THURSDAY, OCTOBER 20, 1904.

ODORIFEROUS SUBSTANCES USED IN PERFUMERY.

Die Riechstoffe. By Georg Cohn, of Görlitz. Pp. viii+219. (Brunswick: Vieweg und Sohn, 1904.) Price 6 marks.

THIS useful little monograph is a section, published in separate form, of Bolley-Engler's "Handbuch der chemischen Technologie." It is not easy to find a single expression in English which could be regarded as the precise equivalent of the German "Riechstoff" in the sense used by the author. The term as here employed is meant to apply to odorous substances of a pleasant smell and of definite chemical composition—in other words, to chemical individual compounds having a more or less fragrant odour. It is obvious that the word perfume does not apply, because a perfume is generally a mixture of various odorous and non-odorous compounds, this being invariably the case with natural perfumes or fragrant plant oils.

The information contained in the present work is to be found in the larger treatises dealing with this subject, the works of Gildemeister and Hoffmann in Germany, of Charabot and his colleagues in France, and of Sawer in this country being familiar to all who are interested in this branch of chemical technology. The arrangement of the subject-matter by Herr Cohn, however, and the inclusion of the later discoveries entitle the little work under notice to take rank as an original contribution to the literature of this branch of applied organic chemistry. In fact, taking into consideration the large amount of information compressed into the volume, and the completeness with which the ground has been covered within a comparatively small compass, it may be fairly claimed that the treatment is more scientific and less technical than in the standard treatises referred to, and chemists who wish to get a general idea of the development of their science in this newer field will find the work of Herr Cohn a very valuable compendium.

The book is divided into ten chapters and an appendix. After defining the term "Riechstoff" in the sense above indicated, the literature of the subject is given in the second chapter, not the least valuable portion of which is a tabulated list of German patents classified under the chemical families to which the patents relate, such as alcohols, ethers, esters, aldehydes, ketones, &c. In the third chapter the historical development of the industry is dealt with, and it is pointed out that while perfumery as an art is of extreme antiquity, the scientific, *i.e.* chemical, history of the compounds employed is a comparatively recent development. The same may be said, it is perhaps hardly necessary to point out, of the tinctorial industry, which existed as an art ages before it came within the province of chemical science. The parallelism between these two branches of technology does not, however, end with this historical analogy, since the development of synthetical chemistry has enabled many natural odorous compounds to be made more economically than they can be obtained from natural sources, while many such compounds unknown in nature have been synthesised in the laboratory and transferred to the factory. The author gives (pp. 20–21) a list of twenty-one firms which are engaged partially or wholly in the manufacture of natural or synthetical perfumes. Of these, three are French, and the remainder German and Swiss. It is not apparent why English and other manufacturers have been excluded. The writer of this notice has a very distinct recollection, when examining the chemical products at the Paris International Exhibition in 1900, of seeing some very good exhibits of perfumes by English and colonial manufacturers. It is true that in the application of *chemical science* to the industry Germany and France are far ahead of this country, but this does not do away with the fact that we have a few factories here which ought at any rate to figure in any list having for its object the instruction of the public as regards the present state of any particular industry.

The fourth chapter, dealing with the occurrence of odorous compounds in nature and with plant physiology, is of particular interest. A list, occupying nearly nine pages, contains the names of all the plants, arranged under their botanical orders, which yield ethereal oils. Another set of tables, occupying twenty-one pages, gives at a glance the name of the ethereal oil, the part of the plant from which it is obtained, the botanical source, the yield per cent., the physical constants (sp. gravity and rotatory power), and the chemical constituents. These tables thus summarise in synoptical form the present state of knowledge of plant oils, and in view of their importance it is much to be regretted that the printing has not been arranged in a less confusing way. The entries, as read horizontally, run across both pages, and by the time the eye has reached the last column, containing the chemical constituents of the oil—to many readers the most important item of information—the connection with the particular oil named in the first column is lost or rendered ambiguous, and the entry has in many cases to be traced back again to make sure which oil contains such or such constituents. We are all familiar with, and have often been led astray by, this want of precise correspondence between the horizontal entries running across both pages of a railway time-table. If in future editions the horizontal entries could be divided by horizontal lines running across both pages there would be no ambiguity, and the tables would be very much enhanced in value.

An interesting point to which the author directs attention is the rarity of the ethyl group in natural ethereal oils. Methyl, propyl, allyl, propenyl, are all of widespread occurrence in the molecules of natural organic compounds—ethyl occurs but in a few exceptional cases, and some of these are doubtful. We could add many to the few cases of the occurrence of ethyl in natural products given by the author, but his general statement is nevertheless correct so far as our present knowledge goes. Extreme advocates of the temperance movement might even find scientific justification for their position in this fact, which is stated by Herr Cohn in the form of an aphorism:—

"Die Natur hat einen *horror* vor dem Alkohol" (p. 28).

Unfortunately for this argument, however, alcohol (ethyl) is itself a biochemical product.

The fifth chapter deals with the modes of preparation and extraction of odorous compounds, and with their synthetical production. The special part of the work (pp. 67–175), devoted to the description of the general modes of preparation of the various compounds classified under chemical families, may be looked upon as a chapter of synthetical organic chemistry having special reference to the formation of odorous compounds, and requires no further comment.

The headings of chapter vi. (physical properties of odorous compounds), chapter vii. (chemical characters and relations between odour and chemical constitution), chapter viii. (quantitative valuation), chapter ix. (physiological relations), and chapter x. (applications of odorous compounds) sufficiently indicate their contents. Chapters vii. and ix. will be found of interest to physiologists as well as to chemists.

We have not found many slips in this little monograph, and it can be safely consulted by all who are interested in the subject. The statement (p. 184) that *m*-oxybenzaldehyde derivatives do not occur in nature is erroneous (see, *per contra*, Jowett, *Trans.* Chemical Society, vol. lxxvii. p. 707). Haller's important partial synthesis of camphor from homocamphoric acid (p. 145) might have been mentioned in the reference given in the foot-note. The omission of English firms from the list on pp. 20–21, and the faulty arrangement of the tables on pp. 38–57, have already been referred to.

Those chemists who, without any special knowledge of the subject, will take the trouble to look through this volume cannot but realise that a new and important branch of industry has been developed out of the ancient art of perfume making. It is apparent also that this newer development is the direct outcome of the application of chemical science—the utilisation for practical purposes of facts and principles discovered by laboratory research. It is the history of the coal-tar colour industry re-told, and we may fairly ask, as in the case of this last branch of manufacture, what is this country doing in the matter? The writer does not propose to do more than raise the question here, because the set reply of "imperfection of patent laws" and "want of duty-free spirit" will no doubt be considered all-sufficient by the majority of our manufacturers. Passing over this point, however, there is another aspect of the modern perfume industry which is of particular interest. Concurrently with the development of synthetical processes and the introduction of new products, a keen and searching examination of volatile plant oils has for many years past been systematically carried out in the laboratories of several foreign factories. Without wishing to be invidious, the firm of Schimmel and Co., of Leipzig, may fairly be named as pioneers in this branch of work. The semi-annual report of this firm is a perfect mine of information concerning the chemical composition of ethereal oils. Now the detection of the chemical constituents of products resulting from the vital activity of plants is also a matter of physiological importance, so that the workers in this field—prompted, no doubt, primarily by practical considerations—are accumulating a stock of material for which plant physiologists ought to be grateful. Certainly no physiologist can afford to ignore this material, buried though it may be in a trade publication, and worked up without direct scientific aim. But the methods employed and the results achieved are as purely scientific and far more definite than much of the work that at the present time passes into literature as physiological chemistry. We have as pretty an illustration as modern times can furnish of the action of pure science upon industry, and the reaction of industry upon pure science.

R. MELDOLA.

SYSTEMATIC BOTANY.

The Classification of Flowering Plants. Vol. i. Gymnosperms and Monocotyledons. By A. B. Rendle, D.Sc. Pp. xiv+403. (Cambridge: University Press, 1904.) Price 10*s.* 6*d.* net.

THE practice which is gaining ground, whereby, to the exclusion of the general text-book, the specialist produces a book in which he takes up merely his own branch of a scientific subject, is satisfactory both from the point of view of the author and the reader. The author is well qualified to express his opinions, and the reader cannot fail to learn much from the critical exposition which he is tolerably sure to obtain. The book under notice is significant not only because it is written by one of our leading systematists, but also inasmuch as it is one of the first taxonomic treatises—another is Willis's "Manual of Flowering Plants and Ferns"—which follows Engler's system of classification. Bentham and Hooker's classification is followed in most British herbaria and collections, but there is much to be said in favour of training students in the system which, originally propounded by Eichler, has been modified by Dr. Engler, one of the principal reasons being that the arrangement of orders, although not developmental, at any rate provides a sequence which is distinctly helpful.

Regarding the title, whereas it is now recognised that the spore-bearing shoots of some of the Pteridophyta may be called flowers, Dr. Rendle has used the term in its ordinary signification, and the first volume deals with Gymnosperms and Monocotyledons, while a second volume will be devoted to Dicotyledons.

After a short historical review of the principal systems of classification which have been proposed, the author takes up the Gymnosperms, making six classes by the inclusion of the two fossil groups, the Cordaitales and the Benettitales. A chapter upon the morphology of the Angiosperms follows, after which the remainder of the book is concerned with the classification of the Monocotyledons.

The Gymnosperms have been very much to the fore of late years, and there is nothing strikingly new in the treatment of the group. The interweaving of the fossil classes is distinctly rational, and the reader will find a good general account, including the results of modern research. A considerable number of the distinctive features of the genera appear in the general account, and a few in the enumeration of the genera, but the latter might with advantage have been expanded.

Dr. Rendle has devoted much time to the Monocotyledons, so that it is with special interest that one turns to this part of the book. As might be expected, one finds here a valuable exposition of the morphology both of vegetative and reproductive organs, with a succinct account of all such doubtful and subtle questions as the morphology of the flower of Orchidaceæ, or the value of the vegetative body of the Lemnaceæ. A noticeable feature is the inclusion of so many facts concerned with the vegetative part of the plant. The various devices manifested by plants during germination, a subject in which the writer has made special investigations, receive very full treatment, and numerous anatomical details are mentioned; but perhaps more striking is the value which is attached to vegetative characters for the purpose of splitting the orders up into tribes. Thus in the Aroideæ anatomical structure and the leaf-nervature are considered by Engler to be the best distinguishing characters; in the Liliaceæ the vegetative habit is important; and Pfilzer makes use of several vegetative characters in separating the sections of the Orchidaceæ. It has already been pointed out that in the enumeration of the genera of the Gymnosperms it would be useful to have more details for comparing one with another, and the same applies to the latter part of the book, where geographical distribution is fully given to the exclusion of critical data. One misses, too, those broad generalisations, which serve as landmarks or guide-posts, until the last chapter—a most important one—in which the writer gives a general review of the important characters and relationships of the series and orders of the Monocotyledons. The author has had some difficulties with his illustrations, and the blocks prepared for the book, which on the whole have reproduced clearly, but are too crowded, suffer by comparison with the illustrations found in other descriptive works; otherwise the book forms a worthy and valuable addition to the standard series which is being issued by the Cambridge University Press, and will certainly be of very great use to students of botany.

A TEXT-BOOK OF NAVIGATION.

Modern Navigation. By W. Hall, R.N. Pp. viii+378. (London: W. B. Clive, 1904.) Price 6*s.* 6*d.*

THIS is a valuable text-book on navigation at a very moderate price. Its small size and general handiness are a great feature compared with other works on the subject. The proofs throughout the book are graphically explained so far as possible, and are easily intelligible to people with a limited knowledge of mathematics; the figures and illustrations are good, numerous examples are given throughout, and the answers are tabulated at the end of the book. The extracts from the "Nautical Almanac" necessary for working any of the examples are also given.

An excellent feature in the book is the great stress laid on navigation by "Sumner" or "position lines," which are the foundation of the present practice of navigation. Without a clear understanding of position lines it is impossible to comprehend the importance of the errors in position due to working with approximate data, such as finding longitude with D.R. latitude and *vice versâ*. These and other errors are thoroughly and clearly explained by the author; in many previous works these errors have been either neglected altogether or passed over without explanation of the methods used in compiling the tables given for their correction.

The method of obtaining position by combining position lines derived from a chronometer sight and from an ex-meridian is rendered complete by the plan given of calculating the final result by factors as opposed to plotting it. It is brief and accurate, and will be welcomed by those who have experienced the difficulties of plotting results in small ships in bad weather. A very short and accurate method of obtaining these results by the "nautical slide rule" is also given. The slide rule was Mr. Hall's invention, and is useful for ex-meridians and other computations.

The treatment of the short equal altitude as a dynamical problem tends to simplify the work, and renders it easier of comprehension. The chapter on the "new navigation" is much in advance of any previous discussion of this method; the explanation is clear and the work straightforward, and the figures required for the computation are reduced. An accurate means of obtaining the final result by calculation instead of plotting is also added to this method. Mr. Hall's treatment of the "new navigation" should greatly assist to popularise this valuable means of navigating, which is applicable to any heavenly body at any azimuth.

The investigation of errors due to inaccuracies in time and altitude is satisfactory, and many interesting problems in theoretical navigation are fully explained. A valuable feature in the book is the shortening of computation by using five places of logarithms and in some cases only four places. The chapter on tides is very simply and effectively written, and supplies a want much felt by seafaring men.

In a book where so much is good, it is a pity more stress has not been laid on the utility of twilight stars for position; the author refers to displacement of the horizon due to abnormal refraction, &c., as a cause of errors in position, but does not mention the best fix that can be obtained in the twenty-four hours at sea. Ex-meridians of stars north and south for latitude, and chronometers of east and west stars for longitude, the mean of the north and south stars for latitude and of the east and west stars for longitude, obviate the effects of displacement of the horizon, and the fix is not dependent on run between observations except to the extent of a few minutes. This fix is specially valuable to men-of-war, which, owing to manœuvres, are seldom long on a steady course, thereby causing the run between observations, taken at an interval of two or three hours, often to be inaccurate. The system of notation used throughout the book and the extensive use of Greek letters are likely to confuse men already practising their profession afloat and used to calling things by their old names; it will consequently not commend itself to them. Possibly young students

who have used this system of notation in other branches of their education may find it an assistance. In conclusion, the book may be recommended to anybody who practises navigation and wishes to keep up to date.

OUR BOOK SHELF.

Birds in their Seasons. By J. A. Owen. Pp. vi+145; plates. (London: G. Routledge and Sons, Ltd., 1904.) Price 2*s.* 6*d.* net.

COMPLETE originality in mode of treatment, perfection in literary style, absolute fidelity to nature in the illustrations, coupled with immaculate accuracy in regard to nomenclature and other technical matters, would appear to be the only possible justifications for adding a new one to the long list of popular works on British birds. If it be asked whether the volume before us fulfils these conditions, there will be no great difficulty in framing a reply. In the first place, the mode of treatment is by no means original; while the following sentence from p. 53, "When talking to Lady Farren, of Bealings House, Suffolk, she told me that her family had had remarkable intimacies with wild birds," can scarcely be regarded either as a sample of elegance in diction or of accuracy in grammar. As specimens of what illustrations, so far as regards colour, ought not to be, we may cite the figure of the bee-eater in the plate facing p. 16, and that of the kingfisher on the one opposite p. 32. As instances of technical inaccuracy, for which there is no excuse, we may quote the following (among other) misspellings of scientific names, viz., (p. 20) *Matacilla* for *Motacilla,* (p. 29) *Musicapa* for *Muscicapa,* (p. 54) *Cocothraustes* for *Coccothraustes,* (p. 104) *Dafilia* for *Dafila,* and (p. 129) *Acanthus* for *Acanthis,* the latter error being the more inexcusable from the fact that the name is correctly spelt on an earlier page. If further reference to inaccuracies be required, we may contrast the statement on p. 140, to the effect that in the index the various species are assigned to their respective orders and families, with the index itself, where in many cases the sub-family, in place of the family, is given.

If cheapness and (to the uninitiated) attractive illustrations were the sole qualifications for a good bird-book, the present volume might perhaps be worthy of commendation; as it is, naturalists at any rate still consider accuracy a *sine quâ non* in works of this nature, while the British public will, we venture to think, demand something strikingly original before it accords extensive patronage to a new history of British Birds. R. L.

The Cultivation of Man. By C. A. Witchell. Pp. xv+168. (London: W. Stewart, 1904.) Price 3*s.* 6*d.*

THE author of this book is very much in earnest. He condemns modern civilisation in strong terms for its many vices, especially for its worship of money and the mammonite marriages that result from it, and urges that men should apply to their own species the methods of the breeder of cattle. He recommends polygamy, apparently in all seriousness, and not as a mere counsel of perfection. It would, of course, destroy the family, but to this Mr. Witchell has no objection. He would have the child that is born "with every sign of some inherent disease of a serious character painlessly destroyed." Certainly he speaks out fearlessly, and that is no small merit. But it is to be regretted that he did not study his subject more before writing. "Natural selection," he says, "is sometimes operative, chiefly among the poor." Considering that in England nearly fifty per cent. of the population die before the average age of marriage, this is a wonderful understatement. If we bear the facts in mind, we can hardly agree with Mr. Witchell that the business man is "the surviving type," *i.e.* apparently the type that is to survive to the exclusion of others. Business men are not a separate species. There is a continual upward movement of able men from the great underlying social stratum, and from this stratum directly or indirectly our successful men, as we call them, have emerged. In the underlying *couche sociale* there is but little accumulation of capital and comparatively little marrying for money. As to style, Mr. Witchell uses his terms vaguely. We hear of the cultivation of the young (*i.e.* by education), and of cultivation by marriage (*i.e.* by selection). But in spite of its defects the book is, much of it, interesting. It dwells upon things which seem to be entirely unknown to Royal Commissions on degeneracy, and to the many people who write letters to the papers and articles in the magazines on the subject.

