent quality, together with the finding of a large vein of gold-bearing quartz and numerous indications of copper ores. Mr. R. W. Brock submits a preliminary report (No. 939) on the Rossland mining district, British Columbia. A more complete report is in preparation. Mr. C. W. Willimott's monograph on the mineral pigments of Canada (No. 913) contains the results of an elaborate series of experiments with the various pigments that can be derived from minerals, ochres, and clays either in their crude state or by burning. They show that in almost every colour a paint of good body and permanent tone may be produced from Canadian material.

AN account of Sinhalese earthenware is given by Mr. A. K. Coomaraswamy in vol. iv., part xiii., of *Spolia Zeylanica*. Elaborate types are not found, and no glaze is used; the sides of the pots are made on the wheel, which is turned by a boy; some hours or days later, putting a smooth stone inside, the potter fashions the lower part of the sides so as to form the bottom—a most unusual procedure. In addition to domestic and ritual pottery, the author deals with roof-tiles, some of which, for use on the eaves, are decorated. Earthen vessels are also decorated with incised, stamped, or slip-painted designs, and the most effective of these styles is stamping, though some of the incised designs produce a very Greek-like effect. The paper is illustrated by three collotypes and numerous blocks in the text.

THE summary of the weather for the week ended September 8, issued by the Meteorological Office, shows that the highest shade temperature in the recent hot spell was 96°, at Bawtry, in the Midland counties, registered on September 2. The rains which occurred with the change to cooler weather were very heavy in places, although by no means general. In parts of London the fall on the night of September 4–5 amounted to an inch, and to 1·68 inches at Ventnor; while at Glencarron the measurement on September 5 was 1·98 inches, and at Fort William 1·87 inches. In most parts of England the weather has been exceptionally dry for nearly three weeks. At Spurn Head and Bath no rain has fallen since August 24, and at Shields none has fallen since August 26, while at many places, widely separated, the measurement since about August 25 amounts only to a few hundredths of an inch. The general type of weather which has characterised the summer is still continuing. Bright sunshine is unusually prevalent, with very dry conditions, but the temperature has fallen, although the days at present are still mostly warm. At Greenwich, the exposed thermometer on the grass registered 28° on the morning of September 11, and the ground in the suburbs of London was coated with hoar-frost.

WE have received from the meteorological reporter to the Government of India a memorandum on the weather conditions during June and July, with an estimate of the monsoon rainfall during August and September, 1906. It is stated that the total rainfall of June and July was distributed with about the usual uniformity over the greater part of India; the only areas of large defect were Sind (52 per cent.), the Punjab (27 per cent.), and Bengal (21 per cent.). In both these months there was, on the average of the whole country, a defect of 3 per cent. in the rainfall. In forming a forecast for August and September, the conditions in various parts of the world are stated; of these, the most powerful factor is thought to be the pressure in the southern Indian Ocean. An illustration of this is given by a table containing all years since 1875 in which pressure at Mauritius in July differed from the normal by more than 0·024 inch, together with the rainfall of Bombay and bay currents in the ensuing August and September; it shows that there is a marked tendency for high pressure to be followed by deficient rainfall, and *vice versâ*. At Mauritius, pressure this year was below the normal in June by 0·045 inch, and in July by 0·020 inch, a fact which is, therefore, decidedly favourable; but so many factors come into play, *e.g.* temperature, the distribution of snowfall in the mountain regions north and west of India, and probably pressure over South America, that Dr. Walker is unable to say more than that there appears, on the whole, to be no reason for anticipating either a large excess or a large defect in the rainfall of August or September.

THE Royal Society of Canada, which was founded by the Duke of Argyll in 1881, celebrated its semi-jubilee this summer. The president, Prof. Alexander Johnson, in his address at the annual meeting, described the conditions which led to the society's inception and the development of its activities. A large portion of the address was appropriately devoted to considering the different conceptions which have been held with regard to matter, culminating in the theory of atomic disintegration, which had its birth in Montreal in 1902.

At the end of an interesting and instructive paper in a recent number of the *Chemiker Zeitung* (No. 61, p. 742) on the chemical composition of the eruptive products of volcanic actions, and more especially that of Vesuvius in April of this year, Prof. Julius Stoklasa, of Prague, directs attention to the meagre primitive equipment of the Royal Seismological Observatory situated in the immediate neighbourhood of Vesuvius, where on April 3 Prof. Matteucci observed the first subterranean signs of this year's eruption, and which Prof. Stoklasa visited in May last. In this article Prof. Stoklasa throws out the suggestion that the observatory should be re-modelled and made an international experimental station with geophysical and chemical laboratories, similar, in fact, to the International Biological Station at Naples, which is being provided with extensions to its physiological and chemical laboratories for the purpose of more thoroughly investigating marine fauna and flora.

In 1903, from the occurrence of a number of lines common to the spectra of krypton and xenon, Dr. Baly inferred the existence of a new element present as an impurity in those gases. From a study of the spectra of different fractions of the most easily condensable portion of the inert gases of the atmosphere, Dr. Rudolf Schmidt now concludes in the *Verhandlungen* of the German Physical Society (vol. viii., No. 14) that xenon is not a true element, but a mixture, possibly of several gases. The ultra-violet spectrum between $\lambda=3450$ and $\lambda=2800$ of one fraction of the gas was found to contain only about forty lines, the greater part corresponding with those ascribed to xenon; several, however, were new. Within the same range Baly measured about 500 lines, and the difference in the two numbers might at first sight appear to be due to insufficient illumination in the one case. This view is contradicted, however, by the fact that some of the lines which appeared feeblest in Baly's spectra showed the greatest intensity in the case of this particular fraction, whilst all the brightest lines of "xenon" were missing. The only explanation appears to be that the gas hitherto called xenon is a more or less complex mixture.

The Country Press, 19 Ball Street, Kensington, W., has added to its series of nature-study picture postcards twelve cards, which may be obtained for one shilling, depicting twenty-three species of British grasses. The popular and botanical names are given in each case, together with the time of flowering and a magnified representation of the fructification.

The Nagari-pracharina Sabha, of Benares, has published a "Hindi Scientific Glossary," containing the terms employed in most of the sciences, except biology and geology. The glossary has been edited by Mr. Syam Sundar Das, honorary secretary of the Nagari-pracharina Sabha, with the cooperation and assistance of an editorial committee. The glossary is divided into seven parts, dealing respectively with terms of geography, astronomy, political economy, chemistry, mathematics, physics, and philosophy. Preference has been given to common and current Hindi terms. In the absence of appropriate Hindi equivalents, certain appropriate terms existing in some of the prevalent vernaculars have been used. When these have failed, the existing Sanskrit terms have been taken or the English terms employed.

OUR ASTRONOMICAL COLUMN.

Holmes's Comet (1906*f*).—According to Prof. Wolf's telegram announcing its re-discovery, as published in No. 4118 of the *Astronomische Nachrichten*, the photographic magnitude of Holmes's comet on August 28 was 15·5. As the comet passed through perihelion on about March 14 it is not likely to become a brilliant object during the present apparition. The corrections to Dr. Zwiers's ephemeris are −6s. and −2′.

Finlay's Comet (1906*d*).—A continuation from M. L. Schulhof's ephemeris for Finlay's comet is given below:—

1906	α (app.) h. m.	δ (app.) ° ′	1906	α (app.) h. m.	δ (app.) ° ′
Sept. 15 ...	6 40 ...	+19 19	Sept. 23 ...	7 7 ...	+20 3
17 ...	6 47 ...	+19 33	25 ...	7 13 ...	+20 11
19 ...	6 54 ...	+19 44	27 ...	7 19 ...	+20 17
21 ...	7 1 ...	+19 54	29 ...	7 24 ...	+20 22

The comet will pass about 1° south of ζ Geminorum on September 20, and about 2° south of δ Geminorum on September 25.

Comet 1906*e* (Kopff).—A further extract from Herr M. Ebell's ephemeris for Kopff's comet (1906*e*) is given below:—

Ephemeris (12h. M.T. Berlin).

1906		α (true) h. m.		δ (true) ° ′		Brightness
Sept. 16	...	22 33	...	+8 28	...	0·54
18	...	22 32	...	+8 16		
20	...	22 31	...	+8 4	...	0·48
22	...	22 31	...	+7 52		
24	...	22 30	...	+7 40	...	0·43
26	...	22 29	...	+7 28		
28	...	22 29	...	+7 16	...	0·38

Herr Ebell calculated two sets of elements, obtaining October 16, 1905, and May 14, 1906, as the respective times of perihelion passage, but, as seen from the residuals (observed-calculated), there is considerable uncertainty attaching to the calculated path.

