THURSDAY, AUGUST 21, 1919.

NAVIGATION AND NAUTICAL ASTRONOMY.

(1) *Air Navigation. Notes and Examples.* By Instructor Capt. S. F. Card. Pp. vi+140. (London: Edward Arnold, 1919.) Price 10s. 6d. net.

(2) *Navigation.* By Prof. Harold Jacoby. Second edition. With a chapter on Compass Adjusting and a Collection of Miscellaneous Examples. Pp. xi+350. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 11s. 6d. net.

(1) THE author of this much-needed little book may be regarded as something of a pioneer, for, despite the general interest taken in the subject, this would appear to be the first work formally devoted to the navigation of the air. When, some years since, schools of navigation were established at various centres of aviation, Capt. Card was associated with Brig.-Gen. Briggs, R.A.F., in framing a general plan for the education of pilots and observers. This fact alone is a sufficient proof of the competence of the author for the work he has taken in hand.

Nautical readers will be interested to see how closely the navigation of the air is related to the coastal navigation with which they are familiar. We have the same problems, but on a greatly magnified scale. Thus in fixing a position by cross-bearings, it is not a matter of a couple of headlands three or four miles apart, but Reading and Oxford, or Bedford and Cambridge, are proposed as pairs of bearings suitable for the exercise of the student.

As stated in the preface, the subject is treated in a very elementary manner, making little demand upon the mathematical knowledge of the student. The explanations are clear and simple, with an abundance of well-executed diagrams. An excellent notion adopted is to add at the end of each chapter a blank page for the reception of any notes the student may wish to make upon the contents of the chapter.

Upon the subject of the navigation of the air Major-Gen. Seely, Under-Secretary for Air, made an important statement in the House of Commons on June 26. He said that the whole system of instruction is being revised, and the schools re-organised, and that endeavours are being made to perfect, so far as possible, mechanical aids, such as the sextant. He added that there is great hope that a satisfactory form of artificial horizon for air use will be brought out, and experiments are in actual progress. Gen. Seely's remarks appear to refer chiefly to that form of navigation over the open ocean with respect to which there is at present much uncertainty and obscurity. Capt. Card's manual, on the other hand, is limited to the type of navigation over the land corresponding with what is known as "pilotage" in ordinary marine navigation, in which position is generally determined by sextant angles and bearings of known objects. Let us hope, when more data are available, that the author may supplement his very clear exposition of this type by a more general treatise, embracing also ocean air navigation, in which position has to be determined by observations of the heavenly bodies. Some knowledge has been gained from the experiences of Grieve and Brown, but much remains to be learnt in these matters.

(2) Prof. Jacoby in his book is somewhat hampered by self-imposed limitations. Navigation and nautical astronomy, being mathematical sciences, can scarcely be completely treated upon a non-mathematical basis, whereas in this instance we have it explicitly stated in the preface that "the author has not assumed that the reader possesses formal mathematical and astronomical knowledge, or desires to possess such knowledge."

Nevertheless, upon the lines so laid down we have a very readable book, calculated to be of interest not only to those unconnected with the sea who would acquire some insight into the processes of navigation, presented in a chatty, discursive, or, as the author himself puts it, "informal," manner, but also to the professional navigator, who, having already some acquaintance with the matters dealt with, may like to see the various problems treated in a somewhat different fashion from that to which he is accustomed. In a little work of 350 pages, about one-half of which is devoted to tabular matter, we have an account of the leading modern methods employed in position finding at sea, while the various tables, though in somewhat abridged form, suffice for the calculations of actual navigation in ordinary circumstances. Amongst these the Davis table of combined natural and logarithmic haversines, which so greatly simplifies the calculations for the Marcq position lines, is conspicuous. Another useful feature is Table ii., an azimuth table, but with regard to this a word of caution might perhaps be added that, based as it is on the formula,

$$\frac{\text{sine azimuth}}{\text{sine hour angle}} = \frac{\text{sine polar distance}}{\text{sine zenith distance}}$$

the slow rate of change in the sine about 90° takes us into troubled waters in the neighbourhood of the prime vertical, where some other method for azimuth might be employed with advantage.

One other observation may be offered, with regard to a statement on p. 99 that "the moon is now so rarely observed that we have not given examples of lunar observations." It is quite true that tables of distances are no longer published, and that the method of finding longitude by measuring lunar distances has in consequence become obsolete. But for position line work an altitude of the moon in the daylight, with a simultaneous observation of the sun, often enables the navigator to obtain a complete "fix" at one and the same time, an advantage unattainable by any other method in the daytime. Probably more altitudes of the moon are observed at sea to-day than at any time previously.

There is one class of reader to whom the work of Prof. Jacoby should especially commend itself, and that is the fortunate owner of the palatial steam yacht who would fain make himself acquainted with what it is that his sailing master is about. It was perhaps in the interest of this type of reader that a final chapter is devoted to a circumstantial account of the voyage of the hypothetical steam yacht *Nav* from New York to Colon on December 18, 1917. Moreover, the story is very well told. H. B. G.

BEVERAGES.

Beverages and their Adulteration. Origin, Composition, Manufacture, Natural, Artificial, Fermented, Distilled, Alkaloidal, and Fruit Juices. By Dr. Harvey W. Wiley. Pp. xv+421+11 plates. (London: J. and A. Churchill, 1919.) Price 21*s.* net.

DR. WILEY remarks that his book "is not written for the scientific investigator, but for the average, sober-minded, reasonably well-educated American citizen." A general account of the beverages discussed is, in fact, what is given, neither severely technical nor flimsily "popular." The facts are stated carefully, as would be expected from the author, but little or no scientific knowledge on the part of the reader is assumed.

Water, as the beverage *par excellence,* is given pride of place. Both ordinary drinking supplies and mineral waters are dealt with, and the information given is such as will enable the reader to obtain an intelligent idea of water supply in its bearing upon the public health and upon manufacturing operations. Various processes of water purification are briefly described, and the utility of chemical and bacteriological analyses of water is explained. Touching on the widespread faith of ordinary humanity in the virtues of medicinal springs, the author dryly remarks that this faith is "not so well founded in fact as it is extensive in belief." At the same time, he indicates the factors producing the undoubted benefits which often result from "taking the waters"—namely, the change of habits, the simpler diet, avoidance of excesses, and so on. These, of course, are active aids in restoring health even when the water itself has no particular therapeutic value, except, perhaps, as a laxative.

Apropos of the habit of drinking ice-cold beverages—a habit more common on the other side of the Atlantic than here—the evil effects are summed up in an amusing quotation:—

Full many a man, both young and old,
Has gone to his sarcophagus
By pouring water, icy cold,
A-down his hot œsophagus.

"Soft drinks" have an especial interest for Americans just now, and perhaps they may presently acquire an added importance for ourselves. The term is applied in the United States to "non-alcoholic" beverages. Whilst the typical "soft drink" is soda-water mixed with a flavoured syrup, other "soft" beverages are legion. Apart from the undesirability of much sugar in drinks consumed largely by children, and the above-mentioned habit of taking them ice-cold in hot weather, Dr. Wiley does not see much objection to the general run of non-alcoholic beverages when these are prepared in a hygienic manner from wholesome materials. Some, however, contain drugs such as caffeine or cocaine; these are highly objectionable, and should, the author considers, be prohibited by law.

In the sections devoted to tea, coffee, and cocoa the reader will find some notes and historical sketches that are worth perusing, apart from the main descriptions of these beverages.

An interesting section is the one dealing with wine. Dr. Wiley has personally inspected nearly all the French vineyards where the most famous wines are produced, and has also visited the Spanish, German, and other wine-growing areas in Europe. His pages will be welcomed as giving a present-day account of the industry. He remarks, by the way, that the mean annual wine-production of the Château Y'quem is only 90 tuns, and opines that there is something miraculous in this quantity supplying the large amount of Château Y'quem wine, so-called, that is drunk in the world.

Some sensible advice is offered on the production of uniform and distinctive types of wine in the United States, and on the adoption of distinctive native names for them, instead of calling them by foreign names which are not really applicable.

Whilst here and there one misses the facile touch of the purely literary man, Dr. Wiley's occasional notes and historical extracts serve agreeably to enliven the substantial body of facts which he has brought together. The book is, of course, written from the American point of view, but much of the matter is of quite general interest, and will appeal to readers on both sides of the Atlantic. C. SIMMONDS.

OUR BOOKSHELF.

Les Symbiotes. By Prof. Paul Portier. Pp. xx+315. (Paris: Masson et Cie, 1918.) Price 5 francs.

THIS book, dedicated to his Serene Highness the Prince of Monaco, contains a lively exposition of a heresy, in regard to which the author frankly admits that if some years ago he had seen it stated at the beginning of an essay, he would probably have read no more. The heresy is that, apart from bacteria, all organisms are double, being formed by the association and "emboîtement" of two different kinds of creature. There are partners within every cell, partner-bacteria, which the author calls "symbiotes." A symbiote is a domesticated micro-organism with two remarkable properties, an extreme plasticity that enables it to adapt itself to the most diverse conditions, and a strong capacity for synthesis. These symbiotic bacteria come in with the food from the extra-organismal environment, and, though the partnership they form is usually indissoluble, they may in certain circumstances rejoin their wild relatives and live an independent life.

Every naturalist knows that lichens are double organisms, due to the symbiosis of algoid and fungoid partners, which form a very effective unity. Prof. Portier maintains that all organisms except bacteria have in a similar fashion a dual nature. A theory somewhat like this was propounded by Mereschowsky in 1910. But if all cells are thus dual, why, one hastens to ask, have not the ubiquitous, symbiotic, intra-cellular bacteria been seen before? The answer is that they have been often seen, but persistently misinterpreted. They are the components of the mitochondrial apparatus, those minute formed bodies, with many an alias, which have been described in the cytoplasm of all sorts of cells. It is true that these mitochondria have often been credited, with more or less probability, with a definite functional *rôle* in the metabolism of the cell, a *rôle* differing from cell to cell; but are not the symbiotes very plastic? Prof. Portier is good-humoured enough to quote the paradox that a theory is not of value unless it can be demonstrated false. We have no hesitation in prophesying that his theory will attain that value—which is just what he would have said himself a few years ago. We are bound to admit that the author is a downright good sportsman.

LETTERS TO THE EDITOR.

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The Magnetic Storm of August 11–12, 1919.

ONE of the very great magnetic storms, the most violent recorded at this observatory since that of September 25, 1909, commenced quite suddenly at 6.50 G.M.T. on August 11 from a very slightly agitated normal curve in both the elements of declination and horizontal force. The H magnet increased sharply by 84 γ ($1\,\gamma \equiv 10^{-5}$ C.G.S. unit), and the D magnet swung 10′ to the west. The direction of motion in each element was immediately reversed, with a very rapid decrease of 113 γ in H, and a swing in D, equally rapid, to the east of 16′. After a few very rapid swings the spot of light due to H decreasing went off the recording drum at 7 a.m., and remained off until it returned at 7.24 G.M.T. At 8.12 G.M.T. H increased rapidly, the range of the swing exceeding 446 γ. At 8.50 G.M.T. it again decreased rapidly, the spot of light remaining off the recording drum until 9.43 G.M.T. These oscillations in H were accompanied by rapid swings in D. After its sudden increase and decrease at the beginning of the storm it swung 60′ to the west. At 8.52 G.M.T. it was 50′ in the opposite direction. The extreme range in D during the storm was 110′, and of H, since the spot of light travelled off the drum on either side, greater than 780 γ.

The greatest phase of the storm was between the hours 14 and 20 G.M.T. on August 11. The spot of light with increasing H was twice off the drum, from 15.36 to 16.10 and from 16.20 to 16.38 G.M.T. At 20 G.M.T. the oscillations of H were less rapid, but they recommenced, after a comparative lull, at 0.50 G.M.T. on August 12. At 1.38 G.M.T. a fine peak of decreasing H began, which was followed by a peak of increasing H at 3.15 G.M.T., the total range being 404 γ. Corresponding with this movement D showed a very fine peak of swing to the west, with a range of 66′, at 1.48 G.M.T. These oscillations in both elements, particularly at the beginning and at the maximum phase of the storm, were extremely rapid.

These rapid oscillations were succeeded for a period of about five hours by a violent shivering of relatively small amplitude, but of great rapidity, in both H and D. This phenomenon of so marked a type I cannot recall to have seen in former storms. After this, at 8.30 G.M.T., August 12, the swings became slower and smaller in amplitude on the whole, until the storm died quite abruptly in H, and less marked, though abrupt, in D, at 19 G.M.T. on August 12.

The *Times* for August 12 announced that the Minister of the Interior in Spain had notified the Press of a breakdown in telegraphic and telephonic communication on the preceding day. The postal authorities in this district were also inconvenienced on the same day by earth currents. Needless to add that the solar surface has been greatly disturbed by sun-spots lately.

I looked out for a possible display of aurora on the night of August 11, but the brightness of the moon effectually veiled any such appearance, even if it were present. The cirrus clouds, however, were arranged in streaks, seemingly radiating from the north-west. I have noticed such an arrangement of the cirrus clouds in former magnetic storms.

A. L. CORTIE, S.J.

Stonyhurst College Observatory, August 14.

