THURSDAY, AUGUST 10, 1905.

SOCIOLOGICAL SPECULATIONS.

A Modern Utopia. By H. G. Wells. Pp. xi+393. (London: Chapman and Hall, Ltd., 1905.) Price 7s. 6d.

It is instructive to watch the growth, both in power and in hopefulness, of Mr. Wells's criticism of life. In the "Time Machine" his forecast of the future of humanity was frankly appalling; in "When the Sleeper Wakes," more lurid (albeit far more probable) than the worst imaginings of "reforming" socialists. "Anticipations" was a most stimulating book, but so deliberately confined itself to exalting and exaggerating the prospects of a single aspect of life, so exclusively devoted itself to glorifying mechanical and material progress, that those sensitive to our spiritual and æsthetic possibilities might be pardoned for regarding the present order, with all its cruelty, waste, sordidness, and grotesqueness, as a golden age in comparison with Mr. Wells's world. "Mankind in the Making" contained much vigorous criticism and many sensible and practical suggestions. In the present book Mr. Wells has become still more moderate and practicable and hopeful, without in the least derogating from his ingenuity and originality. We sincerely hope, therefore, he will not, as he threatens, stick henceforth to his "art or trade of imaginative writing," but will continue from time to time to regale and stimulate us with sociological speculations.

Stripping off the romantic form—in which Mr. Wells dreams himself and a companion, a botanist suffering from a chronic affair of the heart, into a distant planet which is an exact duplicate of our earth, save that it has realised all the good which is attainable with our present resources—his main argument may be condensed as follows.

As the philosophic foundation of his whole enterprise, Mr. Wells assumes what he calls the "metaphysical heresy" (though it is rapidly forcing itself upon the notice even of the most stagnantly "orthodox" philosophers) that all classifications, though convenient, are crude, and that whatever is real and valuable in the world is individual, a thesis he had expounded in the brilliant contribution to *Mind* entitled the "Scepticism of the Instrument," which he has now reprinted as an appendix to his book. From this philosophy he infers that progress depends on individual initiative and variation, leading to successful experiment. Hence the infinite preciousness of freedom, which the Utopian World-State must restrict only when and in so far as it would oppress the freedom of others. Hence, too, there will be extensive toleration of "cranks," while even criminals would merely be segregated as failures and condemned to work out their ideas of a good life in a society of their likes, after a fashion charmingly described in the account of the arrival of involuntary immigrants at the "Island of Incorrigible Cheats." But though Utopia is strangely kind to the cranky, the criminal and the inefficient, because it regards their occurrence as the measure of the State's failure, it does not allow them to reproduce their kind. Parentage is a privilege, and the production of superior offspring a service to the community for which a wise State will handsomely reward its women.

But the efficiency and prosperity of the Utopian order ultimately depend on the ruling class, which Mr. Wells seems to have taken bodily out of the Platonic Republic, and, with a fine compliment to the unparalleled rise of Japan, entitled the "Samurai." The Samurai are conceived as a "voluntary nobility" which (like the mediæval Church) all may enter who are able and willing to lead the strenuous and somewhat ascetic life prescribed by the rules of the Order. Among these the obligations to buy and read every month at least one book published in the last five years, and every year to go out into the wilderness and to travel through it in silence and solitude for at least seven days, are perhaps the most noticeable, together with the prohibition of acting, singing and reciting, and the playing of games in public.

It is remarkable how Platonic is the general spirit of these institutions in all save the high appreciation of individual freedom, to the value of which Plato showed such singular blindness. Nor is their general aim hard to discover. At several points, however, a critic will be disposed to doubt whether Mr. Wells's means are adequate to his ends. He has seen, indeed, what never seems to have occurred to Plato, that if wisdom is to control the State, elaborate precautions must be taken to keep learning progressive, and to prevent it from fossilising into pedantry. The Platonic State, if it could ever have come into existence, would systematically have suppressed originality, and simply have stereotyped the condition of science and art prevailing at the date of its institution. If it could be conceived as surviving to the present day, it would still be sending its heroic hoplites against quick-firing guns, and still be punishing a belief in evolution or metageometry as heresies worthy of death. Mr. Wells seeks to guard against the universal human tendency to fix in rigid forms whatever man admires. But though he insists on the importance of preserving the "poietic," *i.e.* originative, types of man and endowing their researches, it may be doubted whether even under his laws they would not be overpowered by the "kinetic," *i.e.* the efficient administrators, who everywhere conserve the established order. For these latter would control the Order of the Samurai.

Again, Mr. Wells's distrust of eugenics, justified as no doubt it is by the present state of our knowledge, seems unduly to disparage the prospects of scientific discovery in the future. It does not follow that because now we know too little to entrust the State with the function of controlling the reproduction of the race, this will continue to be unsafe, and it is easy to imagine circumstances in which such control would become almost inevitable. For example, if one of the many attempts to discover what determines the sex of an embryo should chance to be crowned with success, the numerical equality of the sexes would in all probability be gravely imperilled, and the State would almost certainly have to intervene. Again, while Mr. Wells is doubtless within his rights in scoffing at the racial prejudices of the time, in his scorn of popular notions of "superior" races, "including such types as the Sussex farm labourer, the Bowery tough, the London hooligan, and the Paris apache," and in his contention that "no race is so superior as to be trusted with human charges," his anticipation of wholesale racial fusions seems to involve a serious underestimate of the æsthetic instincts. Lastly, although Mr. Wells has keenly perceived the spiritual value of a temporary retreat from society, it may be doubted whether he does not purchase its advantages at too high a cost. The solitary voyages of his Samurai would assuredly lead to a high death-rate among them, and though one type of mind was thereby strengthened, another would be unhinged. The rule, in short, seems too rigid for the variety, and too cramping for the freedom, of man, both of which Mr. Wells is elsewhere anxious to appreciate. But Mr. Wells, on the whole, shows a wisdom far superior to that of former Utopists in not seeking to construct out of the imperfect materials which alone the actual can furnish a static order which shall be, and if possible remain eternally, perfect. He aims rather at laying down the principles of an order which shall be capable of progressively growing towards perfection; and so it may well be that in his ideal society men will be less reluctant than now to learn from experience.

F. C. S. S.

THERMODYNAMICS.

Thermodynamik. By Dr. W. Voigt. Vol. ii. Pp. xii+370. (Sammulung Schubert, xlviii.) (Leipzig: G. J. Göschen, 1904.)

Diagrammes et Surfaces thermodynamiques. By J. W. Gibbs. Translated by G. Ray, of Dijon, with an introduction by B. Brunhes, of Clermont. Pp. 86. (Paris: Gauthier-Villars, 1903.)

THE second volume of "Thermodynamik" deals essentially with applications. It is divided into two parts, devoted to thermochemical changes and thermoelectric changes respectively. Under the first heading are included changes of phase of a single substance, which occupy the first 168 pages. In this connection we have sections dealing with Van der Waals's formula, steam and gas engines, the equilibrium of an atmosphere of water vapour, and the Hertzian adiabatics. The next chapter deals with phases formed of more than one component, the properties of binary mixtures occupying about 80 pages, and those of a system with more than two components being treated subsequently. The part dealing with thermoelectric changes contains a good bit of introductory matter on electrostatics. In the third chapter of this part the properties of black-body radiation are discussed at much length.

The subject of thermodynamics can be defined in various ways. In its most restricted sense it deals exclusively with the first and second laws and direct deductions from them, in just the same way that dynamics deals with direct deductions from the laws of motion. But the name thermodynamics is often used to include all phenomena directly or indirectly associated with heat, and it is in a fairly broad sense in this respect that Dr. Voigt deals with the subject. A good many of the formulæ are based more or less on experiment or reasoning not directly connected with the two laws of thermodynamics. Thus, for example, in the chapter on radiation the only piece of work which can be regarded as thermodynamical in the narrower interpretation is the proof of the equation by which Stefan's law is deduced from the formulæ for radiation pressure. But in addition to this we have here a general discussion of radiation based on electrodynamical considerations, Wien's law, Planck's law of mixture, and Kirchhoff's theorem. The relation between the black radiation and wave-length is in no way deducible directly from the first and second laws.

These examples may be taken as affording some indication of the extended scope of the book. Passing to matters of detail, the author is to be congratulated on the lucid way in which he clears up many points usually regarded as obscure. We may instance the detailed discussion of the thermodynamical potential of a gas-mixture (§ 69), a point which receives scanty attention in many books we have seen. The author's task is made easier by the fact that most of the higher applications of thermodynamics deal with *equilibrium*. Now, whether we deduce the conditions of equilibrium from making the available energy a minimum, the entropy a maximum, or by any other equivalent hypothesis, the variation of the function selected must in general vanish to the first order, so that the conditions of thermodynamic equilibrium (apart from stability) are deducible from the equations of *reversible* thermodynamics. Very little is said in this book about irreversible phenomena, and this is perhaps fortunate owing to the great difficulty of dealing with these phenomena in a clear and logical way. The kind of impression which a beginner is likely to form in reading about irreversible thermodynamics may be exemplified by the following three apparently contradictory statements:—"The increase of entropy is dQ/T." "The entropy of the universe tends to a maximum." "For a cyclic irreversible cycle $\int dQ/T<0$."

It would be hardly an exaggeration to assert that whether any statement in irreversible thermodynamics is right or wrong depends entirely on the way of looking at it. For example, in § 105 a very little is said about irreversible electric phenomena, which is doubtless correct according to the author's interpretation; but whether this is the best way of stating the case is necessarily a matter of opinion.

In connection with the continuity of the liquid and gaseous states, the rule for the horizontal line in the isothermal diagram is deduced from van der Waals's equation (p. 151), and is not treated as a general result. In this method, however, the significance of the rule is somewhat lost. The proper condition that the rule may hold good is that the liquid and gaseous states should be connected up in the (p,v) plane by a system of curves T=constant, consistent with the differential equation

$$\frac{dy_v}{dv} = T\frac{d^2p}{dT^2},$$

and making y_v equal to the specific heat at constant volume in the regions which represent physically possible states. For the validity of the rule it does not matter how the curves are joined up provided that the above differential equation is everywhere satisfied.

The notation may appear somewhat cumbersome, but anyone who tries to express thermodynamical formulæ in writing will find it impossible to do so clearly and precisely without some such large array of symbols. In particular, the use of capital letters for the volume, entropy, energy, and other thermodynamic magnitudes of a whole body, and small letters for the corresponding magnitudes per unit mass, is a very useful convention. The different forms of d, δ used for differentiations, variations, and diminutions are less easy to follow. If we attempt to compare the subject of this volume with Prof. Planck's excellent little treatise, we shall probably come to the conclusion that Prof. Voigt goes more into elaborate details, while Prof. Planck keeps more to the main points. The book now before us thus contains the more information about a wide range of physical phenomena, but Prof. Planck's book is the easier to read. Neither book can be said to be better or worse than the other, as each has its own uses.

The French translation, which forms No. 22 of the physico-mathematical series appearing under the title of *Scientia*, contains the two papers "Graphic Methods in the Thermodynamics of Fluids" and "A Method of Geometric Representation of the Thermodynamic Properties of Substances by Means of Surfaces," both originally published in the Connecticut Transactions for 1873. It is accompanied by a short notice of Gibbs's life and works, and an introduction by Prof. Brunhes. The latter, giving as it does a general and explanatory account of the subject-matter of the papers translated, forms a useful addition to the book.

G. H. B.

FUNGUS-GALLS.

Beiträge zur physiologischen Anatomie der Pilzgallen. By Hermann Ritter von Guttenberg. Pp. 70; with 4 plates. (Leipzig: Wilhelm Engelmann, 1905.) Price 2*s*. 9*d*. net.

THE study of galls is never more profitably approached than when the mutual inter-reactions between parasite and host-plant are considered conjointly. The intimate connection existing between these two, whether the parasite be insect or fungus, forbids the divorce of either party, and it is therefore a pleasure to come across a work in which this close union is recognised, and an endeavour made to explain the anatomical changes occurring in fungus-galls from a physiological standpoint.

In this work the effects caused by five different fungi on as many host-plants are described. The fungi all belong to separate families, as also do the hosts, and the series is therefore admirably suited for generalising the results. It includes Albugo on Capsella, Exoascus on Alnus, Ustilago on Maize, Puccinia on Adoxa (where, however, no gall-formation arises), and Exobasidium on Rhododendron.

The constancy of form and complexity of structure, characteristic of many insect-galls, are not found here, and the principal changes observable may be briefly summarised as consisting of the hypertrophied development of a large-celled, thin-walled parenchymatous tissue containing very vacuolated protoplasm, enlarged nuclei, and rich stores of starch or water. This is accompanied by an increase in the number of vascular bundles, or at least of their elements, and by modifications of the epidermis, whilst the assimilatory and aërating systems generally tend to be suppressed.

These anatomical changes are, in the author's opinion, mostly due to a change of function which the tissues assume under the influence and for the exclusive benefit of the parasite. The fungus may almost be regarded as a sculptor working with clay. It moulds the host-plant at will, forcing it to lay down a store house and fill it with food for the tenant's use, forcing the xylem to predominate when water is needed, or the phloëm when carbohydrates are required. Where spore formation is proceeding, accessory bundles are laid down to provide the increased supplies necessary. Here the epidermis is weakened so as not to hinder the dispersal of spores, there the mechanical tissue suppressed lest the progress of the fungus be impeded, while even the chlorophyll granules, when present, work in the service of the parasite. Everywhere the story reads as if the host had become wholly subservient to the will of the parasite; but were the author now to exchange his brief and act as counsel for the host, he might equally well explain many of the changes as evidencing an intense effort put forth by the latter to overcome the former. A final summing up would then be less partial, and productive of still more valuable results.

Here and there the author *has* observed indications of this struggle, and one point to which he directs attention is of special interest, viz. the deposit of a cellulose cap or sheath around the invading haustorium or hypha, apparently for the purpose of preventing its entry. This phenomenon, which, though of frequent occurrence, is not generally known, is most remarkable in *Ustilago Maydis*, where the whole length of an intracellular hypha in its passage through a cell may become enclosed in a cellulose tube. Subsequently this tube may become irregularly thickened in parts, and then shows distinct stratification.

The observations regarding the behaviour of the nucleus—its lobed appearance, occasionally leading on to amitotic division, its participation in the formation of the above mentioned cellulose sheath, its subsequent decrease in size, the aggregation of the chromatin at the periphery, &c.—are all most interesting. Some of them need confirmation by more exact histological methods than the author seems to have employed, before his conclusions can be accepted, *e.g.*

the fate of the nucleus in the epidermal cells of *Alnus incana,* which appears very doubtful. In a few other points doubts have also arisen in the writer's mind whether certain appearances described may not have been due to imperfect fixation.

The discussion concerning the attraction which the nucleus apparently exerts on the haustoria is reverted to in the section dealing with *Puccinia Adoxae,* and the solution arrived at seems natural and satisfactory.

Space will not permit us to mention many other points of interest which the reader will find in this little book. A perusal thereof will, it is believed, repay the mycologist, who, even if he doubts a few of the facts or considers the conclusions often somewhat forced, will at all events find the subject treated from a new point of view, and will thereby gain a stimulus for his own researches.

E. R. BURDON.

OUR BOOK SHELF.

Report on the Injurious Insects and other Animals observed in the Midland Counties during 1904. By Walter E. Collinge, M.Sc. Pp. v+64. (Birmingham: Cornish Bros., 1905.)

THIS is the author's second report. It deals with injurious insects and other animals which have been forwarded to him by various correspondents in the midland counties during 1904.

The work is not bulky, but contains in its sixty-nine pages a great amount of valuable matter, covering a wide ground. Its value is enhanced by twenty-nine illustrations; many of these are those used in the Board of Agriculture leaflets, and some could certainly be improved on, such as Fig. 17, the winter moth, and Fig. 22, the codling moth. The original illustrations are excellent, including those of the goat moth, the birch gall mite, crane flies, and yellow underwing larvæ. Among the most interesting notes are those on a supposed new apple mite (Eriophyes, sp.) and on carnivorous slugs.

With regard to the latter, the author tells us that living specimens have been introduced into green-houses and nursery gardens with very beneficial results. This kind of work is most valuable, and we hope Mr. Collinge will have a larger supply to dispose of among nurserymen in future.

There is a detailed and able account of the pear midge (pp. 42–49), but amongst the supposed remedial measures we find it recommended "to deeply trench the ground beneath the trees." This has probably crept in by error. The goat moth is treated in a short, concise manner, and this paper is excellently illustrated with photographs.

Amongst other fruit pests that the author has had reported from the midlands may be mentioned the apple blossom weevil, codling moth, the plum bark beetle, winter moth, the currant clearwing, magpie moth, and, needless to say, one of the most serious pests in Herefordshire, the apple sucker. A few short notes are also given on parasitic diseases of animals, such as scaly leg in fowls, gapes in poultry, and the pig louse.

In the appendix the use and employment of hydrocyanic acid gas and bisulphide of carbon are dealt with, and a general account of insects and the classification briefly referred to. The author divides the Hexapoda into fourteen orders.

As this report should fall into the hands of practical men, we regret to see new generic names are given in the text. Scientific names have rather a frightening effect, and when we keep changing them it makes matters worse. Probably it would be better if we kept to popular names only in the text of such reports, and referred the reader to the scientific names in an appendix. The farmer and gardener want these matters put before them in as simple a way as possible.

We look forward to another of these reports with pleasure, and hope they will appear annually for the benefit of grower and economic zoologist alike, for the contents of the pages of the one before us are both scientifically accurate and preeminently practical.