Two other sets of elements, communicated by Prof. E. C. Pickering, give April 12, 1907, and December 7, 1906, respectively, as the time of perihelion, and the resultant ephemerides show the comet's brightness to be increasing at the present time. Observing at Hamburg on August 23, Dr. Graff found that the comet had a coma of 0′·5 diameter, with a nucleus of magnitude 12·5, the magnitude of the whole being 11·5 (*Astronomische Nachrichten*, No. 4118).

The Planet Mercury.—Continuing his articles in the *Observatory* (No. 374) on planets and planetary observations, Mr. Denning this month discusses the best times and methods of observing Mercury. Dealing with the legendary lament of Copernicus that he had never seen this planet, Mr. Denning expresses his doubts as to its authenticity. The late Rev. S. J. Johnson saw Mercury as an evening star about 150 times during the years 1858–1905, whilst Mr. Denning has seen it some 130 times since February, 1868, and suggests that, if looked for regularly, this elusive object may probably be seen on about fifteen occasions per annum in the English climate. In the spring, Mercury should be looked for some days *before* the maximum elongation, but in the autumn apparitions some days *after* the elongation. After discussing the observing conditions, Mr. Denning proceeds to describe the surface markings as seen—with great difficulty—on the telescopic image of Mercury since the time of Schröter.

Observations of Satellites.—Prof. Barnard observed the sixth satellite of Jupiter nine times, on February 27 and March 20, during last winter, and found it quite an easy object, under fair weather conditions, with the 40-inch refractor of the Yerkes Observatory.

On February 27 the magnitude was 14·0, and on March 20, when Jupiter was lower down at the time of observation, it was estimated as 14·5. The positions determined from these observations are recorded in No. 4112 of the *Astronomische Nachrichten*.

In No. 4116 of the same journal the same observer gives the results of his observations of Phœbe, the ninth satellite of Saturn, made with the 40-inch on July 24 and 29. The satellite was about 1m. in R.A. and 6′ in declination from the planet, and had a magnitude of 16·5; at times it appeared hazy. The observations give the following corrections, taken (observed-calculated), to Dr. Ross's ephemeris:—

	m. s.	′ ″
July 24	−0 0·93	+0 3·5
29	−0 0·87	+0 2·9

ENGINEERING AT THE BRITISH ASSOCIATION.

IN his presidential address to the section, Dr. Ewing dealt with certain aspects of the inner structure of metals and the manner in which they yield under strain, and he made a notable departure from the usual custom of such addresses by illustrating his speculations by experiments and by models in order to demonstrate his ideas as to the processes of crystal building.

After the presidential address a paper was read by Major W. E. Edwards, R.A., on modern armour and its attack. The author first gave a very complete and useful history of the application of armour to ships and forts, and then explained in detail the elaborate and costly processes through which the material passes, from the casting of the steel ingot to the completion of the plate. The second part of the paper dealt with the attack of armour and the various ways in which a plate may yield, and the influence of the cap in reducing the resisting power of hard-faced plates. In the discussion Sir William White expressed the opinion that British armour-plate makers had introduced many of the more important improvements in the resisting power of armour-plates, and that eventually the 6-inch gun would be chiefly used for defence against torpedo craft.

The first paper on Friday, August 3, was on the removal of dust and smoke from chimney gases, by Messrs. S. H. Davies and F. G. Fryer. The paper dealt with an ingenious plant the authors have designed and fitted up at the cocoa works of Messrs. Rowntree and Co. for thoroughly washing the smoke, and for removing from it the whole of the grit and dust and practically all the sulphur acids. Members of the section had an opportunity later on of seeing this plant in operation; it certainly thoroughly effects the purposes for which it was installed, and it might certainly be adopted with advantage in many factories where a cheap and plentiful supply of water is available.

In the next paper, on standardisation in British engineering practice, Sir John Wolfe-Barry gave an account of the admirable work which has been carried out by the Engineering Standards Committee since its first institution in 1901 at the instance of Sir John Wolfe-Barry himself. There are now thirty-six subcommittees with 260 members dealing with some thirty different branches of the work. The work of the committee has been invaluable both to manufacturers and to engineers, and the publications of the committee are indispensable to all engineers.

Dr. Ewing has during recent years done much valuable research work on the crystalline structure of metals, both in a strained and in an unstrained state, and it was only natural that there should be several papers on this important branch of the subject of the strength of materials. Mr. W. Rosenhain dealt with the deformation and fracture of iron and steel, and his paper was illustrated by a number of beautiful lantern slides. The author of this paper has done such admirable work in the microscopic study of the crystalline structure of metals that everything he has to say on this subject is sure to be of value. In his latest researches he has by a most ingenious method been able to study the crystalline structure of the actual fracture itself in broken test-pieces. The second paper on this subject of the crystalline structure of metals was by Mr. J. E. Stead, and dealt with segregation in steel ingots and its effect in modifying the mechanical properties of steel. To all those concerned either with the manufacture or with the employment of steel in industrial operations this paper was most valuable, for the author had brought together a large amount of information previously scattered in the pages of various publications. The microscopic study of the crystalline structure of different portions of steel ingots is rapidly changing the views of engineers in regard to many important problems in connection with the life of steel rails, and there is no question that the microscope now plays as important a part in the laboratory of the metallurgist as in that of the biologist.

Dr. H. C. H. Carpenter next read his paper on structural changes in nickel wire at high temperatures; this research, carried out at the National Physical Laboratory, was intended to throw light on the fact that fundamental changes occur in the mechanical properties of nickel wire used as the heating coil of an electrically-heated porcelain tube-furnace. Here again the microscope was the chief instrument in the research, and the study of the crystalline structure of the wires showed, the author suggested, that wire intended for electrical heating should be as free from gases as possible. A paper by Mr. W. Taylor describing a magnetic indicator of temperature for hardening steel concluded the day's proceedings.

On Saturday, August 4, the section paid a visit of inspection to the Roundhills Reservoir of the Harrogate Corporation. The dam, a masonry one, will, when completed, be 125 feet in height above the river bed, and members of the section were fortunate enough to see the work when the more difficult operations of such an undertaking were just in their most interesting condition.

On Monday, August 6, the first paper read was by Prof. Hudson Beare, on the new engineering laboratories of the University of Edinburgh and their equipment; the author pointed out that he had made special provision in these new laboratories for experimental work of an advanced character on the strength of materials and on hydraulics. At the conclusion of the discussion of this paper Sir W. H. Preece read a communication on glow lamps up to date, and the grading of voltages, in which he strongly advocated that steps should be taken to secure uniformity of practice in regard to regulation of voltage in connection with the distribution of electrical energy, and also in regard to the grading of carbon filament glow lamps; in the latter part of the paper data were given to show how poor in quality were many of the lamps on the English market. In the discussion on this paper Colonel Crompton directed attention to the fact that only a comparatively small proportion of lamps was used in private houses in America, while in this country the proportion was large; he also pointed out that the demand for electric current for power and for heating was now becoming a very important factor in the working of central stations.

In a paper on the advent of single-phase electric traction, Mr. C. F. Jenkin directed attention to the rapid advance of electric traction on railways, and pointed out its advantages. He pointed out that the real advantage of electrification was that it would make the line pay better. Mr. Jenkin then dealt with the two alternative systems—alternating current transmission, continuous current distribution with low-tension third rail, and alternating current transmission with high-tension trolley wire; he was of opinion that the latter method had very great advantages, and he advocated also single-phase instead of three-phase currents.

The business of the section for this day concluded with a paper by Mr. A. J. Martin on a general supply of gas for light, heat, and power production. Mr. Martin pointed out that the main obstacle to the general use of gas for purposes other than lighting was its cost, and that the chief causes of this high cost were the standards of illuminating value to which gas has to conform and the high prices paid for coal. At the present day both natural gas and coal gas have been piped in America to great distances (in the case of natural gas to 200 miles) with success, and Mr. Martin was of opinion that it would be perfectly feasible to generate gas cheaply at large works in the centre of our coalfields, and then to convey it under pressure to all our large cities for manufacturing and heating purposes.

In the course of the afternoon many members of the section took part in an excursion to Middlesbrough to visit the works of the Cargo Fleet Iron Co., Ltd. The whole of the plant at these works has been recently remodelled and fitted with the latest labour-saving devices and plant for recovery of by-products; the Talbot continuous steel process, which was introduced to the notice of English metallurgists only in 1900, has been adopted, and at the Cargo Fleet Works each of the three furnaces holds about 175 tons of molten steel.

On Tuesday, August 7, the section began its proceedings with a paper by Prof. W. E. Dalby on experiments illustrating the balancing of engines. The beautiful working models which Prof. Dalby has designed to illustrate the principles which underlie the problem of balancing various types of engines were shown in operation, and, as the president remarked during the discussion, it was a pity that the London County Council had not made use of the author's services in this field of engineering research before it began the design of a large generating station not half a mile away from Greenwich Observatory.