Wild Birds and Distasteful Insect Larvæ.

I HAVE read the letter of the Hon. H. Onslow (NATURE, August 14, p. 464) with much interest, and I shall certainly continue the investigation as soon as opportunity offers.

I regret that I must disagree with the attitude adopted by Mr. Edward R. Speyer (NATURE, August 7, p. 445). In my letter on the subject I had no intention of refuting the observations of Prof. Poulton or of any other observer. I simply recorded what I had seen, and suggested that parasitism of the larvæ might afford an explanation, but Mr. Speyer introduces a condition which certainly did not exist in the spring of 1918. He writes:—"In times of stress birds have long been known to subsist upon insects with highly distasteful qualities"; and again: "The currant-moth larva . . . has merely been eaten by the thrush, and possibly by the other birds mentioned . . . when the stress of having to feed a family has made such a practice a necessity."

At the time my observations were made there was no necessity for the birds to feed upon these larvæ. Insect larvæ of all kinds were seldom, if ever, more numerous. There were an abundant supply and a great variety. The currant-moth larvæ were probably the most numerous, and with such an ample supply of food the birds fed upon them.

WALTER E. COLLINGE.

The University, St. Andrews.

NOTES ON STELLAR CLASSIFICATION.

IN NATURE, December 23, 1915, and in the third Bulletin of the Hill Observatory, I referred to the shape of the temperature curve which I had published in connection with the meteoritic hypothesis, and I pointed out that if we could deal with a large number of stars, a generalised temperature curve might be placed before us by considering the number of stars in the various groups, for the reason that the longer a star remained at about the same temperature, the larger would be the number of stars in that group, while a rapid rise of temperature would reduce the number. I gave the curves thus produced by discussion of the stars included in the catalogue of the 470 brighter stars published in 1902, and in the later catalogue of the 354 less bright stars catalogued at the Hill Observatory.

In order to carry the inquiry one step further, I now reproduce these two curves, together with a third (Curve 3) based on the catalogue of 287 stars, the result of still more recent work at the Hill Observatory.

One of my chief objects in plotting this third curve was to see whether its shape agreed with the two former ones, because the more the curves based on different catalogues agree, the more they may be accepted as a basis for consideration.

It will be seen that the third curve follows suit with the first and second. Kinks occur in practically the same positions both on the ascending and descending arms of the curve. The main difference is that the apex of the curve occurs later in the case of the hotter stars than it does in either of the others; but the remarkable verticality of the curve near the middle of the ascending side is common to all, and, indeed, is one of the most striking features.

If the similarity of the three curves obtained from different data may be taken as suggesting a probability that the classification on which they are based does really provide us with homogeneous groups of stars on both sides of the curve, several interesting inquiries are suggested.

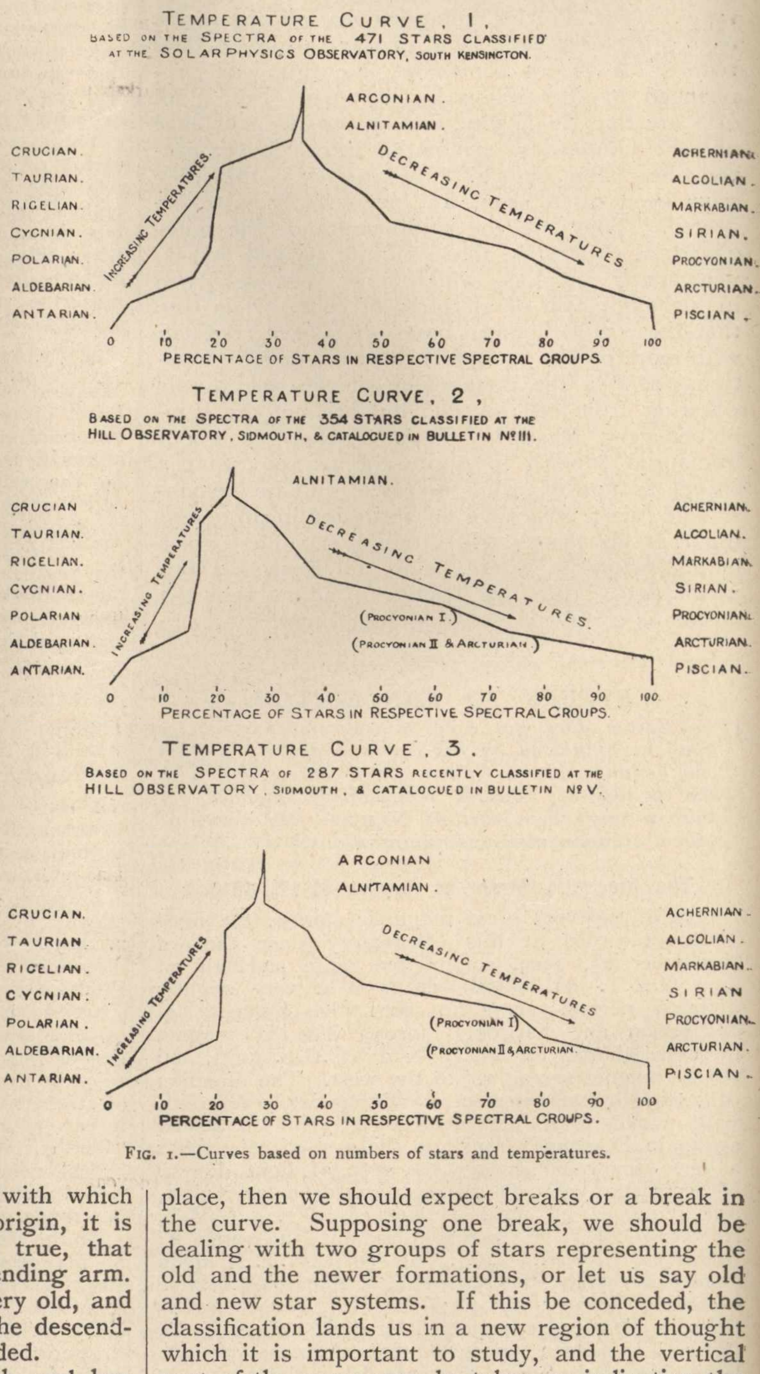

FIG. 1.—Curves based on numbers of stars and temperatures.

Supposing that the stellar systems with which we are dealing were of very recent origin, it is clear, if the meteoritic hypothesis is true, that the stars will all be found in the ascending arm. If, on the contrary, the systems are very old, and there are no recent formations, it is the descending arm into which they will be crowded.

If my classification embracing high and low temperatures really does provide us with homogeneous groups of stars, some hotting, some cooling, and if such a result proceeds from either a simultaneous or a continually acting formation of star groups, a break in the series can only be due to the cause I have already considered in Bulletin IV., a more rapid change of temperature giving an accelerated stellar change at one point of the curve.

But on the supposition that neither a simultaneous nor a continually acting formation took place, then we should expect breaks or a break in the curve. Supposing one break, we should be dealing with two groups of stars representing the old and the newer formations, or let us say old and new star systems. If this be conceded, the classification lands us in a new region of thought which it is important to study, and the vertical part of the curve may be taken as indicating the locus of the cessation of the old system and the advanced guard of the new.

PLATE I.—COMPARISON OF THE TWO CLASSIFICATIONS.

BULLETIN III.—CATALOGUE OF 354 STARS.

Argonian										
Alnitamian		B	O*e*5							
		2	1							
Crucian		B3	B2	B1	B5					
		7	6	1	1					
Taurian										
Rigelian		B9								
		1								
Cygnian		A	A2	A2*p*						
		1	1	1						
Polarian		F8*p*	G							
		2	1							
Aldebarian	II.	K	G	K5*p*	K*p*	F				
		10	2	1	1	1				
	I.	K	K5	K2	K*p*	M*a*				
		12	5	1	1	4				
Antarian		M*a*	M*b*	K5						
		10	3	1						
Achernian		B3	B2	B5	B*p*	B3*p*	B5*p*	B8	K	
		11	4	4	3	1	1	1	1	
Algolian		B8	B5	A						
		7	6	2						
Markabian		A	A*p*	B8*p*	B9					
		12	1	1	2					
Sirian	I.	A	A2	A3	A*p*	A2*p*	A4			
		24	20	8	3	1	1			
	II.	A5	A	A2	A3	A8	F	F5		
		12	2	3	2	1	3	1		
Procyonian	I.	F	F5	F*p*	F8	G	A	A5	A8	
		15	14	1	2	1	1	5	1	
	II.	G	G*p*	G5	F	F5	F8	K5*p*	K	A8*p*
		13	2	6	2	1	2	1	6	1
Arcturian		K	K*p*	K5	G2	G5	B5			
		42	1	2	2	11	1			
Piscian										

BULLETIN V.—CATALOGUE OF 287 STARS.

Argonian		O*d*						
		1						
Alnitamian		B2	B	O*e*5				
		2	1	1				
Crucian		B	B1	B2	B3	B5		
		1	2	2	9	1		
Taurian								
Rigelian		B9						
		2						
Cygnian								
Polarian		F						
		2						
Aldebarian	II.	K	K*p*	K5	G2	G5	M*b*	
		11	1	2	1	1	1	
	I.	K	K5	K5*p*				
		7	7	1				
Antarian		M*a*	M*b*	K5				
		17	5	3				
Achernian		A	B2	B2*p*	B3	B5		
		2	2	1	14	4		
Algolian		B5	B8	B9				
		2	5	1				
Markabian		A	A*p*	A2	B5	B8	B9	
		9	2	1	1	5	2	
Sirian	I.	A	A*p*	A2	A3	A5	B8	B9
		25	1	12	3	9	2	1
	II.	A	A2	A3	A3*p*	A5	F	G*p*
		7	2	1	1	8	6	1
Procyonian	I.	F	F5	F8	F8*p*	A	A5	
		7	5	3	1	1	1	
	II.	F	F8	G	G5	K		
		2	1	4	5	4		
Arcturian		K	G2	G5	F			
		29	2	9	1			
Piscian								

On my classification we shall be able to study the peculiarities and differences of the two systems; and a valuable test is in this way provided.

These considerations are certainly fundamental enough, and there are others.

The similarity of the third curve to the first and second justifies the return to some considerations which I referred to in the fourth Bulletin regarding the kinks in the curves. The descending arm of the curve is much more continuous than the ascending one; the greatest change from the more vertical to the flatter shape of the ascending arm occurs at the Aldebarian and Crucian stages—that is to say, the greatest number of stars at nearly the same temperature occurs in those two regions. It is suggested that this is due to the fact that the stars involved reach their highest temperature in these regions, so that we may assume that not all stars first visible as Antarian reach the highest temperature, but one set may reach it near the Aldebarian stage, and another at the Crucian stage, or rather *between* the Crucian and Alnitamian stages, only a very small number of stars reaching the Argonian stage. It is very remarkable what a small percentage of stars reach the Argonian stage. It is fair to assume that the power of reaching these various stages of temperature must depend on the initial equipment of the swarm, and from this point of view a close inquiry into the mass and density conditions may be expected to help matters.

In all that has gone before I have dealt with a rise followed by a fall of temperature. I am bound to say that for years after I put this view forward as the only one acceptable on the meteoritic hypothesis it was generally scouted. This would not have mattered so much had the Harvard classification, with its thousands upon thousands of stars, not taken the other view of a continued fall of temperature, as demanded by the views formulated by Kant and Laplace.

There have been many signs lately that the opposition to my views is weakening; but the more they are accepted, the more is it necessary that a large number of stars should be added to those I have classified. We want tens of thousands of stars in homogeneous groups in order that inquiries may be prosecuted with advantage.

I showed in Fig. 1 of the fourth Bulletin that the letters A, B, F, K of the Harvard classification occurred in the spectra of stars located on both sides of my temperature curve, and although differences were indicated by sub-numbers, it is a common practice to use the descriptive letters alone, and it is difficult, therefore, to ensure homogeneity.

One of the great desiderata of the moment, therefore, is to inquire whether something cannot be done to render the stupendous and long-continued work of classification carried out at Harvard available under conditions which would ensure the complete homogeneity of the stars classed together. In order to study this question I have prepared tables which show the Harvard classification of the stars included in the Hill Observatory catalogues of 354 and 287 stars (PLATE 1). I chose these catalogues because the classification was carried on by the same three observers and with the same instrument, and the classification by each observer was carefully checked by the others. The dispersion employed between K and H_β, 927 Ångström units, is equal to 28 mm.

My hope was that the same sub-numbers of the Harvard classification would not be found on both sides of the temperature curve.

In the comparisons I have previously made of the Harvard classification and my own I have indicated the Harvard classification of the stars chosen as the type star in each of my groups, but it will be seen from the present comparison that the Harvard classification, in consequence of the much greater detail which it attempts to secure, does not justify us, as I hoped it would, in giving a distinction between the letters and their accompanying numerals used on both sides of the curve.