F. V. T.

Studies of the Museums and Kindred Institutions of New York City, Albany, Buffalo, and Chicago, with Notes on some European Institutions. By A. B. Meyer. *Rep. U.S. Nat. Mus.* for 1903. Pp. 311–608; plates. (Washington, 1905.)

DR. MEYER'S valuable notes and comments on the museums of America and Europe are already familiar to our readers by the notices published in our columns of the issues of the original German text. Of that text the present volume is a translation, revised by the author himself, and with all the original illustrations reproduced, although in some instances on a smaller scale. Since the author's tour of inspection was primarily undertaken for the purpose of learning all that was to be learnt from American museums, the consideration of which occupies by far the greater portion of the report, it was only right and proper that an English translation of the latter should be issued in America rather than in this country, and the Smithsonian Institution deserves the thanks of all interested in museums for the excellent manner in which it has carried out its self-imposed task.

The translation will indeed be fully as acceptable in England as it can be in America, for Dr. Meyer is an outspoken critic who does not mince his opinions, and some of his views with regard to the organisation, installation, and conservancy of museums in this country cannot fail, from this same outspoken and candid manner, to have a permanent value.

Especially important are his opinions with regard to the deteriorating effect of light on the collections of recent zoology in the Natural History Museum in Cromwell Road.

"Everywhere in England," he writes, "the collections are exhibited during the entire day, and it is said that this custom must continue, otherwise the money for expenses will not be forthcoming. I think, however, that this is an error. If the officials themselves were only convinced that the collections intrusted to their keeping are really being injured, they would be able to impress this fact upon the trustees. . . . The public would soon become accustomed to shorter hours of opening if there were some way of making them generally known." Would they?

Whether or no we accept all the author's views and criticisms, there can be no doubt that the issue of an edition of Dr. Meyer's "museum survey" in English is a matter for all-round satisfaction.

R. L.

Notes on Assaying and Metallurgical Laboratory Experiments. By Prof. Richard W. Lodge. Pp. viii+287. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 12*s*. 6*d*. net.

PROF. LODGE has brought together in this book the notes which have been in use for many years by the third-year students in assaying at the Massachusetts Institute of Technology and part of the notes given to fourth-year students. The book may therefore be taken as representing the teaching given to metallurgical students in America, and forms an interesting study to those who wish to know something of the much-praised methods in vogue there. Judging from the contents of Prof. Lodge's volume, the methods do not differ much from those in use in this country and in other parts of the world. The assaying of gold and silver ores is dealt with adequately, and there is an interesting though incomplete chapter on the metals of the platinum group, but the rest of the third-year work (the assay of bullion and of copper and tin ores) is scrappy and of little value. The notes for the fourth-year's work would also not be of much help to students. For example, in the section on cleaning mercury, the student is recommended to wash away soluble and light material with a stream of water, and then to "decant off water and add a small piece of potassium cyanide (poison), which ought to clean it nicely." The author seems to have some misgivings as to whether base metals would really be removed in this way, but the true nature of the problem is nowhere stated, nor are the correct methods of purification described.

In the more valuable part of the book, the assaying of gold and silver ores is discussed at considerable length. The following differences between the instructions given to the student and those usually given in England are noteworthy:—(1) In scorification the slags are not cleaned by the addition of carbon after the eye of lead is closed. (2) In cupellation, the formation of feathers of litharge is strongly insisted on. (3) Beads from gold ores are parted by boiling three times in nitric acid of different strengths.

A large number of exact experiments in assaying are described, and inferences drawn from them. Such work is always useful, but it is better not to put it before students until it has been discussed. Some of the inferences given can hardly be accepted, such, for example, as that the presence of silver does not diminish and that of copper does not increase the cupellation loss of gold. A word of protest may be uttered against the low standard of draughtsmanship in the illustrations. The scorifying tongs, depicted twice, on pp. 13 and 38, are absolutely startling.

T. K. R.

The Practical Photographer. Library Series. Edited by Rev. F. C. Lambert. No. 18, *Gum-bichromate Printing*. Pp. xxiv+64. No. 19, *Floral Photography*. Pp. xx+64. No. 20, *Portraiture*. Pp. xxviii+64. No. 21, *Orthochromatic Photography*. Pp. xx+64. No. 22, *Figure Studies, Groups and Genre*. Pp. xx+64. No. 23, *Summer Number*. Pp. 64. (London: Hodder and Stoughton, 1905.) Price 1*s*. net each.

THE reputation of this excellent series of photographic books is well maintained in the above-named additions to this useful library. As in previous issues, each volume is the work of numerous authors, and the value of the series is that the information is given by those who are at work at the various subjects, and therefore more practical than theoretical.

The illustrations, which are very numerous in each number, are all of a high order of efficiency, and add greatly to the value and utility of the text. The editor in each case contributes an interesting article on the pictorial work of some photographer of note, and those included in these numbers are, in the order of the books given above:—Charles Moss, Mrs. Cadby, Furley Lewis, Harold Baker, William Rawlings, and F. J. Mortimer. An important feature of each of these essays is the reproduction of specimens of their work. As practical handbooks these new volumes will be found very serviceable.

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.*]

Exploration of the Indian Ocean.

MR. STANLEY GARDINER, leader of the Sladen Trust Expedition for the exploration of the Indian Ocean between Ceylon and the Seychelles, in H.M.S. *Sealark*, has sent me the following short account of the progress of the expedition up to the date of writing. The letter is written from the Salomon Atoll, Chagos Group, and is dated June 4. A. SEDGWICK.

Trinity College, Cambridge, August 4.

"We came on board H.M.S. *Sealark* on May 8 at Colombo. Weighing anchor the following evening we set a course for Peros Banhos, the large N.W. atoll of this group, but on the second day out appreciated the fact that we were getting in for the commencement of the burst of the S.W. monsoon. On May 14 we had reached a latitude south of the Maldives, and commenced sounding in view of the possible existence of a bank between this group and the Chagos as indicated by the soundings taken by the German *Valdivia* Expedition. I may say at once that our soundings showed a depth of more than 2000 fathoms between the two groups. The depth increases from the Maldives and Chagos towards the centre of the passage between, but in this position there would seem to be a broad flat, extending along the line of latitude with a depth of 2000 to 2150 fathoms. Of course both east and west the depth probably increases gradually to 25,000 fathoms or even more, but one obviously cannot build up any views of a possible former connection of the Maldive and Chagos Banks on such a slender basis.

"On our way down we took samples of the sea-water and of the plankton (pelagic fauna) at the surface and at every 25 fathoms to 150 fathoms, using a wire with a heavy weight at the end running over a measuring block and clamping on the nets as each 25 fathoms ran out. We also took a series of hauls with the Fowler and Wolfenden closing nets, so as to get our wire into trim, &c. The weather was dead calm with a moderate swell, and generally our results were satisfactory. The Fowler net, being opened at a certain depth and then hauled up vertically to a lesser depth and closed, seemed more suitable for the conditions prevailing in this region than the Wolfenden, which is opened and closed at the same depth, being dependent on the drift of the ship, in the absence of any deep-sea current, for what enters the actual net; heavy messengers, too, are essential for opening and closing the nets. Of course these results on the depth of pelagic animals have a value of their own, but our best haul from a collector's point of view was that of a large net, mouth one yard square, length about twelve yards, made of strong mosquito cloth, ten meshes to the inch. This net we let down on 1200 fathoms of wire and hauled in as fast as our winch could take it. Unfortunately the wire became tied up most abominably, but the comparison of the contents of the tin with the collections made by the Fowler net showed that the net itself must have actually sunk to 600 or 700 fathoms. The presence in the tin of a series of prawns (one 6 inches long), a cuttle fish, and many strong swimming jelly-fish suggests that the use of this method of investigating the swimming fauna (nekton) of the sea should yield valuable results.

"On May 19 we anchored at Île de Diamant, Peros Banhos Atoll, but it became obvious in the next couple of days that in the S.E. trade winds now prevailing in this region, any thorough examination of this atoll, open as it is to the S.E., would be impossible. Accordingly we moved on to the Salomon Atoll on May 22, coming on shore to camp on the following day, selecting it as being of small size (5 miles long by 3½ broad) and enclosed on all sides, save for one passage to the north, by a surface reef. While Cooper and I are collecting the marine fauna and flora, and examining the reefs and land, Captain Somerville and the officers of H.M.S. *Sealark* are making a fresh chart of the atoll on a large scale, while Mr. Fletcher, paymaster, and Dr. Simpson are collecting the insects and land plants. I may say at once that the latter are of the type which one would expect to find on purely oceanic islands, but their distribution from island to island is interesting, as well as their preferences for sand or rock, drought or moisture, &c., most of the islands having definite zones with their peculiar plants.

"It is really as yet too early to say anything about the reefs here, as there are one or two places which I have not yet been able to visit. What strikes one, however, very forcibly is the comparative absence of life on them. Of course there are in places plenty of corals, but the number of species is quite limited. There is a fair number of the usual Alcyonaria, but Sponges, Hydroids, and Tunicates are very few in species and in quantity. Turbellaria are very rare, while Molluscs, Echinoderms, and Crustacea are few in species and, except certain common forms, not numerous. Ptychodera we have obtained, as well as a few Sipunculids, but Amphioxus and Thalassema we have not found. At Minikoi in two tides I have brought to the camp as great a variety of animals as Cooper and I have obtained here working ten tides up to the present. Indeed, life here is strictly limited in variety, and, when the marine collections have been fully worked up, one is inclined to anticipate, even so early, that some definite light will be thrown on the distance to which the larvæ of marine animals can cross the open ocean, on the distribution, in fact, of marine animals. The same, too, is true as well of the marine plants, nullipores alone being common.

"I am now endeavouring to work up the physical conditions of the atoll so as to find, if possible, whether there is any physical cause for the comparative paucity of free-living animals. I am sending Cooper in the ship to-morrow to Diego Garcia, where he will have four or five days while she is coaling to examine the land and reefs. I remain here, but I hope by the time of his return, in about twelve days, to have finished my work and to move on to Peros Banhos, while the *Sealark* is sounding between the banks and round the Chagos Archipelago."

The Problem of the Random Walk.

I HAVE to thank several correspondents for assistance in this matter. Mr. G. J. Bennett finds that my case of $n=3$ can really be solved by elliptic integrals, and, of course, Lord Rayleigh's solution for n very large is most valuable, and may very probably suffice for the purposes I have immediately in view. I ought to have known it, but my reading of late years has drifted into other channels, and one does not expect to find the first stage in a biometric problem provided in a memoir on sound. From the purely mathematical standpoint, it would still be very interesting to have a solution for n comparatively small. The sections through the axis of Lord Rayleigh's frequency surface for n large are simply the "cocked hat" or normal curve of errors type; for $n=2$ or 3 they do not resemble this form at all. For $n=2$, for example, the sections are of the form of a double U, thus UU, the whole being symmetrical about the centre vertical corresponding to $r=0$, but each U itself being asymmetrical. The system has three vertical asymptotes. It would be interesting to see how the multiplicity of types for n small passes over into the normal curve of errors when n is made large.

The lesson of Lord Rayleigh's solution is that in open country the most probable place to find a drunken man who is at all capable of keeping on his feet is somewhere near his starting point! KARL PEARSON.

Proposed Magnetic and Allied Observations during the Total Solar Eclipse on August 30

IN response to my appeal for simultaneous magnetic and allied observations during the coming total solar eclipse, cooperative work will be conducted at stations distributed practically along the entire belt of totality and also at outside stations, nearly every civilised nation participating.

These observations will afford a splendid opportunity for further testing the results already obtained. All those who are able to cooperate are invited to participate in this important work.

The scheme of work proposed embraces the following:—

(1) Simultaneous magnetic observations of any or all of the elements according to instruments at the observer's disposal, every minute from August 29, 22h., to August 30, 4h., Greenwich mean astronomical time.

[To ensure the highest degree of accuracy attainable, the observer should begin work early enough to have everything in complete readiness in proper time. See precautions taken in previous eclipse work as explained in the journal *Terrestrial Magnetism* (vol. v., p. 146, and vol. vii., p. 16). It is essential, as shown by past experience, that the same observer make the readings throughout the entire interval.]

(2) At magnetic observatories, all necessary precautions should be taken so that the self-recording instruments will be in good operation, not only during the proposed interval, but also for some time before and after, and eye readings should be taken in addition wherever it be convenient.

[It is recommended that, in general, the magnetographs be run on the usual speed throughout the interval, and that, if a change in the recording speed be made, every precaution possible be taken to guard against instrumental changes likely to affect the continuity of the base lines.]

(3) Atmospheric electricity observations should be made to the extent possible by the observer's equipment and personnel at his disposal.

(4) Meteorological observations in accordance with the observer's equipment should be made at convenient periods (as short as possible) throughout the interval. It is suggested that, at least, temperatures be read every fifth minute (directly after the magnetic reading for that minute).

(5) Observers in the belt of totality are requested to take the magnetic reading every fifteen seconds during the time of totality, and to read temperatures as frequently as possible.

(6) At those stations where the normal diurnal variation cannot be obtained from self-recording instruments, it is desirable to make the necessary observations for this purpose on as many days as possible before and after the day of the eclipse, and to extend the interval of observations given above if conditions permit. In general, those who will have self-recording instruments have decided to run them for at least eight days before and after the day of the eclipse.

It is hoped that observers will send full reports of their work to me as soon as possible for incorporation in the complete monograph on this subject to be published by the Carnegie Institution of Washington.

L. A. BAUER.

Department Terrestrial Magnetism, Carnegie Institution, Washington, D.C., July 15.

British Fruit Growing.

IN your remarks on p. 297 (July 27) on the above subject, you mention "the diversity of yield from farms in the same neighbourhood . . . due presumably to differences of shelter and aspect." It is a remarkable thing that, so far as I know, nothing has ever been done to find out and publish the most suitable localities, as regards soil and climate, for orchard planting. It is a question of very great complexity, and can only be dealt with properly by officials appointed for that purpose; but its importance in fruit culture is so obvious that a considerable expenditure would be well repaid. Few people have any idea of the great climatic differences in localities within even a few hundreds of yards!

This house is on the south slope of the long range of Lower Greensand hills which runs parallel with the Chalk range the whole length of Kent from west to east. At this point the slope rises steeply from 200 feet above sea-level to 500 feet, my house being about 350 feet. I have carefully observed the effects of frost, &c., for the last six years, and it appears to me that the variations in temperature in the vertical limits mentioned are much greater than would be expected. Up to the 400-feet contour line the climate is singularly equable, which is proved not only by daily thermometrical observations, but by the fact that such tender plants as *Cistus purpureus*, Lam., *Cheiranthus mutabilis*, L'Hérit., and many others have survived the last six winters unprotected; while large bushes of Laurustinus, *Euonymus japonicus*, bay, &c., were evidently little, if at all, injured by the terrible winter of 1895. Yet, even within the limits of my own grounds, with a rise of only 35 feet up to the 400-feet contour line, there is a marked difference of climate. On November 27, 1904, in the upper part of the garden, dahlias planted within 4 feet of a high wall facing south were blackened by frost, while in the lower garden those in the open border were uninjured.

The difference between the climate of this place and the Public Gardens at Maidstone is fairly shown by the following comparative statement, the temperatures from the latter having been taken when I chanced to pass the place where they are put up, and therefore not selected:—

May 11, 1904	Max. in shade	Min. in shade	Min. on grass	Range in shade
	°	°	°	°
Ulcombe	50·0	39·5	35·5 (corrected)	10·5
Maidstone	56·0	38·0	30 0	18·0
May 28 to 30, 1905				
Ulcombe, 28th	67·6	47·5	43·8	20·1
,, 29th	70·6	57·0	44·5	13·6
,, 30th	76·0	52·0	48·0	24·0
Maidstone, 28th	76·0	43·0	39·0	37·0
,, 29th	81·0	50·0	42·0	39·0
,, 30th	85·0	50·0	42·0	43·0

The maxima in both cases are those of the previous day. Maidstone is seven miles from here, and lies in the valley of the Medway.

Yet, in spite of the fact that the thermometer, even on the grass, has not been below 32° since April 3,[1] we are no better off for apples than our neighbours! The apples did not begin to flower until the end of April, so some other cause than frost must be found to account for the bad crop. This is an example of the difficulties of the question; other complications are the nature, mechanical and chemical, of the soil; period of blooming of different varieties of the same fruit; shelter from the generally prevailing cold winds in spring, &c. Still, some effort should be made to ascertain the conditions under which, on an average of years, the best crops can be obtained, and so avoid the waste of time, money, and land that has been incurred in hundreds of instances by planting orchards in unsuitable localities, while hundreds of acres of suitable land are used for corn and other crops that would grow as well elsewhere.

ALFRED O. WALKER.

Ulcombe Place, near Maidstone.

Islands for Weather Forecasting Purposes.

IN NATURE for June 1 is a very suggestive article by Dr. Lockyer under the above heading, in which specific reference is made to the meteorology of Western Australia. It is becoming increasingly evident that the Indian Ocean and its neighbouring continents form one of the most interesting fields in the world for the study of meteorology, and as the officer-in-charge of an important section of this region I am most anxious to assist in this study in any way possible. Our progress will be slow if we start with incorrect theories, and my present object is to point out the probable inaccuracy of a few of the fundamental concepts, and to indicate briefly a few of the observed facts which seem to have a bearing upon the whole matter.

There is little or no rain in Perth of a monsoonal character. The wettest months are May, June, July, and August, during which time the prevailing winds are *not* from the S. or S.W. Rain is almost always associated with the passage of a "low" along the south coast, setting in with the wind at N. or N.W., and *finishing* when the wind veers to S.W. and S.