Mr. G. Stoney then read a paper on recent advances in steam turbines, land and marine. The figures given by the author showed how wonderful had been the advance since Mr. C. A. Parsons built his first turbo-dynamo of about 10 h.p. in 1884; at the present time 6000 kw. generators are in course of construction, while turbines of 10,000 kw. are proposed for the great power scheme to supply electric energy in bulk for London. The use of large turbine blowing engines in metallurgical work has also rapidly developed during the past three or four years, while for marine purposes the total horse-power of turbines, either completed or on order, now approaches 1,000,000. Mr. Stoney also described the "vacuum augmenter," a device for increasing the vacuum in the condenser without increasing unduly the volume of the circulating water by the use of a steam jet placed in a contracted pipe between the condenser and the air pump, which compresses the air and vapour from the condenser and delivers it to the air pump through a small auxiliary condenser.

The next paper was by Mr. J. Smith, on an application of stream-line apparatus to the determination of the direction and approximate magnitude of the principal stresses in certain portions of the structure of ships; this valuable paper was, the president stated, one of the first fruits of the laboratory of the Royal Naval College at Greenwich. The author showed that a strain diagram of the deck of a ship very closely approximated to the stream-line shown by Prof. Hele-Shaw's well-known apparatus, in which a very thin film of water is compelled to flow between two sheets of glass.

In the afternoon the section had a joint meeting with the physical and educational sections, and a discussion on the teaching of mechanics was opened by a paper by Mr. C. E. Ashford, headmaster of the Royal Naval College, Dartmouth. In his paper Mr. Ashford pointed out that there was a serious danger that school science might become as academic as classics, and he directed attention to the absolute necessity of employing for laboratory experimental work, not toys, but apparatus such as screw-jacks, Weston's blocks, &c., and also to the great need of experiments for showing the phenomena of kinetics; several new pieces of apparatus designed for this purpose by the staff at the college were described and illustrated.

Wednesday, August 8, the last day of the meeting, was an unusually busy one for the section; no fewer than six papers were dealt with. Prof. Ashcroft described, and showed in operation, the Central Technical College lecture table testing machine, an exceedingly ingenious and beautiful piece of apparatus; Prof. Ashcroft has adopted, with, however, considerable simplifications, the plan first devised by Prof. Kennedy, of using a "spring bar" to measure the loads upon the specimen under test, and to give one of the two necessary motions to the recording apparatus, thus overcoming the difficulties unavoidable when an attempt is made to keep the steelyard of the testing machine floating during the final drawing-down stage prior to fracture.

The next paper was one by Prof. J. B. Henderson, on recent advances in our knowledge of radiation phenomena and their bearing on the optical measurement of temperature. After discussing the four laws of radiation from an ideal black body, the author dealt with pyrometers based on these laws, such as Féry's, and the optical thermometer of Holborn and Kurlbaum.

Mr. S. Cowper Coles read a paper on electropositive coatings for the protection of iron and steel from corrosion, and showed a number of beautiful examples of electro-deposition. In the discussion Colonel Crompton stated that the processes invented by the author had solved a very difficult problem in connection with the piston rods of steam engines using very high-pressure steam, for it was now possible to give these rods a very hard, incorrodible surface without any sacrifice of strength.

In a paper on suction-gas plants, Prof. Dalby dealt with the principles underlying the design of such plants, and then described a number of plants which were entered for the recent trials in connection with the Royal Agricultural Society's show at Derby, and the methods of starting such plants. In reply to the discussion, Prof. Dalby stated that a 15 h.p. engine would use about 0·7 lb. anthracite coal per B.H.P. during running, or, if allowance is made for lighting up and standing by, about 1·0 lb. per B.H.P. hour.

Mr. W. A. Scoble, in a paper on the strength and behaviour of ductile materials under combined stress, described the results of a series of tests of steel bars with a distribution similar to that which occurs most frequently in practice, as obtained under combined bending and twisting; the experiments showed conclusively that the maximum principal stress and the maximum shear both varied through a wide range, the point used as a criterion of strength being the yield point.

The section concluded its business with the reading of a paper by Mr. D. Mackenzie, on waterproof roads as a solution of the dust problem. The various processes at present in use were described and their deficiencies pointed out. Tar alone was most unsatisfactory; at the end of twelve months it had entirely disappeared; the best material, he considered, was "tarmac," made from blast-furnace slag broken when hot and immediately immersed in hot tar; only forge pig slag should be used for this purpose.

It was a great pleasure to see the section so well attended, especially when it is remembered that the early days of the meeting clashed with the summer meeting of the Institution of Mechanical Engineers. No doubt much of the increased interest shown in the work of the section was due to the personal popularity of its distinguished president. T. H. B.

EDUCATION AT THE BRITISH ASSOCIATION.

AMONG the "growing points" mentioned by Prof. M. E. Sadler in his address were the keenness of intelligent workmen to make the elementary schools better, the demand by adult workers for an education touched by imagination, humanity, and civic idealism, the encouragement of education by employers of labour, educational experiments carefully planned and systematically watched (*e.g.* in practical courses of study and corporal training in higher elementary schools for ages twelve to fifteen, and in the actual results of postponing the beginning of Latin until twelve years of age), and the need for continuation schools to check the drift into the physical and intellectual disorder of the unemployed. A full report of Prof. Sadler's address appears in the *School World* for September.

The list of schools and other institutions to which visits had been arranged included the Yorkshire School for the Blind, the classes in domestic economy for employees at Messrs. Rowntree's Cocoa Works, the British Botanical Association, with its extensive arrangements for the supply of botanical material, and two hospitals for the insane, the latter typifying the help which the schools may expect to receive from all contributions to mental science.

Health at School and *Physical Education* are topics which seem amenable to scientific treatment, and as such were very properly placed in the forefront of the programme. Sir Edward Brabrook presented the report on the conditions of health essential to the carrying on of the work of instruction in schools. This report deals with hearing, teeth, playtime, and leisure. Some standard method of testing the hearing of children is desirable. Reports from other countries show that 12 per cent. to 20 per cent. of school children may be defective in their hearing. An examination of the teeth of 10,500 English and Scotch boys and girls of an average age of twelve years in poor law schools, workhouses, and reformatories showed only 14 per cent. of these children with teeth free from decay. The children in our public elementary schools are in a much more neglected state than the poor-law children. The committee thinks that daily cleansing of teeth should be enforced by parents and teachers, and that dentists employed by school authorities should make systematic examination of teeth.

Sir Lauder Brunton spoke on physical education, and showed that mind development was brain development. The teaching of hygiene might begin with the washing and dressing of dolls. He urged the medical inspection of schools, and brought to the notice of the section the National League of Physical Education and Improvement. His lecture was supported by a most welcome and generous distribution of pamphlets sent by that league, and his display of lantern-slides in the adjacent room when the botanists adjourned for lunch allowed of the presentation of evidence to a section which does not always find it easy to get at the facts which underlie opinions.

Dr. Ethel Williams gave careful estimates of the time, cost, and usefulness of medical inspection. In Newcastle, with 45,000 children on the books, three officers could inspect each child thrice in its school life at a cost of about 2000*l*. per annum, equivalent to a farthing rate. For the whole country 200,000*l*. would give similar inspection of children, with supervision of epidemics and of school buildings. Prof. Sadler pointed to the crux of the difficulty in getting parents to act on medical officers' reports, and Mr. Ernest Gray spoke of the attitude of suspicion in the working classes. Major Salmon spoke of the Swedish system of gymnastics as developed in Denmark. To keep the air clean for breathing exercises a damp felt or sacking is passed over the floors before every lesson.

Mr. A. Burrell said that freedom to move in one's clothes and a sense of cleanliness were the bases of true hygiene. The rightly dressed, clean child, and the well-ventilated class-room were the best lessons. Organised games had been approved, but playing centres had not yet been provided. A medico-ethical training was necessary for the teacher who was to stand hour by hour before weak sight, incipient deafness, and malnutrition. There should be a standard of health in training colleges analogous to that demanded by the Army and Navy.

Mrs. J. R. Macdonald showed how all schemes for the education of wage-earners of school age were bound up with social and economic questions. She urged a better enforcement of the Employment of Children Act, 1903. Mr. Hugh O. Meredith described the Workers' Educational Association—an effort to organise the higher education of working men by means of collegiate life in local guilds associated with the University Extension movement. Mr. Arnold S. Rowntree explained how similar ends were achieved by the adult schools meeting on Sunday mornings.