Richard Meyer's Jahrbuch der Chemie for 1903. Pp. xii+600. (Brunswick: Vieweg und Sohn, 1904.) Price 15 marks.

THE year-book for 1902 has already been reviewed in these pages, and what was then stated applies with little modification to the new volume. Meyer's year-book presents an excellent, though necessarily brief, *résumé* of the year's researches in pure and applied chemistry. Possibly in other hands a slightly different selection might be made, and the weight of emphasis otherwise distributed, but in the rather wide range of subjects which have to be dealt with the question of choice must naturally vary with the taste of the individual reviewer.

Although, as was previously remarked, the small proportion of contributions of English authors does not accurately represent the relative strength of English chemistry either in quantity or quality, it is only too true that our output in chemical research and chemical literature is below what it should be. That this is due to lack of interest or poverty of ideas no one could admit, but it is to be attributed to the want of proper facilities in the way of public encouragement and State assistance.

Meyer's year-book has now reached its thirteenth year, and its success, which is assured, must be placed to the credit of its excellent staff of reviewers.

Perhaps its one shortcoming, if one may so express it, is that it is so long in coming, and many of the researches which are catalogued have assumed a new phase before the year-book appears. J. B. C.

Astronomischer Jahresbericht. By Walter F. Wislicenus. Vol. v. Containing the Literature of the Year 1903. Pp. xxxiv+660. (Berlin: George Reimer, 1904.) Price 20 marks.

IT was thought that the publication of the volumes on astronomy, a part of the "International Catalogue of Scientific Literature," might affect and possibly put an end to this most useful and valuable German publication, but the appearance of this, the fifth yearly issue, renders such an idea untenable. The volume before us is full of vitality and vigour, and the compiler and his co-workers are to be congratulated both on the high standard they maintain throughout such a laborious task and on the great value of the publication to all astronomical workers. To have not only references, but brief summaries of the contents of all, or practically all, astronomical literature published

during the past year is a real help to the astronomical investigator, and saves him much time and labour. In spite of the mass of material that is embodied in the work, the volume is, according to pages, only a trifle larger than its immediate predecessor, and somewhat smaller than vol. iii. As a matter of interest, it may be stated that the number of references in the present and the two preceding volumes are 2582 for vol. v., 2411 for vol. iv., and 2513 for vol. iii.

In conclusion, the statement made with regard to the earlier volumes, namely, that they should be found in every astronomical library and observatory, may be repeated in the present case. W. J. S. L.

LETTERS TO THE EDITOR.

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

The Forest-pig of Central Africa.

I HAVE seen Mr. Oldfield Thomas's interesting letter in your issue of October 13 relative to the remarkable forest-pig (which he has named *Hylochoerus meinertzhageni*). With regard to the discovery of this remarkable beast, there are perhaps other names which should be associated with it as well as those of the late Sir Henry M. Stanley and myself. No mention of this forest-pig appears in Sir Henry Stanley's published works, but in conversation with myself and others he frequently told us that, in addition to hearing of a "donkey-like animal with large ears" (which afterwards turned out to be the okapi), he once saw a huge black pig, and he had reason to believe that a strange new species or genus of pig inhabited that portion of the Congo Forest near the Semliki River. I heard and transmitted similar stories told me by the natives of that forest; but even more detailed accounts were collected and sent later on by the late W. G. Doggett, who, to the great loss of zoological collecting in Africa, was drowned in the River Kagera in the early part of the present year. But I think the first definite accounts of this pig (or at any rate of *Hylochoerus meinertzhageni*) were transmitted by Mr. C. W. Hobley, C.M.G., a sub-commissioner of the East Africa Protectorate, who has recently been acting as Commissioner after the departure of Sir Charles Eliot. Mr. Hobley sent a drawing of the skull and a description of the creature from imperfect specimens he had seen on the slopes of Mount Kenia. Unfortunately his letters were delayed in transmission, so far as their reaching the Zoological Society was concerned. Mr. Hobley is now in England, and it is to be hoped that he will furnish the Zoological Society in detail with the extremely interesting particulars he has given me in conversation regarding this remarkable animal. I would remind your readers that Mr. Hobley (who as regards length of service is almost the senior British official connected with British East Africa) made the important discovery last year of marine organisms in the Victoria Nyanza.

So far, the native stories of the okapi and the big forest-pig have turned out to be true. It only remains to complete the trilogy by the discovery of a third mysterious animal, also alluded to in conversation, if not in writing, by Stanley, and mentioned by Doggett and myself. This, so far as native accounts can be crystallised into a definition, would seem to be some large tragelaphine antelope resembling the nilghai in appearance, with short, twisted horns. A horn or a pair of horns attributed to this animal was, I believe, brought home by a member of Stanley's expedition, and is possibly in the British Museum. It was seen by Dr. P. L. Sclater, and attributed by him to an abnormally developed cow eland; but so far as I could learn from my own researches and those of Doggett, the natives of the Semliki Forest were careful to differentiate this creature from either the forest eland or the bongo. Their accounts of it certainly coincide to a great extent with their stories of the okapi, though they insisted on the difference between the two animals. Perhaps there is as much truth in their stories of this large antelope with small twisted horns as there has been shown to be in connection with the okapi and the forest-pig. H. H. JOHNSTON.

Mendel's Law: a Crucial Experiment.

I SEE from the published account of a recent discussion at the Cambridge meeting of the British Association that the facts of Mendelian segregation are still disputed by the biometric school of evolutionists. I venture, therefore, to submit to your readers the result of an experiment carried out at the Royal Botanic Gardens, Peradeniya, which, in my opinion, proves conclusively that in a particular cross-bred form a particular pair of characters did become segregated in equal numbers of germ cells, both male and female. The characters in question were:—the appearance and absence respectively of a yellow coloration in the endosperm of grains of Indian corn (*Zea Mays*). These characters are discontinuous in the strain examined. Among about 100,000 grains which passed under my notice, I saw only two which were partly yellow and partly white; these were counted as yellow, being presumably heterozygotes.

Some of my specimens were exhibited by Mr. Bateson at the recent meeting of the British Association, but I can now add the results of a further generation.

The facts are represented in the following scheme, in which the absence of the yellow pigment is expressed by the term "white."

I. {(1) White flint corn; extracted recessive from a mongrel strain} ♀ × ♂ {(2) Yellow flint corn; of the same mongrel strain as (1)}

II. {(3) Yellow grains} ♀ × ♂ {(4) Offspring of (1); self-pollinated white}

III. (5) 1963 yellow (49·76 per cent.) + (6) 1982 white.

The plants arising from these grains, both white and yellow, were used as seed parents in the next generation, the pollen parent being "Boone County White" dent corn. There resulted:—(*a*) Offspring of white grains—some 30,000 white grains and 27 yellow grains (0·09 per cent.); the latter were accounted for by the escape of "yellow" pollen. (*b*) Offspring of yellow grains—generation iv.:—

IV. 26,792 yellow (50·03 per cent.) + 26,751 white.

(Self-pollinated)

V. 16,582 yellow + 5681 white (25·5 per cent.)

The plants arising from the above yellow grains (generation iv.) were also used as pollen parents for a cross in which the seed parents were the offspring of "Boone County White" crossed with a strain of extracted recessives from the original mongrel flint corn. There resulted:—

2507 yellow (49·2 per cent.) + 2593 white.

I would direct particular attention to the following points:—

(1) That a perfect Mendelian result was obtained among the offspring of an impure race.

(2) Lest it should be objected that possibly the ancestry of this mongrel strain included equal numbers of yellow and white individuals, a pure recessive strain ("Boone County White," imported from U.S.A.) was introduced into the pedigree, so that the next generation (iv.) possessed at least three times as many white ancestors as yellow. On self-pollinating the offspring of yellow grains, the Mendelian proportion 3 yellow to 1 white was obtained.

(3) In two generations the female germ cells borne upon the heterozygotes were tested by crossing with the recessive form. In each case half of the germ cells were found to

bear the yellow character and half of them the white. In the last generation a similar test was applied to the male germ cells with the same result.

(4) The experiments were carried out under fully "biometric" conditions, the more accurate "Mendelian" method of careful pollination between individual plants being deliberately avoided. Thus, in generation iv. pollination was effected by the aid of the wind from some 1800 recessive parents indiscriminately.

A somewhat fuller description of the early part of this experiment has already appeared in vol. ii., part ii., of the *Annals* of the Royal Botanic Gardens, Peradeniya, and a complete account will be published in a future number of the same journal. R. H. LOCK.

Peradeniya, Ceylon, September 21.

Rock Pressure at Great Depths.

IN his address to the engineering section of the British Association, Mr. Parsons speaks of sinking a shaft into the earth for a distance of 12 miles.

I think, however, he overlooks a factor which sets a limit to the depth to which a mine shaft can be sunk. If we assume that the average specific gravity of the earth's crust is 3, the superlaying rocks would exert at a distance of 12 miles a pressure of about 440 tons per square inch.

There can be little doubt that when subjected to such a pressure the rock material would give way and flow together like a viscous fluid, and so the walls of the shaft would spontaneously close up, probably before the depth of 12 miles was reached. The breaking stress of steel is only 44 tons per square inch, and so, even were the walls encased by a steel tube, this would not avail to prevent the flowing together of the walls. GEOFFREY MARTIN.

Kiel, Preusser-str. 19I, September 17.

I HAVE to thank you for directing my attention to Mr. Martin's letter in which he gives his views as to the probable behaviour of rock around a very deep shaft boring, and his opinion that the inward viscous flow of the rock would place a limit to the possible depth.

I have to thank Mr. Martin for directing attention to the question of this possible limitation, which was considered when writing my address and dismissed as unlikely to occur up to depths of 12 miles, basing my conclusion on general engineering knowledge of the flow of metals, of the relative impressions made on hard brass and on hard rock when struck by hard steel tools, and on the general behaviour of metal when forged.

I must first beg leave to point out some errors in Mr. Martin's figures; he has misplaced the decimal point in calculating the hydraulic pressure of the superlaying rocks at 12 miles depth, which should be 40 tons and not 440 tons per square inch.

Again, of the crushing stress required to make hardened steel flow I have no data by me, but am aware that it lies between 120 tons and 300 tons per square inch, and in the case of hardened knife edges for weigh bridges, if my memory is correct, the pressure per square inch on the area of contact reaches a still higher figure.

Again, the pressure required to make the tough brass ("cartridge metal") flow is about 80 tons per square inch.

I think that the evidence at present available leads to the conclusion that after a small amount of shrinkage of the shaft sides inwards has taken place a state of equilibrium would be established enabling the surrounding rock in its state of great compression to withstand the so-called hydraulic pressure due to a depth from the surface of at least 12 miles.

Since my address I have had the opportunity of discussing the matter with Prof. G. H. Darwin, who has kindly brought to my notice the article by Tresca, "Memoirs des Savants étrangers sur l'écoulement des Corps solides," about the year 1866, and also his own paper in the *Philosophical Transactions* of the Royal Society, part i., 1882, in which the great shearing stresses that are thrown on the earth's structure by the weight of mountain ranges on elevated continents and great depths of the sea are exhaustively treated. I would only point out that such stresses have been endured for long epochs, and that in view of the established fact that rocks are viscous, it is clear that much greater stresses could be sustained for the comparatively short time necessary to complete a deep shaft boring.

It would, however, be interesting to subject a cylinder of granite or quartz rock, carefully fitted into a steel mould and having a small hole bored through its centre, to a pressure of, say, 100 tons per square inch, and see what shrinkage in the hole would result, or a hole might be bored into the specimen through an aperture in the mould while subjected to this pressure. This pressure would correspond to a depth of about 38 miles.

CHARLES A. PARSONS.

Holeyn Hall, Wylam-on-Tyne, October 7.

The Berlin "Thinking" Horse.

IN your issue of September 22 there is a paragraph among the notes (p. 510) with reference to "Clever Hans," a "thinking horse" at present displaying his powers in Berlin. With reference to it I wish to say that twelve or thirteen years ago there was on exhibition in the Royal Aquarium, London, a horse of, if I mistake not, exactly the same stamp. I happened to be then attending lectures at the Royal College of Science, and I went to see the animal. I had, moreover, a long conversation with his trainer, who eventually let me see exactly how it was all accomplished.

With all respect to the members of the "representative committee" at Berlin, I am driven to hold that the performances recorded, counting the number of the audience, picking out the tallest man present, telling the hour, &c., which seemed so deeply to impress them, partake of the nature of a stage trick. They demonstrate what training and perseverance can do with animals rather than the possession on their part of any advanced mental powers.

The Aquarium horse was named, if I remember aright, Mahomet. He could work sums in addition and subtraction, or, for that matter, in multiplication, could count the number present in the little side-show, could make a good guess at the age of an individual, and so on. He had been taught to begin pawing the ground when his trainer looked straight at him, and to cease when the trainer turned his gaze to the floor. It is easy to see the countless changes that can be rung on this accomplishment. Telling the time on a watch or the day of the month are readily recognised to be among them. Similarly, he had been drilled into bowing his head at one tone of his trainer's voice, and shaking it on hearing another. Again one can readily imagine how this bit of instruction will lend itself to a very varied and wonderful display of cleverness.

Mahomet's owner was an American and followed the business of training horses, especially circus ones. This horse, he discovered, was very easily taught—a genius among his kind—and on him he then lavished years of most careful labour, often, he assured me, sleeping of nights in the manger at his head. The results were as shown. They were in themselves sufficiently marvellous, and represent, I fancy, the very utmost that a horse can be trained to do. "Clever Hans" would seem to be blessed with a trainer as painstaking and persevering as my American friend.

After a *séance* which I had all to myself, Mahomet's owner delayed with me to see the performance of a clever dog on the central stage. The dog, a fair specimen of a rough collie, answered questions, spelt his own name, words sent up by the audience, &c. The letters of the alphabet were placed in order in a wire frame towards the back of the stage. The collie went along the letters, picked out the one he needed, and brought and laid it before the footlights. He then went for the next. Wonderful I thought the performance until my friend the horse-trainer showed me how it was done. The collie always began at A. He then trotted along up the alphabet until he reached the one he needed. His master carried his gloves in his hand. A little twitch of the gloves as the dog passed the particular letter wanted was the cue. The well trained animal took in the slightest stir of the gloves with the corner of his eye. This dog even played a game of cards—and won. A hundred and one variations might be made on the same trick.

I have read since in an American newspaper of a Tennessee

pig that acquitted itself creditably in practically the same *rôle*. Doubtless, if the report were true, the porker had swallowed an equal amount of learning.

The collie was without doubt a good, clever one. As member of the Irish Collie Club I have for years past taken a fancier's interest in this particular breed, and I have observed every degree of intelligence, from the brute that could scarcely be taught to bark at a cow—oftenest with a pedigree as long as your arm—to the affectionate animal that could guess almost your thoughts and your passing temper, and was always in perfect sympathy with your moods. The best of these, however, falls far short of a good Irish water spaniel. From my experience, I may be allowed to say in passing that no breed is so teachable—has such brain-power, if you like—as the latter, once he has reached the age of nine or ten months. As puppies I found them rather stupid.

Performances similar to that of the Royal Aquarium collie are not very rare. There are, indeed, some other ingenious stage devices by which a dog can be taught to spell—every word in the dictionary if you are so foolish as to let it be known—and to converse, so to speak, in Russian as readily as in English, but the devices are rather worked out.

Usually such show dogs modestly protest before the audience (through their trainers) their inability to do more with certainty than spell correctly words of three letters, and when pushed they get perplexed and make mistakes. This, for them, is sound policy. It is only when they grow too bold and set up as "thinkers" that they are found out. My American trainer, with Yankee shrewdness, used to claim for his dark bay charge that when he had totted up a row of figures he should be reminded of the number to be carried on to the next column. This was fair enough. It, too, served to baffle the over-canny. That the arithmetician's education could never overstep that was just the puzzle they fastened on and worried over. I wonder what the German professors, good, easy men, would have said had they seen, as I did, Mahomet figure out a sum with his tail to the board!

I may be permitted to add that about the same time I interviewed the ape famous for counting, "Sally" by name, in the London Zoological Gardens, and I was in no way impressed by her intelligence. After what I have written it is not hard to suggest two or three ways by which the oracle could have been worked. I saw her count her straws for the keeper alone, and that gentleman appeared to me none too tolerant of questions or of interference.

I am prepared for believing, however, that counting is not beyond the scope of an animal's powers. It is said that Scotch shepherds count their flocks of sheep in this wise: they drive them through a gap, and the faithful collie ticks off by a bark every score as it passes through.

It is not of late alone that clever horses have come to the front. I happen to possess a MS. diary written by a co. Leitrim man in 1658 and 1659. In the first of these years the writer, James Reynolds, accompanied to London his uncle, Sir James Ware, Auditor-General of Ireland, and famous as an antiquary. Among the sights of the metropolis he records that he saw a "Nagg" which could count, answer questions, and fire off a small cannon.