There is a tendency throughout the year for the winds to alternate from the eastward during the forenoon to the S. or S.W. in the afternoon. This is most marked in the summer months, when the prevailing feature of the weather map is a "high" stretching along the ocean *south* of our coastline. How far south or west this extends I cannot say. The prevalence of southerly winds in the summer time is probably due to this anticyclonic area, and Fig. 2 on p. 111 is therefore somewhat misleading.

As the sun moves north the high pressure follows it, and in June and July forms a belt across the centre of Australia. It is, however, constantly on the move from west to east. A "high" will generally during these months strike the west coast about, or to the north of, Perth, and gradually work across to the eastern States. As it passes our wind sets in strongly from the eastward, gradually veering more northerly. By the time the "high" reaches, say, Adelaide, our wind is N.N.E., the isobars are running nearly parallel to the west coast, and we are looking out for a "low" to approach from the ocean. As a general rule, the "low" is first heralded from Cape Leeuwin, the extreme S.W. corner of Australia, but rain sets in with a N. and N.W. wind all along our west coast as far as the N.W. cape. It is heaviest in the extreme S.W. The "low" generally passes south of Cape Leeuwin and across the bight to Tasmania. So long as our wind, and especially that at the Leeuwin, has any *northerly* component, we are pretty certain to have more rain, but as soon as it reaches W.S.W., and especially S.W., we anticipate clearing weather.

Whence these "lows" come before they reach us is therefore a question of great importance. I believe the usual theory upon this point is incorrect. That is, that these "lows" are northerly extensions of the Antarctic low-pressure belt, which sweep past the Cape of Good Hope, and after the lapse of a few days reach Cape Leeuwin, and so travel along the south coast of Australia. I think this is incorrect for several reasons. In the first place, I have endeavoured to trace notable storms either forward from the Cape to Australia, or backwards from Australia to the Cape, and have not been able to find any connection whatever. Secondly, from theoretical considerations, a rotating body of air in the latitude of the Cape would possess a sufficient southerly component to its motion of translation to carry it well south of Australia. Thirdly, the more direct evidence stated in the next paragraphs.

During the summer months, January, February, and March, there is a class of storm which strikes our N.W. coast and then travels across the State in a S. or S.S.E. direction, emerging in the Great Australian Bight, and travelling thence in an E.S.E. or S.E. direction towards Tasmania. Before striking the N.W. coast it can sometimes be traced from the extreme north of the State moving towards the S.W., down the coast, but keeping well out to sea, then gradually recurving, and striking the coast about lat. 20°. The existence of this class of storm and its approximate path is now beyond doubt, though until recently it was ignored in practical Australian meteorology. I think, however, it would now be safe to say that it dominates the weather of at least the western and southern portions of Australia during the summer months, though on account of the paucity of stations in its track our knowledge of the various conditions is at present elementary. It is important to bear in mind that the study of Western Australian meteorology is in its infancy. Not until the last few years was the importance of this class of disturbance recognised, and therefore any theories which had been formed require to be modified. During the last two years evidence seems to me to be accumulating that this particular class of storm persists throughout the year, and is, in fact, the dominating influence in Australian meteorology. If this be so, it can easily be seen how profoundly older theories are affected, and how necessary it becomes to make a fresh start.

Even during the summer the disturbances do not all follow along the same track. Sometimes they strike the coast near or even south of the N.W. cape, and occasionally they just miss the coast, but can be traced, following it down, but keeping out to sea, and eventually rounding Cape Leeuwin and behaving like an ordinary winter storm. It is this latter path to which I wish to direct special attention.

In the winter, as a general rule, the first intimation of an approaching "low" is obtained from Cape Leeuwin,

[1] Yet severe frost with great damage to crops in the Dartford, Rochester, and Hoo districts; also at Maidstone and Sevenoaks on May 22–3, is reported in the *Kent Messenger* of May 27.

and the storm centre invariably passes to the south of that spot. It was but natural, therefore, to suppose that the storm came from the W. or W.S.W. of the Leeuwin, and the winter and summer disturbances have been regarded as two distinct varieties. Within the last two years, however, circumstances have been noted which seem to show that there is no real distinction between the two. In July, 1904, I first directed public attention to the fact that certain of our winter storms could be distinctly traced *down* the west coast, affecting N.W. districts first, and then travelling in a S. or S.S.E. direction. I have gone somewhat fully into this matter in my "notes" on the climate of Western Australia for the month of July, 1904, and when once the fact has been indicated it becomes easy to find numbers of cases when winter storms can be seen to have a considerable southerly component of motion. Only a few days ago, for instance, a disturbance struck the N.W. coast in about lat. 20°, and travelled in a S.E. direction across the State, giving rain just along the fringe of our most eastern settlements, probably much heavier in the interior desert, and causing a heavy downpour in South Australia from the centre to the south coast. Again on May 20 a disturbance approached the N.W. cape, causing rain there, next day being definitely located in the ocean a little to the S.W. of Perth, and certainly considerably north of Cape Leeuwin, then continued to travel down the coast, rounded the Leeuwin, and behaved thenceforward just like any other winter disturbance.

There is, therefore, plenty of evidence that "lows" do travel down the Indian Ocean, even in the winter months, in a southerly or S.E. direction towards Cape Leeuwin, and probably all, or nearly all, of our storms come in this way. If this be so, the charts on p. 111 are misleading. Our rain certainly does not come mainly with a S.W. or S. wind, nor is there (probably) any stationary "high" as marked. Instead there is a series of "highs" moving towards our west coast, broken up by a series of "lows," which pass between and make for the extreme S.W. corner of Australia. The weather which we specially desire to predict comes with these "lows." Several things follow from this. One is that the Amsterdam and St. Paul Islands are far too much to the southward to be of any use to us for practical forecasting purposes, though a few years' records from there would be exceedingly valuable. Another is that Dr. Lockyer's theory about the S.E. trades and S.W. monsoon requires some modification, though it is very probable that the Indian and Australian weathers are inter-dependent and require to be studied together. A third is that Sir John Eliot's proposal for an Empire study of meteorology ought to be acted upon as soon as possible, and all our observations coordinated to some definite purpose. A fourth is that, failing this, Australian meteorologists ought to make every effort to bring about the establishment of a central Australian bureau for the study of scientific meteorology, as recommended at the recent conference held in Adelaide.

W. ERNEST COOKE.

Perth Observatory, Western Australia, July 3.

DUTY-FREE ALCOHOL.

HOW far the trade in synthetic colours and fine chemicals has been lost to the country through the heavy customs restrictions placed upon the use of alcohol is a question which has been agitating manufacturers for many years past. On the one hand, we are told that the entire chemical trade has been diverted from our shores because of the high cost of alcohol; on the other, that the alcohol question has very little to do with the matter. After the agitation for the use of duty-free alcohol had been going on for some years, and owing to its increasing intensity and to the pertinacity of a few, the Government in the autumn of last year appointed a departmental committee to take evidence in order to find out whether the high duty on alcohol really was the factor which caused the practical extinction of the aniline dye industry and accounted for our inability to found an industry in fine synthetical products. The committee commenced to take evidence on November 8, 1904, and finished on February 17 of this year.

More is heard about the loss of the synthetic colour trade to the country than about the loss of any other industry, or about the failure to establish new industries which flourish on Continental or American soil. The loss of the coal-tar colour industry is variously ascribed to incompetence on the part of our manufacturers and their failure to realise the importance of employing—and paying for—highly trained scientific chemists, to our patent laws, to trade protection abroad, and to the excessive duty charged upon alcohol in this country. The report with which we are at present dealing has to do with the last question—duty-free alcohol. A careful perusal of the questions to and the answers of the witnesses before the commission, which included most of the well-known names in the coal-tar colour industry in this country, does not convince one that this special industry has been lost to the country owing to the high cost of alcohol.

The amount of alcohol used at the present day for preparing the dyes is not very large. At one time many of the dyes were sold as alcoholic extracts, and alcohol was somewhat largely used in the preparation of the products. Since the introduction of the azo dyes, however, alcohol is not nearly so largely employed as formerly. There are, indeed, certain dyes in which the methyl or ethyl radical is introduced during the process of manufacture, and these require the employment of methyl or ethyl alcohol in their preparation, and, of course, in this case the alcohol cannot be recovered; for example, the dyes in which dimethyl aniline is the starting product. British manufacturers who desire to make these colours import all the dimethyl or diethyl aniline from abroad. It came out, however, in the evidence that one large aniline dye company which desired to manufacture dimethyl aniline obtained Government sanction to employ methyl alcohol mixed with one-twentieth of 1 per cent. of mineral naphtha—"a condition which the company stated would suit their purposes." Although from the evidence before the commission it appeared that there was "a substantial profit to be made upon the manufacture of dimethyl aniline," for some reason or other it was never manufactured.

Reviewing the evidence of the different persons connected with the coal-tar dye industry, one is brought to the conclusion that, although the high price of alcohol has militated against the success of the industry, yet there are other even more potent factors which have prevented the industry being successful. Manufacturers, with a few isolated exceptions, have not even been successful in meeting Continental competition in dyes which do not require the use of alcohol. Prof. Green probably came very close to the truth when he said, in reply to a question as to what he considered the cause of the decline of the coal-tar colour industry:—

"They (the manufacturers) did not realise the great importance of research; the great importance of theory. They expected to see an immediate result from experiments, and if they did not get an immediate result they considered that they were wasting their money. They did not employ a sufficient number of research chemists, and they did not pay those research chemists they had to encourage them to remain. . . . There may be other contributory causes, such as the patent laws and this question of the spirit."

There seems to be a strong consensus of opinion that in the xylonite and gunpowder manufactory leave to use pure alcohol is much to be desired. Xylonite when made with methylated spirit is inclined to darken, and there is thus a difficulty in making materials which should be white or ivory coloured.

In the gunpowder manufactory, if pure alcohol were used to dehydrate the material the dangerous drying process by heat could be done away with, because the material moistened with alcohol can be directly placed in the mixers containing acetone, &c., the moistness due to alcohol not interfering with the process of manufacture, whereas that due to water is harmful. For making so-called "condensed" powders which are totally dissolved in the solvent the action of methylated spirit is objectionable; as one of the witnesses stated, "you cannot control the surface of the grain with a methylated-ether mixture in the same way that you can with a pure alcohol-ether." To a large extent the lack of initiative on the part of British powder manufacturers may be indirectly attributed to the high cost of alcohol. Some lacquer manufacturers and users of lacquers state that lacquers made from pure alcohol are very much superior to those made from methylated spirit. Mr. Bagley, the witness from Messrs. Samuel Heath and Sons, the largest brass-founders in the world, stated that, although they are easily able to compete with Continental manufacturers so far as their brass ware is concerned, their goods are often not acceptable because of the want of durability and finish of the lacquering. The lacquer costs something about 4*s.* per gallon, but they can, by paying 32*s.*, obtain a lacquer made with absolute alcohol, and this is as good as the best foreign lacquer. The witness said he was ashamed to have to confess that they could not obtain the fine finish which the Germans produced, and, as regards the French importers, they absolutely refused to take lacquered articles, but bought them unlacquered and finished them themselves. This witness was of the opinion that the foreign lacquers were made with pure alcohol, but it was subsequently pointed out by the chairman that even abroad it was denatured. On the other hand, Mr. Gardiner, the manager of the firm of Messrs. A. Lambley and Sons, said that they not only could make lacquers as good as Continental manufacturers, but that they had a large export trade and had no difficulty in meeting Continental competition; they very rarely used pure alcohol for making lacquers.

From the extremely contradictory evidence of these two witnesses it would appear that it is more a matter of method or knack in the manufacture than of methylated or pure alcohol which determines the quality of the lacquers.

There seems very little doubt but that the manufacture of fine chemicals and synthetic perfumes is considerably interfered with owing to the British manufacturer not being able to use duty-free alcohol. When methylated alcohol is employed for crystallising the substances there is invariably a peculiar and disagreeable odour attending the finished product. But if the manufacturer, in order to get over this difficulty, employs duty-paid absolute alcohol, the increased cost of manufacture is prohibitive. It was stated in evidence, for example, that with regard to the manufacture of phenacetin "the duty on the spirit would come to 140*l.* on 100*l.* worth of the article as imported."

Chloral hydrate is another substance which cannot profitably be made in this country. In the manufacture of ether from methylated spirit Mr. David Howard stated that "if we might have pure methyl alcohol and pure ethyl alcohol, it would be a beautiful thing to make ether of. But the result of the ketones and other bodies in it is that the sulphuric acid gets in a most horrible mess, and we get abominable compounds which I have never been able to excite the interest of any chemist in yet; but they are a very great disadvantage."

Those connected with the motor-car industry and the use of alcohol for motor engines in place of petrol seemed to consider that very much better results can be obtained with pure alcohol than with methylated spirit. A perusal of the evidence leads to the conclusion that further experimenting in this direction would be advisable. One is certainly inclined to the opinion that the presence of bases would be harmful, as these would probably on combustion be converted into products which would corrode the metal work. Of course, if alcohol is to be employed for motor purposes it would of necessity require to be denatured, because it would then be sold in large and small quantities at every little oil-shop in the kingdom. If motor-engineers wish to build alcohol engines they will have to experiment with all sorts of denaturants, and, doubtless, the excise authorities would aid them in their endeavours.

In reading through the report one is struck by the repeated reference which is made to the relative cost of pure *duty-free* alcohol in the United Kingdom and in Germany; British manufacturers do not seem able to compete in the manufacture of alcohol with their German rivals even when working under equal conditions. Further, it is a well-known fact amongst chemists that it is practically impossible to get really good absolute alcohol of British manufacture. It is a remarkable fact that traces of impurities which one can barely find by analysis interfere very much with the smooth working of reactions in which alcohol is employed. This fact came out again and again in the evidence of witnesses before the committee. Those on the committee who were there to look after the interests of the excise endeavoured with great skill to shake the evidence on this point, explaining that if the quantity of an impurity was only a fraction of a per cent., it surely could not possibly cause all the mischief attributed to it. The invariable reply was, the product when made with absolute alcohol has such and such properties, but it is either impossible or a matter of extreme difficulty to obtain the same results with methylated spirit.

On the other hand, in a good many cases it appeared that sufficient experimental work had not been tried. Methylated spirit had been condemned for manufacturing this or that article, but little or no attempt seemed to have been made to try spirit denatured in other ways or to try the use of other solvents. By the Act of 1902 manufacturers were allowed to suggest other means of denaturing the alcohol, and in some cases at least the excise authorities had been very willing to aid them in their efforts. As a matter of fact, in manufacturing operations in Germany it is rare for absolute alcohol to be employed, the alcohol generally being denatured in a way which suits the particular manufacturer. Of course, where the use of pure alcohol is absolutely necessary the German has a much lower excise duty to compete with than the British manufacturer. That excise restrictions, the high duty on alcohol, and a considerable amount of red tape have, in some cases, made the manufacture of certain products—so as to compete with the foreign manufacturer—almost an impossibility there can be no doubt. But why that should hinder British manufacturers who manufacture products in which alcohol is not employed it is not easy to see.

If instead of calling in an outside "expert" (?) when an emergency arises the manufacturers were to employ a certain number of well-trained chemists, men who, after being on the staff for a short time, should be far and away superior to outside experts, there is but little doubt that fewer emergencies would arise and that a progressive and ever-improving concern would be the result. There was a great deal in what Dr. Nichols said in his presidential address to the Society of Chemical Industry—the quotation is from memory—" Never put up duplicate plant; no plant is so perfect that it cannot be improved; after a plant has been in use a short time certain points in which it may be improved are sure to be discovered."

So if we are to compete with foreign competition no process should be worked year after year by rule of thumb, otherwise manufacturers will find their product being pushed out of the market by a similar but improved product in which the brain has been the motive power for the thumb.

It is very much to be hoped that now that the matter has been thoroughly threshed out the Government will step in and—while safeguarding its own interests and the sobriety of the workers—it will aid manufacturers by all means in its power by enabling them to use a class of alcohol which will be suitable to their special needs.

F. MOLLWO PERKIN.

THE GEOLOGY OF SOUTH AFRICA.[1]

TOWARDS the end of last century it appeared as if England had lost her well earned supremacy in geological research in Africa. In Germany, elaborate treatises dealing sometimes with her own African colonies exclusively, and sometimes with that of neighbouring British territory, monthly and almost weekly appeared. French geologists, too, produced essay after essay on their African colonies and possessions. Meanwhile, England was apparently content to lag behind.

It is fitting that the visit of the British Association to one of our most famous and most remote African colonies this year should witness the publication of two geological works, of the highest scientific standing, written by our own countrymen. Early this year, the comprehensive treatise by Mr. A. W. Rogers on the geology of Cape Colony made its appearance. Now, a few months later, we have presented to us the philosophic *résumé* of the geology of South Africa as a whole by Messrs. Hatch and Corstorphine.

Both volumes supply a long-felt want. In their method and conciseness both are equally British.

In a work treating with the richly metalliferous regions of the Transvaal it might have been expected that questions of economic interest would occupy many pages. It is an agreeable surprise to find that this is not the case. On the contrary, the geology of South Africa is here described in a thoroughly scientific manner, clearly and concisely worded. All essential details are brought within a compass of 312 pages of text.

In the opening chapter, on the history of research, ample recognition is given to A. G. Bain, the father of South African geology, and also to Stow. More recent workers cannot complain that their investigations have been neglected.

The book is divided into five parts. Part i. deals with the pre-Karroo rocks, in which those of southern Cape Colony are described in section i., and those of northern Cape Colony, the Transvaal, &c., in section ii. This separation into sections becomes necessary owing to the want of similarity in the succession of the pre-Cape rocks in the two regions.

The authors naturally give somewhat more space to the sequence in the Transvaal, more especially to a description of the upper division of the Witwatersrand system, which includes the famous " Banket." It is interesting to find that the stratigraphical position and age of this well known deposit remain unsolved, except that the authors consider the age to be vastly newer than the Archæan rocks and greatly older than the Table Mountain Sandstone.