The discussion in Section I on the physiological value of rest might almost have been called a joint meeting, considering its interest for those attending Section L. Dr. Acland found that sleep was necessary for the growth of the brain and nervous system, and that many schools had not secured sufficient sleep either for younger boys or for those older boys who needed it. Mental and bodily health cannot be severed, and muscular exertion is not a remedy for brain fatigue. Dr. Bevan Lewis correlated brain-fag with muscular fatigue. The minimum of sleep for growing children was not defined, but no one advocated less than nine hours. Laboratory investigation into the general laws of fatigue is needed in the opinion of Dr. W. H. R. Rivers. Dr. Macdougall suggested that early morning sunlight should be shut out of a child's room.

Sir Philip Magnus presented the report upon the course of *Experimental, Observational, and Practical Studies most Suitable for Elementary Schools*. The committee asks that active and constructive work on the part of children should be largely substituted for ordinary class-teaching. To make this possible, smaller classes, trained teachers, and sympathetic inspectors are necessary. Supplementary reports of subcommittees were presented by Prof. R. A. Gregory on arithmetic and mensuration, by Mr. R. H. Adie on nature-study, and by Mr. George Fletcher on domestic work. There was an eager and universal request for copies of the full text of these reports, and the printed supply proved very unequal to the demand. The committee of the section proposed to arrange for further reprints. Prof. Green said that primary teachers needed training to use the freedom now given them, and needed also the opportunity of a higher professional course at the universities for those desirous of promotion. Mr. Cyril Jackson admitted the difficulties of large classes, Mr. T. P. Sykes emphasised the need for freedom to experiment, and Dr. Traill the importance of training teachers before trying to rush reforms through the schools.

In the discussion on *School Training for the Home Duties of Women*, Prof. A. Smithells said that at present home training reveals the methods of superstition, ignorance, prejudice, and folly. Nor does a formal course on the oxides of nitrogen and chlorides of phosphorus always produce a scientific attitude of mind in a household where ovens will not heat and meat will not keep. A schoolmistress with a scientific degree may fail to understand the hot-water system, the gas meter, or the filter. There is a more excellent way, and it is possible to develop a science of the household free from pedantry and free from empiricism in that vast undeveloped intellectual region connected with the domestic work of women. The discussion was continued by Prof. Armstrong, Prof. Millicent Mackenzie, and others.

The morning of Monday, August 6, was reserved for those public- and secondary-school questions relating to the *Balance of Subjects in the Curriculum*, the perennial interest in which has lately been revived by "Kappa" and by the "Upton Letters." Papers contributed by the Hon. and Rev. E. Lyttelton and by Mr. A. C. Benson were read in the absence of the authors. The possible omission of Latin in the preparatory school seems to have come within the range of discussion; at any rate, precedence for French seems agreed upon. Mr. T. E. Page proposed a committee to draw up a scheme of general study, to indicate the method and purpose of teaching the various subjects, and to show at what stage specialisation should be allowed. Mr. G. Gidley Robinson spoke of the preparatory-school master as not a free agent, scholarships being the root of the mischief. Mr. Arthur Rowntree assumed that training for power of work and service should be the prime object of education, and asked for an unburdening of the curriculum to allow of individuality in leisure hours.

Scientific Method in the Study of School Teaching was described by Prof. J. J. Findlay. Progress has been hindered by those earlier advocates of training who treated education merely as applied logic and ethics, but progress may be expected from experimental psychology and genetic psychology or child study. The popular interest in education leads to the ready adoption of opinions rather than the encouragement of prolonged investigations; but results in methods of school teaching can only be secured by observation of children. Educational experiments require the cooperation of several teachers for several years without external interference. Reforms have recently been introduced by external pressure, and only very inadequately tested by scientific experiments within the schools. Teachers should work in their schools as in a laboratory; but scientific habits are not easily acquired, and men trained in one branch of science do not readily transfer their scientific habits to the regions of prejudice and tradition. The demonstration schools at Manchester propose to investigate a few special topics, such as the elementary teaching of modern languages, practical mathematics, the association of parents with school life, and a school camp. Prof. Findlay applied his experimental methods for more than five years in Cardiff to discover the *Processes involved in the Acquirement of a Foreign Language*. The process is fundamentally one of acquiring habits of automatic re-action in the association of foreign symbols with ideas.

The native speech centre is a special hindrance, and the translation habit, although the path of least discomfort, is really a bar to progress. The rate of progress depends upon the intensity of the learner's absorption during the early stage. Inquiry into cases of aphasia among bilingual people may be expected to throw some light upon the nature of brain centres for foreign speech. The attempt to establish two foreign languages at the same time should not be made; each tends to inhibit the other. Latin, however, taken on a translation method does not appreciably interfere. Progress is hindered by the incapacity of some scholars to perceive new sounds.

The discussion on the *Examination and Inspection of Schools* was started by Prof. Armstrong, who asserted the need for freedom to develop individuality. The ideal system would be for the schools to examine themselves with the aid occasionally of competent assessors. Mr. W. M. Heller spoke on the constructive work of an inspector of schools. The transition from payment by results to inspection was accompanied for some years by a diminution in the proficiency of pupils. An inspector should possess successful teaching experience in both primary and secondary schools, if possible with the wider outlook of a headmaster. It takes time to know a large number of schools and teachers, and first impressions are sometimes wrong; hence an inspector should be left for several years in the same district. An inspector has a magnificent field for scientific research; he can watch, foster, and institute educational experiments of all kinds. The Rev. E. C. Owen doubted whether the inferior teacher well inspected was an improvement on the good teacher uninspected. Training would never eliminate mediocrity. If practical experience in teaching were made a *sine qua non* for administrative posts, this would attract good men to educational work.

A joint meeting was held with Sections A and G to discuss the *Teaching of Mechanics by Experiment*. Mr. C. E. Ashford spoke of the results obtained at Dartmouth by the cooperation of schoolmaster and engineer, and the use of real machinery instead of scientific toys. The science master who plays with laboratory toys is apt to be too academic, and the technical schools are too rule-of-thumb, lacking the rigorous mathematician and trained educationist; but the finest of laboratory toys were the delightful trolleys and vibrating springs shown by the lecturer and used by his pupils for measuring velocity, acceleration, and momentum.

Those who attended Section L greatly enjoyed Prof. Sadler's chairmanship, "serious and sunny." His summing up at the close of each day's discussion pointed through primitive chaos to the spirit of search, the growing desire for educational unity, and the fading away of narrow aims.

HUGH RICHARDSON.

INTERNATIONAL TESTING CONGRESS.

IN NATURE of September 6 (p. 471) brief reference was made to the opening of the International Testing Congress at Brussels on September 3. The work of the sections began on September 4, and was continued on September 5 and 6. The amount of work to be dealt with was so considerable that three sections were formed, A dealing with metals, B with building stone and cement, and C with other materials. Altogether there were twenty-seven reports of committees and forty-five original papers, the greater portion of which were submitted to the section on metals. Mr. J. Magery (Namur) presided over this section, and he was supported by honorary presidents representing the various nationalities present, and including Messrs. Wedding (Berlin), Brough (London), Saladin (France), Hackstroh (Holland), Chernoff (Russia), Brinell (Sweden), Popper (Austria), and Tonello (Spain). The following are brief notes on the various reports presented:—

Mr. A. Rieppel (Nuremberg) reported on the introduction of standard specifications in various countries; Mr. W. Ast (Vienna) reported on methods for inspecting and testing in order to ensure uniformity in iron and steel; Mr. R. Krohn (Danzig) reported that it was not feasible to establish standard welding tests. Prof. E. Heyn (Berlin), reporting on the value of etching malleable iron for the investigation of structure, showed that examination by the unaided eye gave valuable information as to the character of quenched high-carbon steel. Prof. N. Belelubsky (St. Petersburg) reported on the unification of methods of testing, and submitted a series of proposals. Prof. H. M. Howe and Mr. A. Sauveur submitted proposals for the uniform nomenclature of iron and steel. Dr. R. Moldenke (New York) reported on the establishment of standard methods of testing cast-iron and finished castings. He noted that the American and German specifications differ but slightly, and could easily be made identical.

Mr. E. Sauvage (Paris) submitted a report on impact tests on notched bars, and there was an animated discussion as to the value of this method of testing, opinions being equally divided as to the desirability or not of recommending it in specifications. The Brinell hardness test, which was reported on by Mr. J. A. Brinell and Mr. G. Dillner (Stockholm), was also keenly discussed, the general opinion being that, with the view of placing information on record, tensile tests of metals should, when possible, be supplemented by tests by the Brinell method. Mr. W. Ast (Vienna) submitted a report on international researches in the macroscopic examination of iron. The etching test is recommended for preliminary examination. Lastly, Mr. F. Osmond and Mr. G. Cartaud (Paris) submitted an interesting report on the progress of metallography since the Budapest congress of 1901.