There are undoubtedly degrees of intelligence within limits in all mere animals. They are particularly observable in the dog and horse—the most highly developed in this respect of all our animal friends. As every jarvey knows, each horse has a character of its own and mental powers all its own. The same is true of our canine subordinates. A neighbour of mine has a cat which climbs up the door-post and opens the latch with her paw when she wants to enter the house. This for a cat is, I think, more wonderful than are all the performances of the Berlin "thinking horse" for a steed. It is a trick, indeed, I have seen taught two or three dogs. But the cat has had no training. She owes her cleverness solely, I am assured, to her own powers of observation.

I am open to conviction, but I am greatly afraid the "German representative committee," including the "professor of the Physiological Institute of the Berlin University," that have reported, according to the daily Press, on "Clever Hans" have written themselves down as at least not ungullible.

JOSEPH MEEHAN.

Creevelea, co. Leitrim.

Misuse of Words and Phrases.

IN your issue of October 13 attention was directed in the letter column to the misuse of language by English scientific writers. Since the subject of the indictment is one of importance, and since the criticism is in my opinion well founded, I am writing to support it.

There seems to be a tendency growing among writers on scientific subjects, both in pure and applied science, to modify the English language to such an extent as to give rise to no small anxiety with respect to its future state in scientific literature.

Even if language is plastic, its plasticity is limited.

Since science is based upon accuracy, the communication of scientific thought should be accurate. Yet in a large percentage of scientific publications in the English language sentences that are grammatically ambiguous occur frequently, and not seldom such as have no meaning. The sense intended may be, indeed, derived from them, either through study of the context, or through exertion of one's scientific instinct; but it is surely just to demand that the unnecessary labour of a cryptogrammic research be not inflicted on the reader. Viewed in its crudest aspect, such misuse of language is an act of discourtesy to the reader; so legitimate resentment should provoke no surprise in the author.

It is common in a certain class of publications to meet files of nouns marching through the paragraphs. Although this may at times indicate a well grounded derivation of adjectives, yet it is frequently unnecessary, either since a suitable adjective exists, or since a prepositional or adverbial phrase conveys the meaning exactly.

Various other parts of speech are frequently misused.

There is no need for fine style in scientific literature; but good style is obligatory, because it is an essential concomitant of the accurate expression of clear thought.

October 17. F. ESCOMBE.

SCIENCE IN SPORT.[1]

THE late Prof. Tait was probably the first to bring scientific principles and methods of experiment to bear upon the mystery of the flight of a golf ball. Newton, in a pregnant note on the deflection of a tennis ball in air, gave the foundation principle, which curiously enough both Euler and Poisson rejected as of no account. Robins and (later) Magnus experimented on the effect, but it was left to Tait to work out the problem in detail. His papers on the rotating spherical projectile virtually form a new chapter in the dynamics of rotation. In these papers, and elsewhere in more popular form (*e.g.* in NATURE, vol. xlii. p. 420, 1890), he lays down clearly the conditions which must be fulfilled if a man is to drive a far and straight ball. Slicing, pulling, topping, are all completely explained along the lines of Newton's remark, numerical tests are supplied, and various possible curves of flight are calculated out and drawn.

Tait showed how the ball must be started if it is to finish aright. The difficulty the ordinary golfer experiences is to give the proper start. This is *his* problem; and the mode of solution is as varied as the temperament of the player. There is, in fact, a continuous gradation of style and effort from the simple minded golfer whose one aim is to hit the ball to the nervous and pathetically anxious one who looks to every detail of grip and stance as a *sine quâ non* to perfection. There must, however, be a best way for every individual, and in discovering this the aspirant no doubt should be guided by scientific principles.

This is, perhaps, the most important practical standpoint from which to view Mr. George W. Beldam's interesting and beautiful book, "Great Golfers. Their

[1] "Great Golfers. Their Methods at a Glance." By George W. Beldam. Pp. xxiv+481. (London: Macmillan and Co., Ltd., 1904.) Price 12*s.* 6*d.* net.

"The Art of Putting." By Walter J. Travis and Jack White. Edited and Illustrated by G. W. Beldam. Pp. 32. (London: Macmillan and Co., Ltd.). Price 1*s.* net.

Methods at a Glance." It is doubtful if methods essentially kinetic can be effectually disclosed by glances at a few critical positions statically pictured by instantaneous photography. Nevertheless, Mr. Beldam's idea is a good one, and has been carried out with great manipulative skill. The idea is to obtain accurate pictures of some of our best golfers, professional and amateur, in their characteristic poses as they address and play a ball, and to be able from those pictures to deduce important conclusions. By a simple system of rectangular coordinates, with origin at the ball and one axis in the desired direction of flight, the positions of the player's feet are accurately shown. The grip of the club, the poise of the body at different stages of the stroke, and the position of the arms at

FIG. 1.—Golf Ball leaving an Iron Club after impact. From "Great Golfers."

the top of the swing, are all recorded as the player is taking his normal stroke. The descriptive discussion is given by the four professionals Vardon, Taylor, Herd, and Braid in regard to their own pictures, and by Mr. Hilton in regard to the pictures of the amateurs.

It is evident that all the motions of the body, head, arms, thighs, legs and feet are governed by the way the club is raised to the top of the swing and brought down again to the finish of the stroke. Keep the head steady—best done by keeping the eye on the ball—keep down the right elbow, and practice will do the rest. The backward swing of the club and arms makes the body rotate easily about a vertical axis, and produces naturally the characteristic bending of the left knee (in a right handed player). It is interesting by measurements on the successive positions of the player as he (1) addresses the ball, and (2) reaches the top of the swing, to determine how much, if at all, the head rises. In this respect, for example, Vardon and Taylor differ decidedly. Exactly the instant during the swing at which the left leg begins to support the greater part of the weight of the body is not clearly brought out.

There are of course great difficulties, even with an exposure of only one-thousandth of a second, in catching the player at the very instant the ball is struck, or just before the impact takes place. Out of the 268 "action photographs" three only can be accepted as giving any information regarding this critical moment. It is just here, in fact, that a word of criticism might be offered. From a scientific point of view the numerous pictures representing the *finish* of the stroke are comparatively worthless—beautiful and striking and "characteristic" though they are as showing the pose of an athlete who has just done the deed. We could gladly have dispensed with half a hundred of these for the sake of even an extra half dozen like Taylor's Nos. xxi. and xxviii. Unfortunately in these particular pictures the ground is not chalked off with the pattern of six-inch squares, so that we can only roughly estimate the position of the ball when it was struck.

In plate xxviii. (here reproduced) the blurred image of the moving golf club and of the still more rapidly moving ball are finely brought out, while the player, with the exception of the right arm and hands, is as steady as a rock. We may roughly estimate the velocity of the ball to be nearly $2\frac{1}{2}$ times that of the club. The exposure is stated to have been 1/1000 of a second. The blurred image of the club head may be estimated at not less than 4 inches broad, giving a velocity of about 370 feet per second for the club head *after* impact. This would mean fully 900 feet per second for the ball. Tait gave a great deal of attention to this point, and concluded that a well driven ball rarely left the ground with a greater velocity than 350 feet or 400 feet per second. The discrepancy is great, and points to some fundamental error either in Tait's mode of measurement of the velocity or in Mr. Beldam's mode of measurement of the exposure. The photograph tells its own tale, and is above criticism; but we have no precise account of how the times of exposure were estimated. A few more pictures of the kind just discussed, showing the *motion* immediately before impact, at impact, and immediately after, with different clubs and different balls, would give some really important information as to velocities and coefficients of restitution.

Every golfer knows the value of steady and accurate putting, and how curiously variable is his "form" in this respect. Mr. Beldam's photographs bring out the very familiar fact that stance and pose are of comparative insignificance. In a small pamphlet on "The Art of Putting" Mr. Beldam has notably supplemented his volume. Here we have six photographs illustrating the style of Mr. Travis, Amateur Champion of 1904, and fourteen of Jack White, the Open Champion. Each discusses his own methods. The professional's account is particularly instructive, and touches on many difficult points, such as putting uphill or downhill or on a side slope; but here, as in billiards, a knowledge of how to do is one thing, and the power to do quite another.

It is certain that as an exponent of good method no book on golf can compare with "Great Golfers"; and we have indicated above that Mr. Beldam's photographs have a scientific value quite apart from the "science" and art of the royal and ancient game.

C. G. K.

A GERMAN'S DESCRIPTION OF ITALY.[1]

THE volume before us might not inappropriately be called an "Encyclopædia of Italy." It deals in the first eight chapters with the general geographical and geological features of the country, its shape, its surrounding seas, the relief of its principal mountain ranges, its geological construction, its climate, hydrography, fauna and flora. The next seven chapters deal generally with the Italian people and their life, the subject being classified under the various headings of population, history, products, commerce and trade, political institutions, religion, art, language and science. The sixteenth chapter, which is devoted to "Topography," extends over more than 120 pages; in it the various districts of Italy are taken in turn, and their principal towns, antiquities, rivers, and mountains are dealt with in some detail.

To write a treatise of this character is no easy task, if the book is to convey anything like an adequate account of the country. To test the completeness with which the author has accomplished his work we have consulted the book under various headings selected at random, and in few cases have we found any point of real importance or interest missing. The account given of the Italian lakes is very thorough, and contains details of their principal features, as well as information of a statistical character and several illustrations. Still greater interest attaches to the sections dealing with volcanic action and earthquakes, in which excellent illustrations are given of Vesuvius in its various aspects, the Solfatara, Etna, and the Lipari islands; and the references to the changes of relative level of the land and sea at the Temple of Serapis and the Blue Grotto may be cited. The chapter on "Plants and Animals" is not, perhaps, so fully treated as other parts of the book, and also there are a few slight inaccuracies, probably resulting from the difficulty of finding exact equivalents for the German words in the English translation. Whether the name "manna" is correctly applied to the sap of the Calabrian flowering ashes (p. 114) is a point on which we are not competent to pass judgment; it should, however, be mentioned that "manna of the desert" has been considered to be a lichen. When the fruit of the olive is described as green, brown, or red (p. 116) the latter term hardly appears suitable. On p. 120 the name "gorse" is applied to *Genista hispanica*, a plant which, indeed, often takes the place of our English Ulex in Italy, but can hardly be properly called "gorse."

Again, it is doubtless probable, as stated on p. 122, that fishermen often apply the term "frutta di mare" to shell fish generally, but correctly speaking this is the name of the edible echinus. The large cuttlefish or octopus is too characteristic an article of food at Naples to be omitted from the list, and the Agoni and large trout of the Lombardy lakes ought to receive some mention.

FIG. 1.—Arco naturale in Capri. From Prof. Deecke's "Italy."

We pass on to the chapter on "Political Institutions," where it is particularly interesting to see what a German thinks of the slipshod way things are done in a free country like Italy. Prof. Deecke strongly condemns the abuses resulting from political liberty and local government as practised in that country; for example, he says (p. 253):—

"The successful working of a liberal constitution and self government presupposes a conscientiousness and disinterestedness among the officials. There is little of these qualities to be seen in Italy. The honorary posts are looked upon as a kind of milch-

[1] "Italy, a Popular Account of the Country, its People, and its Institutions (including Malta and Sardinia)." By Prof. W. Deecke. Translated by H. A. Nesbitt, M.A. Pp. xii+485; illustrated. (London: Swan Sonnenschein and Co., Ltd.; New York: The Macmillan Co., 1904.)

cow which must be milked with all one's force when one is at the helm. In addition to this there is the want of scruple as regards public money, which, according to a very general view, exists in order to be appropriated to any plausible pretext or to be secured for one's family or friends. . . ."

The author also condemns the wasteful system which exists in municipal bodies of embarking on costly enterprises, which are discontinued after the next municipal election when another party comes into power. In this way the money of the ratepayers is squandered away with no return. In regard to the confiscation of the monasteries, the following sentences may be quoted :—

"These regulations, however, have been applied in the half and half manner characteristic of Italy." "The vast ecclesiastical possessions seized by the State were sold or squandered in the course of a few years." "Thus the enormous source of income which might have proved a blessing to thousands and created a small class of landed proprietors has failed to bestow the expected benefit on the country."

On p. 279 we are told, "The Building Societies are almost a public calamity." "The hideous new quarter near the railway station at Naples, on the Vomero at the same town, and in the Campus Martius at Rome are the best proofs of the results of carrying on business in this manner."

Speaking of universities, Prof. Deecke makes the following remarks, which are equally applicable to our English system :—"There is another difference as compared with Germany, namely, that the Professor appointed to hold a course of lectures is not allowed to take a general survey of his subject or to handle it fully, but has to dispose of a prescribed section of the subject in the three hours a week, so that at the final examination questions can be set within this narrow circle. The instruction given at the Universities naturally suffers, and still more the scientific training of the students, which can only be described as unsatisfactory."

The chapter on art, language and science contains a list of the principal learned academies of Italy.

In connection with music, the author remarks :—"The music of Wagner, poor in melody and difficult to understand, has not become naturalised in Italy."

As illustrating more fully the wide and varied range of the subjects treated, we may instance the statement that there are ten times as many murders in Italy as in Germany, the regulations limiting the number of barrel-organs in Naples, the number of pedlars, the method of smelting sulphur, the statistics of Italians abroad, observations of terrestrial magnetism, the superstition according to which cats' tails are docked, a portrait of Garibaldi and a plan of the harbour of Genoa, photographs of Roman cattle, and descriptions of Italian cheese.

The section on topography might be very well studied by anyone contemplating a tour in Italy. It gives an excellent account of the features worth noticing in different districts, and it includes the Maltese group as well. It is well illustrated. But for that matter the whole book would well repay reading before or after visiting Italy. The average tourist contents himself when visiting a new country with seeing the principal churches and picture galleries, usually conducted by a guide, but to visit a country properly a wider survey should be taken, and a book like the present consulted. To the writer this book brings back the most pleasant reminiscences of bygone travels in Italy; to the reader who has stayed at home it presents as graphic a picture as any book can present of everything that is Italian.

G. H. BRYAN.

DISEASE-PROOF POTATOES?

THE recently established National Potato Society has as one of its many objects the discovery of a "disease-proof" potato. Even if it only succeeds in throwing some light on the relative immunity of some varieties, and on the causes of that comparative exemption, it will do some good. Next to wheat, there is no crop more important in this country, and whilst wheat-growing seems to be getting more and more unprofitable, the culture of potatoes is extending so much that it is evident that the growers must find some good reason for the increased production. The enormous importations from Germany, Holland, and other countries should serve as a stimulus to our farmers, for it is obvious that, excepting in the comparative cheapness of labour, those countries possess no special advantages over our own in the matter of potato-growing.

In dealing with the question of the potato disease, by which we mean the rotting caused by the fungus *Phytopthora infestans*, there are two principal subjects of inquiry: first, the life-history of the fungus; second, the "constitution," if we may use so vague a term, of the potato plant.

Neither of these subjects can be thoroughly investigated by the average potato grower. All important as they are, they lie outside the range of his capabilities. It is to our research stations or to individual experimenters that we must look for guidance. Even now the life-history of the fungus is imperfectly known. We do not know *for certain* what becomes of it in the winter, nor why it suddenly bursts into activity under certain atmospheric conditions. We do not know for certain whether it can pass any portion of its life on some other plant under another guise. We do not know for certain if a resting spore is formed, and our knowledge of the mycelium during the winter is, for the most part, conjectural rather than real. Here, then, are subjects for inquiry at once of the deepest physiological importance and of the greatest practical value.

As to the so-called disease-resisting varieties, also, further information is wanted, and this the practical man might supply. A visitor to the recent display of potatoes at the Crystal Palace, seeing the innumerable varieties there exhibited, might well wonder whether they all "supplied a want," and it was consolatory to the casual observer to hear even experts acknowledge the impossibility in some cases of discriminating one variety from another by the tubers alone. Had it been possible to show the haulms, the foliage, and the flowers and fruits with the tubers, as was, in fact, done in one or two cases, some points of distinction might have been forthcoming.

But although there is often a close resemblance between the tubers of one variety and those of another, and although it frequently happens that tubers of quite different shapes may occur on the same plant, yet it does not appear, from our present knowledge, that this similarity on the one hand, or this diversity on the other, is associated with any structural change which shall indicate either immunity from disease or increased susceptibility to its attacks. In the case of potatoes, certain varieties, like Sutton's Discovery, are unusually robust, producing haulms almost woody in their character, and these are found to be less susceptible to disease than are others of softer, more juicy consistence, which are more easily penetrated by the fungus hyphæ. Differences of this character, dependent on increased vigour of growth, are recognised by the growers, but we are not aware that microscopists have as yet made any researches into the structure of the potato foliage with special reference to its immunity from, or susceptibility to, disease. It

is certainly desirable that such investigations should be made, although, in view of the investigations on various species of Bromus and their liability to disease made by Marshall Ward, Salmon, and others, it is doubtful whether mere microscopic investigation of the internal economy will furnish more valuable results than comparative macroscopical study of the haulm and foliage. Great physiological differences may, on the one hand, exist in conjunction with uniformity of structure, and, on the other hand, great external differences may exist without appreciable physiological diversity.