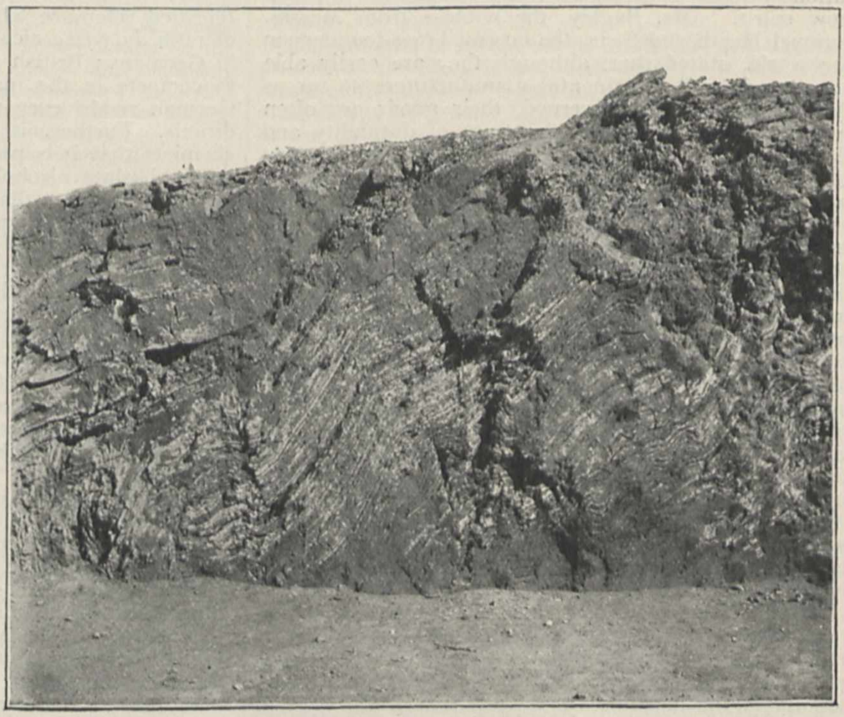

FIG. 1.—Contorted Band, Hospital Hill Slate, Show Yard, Johannesburg. From "The Geology of South Africa," by F. H. Hatch and G. S. Corstorphine.

The complicated nature of the stratigraphy of South Africa, other than that of the peninsula, will be gathered from the following tables :—

North of Cape Colony	Transvaal
Dwyka Conglomerate	Dwyka Conglomerate
Unconformity	*Unconformity*
Matsap Series	Waterberg Series
Unconformity	*Unconformity*
Griqua Town,	Pretoria Series
Campbell Rand and Keis Series	Dolomite and Black Reef Series
Unconformity	*Unconformity*
Volcanic Series	Ventersdorp Series
Unconformity	*Unconformity*
	Witwatersrand Series
	Unconformity
Namaqualand Series	Swaziland Series

This table opens up a vista of infinite possibilities.

The Karroo rocks are adequately dealt with in part ii., but in this and elsewhere Rhodesia,

[1] "The Geology of South Africa." By F. H. Hatch and G. S. Corstorphine. Pp. xiv+336. (London: Macmillan and Co., Ltd., 1905.) Price 21s. net.

Bechuanaland, and Natal receive scant notice. The coastal system, including the Uitenhage and Umtavuna Cretaceous rocks, profusely illustrated with typical fossils, occupies part iii.

The superficial deposits, somewhat summarily dismissed, form a separate chapter. Many of the interesting problems connected with them are not even hinted at. A classification by chemical composition is adopted.

The igneous and volcanic rocks, which take so large a share in South African stratigraphy, are described in connection with the systems with which they are more intimately associated.

Part iv. briefly discusses the igneous rocks of doubtful position. Too much space has here been allotted to the diamond-bearing deposits.

Part v. discusses the correlation of the South African strata. It contains much information guardedly expressed. This portion possesses the almost unique virtue of stating the arguments in favour of the correlation adopted by the authors. Few geologists will now dissent from the view that the Witwatersrand series is older than the Table Mountain Sandstone and newer than the complex of rocks termed Archæan.

Latter-day geologists will miss a chapter on structural and dynamical geology. The authors, and many will no doubt agree with them, have eschewed the problems entailing the use of modern physiographical and dynamical terminology. In dealing with rocks and fossils they have, however, occasionally been compelled to drop into technical language. Thus we met with *Cardium bullennewtoni, Eriphyla rupert-jonesi* among fossils; while among minerals and rocks several of those mentioned wordily lengthen out what, to the general reader, would otherwise be a welcome page.

The authors have certainly succeeded in their self-imposed task "to correlate and systematise the valuable results of both official and private work." They are right in considering that what we know of South African geology lacks coherence. The best efforts, such as that of the authors, must for a long time be regarded as tentative and by no means final.

The volume is profusely and admirably illustrated with photographs of scenery and rock sections. Two coloured geological maps accompany the text, one of South Africa between Bechuanaland and the east coast and the Transvaal and the south coast, and one of the Transvaal. It is to be hoped that the half-mourning adopted for the Karroo system will not be perpetuated. Economically it is false; artistically it is ruinous.

W. G.

NOTES.

THE meeting of the French Association for the Advancement of Science was opened on August 3 at Cherbourg under the presidency of Prof. Giard.

WE regret to learn that Prof. L. Errera, professor of botany in the University of Brussels, and member of the Royal Academy of Belgium, died on August 1 at Uccle.

WE understand that the editorship of the "Fauna of British India," rendered vacant by the death of Dr. W. T. Blanford, has been offered by the Secretary of State for India to Lieut.-Colonel C. T. Bingham.

A REUTER telegram from Rio de Janeiro says that the Latin American Scientific Congress was opened on August 7, delegates from all the South American Republics being present.

THE sixth International Congress of Criminal Anthropology is to take place in Turin on April 26 next under the presidency of Signor Bianchi, Minister of Public Instruction.

PROF. RONALD ROSS and Prof. Boyce, of the Liverpool School of Tropical Medicine, will sail for New Orleans on Saturday to assist in dealing with the epidemic of yellow fever in that city.

WE regret to see the announcement that Mr. Alexander Bell, father of Dr. Alexander Graham Bell, and an active worker in educational science, especially in relation to the study of deaf-mutes, died at Washington on August 6.

MR. CHRISTOPHER HEATH, Emeritus professor of clinical surgery in University College, London, and a former president of the Royal College of Surgeons of England, died suddenly on Tuesday, August 8. Mr. Heath was the author of several standard works on surgical subjects.

THE Amherst College expedition for the observation of the eclipse of the sun on August 30 has departed for Tripoli, where the instruments will be mounted on the edge of the desert. The members of the expedition are Prof. David Todd, Mrs. and Miss Todd, and Mr. E. A. Thompson, and their attention will be chiefly devoted to the photography of the corona and of intra-Mercurial planet regions.

THE Treasury has renewed for a further period of five years the annual grant of 500*l*. to the British School at Athens. The promoters of the movement hope that an influentially signed petition for a similar grant to the British School at Rome may be also favourably considered.

PROF. GUIDO CORA informs us that the earthquake disturbances registered at the Pola Hydrographic Station on July 23 (see p. 298) were also recorded at the Osservatorio Ximeniano of Florence at 3.50 a.m. on the same date. Father Guido Alfani, from an examination of the seismograms, expressed the opinion that a severe and protracted earthquake must have taken place at an estimated distance of about 6800 kilometres (4225 miles).

WE notice with regret the death on July 26 of Prof. Bichat, dean of the faculty of sciences at the University of Nancy. Prof. Bichat was also director of the Electrotechnical Institute of Nancy, and took a very active part in all efforts for the improvement of secondary and higher education.

THE research fellowship in chemistry offered by the Worshipful Company of Salters, and tenable in the research laboratory of the Pharmaceutical Society, has this year been awarded to Miss Nora Renouf, who has been engaged in research work for the past two years in the society's laboratories. The Salters' fellowship is of the annual value of 100*l*., and was founded with the view of encouraging the application of the newest methods of scientific chemistry to the elucidation of pharmacological problems.

THE International Congress of Anatomy was opened in the morning of August 7 at Geneva. Three hundred representatives of the principal universities of Europe and America were present, including office-bearers of the five great anatomical associations of Great Britain, France, Germany, Italy, and the United States. One hundred and fifteen papers on various scientific subjects were put down for reading. The congress will conclude to-day with a banquet given by the city of Geneva to the delegates. The congress has accepted an invitation to assemble at Boston in 1907.

The *Journal of the Royal Microscopical Society* for June contains two papers by Mr. J. E. Stead, F.R.S., one dealing with micro-metallography in general, and the other with the special processes for detecting phosphorised portions in iron and steel.

The two articles in the July issue of the *Irish Naturalist* are devoted to local subjects, the Rev. Canon Norman completing his list of Irish ostracod crustaceans, while Mr. R. Ll. Præger discusses the distribution of fumitories in Ireland.

We have to acknowledge the receipt of a complete copy, with the plates, of the first part of vol. lvii. of the *Proceedings of the Philadelphia Academy*. Many of the papers contained in this part have been already noticed in our columns, as they appeared in the monthly issues.

We have received a fasciculus of "Illustrations of the Zoology of the *Investigator*," containing plates of crustaceans (part xi.) and fishes (part viii.). Special interest attaches to the plate of the crab *Lithodes agassizi* on account of the large size and peculiar form of this species, and also to the plates of deep-sea fishes, a few of which have only recently been described.

Mr. J. E. Robson continues his catalogue of the Lepidoptera of Northumberland and Durham in vol. xv., part i., of the Natural Transactions of the aforesaid counties, dealing in this instance with the groups Pyralidina and Tortricina. Both these sections of the Microlepidoptera are but little studied by collectors, and the author confesses to considerable difficulty in dealing with the second of the two.

In No. 1410 of the *Proceedings of the U.S. National Museum* Mr. E. Linton describes certain cysts of a cestode worm from a bottle-nosed porpoise, which are regarded as indicating a new species of Tænia. No. 1404 of the same publication contains the first part of a description, by Mr. C. B. Wilson, of the North American parasitic copepod crustaceans of the family Caligidæ. An account of the Argulidæ has already appeared in the same journal; the members of the present group are regarded by the author as of the greatest possible ecological interest, so that the study of their life-history cannot fail to yield important results.

Article 7 of vol. xx. of the Journal of the College of Science of Tokyo University contains an account by Dr. I. Ijima of the larva of an apparently new cestode worm which was recently found infesting a Japanese woman in extraordinarily large numbers. This larva has been provisionally described as a new generic and specific type under the name of *Plerocercoides prolifer*. It is believed to be a member of the Bothriocephalus group characterised by the absence of "bothria," a feature probably common to Ligula, with which the Japanese cestode may prove to be nearly related.

In a paper published in the fourth volume of series iii. of the *Anales* of the National Museum of Buenos Aires, Dr. F. Ameghino records the presence of a perforation in the astragalus of the badger, the other living mammals in which this feature is known to occur being the dasyure, the giant armadillo, and the mole. The same volume contains a paper by Mr. F. Lahille on a new type of scombroid fish from Argentine waters, which has been named (in a preliminary notice published a couple of years ago) *Chenogaster holmbergi*. This fish, of which an excellent coloured plate accompanies the memoir, is a member of the same group as the New Zealand Lepidothynnus and Gasterochisma, which inhabit the same latitude as Chubat. From the New Zealand forms Chenogaster differs by the united dorsal fins, while it is distinguished from Gasterochisma by the small ventral fins and from Lepidothynnus by the presence of vomerine teeth. The three genera indicate a circumpolar Antarctic group.

On a previous occasion a special notice was given in this Journal of Dr. Waite's account of the nesting habits of the fighting fish (*Betta pugnax*), as observed in an aquarium. In the *Records of the Australian Museum* (vol. vi., part i.) Dr. Waite publishes a preliminary note of these habits in the allied paradise, or rainbow, fish (*Polyacanthus opercularis*), of which specimens have likewise been successfully kept in captivity. After mentioning that at the commencement of the breeding season the male assumes a gorgeous nuptial coloration, the author goes on to say that the nest of this species is simpler and flatter than that of the fighting fish, a difference probably due to the habit of the former of nesting beneath shelter. The first eggs are often laid in a small mass of bubbles, others being added later; in consequence of this the eggs are raised quite out of the water, and thus hatched. It may be added that, according to older views of nomenclature, the name Polyacanthus renders void that of Polacanthus, applied many years later to a British dinosaur.

The migrations and growth of plaice form the subject of a communication by Mr. A. Meek to vol. i., part ii., of the new series of the *Transactions of the Natural History Society of Northumberland and Durham*. After referring to previous experiments and observations, the author states that during last year 483 plaice (inclusive of a few other flat-fishes) were caught, marked, and returned to the sea on the Northumberland coast. Of these fish 52 were recovered; and among this number only 2 made conspicuous migrations, and only 7 may be said to have left the bays where they were liberated. Apparently, the small plaice on the Northumberland coast gradually travel from the sandy pools to the adjacent deeper water, where they spend the remainder of their immature condition. When four or five years old they migrate into the still deeper extra-territorial waters, and apparently show a constant tendency to reach increasing depths with advancing age.

A restoration of one of the huge Miocene American perissodactyles of the family Titanotheriidæ is attempted by Prof. R. S. Lull in the July number of the *American Naturalist*, the species in question being a member of the genus or group Megacerops. The creature stands about 7 feet 4 inches at the withers, and measures rather more than 12 feet in length. The general proportions are those of a rhinoceros, although the limbs, probably to support the enormous weight of the body, are less angulated, and primitive features are displayed by the shortness of the back and in the structure of the fore-foot. Indeed, if we are to accept Prof. Lull's description of the latter, the definition of the group Perissodactyla requires modification, for the fore-foot of this titanothere is stated to be four-toed and symmetrical, with the main axis lying between the third and fourth digits after the artiodactyle fashion. As regards the nasal horns, which are branched at the summit, the author is inclined to believe, from the absence of groovings on the bone, that the basal portion (which is all now remaining) was clothed with skin during life, and that upon this were growths comparable to the horns of modern rhinoceroses.

PROF. ALBERT M. REESE, of the Syracuse University, has gone to Florida, under the auspices of the Smithsonian Institution, says the *Scientific American*, to collect eggs of the alligator with which to work out its embryology; subsequently he will spend some time at the biological laboratory of the Carnegie Institution of the Dry Tortugas studying the material he collects. Twenty-five years ago alligators existed in great abundance in the region ranging from North Carolina to the Rio Grande of Texas, but as alligator leather became fashionable about that time the demand thus created has reduced the supply by at least 98 per cent. It is said that a person may travel now from Jacksonville to Miami, Fla., without seeing a single alligator. It is estimated that 2,500,000 alligators were killed in Florida from 1880 to 1894.

THE list of new garden plants for the year 1904 has been published as appendix iii. to the *Kew Bulletin*. This list not only affords information respecting new plants, but also gives official authentification to the names, thereby providing an accurate guide for horticulturists.

A REVISION of the genus Zexmenia, prepared by Mr. W. W. Jones, has been issued as No. 7 of vol. xli. of the *Proceedings of the American Academy of Arts and Sciences*. The genus is one of the helianthoid Compositæ restricted to tropical and subtropical America.

NATURE-STUDY, so far as it is founded on the four faculties of observation, deduction, memory, and constructive imagination, is closely allied to the methods of Sherlock Holmes; such is the gist of an article by Mr. Lamborn in the May number of the *Nature-study Review*, and teachers in search of a novelty in nature-study may be referred to the example which is quoted. A short article on observation bee-hives for the schoolroom, by Miss Comstock, suggests another line of work. There is also much truth in the reasons which Mr. L. A. Hatch assigns for failure in teaching the subject, the first and foremost being a want of the observational instinct.

THE *Indian Forester* for June contains many interesting articles relating to forestry and kindred subjects. A new species of Diospyros (*D. Kanjilali*) is described and figured by J. F. Duthie. An article on the prohibition of grass burning and its effects on the game of the country will be read with interest by both forester and sportsman. Another valuable illustrated article, entitled "Some Facts about Gutta Percha," by Mr. A. M. Burn Murdoch, contains a great amount of useful information, especially regarding the rubber trees of the Federated Malay States. The article gives a very clear idea concerning the species and their distribution, the measures adopted for their protection, together with harvesting, manufacture, and properties of the gutta percha. There are many other papers and reviews, together with matters of general interest, which will repay perusal by those interested in forestry and its sister subjects.

THE broad-minded view which the U.S. Department of Agriculture takes of its function for instituting inquiries is well exemplified in three bulletins which have been received from the Bureau of Plant Industry. In Bulletin No. 68 Mr. A. S. Hitchcock presents a carefully prepared classification of North American species of Agrostis. The author, in the preparation of this memoir, has consulted all the large herbaria in Europe; the number of species, including three new to science, is limited to twenty-seven, and these, together with the principal varieties, are fully described and illustrated. A method of exterminating Johnson grass by means of a root-digger is explained by Mr. W. J. Spillman in Bulletin No. 72, and the problem of range management in the State of Washington is discussed by Mr. J. S. Cotton in Bulletin No. 75. The latter pamphlet deals with the protection and seeding of land which had been over-grazed by nomadic stockmen. Experiments on land situated at an altitude of 5000 feet demonstrated that Timothy, brome-grasses, and tall fescue would be found suitable for sowing on these mountain pastures.