The second section, dealing with cements, was under the presidency of Mr. Levie (Charleroi). The subjects discussed included the determination of the adhesive force of hydraulic cement, the determination of the weight of a litre of cement, and the behaviour of cement in sea-water. It was decided to appoint a committee to inquire into reinforced concrete.

The third section, under the presidency of Mr. E. Roussel (Malines), devoted attention to tests of paints, linseed oil, wood, bitumen, asphalt, and india-rubber. The congress concluded with a lecture by Prof. H. Le Chatelier (Paris) on the practical applications of metallography. An interesting feature of the congress was a small laboratory installed to illustrate modern methods of testing, under the direction of Prof. Le Chatelier, Mr. Guillet (Paris), and Prince Gagarine (St. Petersburg). It was decided that the next congress should be held in 1909 in Copenhagen under the presidency of Mr. A. Foss, president of the Society of Danish Engineers.

THE ANTI-TUBERCULOSIS CAMPAIGN.

THE Hague, preparing to receive the great Peace Congress of 1907, which is to discuss questions of peace and disarmament, recently entertained delegates from the chief European and American States to the fifth International Conference on Tuberculosis. At this conference questions of *increased* armaments were discussed, with the view of waging a more effective war against this great evil. The great interest taken all over the world in the proceedings of the conference testifies to the awakening of mankind to the necessity of making further and greater efforts in order to reduce the ravages of tubercular infection to a minimum.

At the present time the campaign against tuberculosis is being carried on with greater energy than at any previous period in medical history. Since Koch's discovery of the tubercle bacillus in 1882, and the publication of his exhaustive researches arising therefrom, it has been known to medical men that tuberculosis is as much a preventable disease as plague or cholera. Nevertheless, the public in England have remained until very recently apathetic and apparently indifferent to the fact that untold misery and sixty thousand actual deaths occur annually from a disease which can and ought to be eradicated. At last we are waking from our lethargy. This change has been gradually induced by the insistent pressure of medical opinion, aided largely by the King's active sympathy and interest. More lately Prof. Wright's great work on "opsonins" has given fresh hope and energy to many who were becoming jaded in an apparently hopeless conflict.

Since 1851 statistics show a steady decline in the mortality of tuberculosis, and for this the principles of general sanitation have been chiefly responsible. We may expect in the future that this improvement will be maintained by the continued prevention of overcrowding, the enforcement of good ventilation, improvement of insanitary areas, more effective drainage, better cleansing of streets, and the more stringent supervision of meat, cowsheds, dairies, &c.; but more rapid progress may be made and eventual extinction of the disease attained if more direct measures are employed in an intelligent and comprehensive manner.

Of more direct measures, hospitals for consumption have no doubt played a part in the decline of phthisis, but anyone acquainted with the conditions of life obtaining in our great centres of population must admit that their sphere of usefulness is but limited. The reasons for this are not far to seek:—firstly, hospital treatment is practically useless for cases of advanced tuberculosis, and most hospitals refuse admission to patients suffering from a widespread infection; secondly, patients well fed and passing a restful existence in hospital under the best hygienic conditions rapidly break down on again returning to their homes, where such favourable conditions are impossible. The recognition of this latter fact has led to the erection of sanatoria in various parts of the country, where patients may continue for a time to build up their powers of resistance after leaving hospital, and where they may by graduated exercise under proper medical supervision steadily fit themselves for the more arduous work of ordinary life.

At the present time the number of sanatoria is limited, and hopelessly inadequate for the work. Efforts are, however, being made all over the country to increase their number, but the cost of building and the cost of maintaining an efficient sanatorium is a practical difficulty with which we are faced at the outset. The King's Sanatorium at Midhurst, perhaps the most perfect of its kind in the world, cost approximately 1000*l.* per bed. Having regard to the number of beds required all over the country, a cost anything approaching these figures is prohibitive. The Open-air League, however, has directed its attention to this point, and has as one of its principal objects the erection of sanatoria at a cost estimated at not more than 100*l.* per bed, including complete equipment and the freehold of the ground. At Woodilee and Gartloch Asylums (Scotland) wood and iron sanatoria have been erected at a cost of 90*l.* per bed. If satisfactory headway is to be made we must have more sanatoria, and from the nature of the case they must be erected as cheaply as possible.

Another philanthropic body, under the presidency of H.R.H. Princess Christian, called The National Committee for the Establishment of Sanatoria for Workers Suffering from Tuberculosis, having similar objects in view, recently purchased 250 acres of land in Kent, and is about to build a sanatorium for poor patients; the committee expects that the institution will be self-supporting, without endowment from local rates or private charitable subscriptions. These organisations are working along the right line and doing splendid work, but so great is the number of tuberculous patients (80,000 in London alone) that they are only able to touch the fringe of this tremendous problem.

Hitherto sanatorium treatment has mainly consisted of fresh air, rest in bed, full diet, and graduated exercise under constant medical supervision. Such a life is not a very healthy moral existence; it produces the "sanatorium habit," which renders one who has acquired it morally unfit, as he is already physically, for the more strenuous life to which he must sooner or later return. In order to counteract the emasculating influence of sanatorium life as hitherto pursued, to reduce the cost of maintenance, and in order to provide work for patients who would otherwise lead an indolent and purposeless life, various schemes have been proposed.

The Open-air League intends to found farm colonies in connection with its sanatoria where patients cured, but as yet unfit to return home, may occupy themselves in farming, in the cultivation of vegetables, and other similar light occupations. An intermediate stage is thus created during which the patient is braced up physically and morally, and his tendency to relapse reduced to a minimum. Hospitals and sanatoria, however, under their rules exclude cases of advanced tuberculosis. Such cases under hospital treatment remain stationary or get worse, and merely occupy beds which may be more usefully employed in the treatment and cure of patients less extensively infected. Advanced cases, then, added to the many who for various reasons prefer to remain at home, are under no control, and constitute a constant and very real menace to the health of the general public. How to reach these patients and bring them under proper medical supervision is in most localities a great difficulty, yet until it is dealt with all hope of eradicating tuberculosis may be abandoned. In London there appears to be no organisation as yet which will undertake this necessary work. The difficulty has been met in Scotland by the founding of "dispensaries for tuberculosis," and this example has been followed in France and Belgium. In Germany, too, similar institutions (Wohlfahrtstellen für Lungenkranke) have been founded. The functions of a dispensary are briefly these:—

(1) Medical examination of patients.

(2) Inquiry by a medical man or nurse into the history of the illness, the home conditions, the economic condition of the family, the suitability of the accommodation for home treatment.

(3) Arrangements for providing medical treatment and nursing of patients that could be treated at home without risk of infection.

(4) Dispensing of medicines and disinfectants.

(5) Selection of cases suitable for hospital treatment.

The type of dispensary which might well be copied by other cities is the Royal Victoria Dispensary, founded eighteen years ago by Dr. R. W. Philip in Edinburgh. The excellent work done by this pioneer institution has been of incalculable benefit to the community.

By these means the campaign is carried into the very homes of the patients, and an attempt is made to limit at its source the constant stream of more or less advanced cases of tuberculosis which appear daily in the out-patient departments of our hospitals.

The cost of such dispensaries is not great; Dr. Philip estimates it at 500*l.* to 1000*l.* per annum for a city of 300,000 inhabitants. It might be paid out of the rates, and the dispensaries, for administrative purposes, should be under the control of the medical officer of health.

Pulmonary tuberculosis has been recognised in Scotland by the Local Government Board as an infectious disease within the meaning of the Public Health Act (Scotland), 1897; consequently the obligations of the local authority with regard to infectious disease are extended to phthisis, and much more efficient control is established.

Under the Infectious Diseases Act (1889) the Local Government Board can invest local authorities with similar powers. In Sheffield these powers have been obtained in a modified form, and in Manchester and some other localities notification of tuberculosis has been tried with success.

Surely the time has now arrived when the powers possible under the Infectious Diseases Act should be more generally employed. A system of voluntary notification has been inaugurated in Manchester; this was at first limited to public institutions, but in 1900 medical men were invited to notify the cases occurring in their private practice. The system has worked well, and has been of immense benefit in affording opportunities for visiting the homes of the patients and instructing them in the principles of disinfection, ventilation, and the proper disposal of sputa, &c. It cannot be doubted that some system of notification (voluntary or compulsory) is imperative if efficient control is to be obtained. It is not contended that notification by itself has any administrative value, but if efficiently followed up by adequate preventive measures it would alter the whole aspect of affairs; on the other hand, application of the provisions of the Public Health Act to tuberculosis is impossible unless some system of notification is employed.