But this difficulty is not common to all parts of the curve. Near the top, at the Crucian and Achernian stages, the greatest number of stars in which, on both sides, are classified B3, it is not of the highest importance to draw the distinction. In the case of the Sirian and Cygnian stars, where it is imperative that a complete separation should be chosen, the majority of stars in both are classified in A, with the exception of two classified as F, which probably may be due to misprints. But when we come to the difference between the Polarian and Procyonian and the Aldebarian and Arcturian, it will be seen that the attempt is hopeless. Twenty-two Aldebarian stars are classified as K, and forty-two Arcturian stars also classified as K.

NORMAN LOCKYER.

Hill Observatory,
August 21, 1919.

THE SUPPLY OF DRUGS DURING THE WAR.

WHEN war broke out, the National Health Insurance Commission was charged by the Government with the duty of safeguarding the position of this country with regard to the supply of drugs, and the Commissioners have just issued a memorandum[1] describing the work done in this connection. The work fell mainly into two categories, viz. (1) conservation of existing supplies by such means as restriction of exports and the most economical use of the materials available, and (2) encouragement of home production of fine chemicals used in medicine. The second is, of course, much the more interesting, and some of the results of this work were illustrated in the exhibits shown by various fine chemical manufactureres at the recent British Scientific Products Exhibition. Certain manufacturers took up on their own initiative the pro-

[1] Memorandum on the Special Measures Taken by the National Health Insurance Commission (England) in Relation to the Supply of Drugs and her Medical Stores during the War. Cd. 183. (1919.)

duction of such drugs as salvarsan, aspirin, and salicylic acid, and in these cases the Commission assisted by securing the release of controlled raw materials.

The report alludes to the help rendered by the Royal Society, under whose auspices the manufacture of a number of drugs was undertaken in about forty university and other laboratories. It is satisfactory to learn that the knowledge so acquired of the best methods of manufacture has not been wasted, but has been placed at the disposal of manufacturers. As a result the Commissioners are able to report that some sixteen medicinal chemicals, in which Germany had a virtual monopoly before the war, are now being made in this country, in some cases on a scale large enough to provide a margin for export.

On the whole, though difficulties arose from time to time, the needs of the Army and the nation appear to have been met adequately so far as all essential drugs are concerned.

In view of this it seems clear that of the hundreds of synthetic drugs which used to be imported from Germany before the war many were unnecessary additions to our therapeutical resources. It is, in fact, an interesting exercise to look through such a publication as Arend's "Arznei-Mittel," or one of the "Guides" and "Mentors" to therapeutics, which used to be distributed by the German drug manufacturers, and see how many of the products, each with its carefully plausible name duly registered, have passed out of use and almost out of memory.

The Commissioners point out that the manufacture of fine chemicals developed in this country during the war will need to be watched carefully, suitable encouragement being given, where necessary, and means provided for keeping manufacturers in touch with scientific workers. These functions they consider might well form part of the duties of the Ministry of Health.

While it is important that the manufacture of synthetic drugs should be assisted in every possible way, it is no less important that the old-established British fine chemical industry in the manufacture of alkaloids should not be neglected. In this connection it should not be forgotten that the supply of some of the raw materials, such as cinchona bark and opium, required by this branch of the industry is now in urgent need of attention from an Imperial point of view.

ERNST HAECKEL.

AFTER a prolonged illness Prof. Haeckel died at his house in Jena on August 8 at the age of eighty-five. His signature of the infamous manifesto issued by ninety-three German professors in 1914, his recent bitterness towards Britain, and his acquiescence in Germany's crimes need not blind us to what is lasting in the work he did, to features of greatness in his character, and to the irresistible charm of his personality. He was a champion of evolutionism from the publication of the "Origin of Species" onwards, in days when the doctrine was unpopular and upholding it meant obloquy; he broke new zoological ground in many directions, and he was the teacher of many illustrious naturalists.

Ernst Heinrich Haeckel was born at Potsdam on February 16, 1834, and went to school at Merseburg; he studied medicine at Würzburg, Berlin, and Vienna; he was much influenced by the writings of Schleiden, one of the founders of the cell theory; by Johannes Müller and Virchow among his teachers; and by his friend and fellow-worker, Gegenbaur. After a short period of medical practice he became lecturer in the University of Jena and full professor of zoology in 1865. In spite of repeated and tempting offers, he remained in this position until his retirement from active duties a few years ago. He found opportunity, however, for many journeys, from an early pilgrimage to Down in 1866 to later explorations in Ceylon and further east. He wrote three interesting volumes of travel, and indulged his love of sketching in a large series of landscapes. In his early youth he had dreams of becoming a painter, and his artistic skill is familiar to those who know his monographs on Radiolarians, Sponges, Siphonophora, and Jellyfishes. Indeed, his facility became almost a snare, for he was sometimes guilty, they say, of improving upon Nature and allowing art to mingle with his science. The symmetry which is exhibited in his well-known genealogical trees, which are often referred to contemptuously, as if it was not a legitimate zoological ambition to discover and describe relationships, was an expression of the same artistic sense, which the rugged facts of Nature do not often gratify.

Haeckel was a popular teacher, and students from many parts came to listen to his lectures and to work in his laboratory. He lectured rapidly and picturesquely, with infectious enthusiasm, and the beautiful diagrams and blackboard drawings added to the vividness of the impression. While he was always very busy with work of his own, especially perhaps during the *Challenger* period, he took a keen interest in those students who showed anything of his own temper, helping those who helped themselves. At his best he was a very handsome man, with overflowing kindliness, with no end of energy, with a passionate love of the beautiful whether in the microscopic Protists or in mountain scenery. His bible was Goethe.

In addition to his technical systematic work and his championing of Darwinism and freedom of thought and speech, what services did Haeckel render? By his vivid style he made biology popular and diffused concepts of development and evolution throughout the world, for the sale of books like "The Natural History of Creation" was colossal. His "Generelle Morphologie" (1866), as a generalising survey, occupies a place beside Spencer's "Principles of Biology," and, like it, is held in considerable esteem by the few who have read it. He led the way in applying evolution ideas to zoology in general, as in his adoption of Fritz Müller's law of recapitulation —that individual development (ontogeny) tends to be a condensed epitome of racial evolution (phylogeny); and although this generalisation requires very careful handling, and has often led to abuse in the writings of undisciplined popularisers, few would go the length of saying that its recognition has not enriched zoology. In his studies of Monera and the like Haeckel did not a little to show the fundamental biological importance of the Protozoa; his gastræa theory had a considerable and, on the whole, useful influence on embryology, though it has now been superseded; he was an explorer of the rarely visited field of pro-morphology (the study of shape and symmetry), in which the pioneers of bio-physics are now finding treasure. We might recall many of his suggestions which subsequent research has justified or may still justify: he was very early on the track of phagocytosis; he was sure that crystals have much to tell the biologist; he felt that heredity and memory were in some way related phenomena, and that the unconscious-psychical was not a contradiction in terms; he insisted that we have not heard the last of the application of the second law of thermodynamics to organisms; he was one of the early voices crying in the wilderness that biology was an integral part of education.

Anti-metaphysical by profession, Haeckel nevertheless expressed in his theory of cell-souls and the subjective aspect of the movements of matter a poetical hylozoism, akin to that of the early Ionic philosophers. He has been likened in this respect to a re-incarnation of Xenophanes. It was characteristic of his buoyant optimism that he never seems to have suspected how naïve his monistic philosophy was; but those who deplore the mischievousness for the ignorant of such a book as "The Riddle of the Universe" ought to take their share of the blame for not providing for the people equally readable antidotes or prophylactics. The rancour he displayed in these tragic years towards a country where he had many friends and in which he had been highly honoured must be viewed in the light of the fact that he was an octogenarian in enfeebled health when the war broke out, yet in his attitude and his utterances we see the continuation of that aggressiveness and bitterness which marked his attacks on conventional Christianity. It is in general terms a difficult riddle which his fellow-countryman Ostwald had the frankness to express in 1914: "Dieser unversöhnliche Gegner alles dogmatischen Christentums erwies sich als der beste und vorgeschrittendenste 'Christ' den Ich je persönlich kennen gelernt hatte." The explanation may be in part this, that Haeckel had several moods almost equally dominant. He was scientific, doubtless, and he himself declared that he was all for science, yet he had not that resoluteness of precision which Huxley referred to when he said that the assertion that outstrips the evidence is not only an error, but also a crime. He had the artistic and romantic temperament, he was a worshipper of beauty, he was to an extraordinary degree a passionate man of feeling. But he was also a preacher, a reformer, a propagandist—hence his surprising sympathy with Luther. He was so convinced in his own mind that he had got hold of the truth, and that those who differed from him were following errors and superstitions, that he was incapable of calmly considering criticism, still less of changing his views. His enthusiasm for science and his passion for Nature showed themselves in another expression in something like fanatic intolerance in his propagandist writings. Yet Haeckel did a day's work and a man's work in a fine, vigorous way, always himself and no other, and if he overdid the hunt for superstitions, who shall say that there was no excuse? Many people are not so good as their creeds, but everyone who knew Haeckel in his prime will agree that he was much better. *Vale.*

NOTES.

A CONFERENCE of representatives of the Meteorological Services of the British Dominions is to be held in London on September 23–27, when the subjects to be considered will include the meteorological arrangements for the exchange of observations by wireless at comparatively long distances; specification of observations for the surface and the upper air with the codes for transmission; the consideration of instruments and material for the investigation of the upper air; the selection of stations of the "Réseau Mondial" for the purpose of the general climatology of the globe (see "Réseau Mondial," 1911–12–13, M.O. Publications 207g, 209g, and 214g); the provision of current meteorological information for the main air routes of the world; co-operation in the investigation of the meteorological conditions of aerial navigation; and the trade routes and the meteorological survey of the oceans by observations transmitted by radio-telegraphy from ships. The following official meteorologists of the Dominions beyond the seas are expected to be present:—Capt. A. J. Bamford (Director of the Meteorological Service of Ceylon), the Rev. D. C. Bates (Director of the Meteorological Office of New Zealand), Mr. H. A. Hunt (Director of the Weather Bureau of the Commonwealth of Australia, Melbourne), Mr. H. Knox Shaw (Director of the Meteorological Service of the Public Works Ministry, Egypt), Mr. C. Stewart (Chief Meteorologist of the Union of South Africa), Sir Frederick Stupart (Director of the Meteorological Service of Canada), and Dr. G. T. Walker (Director-General of Indian Observatories).

IN connection with the autumn meeting of the Iron and Steel Institute, which is to be held at the Institution of Civil Engineers, Great George Street, Westminster, on September 18 and 19, there is to be, on the first-named date, a general conference on fuel economy, at which the following communications will be read:—Report on "Fuel Economy in Steel Works," Dr. W. A. Bone, Sir Robert Hadfield, Bart., and A. Hutchinson; Report on "Fuel Economy in Foundry Practice," H. J. Yates; and "Fuel Economy in German Iron and Steel Works," Cosmo Johns and L. Ennis. Papers down for reading and discussion on September 19 are:—"Synthetic Cast-Iron," C. A. Keller; "The Fluxing Action of Iron Oxides on Acid-Furnace Structures," J. H. Whiteley and A. F. Hallimond; "The Woody Structure of the Fractures of Transverse Test

Pieces from Special Steels," J. J. Cohade; "Nickel-chrome Forgings," J. H. Andrew, J. N. Greenwood, and G. W. Green; "Brittleness in Nickel-chrome and other Steels," F. Rogers; "Temper Brittleness of Nickel-chrome Steel," R. H. Greaves; "Experiments with Nickel Steels," N. Hudson; and "The Cause of Irreversibility in Nickel Steels," K. Honda and H. Takagi. Other papers expected are:—"Decarburisation of Steel," E. D. Campbell; "Nature of the A_1 Transformation and a Theory of Quenching," K. Honda; and "The Structure of Iron-Carbon-Chromium Alloys," T. Murakami.

PROF. G. E. HALE, director of the Mount Wilson Observatory, has been elected a foreign associate of the Paris Academy of Sciences.

THE appointment of Lord Lee of Fareham to the Presidency of the Board of Agriculture and Fisheries, in succession to Lord Ernle, resigned, has been approved by the King, as has also that of Sir Eric Geddes as Minister of Transport.

THE Bessemer medal of the Iron and Steel Institute for the present year has been awarded to Prof. F. Giolitti, of Turin.

THE Fream memorial prize for 1919 has been awarded by the Board of Agriculture and Fisheries to Miss Doris Anderson, a student of University College, Reading.

THE Elgar scholarship in naval architecture of the Institution of Naval Architects has been awarded to Mr. W. G. Green, and the Earl of Durham prize to Mr. W. G. Perring, both of Chatham Dockyard.

IT is announced that the widow of Prof. Milne has decided to return to her native country, Japan, and that in consequence the house at Shide, Newport, Isle of Wight, in which Prof. Milne did such important work in seismology is to be sold shortly by public auction.

THE death is announced of Prof. William Smith Greenfield, who held the joint chair of pathology and clinical medicine in the University of Edinburgh from 1881 to 1912. He was, in addition, physician to the Royal Infirmary, Edinburgh, and was probably the last occupant of such a dual professorship, which was not infrequent in a former generation before the present era of specialisation. Prof. Greenfield was a student of University College, London, and a graduate of the University of London, and previous to his appointment to the Edinburgh chair had been assistant physician and lecturer on pathological anatomy at St. Thomas's Hospital and professor-superintendent of the Brown Institution. His chief contributions to pathology were on anthrax and allied diseases, renal diseases, pyæmia, and diseases of the thyroid gland.