WE have received a copy of the year-book of the Norwegian Meteorological Institute for 1904, containing hourly observations of air pressure and temperature for Christiania, in addition to observations made three times daily, and monthly and yearly summaries at a number of other stations in Norway. There is also a valuable appendix showing the departures of the monthly and yearly values from the normal at a number of stations for each year from 1874 to 1904. Since 1903 the station at Bergen has undertaken the duties of weather prediction and storm warnings for the western part of Norway. This arrangement allows Prof. Mohn, director of the Norwegian Meteorological Institute, to devote more attention to general climatology, and is conducive to more rapid dissemination of forecasts of the depressions arriving from the Atlantic.

THE *Annuaire météorologique* of the Royal Observatory of Belgium for 1905, published under the superintendence of M. A. Lancaster, director of the Belgian Meteorological Service, contains a large amount of useful information relating to that country in particular and to meteorological science generally. For sixty-eight years the *Annuaire* referred to astronomy and meteorology combined, but since 1901 each of these sciences is separately dealt with. Some 240 pages of the work now in question contain valuable data relating to the variability of atmospheric pressure and rainfall for each month since 1833, and to the frequency of sunshine since 1886. The following contributions are worthy of special notice:—(1) A discussion of the late spring and early autumn frosts by Dr. Vanderlinden, containing valuable particulars as to the conditions under which they generally occur, and the possibility of foretelling their occurrence. (2) A bibliography of meteorological treatises by M. L. Vincent from the earliest times. The author gives most attention to general treatises, but anyone wishing to study special subjects, *e.g.* marine, agricultural, and medical meteorology, or weather prediction, will find it an invaluable guide. (3) A collection of meteorological and physical constants and conversion tables which will be found exceedingly useful for general reference.

CAPTAIN H. G. LYONS contributes to the *Geographical Journal* for August an instructive summary of the dimensions of the Nile and its basin. The length of the Nile is given usually as 5400 kilometres (3355 stat. miles) to the centre of Lake Victoria, or 6000 kilometres (3728 stat. miles) for the continuous water-way from the source of the Kagera to the sea; the area of its basin is given as about 2,900,000 square kilometres (1,119,737 square miles). It is now possible to measure the length of the river with sufficient accuracy to furnish a value which later surveys probably will not materially alter. The length of the Nile from Ripon Falls to Rosetta mouth is 5589 kilometres, or 3473 miles. The area of the catch ment basin has been calculated from a map on the scale 1 : 4,000,000 for the Sudan and Uganda, and from one of 1 : 2,000,000 for Egypt. The area of catchment of the Nile basin is 2,867,600 square kilometres (1,107,227 square miles). The area of the basin will vary according to the distance to which its limits are considered to extend on the west of the Nile northwards of Khartum. Captain Lyons has taken it as far as the cliff of the desert plateau, or the first marked rise of the desert where the cliff is absent, probably, on the average, about 3 to 4 kilometres (2 to 2½ miles) from the edge of the cultivation. The whole of the Nile basin below Khartum, and practically all the White Nile basin, are non-effective in increasing the river supply, since the occasional local cloud-bursts may be neglected. The Bahr el Ghazal, as has been shown by recent measurements of the volume discharged, is also practically non-effective.

MR. S. TETSU TAMURA has contributed to the *Monthly Weather Review* (February and April) two papers dealing with applications of the Fourier methods of analysis, one to ice formation and the other to the nocturnal cooling of the atmosphere.

A VERY compact form of direct-reading cymometer for the measurement of wave-lengths and frequencies in connection with electric-wave telegraphy is described by Prof. J. A. Fleming in vol. xix. of the *Proceedings of the Physical Society of London*. In the described form the cymometer can be used to measure not only the length of the outgoing wave from a sending aërial, but also the length of the wave being received. The instrument can further be used for measuring the capacity of a Leyden jar or the inductance of a circuit for high-frequency currents.

IN the *Journal de Physique* for May, M. Adrien Guébhard contributes a paper on photographic action, illustrated by curves showing the darkening due to development as a function of the time, and the superficial changes as a function of the sum of the causes producing them—as he calls it, the "photographic function." It is well known that the effect of greatly over-exposing a negative is to reverse the photographic action, sometimes producing a positive instead of negative impression. M. Guébhard discusses the theory that the photographic function, after reaching its maximum and descending to a minimum, attains a second maximum, followed by a second minimum, and he describes experiments in support of this view.

PROF. O. ZANOTTI BIANCO, of Turin, has published (Florence: L. S. Olschki, 1905) a short discussion on Dante's "Quaestio de Aqua et Terra" considered in the light of modern geodesy. The question as proposed by Dante was essentially whether the water of the terrestrial globe is anywhere higher than the land which emerges from it. This question resolves itself largely into what is the definition of height adopted. According to Dante's belief that the earth was a sphere, points would be at the same height if they were equally distant from the centre, and the fact that the earth is not spherical, but ellipsoidal, would thus afford, in effect, an answer to Dante's question according to which the sea-level is considerably higher at the equator than at the poles. This particular interpretation appears to be the one favoured by Prof. Bianco.

No. 29 of the monograph supplements of the *Psychological Review* contains the first part of a new series of "Yale Psychological Studies," edited by Prof. Charles H. Judd, a large part of which is devoted to a series of studies of eye movements in connection with optical illusions. The contributors are Messrs. C. H. Judd, Cloyd N. Macalister, W. M. Steele, E. H. Cameron, and Henry C. Courten. Some idea of the researches on eye movements may be obtained from the following necessarily fragmentary summary. In order to trace the movements of the eye during the fixation of different points in the visual field, a tiny speck of Chinese white was attached to the cornea, and kinematographs were taken showing its movements as the subject followed the various details of a diagram. This was applied in the case of several well known optical illusions in which the lines of figures appear distorted or equal lengths appear unequal. In another series of experiments the subject was made to record his impressions by a series of pin pricks.

IN the *Bulletin de l'Académie Royale de Belgique*, No. 5, p. 201, Prof. W. Spring describes experiments which he has made on the limit of visibility of fluorescence. A conical beam of light of great intensity was brought to a focus in solutions of fluorescein of gradually increasing dilution. Fluorescence was perceptible on an area equal to one square millimetre at the apex of the conical beam, when the solution contained 1×10^{-15} gram of fluorescein, but imperceptible when the solution was ten times more dilute. On the assumption that in the limiting fluorescent condition at least one molecule of fluorescein is present in each cubic centimetre of solution, the value 1×10^{-18} gram is calculated as the superior limit of the weight of a molecule of fluorescein, and $2{\cdot}5 \times 10^{-21}$ gram as that of the weight of an atom of hydrogen.

SOME interesting observations on the decomposition of silver oxide at high temperatures are recorded by Mr. G. N. Lewis in the current number of the *Zeitschrift für physikalische Chemie* (vol. lii. p. 310). The velocity of decomposition of the oxide, when heated at 330° C. to 350° C., is at first so small that no appreciable evolution of oxygen is observed during several hours. The rate of change increases rapidly, however, as decomposition proceeds, passes through a maximum, and then gradually falls to zero. Experiments carried out to elucidate the peculiar phenomenon indicate that the reaction is autocatalytic, the silver produced by the decomposition being the catalytic agent. Other substances, such as platinum black and manganese dioxide, are found to exert a similar influence on the rate of decomposition of silver oxide.

A CONTINUOUS series of articles on the radio-activity of the soil and of the atmosphere is being written for *Le Radium* by Prof. Geitel. These articles connect together the several original papers published by Prof. Geitel in conjunction with J. Elster, many of which have already received notice in these columns. The number of *Le Radium* for July 15 contains in addition an article on the results obtained by the use of radium in the treatment of cutaneous cancer. It is illustrated by some striking photographs.

IN a brief note in the current number of the *Atti dei Lincei* Prof. A. Righi states that, using an experimental method essentially different from that employed by Prof. McClelland, he has obtained results which fully confirm the connection maintained by the latter to exist between the atomic weight of a substance and the amount of secondary radiation which it emits when subjected to the β and γ rays of radium (compare NATURE, vol. lxxi., p. 543, and lxxii., p. 158). The method used was to measure the change of potential of a disc of the material suspended in a vacuum when subjected to the radiation of radium. The disc being under two influences, namely, an increase in the negative charge owing to the impact of the β electrons and a loss of negative charge owing to the emission of a secondary radiation, the actual rate of accumulation of the negative potential measured inversely the rate of production of the secondary radiation.

The Engineering Standards Committee has issued a report on the effect of temperature on insulating materials. A series of measurements showing the influence of temperatures ranging from 75° C. to 150° C. on the disruptive voltage, the resistance and the mechanical properties of the insulating materials used in industry, were made by Mr. E. H. Rayner at the National Physical Laboratory, by Messrs. Crompton and Co. at Chelmsford, and by Messrs. Siemens Bros. and Co. at Woolwich. The electrical properties of the materials do not seem to be greatly influenced by exposure at the temperatures given, but the material itself perishes on long-continued heating. An interesting point established is the extraordinary increase in resistance of the insulating substances which, owing to the removal of water, accompanies drying at 100° C. The price of the report is 5*s*. net.

An interesting Parliamentary return just issued gives some particulars of the first three months' working of the Wireless Telegraph Act. Part of the return relates to licences, seventy-eight applications for which have been received; the majority of these are for experimental purposes, but a fair number are for commercial purposes. No less than four companies have applied for licences to establish stations to communicate with America; two of these have been granted, one is under consideration, and the fourth is offered with an alteration in locality. The paper also contains particulars of the working of the arrangement between the Post Office and the Marconi Co. It seems that 111 messages have been received by the Post Office for transmission to outward bound ships, of which 21 could not be delivered (in six cases at least through the senders' fault in transmitting after the latest guaranteed time). The number of messages received from ships at sea is 1655, which, if it does not represent a very great volume of business, still serves to show that the system is beginning to develop in practical utility.

A most interesting paper on a new carbon filament, read recently by Mr. Howell before the American Institute of Electrical Engineers, is published in the *Electrician* for July 28. The author claims to have produced a new allotropic modification of carbon, so different are the physical and mechanical properties of his filament, which is prepared in the following way:—An ordinary carbon filament made from a solution of cellulose is baked to as high a temperature as possible in an electric resistance furnace; it is then "flashed" in the usual manner, and afterwards again electrically baked. Although the first electrical baking considerably affects the final result, it seems that the graphite coating deposited during flashing undergoes a very marked change during the subsequent baking, which is especially remarkable considering the high temperature at which the deposit is formed. The filament possesses a very much lower specific resistance than ordinary filaments, and this is a disadvantage from the point of view of practical lamp making; but, on the other hand, the resistance-temperature curve rises instead of falls, which is a distinct gain, and will undoubtedly confer on the lamp an indifference to fluctuations of line voltage, and so enable it to be run at a high efficiency. The inventor claims a useful life of 500 hours at a power consumption of 2·5 watts per candle, which is an extremely good result for a carbon lamp.

The De La More Press will publish in the autumn "A First German Course for Science Students," by Prof. H. G. Fiedler and Dr. F. E. Sandbach.

We have received a copy of the first volume of the "Collected Researches" of the National Physical Laboratory. The volume contains five contributions, viz.:—An analysis of the results of the Kew magnetographs on "quiet" days during the eleven years 1890–1900, by Dr. Charles Chree, F.R.S.; the high-temperature standards of the National Physical Laboratory, by Dr. J. A. Harker; the construction of some mercury standards of resistance, with a determination of the temperature coefficient of resistance of mercury, by Mr. F. E. Smith; the range of solidification and the critical ranges of iron-carbon alloys, by Dr. H. C. H. Carpenter and Mr. B. F. E. Keeling; and the resistance of plane surfaces in a uniform current of air, by Dr. T. E. Stanton. All the papers have been published previously, three of them in the *Transactions of the Royal Society* and two in journals of other scientific bodies. As Lord Rayleigh says in a preface to the volume:—"A multitude of other problems of scientific and technical importance press for solution. Some of these are already in hand, but the rate at which progress can be made will depend in great measure upon the amount of support which may be forthcoming from those more immediately concerned in the development of industry. It is hoped that the publication of the present volume may serve as a stimulus, by showing the character of the work of which the Laboratory and the Staff are capable."

Prof. N. Zarudnoi publishes in vol. xxxvi. of the Memoirs of the Russian Geographical Society the herpetological and ichthyological results of his journeys in eastern Persia. The Reptilia are represented by 72 species, the Amphibia by 6 species, and the fishes by 17 species, many of which, especially among the first division, are new species described by Prof. A. M. Nikolsky.

The last volume of the Memoirs of the Russian Geographical Society, for ethnography (vol. xxv., 1), contains a very valuable bibliography, by M. Baltramaitis, of everything that has been printed about Lithuania (8514 titles), its geography, history, law, statistics, and ethnography, including folklore. This volume, which covers 614 pages, is followed by an appendix, which contains a list of Lithuanian and old Prussian books printed from the year 1553 to 1903 (2665 titles). The whole is admirably indexed.

Notice is given by the Clarendon Press of the first part of a new book on "Elementary Chemistry," by Mr. F. R. L. Wilson and Mr. G. W. Hedley. According to the preliminary announcement which has reached us, the ultimate object of the authors is "the cultivation of a scientific habit of mind in the pupils, through the medium of chemistry, rather than the mere acquisition of the facts of science."

Mr. John Heywood has published a fourth edition of Mr. R. L. Taylor's "Student's Chemistry." The book has been enlarged and revised by Mr. J. H. Wolfenden, and an appendix on the radio-active elements and an introduction to the study of organic chemistry has been added. The volume contains more than six hundred questions and problems, and is likely to continue to be a popular manual on the outlines of inorganic chemistry and chemical philosophy.

MESSRS. MACMILLAN AND CO., LTD., have issued a new and revised edition of stage vi. of Mr. Vincent T. Murché's "Object Lessons in Elementary Science," the price of which is 2s.

A FIFTH edition of Mr. W. W. Fisher's "Class Book of Elementary Chemistry" has been issued by the Clarendon Press, Oxford. The text has been entirely revised, and numerous additions have been made. Several chapters on organic chemistry, intended to serve as an introduction to this division of the subject, have been included in the new edition, which is now in line with the present state of knowledge of the subjects dealt with in the volume.

OUR ASTRONOMICAL COLUMN.

JUPITER'S SIXTH AND SEVENTH SATELLITES.—A telegram from Prof. Pickering to the Kiel Centralstelle announces that Dr. Albrecht has observed the recently discovered sixth satellite of Jupiter with the Crossley reflector of the Lick Observatory. The times of observation and the determined positions were as follows:—

G.M.T.	Position angle	Distance
	°	′
1905 July 25·95	55·0	25·1
„ 26·97	52·7	24·3
„ 27·93	50·7	23·6

(Circular No. 77, Kiel Centralstelle).

In Bulletin No. 82 of the Lick Observatory Dr. Frank E. Ross publishes the following set of elements for the orbit of Jupiter's seventh satellite, which he has computed from the observations made by Prof. Perrine on January 3, February 8, and March 6:—

Ecliptic Elements.

Mean Jovicentric Longitude at Epoch	° 333·55	1905 Jan. 0·0 G.M.T.
Longitude of Perijove	336·65	
„ Node	237·23	
Inclination to Ecliptic	31·0	
„ Jupiter's Orbit	32·0	
Longitude of Node on Jupiter's Orbit	238·6	
Elements referred to Earth's Equator.		
Mean Jovicentric Right Ascension	328·18	
Right Ascension of Perijove	331·28	
„ „ Node	281·13	
Inclination to Equator	26·2	

Mean Daily Motion $= 1^\circ{\cdot}358$

$\log a = 8{\cdot}9004$

$a = 52'{\cdot}54$ (for $\log \Delta = 0{\cdot}71624$)

$e = 0{\cdot}0246$

$P = 265{\cdot}0$ days

Distance at maximum elongation $= 70'$.

Calculating from these elements the positions at the times of Prof. Perrine's observations, it was found that the residuals were satisfactorily small, but for five intermediate dates, on which observations were secured, they proved to be larger than were expected. Dr. Ross accepts this result as evidence of the large periodic perturbations, chiefly solar, to which the satellite is subjected. The above elements indicate that this satellite revolves about Jupiter in a *direct* orbit, for although a retrograde orbit was computed and found to fit the three primary observations, it did not agree with the positions obtained from the intermediate observations.

An ephemeris, covering the period July 1 to November 13, from which the following positions are taken, accompanies Dr. Ross's paper:—

	p.	*s.*		*p.*	*s.*
	°	′		°	′
Aug. 10	294	26	Sept. 9	292	53
„ 20	293	36	„ 19	291	58
„ 30	293	45	„ 29	290	59

On October 4 the distance will still be 59′, but after that date it will slowly decrease, until on November 13 it will be only 18′.

According to a note communicated by Prof. Perrine to the Astronomical Society of the Pacific, and reproduced in No. 4035 of the *Astronomische Nachrichten*, Dr. Ross has also computed the orbit of Jupiter's sixth satellite. This satellite, like the seventh, moves in a direct orbit, its period being 242 days. The eccentricity of the orbit is large, amounting to 0·16, and the inclination to the plane of Jupiter's equator is about 30°. The mean distance of the satellite from Jupiter is about seven million miles. Thus the periods, and therefore the distances from Jupiter, of the sixth and seventh satellites are nearly alike, their orbits mutually interlocking. Otherwise the two orbits are dissimilar.

THE FORMATION OF THE NEW NORTH POLAR CAP ON MARS.—According to Mr. Lowell's observations, as recorded in No. 22 of the *Lowell Observatory Bulletins*, the first frost of this year in the Arctic regions of Mars occurred on May 19. The region wherein the phenomena were observed had been under daily scrutiny since coming into view on May 11, but no new feature had been discovered. However, on May 19 an enormous, unmistakably white patch was seen which extended from the western edge of the old cap to a point on the terminator about one and a half times the old cap's diameter away, and reached down to latitude +63°. The deposit was so thin on its northern edge that the band girdling the old cap could be plainly seen showing through it, but on May 20 a bright nucleus formed on the southern edge of the frost-bound area.