Many new cases of infection arise from ignorance of the infectivity of tuberculosis, and from an absence of any knowledge as to how best to live without spreading infection. To combat this local authorities have distributed leaflets conveying simple instructions for the everyday life of tuberculous persons, and various philanthropic bodies (*e.g.* the Open-air League) have this education of the public as one of their chief objects.

Brighton, however, under the able leadership of Dr

Newsholme, has struck out a new line. The vacant wards of the hospital are utilised for the education of consumptives. Patients living at home are admitted to the hospital for short periods (four to six weeks), during which time they are instructed as to how they should live and in all the precautions and preventive measures they should practise on returning to their homes. In this way a constant stream of enlightened information is continually disseminated among the most ignorant. Some other towns are following this excellent example.

Although it has been shown that much time, money, and energy are being expended by various public and private bodies in the effort to throw a net over the whole tuberculous population, yet it must be confessed there remain many gaps which must be filled up if success is to be attained in our war against consumption. Proper organisation and coordination of effort are needed. A well-thought-out scheme must be put in action throughout the country and controlled by some central authority. This duty falls naturally to the Local Government Board, and is it too much to expect that a "tuberculosis committee" of that board may be appointed the chief duty of which should be the control and direction of the isolated efforts now being made in various parts of the country? By this means greater efficiency and better results would accrue at a proportionately smaller cost. R. FIELDING-OULD.

ATMOSPHERIC ELECTRICITY IN ALGERIA.

IN the *Revue générale des Sciences* of May 30, M. Ch. Nordmann gives an account of the phenomena of atmospheric electricity, and of one or two of the latest theories on the subject, and also describes some recent observations made by himself in Algeria. Atmospheric electricity is now so large a subject that the essay naturally covers only a part of the ground, and does not go into many details. It shows, however, the clearness and lightness of touch one expects from our neighbours across the Channel. In a few points perhaps its conclusions are a little precipitate, but it contains some shrewd criticisms of other people's theories. The paper contains copies of some interesting electrograms, mostly obtained by the author in August and September, 1905, at Philippeville, on the southern coast of the Mediterranean.

M. Nordmann first points out that the normal potential gradient in the atmosphere may arise from a negative charge on the earth, or a positive charge in the air, or from the two combined. He regards the presence of an excess of positive electrification in the air as proved by the fall in the potential gradient with increasing height observed in balloon ascents. He refers to Elster and Geitel as having discovered that any charged body, however well insulated, loses its charge in ordinary atmospheric air. Historically this is hardly complete, as Elster and Geitel merely confirmed what Linss had discovered many years before. Elster and Geitel have, of course, added enormously to our knowledge of the subject, and they gave it much greater precision, besides bringing it into line with recent laboratory research.

Passing to the diurnal variation in the potential gradient, p. 445, M. Nordmann refers to the double period with maxima about 8 a.m. and 8 p.m. as having been regarded until recently as universal. He next refers to observations on mountains, especially those on the Sonnblick, as showing that at high levels the afternoon minimum disappears, the diurnal variation becoming simple, and mentions Chauveau as having established the existence of the same phenomenon on the Eiffel Tower. In both cases the observations show rather a reduced prominence in the afternoon minimum than its total absence, and on p. 447 Nordmann somewhat qualifies his earlier remarks. His own observations at Philippeville supply a very interesting example of a simple period. Observing on an eminence 160 metres high, immediately adjacent to the sea, he obtained as the mean from the quietest days of his stay (the number of which is not stated) a diurnal variation with a minimum from 4 a.m. to 5 a.m., and a maximum about 5 p.m. The value was above the mean from 11 a.m. to 10 p.m., and below from 11 p.m. to 10 a.m. During the day the wind blew straight from the sea, and during the night from the land. The results are so unusual, and if confirmed so suggestive, that an extension of the observations over a much longer period is desirable. Until that is done, one cannot feel sure that the results are fairly representative, even of the particular season of the year when they were observed. Among the electrograms reproduced is one showing the effects of a sirocco from the desert. The large and sudden changes of potential, the curves going off the sheet both in the positive and negative directions, are similar to those met with in England during thunder or heavy rain. Other curves of interest are those showing the changes of the potential and of the positive ionisation of the air at Philippeville during the total eclipse of the sun on August 30, 1905. Between the times of the first and last contacts the potential was *slightly* above its mean for the time of the day, and the ionisation fell decidedly as totality approached. The maximum in the one curve and the minimum in the other occurred forty-five minutes after totality.

In his criticisms of theories by Elster and Geitel and Ebert the author points out that at Philippeville the potential was below, not above, its mean when the wind blew off the land, and that the barometric pressure showed the ordinary double period. In discussing some theoretical views of his own, he refers to a difficulty in that "en passant de l'été à l'hiver la diminution du rayonnement solaire s'accompagne d'un abaissement du champ, en passant du jour à la nuit elle coincide, au contraire, avec une augmentation." This is rather puzzling in view of the author's perfectly correct statement, p. 446, that the potential is highest in winter. C. CHREE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Greifswald has received a legacy of 60,000 marks under the will of the late Dr. Milschewsky, who died recently in Loburg.

PROF. MORRIS TRAVERS, F.R.S., professor of chemistry at the University College, Bristol, has been appointed director of the Indian Institute of Science which is to be established in Bangalore.

ACCORDING to the *Chemiker Zeitung*, the authorities of the Zürich University have decided to increase considerably the University lecture and laboratory fees chargeable to foreigners, with the idea of lessening to some extent the present high percentage of foreigners who attend.

IN the columns of the *Chemiker Zeitung* for last week we read that the Grecian Government recently received from St. Petersburg a legacy of about eight million roubles, or 1¼ millions sterling, which was left in the beginning of the last century by a rich Grecian merchant, of the name of Dombolis, with the condition that after the lapse of a definite time a second Grecian university should be built in Corfu out of the capital and interest, and be called the Kapodistrias University.

THE fees for the examinations of the German technical high schools have been fixed on the following scale:—for the preliminary diploma examination, 60 marks for naturalised Germans, 120 marks for foreigners; for the diploma examination, 120 marks for Germans and 240 marks for foreigners; for the doctor of engineering examination, 240 marks, of which the first half is to be paid when the examination thesis is handed in, and the remainder before the oral examination is taken.

THE university buildings of Groningen were almost completely destroyed by fire on August 30. The fire is supposed to have been caused by careless use of benzine or methylated spirits on the part of workmen. The natural history museum and the chemical and pharmaceutical laboratories were entirely destroyed, while the hygienic and physiological laboratories were saved. The university buildings, which, strangely enough, were not insured, were erected in 1846–1852. An emergency committee has made arrangements for the lectures and classes of the coming session to be begun as usual. The University has approximately five hundred students.

THE prospectus of the Borough Polytechnic Institute for the session 1906–7 contains abundant proof that the educational needs of the young men and women of South London are well provided for. The object of the classes is to provide sound instruction and to promote industrial skill and general knowledge. It is interesting to note that the trade classes are intended especially and only for those who are engaged in the several trades. Among such classes may be mentioned as typical those for motor drivers and repairers, motor engineers and designers, sanitary inspectors, men engaged in electrical and building industries, and bakers and confectioners. Special attention is paid also to the technical education of women, for whom a variety of trade classes has been arranged. Women are trained for home duties in a special department, and prominence is given to the scientific principles upon which successful domestic practices depend. The arrangements made for the coming winter are of a very complete character.

IN the opening pages of the new calendar of the University College Hospital Medical School is an explanatory statement of the new arrangements for medical education consequent upon the formation by the University of London of university centres for instruction. Under these arrangements a student will enter one of the university centres for the preliminary and intermediate medical studies, and will then complete his career at the Hospital Medical School, the whole of the energies and resources of which will be devoted to a development of the medical studies proper. The calendar contains an engraving of the new buildings of University College Hospital, provided by the generosity of the late Sir Blundell Maple, which will be opened formally by H.R.H. the Duke of Connaught on November 6. Another engraving shows an elevation of the new medical school buildings erected through the munificence of Sir Donald Currie. These buildings are being specially constructed with laboratories and research rooms for medicine, surgery, pathology, and other departments.

A COMPREHENSIVE resolution referring to education was adopted last week at the Trade Union Congress at Liverpool. Among the points accepted by the congress as essential to a sound educational system are the following:—(1) scientific physical education with medical inspection and records of the physical development of all children attending State schools, and skilled medical attendance for any child requiring same; (2) a national system of education under full popular control, free and secular, from the primary school to the university; (3) secondary and technical education to be an essential part of every child's education, and to be secured by such an extension of the scholarship system as will place a maintenance scholarship within the reach of every child, and thus make it possible for all children to be full-time day pupils up to the age of sixteen; (4) the best intellectual and technical training to be provided for the teachers of the children; (5) the cost of education to be met by grants from the Imperial Exchequer, and by the restoration of misappropriated educational endowments.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 28.—"Researches on Explosives." Part iv. By Sir A. **Noble**, Bart., K.C.B., F.R.S.