THE Government has decided to institute a competition for commercial types of aircraft with the view of obtaining a type giving greater safety. Prizes will be offered for three types of aircraft—a smaller aeroplane, a larger aeroplane, and a seaplane respectively. The terms of the competition will be announced shortly.

THE Home Office Committee on Miners' Lamps gives notice that it is open to consider new suggestions for improving the safety or illuminating power of safety lamps, and to examine and, if necessary, test any new devices or new types of lamps that may be sent by inventors. Communications on the matter should be addressed to Mr. E. Fudge, secretary of the Committee, Home Office, Whitehall, S.W.1.

THE United States Ordnance Department is appointing a number of experts in mathematics and dynamics to conduct scientific research on ordnance problems, to act as advisers on mathematical and scientific problems for the Department, and to maintain connection between the Department and the scientific world.

DR. PH. VOGEL, the well-known Indian archæologist, has published at Leyden an interesting paper entitled "The Sign of the Spread Hand, or Five-finger Token, in Pali Literature." He quotes numerous examples from the sacred books of Buddhism to show that this familiar symbol, a protection against the Evil Eye and the influence of malignant spirits, was commonly used in ancient India in connection with animal sacrifice and tree-worship. In one remarkable case the tree is a *Ficus indica*, and the spirit by which it is haunted is propitiated by means of a human sacrifice, the entrails being used as garlands and palm-marks made with the blood. This explains why women in the case of suttee up to recent times, when going to cremation with their lords, used to make marks on the gates of the palace with their hands steeped in vermilion. Numerous examples are given to prove that the use of this symbol as a protection is common in modern India and in other parts of the world.

IN the *Museum Journal* (vol. ix., Nos. 2–3) for September–December, 1918, Mr. C. W. Bishop discusses the horses of Tang T'ai-Tsung and the antecedents of the Chinese horse. In considering this series of reliefs in the University Museum, Philadelphia, a question arises about the origin of the representation of the flying gallop, showing the horse with legs extended skimming through the air as if shot from a bow. There was one culture area in which the representations of both animals and men in motion were executed with a vigour and a force unknown elsewhere—the Minoan or Ægean. All study points to the extreme unlikelihood of an independent invention of the same artistic convention in the Mediterranean and in China. The problem is by what means the idea was transmitted. The writer concludes that it spread in pre-Classical times to the regions north of the Black Sea, where it was eventually carried both to Sassanian Persia and to ancient China, apparently through the medium of the so-called Scythian culture, which overspread to much of Eastern Europe and Central Asia in early times, and in many ways acted as a sort of connecting link between East and West.

THE first number of a new periodical, the *Journal of Industrial Hygiene* (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.), has reached us. It has grown out of the recent establishment, at Harvard University, of teaching and research in this field, and is published mainly under the auspices of this organisation, although it aims at being international in character. The scope of the journal may be gathered from the titles of the articles in the present issue. "Industrial Medicine and Surgery," "Lead Poisoning," "Fatigue," and "Telephone Operating in its Medical Aspects," together with full abstracts of current literature bearing on cognate subjects, are included. The printing and illustrations are well done. Although the formation of so many new journals for special departments of knowledge is in general to be regretted, there is no doubt that this one will be found of much value in bringing the results of scientific research to the acquaintance of the industrial world. The publication of results of original work, however, except such as is directed to very special economic ends, in journals of limited range is apt to lead to their becoming lost to the general body of scientific doctrine.

DURING the war the proper provision of life-belts and other life-saving appliances on ships became of vital importance owing to the submarine menace. One of the most widely used appliances was a life-jacket stuffed with "kapok" or floss. This floss has very great buoyancy, a jacket containing 24 oz. of the fibre being capable of supporting an adult in the water. According to the existing official regulations, the only kapok that may be used for this purpose is Java kapok, which consists of the long hair surrounding the seeds of a tree which occurs abundantly in the Dutch East Indies. A similar material is, however, obtainable from India, but from a different tree, and this Indian floss cannot under the existing regulations be used for life-jackets. The results of trials made at the Imperial Institute, details of which are given in the current issue of the Bulletin of the institute, have shown that the Indian floss can fully satisfy all the requirements as regards buoyancy and freedom from water-logging. It is, therefore, suggested that the use of Indian kapok should be officially permitted for life-jackets. Inquiries made by the Imperial Institute showed that kapok, equal in quality to that used in the trials, is available in India in large quantities.

THERE seemed a prospect but a little while ago of seeing a live okapi in London, for it was known that the Zoological Society had made a generous offer for a young animal which had for nearly three years been the pet of Mme. Landaghem, the wife of a Belgian medical officer stationed several hundred miles above Boma, on the Congo. This, however, was not to be, for Mme. Landaghem has patriotically presented her pet to her native country. It has just arrived in Antwerp, the first of its kind ever seen in Europe. The existence of this remarkable animal was first brought to light, it may be remembered, by Sir Harry Johnston, and through his good offices the first skin and skeleton to reach Europe were those of the female which arrived in London in 1901. Previous to this he had demonstrated the existence in the Belgian Congo of a large mammal new to science by sending to the Zoological Society of London a bandolier cut from the remarkably striped hindquarters of one of these elusive creatures—elusive because, though the natives had long talked mysteriously of some strange animal living in the innermost recesses of the forest, and had constantly promised to produce a specimen, that promise was overlong in its fulfilment. This bandolier Dr. P. L. Sclater—then secretary to the Zoological Society—concluded had been cut from some species of zebra hitherto unknown, and accordingly bestowed upon it the name *Equus johnstoni*. This seemed warranted by the evidence, but the sequel showed that it was to the giraffes, and not to the horses, that this bizarre-looking animal was related. As yet the sex of the new arrival has not been stated, but if it should prove to be a male the development of its horns will be watched with interest by all zoologists.

WE learn from the *Revue Scientifique* that the courses of higher instruction at the Institut d'Optique will be attended each year by selected military and naval officers in addition to university students and others associated with the optical industry. On the industrial side, the full course covering the working of glass and fine mechanics will extend over three years. Subsidies have been promised from the French Government to meet the annual expenditure, but an appeal is made for donations towards the initial expenses of the establishment of the institute. The list of members of the council of the institute includes a number of distinguished physicists.

DR. ARTHUR HOLMES (Quart. Journ. Geol. Soc., London, vol. xliv., p. 31, 1919), in a paper in which field-observation and delicate laboratory studies are happily combined, describes the pre-Cambrian and associated rocks of Mozambique. He utilises radioactivity as a means of correlating the ancient rocks with those of other areas; the ratio of lead to uranium present assigns the granulitic granites of Mozambique to the Middle pre-Cambrian, and the gneissose granite to a lower series, probably corresponding with the intrusive "Laurentian" rocks of Canada. The composite origin of the biotite-gneisses is shown, not only by the field-evidence of assimilation of schists by a granitic magma, but also by a radium-content intermediate between that of granites and schists. The lines of "inselberge" in the country are well discussed, and are connected with axes along which the uprising magmas have elongated themselves in the direction of the strike. Though we hesitate to use the phrase "the new geology," Dr. Holmes is an exponent of the most recent developments in an old science, which his papers help to keep very much alive.

MESSRS. POSNJAK and Merwin (*Amer. Journ. Sci.*, vol. xlvii., p. 311, 1919) provide a critical review of the natural hydrated ferric oxides, stress being laid on the curves that represent the phenomena of experimental dehydration. Turgite, which we should now write as turiite, is the only exception to the rule that decomposition takes place in the middle portion of the curve, accompanied by a colour-change from yellow to red. Turiite shows a gradual loss of water, and is, therefore, not regarded as a definite chemical compound, but as a solid solution of hæmatite and göthite with adsorbed water. The authors conclude from the close agreement of the molecular ratio of Fe_2O_3 and H_2O in specimens bearing different mineral names that there is no *series* of hydrates of ferric oxide in Nature, but that the only existing mineral ferric hydrate is "ferric oxide monohydrate," crystallising polymorphically as göthite and lepidocrocite. Limonite is an "amorphous" condition of the same substance. The fibrous structure that is so common in specimens styled "limonite" indicates some form of crystallisation, and the authors regard the fibrous examples, not as true limonite, but as göthite which has adsorbed capillary water. Both göthite and lepidocrocite are rhombic, the latter having a slightly lower density, and occurring in red, scaly crystals. The authors are able to add some new points to the mineralogical description of this species.

THE question of the degree of roundness of grains of various minerals occurring in sands is interestingly dealt with by Mr. J. J. Galloway ("Rounding of Sand Grains by Solution," *Amer. Journ. Sci.*, vol. xlvii., p. 270, 1919). The author urges that even quartz becomes appreciably rounded in natural waters by solution, and he illustrates experimentally how the smaller grains of a powdered mineral lose their forms and become spheroidal far more quickly than the larger ones. Rapid solution produces grain-surfaces as smooth as glass, while slow solution, of which quartz serves as an example, gives dull surfaces like those due to strong abrasion. Mr. Galloway does not assert that the cause of rounding can be determined in any given case. He shows, however, that we must consider solution as a factor.

PROF. P. G. H. BOSWELL summarises his recent work on sands, including the graphic representation of their texture, in a very convenient form by the publication of his inaugural lecture on "Sands: considered Geologically and Industrially, under War Conditions" (University Press of Liverpool, 1919, price 1*s*.).

Under the heading of "The Freedom of the Skies" the *Scientific American* for July 26 has an article by Prof. McAdie which deals with "some of the problems that will have to be solved as the human race takes to the air." Much that is said is reasoned from the analogy of the "freedom of the seas." The recent great war has fully shown the value of a command of the sea or air. The word "overcloud" is proposed for association and definition with "oversea" and "overland." It is suggested that what the Gulf Stream and the Japan Current are to the mariner the prevailing westerlies are to the aviator. The trades and monsoons are likened to rivers at the ground surface. It is stated that "the war just ended exemplified for the first time in history the right of a neutral nation to claim as territory the air above." The author deals with many features of interest, and the article contains much that is suggestive; one such point is that "if a steamship meets an adverse tide, her progress is delayed just so much, depending on the strength of the current; whereas when an airship encounters strong head winds, her pilot can rise or fall below the level of that particular air current and find a level in which the air will be moving with him and not against him." Many of the analogies dealt with show the great advantage of the combined association of mathematics and meteorology for a proper study of the upper air.

Monthly meteorological charts, which are issued by the Meteorological Office both for the North Atlantic and East Indian seas, are primarily intended for seamen. Now that aircraft are becoming of such importance, especially considering the rapid strides made in the last few months and the prospective voyage to India of R 33, these meteorological charts are assuming much greater interest. The Atlantic chart for the present month contains a large amount of valuable information. At present the North Atlantic is the ocean of primary importance for aircraft, but the winds are dealt with in a less satisfactory manner than for other oceans, "the frequency, the direction, and the average force of some characteristic winds are shown," whilst fuller details and *greater precision* are essential. A track is given showing the mean path of centres of cyclonic areas between America and Europe in August for the years 1883–91. A longer period, embracing the storms of recent years, would enhance the value of this information, appending, if practicable, details of individual instances. In August the south-east trade is seen to extend considerably to the northward of the equator, reaching on the eastern side so far north as latitude 13° N. The frequency of cloud with various winds at different times of day is given for Valencia and for St. Johns, Newfoundland, at the back of the chart. The August chart for the East Indian seas shows that the south-west monsoon is predominant over the sea to the north of the equator, whilst south of the equator to 25° S. the south-east trade blows almost uninterruptedly. North-westerly winds predominate over the whole length of the Red Sea. In August the average barometric pressure in the Red Sea is lower than in any month of the year, and the average air temperature is the highest of the twelve monthly values.

In the Journal of the Royal Society of Arts for June 20 Mr. Watson Smith directs attention to a theory recently advanced by Tschirch to account for the spontaneous combustion of haystacks. It is based upon observations made in the drying of medicinal plants. A first phase of heating is regarded as due to oxidation processes caused by the plant oxydases at the expense of the air present in the stack. This results in a small rise of temperature, which ceases when the oxygen of the air in the stack is exhausted. In the next phase the chief *rôle* is played by reductases, which act energetically between 50° and 70° C., deoxidising and eventually carbonising such substances as amino-acids and carbohydrates. The danger of ignition lies in the accumulation of oxygen withdrawn by the reductases; the actual reduction processes would not themselves produce sufficient heat to ignite the material. To obviate the risk of spontaneous combustion two precautions are recommended:—(1) A thorough drying of the hay before stacking, which minimises enzyme action, and (2) thorough aeration of the stacks, which may be secured by building them in layers with air spaces between.