The date of the first observation corresponds to August 20 in our calendar, and is 126 days after the summer solstice in the northern hemisphere of Mars. In 1903 the first frost effects were observed on Mars about 128 days after the summer solstice; thus the recent observation strongly confirms those made in 1903.

LIQUID AIR—PRODUCTION AND APPLICATIONS.[1]

IN the former of these papers the author details experiments showing the trustworthiness of a German silver platinum couple to measure temperatures in the neighbourhood of those of liquid air and liquid and solid hydrogen. The electric resistance of metals is an unsafe guide at very low temperatures, and the manipulation of gas thermometers involves much time and care. A thermoelectric junction would be much more convenient if trustworthy. That it is trustworthy the experiments go to show, but only within limits. If the constants of the formula for interpreting the observations be determined at temperatures between 90½° and 123½° abs., the formula will then give the temperature of solid hydrogen at low pressure as 15°·27 abs., whereas if the constants be deduced from experiments at a lower temperature, 20½° to 77½°, the interpretation formula then makes the temperature of solid hydrogen at low pressure 1¾° lower, *i.e.* 13°·5 abs., which the author considers more correct. Bearing in mind that at this very low temperature a difference of 1¾° is equivalent to a difference of 37° at the ordinary temperature, we see that the method has no confirmatory value, and can itself be trusted only over the range for which it has been verified by the careful use of gas thermometers. If, therefore, helium be procured in sufficient quantity for liquefaction or solidification, its lower temperatures, possibly within 5° of the absolute zero, will have to be ascertained by the low-pressure helium thermometer. For ranges of temperature over which its indications can be verified, the thermoelectric junction thermometer will have a useful sphere of work in saving the inconvenience of employing gas thermometers. Among important cautions given by the author is a warning that junctions made with soft solder are affected by the low temperature. The junctions should be made with hard silver solder, and the indications at the temperature

[1] "On the Thermo-electric Junction as a Means of Determining the Lowest Temperatures, and on Liquid Hydrogen and Air Calorimeters." Papers by Sir James Dewar, read before the Royal Society, June 8, 1905.

of liquid oxygen compared before and after exposure to the temperature of liquid hydrogen, to see whether there has been any change produced. A German silver platinum junction was employed, but as the result of his experience the author recommends German silver gold.

The paper on "Liquid Hydrogen and Air Calorimeters" gives an account of experiments in which the specific heats of substances are determined by measuring the quantity of liquid air or hydrogen which they vaporise in falling through a given range of temperatures. From these experiments it appears that, at temperatures between those of these two liquids, ice has only one-third of its specific heat at ordinary temperature, graphite has only one-tenth, while diamond has as little as one-nineteenth of its ordinary specific heat. The second part of this paper deals with the latent heats of the volatile liquids, that of hydrogen being given as 121 or 122 calories, of oxygen 51·15 calories, and of nitrogen 50·4 calories. The latent heat of liquid air is not yet definitely determined, but when there is a high percentage of oxygen it is about 54 calories. The specific heat of hydrogen is found to be substantially the same, whether the substance be liquid, occluded, or gaseous.

The employment, just mentioned, of liquid air to determine the specific heat of substances may be called a practical application, though, so far, its utility is limited to scientific research; and the present time, ten years after the introduction of the new and comparatively economical method of producing it, is suitable for a review of its applications generally, the further developments in the methods of producing it, and the extent to which it has been possible so far to realise the expectations founded on the appearance of the new method of production.

It will be remembered that down to the year 1895 the method of liquefying air developed and employed by Olszewski and Dewar was what is called the cascade method, in which a gas condensed at high pressure is vaporised at a much lower pressure, so as to produce a much lower temperature, one low enough, perhaps, to condense a more volatile gas highly compressed. Thus nitrous oxide was made to produce liquid ethylene at a temperature below $-90°$ C., and the ethylene, boiled at low pressure, similarly produced liquid oxygen, nitrogen, or air at $-140°$ C. These liquids, boiling in the open, reduced their residual portions to their well known boiling points, and, boiled at low pressure, produced much lower temperatures, but in no case low enough to act in the same way as a means of liquefying compressed hydrogen, which is so volatile that its critical temperature is below the lowest obtainable by boiling the atmospheric gases at low pressure. The nearest approach to the liquefaction of hydrogen was Olszewski's imitation of Cailletet's combination of the cascade system with sudden expansion. He obtained a similar result—the brief appearance of an evanescent mist, which just sufficed to show that hydrogen was, under proper conditions, liquefiable. An ingenious means for getting below the lowest temperatures obtainable on the cascade system by boiling oxygen or nitrogen at low pressure was adopted by Olszewski and Dewar, who mixed hydrogen, the former with oxygen, the latter with nitrogen, in the hope of making a substitute for a natural gas of intermediate properties, which, boiling at low pressure, would give a temperature low enough for the liquefaction of compressed hydrogen on the cascade system. Both attempts were unsuccessful, though Dewar thought that the nitrogen jelly behaved as if it had some condensed hydrogen in solution.

At this stage there appeared a new and more powerful method for cooling and liquefying gases, the self-intensive system, by which compressed gas, allowed to cool itself by expanding to low pressure at a free orifice, has its cooling accumulated by an interchanger, and so intensified continually. Thus oxygen, nitrogen, and air starting from ordinary temperatures, and hydrogen starting from a temperature below $-200°$ C., can be made to cool themselves to the liquefaction point, and gradually liquefy themselves at ordinary pressure without the help of any less volatile liquid to assist the fall of temperature.

With such apparatus available, great expectations were indulged in as to the future possibilities of liquid air. As with electricity, the enthusiast and the impostor were soon at work, making unlimited promises to attract the interest of the public, and company schemes to attract their money. Liquid air as a source of power was going to eclipse and replace steam and electricity. As an artificial refrigerant it was to banish ice, ammonia, sulphur dioxide, and carbonic acid. In surgery it was soon to be the only anæsthetic, antiseptic, and caustic employed; in medicine it was to cure consumption and many other diseases. Our prominent scientific men cannot claim much credit for doing their duty to the public in this matter. In a few reported interviews some of them mildly recommended caution. In this country only one prominent worker with liquid air plainly warned the public at the beginning of this boom that such promises were either foolish or fraudulent, and declared that on the score of expense liquid air, as made by the new method, could never compete with steam as a source of power or with ice as a source of refrigeration. The last ten years have too fully justified the warning; but in the meantime large sums of money were extracted from the public in America by fraudulent liquid air companies, one of which attempted to continue operations in this country; and many business men in England held over orders for new refrigerating plants for some years, for fear lest, as soon as they had put one down, they might find it superseded by a liquid-air contrivance. Apart from scientific research, the nearest approach to a commercial application of liquid air began last autumn, when experiments were given at music-halls under the name of the "Magic Kettle." The performance was anything but a popularising of scientific knowledge, of which the performers themselves in most cases had none; besides which they purposely deepened the mystery of the matter by adding a little juggling, and making misleading statements.

Air liquefiers of the best make are now such perfect machines that they seem to offer no scope for improvement within the existing system. The chief attempt to improve the system consists in substituting an engine to do work for the free-expansion valve, in order to obtain more cooling for a given amount of compression. This device, in the form of a turbine, was discussed as early as 1895, but rejected on the ground of complication. In 1896 Lord Rayleigh suggested it in a letter to NATURE, and others have proposed or attempted it since. Thermodynamically it would be a great gain; but in apparatus of this kind a thermodynamic gain often actually involves a greater practical loss, owing to the importance of simplicity. In *Comptes rendus*, vol. cxxxiv. pp. 1568–1571, is an account of such an apparatus made by M. G. Claude, which is declared to have been entirely successful. As this is purely a question of economy and convenience, which are dominating factors commercially, the fact that this apparatus is not yet displacing others makes it likely that the complications involved are found to be a serious stumbling-block. They have hitherto prevented the adoption of a similar device in commercial refrigerating machines working with ammonia and carbonic acid, which are now made on such a very large scale that in them, if anywhere, the thermodynamic gain would outweigh the complications.

One of the most promising practical applications proposed for liquid air has been the manufacture of oxygen from air by liquefying it and letting the nitrogen boil away before the oxygen, separating them by distillation. Theoretically the power, that is, the cost, required should be small. The latent heat taken up by the two gases separately in volatilising should balance that given out by the air in condensing. One of the prominent names associated with attempts of this kind is that of Pictet, who was long believed to have liquefied oxygen and hydrogen at the time when Cailletet undoubtedly produced a mist of oxygen. In New York Pictet was associated with others in an attempt of this kind under a patent (U.S.A.) in which he commits the fallacy of expecting the gases to separate at a low temperature, but while both are still in the gaseous condition, the greater density of the oxygen taking it to the bottom of the container! The oxygen did not drop, but the scheme, the patent, the fallacy, and the investors' money did. Pictet next appeared with a French patent, in which the U.S. patent fallacy was replaced by another. He arranged to make a gain of cooling by letting liquid air vaporise at a lower temperature than that at which it had condensed, taking up more latent heat at the lower temperature than it had given out at the higher; and he overlooked the fact that the difference would be balanced by the specific heat given out by the liquid while being cooled to the lower temperature! Under a fresh patent in England Pictet has now for some years been associated with powerful supporters in installing a large and costly plant at Manchester with the same object. None of the former fallacies appear in the new patent. Whether practical success will attend the effort remains to be seen.

The liquid oxygen, or air rich in oxygen, obtained by distillation from liquid air, if mixed with a good combustible, such as cotton wool, makes an explosive. The Austrian military authorities, and the engineers engaged in tunnelling under the Alps, both made long and careful trials of such explosives; but the inevitable arrangements were too cumbrous, and the results too uncertain.

The nearest attempt to make what is called a practical use of liquid air is that of Dr. Allan Macfadyen (see NATURE, June 18, 1903, p. 152, and October 22, 1903, p. 608). By freezing the bacilli of typhoid in liquid air he makes them brittle enough for trituration in a mortar. By centrifugalisation the intracellular poison can then be separated from more fibrous material, and then by the methods of Pasteur an anti-typhoid serum prepared which promises to be of real value.

The most pronounced successes of liquid air have been in connection with scientific research. It was with liquid air made by the self-intensive process with a Hampson machine that Sir William Ramsay discovered krypton, xenon, and neon, that Prof. Rutherford and Mr. Soddy proved the emanations of radium and thorium to be condensable and vaporisable, that Ramsay proved the evolution of helium from radium emanations, and many other important investigations were carried out. Finally, it was by an extension of the same process that hydrogen was liquefied.

THE MEETING OF THE BRITISH MEDICAL ASSOCIATION.

A NUMBER of valuable and instructive papers were contributed at the recent meeting of the British Medical Association at Leicester, but the majority were technical and of a medical nature. The following, in addition to those described last week (p. 330), are, however, of more general interest:—

In the section of medicine, Dr. Nathan Raw (Liverpool) read a paper on human and bovine tuberculosis, with special reference to bovine infection in children. He said that while agreeing with the German view that there were decided differences between the bovine and human tubercle bacilli, he believed that bovine tuberculosis was a danger to human beings.

Bovine tuberculosis affected young people, was traceable to infected milk, and infected the tonsils, the alimentary tract, the glands, and, through the blood, the meninges, the bones, the joints, and other parts, while human tuberculosis was air-borne, and infected adults by way of the lungs as pulmonary phthisis. In evidence of this Dr. Raw indicated the rarity of pulmonary phthisis in infants and children, and, on the other hand, the comparative rarity of other than pulmonary lesions in adults, and suggested, further, that early tuberculous disease, presumably bovine, appeared to be protective against phthisis, as the development of pulmonary tubercle was relatively rare in those of a strumous diathesis who had suffered in infancy from bone and gland lesions.

In conclusion, Dr. Raw alluded to the frequency of tuberculosis among cattle, and the importance of the inspection of cattle and dairies.

Dr. F. J. Poynton (London) gave the results of his experience of milk to which sodium citrate had been added in the feeding of infants. The addition of sodium citrate to milk results in the formation of calcium citrate, and milk so treated forms a much finer curd and is more digestible than untreated milk. The sodium citrate may be added to the amount of 1 to 2 grains to the fluid ounce of milk.

In the section of ophthalmology, Prof. Hess (Würzburg) demonstrated by a series of beautiful drawings the influence of light in causing a migration of pigment in the retina of cephalopods. He had found in these eyes visual purple which had hitherto not been detected in any invertebrate.

All cephalopods studied by him showed this pigmentary migration within the retina, but the rapidity of the migration differed in various species, and it was different in different parts of the same retina, especially in the small horizontal stripe which contained very long and small rods, and corresponded evidently to an area of maximum vision.

In the section of tropical medicine, Mr. R. Newstead, of the Liverpool School of Tropical Medicine, read a paper on ticks concerned in the dissemination of disease in man, and gave a description of the *Ornithodorus moubata* which conveys tick fever, a spirillar infection, in the Congo Free State.

Mr. Newstead had found that in many respects the habits of the *Ornithodorus moubata* were not unlike those of *Argas persicus*, but the inert character of the larva of *Ornithodorus moubata* was unique among the Ixodinæ, in that it passes the whole of its life within the egg. The female *Ornithodorus moubata* laid eggs which were hatched, not as larvæ, but as nymphæ, although on the ninth day the larva was fully formed and the egg shell split, but the young tick remained until the fifteenth day, when as a nymph it escaped simultaneously from its larva covering and egg shell.

Dr. Graham (Sierra Leone) contributed a paper on guinea worm and its hosts. He had found that the incidence of the disease corresponded with the incidence of a cyclops, the presumed intermediate host, both seasonally and as regards its maximum manifestation.

SOME ASPECTS OF MODERN WEATHER FORECASTING.[1]

AFTER referring to the circumstances in which he was called upon to deliver the evening discourse in the absence of the Dean of Westminster, the lecturer explained that he had chosen the subject, not because he regarded weather forecasting as the only, or, from the scientific point of view, the most important practical branch of meteorology, but because, in a general sense, the possibility of its application to forecasting—the deduction of effects from given causes—was the touchstone of scientific knowledge.

The process of modern forecasting was illustrated by the daily weather charts of the period from February 1, 1904, up to the evening of February 12, which exhibited the passage over the British Isles of a remarkable sequence of cyclonic depressions, reaching a climax in a very deep and stormy one on the evening of the lecture. It was thus pointed out that the barometric distribution and its changes were the key to the situation as regards the weather, and this was supported by exhibiting the sequence of weather accompanying recognised types of barometric changes, as shown in the self-recording instruments at the observatories in connection with the Meteorological Office.

Some cases of difficulty in the quantitative association of rainfall or temperature changes with barometric variations were then illustrated. The barometric distributions in the weather maps for April 8 and April 16, 1903, were shown to be almost identical, and yet the weather on the later date was 10° colder than on the earlier. The observatory records for June 22, 1900, showed that a barometric disturbance of about the fiftieth of an inch, too small to be noticed on the scale of the daily charts, passed across the country from Valencia to Kew, over Falmouth, in about twenty-four hours, and produced at each observatory characteristic changes of temperature and wind, and also in each case about a fifth of an inch of rainfall.

Some examples of the irregularity of motion of the centres of depressions were also given, including one which travelled up the western coasts of the British Isles on October 14 and 15, and down the eastern coasts on

[1] Abstract of a discourse delivered at the Royal Institution of Great Britain by Dr W. N. Shaw, F.R.S.

October 16 and 17, 1903, one which developed from scarcely visible indications into a gale on December 30, 1900, and one which disappeared, or "filled up," as it is technically called, on February 6, 1904. The conclusion was drawn that the suggested extension of the area of observation by means of wireless telegraphy from ships crossing the Atlantic would not immediately place forecasting in the position of an exact science, but would add greatly to the facilities for studying the life-history of depressions.

The irregularities and uncertainties illustrated by the examples given might be attributed in part to the complexities of pressure due to the irregular distribution of land and sea in the northern hemisphere. Charts of the mean isobars for the world for January and July showed greater simplicity of arrangement in the southern hemisphere, where the ocean was almost uninterrupted, than in the northern hemisphere, where there were alternately large areas of sea and land. The comparative simplicity of the south as compared with the north was also illustrated by a chart representing an attempt at a synoptic barometric chart for the world for September 21, 1901.

The simplification of the barometric distribution at successively higher layers of the atmosphere, as illustrated by Teisserenc de Bort's chart of mean isobars at the 4000-metre level, was pointed out, and illustrations were also given of the method of computing the barometric distribution at high levels from observations at the surface, using data obtained from observations at high-level observatories, or those made with balloons and kites.

Some indication of the connection between the complexity of the surface and the simplicity of the upper strata might be established by means of careful observations of the actual course of air upon the surface and the accompanying weather conditions.

The actual course of air along the surface was often misunderstood. The conventional S-shaped curves representing the stream lines from anticyclonic to cyclonic regions were shown to be quite incorrect as a representation of the actual paths of air along the surface. A diagram contributed to the *Quarterly Journal of the Royal Meteorological Society*[1] showed the computed paths for special case of a storm of circular isobars and uniform winds, travelling without change of tyoe at a speed equal to that of its winds. An instrument made by the Cambridge Scientific Instrument Company to draw the actual paths of air for a number of different assumptions as to relative speed of wind and centre, and of incurvature of wind from isobars, was also shown, and the general character of the differences of path exhibited under different conditions was discussed.