In part iii. of his "Researches on Explosives" the author gave the results of a very extensive series of experiments on certain explosives, which were, first, the cordite of the Service, known as Mark I.; second, the modified cordite, known as M.D.; and third, the nitrocellulose, known as Rottweil R.R. The experiments made extended, for all the above explosives, from densities of 0·05 to 0·45 or 0·50, and pressures of from 2·75 tons per square inch (419 atmospheres) to pressures of 60 tons per square inch (9145 atmospheres).

In the present paper full details are given of three other explosives, and comparisons are made between them and the explosives which have been so much experimented with in this country. If reference be made to the tables, which cannot be given in this abstract, it will be seen how wide are the differences between the explosives, not only in the absolute volumes of the several gases, but in the variations with reference to the densities at which they were fired.

Thus, for example, comparing Norwegian 165 and Italian ballistites, while in the former the carbon monoxide commences at the density 0·05, with a percentage volume of 38·5, falling at a density of 0·45 to 22 per cent., the carbon dioxide commences with 13·3 per cent., rising rapidly to 31 per cent. In the latter explosive the CO commences at 20·5 per cent., and falls slowly to 15 per cent., while the CO_2 commences a little above 26 per cent., rising also comparatively slowly to nearly 34 per cent.

But there are, in these two explosives, other remarkable differences. Thus, in the Italian ballistite, at a density of 0·05, the volume of methane CH_4 is a mere trace, about 0·02 per cent., and it remains very much lower than is the case with any other explosive, being only 1·9 per cent. at the density of 0·45. With the Norwegian, on the other hand, the CH_4, although the volume at commencement is only 0·04 per cent., is, at 0·45 density, 11 per cent.

Again, as might be expected, from the large quantity of CH_4 found in the case of the Norwegian ballistite, the volume of hydrogen falls from more than 20 per cent. to about 9 per cent.; in the Italian the H rises from about 8 per cent. to about 10 per cent., falling slightly at higher densities.

In both explosives the N is practically constant at about 12 and 16 per cent. respectively, but there is a very great difference as regards the H_2O. In the Norwegian the H_2O is constant at 14 per cent., there being no greater difference than might be expected from errors of observation, while, in the Italian, the H_2O, which commences at density 0·05, with a volume of 29 per cent., falls at a density of 0·45 to about 24 per cent. No other explosive approaches the Italian ballistite in respect to the large volume of aqueous vapour formed, especially at low densities.

In the tables are given the volumes in cubic centimetres per gram of the permanent and total gases, and curves have been drawn representing for the six explosives the observations of these volumes. In the case of five of the explosives there is, with increasing density, a very considerable decrease in volume, but with the Italian ballistite, throughout the range of the experiments, there is hardly any change. Curves representing these volumes are concave to the axis of abscissæ.

In the tables are shown the units of heat, both for water fluid and water gaseous. Curves have also been drawn for the units of heat (water gaseous); the curves in this instance are all convex to the axis of abscissæ, and it may be noted that, where the volume of gas per gram is large, the units of heat are low, and that, where the volumes of gas are rapidly decreasing, the curves representing the amount of heat developed show a rapid increase.

The next point to be considered is, the data being as is shown in the tables, what temperature are we to assign to that generated by the explosion? With the view of studying the question, the author resorted to two methods:—(1) Knowing with very considerable accuracy the units of heat (water gaseous) generated by the explosion, and having determined approximately the specific heat of the gases, the temperature of explosion should be given by the equation

$$t = \frac{\text{gram units of heat}}{\text{specific heat}} \quad \ldots \ldots \quad (1)$$

(2) Knowing also with considerable accuracy the pressure at any given density, and knowing the pressure p_0 when the volume of gas generated is reduced to the temperature of 0° C., and a pressure of 760 mm. of mercury, the temperature is given by the equation

$$t = \frac{p - p_0}{0{\cdot}00367\ p_0} \quad \ldots \ldots \quad (2)$$

With reference to equation (1), the specific heat of CO_2 is a very important factor in this determination, and the recent researches of Messrs. Holborn and Austin upon the specific heat of gases at constant pressure at high temperatures having apparently shown that the specific heats given by Mallard and Le Chatelier for temperatures above 100° C. are considerably too high, the author has taken the figures given by the former physicists, which, it may be remarked, up to temperatures of 800° C., are confirmed by Langen.

The specific heats given are, as has been said, those for constant pressure, and to obtain those at constant volume it is necessary to divide by the constant k, connecting the specific heats of gases and vapours at constant pressure and constant volume.

The author gives the values he has used, (1) of the specific heats at constant pressure; these are taken either from Holborn and Austin's paper, or from Landolt, "Physikalisch Chemische Tabellen," 1905; (2) of the constant k; these are all taken from Landolt, pp. 407–8; (3) of the specific heats at constant volume.

Gases, &c.	Specific heat, constant pressure	Value of k	Specific heat, constant volume
CO_2	0·2986	1·282	0·232
CO	0·2425	1·401	0·173
H	3·4100	1·408	2·422
CH_4	0·5922	1·316	0·450
N	0·2497	1·410	0·177
H_2O	0·4210	1·330	0·361

The specific heats calculated from the above data, of the gases generated by the explosion of the six propellants, are given in the tables embodying the results of the whole of the experiments for each propellant, and in the tables are also given the temperatures of explosion deduced from equations (1) and (2), and here again it must be remembered that the temperatures with which artillerists are chiefly concerned are those due to densities varying approximately between 0·17 and 0·23.

The Italian ballistite, which from equation (1) shows the highest temperature, commences at the density of 0·05 with 4943° C., this temperature hardly varying at all until the density of 0·25 is reached, when it slowly but regularly increases to about 5000° C. at $d=0{\cdot}45$. Cordite Mark I., commencing at 4742° C., with a very slight fall, is practically constant up to $d=0{\cdot}30$, after which it rises somewhat rapidly to a temperature of 4921° C. at $d=0{\cdot}45$, and to 5065° C. at $d=0{\cdot}50$.

When, however, the temperatures given by equation (2) are reached some very remarkable differences are met with.

It is found that at the higher densities and pressures there is generally a very tolerable accordance in the temperatures obtained from the two formulæ, but as the density and pressure diminish the divergence becomes in all cases considerable, but very greatly more with the explosives which develop very high temperatures, and which give rise to large percentages of carbonic anhydride.

The only construction the author is able to put upon the close approximation of temperature given by the two formulæ at high densities and pressures, and the wide differences which exist in some of the explosives at low densities, is that at high densities dissociation of the carbonic anhydride is prevented by the very high pressure, and that the great difference between, for instance, Italian ballistite and nitrocellulose R.R. at, say, the density of 0·1, is due, firstly, to the difference of the temperature at which the nascent gases are generated, and, secondly, to the proportion of CO_2 which is subject to dissociation.

The theory submitted is as follows:—

The nascent gases are generated at temperatures approximately as given by equation (1).

Under the low densities and pressures at the very high temperatures with which we are concerned, the CO_2 and possibly some H_2O are partially dissociated, giving rise to the fall in temperature exhibited by the results obtained from equation (2) at low densities. At high densities, as already pointed out, the two equations give in some cases accordant results, in all cases tolerable agreement; it therefore appears to the author to be reasonable to suppose that the facts he has recorded are due to partial dissociation at low densities and pressures, which dissociation is prevented by the very high pressures ruling at densities of 0·40, 0·45, and 0·50.

As no free oxygen is ever found in the analyses in cooling down, any free oxygen due to dissociation must have recombined, and the heat lost by dissociation regained. The re-combination must, however, be very gradual, as no discontinuity is observed in the cooling curves.

It is then pointed out that a certain amount of confirmation is given to the view taken by the fact that if the explosives be arranged according to the amount of heat generated, derived from equation (1), regard being also had to the amount of CO_2 found, it will be found that the differences between the two formulæ decrease approximately as the factors to which the author has referred decrease, and a table is given showing these differences.

"On the Julianiaceæ, a New Natural Order of Plants." By W. Botting **Hemsley**, F.R.S.