The forty-third annual report of his Majesty's Inspectors of Explosives (1918) (Cd. 278, 1919) is of particular interest by reason of the inclusion of approximate figures for the production of explosives and ammunition of all classes in this country for the whole period from the outbreak of war to the signing of the armistice, together with statistics of the accidents which occurred. Of the three chief classes of military explosives the outputs and casualties were:—(1) Ballistites and cordites, 181,712 tons; persons killed, 35; injured, 50 (of the killed 27 lost their lives in one accident). (2) Picric acid, T.N.T., and other coal-tar products, 107,713 tons; killed, 177; injured, 368. (3) Other nitro-compounds, 62,048 tons; killed, 31; injured, 91. In all there were 1277 accidents reported, and in 544 no personal injury was caused. The maximum number of persons employed was 86,555; the average, 61,808. The total loss of life was 325, with 1316 injured, giving 1·25 killed per 1000 and 5 injured, compared with a fatality rate of 1 per 1000 for the five-year period ending 1910. The inspectors are more than justified in their comment that, "having regard to the output produced at high pressure, largely by workers with no previous experience, supervised in many cases by equally inexperienced officials, the general result may be regarded as satisfactory." It is a remarkable testimony to the supervision and protection of the workers that in filling more than 8,374,000,000 small-arm cartridges and 83,600,000 hand grenades in licensed factories during the war period there was not a single fatal accident and only 48 workers injured, with one exception all being engaged on cartridges. Nor was there any loss of life in the manufacture of blasting explosives (other than gunpowder) or in the conveyance of explosives during the year 1918. The report lays special stress on the dangers of compositions containing aluminium powder, for, although such mixtures are not unduly sensitive during test, accidents have been somewhat frequent, the reason of the primary ignition being obscure.

When a photographic negative is treated with a solution of a chromate well acidified with hydrochloric acid, the silver of the image is converted into silver chloride, and subsequent application of a developer reduces the silver chloride and leaves the metallic silver much as it was. But if the acid is deficient in quantity, reduction products of the chromate remain and reinforce the image. This method of intensification is well known. In the *British Journal of Photography* for August 8 Messrs. Lumière and Seyewetz state that they find that the acidified chromate may be replaced by a solution of potassium chlorochromate, thus using a definite substance instead of an indefinite or adjustable mixture. They find, too, that if the process is repeated on the same negative, the effect gradually diminishes, and after five or six treatments the intensification becomes negligible. They suggest that the chlorochromate acts thus :—

$$KClCrO_3 + 2Ag = KAgSO_3 + AgCl,$$

and that as only the silver chloride is reduced by the developer, the amount of silver available for the process is halved by each application of it. They have not, however, yet proved that the double sulphite is produced and that it resists the developer, and they are carrying their investigations further in this direction.

DURING the last few years the use of electric heating appliances has become common in the laboratory and workshop owing to the production of trustworthy heating elements. In most of these an alloy, capable of resisting oxidation at 1100° C., is wound round a tube or muffle, in the interior of which a temperature of 1000° C. can be attained. The small electric furnaces exhibited by Messrs. A. Gallenkamp and Co., Ltd., at the recent British Scientific Products Exhibition of the British Science Guild illustrated the numerous purposes for which such articles may be used with advantage, and were of satisfactory design. For heating small articles, or for estimating the amount of carbon in steel by combustion, the heating chamber consists of a silica tube 1–2 in. in diameter and 12–20 in. long, the power required to maintain a temperature of 1000° C. ranging from 400 to 800 watts. For laboratories in which many estimations of carbon in steel have to be made daily, two- or four-tube furnaces are constructed to facilitate rapid working. A special type, wound in sections capable of separate heating, is provided for organic combustions. For incinerations, the hardening of small steel articles such as taps, dies and gauges, etc., the muffle type of furnace is used, the dimensions of the largest made being 14×7×5 in., consuming 2300 watts. Messrs. Gallenkamp's furnaces are designed so that a new heating element can easily be inserted by the user, thus avoiding delay in the case of a winding burning out. Special attention is also paid to efficient lagging, and the casing and supports are strong and durable. Resistances for controlling the temperature are supplied with each furnace. A further commendable feature is that a purchaser may procure a furnace to suit his own work, and is not compelled to take one of the ordinary stock patterns.

THE following new books of science are announced :—By *Messrs. George Allen and Unwin, Ltd.*—"Mineral Resources of Georgia and Caucasia," D. Ghambashidze; "The Equipment of the Workers," "The Education of the Workers," and "The Environment of the Workers." By *Mr. Edward Arnold*—"Ions, Electrons, and Ionising Rays," Dr. J. A. Crowther; "Surveying," W. N. Thomas; "Tacheometer Tables," Prof. H. Louis and G. W. Gaunt; "The Principles of Electrical Engineering and their Application," Prof. Gisbert Kapp, vol. ii.; "Examples in Electrical Engineering," J. S. Gill and F. J. Teago; and "Algebra for Engineering Students," S. Eastwood and J. R. Fielden. By *Messrs. W. Heffer and Sons, Ltd. (Cambridge)*—"Groundwork of Surgery for First-year Students," A. Cooke. By *Messrs. Crosby Lockwood and Son*—"Electric Spark Ignition in Internal Combustion Engines," J. D. Morgan; and new editions of the "Mechanical Engineer's Pocket-Book," the late D. Kinnear Clark, revised and enlarged by H. H. P. Powles; and "Hand Sketching for Mining Students," G. A. Lodge and N. Harwood. By *Messrs. Methuen and Co., Ltd.*—"Coal Mining and the Coal Miner," H. F. Bulman. By *Messrs. Seeley, Service, and Co., Ltd.*—"Chemistry and its Mysteries: The Story of what Things are made of, Told in Simple Language," C. R. Gibson, and "The Marvels of Photography: Describing its Discovery and Many of its Achievements," C. R. Gibson. By *Messrs. Witherby and Co.*—"A Geographical Bibliography of British Ornithology," H. Kirke Swann, W. H. Mullens, and F. C. R. Jourdain; "A Handbook to the Vertebrate Fauna of North Wales," H. E. Forrest; "Meteorology for All," D. W. Horner; "The Birds of France," C. Ingram; and "Monograph of the Pheasants," W. Beebe, vol. ii.

OUR ASTRONOMICAL COLUMN.

KOPFF'S COMET 1906 IV. = 1919*a*.—M. Ebell has published (*Ast. Nach.*, 4996) an ephemeris of this comet from Dr. Zappa's elements (*A.N.*, Bd. 194) with a correction of +23·48′ to the mean anomaly. The observations made during the month show a correction to this of about −7′ in declination. The following positions (for Greenwich midnight) include this correction :—

	R.A. h. m. s.	S. Decl. ° ′	Log *r*	Log Δ
Aug. 21 ...	19 29 22	8 16·4		
23 ...	19 30 16	8 13·6	0·250	9·942
25 ...	19 31 19	8 11·2		
27 ...	19 32 28	8 9·1		
29 ...	19 33 45	8 7·3		
31 ..	19 35 8	8 5·8	0·256	9·973

The computed brightness decreases from magnitude 10·9 to 11·1 during this period. The comet passed through perihelion on June 28 last.

OCCULTATION OF SMALL STARS BY JUPITER.—Mr. Arthur Burnet sends particulars of two phenomena of this kind that he predicts will happen in the coming months. The star B.D. +18° 2062, mag. 8·9, R.A. 8h. 46m. 52s., dec. 18° 23′ 22″ N., will be occulted on September 15 between 14h. 15m. and 15h. 1m. G.M.T. As Jupiter will rise at Greenwich at 13h. 30m. on that night, the possibility of successful observation from this part of the world is doubtful. On October 5 the star B.D. +17° 2007, mag. 7·8, will be occulted before 11 o'clock G.M.T., when it will not rise at Greenwich until after midnight. The occultation may be visible in India from 10h. 25m. to 11h. 36m. Apparent place of the star on October 5, R.A. 9h. 1m. 46s., dec. 17° 26′ 2″ N.

A MAGNETIC STORM.—The traces on the sheets of the magnetographs at Greenwich showed violent disturbance on Monday, August 11, beginning about 7 o'clock in the morning and lasting for twenty-four hours. From notes in the daily Press it appears that telegraph lines and cables were affected, and that operators experienced much difficulty due to earth currents. There was a spot on the sun at the time, not of the largest size, but about 500 millionths of the visible surface in area, which had passed the central meridian on August 8. There was also a broken group of small spots following this, and another regular spot rather less in area than the first was approaching the central meridian.

THE RECENT SOLAR ECLIPSE.—Though the observers of the British expedition to the Island of Principe were not favoured with specially fine weather, some useful results were obtained. Ten of the plates exposed were spoiled by cloud so far as the object of the expedition was concerned, but give an excellent representation of the large prominence which was on the sun's limb at the time. The remaining six photographs show κ^1 and κ^2 Tauri and two or three other stars. The measurement of these should show the looked-for deflection if it exists.

INDUSTRIAL FATIGUE.

THE Industrial Fatigue Research Board, which was recently appointed by the Department of Scientific and Industrial Research and the Medical Research Committee jointly, has quickly got into the swing of its labours. It has just issued two brief reports, and announces other more lengthy reports which are in preparation. In Report No. 2 Mrs. Ethel E. Osborne describes "The Output of Women Workers in Relation to Hours of Work in Shell-making." The women were engaged in the operation of "ripping" or "part-off" on 6-in. shells, and their output was compared when they were on twelve-hour and eight-hour shifts. The output of work achieved during each hour of actual work in the shorter shifts was 6·5 per cent. greater than in the longer shifts, but because of the improvement in time-keeping and the more efficient running of the machinery the production per hour of factory work was 15 per cent. greater. Determinations of hourly output showed that during the last hour of the long shifts there was always a low output, whilst on the short shifts output was maintained throughout.

In Report No. 3 Col. C. S. Myers, a member of the Board, describes "A Study of Improved Methods in an Iron Foundry." Hitherto the American methods of time and motion study have gained very little acceptance in this country, and the enterprising managing director of the iron foundry investigated by Col. Myers is greatly to be congratulated on his initiative in applying the methods practically to the production of small iron castings. Although the hours of work were at the same time reduced from fifty-four to forty-eight per week, the men were able to increase their total output greatly, and they suffered less fatigue. The men were on piece rates, but they were paid on the novel, but wholly equitable, principle that the greater their production the greater their scale of pay *per piece*, or the rate of pay rose automatically with increase of total output. In that the overhead charges of a factory are usually almost the same whether the output of a worker be small or great, it is only fair that employers should adopt this system of payment, but it is absolutely exceptional for them to do so.

MEAN SEA-LEVEL.[1]

THE science of oceanography is slowly coming into its own, and it has advanced greatly in the last twenty years; but still, of those who think of it at all, many people know very little what it is. It is looked upon, often enough, as an easy, descriptive science, a small part of a simple, descriptive geography. But if this be true at all, it is a very small part of the truth; for the great problems of oceanography are physical problems, to be approached by mathematical methods, and soon involving us in difficult questions of hydrodynamics, and other difficulties besides. In the elementary task of the exploration of the sea Englishmen have taken a large, perhaps a lion's, share; in one special part of scientific hydrography, the theory of the tides, they have done a great deal, for such names as Lubbock, Whewell, Airy, Kelvin, and George Darwin come at once to our minds. But in other parts of the subject, and in recent times, we have done less; and the Scandinavian countries especially have done a great deal more. Bjerknes, Witting, Otto Pettersson, Sandström, Fridjof Nansen, Helland-Hansen, Madsen, and De la Cour are only a few names of men who, from Denmark to Finland, have studied the hydrographical phenomena of the Baltic or the wider problems of hydrography.

[1] Rolf Witting: "Hafsytan, Geoidytan och Landhöjningen utmed Baltiska Hafvet och vid Nordsjön." Fennia 39, No. 5. (Helsingfors, 1918.)

Among its most fundamental problems are those connected with the determination of mean sea-level—if we may so speak of something that has never yet been determined. There is scarcely a physical constant so freely spoken of or so often used; every elevation in the world is referred to it, but no man knows what it is. Two or three generations ago a few observations of consecutive tides were supposed to be enough to ascertain it—a month was ample; but we have long known that the "constant" so determined is no constant at all, but is subject to complicated fluctuations, some regular and some, at first sight, erratic. This first approximation to "mean sea-level" has a very appreciable annual fluctuation, an "annual tide"; it alters from year to year; at any one locality these changes are apparently irregular, but they are found to tally with one another over large areas of coast; there are important differences of sea-level between one station and another; and there are slow changes of long period which again may be found common to large areas. Among the elementary difficulties of the problem is the fact that the annual change of level is much too great for a simple astronomical explanation—it is not a "solar tide"; and, that being excluded, we are thrown back on two hypotheses or sets of hypotheses, the one meteorological, the other based in one way or another upon movements of the earth's crust. A great deal has been written on the subject in recent years; we cannot attempt to review the whole question, but must be content to give an abstract of an important paper lately published by Prof. Rolf Witting, of Helsingfors, director of the Oceanographical Institute in that University.

The "level" of the sea, or, more generally speaking, the form of the surface of the sea, is a resultant of forces both extrinsic and intrinsic; that is to say (after we have eliminated by a sufficient number of observations the effect of the tides), we have to deal with the densities and currents of the sea itself, and with the winds and the atmospheric pressure acting upon its surface. It is plain that where the sea is less dense its surface will tend to stand at a higher level than where it is more so; this is an intrinsic phenomenon. As to the extrinsic forces, inasmuch as the winds are determined by the distribution of atmospheric pressure, the latter may be employed as our common indicator for both factors—that is to say, for the winds and for their effect upon the sea.