In illustration of the application of these considerations to practical meteorology, it was noted that rainfall is an indication of the existence of rising air, and conversely the disappearance of cloud may be an indication of descending air. It was further noted that if the ascent and descent of air extended from or to the surface, the actual paths of air along the surface, as traced from the direction and speed of the winds, ought to show convergence in the case of rising air and divergence in the case of descending air.

The chart for April 16, 1903, was referred to for an obvious case of dilatation or divergence of air from a centre corresponding with fine weather, the centre of the area of divergence being specially marked "no rain," and the actual trajectories or paths of air for two different travelling storms were contrasted, to show how the rainfall might be related to the convergence of the paths of air. The two occasions selected were (1) the rapid travelling storm of March 24–25, 1902, and (2) the slow travelling storm of November 11–13, 1901.[2] The trajectories or actual paths of air for these two storms had been constructed from two-hourly maps drawn for the purpose from a collection of records of self-recording barographs, &c. Those for March 24–25 showed the paths to be looped curves with very little convergence, whereas those for the storm of November 11–13 showed very great convergence; so much so that if four puffs of smoke could be imagined starting at the same time from Aberdeen, Blacksod Point, Brest, and Yarmouth respectively, and travelling for twenty-four hours, they would find themselves at the end of the time enclosing a very small area in the neighbourhood of London.

Corresponding to this difference of convergence as shown by the paths was the difference of rainfall as illustrated by two maps showing the distribution of the rain deposited from the two storms. The first, with little convergence, gave hardly anywhere more than half an inch; the second, with its great convergence, gave four inches of rain in some parts of its area.

[1] The Meteroological Aspects of the Storm of February 26–27, 1903. *Q. J. R. Met. Soc.*, vol. xxix. p. 233, 1903.
[2] See Pilot Charts for the North Atlantic and Mediterranean, issued by the Meteorological Office. February, 1904.

BREATHING, IN LIVING BEINGS.[1]

IT has been said that the most striking facts connected with respiration are its universality and its continuity. In popular language "the breath is the life." Breathing is not only a sign of life, it is a condition of its existence. Permanent cessation of breathing is regarded as a sign of death. Link up with this the icy coldness of death and you have two significant facts.

Respiration and calorification are therefore intimately related; in fact, calorification is one form of expression of the results of respiratory activity.

The popular view of respiration is an inference from what is observed in man and animals. During life the rise and fall of the chest goes on rhythmically from the beginning to the end. The respiratory exchanges effected in the breathing organs—lungs or gills—constitute "external respiration." This, however, scarcely touches the main problem, viz. what is called "internal respiration," or tissue respiration—*i.e.* the actual breathing by the living cells and tissues which make up a complex organism.

We are told that man does not live by bread alone. We know he requires, in addition, solids, fluids and air. Taking these to represent the three graces, then air is of all the graces best.

The higher animals have practically no reserve stores of air—unlike what happens with the storage of fats and proteids—and hence the necessity for mechanisms by which air is continually supplied to the living tissues, and also by which the waste product of combustion, viz. carbon dioxide, is got rid of. Closure of the wind-pipe, even for a few minutes, brings death with it from suffocation. The entrance of oxygen is prevented and the escape of carbon dioxide is arrested.

The process of breathing is common to all living beings—to plants and animals alike. It consists essentially in the consumption of oxygen by the tissues and the giving out of carbon dioxide. It is immaterial whether the animals or plants live in water or air, the principle is the same in both cases. Living active protoplasm demands a supply of oxygen.

All the world's a stage. The human body is at once a stage, and a tabernacle—a vast theatre—and the myriads of diverse cells of which it is composed, the players.

The cells or players, as active living entities, not only require food, but they require energy. The respiratory exchanges in and by the living cells provide the energy for the organism. This breathing by the cells is called "internal respiration." In a complex organism, therefore, the respiratory exchanges represent the algebraic sum of the respiratory activity of the several tissues that make up the organism. The various tissues, however, breathe at very unequal rates.

In one of his charming "contes philosophiques," Voltaire describes the visit of a giant of Sirius to our planet. Before reaching his journey's end he would have to traverse an aërial medium, and on arriving would see before him a fluid medium in continual movement, and tracts of solid land. After investigation—or no doubt he would be told, even though he was not personally conducted—that the water surface of this our globe is two

[1] Abstract of a discourse delivered at the Royal Institution of Great Britain by Dr. William Stirling.

and a half times greater than the land surface. He would discover that there are animals that live in air, others in water, and again others on land. Our visitor would find out that the respirable media are two—water and air—and that there are 210 parts of free oxygen in a litre of air, while there are only 3–10 dissolved in a litre of water.

Had Voltaire's friend paid us another visit during the present century, we should be able to tell him that the water of the Thames above London contains 7·40 c.c. of O per litre; at Woolwich only 0·25, the decrease being due to the pollution of the river. Putting it broadly, water contains only 3–10 parts per litre, while air contains 210. Water-breathers under good conditions have twenty times less O than air-breathers. It is as if air-breathers on land had the percentage of O_2 reduced to 1.

He would also be told that carbon dioxide—CO_2—is also remarkably soluble in water, and readily combines with certain bases present in water; thus water forms an admirable medium into which an animal may discharge its effete and poisonous irrespirable CO_2.

He would also be told that our blood contains 60 volumes per cent. of gases, and that there is more O and less CO_2 in arterial blood than in venous blood.

Perhaps the name of Sir H. Davy might be whispered to him, for he was one of the first to detect the presence of gases O and CO_2 in blood.

In story, one has heard of the "Quest of the Holy Grail." I have even listened with rapt attention to an entrancing lecture on the "Quest of the Ideal." For the cell, the quest is the "quest of oxygen," and it is not happy until it gets it.

We speak of a distinction between air-breathers and water-breathers. If, however, we push the matter to its ultimate issue, we find that all our tissues—and equally those of plants—live in a watery medium; in us the fluid lymph which exudes from our capillary blood-vessels, and in plants in the sap. Thus we come upon what at first seems a paradox, but is not so; all our cells not only live in water, but they live in running water. They are bathed everywhere by the lymph which is the real nutrient fluid for our cells. Thus, in its final form, all respiration is actually aquatic. The process of internal respiration, besides other conditions, requires the presence of a certain amount of water. In fact, all vital phenomena require the presence of water.

The unity and identity of the process in animal and vegetable cells, as the theatre of combustion, is the striking fact. The means by which the necessary oxygen is brought to the cells is as varied as the forms of animated organisms themselves. This function exists for the cells, and not the cells for the function.

If the mountain will not go to Mohammed, Mohammed must go to the mountain. There are, at least, two principles on which animal cells obtain oxygen.

The air or water containing air is carried to the cells. This is the principle adopted in the lower invertebrates, as in sponges and with regard to certain air-breathers such as insects.

The other principle is this, that an intermediary carries the respiratory oxygen from some more or less central localised or diffuse surface to the cells. This intermediary is the blood—an internal medium of exchange. The fluid part of the blood may carry the oxygen supply and remove the carbonic dioxide waste. This is the case in many of the invertebrates, and it reaches its highest development in the vertebrates. Hence in them the circulating and respiratory systems reach their fullest development.

In most invertebrates the fluid part of the blood contains the nutritive substances and also the oxygen and carbonic acid. In the vertebrates, the hæmoglobin of the red blood corpuscles carries the oxygen from the gills or lungs to the tissues, whilst the CO_2 is contained in and carried chiefly by the blood plasma from the tissues to the gills or lungs.

It is singular that in the cephalopods, such as the squid and cuttle-fish, the blood is bluish in tint; and this is due to the presence in the plasma of a respiratory pigment called hæmocyanin. This body has a composition like that of hæmoglobin, but copper is substituted for the iron of the hæmoglobin. Copper also exists in organic combination in the red part of the feathers of the plantain-eater or turaco.

The real aristocracy with genuine blue blood are the crab, lobsters, squids, and cuttle-fishes.

Perhaps one of the most striking ways of dissociating this accessory mechanism from the activity of the cell itself is by the use of a poison. When a person is poisoned by coal gas, what happens? The coal gas contains carbon monoxide. This gas does not poison invertebrate animals or plants. Still it kills vertebrate animals. Why? It does not kill by acting on the living cells, only by depriving them of oxygen and asphyxiating them. It combines with the respiratory pigment hæmoglobin. Chloroform, ether, and similar drugs destroy the actual life of the cell elements by destroying their irritability.

In 1771, Priestley found that air vitiated by combustion of a candle, or by the breathing of animals—such as mice—could be made pure or respirable again by the action of green plants.

Under certain conditions, however, Priestley found that plants gave off carbonic acid, and the air did not support combustion or animal life. He regarded these as "bad experiments," and he selected what he was pleased to regard as "good experiments," *i.e.* those in which the air, rendered impure by the respiration of animals, was rendered respirable by the action of green plants.

In 1779 John Ingen-Housz published his "Experiments on Vegetables, discovering their great power of purifying the common air in sunshine, and of injuring it in the shade and at night."

He confirmed Priestley's observations that green plants thrive in putrid air, and that vegetables could convert air fouled by burning of a candle, and restore it again to its former purity and fitness for supporting flame, and for the respiration of animals—or; as he puts it, "plants correct bad air."

In 1787 Ingen-Housz, an English physician at the Austrian court, found that only in daylight did green plants give off oxygen. In darkness, or where there was little light, they behaved like animals so far as exchange of gases is concerned, *i.e.* they used up oxygen and exhaled carbonic acid. He found also that all roots, when left out of the ground, yielded by day and by night foul air, *i.e.* carbonic acid.

In the same year, 1804—the year of Priestley's death—Nicolas Theodore de Saussure, a Swiss naturalist and chemist, published his "Recherches Chimiques sur la Végétation" (Paris, 1804), a veritable encyclopædia of experiments of the effects of air on flowers, fruits, plants, and vegetation generally, and on the effects of these on atmospheric acid.

It is an old adage—the exception proves the rule. The exception "probes" the rule as the surgeon's probe probes a wound. The tactus eruditus of the surgeon, by his probe—indeed an elongated tactile sense—enables him to discover the presence or absence of a body in a wound. Had Priestley used the probe of a bad experiment, he in all probability would have anticipated the discovery of Ingen-Housz.

Some of you, no doubt, recollect the words of Goldsmith's famous description of his own bedroom and of the furniture of the inn—

"The house where nut-brown draughts inspired."

And how his imagination stooped to trace the story of—

"The chest that contrived a double debt to pay,
A bed by night, a chest of drawers by day."

As to himself he tells us how—

"A night-cap decked his brows instead of bay,
A cap by night—a stocking all the day."

Green plants contrive a double debt to pay; they give off oxygen by day, and at night exhale CO_2.

How do the vast number of plants, the microbes, the bacteria without chlorophyll get oxygen? Most of them get it as we get it. Some, however, cannot live in pure oxygen and are anærobic, such as the micro-organisms that cause tetanus, malignant œdema, and those that set up butyric acid fermentation.

Pushing the matter still further, it is extremely probable that the oxidation processes in our tissues are largely due to the presence of oxydases.

This raises the question as to the part played by the nucleus of a cell in its respiratory processes.

Is the source of muscular energy to be sought in oxidation or cleavage processes in tissues? In some animals there is not a direct relation between the muscular work and oxygen consumed, though there is to heat production. Bunge, on this ground, thought that the intestinal parasites of warm-blooded animals must have their oxygen at a minimum. In the intestinal contents there is no estimable oxygen; there active reduction processes go on. Entozoa might get oxygen from O_2 diffusing from blood-vessels.

Bunge found that intestinal worms of the cat and pike can live in an alkaline solution of common salt, free from gases, under Hg, for four to six days. They made active movements, and gave off much CO_2.

Ascaris lumbricoides from the intestine of the pig lived four to six days in 1 per cent. boiled NaCl solution. It made little difference whether oxygen or hydrogen was passed through the fluid. They lived seven to nine days if fluid was saturated with carbon dioxide, so that they have accommodated themselves to high percentages of carbon dioxide.

They give off to the fluid valerianic acid, an acid with a characteristic butyric acid odour. These worms contain a very large quantity of glycogen, the dry body yielding 20 per cent. to 34 per cent. of this carbohydrate.

100 grams Ascaris, placed in boiled normal saline solution, used per day—

0·7 gram glycogen,
0·1 ,, sugar,
No fat;

and yielded—

0·4 gram CO_2
0·3 valerianic acid.

It would seem that glycogen had split into CO_2, and valerianic acid—

$$4C_6H_{12}O_6 = 9CO_2 + 3C_5H_{10}O_2 + 9H_2$$
$$720 = 396 + 306 + 18.$$

Is it a genuine fermentation?

Weinland found that he could express by Buchner's method a substance, "zymase," which could split glycogen into CO_2 and valerianic acid.

Turning now to respiration in invertebrate animals, and dealing first with those which live in water, let us see some of the contrivances by which this end is achieved. The mechanisms are but means to an end. The ultimate union of oxygen, and the discharge of carbon dioxide with the liberation of energy, occur in the protoplasm of the cell itself.

There are two distinct processes, and it may be that the oxygen is introduced by one portal and the carbon dioxide got rid of by another, or it may be that one portal may do for both processes—the letting in of oxygen and the giving off of carbon dioxide.

Although the principle itself is simple, the variety of mechanisms adopted by nature to secure this double function is remarkable. Let us glance at some of the mechanisms proceeding from the simple to the complex, and first with regard to those animals that live in water.

Consider the oceanic fauna. It is immense both from the point of view of number and variety. Save insects and certain groups of molluscs, all invertebrates are aquatic. Amongst vertebrates, fishes have aquatic respiration, and some mammals, *e.g.* cetaceans or whales, have water as their sphere of existence, though they depend on the air for their respiratory oxygen.

The evolution from an aquatic to an aërial mode of existence can be traced in the animal kingdom, and may even be seen within limits in the history of certain species.

Every living cell, animal or vegetable, requires for its continued existence a supply of oxygen, and every living cell exhales carbon dioxide. The exchange of these two gases between the fluids of the body and the outer medium is the process of respiration. The simplest form of respiratory exchange occurs where there is no specially differentiated organ or mechanism for this purpose, so-called diffuse respiration. The whole surface of the organism in a watery medium may be concerned in this respiratory exchange. This is only possible, however, so long as the boundary surface, skin, or otherwise is permeable to gases, and no great respiratory exchanges are necessary.

Before showing you some lantern slides, I should like to point out how one process is made to aid another.

Motion associated with respiratory processes.

Ciliary motion with respiration and the capture of prey for food.

The old idea of one function for an organ is exploded. One speaks of one man one vote. One man one value. It is not really so.

With Shelley we may say—

"Nothing in this world is single;
All things, by a law Divine,
In each other's being mingle."

As regards the surfaces for these respiratory exchanges for diffuse respiration, it may take place through the inner surface of the body cavity of cœlenterates, the under surface of the bell of a medusa, the tentacles of an echinus, the respiratory tree at the hind gut of the sea cucumber, or the intestine of the young of the dragon fly, or by the intestinal mucous membrane of the mites which have no lungs or other directly respiratory organ. In the higher animals we have tracheæ, gills and lungs.

In some animals, the respiratory mechanism is closely related to the motor apparatus, as in some crustacea. In some mollusca the nutritive and respiratory mechanisms are closely related. In the highest of all there is central apparatus—gills or lungs—for the respiratory exchange between the blood and the air, and a circulatory apparatus for carrying the blood to and from the respiratory organs. The adaptivity of insects to varied conditions of oxygen supply is marvellous.

Before showing some classical experiments and illustrating the principles already laid down, I should like again to direct your attention to the association of several processes with respiratory mechanisms.

[The lecture was illustrated by means of lantern slides, showing the respiratory mechanisms from the lowest to the highest animals, and also by a number of experiments dealing with the chemical exchanges in the process of respiration. Lastly, the classical experiment of John Hunter, on the pneumaticity of the bones of birds, was shown in the duck. A candle flame was extinguished when held in front of the divided trachea, when air was blown into the divided humerus bone of the wing.]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ON June 27, Amherst College, Massachusetts, conferred the degree of M.A. upon Mr. Lundin, of Messrs. Alvan Clark and Sons, the following being President Harris's characterisation:—"CARL AXEL ROBERT LUNDIN: Scientific expert in cutting and fashioning glasses of great telescopes. He has done important work on the large objectives of Russia, of the Lick and Yerkes observatories, and lately on the 18-inch objective of the Amherst College Observatory, which is wholly his work. In 1854 Amherst conferred the degree of Master of Arts on Alvan Clark, who had built our first telescope. The same degree, for a similar service, is conferred on his successor, who has kept pace with the progress of astronomical science."

AN interesting inquiry as to the representation of science in the principal public libraries of Paris is being made by the *Revue Scientifique*, and the results are published week by week, from July 1 onwards, in the form of letters and opinions from the principal librarians and professors of science in France. The opinion is generally expressed that an unsatisfactory state of affairs exists in libraries such, for instance, as the Bibliothèque nationale and the library of the University of Paris owing to the fact that the librarians are almost exclusively graduates in arts and letters, and ignorant of the requirements of men of science. It thus happens that, the available funds being limited, preference is given in the purchase of foreign works to the departments of history, letters, and the arts, these being the subjects in which the librarians themselves have special interest and knowledge. Important scientific books are thus often overlooked. The current books of reference and the principal foreign journals are difficult of access, and are not at hand for immediate use; journals are often not available for a year, or more, after the date of issue owing to their being sent to the binders. For these reasons, and on account of the time wasted in waiting and formalities, the principal libraries are hardly used at all for scientific purposes by most of the workers engaged in active research. The professors and teachers of Paris consider that the special libraries attached to the actual laboratories are more valued and are of greater use than the larger and more general libraries, and that these should be coordinated so as to be available for any properly accredited worker. On the other hand, there seems to be a desire on the part of the Government to limit the usefulness of these actual working libraries by reducing the grants formerly allotted to them. Some of the criticisms of the Paris libraries and suggestions for their amelioration are not without application in this country.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 15.—"Contributions to the Physiology of Mammalian Reproduction. Part i., The Œstrous Cycle in the Dog. Part ii., The Ovary as an Organ of Internal Secretion." By F. H. A. **Marshall** and W. A. **Jolly**. Communicated by Prof. E. A. Schäfer, F.R.S.