Some improved method of investigating the nature and construction of the protoplasm seems to be required, and when this is obtained our knowledge of the relation of function to structure will of necessity be much enhanced. At present the three most efficient means of preventing or combating the disease are the production of immune varieties, the use of sulphate of copper in the form of Bordeaux mixture, and the adoption of "high-moulding," by means of which access of the fungus spores to the tubers is at least in part prevented.

NOTES.

WE regret to announce that Dr. Selim Lemström died at Helsingfors on October 2, in the sixty-sixth year of his age. Dr. Lemström devoted much attention to experimental investigations on the uses of electricity in stimulating the growth of cereals, vegetables, and other plants.

As already noted in these columns, a distinguished party of French physicians and surgeons has during the past week paid a visit to London in order to become acquainted with our medical schools and hospitals and to study their methods and administration. About 150 gentlemen availed themselves of the opportunity, amongst others M. Lucas Championnière, Prof. Poirier, Prof. Marie, Prof. Netter, M. Louis Martin, M. Huchard, M. Triboulet, president of the French committee, and Dr. Sillonville, secretary. An English committee, with Sir W. Broadbent as president, Sir T. Barlow and Dr. Dundas Grant as treasurers, and Drs. Dawson Williams and Jobson Horne as secretaries, made arrangements for the reception and entertainment of the visitors. Visits were paid to the hospitals, general and special, the physiological laboratories of the University of London, University and King's Colleges, the Lister Institute, the Royal College of Surgeons, cancer research laboratories, the County Council laboratories at Claybury, the London School of Tropical Medicine, and to the Islington Infirmary. The visitors expressed themselves as specially pleased with the order and neatness, the decorations, &c., and the home-like comfort of the wards of our hospitals. During the visit they were the guests of the editors of the *Lancet*, Dr. and Mrs. Dundas Grant, the Dean of the Faculty of Medicine of the University of London and Mrs. Butlin, and on Wednesday evening, October 12, they were entertained at a farewell banquet at the Hotel Cecil, at which Sir W. Broadbent presided. The chairman, in proposing the health of the King, alluded to His Majesty's interest in hospitals and medical work. The other toasts were the President of the French Republic, and "Welcome and *Au revoir*," proposed by the chairman; our guests, by Dr. George Ogilvie, responded to by M. Championnière and Prof. Huchard; and the Faculty of Medicine of Paris, by Dr. Pye-Smith, responded to by Prof. Poirier, Prof. Chauffard, and M. Triboulet. The visit has been a great success, and should prove a benefit to both nations.

REUTER reports that the commander of the *Neptune* Scientific Research Expedition to Hudson Bay and the northern waters has returned to Ottawa with several interesting mementoes of the Franklin Expedition.

MR. H. MARTIN LEAKE, of Christ's College, Cambridge, has been appointed economic botanist to the Government of the United Provinces, India, and proceeds at once to the botanic gardens, Saharanpur, N.W.P.

A CONFERENCE of members of the Museums Association and others interested will be held at Warrington on Saturday afternoon, October 29, for the purpose of discussing subjects of common interest to those concerned in the work of museums, art galleries, and kindred institutions.

THE *Electrician* announces that a congress for the purpose of discussing the production and application of Röntgen rays will be held in Berlin on April 30, 1905. The occasion is the tenth anniversary of the discovery, and Prof. Röntgen will be present as the guest of honour.

A COURSE of twelve Swiney lectures on geology will be commenced by Dr. J. S. Flett at the Victoria and Albert Museum, South Kensington, on Monday, November 7. The subject of the lectures will be "Geology—the Record and its Interpretation." Admission to the course is free.

THE King has consented to give his patronage to the Sanitary Institute, which is carrying on a large work in teaching and examining in hygiene and sanitary science, both in the United Kingdom and in other parts of the Empire.

AT the opening meeting of the new session of the Royal Geographical Society, to be held at the Albert Hall on November 7, Captain Robert F. Scott will deal with the leading features of the National Antarctic Expedition. At subsequent meetings Lieut. Royds will deal with the meteorology of the expedition, Mr. Ferrar with the geology, Dr. Wilson with the zoology, and Mr. Bernacchi with the terrestrial magnetism.

THE inaugural meeting of the Association of Economic Biologists will be held at the rooms of the Linnean Society, Burlington House, on Tuesday, November 8, at 3 p.m. All who signify to Mr. W. E. Collinge, the University, Birmingham, their intention of becoming members before October 31 will constitute the list of original members.

WE learn from a note in the Isle of Man *Times* that within the last few days the large pond at the biological station and fish hatchery, Port Erin, has been in great part emptied for the purpose of examining the condition of the stock of fish of spawning size and the state of the bottom of the pond. Out of 180 large adult plaice which had been, at various times since the autumn of 1903, deposited therein, 168 were safely transferred to the lower supply tank. The condition of these fish was all that could be desired; they were thick, strong, and well fed; many were very large. There were also very many young plaice which were hatched at the station last Easter from parents in captivity—the large fish alluded to, and so have been under artificial conditions—made as natural as possible—during the whole of their existence. These young plaice, four to five months old, were from one to four inches long (the large variation in size is noteworthy), active, and well nourished. Some hundreds were picked out for experiment in rearing in small wooden tanks lately fitted up. There were also found some shrimps, some young of the cod tribe, and a small shoal of young herring (whitebait size). All these must have passed through the pumps from the sea, probably in a larval condition. The young plaice examined were found to be feeding mainly on Copepoda.

IT is announced in the *Times* that the Secretary of State for India has appointed an expert committee to assist in and supervise the preparation of an abridged and revised edition of the "Dictionary of Indian Economic Products," by Sir George Watt, the editor of the original work, which was issued in seven octavo volumes, with index, between 1889 and 1893. The new edition will be compressed into two volumes, and care will be taken to give the latest figures and information available in respect to the products described, and to their commercial development. Special facilities have been afforded for Sir George Watt to carry on the work of revision at Kew, and Sir W. Thiselton-Dyer, director of the Royal Botanic Gardens there, is chairman of the committee, the other members being Mr. T. W. Holderness, secretary of the Revenue and Statistics Department, India Office; Prof. Wyndham R. Dunstan, director of the Imperial Institute; and Mr. J. S. Gamble, late of the Indian Forest Department.

A SECOND conference of local authorities, owners of foreshore, and others interested in the defence of the coast against the encroachment of the sea in the counties of Norfolk and Suffolk was held at the Guildhall, Norwich, on October 15, for the purpose of considering the report of the committee appointed by the previous conference. Dr. H. B. Walker, mayor of Lowestoft, presided. The report stated that the Government had been asked to adopt promptly such measures as would preserve the sea coasts from waste and provide a more equitable adjustment of the financial burden which now pressed exclusively upon the immediate frontagers. Mr. Nicholson (town clerk of Lowestoft) said that the Board of Trade had declined to appoint an engineer to make inquiries. A resolution was adopted in favour of communicating with other authorities in Great Britain whose districts abut upon and are liable to erosion by the sea, and with members of Parliament representing such districts, to ascertain how far they would cooperate in an application to the Government to accede to the recommendations contained in the report.

IT is reported that the Antarctic relief ship *Morning* has brought home a considerable collection of natural history specimens which will supplement those obtained by the *Discovery*. A considerable amount of dredging was accomplished on the *Morning*, so that the collection consists chiefly of marine invertebrates. As she is an Admiralty ship, all the specimens collected will doubtless be handed over to the British (Natural History) Museum, where the *Discovery* collections have already been received.

IN the *Irish Naturalist* for October Mr. D. R. P. Beresford records the discovery in Ireland of a second nest of the Continental wasp, *Vespa rufa austriaca*; the first was found in 1902.

IN his report for 1903 (issued in the *Circulars* of the Royal Botanic Garden) the Government entomologist for Ceylon refers with satisfaction to the appreciation of the efforts of his department to aid cultivators in freeing their plantations from the attacks of noxious insects. The report deals largely with those affecting the tea-plant.

THE contents of part i. of the second volume of the quarterly issue of the *Smithsonian Miscellaneous Collections* include a continuation of Messrs. Ulrich and Bassler's revision of the Palæozoic Bryozoa; a paper by Miss E. Wood on Devonian crinoids, with descriptions of new genera and species; and a review of the triton and frog-shells by Mr. W. H. Dall, in which several new subgeneric names are proposed.

THE Society for the Protection of Birds has issued as a leaflet an abbreviation of an admirable article by Mr. W. P. Pycraft on the manufacture and sale of the so-called "osprey" plumes, which recently appeared in *Knowledge and Scientific News*. In the October number of *Bird Notes and News* the society directs attention to the marked decrease in the number of swallows visiting this country and the Continent during the last few years. The scarcity is attributed to the capture of these birds for their plumage and for the table, and it is suggested that extensive netting must take place at both migrations, though where this occurs has not been ascertained.

ACCORDING to the report of the Manchester Museum for 1903–4, it appears that the most important acquisition received by the museum during the period under review is the Cosmo Melville herbarium, which was presented by the chairman of the committee. The contents of this collection, stated to be the only private one of which the limits extend beyond the Palæarctic region, are estimated to number more than 40,000 species. It is incidentally mentioned that the skin of Napoleon's Arab charger "Marengo," which is reported to have been lately discovered in a cellar at the Louvre, was formerly in the Manchester Museum. The skeleton is, we believe, in the United Service Museum.

THE latest of the series of handbooks to the contents of the Horniman Museum at Forest Hill, issued by the London County Council, relates to the fresh-water aquariums and vivariums. In these receptacles are exhibited a large number of the common British invertebrates, together with a selection of fishes, reptiles, and amphibians. The descriptions of the various species grouped are written, as a rule, in language which can be well understood by the ordinary reader; we may point out, however, that if it is necessary to explain a term like "Porifera" it is equally necessary to do the same in the case of one like "unicellular" (p. 4), the meaning of which, we venture to think, will not be comprehended by 1 per cent. of the visitors to the museum.

IN the October issue of the *Journal of Conchology* Mr. A. J. Jukes-Browne refers to the dissatisfaction which exists among many naturalists on account of the sweeping changes proposed in zoological nomenclature by a strict and slavish adherence to the rule of priority. He points out that no less than a dozen familiar names of molluscan genera would have to be changed if those used in a certain obscure work be admitted. The evil is a very real one, and we refer to two points in connection with it. In the first place we notice that in the main only systematic naturalists adopt the proposed changes, anatomists, physiologists, &c., adhering to the old names; this at once introduces a dual system of nomenclature, which is much to be deprecated. Secondly, it may be admitted that to specialists the changes in nomenclature in their own particular groups are not very serious, as they ought to be able to keep abreast of them; but to "all-round" naturalists such changes are very serious indeed. An authoritative conference on the subject is urgently needed.

IN the *Revue générale des Sciences* (September 30) M. Ernest Fourneau describes the chemical constitution of the chief local anæsthetics, such as cocaine, eucaine, &c., and discusses the nature of the chemical groups and their arrangement on which analgesic action seems to depend.

WE have received Mr. W. Martindale's price list of drugs, chemicals, surgical instruments, &c. The catalogue

of drugs, chemicals, and microscopical stains seems to be very complete, and we note that several pages are devoted to X-ray apparatus.

IN the *Bulletin* of the Johns Hopkins Hospital for September (xv., No. 162) Dr. Howard Kelly describes an ingenious instrument, the piezometer, for measuring degrees of resistance, *e.g.* rigidity of the abdominal wall or the limits of a tumour. Reviews of books and some medical and medico-historical articles complete this excellent number.

IN the *Bulletin international de l'Académie des Sciences de Cracovie* (No. 7, July, 1904) M. Nitsch describes some experiments on rabies in rabbits, and states that the earliest symptoms of infection are movement of the jaws and grinding of the teeth. M. Maziarski discusses the relation of the nucleus to the cytoplasm, and M. Kowalewski describes a new species of tape-worm, *Tatria biremis*, found by him in the intestine of *Podiceps auritus*.

THE Liverpool School of Tropical Medicine has issued an important series of reports on trypanosomiasis by Drs. Dutton, Todd, and Christy, which seem to establish conclusively that sleeping sickness is trypanosomiasis, although there are severe and even fatal cases of the latter in which the somnolence is not observed. In one of the expeditions of the school a blood-sucking larva of nocturnal habits was found to be abundant in many districts of the Congo.

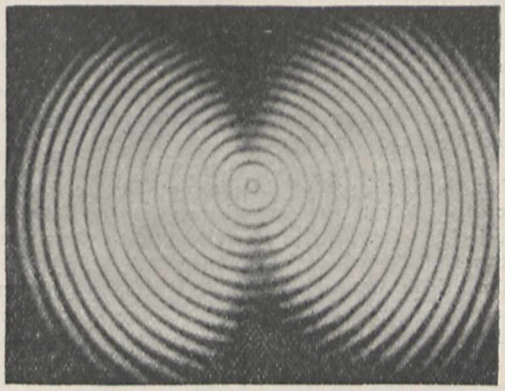
IN the October number of the *Journal of Hygiene* (vol. iv., No. 4) Dr. Boycott discusses the diagnosis of ankylostoma infection with special reference to the examination of the blood, Dr. Todd describes experiments on the preparation of dysenteric toxin and antitoxin, and Dr. Castellani details researches on the etiology of dysentery in Ceylon. The Swedish Antarctic Expedition forms the subject of an article by Dr. Ekelof, the medical member of the expedition, in which he discusses its medical aspects.

AN interesting report by Drs. Jobling and Woolley on Texas fever of cattle in the Philippine Islands is published by the Bureau of Government Laboratories, Manila (1904, No. 14). Some imported American cattle, after inoculation for rinderpest with the blood of native animals, rapidly died with all the symptoms of Texas fever. Investigation proved that Texas fever was endemic among the native cattle, which, however, had acquired an immunity and suffered but little from the disease. The species of tick in the islands was found by Mr. Banks, Government entomologist, to be the Australian variety (*Boophilus australis*).

THE Meteorological Department of the Transvaal (Mr. R. T. A. Innes, director) has issued its administration report for the year ending June 30, 1904. Such of the instruments ordered from this country as had then arrived there had been distributed, and continuous records of some elements would be available from July 1, 1904. Rain gauges were considered to be the most important for immediate erection, and nearly 200 voluntary observers had been supplied with these instruments. All the observations made in the colony will be published in an annual volume. Telegraphic or telephonic weather reports are received daily from twenty-nine stations, and telegrams exchanged with other colonies. The staff is at present much too small for the important work in hand.

PART iii. of the new monthly journal *Le Radium* contains a summary by Prof. Turpain of the present methods of producing high frequency currents, an account by M. M. Moulin of the *n*-rays and the methods used in their study, and an article by Dr. A. Darier on the physiological effects of the radiations from radio-active substances.

BY slightly modifying Pocklington's method of observation, M. H. Dufet has succeeded in making measurements of the rotatory power of biaxial crystals in the direction of the optic axes. The results are described in the October part of the *Journal de Physique*. With the apparatus employed it becomes possible to make observations with much thicker plates than have hitherto been used, and in this way to observe a large number of turns of the isochromatic spirals instead of only their commencement. The paper is illustrated by photographs, and the accompanying figure represents the rings and spirals for the violet mercury



line λ 4358 in the case of the slightly birefringent substance rhamnose. The plate used was cut normally to the stronger axis, and had a thickness of 6·27 mm. The rotation along the symmetrical optic axes of crystalline *d*-tartaric acid has a value of $-114°$ per cm.; it is a striking fact that the rotatory dispersion of solid tartaric acid is normal seeing that in aqueous solution the dextro-rotation of the acid undergoes very anomalous changes with variation of the wave-length. All the biaxial substances studied which were found to show rotatory polarisation in the solid state are capable of existing in enantiomorphous hemihedral forms.

AN interesting paper by T. Godlewski on the dissociation of electrolytes in alcoholic solution appears in the *Bulletin* of the Cracow Academy of Sciences (1904, No. 6). The well known dilution law of Ostwald is satisfied by all the eight acids which have been examined. The order in which the acids appear, when arranged according to the magnitude of their electrolytic dissociation constants, is different from that which holds for aqueous solutions of the acids.

A VERY sensitive method of testing for minute traces of gold is described by J. Donau in the *Sitzungsberichte* of the Vienna Academy of Sciences (vol. cxiii. p. 180). A silk or woollen fibre, previously treated with a solution of tannin or a solution containing pyrogallol and stannous chloride, is immersed in the acidified solution to be examined for gold. If present, the latter is precipitated in the colloidal form on the fibre, and imparts to it a red coloration which is observed by examining the fibre under the microscope. With a silk fibre, mordanted with pyrogallol and stannous chloride, 2×10^{-9} gram of gold can thus be detected.

SOME interesting observations on aqueous solutions of magnesium oxalate are communicated by Kohlrausch and Mylius in the *Sitzungsberichte* of the Prussian Academy of Sciences (1904, p. 1223). By dissolving magnesium hydroxide in aqueous oxalic acid, it is possible to obtain

solutions which contain three hundred times as much magnesium oxalate as that present in the saturated solution of the hydrated salt. Electrical measurements show that the equivalent conductivity decreases at an abnormally high rate as the concentration increases. This and other phenomena furnish strong evidence in support of the view that polymerised molecules are present in the solution in considerable proportion.

A SECOND edition of Mr. Borchardt's "Arithmetical Examples," to which twenty-four pages of new exercises, oral and otherwise, have been added, has been published by Messrs. Rivingtons.