For the latter, or extrinsic, forces Prof. Witting gives us the following law or laws:—(1) Every barometric distribution of any permanency produces a deformation of the surface of the sea. (2) The ascending slope so produced is not identical in direction with the barometric gradient, but deviates to its right-hand side, in the northern hemisphere. (3) The amount of slope is greater than that which would correspond with the hydrostatic pressure induced by the barometric distribution. (4) The amount of the deviation, and also the ratio between the amount of slope and the barometric gradient, are (to a first approximation) independent of the gradient, but largely affected by the shape of the basin and by the distribution of densities in its water-layers.

From Fig. 1 we may judge, for a particular date, the relative directions of the barometric gradient and of the sloping surface of the Baltic Sea.

In a celebrated observation (to which, by the way, Prof. Witting does not happen to refer) Sir James Ross found that, at a certain point within the Antarctic Ocean, a change of barometric pressure produced, to all intents and purposes, its precise hydrostatic equivalent in the level of the sea. But, whatever may have been the exact circumstances and conditions of that experiment, its result is very far from holding good within our narrow seas. According to Prof. Witting, both in the North Sea (on the average) and in the open basin of the Baltic the slope of the sea-surface is equivalent to a column of water about 35 times that of the barometric gradient measured in mercury; whereas, hydrostatically, the ratio should be only about 13·5 times, or in the simple ratio of the specific gravities of mercury and water; in still narrower areas, as in the gateways of the Baltic, the ratio may be much greater, amounting to as much as 100 times. In the open basins the direction of the water-slope deviates from that of the barometric gradient by about 55°; and this value is again exceeded in the narrower channels. In other words, then, we find that in the opener basins the disturbance of the sea-level is nearly three times as great as the direct hydrostatic effect due to atmospheric pressure, which is as much as to say that the dynamical effect of the wind must account for well-nigh two-thirds of the total effect produced. Moreover, in these waters the current produced by the wind deviates by about 20° to the right of the direction of the wind itself; and the current thus moves sideways up the slope, about 45° to the right of its uphill direction, which is an oceanographical paradox.

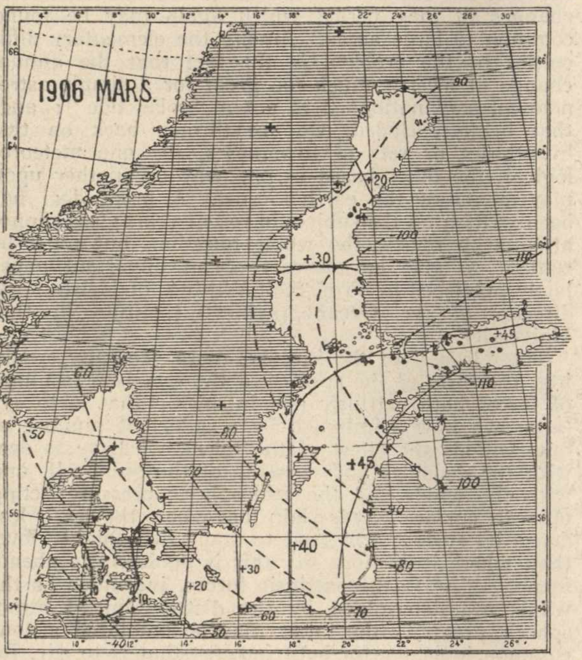

FIG. 1.—Sea-level and pressure-distribution in March, 1906; represented by isanomalies from the means for the whole period 1898–1912. Thick lines, sea-level in half-centimetres; broken lines, barometric pressure in tenth-millimetres.

In the gateways of the Baltic these external forces by no means fully explain the phenomena which occur. We may calculate the amount of water which escapes from the Baltic, on an average, month by month; and, proportional to these amounts, we then discover residual deviations of slope in the water-levels. Within its gates the Baltic may be regarded as a basin the levels of which (except for perturbations at the mouths of rivers) are mainly determined by the barometric field. But the gateways themselves constitute a sluice, damming up the waters within; and in this region the height of the dam will depend not only on the atmospheric pressure, but also on the quantity of water which passes over into the North Sea, the level of which varies according to its local conditions and to more distant phenomena in the ocean. In a general way, the peculiarities of the narrow entrances to the Baltic are not difficult to comprehend.

But let us return to the internal forces, or, practically speaking, to the distribution of densities in the sea. We have here a direct cause of variation of surface-level, giving us, as it were, a theoretic or ideal sea-level at any particular place, largely affected in actual fact by extrinsic forces which move and heap up the waters. Now, we began by saying that mean sea-level, properly so-called, is a constant as yet undetermined. But, nevertheless, we know a very great deal more about it than we did even a few years ago, and can give a very fair approximation to it in a considerable number of localities. Even at Dundee or Aberdeen mean sea-level is a very different thing from that mark at Liverpool from which all our Ordnance levels are reckoned, and which (though by a happy accident it is not far from the truth) we all know to be a purely empirical or conventional datum. Now, as Prof. Witting argues, we do already know enough about this subject to be able to define, with a fair amount of accuracy, a "zero-pressure level" in the sea at a point where no movements are caused by the distribution of densities; to be more specific, we may choose a point somewhere towards the middle of the northern part of the North Sea, describe a geoidic surface touching it, and call that (to the best of our present knowledge) our datum level. Proceeding outwards from this zero point, we may calculate the hydrodynamical part of the slope due to the distribution of densities; and again we may calculate, and superadd to this, the slope due to barometric pressures, either for some particular epoch or in average values corresponding with long-period barometric means. In Fig. 2 Prof. Witting shows, after this manner, the

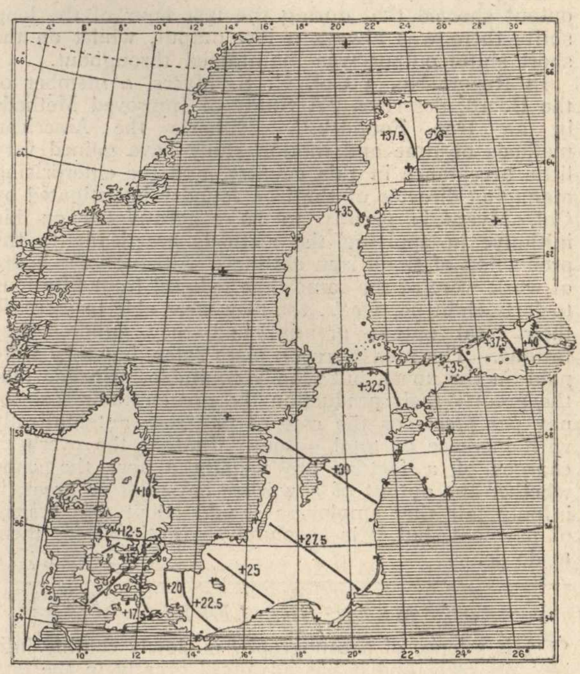

FIG. 2.—Mean sea-level, calculated values; referred (in centimetre-units) to a geoidic surface touching the North Sea in the middle of its northern part.

calculated or hypothetic values of mean sea-level over the Baltic area, expressed in terms of deviation (or as isanomalies) from the geoidic surface defined above. It will be seen that these isanomalies are of an order of magnitude far beyond any probable errors in the determination of our base.

The next step, to be immediately taken, is to compare these *calculated* results with the *observed* results obtained by actual survey on land, with the most modern *nivellements de précision* achieved by the national Surveys. On this subject Prof. Witting has much to say, and he succeeds in showing that the two sets of results, the calculated and the observed, are wonderfully congruent. For example (and one example must suffice), Prof. Witting arrives by calculation at an estimated mean difference of sea-level between Marienleuchte, on the North Sea, and Arkona and Memel, in the Baltic, amounting respectively to +9·8 and +17 centimetres. The German *Präcisionsnivellierung* gives observed values of 11 and 17·6 centimetres.

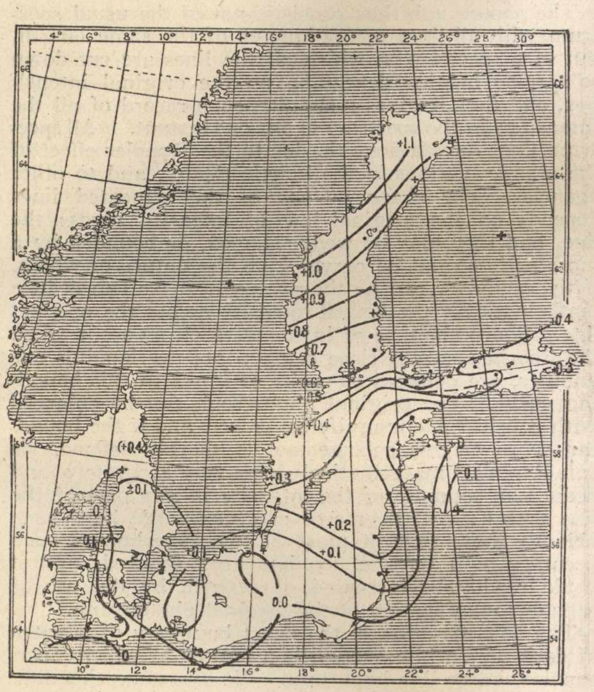

FIG. 3.—The mean rate of elevation of the land during the period 1898–19 in centimetres per annum.

As good, or even better, agreement is shown between stations in the Baltic and Amsterdam, making use of the Dutch as well as the German levellings. In short, Prof. Witting has good right to boast that this part of oceanography has become an exact science, and that his "thalassographic levelling" bears favourable comparison with, and may even be used to check and to control, the most refined achievements of actual surveys on land.

The last remaining matter which presents itself is the question of long-period fluctuations of sea-level and the whole subject of secular elevation or depression of the land. Here we start at a disadvantage, from our great ignorance of the variations in level of the ocean itself. But we do know a good deal by observation, and we may learn a good deal more by Prof. Witting's method of calculation of the *relative* variations of level at various points of the coast. There is no fixed point which we can designate, but Prof. Witting shows that for about a century the coastal variations in the southern Baltic must have been very small. Suppose, then, that the coast from Wismar to Pillau has, on the whole, kept a constant level; we may then map out the relative changes over the rest of the Baltic area (as in Fig. 3) during the period of years (1898–1912) over which Prof. Witting's work extends. The result is striking enough; but the story does not end there. There are, on one hand, minor fluctuations within the area itself, and some of them are related to seismic phenomena; for instance, there was an interruption in the general upheaval about the time of the Scandinavian earthquake of 1904. On the other hand, the phenomena are directly related to those exhibited outside the Baltic area; and it may be said that, though certain minor differences exist—for instance, in Holland—it is clear enough that the Fennoscandian upheaval is only part of a larger movement of the earth's crust, which extends at least as far as the Netherlands and Scotland. From England the author has to regret that no observations were available.

With these recent scientific results regarding the elevation of the Baltic coasts Prof. Witting goes on to compare the earlier historic records and the prehistoric evidence, such as it is, which is available from archæology and from geology. He finds that for some centuries past the elevation of the Fennoscandian lands has gone on at just about the same rate as to-day. The archæological evidence is more doubtful. It may be that the phenomenon has been approximately the same for some six thousand years; but it was possibly slower during and just after the Bronze age. Prof. Witting suggests—and this should interest the archæologists—that apparent contradictions would disappear if we might assume that the older relics are considerably older than Scandinavian archæologists are accustomed to consider them; and that, on the other hand, the Bronze age is not quite so old as it is commonly supposed to be. The more ancient phenomena are difficult to discuss, because a damming-up of the Baltic outlet may have produced results not to be distinguished from actual elevation of the lands within. But Prof. Witting believes that in the Littorina period there was certainly an interruption, and that probably just after the Glacial period there was an acceleration in the rate of elevation.

Prof. Witting brings a most interesting paper to a close with a strong plea for increased study of sea-levels and all the related phenomena, and for such international co-operation as is obviously essential for a complete and systematic investigation of the whole subject.

D'ARCY W. THOMPSON.

ENERGY DISTRIBUTION IN SPECTRA.[1]

OUR knowledge of the structure of very fine spectrum lines is now on a secure and nearly comprehensive basis, from the points of view of both theory and of experiment, and it is very remarkable that so little is known of the distribution of energy in these lines, either in individual lines or as between the different lines contained in the spectrum of any atom. The analysis of the spectra of atoms, theoretically and in the laboratory, is now recognised as the most critical test to which any theory of atomic structure can be subjected, and we have recently had theories of the atom entirely based upon the wave-lengths of the radiations which they emit. A question of equal importance, to which I now wish to direct your attention, is the relative amounts of energy which the atom throws out in the form of radiation in the different

[1] Discourse delivered at the Royal Institution on May 2 by Prof. J. W. Nicholson, F.R.S.

wave-lengths, for this is well known to vary in some cases very greatly according to the circumstances in which the atom is excited. I shall describe, in the first instance, a method designed by Dr. Merton for investigating the distribution of energy among spectrum lines, or in the breadth of an individual line, with great accuracy. It is possible by this means to obtain the long-desired object of an absolute scale of spectral intensity, independent of all the ordinary difficulties determined by such matters as the unequal behaviour of the photographic plate for light in different regions of the spectrum. Dr. Merton and I have been working together on this subject for the past three years, and I shall conclude the present lecture with an account of some of the more interesting results which have been reached, after an explanation of the method.