The experiments lead to the conclusion that the ovary is an organ providing an internal secretion which is elaborated by the follicular epithelial cells or by the interstitial cells of the stroma. This secretion circulating in the blood induces menstruation and heat. After ovulation, which takes place during œstrus, the corpus luteum is formed, and this organ provides a further secretion the function of which is essential for the changes taking place during the attachment and development of the embryo in the first stages of pregnancy.

June 8.—"Researches on Explosives." Part iii. By Sir Andrew **Noble**, Bart., K.C.B., F.R.S.

The principal object of the researches which are communicated in this paper was to ascertain, with as much accuracy as possible, the differences in the transformations which modern explosives suffer when fired under gradually increasing pressures. The first part of the paper gives a description of the varied apparatus employed.

Although the author has made experiments with many other explosives, those examined in this paper are three in number:—(1) Cordite; (2) the cordite known as M.D.; and (3) a tubular nitro-cellulose.

The modes of observation and calculation followed are described, and then in tabular form are given the results of the series of experiments on the three explosives named. These tables being too extensive to reproduce in full, the results of the experiments at the lowest and highest densities alone are given:—

Density of charge exploded.	Cordite Mark I.		M.D. Cordite		Nitro-Cellulose	
	0·05	0·50	0·05	0·45	0·05	0·45
Volumes of permanent gas per gram.	678·0	623·6	781·8	676·3	814·7	680·9
Volume of total gas per gram.	877·8	798·8	955·4	810·6	993·1	816·3
Percentage volumes of permanent gases.						
CO_2 ...	27·15	41·95	18·15	36·60	17·90	35·00
CO ...	34·35	19·10	42·60	24·80	43·45	27·85
H ...	17·50	12·05	23·15	11·90	24·40	12·65
CH_4 ...	0·30	7·05	0·35	10·70	0·60	11·10
N ...	20·70	19·85	15·75	16·00	13·65	13·40
Percentage volumes of total gases.						
CO_2 ...	20·97	33·02	14·85	30·56	14·68	29·16
CO ...	26·53	15·03	34·87	20·71	35·63	23·20
H ..	13·52	9·48	18·95	9·94	20·01	10·54
CH_4 ...	0·23	5·55	0·29	8·94	0·49	9·25
N ...	15·99	15·62	12·89	13·36	11·19	11·16
H_2O ...	22·76	21·30	18·15	16·49	18·00	16·69
Percentage weights of total gases.						
CO_2 ...	36·10	51·84	27·69	48·75	28·19	47·26
CO ...	29·00	15·03	41·38	21·02	43·53	23·92
H ...	1·14	0·67	1·62	0·72	1·74	0·79
CH_4 ...	0·18	3·18	0·18	5·19	0·34	5·45
N ...	17·63	15·65	15·32	13·59	13·71	11·54
H_2O ...	15·95	13·63	13·81	10·73	12·49	11·04
Pressure in tons per square inch.	2·9	52·9	2·7	43·22	3·35	40·5
Pressure in atmospheres.	442·1	8063·8	411·6	6587·3	510·7	6173·6
Units of heat, water fluid.	1272·3	1360·0	1035·9	1190·0	896·1	1036·9
Units of heat, water gaseous.	1186·8	1287·0	961·9	1132·5	829·2	977·7
Specific heat.	0·23040	0·22385	0·23714	0·22529	0·23772	0·22828
Temperatures of explosion, Centigrade.	5151°·1	5749°·4	4056°·2	5026°·8	3488°·1	4282°·9
Comparative potential energy.	0·9825	1·0000	0·8401	0·8842	0·7389	0·7686

If the figures given in these tables be carefully examined, it will be observed that for the three explosives the transformation on firing appears, in all, to follow the same general laws.

Thus in all three there is, with increase of pressure, at first a slight increase, afterwards a steady decrease, in the volume of permanent gases produced.

In all three explosives there is, with increased pressure, a large increase in the volume of carbonic anhydride, and a large decrease in the volume of carbonic monoxide. In the volume of hydrogen this decrease with increase of pressure is very great; while methane, the percentage of which with low pressures is quite insignificant, very rapidly increases, and at the highest density is from twenty to thirty times greater than at the lowest density.

There are some variations in the percentages of nitrogen and water vapour, but on the whole these constituents may be considered to be nearly constant.

The units of heat developed show with increased pressure a slight decline at first, but afterwards increase somewhat rapidly at the higher pressures.

In the tables submitted it will be observed that the specific heats and the temperatures of explosion have been given, but with respect to temperatures so far above those in regard to which accurate observations have been made the figures given can only be taken as provisional.

These temperatures have been obtained by dividing the units of heat (water gaseous) by the specific heats; although provisional, they can safely be used in comparing the temperatures of explosion of the three explosives.

The comparative approximate potential energies are obtained by multiplying the volume of gas produced by the temperature of explosion. The means for the three explosives are respectively:—cordite, 0·9762; M.D., 0·8387; nitro-cellulose, 0·7464. The highest potential energy (taken as unity), it will be noted, was obtained from cordite at a density of 0·5.

It is submitted that the wide differences in the transformation of the three explosives with which the experiments have been made justify the general conclusion at which Sir F. Abel and the writer arrived in the year 1874 (*Transactions of the Royal Society*, vol. clxiii. p. 85) with respect to gunpowder, viz. that any attempt to define by a chemical equation the nature of the metamorphosis which an explosive may be considered to undergo would only be calculated to convey an erroneous impression regarding the *definite nature* of the chemical results and *their uniformity* under different conditions.

The paper continues with a description of the experiments made to determine the time required for the complete ignition of certain explosives, and also of other experiments to determine the rate at which the exploded gases part with their heat to the walls of the vessels in which they are confined; and in conclusion it is pointed out that the experiments made on erosion, with the three explosives referred to in this paper, and with some other explosives, have satisfied the author that the amount of absolute erosion is governed practically entirely by the heat developed by the explosion.

"Colours in Metal Glasses, in Metallic Films, and in Metallic Solutions." II. By J. C. Maxwell **Garnett.**

Expressions, giving the refractive index and the absorption coefficient (the optical constants) of a compound medium consisting of metal (1) in small spheres (granular), and (2) in discrete molecules (amorphous), diffused through an isotropic non-dispersive transparent medium (the solvent), in terms of the corresponding optical constants of the normal metal, were first obtained. The particular formulæ, which apply when the volume proportion (μ) of metal in the compound medium is small, followed immediately. By means of these formulæ and of the numerical values of the optical constants of gold, silver, and copper for monochromatic light of several different wavelengths, the values of the corresponding optical constants of diffusions of spheres and of molecules of these metals, in glass, in water, and *in vacuo*, were calculated and tabulated. The absorptions of monochromatic light by specimens of gold and copper ruby glass and of silver-stained glass were measured. A comparison of the measured absorptions of gold ruby glass with the calculated absorptions of gold spheres and of gold molecules diffused in glass, and a collation of the results with others previously published,[1] show that the colour of gold ruby glass is primarily due to the presence of spheres (not molecules) of the metal. The presence of crystallites, formed by the coagulation of the gold spheres, and reflecting red light, accounts for the irregular blue and purple colours sometimes transmitted by gold glass. Further, when the absorptions of a colloidal solution of gold in water are compared with the calculated absorptions of gold spheres and molecules diffused in water, it appears that colloidal gold consists of small spheres in suspension.

The close similarity between the observed absorptions of glass stained (amber) with silver, and the calculated absorptions of silver spheres in glass—those of a diffusion of silver molecules in glass are quite different—indicates that the stained region must contain small spheres of silver. The presence of silver spheres (but not of discrete molecules of silver) also accounts for the brilliant blue reflection from the interface between the stained and unstained regions of Stokes's specimens of silver glass. Ehrenhaft's[2] description of the nature and position of the absorption band observed in the spectrum of colloidal solutions of silver describes so well the position of the absorption band determined by calculation for a diffusion of silver spheres (but not of silver molecules) in water as to justify the conclusion that the bulk of the silver present in colloidal solution is in the form of small spheres, little, if any, being in true solution (*i.e.* molecularly subdivided); and this conclusion is confirmed by the fact that the refractive index of a colloidal solution of silver, which was measured by Barus and Schneider, is precisely that which calculation gives as the refractive index of a diffusion of silver spheres (but not of molecules) in water.

A comparison of the observed and calculated absorptions shows that copper ruby glass owes its colour to the presence in the glass of small spheres of metallic copper; but some copper molecules are probably also present.

Calculation proves that diffused spheres of cobalt would give a reddish colour to glass. Cobalt glass is not coloured by the metal in the metallic form.

[1] *Phil. Trans.*, A, 1904, pp. 385 *et seq.*; NATURE, vol. lxx. p. 213 (June 30, 1904).
[2] Felix Ehrenhaft, *Ann. der Phys.*, vol. xi. p. 489 (1903).

The colours produced in gold, silver, and soda glasses by the radiation from the emanation from radium suggest that these glasses contain free ions of the metal, and that it is by the discharge of these ions and the consequent reduction of the metal that kathode and Becquerel rays are able to colour the glasses.

Curves were constructed to show how the calculated absorptions and reflections of red, yellow, green, and blue light by gold and silver films vary with the volume proportion, μ, of metal in the film; and a comparison of these calculated colour changes with those exhibited by the gold and silver films, which Faraday and Beilby had prepared, when subjected to heat and to pressure, indicated that (*a*) the films as first prepared were in the amorphous or granular phase; (*b*) heating diminished the density of the film, while pressure was able to increase that density again; and finally (*c*) this diminution of density was probably effected by the passage of the metal from the amorphous to the granular phase, and by the growth of the larger granules at the expense of the smaller, while increase of density was accomplished by changing some of the metal from the granular to the amorphous phase.

Optical and other evidence led to the conclusion that Carey Lea's silver was not allotropic, but consisted of normal silver in a finely divided (but not necessarily granular) state. It appeared, therefore, probable that many forms of metals, which have hitherto been supposed to be allotropic because they possessed optical properties distinct from those belonging to the metals in their normal states, were merely cases of fine division. Thus the properties of Bolley's lead, of Schützenberger's silver, and of other alleged cases of allotropy cited by Roberts-Austen ("Metallurgy," p. 90), do not require the postulation of an allotropic molecule for their explanation.

Faraday Society, July 3.—Mr. W. R. Cooper in the chair.—Some notes on the rapid electro-deposition of copper: Sherard **Cowper-Coles.** The various processes for increasing the current densities in copper deposition by using mechanical means for keeping the copper smooth are classified as follows:—(1) revolving or moving the kathode; (2) burnishing the copper during electro-deposition; (3) insulating the growths on the copper so as to prevent further increase; (4) rapid circulation of the electrolyte; (5) revolving mandrel at a critical speed (centrifugal process).—The use of balanced electrodes: W. W. Haldane **Gee.**—The electrolytic oxidation of hydrocarbons of the benzene series, part ii., ethyl benzene, cumene and cymene: H. D. **Law** and Dr. F. Mollwo **Perkin.**—The electrolytic analysis of antimony: H. D. **Law** and Dr. F. Mollwo **Perkin.**—Notes on heat insulation, particularly with regard to materials used in furnace construction: R. S. **Hutton** and J. R. **Beard.**—Storage batteries and their electrolytes: R. W. **Vicarey.**—Alternate current electrolysis: Prof. E. **Wilson.**—The two last papers were taken as read, and the discussions postponed until the autumn.

DUBLIN.

Royal Irish Academy, June 26.—Prof. R. Atkinson, president, in the chair.—Prof. Ronald **Ross** gave an account of the researches which resolved the malaria problem, and took occasion to refer to the interesting mathematical problems connected with the diffusion of mosquitoes.

PARIS.

Academy of Sciences, July 31.—M. H. Poincaré in the chair.—The study of refraction at all heights. Formulæ relating to the determination of the coordinates of the stars: M. **Lœwy.** A development of a system of formulæ allowing of the deduction of the positions of two pairs of stars according to the new method given in the *Comptes rendus* for July 17. Three tables of solutions accompany the paper.—On an endoglobular hæmatozoa found in the jerboa: M. **Laveran.** The parasite is described and classified as *Haemogregarina Balfouri.*—On a secondary reaction of the halogen organo-magnesium compounds: Paul **Sabatier** and A. **Mailhe.** The cause of the low yield sometimes observed in the reaction between a ketone and an alkyl magnesium halogen compound is due to a secondary reaction resulting in the formation of a substituted ethylene. This tendency to the formation of an unsaturated hydrocarbon is especially marked in the case of the isobutyl derivatives. Details are given of several cases.—On the theory of surfaces and of envelopes of spheres in anallagmatic geometry: A. **Demoulin.**—On the properties of a holomorphic function in a circle where it does not take the values zero and unity: Pierre **Boutroux.** —On a new series of polynomials: A. **Buhl.**—On sliding friction: M. **de Sparre.** A solution of a problem enunciated by M. Appell in his treatise on mechanics. —The passage of electricity through gaseous layers of great thickness: E. **Bouty.** It has been shown in previous papers that the critical field $y=a\sqrt{p(p+b)}$, where p is the pressure (above 0·1 mm. of mercury), a the dielectric cohesion of the gas, and b a constant for the given flask and gas. In the present communication the constant b is found to be in inverse proportion with the thickness of the gaseous layer, e. The formula thus becomes

$$v=a\sqrt{p\left(p+\frac{k}{e}\right)},$$

where k is a constant which depends only on the nature of the gas.—The electrolytic detector with a metallic point: G. **Ferrié.** An experimental study of the use of the imperfect contact of a fine metallic point and an electrolyte as a detector for Hertzian oscillations.—On the phenomenon of Marjorana: A. **Cotton** and H. **Mouton.** A study of the behaviour of solutions of colloidal iron hydroxide in a strong magnetic field.—On a megaphone: G. **Laudet** and L. **Gaumont.** A gas flame, mechanically controlled, is used to intensify the sound waves.—On the state of matter in the neighbourhood of the critical point: Gabriel **Bertrand** and Jean **Lecarme.** Experiments made upon solutions of potassium bichromate in water and of alizarin in alcohol, at temperatures slightly above the critical points, have led to the conclusions that slightly above and below the critical temperature both the liquid and gaseous states exist simultaneously.—On the different states of oxidation of aluminium powder: M. **Kohn-Abrest.** Aluminium powder was heated by electrical means to various temperatures in a current of air; evidence was obtained of the formation of an oxide AlO.—The influence of the fragility of steel on the effects of mechanical treatment in a boiler works: Ch. **Frémont.**—The modification produced in the metal of rivets produced by the operation of riveting: M. **Charpy.**—On the constitution of sparteine: Charles **Moureu** and Amand **Valeur.** The authors summarise their recent work on this alkaloid, and propose a formula for it which is completely in accord with the facts known up to the present.—Chemical oxydases: G. **Baudran.**—On the variations of the basic function in chromium salts: Albert **Colson.**—On the presence of bile pigments in the medicinal leach: Camille **Spiess.**—Folded faults and horizontal overlapping in the Mesozoic of Portugal: P. **Choffat.**—On the geology of the southern Carpathians: G. M. **Murgoci.**—Observations on the mode of formation of deposits of blende enclosed in the stratified rocks: A. **Lodin.**

CALCUTTA.

Asiatic Society of Bengal, June 7.—Religion and customs of the Uraons or Oraons: Father **Dehon,** S.J., communicated by E. A. Gait. An account of the reputed origin, mythology, ceremonies, and folklore of an agricultural tribe now settled in Chota Nagpur, but thought to have come from farther south.—Note on a decomposition product of a peculiar variety of Bundelkhand Gneiss: C. **Silberrad.** A white clayey material found in the Ajaigarh State has been submitted by the author to Dr. O. T. Silberrad, the analysis of which is compared with that of pinite. The two substances were found to resemble one another.

July 5.—Four new barnacles from the neighbourhood of Java, with records of Indian pedunculate forms: Dr. N. **Annandale.** Of the new species, two belong to the genus Scalpellum, two to Alepas. Of the former, one is remarkable for its great size and for the reduction of the calcified valves; the other for its habit of forming a regular, branched, though not organically connected, colony of several generations. One Alepas is larger than any hitherto described. The specimens were presented to the Indian Museum by the Eastern Telegraph Company, and come, with one exception, from a depth of 160 fathoms. A list of the pedunculate cirripedes known from the seas of British India is added.—Additions to the collection of Oriental snakes in the Indian Museum, part ii.: Dr. N. **Annandale.** Notes on specimens lately received from the Andamans and Nicobars, with the description of a new sea-snake and a list of the Ophidia known to occur in these islands.—The Tibetan version of the Pramanasamuccaya, the first Indian work on logic proper, recovered from Tibet by the late Tibet Mission: Prof. Satis Chandra **Vidyābhūṣaṇa.**—Materials for a flora of the Malayan Peninsula, No. 17: Sir George **King,** F.R.S., and J. S. **Gamble,** F.R.S. This contribution commences with natural order Myrsineæ, and is continued by Sapotaceæ, Ebenaceæ, Styraceæ, and Oleaceæ. The draft of Ebenaceæ was prepared by Sir George King, that of the other orders by Mr. J. S. Gamble; but the new species are given under their joint names.

CONTENTS.