A "GEOMETRICAL Political Economy," by Mr. H. Cunynghame, C.B., is about to be published by the Oxford University Press. The work is an elementary treatise on the method of explaining some of the theories of pure economic science by means of diagrams.

THE October issue of the *Popular Science Monthly* is devoted entirely to the Cambridge meeting of the British Association. Dr. Pritchett, president of the Massachusetts Institute of Technology, contributes "A Traveller's View of the British Association Meeting," and in addition are included the presidential addresses of the Prime Minister, Prof. Horace Lamb, Mr. W. Bateson, Mr. Francis Darwin, Mr. Henry Balfour, Mr. Douglas Freshfield, Prof. C. S. Sherrington, and the Hon. Charles A. Parsons.

OUR ASTRONOMICAL COLUMN.

ENCKE'S COMET.—The absence of further observations of Encke's comet has caused some doubt to be expressed as to the correctness of Herr Kopff's conclusion regarding the identity of the object which he obtained on his photograph of September 11.

In the *Astronomische Nachrichten*, No. 3970, the same observer states that he has obtained confirmatory evidence which places the identity beyond doubt, although the comet is still extremely faint and diffuse. On a photograph exposed on September 17, at 13h. 29.2m. (Heidelberg M.T.), the same object appeared in the following position :—

$$\text{R.A.} = 1\text{h. } 40.6\text{m., dec.} = +26^\circ\ 14'.$$

On comparing this position, and the one determined in the first observation (September 11), with the interpolated values obtained from the ephemeris published by MM. Ocoulitsch and Kaminsky, it is seen that the ephemeris requires the following approximate corrections :—

$$-0.7\text{m. and } -6'.0.$$

Herr P. Gotz, of Heidelberg, was unable to find the comet on September 6 with a 6-inch telescope.

STRUCTURE OF THE OXYGEN BANDS IN THE SOLAR SPECTRUM.—In the September number of the *Astrophysical Journal* Mr. O. C. Lester, of the Sloane Physical Laboratory, Yale University, discusses the results recently obtained by him in a research as to the nature of the oxygen bands in the solar spectrum, of which the B group is a typical example.

The purpose of the research was to investigate the relations existing between the lines of each band and between the several bands, including in the latter two bands above *a* which do not appear to have been discussed previously.

The results may be summarised as follows :—(1) More accurate measures of the wave-lengths of the lines in groups A, B, and *a* have been made, the *a'* band has been measured for the first time, and a new group (a'') at λ 5377.2 has been discovered and its lines measured. (2) It has been shown that the oxygen absorption spectrum consists of two distinct series of bands, instead of one, which occur in pairs similarly to the series of lines in a band. (3) Deslandre's first law concerning the distribution of lines in a spectral band, viz. $N = a + bn^2$ (where N = the vibration frequency number, a and b are constants, and n takes on all integral values from 0 to n), is shown to be inadequate to represent the line series of the several bands. A modification of this formula suggested by Mr. Lester is

$$N = a + kn + c^{-1}n^2,$$

and this represents the series within the limits of observational errors; c and k are constants which are different for each series, although the differences are but small.

RECURRENT MARKINGS ON JUPITER.—From the inspection of several thousand drawings of Jupiter made during the last half-century, Mr. Denning has arrived at the conclusion that "features exhibiting various peculiarities of appearance and rates of motion are common to certain latitudes and break out from time to time, enduring for certain unknown intervals, then disappearing to be replaced by similar phenomena." Some exceptional outbreaks, no doubt, only take place at long intervals, whilst the evidences of others remain visible for long periods.

Mr. Denning suggests that if the old drawings could be collected and suitably discussed, considerable light might be thrown on the physical changes which are ever taking place. The value of this discussion must, in a measure, depend upon the continuity of the observations, and it is suggested that, as Jupiter is now being continuously observed and delineated, there will in a few years be ample material for such a discussion.

In the meantime Mr. Denning suggests that further insight into the wonderful atmospheric phenomena of the planet might be obtained from a study of the large number of drawings made by Schwabe between 1830 and 1860, and the 300 or 400, or more, made by Schmidt between 1843 and 1880 (the *Observatory*, October, 1904).

COMPARISON OF THE INTENSITIES OF PHOTOGRAPHIC STELLAR IMAGES.—The second chapter of the "Instructions to Variable Star Observers," of which the first chapter was summarised in these columns on September 15, is published in the October number of the *Bulletin de la Société astronomique de France*. Variable star observers will find many points of interest and instruction in the present chapter, which deals with the details of obtaining suitable photographs, and afterwards comparing and reducing the plates.

OBSERVATIONS IN THE SOUTHERN HEMISPHERE.—The Lick Observatory expedition to the southern hemisphere installed its apparatus at Santiago de Chile during the southern winter of 1903, and commenced observations on September 11 (1903).

A detailed description of the instruments in use, the observations and results, is promised for a later publication, but in the meantime Prof. W. H. Wright records several important results obtained with a powerful three-prism spectroscope attached to a Cassegrainian reflector of 94 cm. aperture, in No. 2, vol. xx., of the *Astrophysical Journal*.

The stars β Doradus, w Velorum, l Carinæ, κ Pavonis, and τ Sagittarii, have been found to have variable radial velocities.

Observations of α Centauri have also been made, and indicate an average difference between the radial velocities of the two components of about 5.17 km. One probable explanation as to the cause of this difference is that it is due to the relative orbital motion of the two components, and if this is true the parallax of the system may be determined, because the visual orbit of the pair is already well known. Dr. Palmer made the computation, and obtained the following results :—

$$\pi = 0''.76$$
$$a = 3.46 \times 10^9 \text{ km.}$$
$$m_1 + m_2 = 1.9.$$

a = mean distance between components in kilometres, m_1 and m_2 = the respective masses of α_1 and α_2 Centauri in terms of the sun's mass.

The relative masses of the components, as previously determined, is about 51 : 49 in favour of the brighter. The spectrum of the latter is of the solar type, whilst in that of the fainter the iron lines are more pronounced and the calcium absorption is exceedingly heavy.

THE CLASSIFICATION OF STARS ACCORDING TO THEIR TEMPERATURE AND CHEMISTRY.

I.

ALTHOUGH the observations made by Fraunhofer in 1814 first indicated that the spectra of stars were not all of the same character, it was the more systematic observations of Rutherfurd and Secchi fifty years later which revealed the fact that the different varieties of stellar spectra were, generally speaking, associated with stars of different colours. The stars with fluted spectra, for instance, were generally found to be red; those resembling the sun in having abundant metallic lines were yellowish; while those in which the chief absorption was due to hydrogen were white. Closely following these observations came Zöllner's suggestion that the spectra might indicate the relative ages of the stars, and that the yellow and red stars were older and cooler than the white ones, thus giving birth to the now generally accepted view that the different kinds of stellar spectra represent different temperature stages in the evolution of more or less similar masses of matter. More direct evidence as to temperature differences was brought forward shortly after by Ångström, who directed attention to the probability that the flutings characteristic of the red stars originated in chemical compounds, and pointed out that the occurrence of flutings in such a star as Betelgeuse might be taken as an indication that the temperature of the star was sufficiently reduced to permit the formation of chemical combinations. Subsequent researches have shown that all flutings do not proceed from compounds, but the fact remains that in laboratory experiments flutings are only produced by relatively cool vapours and gases, and their presence in the spectrum of a star may therefore be still accepted as evidence of greatly reduced temperature. The broad distinction between the spectra of cool and hot stars was thus early recognised, but it remained to establish the sequence of temperature in the stars characterised by line spectra.

It was next pointed out by Sir Norman Lockyer in 1873 [1] that the spectrum of the sun was intermediate between the more complex fluted spectrum of the red stars and the simpler line spectrum of the white ones, and further that the great development of the blue end of the spectrum in the white stars, as contrasted with stars like the sun, afforded strong presumptive evidence that the white stars were the hotter. Experiments had, in fact, shown that the continuous absorption exerted by certain gases was restricted to the most refrangible part of the spectrum when the density was low, and advanced gradually into the visible spectrum as the pressure was increased. Utilising this criterion, it thus appeared that the hotter a star the simpler was its spectrum, and it was pointed out also that the metallic elements seemed to make their appearance in the order of their atomic weights. As a working hypothesis, founded primarily on results obtained in solar inquiries, it was suggested that in the atmospheres of the sun and stars various degrees of dissociation were at work, so that in some cases the atoms which compose what at terrestrial temperatures we distinguish as metals, metalloids, and compounds, were prevented from coming together. Hence "the so-called elements not present in the reversing layer of a star will be in course of formation in the coronal atmosphere, and in course of destruction as their vapour densities carry them down; and their absorptions will not only be small in consequence of the reduced pressure in that region, but what absorption there is will probably be limited wholly or in great part to the invisible violet end of the spectrum."

Secchi's classification was, of course, made quite independently of such considerations as to temperature; but being based to a great extent on the colours of the stars associated with the different spectra, the numerical sequence of his four well known types is more or less in accordance with the probable temperature gradation.

Vogel [2] was the first to propose a classification professedly depending upon the supposition that the spectrum is indicative of the phase of development which a star has reached, and making use of the condition of the blue end of the spectrum as a guide to the temperature conditions. In stars of his class i. the more refrangible portions of the spectrum are of conspicuous intensity, in class ii. the blue and violet are weaker, while in class iii., which includes Secchi's third and fourth types, this part of the spectrum is described as being strikingly feeble. This is, indeed, the principal feature which is common to the several subdivisions of each of the three classes, and, apart from such possible resemblance, it is difficult to understand, for example, how stars so widely different as Arcturus and the bright line stars of the Wolf-Rayet group could have been brought together in the same class. Thus, although the idea underlying the classification was that of decreasing temperature in passing from the first to the third class, there was no adequate attempt to define the successive positions of the various subclasses on the descending scale of temperature.

Another idea was put forward in 1887 by Sir Norman Lockyer in connection with the meteoritic hypothesis.[1] Hitherto the generally accepted view as to stellar evolution had started with the assumption that all the stars were intensely hot to begin with, and that all further development was brought about by reduction of temperature; but it was objected that all bodies in the universe cannot be finished suns in the ordinary sense, and that the old view took no account of the processes of manufacture from nebula to sun. It was then suggested that the progress of stellar development was from comparatively cool nebulæ, through uncondensed "stars" of rising temperature, to the hottest stars, with a subsequent decline, through stars like the sun, to planetary conditions. On this modified basis a new classification was proposed in which seven groups were found sufficient to include the data depending on the visual observations, which were then practically all that were available. Some such arrangement of the stars in two series is, in fact, demanded by thermodynamical principles, since a mass of gas condensing under the influence of gravitation must continue to rise in temperature so long as it remains in a condition approaching that of a perfect gas, and Prof. Darwin has shown that a condensing swarm of meteorites would behave in a similar manner.

The magnificent success which soon after attended Prof. Pickering's photographic application of Fraunhofer's method of studying stellar spectra by means of an objective prism, and the subsequent use of the same form of instrument by Sir Norman Lockyer and others, provided data for a far more searching inquiry into the processes of stellar development. Conclusions as to the relative temperatures of the stars could now be more certainly drawn from the extension of their spectra towards the ultra-violet, as shown by the photographs, and the chemical changes accompanying the variation of temperature from star to star could be much more accurately observed.

In a discussion of the photographic spectra of 171 of the brighter stars, Sir Norman Lockyer [2] again found it necessary to arrange the stars in an ascending and a descending temperature series, as was previously the case when dealing with the visual observations, and the general sequence of events demanded by the meteoritic hypothesis was therefore so far confirmed. The classification into seven groups was still retained, but various subgroups were introduced in order to include the finer shades of difference revealed by the photographs.

At this stage of the inquiry many of the stellar lines, especially in the case of the hotter stars, had not been identified with terrestrial spectra, and further progress resulted rather from laboratory than from observatory work. Sir William Ramsay's discovery of terrestrial helium permitted a complete study of the spectrum of that element, and provided a most satisfactory explanation of many of the previously unknown lines appearing in the spectra of some of the white stars, and other lines usually associated in the stars with those of helium were subsequently traced to oxygen, nitrogen, carbon, and silicium.

But there was still another great class of outstanding lines, occurring in such stars as Sirius and α Cygni, for which chemical origins could not be certainly assigned on current principles. Continuing his researches, dating from

[1] *Phil. Trans.*, vol. clxiv., p. 492 (1874), and *Comptes rendus*, vol. lxxvii. p. 1357 (1873).
[2] *Ast. Nach.*, vol. lxxxiv. (1874), p. 113.

[1] Roy. Soc. *Proc.*, vol. xliii. p. 117.
[2] *Phil. Trans.*, vol. clxxxvi. A 1893), pp. 675-726.

1879, Sir Norman Lockyer[1] made the important discovery that several of these "unknown" stellar lines were coincident with lines of iron which were enhanced in brightness in passing from the arc to the spark spectrum. What is meant precisely by "enhanced lines" may be gathered from Fig. 1, and the first idea of their relation to stellar spectra is well brought out in Fig. 2.

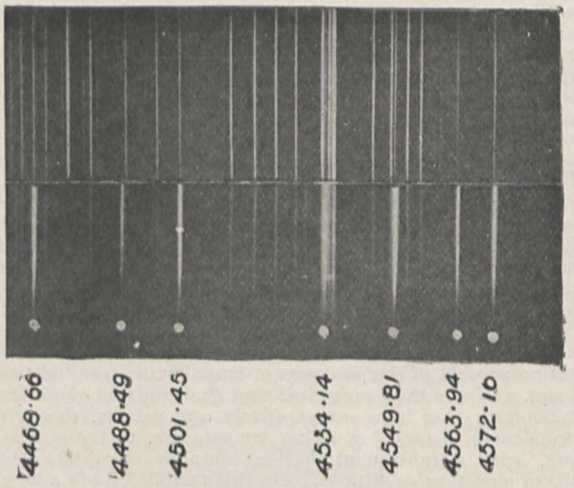


FIG. 1.—Illustrating enhanced lines of titanium; (1) arc, (2) spark.

The laboratory experiments suggested that in a space heated to the temperature of the hottest spark, and shielded from the effects of a lower temperature, the spectrum of iron would consist of these enhanced lines alone, and the outcome of the investigation was, in fact, to show that this condition is realised in the stars which are judged to be very hot by the extension of their spectra into the violet. Thus in α Orionis the continuous spectrum in the violet is feeble, and the arc lines and flutings appear without the enhanced lines; in α Cygni the violet radiation is more intense, and the enhanced lines are relatively much stronger than the arc lines; while in Rigel, with still stronger violet radiation, the enhanced lines appear in the absence of the arc lines. At a still higher stage, represented in the diagram by γ Orionis, the metallic lines have disappeared altogether, and are replaced by lines chiefly due to gases.

In a subsequent paper[2] it was shown that similar results were obtained in the case of other elements, and the presence or absence of enhanced lines, or their intensities as compared with those of the arc lines, appeared to afford a ready means of arranging stars at certain stages in order of temperature independently of a special study of the violet radiation. Adopting this mode of bringing together stars of approximately the same mean temperature, it was found, as before, that at each stage the stars were divisible into two groups, and that these groups naturally fell into two series, in each of which there was an almost unbroken sequence of changes in the line spectra. As determined in this way, stars of one series differ from those of the other at the same stage of heat:—"(1) in the greater continuous absorption in the violet or ultra-violet, (2) in the generally greater intensity and breadth of the metallic lines, (3) in the smaller thickness of the hydrogen lines, (4) in the greater thickness of the helium lines at those stages in which they are visible." The differences indicated in (2) and (3) are well illustrated by the comparison of the spectra of Sirius and α Cygni given in Fig. 3.

[1] Roy. Soc. *Proc.*, vol. lx. p. 475 (1896). [2] *Ibid*, vol. lxi., pp. 148–209 (1897).

It is to be noted that while the *relative* intensities of the arc and enhanced lines of the same metal are the same in both stars, thus indicating probable near equality of temperature, the metallic lines generally are weaker in Sirius than in α Cygni, while the lines of hydrogen behave in an exactly opposite manner.

The differences between the two series were explained by supposing, as before, that one of them comprises stars of increasing temperature and the other those which are becoming cooler. On the meteoritic hypothesis, stars of the first series would still be in the state of uncondensed swarms, and the greater thickness of effective absorbing vapours would account for the increased continuous absorption at the violet end of the spectrum, as well as for the greater thickness of the metallic lines, as compared with those stars in which a photosphere has been formed.

In 1899, in view of the fruitful results of the continued investigation of enhanced lines in relation to the stars, Sir Norman Lockyer[1] concluded that the time had arrived for a complete revision of the nomenclature of the stellar groups, and a more extensive definition of their chemical peculiarities. This new classification, in a slightly revised form, is fully stated and applied to the spectra of 470 of the brighter stars in a recent publication of the Solar Physics Committee.[2] On account of divergences of opinion among those engaged in these investigations, the same type of spectrum was referred to differently numbered groups in the various classifications which had been previously proposed, and to avoid the confusion to which this gave rise the use of numbers was entirely dispensed with. The idea underlying the new nomenclature cannot be better stated than in the words of the author, namely:—"As we know beyond all question that a series of geological strata from the most ancient to the most recent brings us in presence of different organic forms, of which the most recent are the most complex, it is natural to suppose that the many sharp changes of spectra observed in a series of stars from the highest temperature to the lowest, brings us in presence of a series of chemical forms which become more complex as the temperature is reduced. Hence we can in the stars study the actual facts relating to the workings of inorganic evolution on lines parallel to those which have already been made available in the case of organic evolution. If then we regard the typical stars as the equivalents of the typical strata, such as the Cambrian, Silurian, &c., it is convenient that the form of the words used to define them should be common to both." An adjectival form ending in *ian* was therefore suggested.