The Julianiaceæ comprise two genera and five species. They are resiniferous, tortuously branched, deciduous, diœcious shrubs or small trees, having alternate, exstipulate, imparipinnate leaves, from about one to three decimetres long, clustered at the tips of the flowering branches and scattered along the short barren shoots. The flowers are small, green or yellow-green, quite inconspicuous, and the males are very different from the females. The male inflorescence is a more or less densely branched axillary panicle or compound catkin, from 2½ cm. to 15 cm. long, with weak, thread-like, hairy branches and pedicels. The male flowers are numerous, 3 mm. to 5 mm. in diameter, and consist of a simple, very thin perianth, divided nearly to the base into four to nine narrow, equal segments, and an equal number of stamens alternating with the segments. In structure and appearance they are almost exactly like those of the common oak. The female inflorescence is similar in structure to that of the sweet chestnut, consisting of an almost closed, usually five-toothed involucre, borne on a flattened pedicel and containing three or four collateral flowers, of which the two outside ones are, perhaps, always abortive.

At the flowering stage, the female inflorescences, including the narrow flattened pedicel and the exserted styles, are about 2 cm. long, and, as they are seated close in the axils of the crowded leaves and of the same colour, they are easily overlooked. The female flowers are destitute of a perianth, and consist of a flattened, one-celled ovary, terminated by a trifid style and containing a solitary ovule. The ovule in both genera is a very peculiar structure. That of Juliania, in the flowering stage, is a thin, flat, obliquely horseshoe-shaped or unequally two-lobed body, about 2 mm. in its greatest diameter, attached to the base of the cell. At a little later stage, in consequence of unequal growth, it is horizontally oblong, nearly as large as the mature seed, that is, 6 mm. to 8 mm. long, and almost symmetrically two-lobed at the top. A vascular bundle or strand runs from the point of attachment to the placenta upwards near the margin into one of the lobes. In this lobe the embryo is tardily developed, and at this stage it is more or less enclosed in the opposite lobe, the relations of the two being as nozzle and socket to each other. It is assumed that the whole of this body, with the exception of the lobe in which the embryo is formed, is a funicle with a unilaterally developed appendage, which breaks up and is absorbed during the development of the ovule into seed.

The ovule of Orthopterygium is very imperfectly known, but the attachment appears to be lateral and the funicular appendage cup-shaped at the basal end, bilamellate upwards, and more or less enclosing the embryoniferous lobe.

The compound fruits of Juliania are samaroid in form, the wing being the flattened pedicel, at the base of which it disarticulates from the undifferentiated part of the pedicel. They vary from 4 cm. to 7 cm. in length by 1½ cm. to 2½ cm. in width. Externally they strongly resemble the samaroid pods of certain genera of Leguminosæ, notably those of Platypodium and Myroxylon. The involucre itself, of the largest fruits seen, is only about 1 cm. deep by 2 cm. wide. It is composed of very hard tissues, and is quite indehiscent. Only quite young fruit of Orthopterygium is known. In this the flattened pedicel is narrow, straight, and equilateral, from 6 cm. to 7 cm. long and about 1 cm. wide.

The nuts of Juliania are almost orbicular, biconvex, hairy on the outside, and have a very hard endocarp. The solitary exalbuminous seed is circular or oblong, 6 mm. to 10 mm. long, compressed, with a smooth, thin testa. The embryo is horizontal, with thin, plano-convex, more or less oblique, obscurely lobed cotyledons, which are epigæous in germination, and a long ascending radicle applied to the edges of the cotyledons.

So far as at present known Juliania is confined to Mexico, and the various species occur in isolated localities between about 17° 40′ and 23° N. lat., and 97° and 104° W. long., and at altitudes of about 1500 feet to 5500 feet.

The habitat of the Peruvian Orthopterygium Huaucui is 2000 miles distant from the nearest locality of any species of Juliania. The exact position of the only place in which it has been found cannot be given, but it is in the Province of Canta, in the Department of Lima, between 11° and 12° S. lat.

PARIS.

Academy of Sciences, September 3.—M. A. Chauveau in the chair.—Observations of the Kopff comet made with the bent equatorial at the Algiers Observatory: M. F. **Sy.** Details of observations made on August 24 and 25. The comet appeared as a round nebulosity, with a nucleus, the lustre of which was comparable to a star of the twelfth magnitude.—Observations of the Kopff comet (1906*e*) made with the bent equatorial (32 cm.) of the Lyons Observatory: J. **Guillaume.** Results for six nights, August 26–31.—The growth of multiform functions: Georges **Rémoundos.**—Description of an autocollimator level with a mercury horizon: MM. **Claude** and **Driencourt.** The description is accompanied with a diagram of the apparatus, for which a greatly increased accuracy is claimed.—The determination of the melting points of the alloys of aluminium with lead and bismuth by means of thermoelectric pyrometers: H. **Pécheux.** The melting points were studied by two couples, platinum|10 per cent. platinum-iridium and nickel|copper. The temperatures given by each couple for eight alloys are stated, and the agreement is sufficiently good for the author to suggest that the nickel-copper couple may render good service for commercial uses.—The action of nascent hypoiodous acid on unsaturated acids. Iodo-lactones: J. **Bougault.**—Starchy material studied with the aid of our knowledge of the colloidal state: G. **Malfitano.**—The isomorphism of northupite with tychite: A. **de Schulten.**

NEW SOUTH WALES.

Linnean Society, July 25.—Mr. Thomas Steel, president, in the chair.—The botany of north-eastern New South Wales: F. **Turner.** The paper gives a general account of the indigenous vegetation and of the exotic weeds of the country comprised between the New South Wales-Queensland border and 32° S. lat.; the S. Pacific on the east, and 152° 20′ or 151° E. long. From a botanical point of view, the region in question is one of the most fertile and interesting sections of country in Australia, and a census of its semi-tropical flora is estimated to comprehend 734 genera and 1767 species.—A review of the New South Wales species of Halorrhagaceæ, as described in Prof. A. K. Schindler's monograph (1905), with the description of a new species: J. H. **Maiden** and E. **Betche.** The paper contains a list of New South Wales species of Halorrhagaceæ, showing the important changes made by Prof. Schindler, and gives description of a new species, *H. verrucosa*, from Woodburn, Richmond River, the specific name being given from the character of the fruit. Its nearest ally in Schindler's classification is *H. tenuis*, and in Bentham's *H. micrantha*, R.Br.—Notes on the hymenopterous genus Megalyra, with descriptions of new species: W. W. **Froggatt.** A general account of the members of this curious genus of parasitic Hymenoptera is given, with notes on the species previously described, their general structure, and the longicorn beetles the larvæ of which they parasitise. Eight new species are added to the seven previously described from Australia.—Description of a new tick of the family Argasidæ: W. W. **Froggatt.** The common "fowl-tick," *Argas americanus*, has been acclimatised in Australia for more than twenty years. An indigenous species is now described. This Argasid is common in the clay nests of the fairy martin, *Petrochelidon (Lagenoplastes) ariel*, and is usually to be found under the lining of feathers and grass resting against the clay in the nests containing the young birds, and for some time after the nestlings have flown.—The life-history of *Lestes leda*: R. J. **Tillyard.** The species is shown to be double-brooded. The male assists the female in the act of oviposition, seizing her round the neck. The method of oviposition is discussed, and various statements that have been made by different entomologists from time to time are shown to differ from the results of observations on this species.

CALCUTTA.

Asiatic Society of Bengal, August 1.—Bibliomancy, divination, superstitions amongst the Persians: Lieut.-Colonel D. C. **Phillott.**—*Gentiana Hügelii*, Griseb., re-described: Dr. Otto **Stapf.** In 1835 Baron Karl von Hügel collected this gentian in Kashmir, and the specimens are preserved at Vienna. They have never been examined by writers on Indian gentians, and because Grisebach did not describe them quite accurately the species has never been fully understood. A new description is therefore necessary, and is offered with illustrations.—*Swertia angustifolia*, Ham., and its allies: I. H. **Burkill.** An account of *Swertia angustifolia*, with *pulchella* and *affinis, S. corymbosa, S. zeylanica*, and the whole of their close alliance, based on an examination of all the material available at the herbaria at Kew, at the Natural History Museum, South Kensington, at the Jardin des Plantes, Paris, and at Shibpur, Saharanpur, Madras, and Peradeniya, Ceylon. Some of the species defined are used medicinally for the true Chiretta.—Notes on some rare and interesting insects added to the Indian Museum collection during the year 1905–6: C. A. **Paiva.** Notes on specimens, chiefly of Hymenoptera and Hemiptera, collected in Calcutta and the Darjiling and Purneah districts, together with a list of the Hymenoptera received from the Seistan Boundary Commission.—*Bulbophyllum Burkilli*: a hitherto undescribed species from Burma: Captain A. T. **Gage.** A description of a new Bulbophyllum from the Burmo-Siamese frontier, Tenasserim, which has flowered in the Royal Botanic Garden, Shibpur.

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