The intensities of spectrum lines have usually been recorded on an arbitrary scale, ranging between 10 and zero, the numbers assigned being at the discretion of the observer, and varying so greatly among different observers as frequently to be of little value for exact knowledge. They depend also very much on the nature of the observation, whether visual or photographic, and in the latter case on the region of the spectrum to which the line belongs. The sensitivity of a photographic plate varies with the wave-length of the light in a curious manner, and apparently an irregular one not following any simple law. The sensitivity of the eye is also different for different colours. When the line is outside the visible spectrum, in the infra-red or dark heat region, measurements of intensity can be made with some accuracy by a thermopile or a bolometer. But they are needed more urgently in the visible region at present, not only for the information they will afford regarding the nature of the atom, but also for application to other problems. The subject is very important, for instance, in the interpretation of celestial spectra, and more particularly those spectra of great complexity and variability which are associated with the birth of new stars, from which most of our knowledge regarding such stars must be constructed.

Previous knowledge of changes in spectral intensity under varying conditions was of necessity limited to the great changes. Those changes, which are of especial value in connections such as I have mentioned, are liable to be of a less conspicuous type, not readily capable of detection by the ordinary photographic or the visual method, and, if detected, not capable of accurate measurement.

In the visual region of the spectrum observations with the bolometer are not satisfactory. The source of light must be very intense in order to produce large deflections in the galvanometer, and only the brightest lines could be dealt with even in this way. Only one line in the spectrum can be experimented upon at one time, and the source of light cannot be maintained constant over a protracted period. The method is, in fact, quite unsuitable, and the spectrophotometer has been tried instead, but no great accuracy is possible, and its use is confined to a very narrow region of wave-length. Moreover, the variability of the source of light is again present.

In adopting any photographic method for quantitative work we must remember that not only does the sensitivity of the plate vary with the wave-length, but also that there is no very definite relation between the density of a photographic image and either the intensity of the light or the time of exposure. If we halve the former and double the latter, we do not get the same density of the image, but another which depends on the particular plate used. The grain of a plate also scatters light, and the actual size of the image thus depends on the exposure and the intensity of the light. We were early compelled to conclude that accurate measurements of intensity by a photographic method involve the necessity of an equal exposure on the same plate for all the sources of light to be compared, and the method to be described satisfies this necessity.

The spectrograph for producing and photographing the lines of a spectrum is set up in the usual way, which requires no description. A wedge of neutral-tinted glass, cemented to another of clear glass so as to form a plane parallel plate, is mounted in front of the slit. The image of the slit formed by light of any wave-length is thus attenuated towards the part of the slit opposite the thick end of the wedge, where the absorption of light is greatest, and the image ceases to be strong enough to affect the plate beyond a certain specific height, which depends on the original intensity, in the beam from the source, of this particular wave-length.

The photograph thus consists, not of the usual spectrum with all lines or slit-images of the same length, but of a spectrum in which all the lines are cut down to specific heights depending on the original intensities, and thus it gives a simultaneous record of all the intensities in the spectrum at any one instant. All spectrum lines have a breadth, due to the Doppler effect of the atomic motions in the kinetic theory, and to other agencies. The shape of one of the truncated lines depends on the original law of intensity across the line, and they may be wedge-shaped, or bounded by a more or less rounded curve, from the nature of which, if the boundary can be sharply defined, we can deduce mathematically the law of intensity across the original line. Sharp changes of intensity, such as occur when the line has several close components overlapping one another, are detected as peaks or kinks in this bounding curve. The original photograph can be enlarged with considerable magnifying power, and if the bounding curve on this enlargement is sharply defined, we can obtain its mathematical shape very accurately, and deduce an estimate of the intensity in any part of the line with a great degree of precision. We have been able to show that in most of our experiments such accuracy as 1 part in 100 has been reached, and it could readily be increased, if desired, by the use of greater magnification of the original photograph.

The determination of the exact boundary of a patch of dark on a white ground is a matter in which "personal equation" is important. We overcame this difficulty by enlarging positives, prepared from the negatives, on to bromide paper through a ruled "process" screen. The resulting photograph consists in this way of an assemblage of very minute dots, fading away towards the boundary into invisibility. It is a simple matter to prick out the last dots visible all round the contour, and in this way personal equation can apparently be entirely eliminated. We adopted usually about 100 dots to the inch on the final photograph. If comparisons of different lines with one another are required, only the central heights of the figures are necessary, and the topmost dot can be seen at once.

The first application of the method was to the intensity distribution in the lines of the hydrogen spectrum when a condensed discharge was passed through the exciting tube. It was known that with a condensed discharge the lines always appeared much broader, and we concluded that the best method of obtaining information as to the source of the effect was to examine the intensity distribution across the lines. Some remarkable contours were obtained, showing at once a clear distinction between this source of broadening and that associated with the Doppler effect.

The contours associated with the latter should be thin, symmetrical parabolas. Those we found were wedge-shaped, with definite kinks indicating the introduction of new component lines when the condenser was put into the circuit. The wedge shape indicates that the law of decrease of intensity from the centre of a component is exponential, and not the law of error as in the Doppler effect. By measuring the distances between the kinks, and knowing the magnification and a previous calibration of the wedge, all necessary quantitative data of the spectrum line can be calculated. It was possible to show in particular that the separations in wave-length of the components of H_α were those found by Stark when new components were called into being by the existence of an enormous external potential gradient. As we had suspected, the origin of this exceptional broadening under the condensed discharge is the "electric Zeeman effect," the origin of the large electric field on any atom being the close proximity of other charged atoms. We thus have a new means of studying the electrical resolution of spectral lines, more convenient in many ways than the older methods, and capable of much greater generality and accuracy. A large number of observations of the same phenomenon were made also on the spectral lines of helium and lithium, and the correspondence with the Stark effect always held good.

The examination of an individual line has also been applied in the case of an "ordinary" discharge, and has given the first direct proof of the probability distribution of velocities in the radiating atoms of a gas. This distribution was taken as a basis by Lord Rayleigh in the elaboration of a precise method of determining the mass of a radiating atom from the breadth of the spectrum lines—a method applied by Buisson and Fabry with great success, when the breadth is measured by methods of interference of light. Our experiments have defined very closely the circumstances in which this method is practicable, and shown that it fails altogether if condensed discharges are employed. In the ordinary uncondensed discharge under low pressure, however, our contours are very accurately parabolic, which fact can be shown to imply a very rigorous probability law of velocities in the atoms, and no other important source of broadening of lines in these circumstances.

The only other application to an individual line which I shall mention concerns the nature of the Balmer series of hydrogen, long believed to be a diffuse series, with each line consisting of two close components, scarcely separable or not separable at all, with the same interval in frequency between them for every line. We have shown that it is in fact a principal series, with the separations decreasing in a calculable way required by theory, confirming also the value of the separation in H_α given by Fabry and Buisson. The method was to use the neutral wedge in combination with another apparatus of extreme resolving power—in this case a Lummer-Gehrcke plate. We can in this way obtain contours for a pair of close components which cannot be detected visually as a pair, and the actual interval can be deduced by a series of measurements of the joint contour, consisting of two overlapping parabolas. We calculate the position of the vertex of the inner one, and thence the separation, which can, in H_β, be determined within about 0·001 of an Ångström unit. The actual separation in this line is as small as 0·030 Å., and the present method could measure separations accurately, even if they were much smaller.

We pass now from the phenomena of structure and intensity of a single line to those involving a comparison of different lines. Here the behaviour of the plate for different wave-lengths must be dealt with. But it so happens that every plate can be calibrated by throwing on to it, not only the whole spectrum under examination, but also the radiation—a continuous spectrum—from the positive crater of the carbon arc. The energy distribution in this case is known from Wien's law when the temperature of the arc is known, as it is very closely. On the slide you will notice the curious contour bounding this spectrum, largely due to vagaries in the sensitivity of the plate. Above it is the helium spectrum on the same plate. To obtain an absolute scale of intensities down the helium spectrum, independent of all sources of error due to apparatus, we only need to compare the heights of the lines with the corresponding heights directly below them in the carbon-arc spectrum. It is, in fact, logarithms of intensity which the heights represent, and differences of height represent powers of a definite *factor* entering into the intensities, so that the photographs give no visual impression of the enormous differences of intensity which occur. For example, the line of wave-length λ 3888, a principal line in the helium spectrum, appears quite short on the photographs, but is actually the most intense in the spectrum. It happens to be in a region of wave-length where the plate is not sensitive. One of our conclusions is, in fact, that principal series deserve their name even in elements which appeared hitherto to be exceptions, in that they do contain, for the visible region, a preponderant part of the energy radiated

It is not necessary to use the carbon arc in every subsequent experiment. We can, by its means, calibrate the helium spectrum under conditions easily reproduced, and afterwards take this as our standard, especially when the work projected is the variation of the helium spectrum under changing conditions of excitation. Some of the remaining slides indicate the unexpected character of some of these variations. It would not be possible, in this discourse, to give anything like a complete account of the phenomena of this class already investigated, and I shall therefore confine myself to some of those which are most striking. In the first place, we may notice the spectrum of a mixture of hydrogen and helium or neon. The fundamental phenomenon which this method has detected is what we have called "transfer of energy along a series." For instance, in the Balmer series of hydrogen, produced from pure hydrogen under "ordinary" conditions, there is a perfectly definite intensity relation among the lines H_α, H_β, and so on, but in the presence of helium this is disturbed, and the ratios H_β/H_α, H_γ/H_β, are notably increased. In other words, more energy tends to be emitted in the form of the more refrangible rays, at the expense of the less refrangible. It is interesting to speculate as to how far this process can be carried, for its logical extreme is a radiation from hydrogen concentrated at λ 3646, the limit of the Balmer series. We have not, in fact, examined the matter from this point of view.

Neon produces the same effect on the hydrogen spectrum, the first recorded evidence being an experiment of Liveing and Dewar, who found in 1900 that it was possible to observe more of the violet members of the Balmer series when neon was present. We have made quantitative measurements of the effect in various cases, and in one experiment, for instance, the neon was found to make H_β 6/5 as strong, H_γ 9/5 as strong, and H_δ 11/5 as strong in comparison with H_α. But I shall not enter into further numerical detail. A particularly interesting fact is that the effect of a small trace of an impurity is often diametrically opposite to that of a large quantity, and causes the transfer of energy to take place in the opposite direction along the spectrum. There are evidently two quite different mechanisms of interaction possible between the atoms of the two gases—a problem I commend to the chemist for investigation.

But it is not necessary to mix one gas with another in order to produce the energy transfer. It can be achieved otherwise, as some further slides I have here will suffice to show. We have made many measurements of intensity, more especially in the spectrum of pure helium, of the lines from a pure gas as dependent on the part of the tube they arise from, and on the conditions of excitation. We shall only consider one or two of the more interesting results which arise from a comparison of three spectra of helium: (1) the "ordinary" spectrum, or the spectrum given by the capillary of a vacuum tube containing helium at about a millimetre pressure, excited by the discharge from an induction coil without capacity or spark-gap; (2) the bulb spectrum, obtained by putting a small condenser and a very small spark-gap in parallel in the circuit; (3) the capillary spectrum with a spark-gap and a strong condensed discharge. In both (2) and (3) the transfer of energy to the more refrangible members of a series takes place very strongly. In the diffuse series the transferred energy goes in (3) mainly towards increased breadth of the line, but in (2) mainly towards enhanced central intensity—two quite distinct effects. The sharp and principal series show the same transfer quite definitely, though on a smaller scale, and the effect is in these cases more closely confined to enhancement of the central intensity.

The most striking enhancements produced by the condensed discharge in helium occur with the lines λ 4472 and λ 4388, which are precisely the helium lines apt to be found abnormally strongly in the spectra of some of the planetary nebulæ. Some other experiments we have made, on the spectrum of helium at very low pressure, indicate that these lines, together with the line λ 5015 more frequently quoted, are the strongly enhanced lines also in these circumstances. If the two sets of circumstances occur together, λ 5015 is not especially strong, but the others are enhanced for both reasons. We have, in fact, been able to demonstrate that the peculiar "nebular" spectrum of helium could be produced in the laboratory by a combination of the condensed discharge with an extremely low pressure.

I shall not discuss the spectra of gases as dependent, in their intensity relations, on pressure. The time required would be prohibitive, and my object is to indicate the range of work now open to precise investigation, rather than to give any complete account of the phenomena which the method has yet indicated or elucidated. One remark must, however, be made in connection with high-pressure spectra. We investigated the intensity distribution in a helium tube at the extraordinary pressure of 42 mm. Except for the trace of hydrogen which came out of the electrodes during the discharge, the helium was pure. Yet the hydrogen spectrum was nevertheless predominant on the plate, and fourteen members of the Balmer series, instead of the usual six or seven at most, could be seen visually as very sharp lines. This phenomenon incidentally cannot be reconciled with the current quantum theory of the hydrogen spectrum—perhaps not an unexpected fact to those conversant with the hydrogen spectrum. No atomic theory as yet has begun to interpret any of this spectrum except the Balmer series, and many have done this. No spectroscopist can, in fact, accept a theory which can give no hint of the origin of the so-called "secondary spectrum" of hydrogen, known to arise mainly from the atom, and, in the laboratory at least, the most important and extensive part of the spectrum. The elucidation of this spectrum is in many ways the most fundamental problem of physics, and far more fundamental than the Balmer series problem.