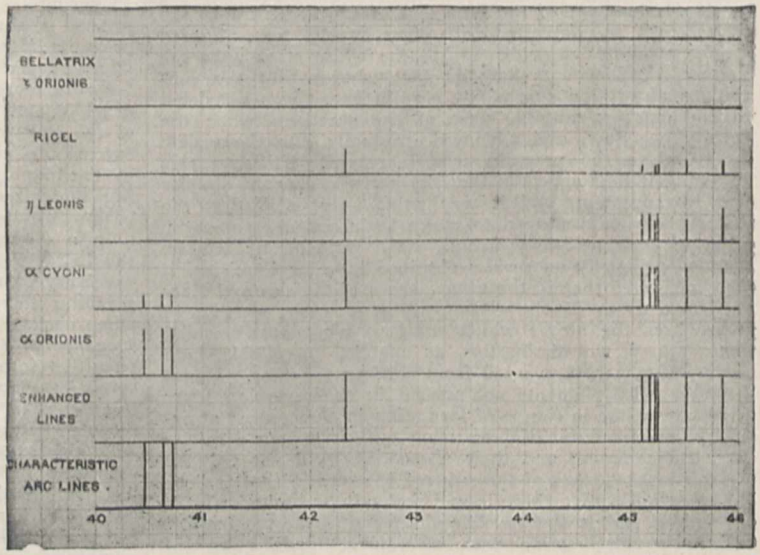


FIG. 2.—Illustrating the gradual replacement of arc lines of iron by enhanced lines in stars of increasing temperature.

[1] Roy. Soc. *Proc.*, vol. lxv. p. 186.
[2] "Catalogue of 470 of the Brighter Stars, classified according to their Chemistry." (London: H.M. Stationery Office, 1902.)

Generally, if the typical star is the brightest in the constellation to which it belongs, the Arabic name is used as a root; if the typical star be not the brightest, the name of the constellation is used in a similar manner. Thus we have *Antarian* from Antares, *Alnitamian* from Alnitam, but when its presence is manifested by enhanced lines the prefix "*proto*" is added, the idea being that a substance reduced to the state in which it gives such lines is subjected to some sort of molecular simplification resulting from the dissociating effects of increased temperature. In the case

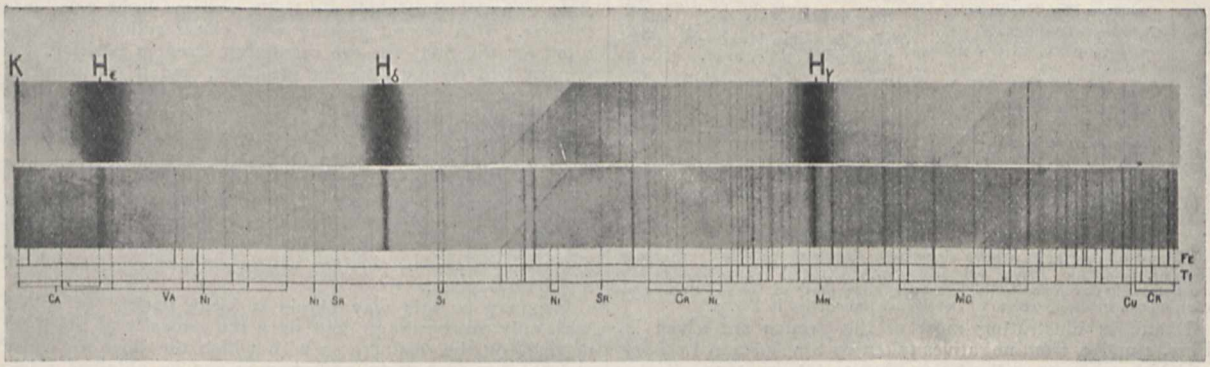


FIG. 3.—Spectra of (1) Sirius (decreasing temperature) compared with that of (2) α Cygni (increasing temperature). The chemical origins indicated are those depending upon coincidences with enhanced lines.

Taurian from ζ Tauri, *Piscian* from 19 Piscium, and so on. In this way the names given to the various groups have very definite associations, and will doubtless be found much more convenient than the old confusing numbers and letters, even for the mere sorting of spectra into similar groups.

of hydrogen, the proto-lines have not yet been even partially produced in laboratory experiments, but that they are really due to hydrogen is sufficiently demonstrated by the "series" connection of their wave-lengths with the wave-lengths of the more familiar lines of that element. Silicium exhibits four distinct line spectra under different conditions, and it

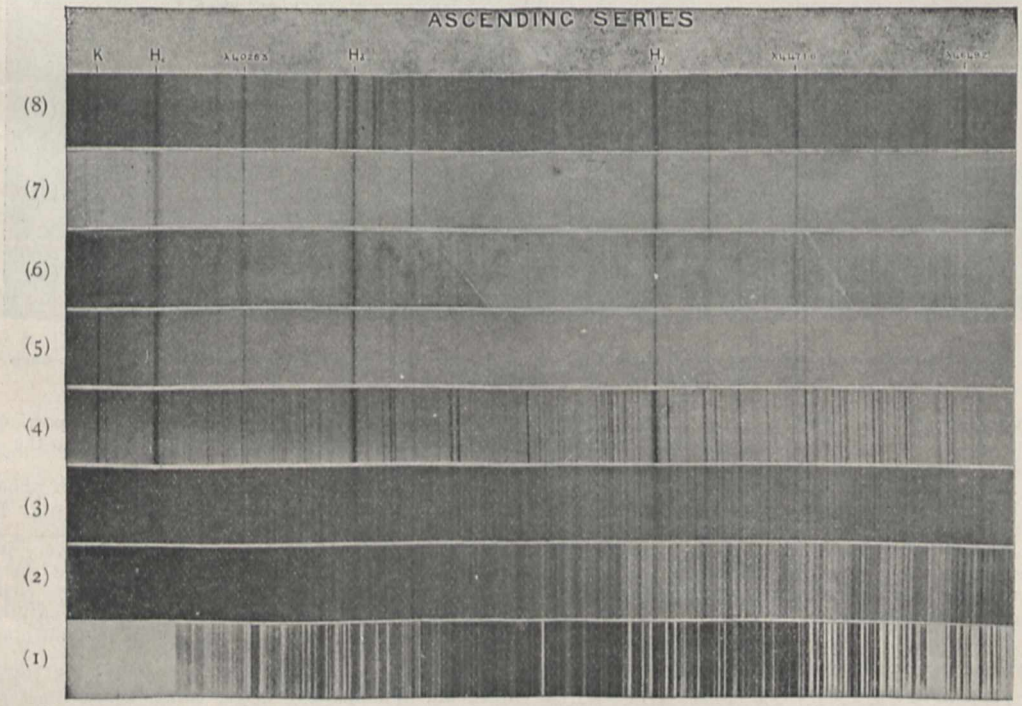


FIG. 4.—Stars of increasing temperature:—(1) α Orionis (Antarian); (2) α Tauri (Aldebarian); (3) α Persei (Polarian); (4) α Cygni (Cygnian); (5) β Orionis (Rigelian); (6) ζ Tauri (Taurian); (7) γ Orionis (Crucian); (8) ε Orionis (Alnitamian).

Bearing in mind the important distinction to be drawn between enhanced lines and the ordinary arc lines of a metal, a new term was found necessary for the proper chemical definition of several of the groups. When a substance is represented by lines which have their greatest development in the arc spectrum its ordinary name suffices; has been found convenient to refer to these in numbered groups. It would be out of place here to reproduce all the minute details of the new classification, but referring only to the most characteristic lines of the various stellar groups, the classification may be shortly stated as follows, the prefix "p" signifying "proto":—

Argonian (γ Argûs).—H, p H.

Alnitamian (ε Orionis).—H, He, λ4649, Si IV.

Proto-metallic lines relatively thick, hydrogen relatively thin.

Crucian (α Crucis).—H, He, Ast, O, N, C.

Taurian (ζ Tauri).—H, He, p Mg, Ast.

Rigelian (β Orionis).—H, p Ca, p Mg, He, Si II.

Cygnian (α Cygni).—H, p Ca, p Mg, p Fe, Si II., p Ti, p Cr.

Polarian (α Urs. Min.).—p Ca, p Ti, H, p Mg, p Fe, Ca, Fe, Mn, Si I.

Aldebarian (α Tauri).—p Ca, Fe, Ca, Mn, p Sr, H, Si I.

Antarian (α Scorpionis).—Flutings of manganese,[1] and many metallic lines.

[Nebulæ.]

Achernian (α Eridani).—Same as Crucian.

Algolian (β Persei).—H, p Mg, p Ca, He, Si II.

Markabian (α Pegasi).—H, p Ca, p Mg, Si II.

Sirian (α Canis Maj.).—H, p Ca, p Mg, p Fe, Si II.

Procyonian (α Canis Min.).—Same as Polarian.

Arcturian (α Boötis).—Same as Aldebarian (includes the Sun).

Piscian (19 Piscium).—Flutings of carbon and many metallic lines.

[Dark Stars.]

Proto-metallic lines relatively thin, hydrogen relatively thick.

[1] Many of the flutings have since been shown to be due to titanium [Fowler, Roy. Soc. *Proc.*, vol. lxxiii. p. 219 (1904)]. The flutings are most strongly developed in the less refrangible parts of the spectrum, and are not seen in the spectrum of Betelgeuse reproduced in Fig. 4.

Examples illustrating most of the groups are given in Figs. 4 and 5, from negatives taken by Sir Norman Lockyer and his assistants at the Solar Physics Observatory. These

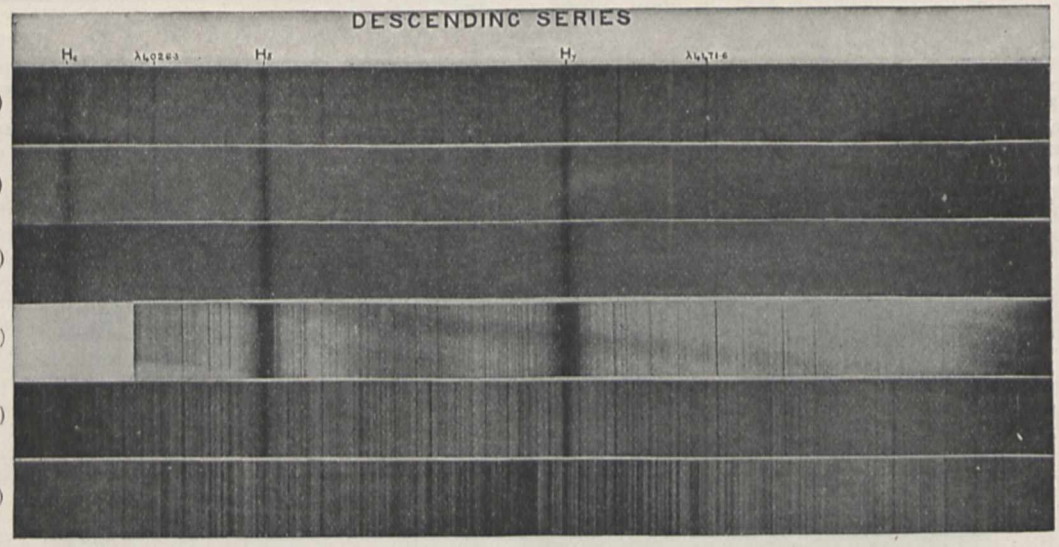


FIG 5.—Stars of decreasing temperature:—(1) γ Orionis (Crucian); (2) β Persei (Algolian); (3) α Pegasi (Markabian); (4) α Canis Majoris (Sirian); (5) α Canis Minoris (Procyonian); (6) α Boötis (Arcturian).

bring out very clearly the gradual simplification of the spectrum in the first series as the temperature rises, and the increasing complexity in the second series as the temperature falls. On the dissociation hypothesis, we have first to deal chiefly with relatively cool metallic vapours, which, as the temperature rises, are brought by *dissociation* to the proto-metallic stage, and finally to the gaseous condition represented by hydrogen and helium; then, through subsequent cooling, *association* begins and produces somewhat similar changes in inverse order.

A. FOWLER.

RECENT IMPROVEMENTS IN THE DIFFRACTION PROCESS OF COLOUR-PHOTOGRAPHY.[1]

THE fundamental principles of the diffraction process of colour-photography will be found in my earlier papers on the subject.[2] In brief, the method consists in preparing by photographic means a picture in which the areas which are to appear coloured are represented by diffraction gratings of various spacings. A grating ruled on glass, when combined with a convex lens and directed towards a lamp flame or other source of light, forms diffraction spectra in the focal plane of the lens. If the pupil of the eye is brought into the red portion of one of these spectra, we perceive the entire surface of the grating illuminated in red light, since every portion sends red light, and red light only, into the eye. If a second grating with closer ruling is substituted for the first, the eye remaining fixed in position, the spectra will occupy different positions, and if the pupil of the eye occupies, say, the green region of one of them, this grating will appear green. If the two gratings are placed side by side, and overlapping one another, the one will appear red, the other green, while the overlapping region, since it sends both red and green light to the eye, appears yellow (secondary yellow). If a third grating of still finer spacing is now placed before the lens, partly overlapping the other two, it will appear illuminated in blue-violet light, and the overlapping portions will be coloured purple, white, and bluish-green.

We may in this way obtain a large variety of colour with only three rulings, and since the intensity of the light depends on the distinctness with which the lines are ruled or photographed, light and shadow can be obtained solely by the presence of the diffracting lines. The portions of the plate on which they are absent send no light to the eye, and appear black.

A full description of the method by which photographs showing the colours of the original object were prepared will be found in the papers above referred to.

The earlier experiments were made with very imperfect gratings, the periodic errors of which caused the pictures to show vertical bands of colour. During the past winter I have ruled gratings of various description on one of the Rowland engines, and continued the experiments of five years ago.

This machine was designed to rule 14,438 lines to the inch, but by employing larger cams, which cause the pawl to skip a specified number of teeth, it may be made to rule at the rate of 7219, 4812, 3609, and so on. Calculations showed that gratings ruled on this machine with cams which advanced the toothed rim of the large wheel five, six, and seven teeth respectively would be suitable, that is, would have the relative spacings necessary to produce white when they were superposed.

To illustrate the principle of the colour synthesis, a glass plate was ruled with the three spacings, the ruled squares overlapping as shown in Fig. 1*a*. The areas appeared coloured as indicated when the plate was placed in front

[1] Paper read before Section A of the British Association at the Cambridge meeting by Prof. R. W. Wood.

[2] Wood, "Application of the Diffraction Grating to Colour-photography" (*Phil. Mag.*, April, 1899); "Diffraction Process of Colour-photography," (NATURE, vol. lx. p. 199, 1899).

of the viewing lens. The white area in the centre was of good quality, though not quite so bright as in the photographic gratings, for the reason that the three sets of rulings were rather more than the glass surface would take without breaking down between the lines. Photographic copies of this multiple ruling have been made, and will probably prove useful in demonstrating colour synthesis.

The appearance of two overlapping rulings under the microscope is shown in Fig. 1*b*.

It would appear at first sight as if a ruling of this description would be incapable of giving distinct spectra, and we should certainly not expect it to give merely the superposed spectra of the two gratings.

As a matter of fact, secondary spectra are produced, though they are usually so faint that they give no trouble. In some cases, however, owing to some peculiarity of the form of the groove, the photographic copies when superposed do not give the expected colour. For example, in one exceptionally pronounced case, the superposition of the red and violet gratings gave, instead of purple, a brilliant yellow-green.

The origin of the secondary spectra can be seen in the following way. If the red and violet gratings are superposed with the lines mutually perpendicular, and a lamp is viewed through the combination, the spectra appear as in

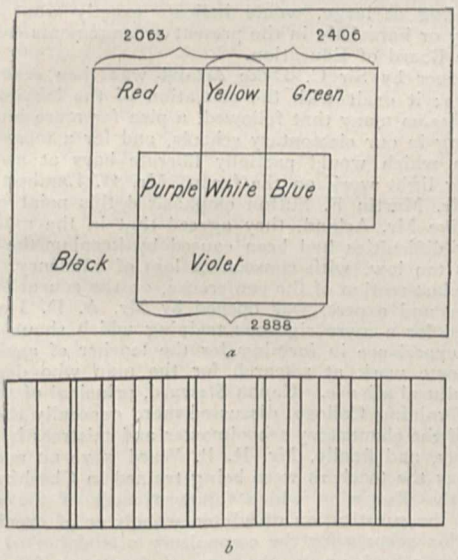


FIG. 1.

Fig. 2, the secondary spectra being usually much fainter than the principal ones. If, now, one of the gratings is slowly rotated through a right angle, the spectra will gradually wheel around into a straight line, and the secondary spectra will be found to fall *between* the principal spectra. In the particular case alluded to above, the secondary spectra for some reason or other were brighter than the principal, and it was found that the yellow-green of one of them fell at the point where the red and violet of two of the principal spectra coincided. This accounted for the abnormal colour which appeared in this case. It is very seldom, however, that these abnormal colours appear in the pictures.

A set of gratings for the production of colour photographs was ruled on this machine, and results far superior to any that had ever been obtained before were immediately secured. A few of the pictures were of such excellence as to compare favourably with the results obtained in the Kromshop. The method of preparing the pictures was essentially as I have described in previous papers.

The diffraction process has also been successfully combined with the Joly process. To accomplish this it was necessary to rule the three sets of lines in bands corresponding to the width of the red, green, and blue lines of the Joly screen. Calculation showed that if 12 lines were ruled with the 5-tooth cam, 10 with the 6-tooth, and 9 with the 5-tooth, the spaces would be about right.

Various schemes for making a ruling of this description were considered, but no satisfactory automatic device appeared to be possible, since the period of the bands on the Joly screen could not be exactly duplicated by any combination of cams.

The following simple device was finally hit upon. The engine was equipped with the 7-tooth cam, and a small stepped piece of brass mounted under the lever which operated the pawl, which, by preventing the complete descent of the lever, caused an advance of only 6 teeth or 5 teeth according to its position. The Joly screen was mounted on the table of the engine under a microscope, and the transit of the coloured lines across the × hair in the eye-piece observed, the rate of the ruling being changed at the proper moment by sliding the stepped piece of brass into the proper position, which was done by means of a short brass rod. The ruling of the grating occupied twelve hours, during which time I was obliged to sit with my eye constantly at the microscope, for the change of rate occurred about every half minute. Two very satisfactory gratings were prepared in this way, one corresponding to the Joly screen and the other to one of the screens ruled on the machine of the McDonough Co., of Chicago.

These gratings when placed in the viewing apparatus appeared white and very brilliant, and were easily duplicated by photography.

They were used in the following way:—

A positive on glass, made from a Joly negative, was flowed with a thin solution of gelatin sensitised with

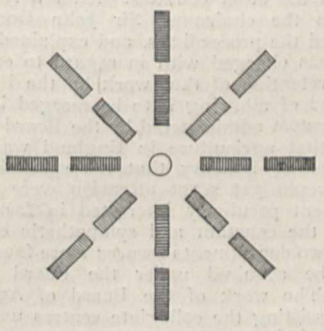


FIG. 2.

bichromate of potash, and allowed to dry. The triple ruled grating was then placed with its ruled surface in contact with the sensitive film, and held before the lens of the viewing apparatus. The appearance of the picture was now precisely similar to the appearance when a Joly colour screen was used, and the lines could be brought into register at once, when the picture appeared in its natural colours. A ten-second exposure to the light of the arc recorded the grating lines on the film, and the plate was then dipped into warm water and dried. The colours of the picture prepared in this way were fully equal, if not superior, to those obtained with the Joly viewing screen. There is the added advantage that the colour lines and picture lines are on one and the same film, consequently there is no liability of the lines to get out of register. Moreover, the picture can be duplicated by contact printing on glass sensitised with chrom-gelatin. These prints are, of course, quite transparent until they are placed in the viewing apparatus, when the coloured picture at once appears.

By this means the trichromatic screen, which in the Joly process must be mounted with every picture, is done away with, and a picture obtained which can be easily duplicated. To offset the advantages gained we have, however, the disadvantage that the pictures require the viewing apparatus, and show the same obtrusive lines as the original Joly pictures. The triple diffraction screen could easily be ruled with its colour elements much closer together, but we should gain nothing in this way until some method of taking a negative with narrower colour elements is devised.

The pictures made by the old method with three separate

gratings can, I believe, be very much improved, as soon as some better method of printing gratings is devised. I have worked exclusively with chrom-gelatin, and it is by no means easy to get a film of such uniform thickness that the print made on it appears uniformly illuminated.

During the past summer I made some experiments with Prof. Lippmann, of Paris, on copying gratings by means of the plates which he uses in his process of colour-photography. These plates are much more sensitive than chrom-gelatin plates, are orthochromatic, and yield gratings of great brilliancy and uniformity. Whether they are capable of receiving two or more impressions remains to be seen. If they are it will probably be possible to form a diffraction colour-photograph directly in the camera, in the manner suggested in one of my earlier papers.

Moreover, if the triple ruling can be transferred in any way to the Joly taking screen, it is obvious that the *negative* taken by means of it in the camera will, when placed in the viewing apparatus, appear as a positive in natural colours; we can thus obtain our coloured positive at once in the camera, and make as many duplicates from it as we please by contact printing.

THE AGRICULTURAL EDUCATION CONFERENCE AT GLOUCESTER.

UNDER the auspices of the Gloucestershire County Council, a conference on agricultural education was held at the Shire Hall, Gloucester, on October 15. There was a large attendance not only of those locally interested in either education or agriculture, but also of delegates from many of the other counties. After a few preliminary remarks from the chairman, Sir John Dorington, Lord Onslow opened the proceedings, and explained the work his department was charged with in regard to education. He justified the retention of that work by the Board of Agriculture instead of allowing it to be merged in the general educational system administered by the Board of Education, on the plea that agriculture in England was so far from being the leading industry that the specialised education it required would get scant attention were there not his own department peculiarly interested in fostering it. He claimed that the constant and sympathetic communication between the two departments secured more favourable results than could be acquired under the Board of Education exclusively. The work of the Board of Agriculture was confined to assisting the collegiate centres under which the greater part of the country was now grouped; there was, however, a large blank on the educational map, for the whole of the west country, including Gloucestershire itself, had no centre of university rank from which agricultural instruction emanated. He trusted that the present conference would pave the way towards remedying the need he had indicated.

Sir William Hart-Dyke, to whom the first paper, on higher agricultural education, had been entrusted, was unable to be present; his paper, of which an abstract was read, warned the meeting of the difficulty that now confronted all counties in the matter of higher education because of the great draft on their funds for the future training of elementary schoolmasters.

A paper by Prof. Middleton, of Cambridge University, next dealt with the proper function of experimental plots in local agricultural education; Prof. Percival, of Reading, who followed, dealt with the ideal course of instruction in an agricultural college. The current courses, he maintained, were far too scientific; chemistry, botany and kindred sciences should be reduced to a minimum in favour of work on the farm, a thoroughly popular programme which appealed to the "practical men" in the room.

Lord Monteagle then opened the second part of the proceedings, on the education of the small farmer, with an account of the way the Irish Board of Agriculture had gone to work.

In Ireland the central authority administered the larger part of the funds, contributing five-ninths of the cost of any work, and securing four-ninths from the local authority; thus the organisation proceeded more evenly over the whole country than in England, where the initiative rests with the local authority. Next, they had proceeded in Ireland on the principle of establishing no institution until they had created a demand for it by means of pioneer lecturing and demonstrations. Lastly, in Ireland they believed that the industrial organisation of the farmers must go hand in hand with their education.

Prof. Wallace, of Edinburgh, who followed, dwelt on the necessity of beginning an agricultural training at an early age, so far as practical work on the farm went, leaving the true technical instruction to come when the lad had matured. Mr. Frederick Verney also dwelt on the harm that was being done to country children by keeping them at unsuitable school subjects until they had lost all taste for farming pursuits; the present system of elementary education contributed both to the depopulation of the country and the overcrowding of the towns.

Mr. H. Hobhouse, M.P., spoke on the value of attaching agricultural sides to the ordinary country grammar schools; the training would not be technical, but scientific with an agricultural bias.

After lunch Mr. Morant expressed his pleasure at the opportunity the conference afforded him of learning the feelings of the great agricultural community towards the educational system of the country. He assured the meeting that the Board of Education was wholly anxious to assist, provided the men who represented agriculture on such occasions would make their views precise, and, instead of grumbling at large, would indicate exactly what worked harshly or harmfully in the present arrangements controlled by the Board of Education.

A paper by Sir C. Dyke Acland was then read in his absence; it dealt with the education of the labourer, and was, like so many that followed, a plea for more intelligent teaching in our elementary schools, and for a more flexible system which would partially liberate boys at an earlier age for light work on the farm. Mr. G. Lambert, M.P., and Mr. Martin F. Sutton emphasised this point of view, and, like Mr. Acland, they agreed that in the main rural labour difficulties had been caused by keeping the rate of wages too low, with consequent loss of efficiency.

The last section of the conference, on the education of the teacher and expert, was opened by Mr. A. D. Hall, who pleaded for a more rigorous training which should include some experience in farming for the teacher of agriculture, and some work at research for the man who dealt with agricultural science. Canon Steward, principal of the Salisbury Training College, discussed more generally the education of the elementary schoolmaster and mistress in country districts, and finally, Mr. R. P. Ward gave an account of the way the teachers were being trained in Cheshire.

In the discussion which followed most of the speakers urged the substitution of winter schools or of evening continuation schools for the compulsory attendance of country boys at school up to the age of fourteen; for farming purposes a boy ought to begin light work on the farm at the age of twelve at latest, though his education should go on much later than it does now.

The conference was noteworthy not only for the quality of the papers read, but for the advance they showed in the direction of organisation on those submitted to previous conferences. It was made clear that there are several different classes to be provided for; the large farmer's son or future land agent wants a different equipment from that of the small holder; the farmer himself must be reached by an entirely different method; the labourer, again, has to be treated separately. At Gloucester the various speakers defined clearly their aim and their method; in former gatherings of the same nature the speakers seemed to consider there was only one kind of worker engaged in agriculture.

THE SPREAD OF PLAGUE.[1]

IN accordance with our views on the origin of epidemics it is necessary to believe that the plague which appeared in Bombay in the autumn of 1896 was derived from some previously infected locality. Two such localities have been

[1] Substance of a paper read before the Section of Physiology at the Cambridge meeting of the British Association on August 19 by Dr. E. H. Hankin.

suggested. The most obvious suggestion is to the effect that it was derived from Hong Kong, which town had been the seat of a serious epidemic in 1894, and which in 1896 remained still infected. An alternative suggestion was put forward in the report of the German Plague Commission to the effect that it was derived from Garhwal. The suggestion was to some extent substantiated by the fact mentioned in the report in question that two thousand fakirs from Garhwal had arrived in Bombay on their way to a pilgrimage at Nassik shortly before the appearance of the disease. Plague is endemic in Garhwal (a district in the Himalaya Mountains), and this locality is therefore a possible source of infection. By conversation with a fakir who had attended the Nassik festival, Mr. Hankin learnt that the Garhwal fakirs only visit western India on occasions when the Nassik festival is being held. This festival is held regularly at twelve-yearly intervals.

It occurred to Mr. Hankin that if Garhwal was the source of the Bombay plague, by means of fakirs, it might also be the source of previous epidemics of plague in western India. On counting backwards from 1896 by twelve-yearly intervals, one arrives at 1836, the date of the Pali plague, and at 1812, the date of the Gujerat plague. That is to say, of the eight occasions on which these fakirs visited western India during the nineteenth century, on no less than three an outbreak of plague appeared. This fact may be regarded as strongly substantiating the suggestion of the German Plague Commission as to the origin of the Bombay outbreak. Further, it is stated by Forbes that the Pali plague originated in a village a few miles distant from the town of Pali shortly after the arrival of some wandering fakirs, and that it was preceded by a mortality among the rats. It was pointed out that these three plagues of western India had certain characters in common in which they differed from the majority of plagues in other parts of the world. First, they were characterised by their greater intensity and persistence; secondly, during the greater part of their course, at all events, they showed more virulence in villages than in towns; thirdly, they spread over the affected country, like a wave, from village to village, and showed but little tendency to travel along trade routes; fourthly, in each of the outbreaks the pneumonic form of the disease was frequently observed. The fact that these outbreaks resembled each other, and differed in general from outbreaks elsewhere, in the above characters, accords with the idea that they have a common origin. One apparent exception, however, which is of great importance must be described. This is the black death. So far as evidence goes, this outbreak was distinguished by each of the characters that have been ascribed to Indian plagues. In order, therefore, to be able to hold that Indian plague is of Garhwal origin, it is necessary to show that the black death may possibly have been derived from the same source.

The black death is known to have been imported into Europe from the town of Caffa, in the Crimea, where the Tartar army had been besieging some Italian merchants. According to an Arab historian, Aboel Mahasin, the plague was brought to the Tartar army from Tartary, where it was present in the year 1346, if not earlier. At that period, trade in horses and merchandise existed between India and Tartary. It is therefore necessary to investigate whether a Nassik festival occurred shortly before that time, and whether it was accompanied by an outbreak of pestilence. At first sight a study of Indian history appeared to negative the suggestion. It is stated, however, in Elphinstone's "History of India" that a rebellion broke out in Ma'bar in 1341, and that the army sent to suppress it was destroyed by plague. It appeared desirable to investigate this statement in detail. Counting back by twelve-yearly intervals, we arrive at 1344 as the year of a Nassik festival. In view of the great antiquity of Indian religious festivals, we are safe in assuming that in that year a number of fakirs emerged from Garhwal on their way to the sacred shrine. Ma'bar is situated on the Coromandel coast, on the Madras side of India, and one would expect that the army of the Emperor of Delhi would not march anywhere near to Nassik. But a contemporary history dealing with the conquest of Ma'bar, some thirty-five years previously, describes minutely the route then followed by the army. It appears to have lain through, or near, Nassik, and that the soldiers must have marched along the same route as the fakirs for all the first part of their journey. It is further recorded that when the army was destroyed by pestilence the Emperor himself was attacked, and that when suffering from the disease he halted at Deogiri, a town close to Nassik. It appears from a contemporary history that the army originally sent in 1341 was insufficient for its purpose, that the Emperor returned for reinforcements at a time when a famine was raging in Delhi, and that it was these reinforcements that were destroyed by the pestilence. The date of the famine is given as 1344. This is also given as the date at which the campaign terminated, and at which the rebels recovered their independence. Thus we have evidence that a plague broke out near Nassik in the year 1344, at a time when Garhwal fakirs were present, and it is obvious that this plague may have been carried to Tartary in time to have been the precursor of the black death, which is first known to have been present there in the year 1346. Other suggestions as to the origin of the black death, as, for instance, that it came from China, or from the supposed endemic area in Mesopotamia, or from the then existing endemic area of the Levant, if not contradicted by known facts, are at least unsupported by any positive evidence.

Prof. G. S. Woodhead asked whether it was known to what the pneumonic form of plague was due. Was it due to extra virulence or to the climatic conditions?

Sir Edward Candy asked if the outbreaks of plague in 1812 and 1836 spread and continued in the same manner as that of 1896, which re-appeared for some time after with every return of cold weather. It was noteworthy that the plague of 1896 took hold of the country up to the Punjaub, but missed out Calcutta and Madras.

In the course of his reply, Mr. Hankin pointed out that it was a remarkable fact that the pneumonic form of the disease showed but little tendency to spread as such by direct infection from person to person. Mr. Hankin had found that the plague virus lost its virulence by passages through rats. It was possible that it would also lose its virulence by passages through human beings, and that the true nidus of the disease in which it could retain or regain its virulence was to be found in some other living organism, as, for example, some species of flea. With regard to the important point raised by Sir Edward Candy as to the spread of plague, Mr. Hankin stated that it was a necessary corollary of his theory that the present outbreak of plague in India had not established itself in any other part of the world. It was probable that plague was carried from Hong Kong to Noumea, to Australia, to Madagascar, thence to South Africa, Oporto, and other localities. The present pandemic of plague was essentially a disease of sea-ports, in the first instance, and then of towns. It but rarely established itself in villages, and then always rapidly died out. In this and in other characters it showed itself distinctly different from the Indian form of the disease.

INVESTIGATIONS ON THE NUTRITION OF MAN.[1]

PROF. W. O. ATWATER, Middletown, Connecticut, chief of nutrition investigators of the United States Department of Agriculture, gave an account of the inquiry regarding the food and nutrition of man which is carried out in the United States by authority of Congress. The work is done by cooperation between the Department of Agriculture and a large number of universities, experiment stations, and other organisations from Maine to California. The headquarters is at Wesleyan University, Middletown, Connecticut, where the speaker, who is in charge of the work, is situated. The Federal Government devotes 20,000 dollars (4000*l.*) a year to the enterprise. This is used mainly as aid to research, and is supplemented by grants of money and other aid from State Governments and other sources. The inquiry has three aspects, one very practical, another more purely scientific, and a third educational.

On the practical side studies are made of the composition, the digestibility, and the nutritive values of food materials

[1] Abstract of an address before the Sections of Physiology and Economics at the Cambridge meeting of the British Association on August 23.

commonly used in the United States. This is done by chemical analyses and by actual experiments with men. Investigations are also made of the kinds, amounts, and costs of the food consumed by people of different classes and occupations in different parts of the country. The results throw valuable light upon the physiological, hygienic, and economic phases of the subject. At the same time experiments are made on various collateral topics, and thus information of the greatest usefulness is being acquired.

The more abstract scientific researches have to do with the transformations of matter and energy in the body, and consequently with the fundamental laws of nutrition. The experiments are made with men by use of the respiration calorimeter, an apparatus which serves to measure the changes which take place in the body with different diets and under different conditions, as, for instance, with physical or mental work or of rest. One very interesting result is the demonstration that the law of the conservation of energy obtains in the living body. Such purely scientific research is difficult and costly, but the speaker insisted earnestly upon its fundamental importance. These experiments show very clearly how the demands of the body for energy, for warmth, and work decide the needs for food. Taken in connection with the practical inquiries, they reveal much that was previously unknown regarding the uses of food and the adaptation of diet to health, purse, and welfare.