Many of the [illegible] problems of interest, which the possession of an acc[illegible] method of intensity determination in spectra enables us to attack, are mainly of astrophysical importance. There may be variations of intensity in the Fraunhofer lines accompanying other more readily perceived solar phenomena, for example, but of more urgent importance is the need for a series of photographic registers of the intensity across the whole spectrum of a new star at different stages of its history. It has not often been possible even to determine the actual number of component radiations, in an apparent broad band with a structure, emitted from such a star—at least with any real certainty. A method which automatically sifts out such bands and gives peaks on a photograph at all the maxima of intensity in the band may well be expected to contribute greatly to the elucidation of the phenomena taking place, which must in any case be totally different from anything known by our terrestrial experience.

The only other class of phenomenon depending for its elucidation on precise measures of intensity in spectrum lines, to which I shall refer with further illustrative slides, is the variation which takes place in the spectrum from a helium tube as we recede from the cathode. The slides serve to show the considerable differences which take place in the distribution of the various series, which are all emitted most strongly at unequal distances from the cathode. One very extraordinary result, shown clearly on the last slide, is the fact that there exists a narrow region of the tube in which the characteristic spark line λ 4686 is emitted simultaneously with the helium band spectrum—a circumstance which necessitates some readjustment of preconceived ideas.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. S. Lees, who was recently appointed University lecturer in thermodynamics, has been re-elected a fellow of St. John's College.

LONDON.—The following appointments have been made in connection with the newly instituted school of librarianship at University College, of which, as already stated, Dr. E. A. Baker is the director:—Bibliography, Mr. A. Esdaile; Cataloguing and Library Routine, Mr. W. R. B. Prideaux; Classification, Mr. W. C. B. Sayers; Public Library Law, Mr. H. W. Fovargue; Library Organisation, Mr. B. M. Headicar; Literary History, Dr. A. W. Chambers; Literary History and Book Selection, Dr. E. A. Baker; Palæography and Archives, Mr. H. Jenkinson; assistant to the director, Mr. L. F. Newcombe. The work of the school is to begin on October 1, but the formal opening will take place on October 8, at 5 o'clock, at the hands of Sir F. G. Kenyon, the director and principal librarian of the British Museum.

DR. S. W. PATTERSON has been appointed director of the Eliza Hall Institute of Research, in connection with the Melbourne Hospital.

MR. W. H. N. JAMES has been appointed head of the electrical engineering department of the Bradford Municipal Technical College.

MR. J. A. R. MARRIOTT has intimated to the vice-chancellor of the University of Oxford his intention to resign the secretaryship to the University Extension Delegacy in March next.

MR. M. H. HADDOCK, of the Doncaster Technical College, has been appointed county mining organiser for Leicestershire, and to have charge of the new mining institute and technical school at Coalville.

IT is proposed to erect a geological building in connection with the University of Wisconsin as a memorial to Dr. C. R. Van Hise, late president of the University, thus bringing together under one roof the departments of geology and mining engineering, and the State and Federal geological surveys.

IN connection with the New York Botanical Garden, which has well-equipped laboratories and an extensive horticultural library, a two-year course in practical gardening has been inaugurated for the purpose of providing careers for convalescent soldiers and sailors and to meet the increasing demand for trained gardeners.

THE following appointments to professorships in the University College of Wales, Aberystwyth, have been made:—*Physics:* Prof. G. Owen (University of New Zealand). *Mathematics:* Prof. W. H. Young (University of Liverpool). *Agriculture:* A. E. Jones (head of the Department of Agriculture, University of Wales). *Geology:* Capt. W. T. Pugh.

THE total number of higher education grants for ex-Service officers and men awarded by the Board of Education now amounts to 5400. The courses in respect of which grants have been awarded include more than 1000 for engineering and technological subjects, between 600 and 700 for classics, philosophy, and literature, and about an equal number for pure science and mathematics.

AN association has been formed in New York, called "The New York Association for the Advancement of Medical Education and Medical Science," the main objects of which are: To improve and amplify the methods of undergraduate teaching; to perfect plans for utilising the clinical material of the city for teaching purposes and to make use of teaching talent now unemployed; to bring about a working affiliation of the medical schools, hospitals, and laboratories, and the public health facilities of the city; and to initiate the establishment of a medical foundation in the city whereby funds may be secured to meet the financial requirements of all forms of medical education and investigation.

THE prospectus of the evening courses in technology at Leeds University for the session 1919–20 is now available. The arrangements announced are subject to revision in consequence of the special circumstances of the present time. Technological courses will be held, it is hoped, in the following departments of the University:—Civil, mechanical, and electrical engineering; coal-mining; textile and leather industries; colour chemistry and dyeing; and geology applied to sanitary and civil engineering. The evening courses in the department of textile industries, to refer in more detail to one department, are primarily designed to meet the requirements of persons who, having already passed through approved courses of study, wish to take up some particular line of research work, or to conduct trade investigations necessitating the use of special equipment.

THE Board of Agriculture and Fisheries announces that, as part of the Government schemes of higher education and training of ex-Service officers, provision is made by the Board for financial assistance for agricultural training by means of (*a*) grants for residential training with selected farmers in England and Wales, and (*b*) agricultural scholarships at approved universities or agricultural colleges in England or Wales. More than 1300 officers have now been approved for grants under (*a*), of whom more than 1000 are actually in training on farms, whilst 65 out of the 100 scholarships available under (*b*) have been awarded. In view of the numerous applications which are still being received, the Board has decided that no application either for a grant for training on a farm or for a scholarship can be entertained by them (1) from any officer who has been demobilised by July 31, 1919, unless the application has been lodged at the appropriate district directorate of the Ministry of Labour on or before August 31, 1919; and (2) from any officer who has not been demobilised by July 31, 1919, unless it is received by December 31, 1919, except in any case in which it can be shown that for military reasons the application could not have been made by that date. All applications from non-demobilised officers should be made as soon as possible. Particulars of these farm-training grants and agricultural scholarships and of the manner of making application are given in the Board's booklet, "Land Settlement in the Mother Country" (L.S.9), which can be obtained either from the Board's offices at 72 Victoria Street, London, S.W.1, or from any district directorate of the Appointments Department, Ministry of Labour. The address of the appropriate district directorate can be ascertained at any post office. Non-demobilised officers should make their applications on Army form Z15 or Navy form S1299. Warrant officers, non-commissioned officers, and men in the ranks of suitable educational promise are also eligible for these grants.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 28.—M. Léon Guignard in the chair.—A. **Laveran** and G. **Franchini**: Some flagellæ of insects obtained in a pure culture, and in particular *Crithidia melophagi*. Details of the technique for obtaining pure cultures are given, and proof of the pathogenic action on mice.—A. **Rateau**: The theory of aeroplanes: application to an example.—R. **de Forcrand** and F. **Taboury**: The stability of the sulphones formed by the iodides of sodium, rubidium, and cæsium. These compounds have the composition $MI+3SO_2$; their dissociation pressures have been measured at $-22{\cdot}5°$ C., $0°$ C., $+9{\cdot}65°$ C., and at $15°$ C., and the results are given in the form of curves.—N. E. **Nörlund**: The polynomials of Euler.—Ch. **Platrier**: The elastic equilibrium of a homogeneous isotropic body of revolution submitted to radial forces either proportional or inversely proportional to the radius.—H. **Abraham** and E. **Bloch**: Recording galvanometers with movable needle.—E. **Brylinski**: The induction reaction of alternators.—E. **Poirson**: A method of secret telephony. The telephonic currents are deformed by periodic interruptions by mechanical means, and the message cannot then be understood. The distorted currents can be rectified at the receiving end by a synchronised apparatus. Experiments have been carried out by this method with success over distances up to 600 km.—J. **Lavaux**: Electrolytic luminescence phenomena presented by certain metallic anodes.—Jh. **Martinet**: The indirubins.—Ch. **Chavanne** and L. J. **Simon**: The critical solution temperatures in aniline of mixtures of hydrocarbons. Application to the analyses of petrols.—H. **Colin** and O. **Liévin**: The spontaneous oxidation of complex organic compounds of cobalt. Alkaline solutions of glycerol or lactic acid containing cobalt absorb oxygen up to a maximum of one atom of oxygen for one atom of cobalt. Other substances, such as mannitol, erythritol, and glucose, under similar conditions absorb oxygen continuously beyond this limit.—P. **Russo**: The Eocene containing phosphate at Oued Zem (western Morocco).—G. **Reboul** and L. **Dunoyer**: The utilisation of temperature for the prediction of barometric variations.—L. **Blaringhem**: Floral variations in the large marguerite, *Leucanthemum vulgare*.—Mme. E. **Bloch**: Anatomical modifications of roots by mechanical action. Compression causes important local modifications, but the general development of the plant is uninfluenced, flowers and fruit remaining normal.—H. **Bierry**: Food ration. The minimum requirements of sugar and of fat.—L. **Vialleton**: The epiphyses and cartilage of conjugation in mammals.—A. **Paillot**: The cytology of the blood of the caterpillars of the Macrolepidoptera.

CALCUTTA.

Asiatic Society of Bengal, July 2.—G. R. **Kaye**: Hindu astronomical deities. This paper deals primarily with the navagraha or nine planets and the planetary cult as it obtains in India. It also refers to a separate solar worship which is traced back to Vedic influences, while it is indicated that the planetary cult proper is possibly of exotic origin. Details of planetary iconography are given which are traced to Paurānic teaching, and are illustrated by photographs of ancient sculptures of the navagraha, and extracts from early texts and inscriptions; and these details are contrasted with the modern practice as exhibited in paddhatis and pañchāṅgas.—H. B. **Hannay**: Note on ancient Romic chronology. The paper indicates the nature of the sothic cycle, starting from zero at the autumnal equinox as understood by the ancient Egyptians; also the nature, length, and practical significance of the Sed and Hunti Hebs, or festivals, as based on that cycle; it shows that all official and other data from monuments, etc., regarding sothic risings, hebs, etc., are placeable in the cycle.

BOOKS RECEIVED.

Board of Agriculture and Fisheries: Guides to Smallholders. No. 2: Dairy Farming under Smallholding Conditions. (London: Board of Agriculture and Fisheries, 1919.) 2*d*.

Experimental Researches carried out in the Department of Glass Technology, University of Sheffield. (Reprinted from the Journal of the Society of Glass Technology.) Pp. iii+178. (Sheffield: The University, n.d.)

The Stars Night by Night: Being the Journal of a Star Gazer. By J. H. Elgie. First published as "Night Skies of a Year," 1910. Pp. xiv+247. (London: C. Arthur Pearson, Ltd., 1919.) 1*s*. 6*d*. net.

Problems of Fertilisation. By Prof. F. R. Lillie. (University of Chicago Science Series.) Pp. xii+278. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1.75 dollars.

A Source Book of Biological Nature-Study. By E. R. Downing. (University of Chicago Nature-Study Series.) Pp. xxi+503. (Chicago: University of Chicago Press; London: Cambridge University Press, 1919.) 3 dollars.

Mining and Manufacture of Fertilising Materials and their Relation to Soils. By S. E. Lloyd. Pp. vi+153. (New York: D. Van Nostrand Co.; London: Crosby Lockwood and Son, 1919.) 9*s*. net.

Mathematics for Collegiate Students of Agriculture and General Science. By Profs. A. M. Kenyon and W. V. Lovitt. Revised edition. Pp. vii+337. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) 10*s*. 6*d*. net.

The Whole Truth about Alcohol. By G. E. Flint. With an introduction by Dr. A. Jacobi. Pp. xii+294. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) 6*s*. net.

Lectures on the Principle of Symmetry and its Applications in all Natural Sciences. By Prof. F. M. Jaeger. Pp. xii+333. (Amsterdam: "Elsevier" Publishing Co.; London: Cambridge University Press, 1917.) 20*s*. net.

Medicine and Nursing. By Sir William Osler. (Essays on Vocation.) Pp. 12. (London: Humphrey Milford; Oxford University Press, 1919.) 6*d*. net.

Annual Reports of the New York State College of Agriculture at Cornell University and the Agricultural Experiment Station, established under the direction of Cornell University, Ithaca, New York. Vol. i., 1914. Pp. clxxxii+1140+13. Vol. i., 1915. Pp. lxxxix+996+8. Vol. i., 1916. Pp. lxxxvii+827+7. Vol. i., 1917. Pp. xc+1183+8. (Ithaca: Published by the University, 1915–18.)

House of Representatives: Library of Congress. Report of the Librarian of Congress and Report of the Superintendent of the Library Building and Grounds for the Fiscal Year ending June 30, 1918. Pp. 191. (Washington: Government Printing Office, 1918.) 45 cents.

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