Numerous illustrations were given of the results of these inquiries. The average man on average diet digests and utilises about 96 per cent. of the material and 91 per cent. of the energy of his food, the rest being rejected in the excretory products; but the proportions thus utilised vary with the person, and still more with the food. The investigations bring out these differences in much detail.

The question of the nutritive values of bread made from ordinary white flour as compared with the whole wheat meal or brown flour, such as is used to make "brown bread," was considered. Chemical analysis shows that the bran which is removed in making the white flour contains considerable quantities of nitrogenous materials, and also of mineral matters, such as phosphates. A natural inference is that when the miller removes the bran he takes out the most valuable part of the flour. But the analysis in the chemical laboratory is not the same as that in the human body. The digestive apparatus of man has not the power to utilise the bran, consequently, when we eat the meal from the whole wheat we digest the part which makes the white flour and reject most of the ingredients of the bran. Cattle and sheep can digest the bran; the miller is therefore right in selling the bran for fodder for stock, and the white flour bread for man. This last statement perhaps requires a slight qualification. A large number of experiments with healthy men show that the nitrogenous ingredients of the bran escape digestion when made into bread, so that 1 lb. of white flour furnishes more digestible material than 1 lb. of the whole wheat meal; but it may be that the body obtains more phosphates from the whole wheat. This last question is still under investigation. The present probability, however, is that the chief value of the bran is as a stimulant to digestion in some cases where peristaltic action or the secretion of digestive juices is enfeebled.

While Prof. Atwater could hardly adopt the vegetarian theory of diet, he believed that the idea of the needs of large amounts of meat is often greatly exaggerated.

The investigations emphasise the great importance of a liberal diet for people engaged in muscular labour. They make it clear that in many cases the food of the poor is inadequate for normal nourishment, and must remain so until they have larger incomes or cheaper food.

The investigations also bring out clearly the reasons why people with sedentary occupations need less food than those with more physical exercise. Mental labour differs from muscular labour in requiring much less material and energy for its support. In general, people with sedentary occupations have the larger, and those whose labour is manual the smaller, incomes. Thus it comes about that the well-to-do are apt to be over-fed and the poor under-fed.

The application of these principles to some of the economic questions of the day was emphasised. High value was placed upon the inquiries of Mr. Rowntree regarding the conditions of living of the labouring classes in York. Other investigations in England and Scotland were referred to, and the statements of Mr. Charles Booth, in his monumental work on "Life and Labour in London," regarding the need of such an inquiry in Great Britain were quoted with approval.

"Half the struggle of life is a struggle for food"; half the wages of the bread-winner are spent on the food for himself and his family. Little regard is paid to the relation between the real nutritive value of food and its cost. The poor man's money is worst spent in the market, the poor man's food is worst cooked and served at home; here it is emphatically true that "To him that hath, shall be given, and from him that hath not, shall be taken away even that which he hath."

The importance of proper diet as an aid to temperance reform was emphasised. In countless cases in the United States, and he presumed the same was true in England, the home diet of the labouring classes is not what it should be, and the cooking and the serving of the food are the opposite of attractive. It is not strange that the people take to drink. One place to work against the evil of alcohol is at the table.

The educational aspect of the subject was also dwelt upon. The Federal and State Governments which support these inquiries, and the institutions and individuals who carry them on, lay great stress upon the distribution of the results among the people at large. Not only are the details printed in scientific memoirs, but the practical outcome is condensed in pamphlets and leaflets which the Government prints literally by the million, and distributes gratuitously. Copies of these publications were shown. Schools, from the lower grades to the universities, are introducing the subject into their curricula, and leading educators are coming to recognise that when such themes are treated in the true scientific spirit as revelations of natural law, and their significance and their connection with life and thought are explained, they are valuable both for mental discipline and for daily use. It is not a lowering, but a broadening, of the ideal of education which thus makes these subjects in the best sense humanistic.

In closing, Prof. Atwater urged the importance of such inquiries. He showed how they were already being actively pursued in the different countries of the world, in Europe, in Japan, and in the United States, and suggested that the time had come for the development of the science of the comparative nutrition of mankind.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following appointments are announced: Prof. Marshall Ward, F.R.S., to be a member of the general board of studies; Dr. W. E. Dixon to be assistant to the Downing professor of medicine; Mr. P. V. Bevan to be demonstrator, and Mr. C. Chittock to be assistant demonstrator, of experimental physics; Mr. J. J. Lister, F.R.S., to occupy the university table at the Plymouth Marine Biological Laboratory; Mr. J. W. Clark to be an additional manager of the Balfour Fund.

MR. H. M. MACDONALD, F.R.S., has been appointed professor of mathematics in the University of Aberdeen.

THE death is announced of Mr. Alonzo B. Cornell, who was the founder of Cornell University, and gave special attention to the development of teaching of scientific subjects at the university.

A COURSE of ten lectures on "The Chemistry of Proteids," by Dr. S. B. Schryver, was commenced on Wednesday, October 19, in the physiological theatre, University College, London, and will be continued on following Wednesdays at 5 p.m. The lectures are open to all internal students of the university, and also to medical men on presentation of their cards.

IT is reported, says *Science*, that about 60,000*l.* is left to public institutions by Mrs. Elizabeth Green Kelly, including 20,000*l.* to the University of Chicago. We learn from the same source that the will of Mrs. Sarah B. Potter, of Boston, contains public bequests aggregating more than

200,000*l.*, including 30,000*l.* to the Boston Medical Library and 10,000*l.* to Harvard University. It is also announced that the increased appropriations for Miami University by the Legislature of the State of Ohio at its last session have rendered it possible to enlarge the science hall, given by Senator Brice, to about three times its present capacity. The new Brice Hall will be occupied by the departments of chemistry, physics, and biology of the Liberal Arts College, and by the natural history department of the State Normal School. The University of Southern California, at Los Angeles, is also to be extended by a new building to cost 20,000*l.* It will be devoted to the science departments.

AN attempt is being made to establish an association of teachers of science, art, and technology who are engaged in teaching at London institutions. It is hoped that the new association may become ultimately a national body. It has been agreed at meetings already held that the principal aims and objects of the association should be the general advancement of technical education; the interchange of ideas regarding methods of teaching technical subjects; the promotion and safeguarding of the professional interests of the members of the association in such matters as tenure, pensions, and registration; to lay the views of the association before educational authorities and before the public; and to enable the members to cooperate as a body with other scientific and educational associations. Arrangements have been made for a general meeting to be held on October 22 at the Birkbeck College, Chancery Lane, at 3.30. All London teachers of science, art, and technology, other than those employed in secondary schools, are invited to be present. Fuller particulars may be obtained from Mr. J. Wilson, head of the chemical department, Battersea Polytechnic, who is acting as temporary honorary secretary.

THE annual report of the Glasgow and West of Scotland Technical College, recently adopted by the governors of the institution, shows that the first section of the new buildings has proceeded satisfactorily. The main structure is nearly completed, and the internal equipment is advanced sufficiently to permit of the occupation of a few rooms during the present session. It does not seem possible to proceed immediately with the erection of the second section. The subscriptions to the building fund amount to 186,525*l.*; the cost of the first section will be 140,000*l.*, and to this must be added 44,654*l.*, the cost of the site. The second section will cost at least 60,000*l.*, and the governors appeal for further contributions to enable them to erect the whole of the buildings. It is estimated that the equipment of the first section will mean an expenditure of 40,000*l.* Conditional upon a new fund of this amount being raised for the purpose, the Carnegie University Trust promised a grant of 5000*l.* A second grant of 5000*l.* from the Education Department and other subscriptions have been placed to the credit of the fund, which now stands at 18,135*l.* The governors hope that they will soon be placed in a position to claim the grant conditionally promised by the trust. It is worthy of note that the total number of individual students reaches 5333, of whom 489 are adult day students, 4212 evening students, and 632 pupils of Allan Glen's School.

AN article on the selection of Rhodes scholars in connection with the Rhodes Scholarship Bequest was contributed to the *Times* of October 13 by Dr. G. R. Parkin. It appears that during the present month about seventy-five men, the first large group of scholars selected, enter on residence at Oxford University. Canada, Australia, South Africa, New Zealand, Newfoundland, Bermuda, and Jamaica, within the Empire, and, outside the Empire, Germany and the United States, with the exception of a few States where no suitable candidate was found, will have their representatives. In 1905 a larger number will probably be selected; in 1906 scholars will be chosen only from colonies of the Empire and from Germany, to which annual scholarships are assigned, whereas each of the United States has only two scholarships in three years. Thus in 1906 the full number—about 190 in all—provided for under the bequest will be in residence. It is interesting to note that the men sent as scholars are selected, where practicable, from colleges or universities rather than from secondary schools. It has been decided that throughout the United States generally only those candidates shall be eligible who have done at least two years' work at a recognised degree-granting university or college. In cases where the committee of any State expressly asks leave to appoint from secondary schools this leave is granted. The limits of eligible age were placed between nineteen and twenty-five. The public interest taken in the organisation of the scheme of award has been most striking. It will probably take some time to complete a system of selection which is beyond criticism, but a fair beginning seems to have been made in giving practical effect to the conception of the testator.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 5.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. G. H. **Verrall** exhibited specimens of (*a*) *Callicera yerburyi*, Verr., a Syrphid new to science, taken this year in Scotland by Colonel J. W. Yerbury, and (*b*) *C. aenea*, F., the other British species of the genus, together with three European species of Callicera, *C. macquatii*, *C. spinolae*, and *C. porrii*.—Mr. H. St. J. **Donisthorpe** exhibited *Tetropium fuscum*, L. (♂ and ♀), and *Abdera 4-fasciata*, Curt., taken by him at Market Bosworth, Leicestershire.—The Rev. F. D. **Morice** exhibited cells constructed by two wasps, *Polistes gallicus* and *Eumenes coarctatus*, found by him in the Balearic Islands.—Mr. A. J. **Chitty** exhibited specimens of the earwig *Apterygida media* (*albipennis*), found originally by Westwood, and hitherto recorded only from Norfolk. He had taken the species at Huntingfield and Charing, Kent, this year.—Mr. W. J. **Lucas** exhibited a living specimen of *Labidura riparia*, ♂, from the shore near Christchurch, Hants, kept alive for more than a month, and fed upon fruit, meat, &c.—Prof. Hudson **Beare** exhibited on behalf of Mr. C. J. C. Poole specimens of *Aulonium sulcatum*, Oliv., a beetle new to the British fauna.—Mr. W. **Dannatt** exhibited a specimen of *Papilio homerus* from the Blue Mountains, Jamaica, and three new butterflies, *Chlorippe godmani*, from Venezuela, *Delias hempeli*, from Gilolo, and *Monethe johnstoni*, from British Guiana.—Dr. T. A. **Chapman** exhibited for Mr. Hugh Main a teratological specimen of *Arctia caja*, bred this year. Immediately below the costa the left hind wing divided into three layers, each of which was apparently a normal wing so far as form, colour, and markings went, but which, when the insect was alive, were so closely applied to each other as to look like one normal wing, until they were separated.—Mr. F. **Merrifield** exhibited pod-like galls found on a terebinthine shrub in the limestone region of Auvergne, apparently those of *Pemphigus cornicularius*.—Mr. Norman **Joy** exhibited the black variety of *Bledius taurus*, Germ., taken at Wells, Norfolk, August, 1904; *Bledius femoralis*, Gyll, from Wokingham, Berks, a species that has not been taken in the British Isles for more than fifty years; *Polydrucsus sericens*, from Hampshire; *Neuraphes carinatus*, Mul., from Bradfield, near Reading; a small form of *Dyschirius politus*, Dej., taken at Bridlington and at Wokingham; and a Rhizotrogus (? species), taken in some numbers near Streatley, Berks.—Dr. F. A. **Dixey** exhibited some preparations of the scent of male Pierine butterflies, and read a note descriptive of the same.—Mr. H. J. **Turner** exhibited living examples of the larva of *Phorodesma smaragdaria* from the Essex marshes. He also contributed notes on the life-histories, and living larvæ and cases, of several Coleophorids, among them *C. vibicella*, a species which, although generally distributed on the Continent, has only been recorded from a few English localities.—Mr. G. J. **Arrow** read a paper on sound production in the lamellicorn beetles.—Prof. C. **Aurivillius** communicated a paper on new species of African Striphnapterygidæ, Notdontidæ, and Chrysapalonidæ in the British Museum.—Mr. A. H. **Swinton** communicated a paper on the droughts and weather, and insect increase and migration.—Mr. E. Ernest **Green** communicated a paper on some new mosquitoes from Ceylon, by Frederick V. Theobald.

MANCHESTER.

Literary and Philosophical Society, October 4.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—Mr. Charles **Bailey** exhibited some specimens of *Sisymbrium strictissimum*, L., which had been sent him by Mr. James E. McDonald, of Stockport, as occurring at Heaton Mersey, where it had been established for the last fifteen years. He remarked that this genus, apart from the aboriginal species, was already represented in Lancashire and Cheshire by two aliens, *S. polyceratium* at Birkenhead, and *S. pannonicum* at St. Anne's-on-the-Sea and elsewhere. *S. strictissimum* is, therefore, a third colonist of this genus which has obtained a permanent footing in our flora.—Prof. W. Boyd **Dawkins,** F.R.S., directed attention to a new cause of folding of the rock other than that which has been long recognised by geologists as ultimately due to the folding of the outer layers of the earth as they follow the contracting nucleus. The deep cuts made through valleys to make watertight barriers in the construction of reservoirs revealed the fact that the bottom of the valleys, wherever it was formed of shales and thin sandstones, was more or less folded and contorted. These folds and contortions caused the shales to let the water through with more or less freedom, and he had been called in repeatedly to advise as to how far it was necessary to carry the puddle trenches down below the valley bottom. He found, as a matter of experience, that these folds were superficial, and if the sinking were made to a sufficient depth below the bottom of the valley they disappeared altogether. It was therefore obvious that they were not due to deep-seated movements of compression resulting from the contraction of the earth. They are due to the relaxation of pressure caused by the removal of the rock by denudation from the area of the valley, and are analogous in every particular to "the creep" in coal workings, caused by the excavation of coal, by which the surrounding strata crush down into the area of relaxed pressure and ultimately fill it up. This may be studied in any coal pit where there is a superincumbent pressure, say, of more than 1000 feet. The two following illustrations of folding and faulting by relaxation of pressure are presented by the puddle trench of the Langsett reservoir belonging to the Sheffield Corporation, and by the two reservoirs now under construction on the head waters of the Derwent by the Derwent Water Board. In the first of these the foldings in question at the bottom of the valley in the shale under the first grit are strongly marked at the surface. These folds gradually disappear, and are based upon a hard black unmoved shale offering a good foundation about 60 feet below the bottom of the valley. This is in the valley of the little Don. The thickness of rock removed from the bottom of the valley amounted to no less than something like 8000 feet of Coal-measures and Millstone Grit. In the case of the Derwent, in which the folding is much more marked and is accompanied by faulting, the thickness of rock removed amounted to at least 9700 feet (7200 feet of Coal-measures, 2000 feet of Millstone Grit, and at least 500 feet of Yoredale). In this the movement had not extended beyond a depth of 90 feet. In the case of the Derwent reservoir lower down the river there are two systems of folding and faulting which do not penetrate beyond 60 feet from the surface. At that point a good foundation is found for the puddle trench of the embankment.

PARIS.

Academy of Sciences, October 10.—M. Mascart in the chair.—The discontinuity of the external work of muscles compared with the discontinuity of their internal work from the point of view of the energy expenditure of the contraction: A. **Chauveau.** The results of two sets of experiments are given graphically.—On Perrot's experiment: Louis **Maillard.** A preliminary account of some qualitative results is given. In the first set of experiments twelve succeeded out of twenty-one. In a second set, in which greater precautions were taken to ensure the stability of the receiver, and to avoid currents of air and temperature changes, thirty-one out of thirty-three experiments were successful.—Colour photographs obtained by the interference method without using the mercury mirror: E. **Rothé.** A careful examination of some photographs taken by Lippmann's method led to the conclusion that it ought to be possible, by prolonged exposure, to obtain photographs in colour by the reflection of light on the air-gelatine surface only, and this has been proved experimentally. The method presents the advantages of being applicable in any apparatus without the use of special material.—On the temperatures of transformation of steels: Georges **Charpy** and Louis **Grenet.** Three methods were applied to each sample, making use of the electrical resistance, the expansion, and the thermoelectric power. It was found that the thermoelectric and dilatometric methods show no well marked correlation except for the softer steels. On the other hand, the results furnished by the electrical resistance and dilatometric methods agree closely qualitatively and even quantitatively within the limits of experimental error.—Substituted derivatives of phenyldiazoaminobenzene: Léo **Vignon** and M. **Simonet.** The preparation and properties of several substitution derivatives of phenyldiazoaminobenzene are described. These substances are easily prepared by the interaction of the substituted diazoanilines with diphenylamine, and possess the general properties of the diazoamines, being usually unstable.—The influence of castration on the physique: Eugène **Pittard.**—Culture of a trypanosome of the frog: A. **Billet.**—On some Hæmoflagellæ of marine Teleostea: C. **Lebailly.**—New geological observations on underground sheets of water in the Brenner district: Pierre **Termier.**

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